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Protected Areas in Forest Conservation

Challenges and Opportunities

Edited by

Panayiotis Dimitrakopoulos and Nikoleta Jones

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About the Editors

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Preface to "Protected Areas in Forest Conservation: Challenges and Opportunities"

Forest ecosystems are important habitats for a vast number of species worldwide. These ecosystems are degrading faster than they are regenerating, due to the increased demand for natural resources. In order to protect these ecosystems, the designation of Protected Areas (PAs) has become the primary policy tool for forest conservation. The articles included in this book explore challenges and opportunities within forest PAs, focusing on four main themes. The first theme is current initiatives in forest management across the world, reflecting the efforts of several organizations in halting deforestation. Major challenges are also identified, reflecting the declining rates of forest coverage across the world. A second theme refers to policy planning processes withing existing governance frameworks focusing, in particular, on the level of engagement of local stakeholders. A third theme of the book refers to social equity and how the impacts of forest PAs are distributed among different users. A final theme in the SI refers to potential solutions in order to halt the loss of biodiversity within forest ecosystems. Several directions are proposed by the authors that can be useful for policy makers and practitioners, especially in the context of the 30 by 30 targets.

Panayiotis Dimitrakopoulos, Nikoleta Jones
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Editorial

Protected Areas in Forest Conservation: Challenges and Opportunities

Panayiotis G. Dimitrakopoulos and Nikoleta Jones

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Forest ecosystems are important habitats for a vast number of species worldwide. These ecosystems are degrading faster than they are regenerating, due to the increased demand for natural resources and the continued application of non-sustainable practices by humans. In order to protect these important ecosystems, the designation of protected areas (PAs) has become the primary policy tool for forest conservation and the provision of ecosystem services nowadays. According to the International Union for Conservation of Nature (IUCN) approximately 10% of forests across the world are officially designated as protected areas [1].

The number of forest PAs is expected to significantly increase in the next decade considering the commitment of several governments to protect 30% of land by 2030 (such as the European Union and the United States). This Special Issue (SI) aims to explore challenges and opportunities within forest Pas, focusing on all aspects of the forest policy process, from forest policy planning to implementation. A total of 15 papers are included, ranging from studies focusing on national and regional, to global scales.

Four main themes are explored in the SI. The first theme refers to current initiatives of forest management across the world, reflecting the tremendous efforts by several organizations in halting deforestation. Major challenges have also been identified, reflecting the declining rates of forest coverage across the world [2,3]. A second theme refers to policy planning processes within existing forest governance frameworks focusing, in particular, on the level of engagement and empowerment of local stakeholders. The benefits of including a variety of stakeholders in decision-making process has long been underlined in the literature [4]. In this SI, several studies focus on this topic, identifying the urgent need for further improvements based on the principles of inclusivity and diversity while highlighting the important role of trust in specific entities. In close relation to this topic, a third theme of the SI refers to social equity, and in particular, how the impacts of forest PAs are distributed among different users [5]. The need to accurately assess the social impacts of PAs has been gaining momentum in the relevant literature during recent years [6]. How these impacts are distributed will influence social equity issues and ultimately the governance of PAs [7]. Several papers in this SI highlight issues with social equity and how this has obstructed the effectiveness of forest PAs. A final theme in the SI refers to potential solutions aimed at halting the loss of biodiversity within forest ecosystems. Several directions are proposed by the SI authors which can be useful for policy makers and practitioners, especially in the context of the 30 by 30 targets.

As regards the first theme of the SI, on current policy practices, a variety of initiatives in forest management across different regions are presented. In the Misuku Hills in Malawi, for example, a variety of policies have been adopted following international standards to increase local control and promote community-based management in forests. Despite the lack of implementation and enforcement of the proposed policies, forest conservation activities (e.g., enhancing tree planting and natural regeneration, forest protection at a

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catchment scale to conserve biological and cultural diversity, forest resources extraction regulation, promotion of beekeeping) indicate that rural communities have the potential to take over the management of customary and public forest lands [8]. In Tanzania, Gizachew et al. [9] found that most PAs were effective in reducing deforestation rates, even if there were important pressures in their surrounding lands. In Europe, Bujoczek et al. [10] found that the quality of forest habitats under strict and active protected status in the regions was enhanced relative to that of managed forests. In Serbia, Maruna et al. [11] describe the historical context of forest planning and management processes and discuss how the concept of land use planning for urban forest protection was established in the country through the critical re-assessment of the institutional structure of land use planning in a post-socialist environment. Finally, in the Western Terai Region of Nepal, timber harvesting increased substantially three years after scientific forest management implementation in community forestry systems, even if mean timber volume was reduced for community forest users [12].

Despite the increase in policy initiatives such as those mentioned above, meeting biodiversity conservation targets remains problematic, as many areas face continuous pressures. In the study by Wade et al. [13] presented in this SI, the authors estimated global trends in tree cover loss between 2001 and 2018. They found a remarkable loss of forested land inside PAs, and a similar pattern in temporal trends in forest loss in PAs compared to those of global forest loss. These challenges are expected to be further aggravated by the COVID-19 pandemic. The actual long-term impacts of the pandemic on environmental and socio-economic issues are expected to be extremely complex and will take several years to be thoroughly explored. In this SI, a collaborative study by researchers and practitioners from European PAs is presented [14], with some initial findings on how COVID-19 has caused an increase in PA visitors, accompanied by an increase in irresponsible behaviors bringing additional challenges for management authorities.

The second theme of this SI analyzes issues of decision-making processes. Laktić et al. [15] analyze links and relations between different stakeholders during participatory planning processes of the Natura 2000 management program in Slovenia. A main direction proposed by the authors is that groups of stakeholders from different institutions and sectors must be further empowered in order to be included in such processes. Similar issues emerged in the study by Kimengsi et al. [16] in Nepal. The authors highlighted the need to include underprivileged groups in co-management processes in the Annapurna Conservation Area who remain highly motivated to participate despite the current top-down approach [16]. Furthermore, in the study by Pezdevšek Malovrh et al. [17] the authors identify a lack of stakeholder engagement and participation as one of the main parameters negatively influencing the implementation of conservation policies in several EU and non-EU countries. In close relation to engagement and empowerment, trust in specific entities and organizations is another important factor that needs to be taken into consideration. For example, in the study by Referowska-Chodak [18] in Poland, the authors found that levels of trust towards foresters were high, leading to a favorable opinion for this specific group to have a more leading role in nature conservation policies.

The third theme of the SI refers to issues of social equity in forest PAs. Forests provide a variety of goods to local communities such as timber, food, fuel, and pharmaceutical products. Nevertheless, the equitable distribution of benefits derived from forests among users remains unclear. For example, in a study conducted in the Western Terai Region of Nepal, most of produced timber was distributed among middle- and high-class groups, while poor households had very limited access to these resources [12]. In Mount Cameroon National Park, Akonwi Nebasifu and Majory Atong [19] found, through an ethnographic study, that state regulations restricted—to some extent—access to natural resources for local communities. However, the authors identified alternative unofficial pathways, which allowed customary practices to take place, and access to resources was possible for local communities via informal processes.

Considering the challenges identified in the previous three topics and the ambitious 30 by 30 target, it is crucial for the Editors of this SI to define a final theme which focuses on potential solutions and future policy directions. Several suggestions have been made in the papers constituting the SI, focusing on ecological and socio-economic aspects. Ecological connectivity is a key point for future policy directions. Common management activities aimed at reducing high deforestation rates in large PAs and connecting these areas through restored forest corridors at the landscape level were proposed as a main priority in the study by Gizachew et al. [9] in Tanzania. Connectivity of forests with corridors was also proposed to promote long-term persistence of sacred church forests in northern Ethiopia by increasing species dispersal rates and reducing human disturbance within forests [20]. Restoration of the structure and composition of remaining forest habitats and reforestation were proposed to be adopted in the Mississippi Alluvial Valley, as a small percentage of the forest patch area was currently protected [21].

Following a more holistic approach, Ola and Benjamin [22] demonstrated in Western Africa, that both environmental protection and economic goals must be combined before effective environmental protection can take place. However, poverty alleviation targets must not be completely ignored, as many West Africans rely on forest and catchment resources to support their livelihoods [19,22]. Finally, a common proposal in several papers of the SI, which brings us back to the second theme of the SI, is that forest conservation needs to become more inclusive and diverse by incorporating a number of local stakeholders in decision making processes [15–18].

As a concluding remark, this SI captures key debates in the forest management literature, especially in relation to PAs and how the management of these areas can be improved. The next decade is expected to be particularly important for biodiversity conservation, considering the commitment of several nations to the ambitious target of protecting 30% of land and 30% of water by 2030. The evidence provided in this SI is useful for practitioners, policy-makers and researchers working towards these targets. A broad conclusion in this SI is that future policies in forest management need to focus on the issues of social equity, empowerment and governance in order to halt the loss of biodiversity and achieve the more sustainable co-existence of people and forests.

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References

1. Dudley, N.; Phillips, A. *Forests and Protected Areas: Guidance on the Use of the IUCN Protected Area Management Categories*; IUCN: Gland, Switzerland; Cambridge, UK, 2006; p. 58.
2. Keenan, R.J.; Reams, G.A.; Achard, F.; de Freitas, J.V.; Grainger, A.; Lindquist, E. Dynamics of global forest area: Results from the FAO global forest resources assessment. *For. Ecol. Manag.* **2015**, *352*, 9–20. [CrossRef]
3. Wolf, C.; Levi, T.; Ripple, W.J.; Zárrate-Charry, D.A.; Betts, M.G. A forest loss report card for the world's protected areas. *Nature Ecol. Evol.* **2021**. [CrossRef] [PubMed]
4. Berkes, F. Evolution of co-management: Role of knowledge generation, bridging organizations and social learning. *J. Environ. Manag.* **2009**, *90*, 1692–1702. [CrossRef] [PubMed]
5. Jones, N.; Graziano, M.; Dimitrakopoulos, P.G. Social impacts of European Protected Areas and policy recommendations. *Environ. Sci. Policy* **2020**, *112*, 134–140. [CrossRef] [PubMed]
6. Jones, N.; McGinlay, J.; Dimitrakopoulos, P.G. Improving social impact assessment of Protected Areas: A review of the literature and directions for future research. *Environ. Impact Asses.* **2017**, *64*, 1–7. [CrossRef]
7. Ward, C.; Stringer, L.C.; Holmes, G. Protected area co-management and perceived livelihood impacts. *J. Environ. Manag.* **2018**, *228*, 1–12. [CrossRef]
8. Coutts, C.; Holmes, T.; Jackson, A. Forestry Policy, Conservation Activities, and Ecosystem Services in the Remote Misuku Hills of Malawi. *Forests* **2019**, *10*, 1056. [CrossRef]

9. Gizachew, B.; Rizzi, J.; Shirima, D.D.; Zahabu, E. Deforestation and Connectivity among Protected Areas of Tanzania. *Forests* **2020**, *11*, 170. [CrossRef]
10. Bujoczek, L.; Zięba, S.; Bujoczek, M. Variation in Deadwood Microsites in Areas Designated under the Habitats Directive (Natura 2000). *Forests* **2020**, *11*, 486. [CrossRef]
11. Maruna, M.; Crnčević, T.; Milojević, M.P. The Institutional Structure of Land Use Planning for Urban Forest Protection in the Post-Socialist Transition Environment: Serbian Experiences. *Forests* **2019**, *10*, 560. [CrossRef]
12. Bhusal, P.; Karki, P.; Kimengsi, J.N. Timber Distribution Dynamics in Scientifically Managed Community Forests: Learning from Nepal. *Forests* **2020**, *11*, 1032. [CrossRef]
13. Wade, C.M.; Austin, K.G.; Cajka, J.; Lapidus, D.; Everett, K.H.; Galperin, D.; Maynard, R.; Sobel, A. What Is Threatening Forests in Protected Areas? A Global Assessment of Deforestation in Protected Areas, 2001–2018. *Forests* **2020**, *11*, 539. [CrossRef] [PubMed]
14. McGinlay, J.; Gkoumas, V.; Holtvoeth, J.; Fuertes, R.F.A.; Bazhenova, E.; Benzoni, A.; Botsch, K.; Martel, C.C.; Sánchez, C.C.; Cervera, I.; et al. The Impact of COVID-19 on the Management of European Protected Areas and Policy Implications. *Forests* **2020**, *11*, 1214. [CrossRef]
15. Laktić, T.; Žiberna, A.; Kogovšek, T.; Pezdevšek Malovrh, Š. Stakeholders' Social Network in the Participatory Process of Formulation of Natura 2000 Management Programme in Slovenia. *Forests* **2020**, *11*, 332. [CrossRef]
16. Kimengsi, J.N.; Bhusal, P.; Aryal, A.; Fernandez, M.V.B.C.; Owusu, R.; Chaudhary, A.; Nielsen, W. What (De)Motivates Forest Users' Participation in Co-Management? Evidence from Nepal. *Forests* **2019**, *10*, 512. [CrossRef]
17. Pezdevšek Malovrh, Š.; Paletto, A.; Posavec, S.; Dobšinská, Z.; Đorđević, I.; Marić, B.; Avdibegović, M.; Kitchoukov, E.; Stijović, A.; Trajkov, P.; et al. Evaluation of the Operational Environment Factors of Nature Conservation Policy Implementation: Cases of Selected EU and Non-EU Countries. *Forests* **2019**, *10*, 1099. [CrossRef]
18. Referowska-Chodak, E. The Organization of Nature Conservation in State-Owned Forests in Poland and Expectations of Polish Stakeholders. *Forests* **2020**, *11*, 796. [CrossRef]
19. Akonwi Nebasifu, A.; Majory Atong, N. Land Use and Access in Protected Areas: A Hunter's View of Flexibility. *Forests* **2020**, *11*, 481. [CrossRef]
20. Woods, C.L.; Bitew Mekonnen, A.; Baez-Schon, M.; Thomas, R.; Scull, P.; Abraha Tsegay, B.; Cardelús, C.L. Tree Community Composition and Dispersal Syndrome Vary with Human Disturbance in Sacred Church Forests in Ethiopia. *Forests* **2020**, *11*, 1082. [CrossRef]
21. Elliott, A.B.; Mini, A.E.; McKnight, S.K.; Twedt, D.J. Conservation–Protection of Forests for Wildlife in the Mississippi Alluvial Valley. *Forests* **2020**, *11*, 75. [CrossRef]
22. Ola, O.; Benjamin, E. Preserving Biodiversity and Ecosystem Services in West African Forest, Watersheds, and Wetlands: A Review of Incentives. *Forests* **2019**, *10*, 479. [CrossRef]

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Forestry Policy, Conservation Activities, and Ecosystem Services in the Remote Misuku Hills of Malawi

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Abstract: Research Highlights: Most of Malawi's land area has been deforested; however, expansive indigenous forests remain in the remote Misuku Hills in Malawi's northern region. Despite its conservation potential, this region of Malawi has been overlooked in forestry conservation research. Background and Objectives: The Misuku Hills is one the most floristically diverse regions in Malawi, but this region is facing similar pressures and forestry policy enforcement challenges that drive deforestation of other regions. This study therefore addresses the questions: What are the forestry policy challenges and opportunities for forest conservation in Malawi? What conservation activities are taking place in the Misuku Hills in support of these policies? What ecosystem services are residents using that are in need of protection? Materials and Methods: A comprehensive inventory and review of the national forest policies and current programs in the Misuku Hills region was compiled through document reviews and communications with governmental and non-governmental stakeholders. A Photovoice exercise was conducted with residents of Chikutu village to create an inventory of resident-identified ecosystem services. Results: While there is an impressive array of policies in place to protect the forests of Malawi, there is little institutionalization or enforcement of these policies. There have been funded conservation programs in the Misuku Hills, but these have been limited to the areas surrounding the three small public forest reserves. The Photovoice exercise revealed that residents rely on an abundance of forest ecosystem services to support their livelihoods, including food, medicine, and timber products. Conclusions: The challenges to conserving forests and their ecosystem services are being met at a local level in a variety of creative ways in the Misuku Hills (e.g., tree planting, beekeeping) that could be used as community-based models for other areas in Africa and elsewhere, where people depend directly on these services to meet daily needs.

Keywords: forests; environment; Malawi; ecosystem services; Photovoice; conservation; policy; community-based forest management; participatory forest management

1. Introduction

1.1. Rates of Deforestation in Malawi

Deforestation rates in the tropics are increasing after a promising lag supported by conservation efforts and good governance measures during the 1990s and early 2000s [1]. Increased deforestation is particularly concerning in Africa, where land is rapidly converted to support growing populations and expansion of small-scale and subsistence agriculture [2–4]. In the southeast African nation of Malawi, concerns are growing around the preservation of forest resources, the livelihoods dependent on these resources, and the dynamics which threaten their viability. The most methodologically forthcoming

and rigorous estimate available of the forested land area in Malawi reveals that 26.8% of this small African country is forested (Figure 1), and Malawi experienced a 1.6% aggregated loss of tree cover between 1990 and 2010 (1.4% 1990–2000; 0.2% 2000–2010) [5]. The 1.6% total forest loss over this 20-year period is almost completely explained by the equivalent expansion of agricultural land [5]. Most of the agricultural expansion in Malawi has happened on customary land (defined below), outside the jurisdiction of government-controlled parks and reserves [6].

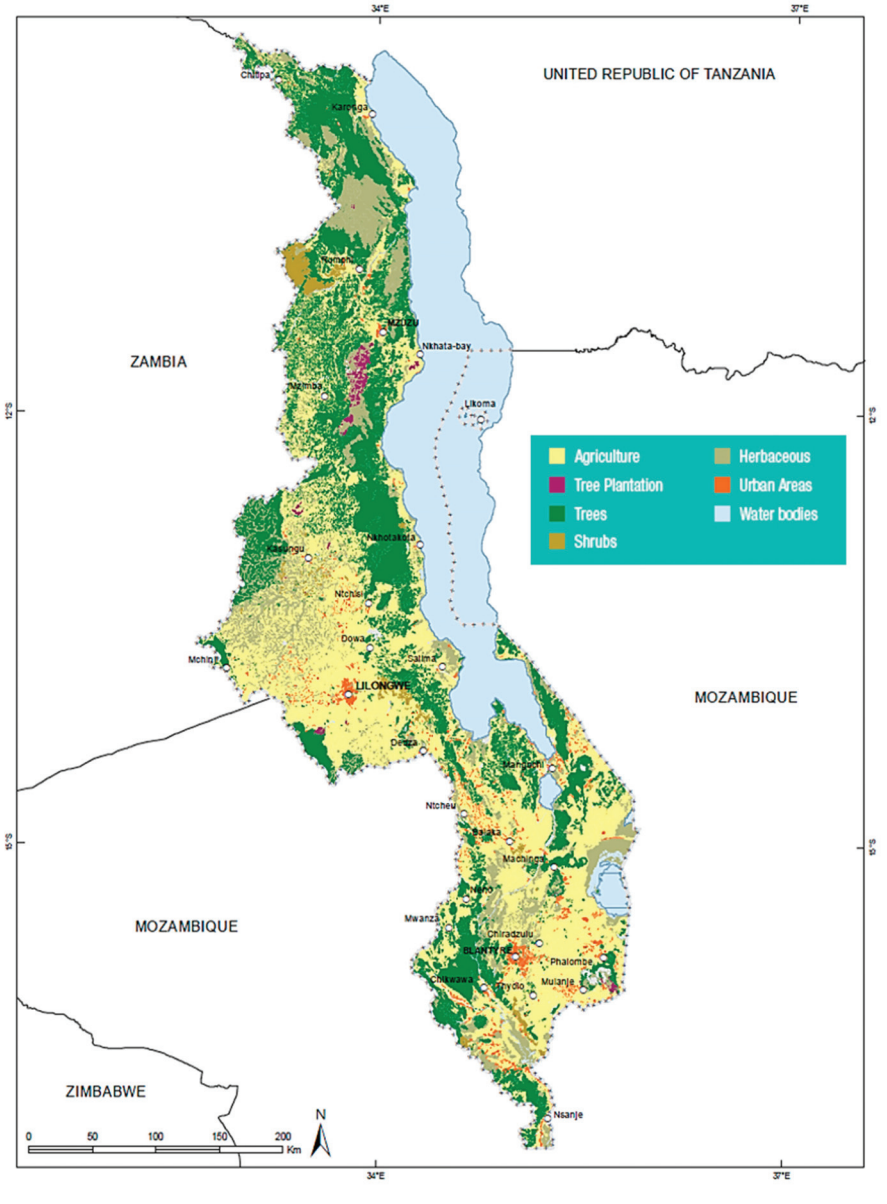


Figure 1. Vegetation map of Malawi. Source: Adapted from FAO (2013).

There are many conflicting estimates of Malawi's forest cover, land tenure regimes in forested areas, and overall deforestation rates. These discrepancies and their potential implications are presented in Appendix A. The deforestation rates above are much less grave than other widely cited estimates. Nonetheless, deforestation continues and the persistent drivers of deforestation provide reason to believe that its consequences will continue to threaten the livelihoods of Malawians who are heavily dependent on forest ecosystem services [7].

The available estimates for the land tenure of forested areas indicate a nearly equal distribution in national parks and game reserves, forest reserves, and on customary land [6,8]. National parks, game reserves, and forest reserves are public, government-controlled lands. Customary land is under Tradition Authority, an indigenous geo-political and socio-economic jurisdiction with customary sovereignty under authority of a Chief [9]. Essentially, all land that is not public or privately owned is customary, and customary land accounts for approximately 85% of the total land area in Malawi [10].

1.2. Drivers of Deforestation

The main drivers of deforestation in Malawi are a rapidly growing and extremely poor population converting forested land to support small-scale subsistence agriculture for food provisioning and income [11] and using wood as a primary energy source.

First, population. The total population of Malawi grew by 35% between 2008 (13,029,498) and 2018 (17,563,749). While this may seem startling, the gross increase in population equates to a current population density of 186 persons/km^2 in this comparatively small African country [12]. There are inconsistencies in various country rankings of population density, but 186 persons/km^2 currently places Malawi at approximately the 75th most densely populated country in the world, still far less dense than other small African countries (e.g., Rwanda, Burundi, The Gambia), but also less dense than some comparatively larger African countries (e.g., Nigeria, Uganda). A major difference between Malawi is that 84% of the population resides in rural areas, making Malawi one of the least urbanized countries in Africa [12,13]. The population is dispersed, placing greater pressures on the entirety of the landscape. Population density in Malawi has been shown to be a significant socio-economic explanatory variable of deforestation in Malawi [14], and population growth is a perceived underlying driver of land use and land cover change in Malawi [15].

Second, agriculture. Malawi's economy and the livelihood of Malawians are heavily dependent on agriculture, which "accounts for about 36% of the Gross Domestic Product (GDP), 87% of the total employment, and supplies more than 65% of the manufacturing sector's raw materials" [13] (p. 4). A 2009 report estimates an expansion of agriculture by 31% between 1975 and 1990, with the majority of expansion coming through the clearing of indigenous forest and woodlands. The report attributes these changes to the need to feed a rapidly growing population and desires to promote economic growth through expansion of agriculture production [7]. Indigenous forests on customary land have been the main source of additional agricultural land [16]. The overwhelmingly rural population derives its livelihood from small land holdings of 0.5–2 ha per household, but it is not agriculture on these small landholdings per se that is the threat to forests, but rather "poor husbandry techniques in the absence of alternative economic opportunities" [7] (Preface).

Third, poverty. Poverty is a critical and compounding factor which exacerbates the pressures of a growing population primarily dependent on subsistence agriculture. Malawi is the second poorest county in the world, as measured by annual per capita income [17]. A lack of income-generating opportunities leads many Malawians to extract natural resources directly from the immediate environment, both for daily household use and to sell for profit. Despite positive attitudes towards tree planting [18,19] and awareness of the negative consequences of a lack of social support for deforestation—making the intention to cut down forest trees generally low—extreme poverty and a lack of alternative income opportunities [20] continue to fuel deforestation.

Fourth, energy. The extraction of resources from forests is the main source of many essential products for the rural poor, most notably fuelwood. In fact, "over 90% of the energy demands of the

country for domestic and industrial use are met from wood energy" [7] (p. 2). Trade in firewood and charcoal is the primary source of income for many rural poor and the only form of cooking fuel for 99% of the population [21].

Other extractive industries supported by forest resources also include poles and timber for home construction and hand tools, as well as non-timber forest products such as thatch, mushrooms, caterpillars, bushmeat, beeswax, medicinal plants, and materials for handicrafts [13,16]. Malawi also has a large pool (in terms of both diversity and quantity) of indigenous fruit tree resources [22–24]. These forest food "resources are an insurance against hunger and malnutrition. They provide much needed dietary diversity which avails both macro and micro nutrients necessary for good health" [13] (p. 30).

Although these goods are "free" to Malawians with access to forests, monetary value can be assigned to these products based on what a person without access will pay for it. Using this method, it was estimated that an annual supply of firewood equated to almost half a year's supply of maize (or 416 kg using 1996 prices) for a household, and an annual supply of poles equated to 120 days' supply of maize [25] (as cited in [13]). Using data from the National Statistical Office of Malawi, the Forestry Research Institute reports that "studies on micro-enterprises in Malawi have shown that most people who sell forest produce do so as individuals or as small family operations, start off with little, if any, capital outlay, produce small quantities of mainly unprocessed or crudely processed goods and make little profit" [13] (p. 33). As a result, little to no profit or savings are generated, as monies earned are used to meet immediate domestic needs rather than used for savings and/or investments.

On a national level, forests account for 12% of Malawi's natural capital [26]. A highly conservative underestimate is that Malawi's forests contribute 6.2% of GDP [27]. Another more comprehensive evaluation reveals that forests contribute 8% of GDP with a substantial total economic value and enormous economic contribution to livelihoods [26]. These underestimates do not take into account many environmental protection, goods, and ecosystem services provided by forests. Taking a small subset of the services provided by soil, forests, fisheries, and wildlife into account, it has been estimated that Malawi's GDP would be higher by 5.3% per year (2007 prices) were it not for unsustainable use of these resources. The discounted cost of damage over a 10-year period equated to 21.4% (in 2010) of GDP [28]. Over half (11%) of this 21.4% value was attributed to forests with only wood products, flood prevention, and air pollution services taken into account. The unsustainable use of forest resources and loss of economic value is negatively impacting Malawi's growth, where resources are limited and even small gains in natural and economic resources could have significant impacts on people's ability to meet basic needs.

1.3. Response to Deforestation

The national government recognizes the crucial regulating services (e.g., climate regulation, moderation of extreme weather, soil erosion, and pollination), habitat/supporting services (e.g., biodiversity), and cultural services (e.g., tourism) of forests [29]. Citizens are more aware of the provisioning services such as food, raw materials, and medicine that are acutely tied to their daily lives, but there is increasing awareness of the regulating services forests provide to maintain supplies of fresh water, prevent flooding, protect crops from wind damage, stabilize soil, and avoid excessive siltation of riverbeds downstream.

The largest threat to these services is occurring on customary lands, where ownership or usufruct rights (rights held by a member of the land-holding community in customary freehold [9]) "rest with individual villagers or group of individuals who the customary authority have appointed or delegated temporary ownership to, otherwise all authority rests with the customary leaders" [13] (p. 25). These lands are controlled by people residing in villages and the Traditional Authorities who oversee land tenure and land disputes on customary lands. Little research has been conducted at the local level on forests located on customary land [30]. In line with Malawi's move towards decentralization and community-based forestry, local level interventions are key to understanding country-level trends and policies that address deforestation [31].

1.4. The Misuku Hills Study

The Misuku Hills of Malawi have been recognized as one of the world's Key Biodiversity Areas [32]. There are three small forest reserves in the Misuku Hills, but it is the largest contiguous area of remaining forest in Malawi on customary land outside of public parks and forest reserves. This is most notably due to its comparatively low population. To maintain the integrity of this slowly dwindling forest, the policies that govern forest conservation must be understood for their applicability in this region and their pertinence to local control of forest resources and management of ecosystem services. There is a great need for local ecosystem service assessments in Africa that capture local resources and needs [33].

There is a long history of forestry conservation in Malawi, and the most recent forestry policies recognize deforestation as a cross-cutting issue with various drivers and impacts on a myriad of development goals. In line with the purpose of this special issue of *Forests*, we explore the policies aimed at forest protection in Malawi and discuss the challenges and opportunities faced in their implementation nationally and locally in the Misuku Hills bioregion. The research activities of this inter-disciplinary study are therefore threefold. First, an assessment of national forestry policies was conducted to determine how Malawi's forestry policies have evolved and how current policies aim to guide forestry conservation activities. Second, an inventory of the forestry conservation activities in the Misuku Hills region was conducted to determine how these policies are being applied to protect one of Malawi's last remaining indigenous forests on customary land. Third, an ecosystem services assessment was conducted using a Photovoice methodology in a remote village on customary land in the Misuku Hills.

The results reveal that Malawi has enacted a plethora of forestry policies that have been developed to meet international standards. While these policies should be lauded, the case of the Misuku Hills reveals that the full potential of these policies is underwhelming due to weak implementation and shortcomings in empowering communities to practice local control. The ecosystem services inventory conducted in Chikutu village reveals that community members have extensive knowledge of forest resources, and these resources are still readily available to the indigenous communities. These findings underscore the important role that community-based and indigenous land tenure regimes play in advancing national forest policies. The paper begins with a description of the materials and methods of analysis, followed by the results on national and local forest conservation policies and practices. The paper concludes with an examination of implications for forest management in the Misuku Hills forested region and proposals for future research.

2. Materials and Methods

2.1. Malawi Forestry Policy Evolution and Analysis

The search and retrieval of Malawi government forestry policy and guideline documents was conducted online and through personal communications with government officials, representatives of non-governmental organizations (NGO), and faculty at Mzuzu University. Policy document retrieval was further guided by a previous outline of forestry policies and by contemporary policies and guidelines that referenced previous policies. The search was focused on policies and guidelines directly related to forestry, although policies that included forestry conservation (e.g., environmental policy) were also reviewed. When the search for documents began to reveal no new information, and the body of policies could be considered comprehensive and complete, the policies were then reviewed for changes that have occurred over time. Some of the changes to previous policies were noted in the subsequent policies themselves. The evaluation of policy changes took into account changes in the form of government in Malawi and advancements and best practices in international forestry policies.

2.2. Conservation Activity Inventory in the Misuku Hills Forested Region

2.2.1. The Misuku Hills Forested Region Study Area

The Misuku Hills are part of the southern end and western branch of the East African Rift System within the Southern Rift Montane bioregion [34] and the Miombo woodlands ecoregion. The Misuku Hills forest, like other remaining forests in Malawi, is in upland and hilly areas and along the rift valley scarps [7].

The Miombo woodlands of the Misuku Hills are the most floristically diverse in the country [35], encompassing the vegetative/biotic communities of open canopy woodland of hills and scarps (*Brachystegia spp.*), open canopy woodland of plateau (*Brachystegia/Julbernardia/Isoberlinia*), closed canopy woodland of wetter uplands (tall *Brachystegia spp.*), and montane evergreen forest [36]. Within the Misuku Hills, there are three public forest reserves (FR): Matipa FR (1055 ha), Mughese FR (771 ha), and Wilindi FR (937 ha), all established in 1948 [6]. These forest reserves are largely composed of montane evergreen forest. The reserve land area comprises only a small fraction of the larger contiguous forest referred to in this study as the Misuku Hills forested region (MHFR). The MHFR spans a number of political and administrative boundaries, and data from these administrative units are presented below to provide context to the MHFR study area (Figure 2).

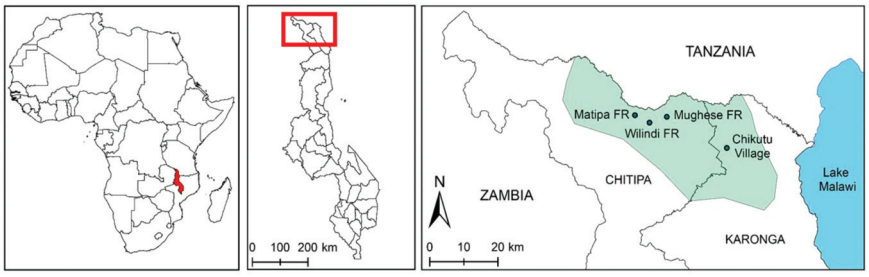


Figure 2. Location of the Misuku Hills forested region (MHFR) study area.

The area commonly identified as the Misuku Hills is within the administrative territory of Traditional Authority (TA) Mwenemisuku, but, from a biotic perspective, the contiguous forest of the MHFR spans two TAs and the country borders of Malawi and Tanzania (where they are referred to as the Umalila mountains). The focus of this study is confined to MHFR in Malawi.

Malawi is divided into three administrative regions (north, central, south), and the MHFR is one the most remote areas in the northern region of Malawi, where the most dramatic and highest concentration of hills and scarps are found. Since the country's independence in 1964, there has been a gradual migration of people to the northern region [37], but the effects of this migration on development in the region have been minimal. Only 13% (2,286,960) of the total population of Malawi lives in the northern region [12]. Not surprisingly, the northern region remains by far the most forested, with 48.7% tree cover as compared to the central (26.3%) and south (27.3%) regions [5]. Compared to Malawi's two other regions, the northern region has over double the rate of those reporting use of forest resources from their own land (9.9%), the highest proportion of forest resources use from communal land (18.2%), and the lowest proportion of those buying forest products from someone else (44.7%) [38]. Table 1 depicts the proportion of use and source of forest products in these two districts [38].

Table 1. Proportion and source of forest resources in study area districts.

District	Proportion of Enterprises Selling Forest Products	Own Land	Forest/Wild Park Reserve	Communal Land	Purchased from Someone
Chitipa	11.5	12.2	37.8	8.9	41.2
Karonga	12.3	15.0	27.7	41.6	15.7

Malawi's three regions are divided into a number of districts. The MHFR spans the borders of two of the seven districts within the northern region, Chitipa and Karonga. The population density of Chitipa (54/km^2) and Karonga (107/km^2) are both well below the country average of 186/km^2 [12]. This population density estimate for Karonga exaggerates the population density in its forested areas. Karonga is topographically unique, as it is split north to south between coastal lake plains to the east and hills and scarps to the west. The overwhelming majority of the population resides in the lake plains. The population density in the hills and scarps of Karonga is similar to that of Chitipa district.

It is difficult to accurately estimate the population of the MHFR study area, as it overlaps census units, but most of the MHFR is within the administrative unit of Traditional Authority (TA) Mwenemisuku. Field observations in the area of the MHFR outside TA Mwenemisuku confirm that it is very lightly inhabited. In 2018, the population of TA Mwenemisuku was estimated at 25,816 [12]. Strangely, this is approximately 2000 fewer people than the 2008 census estimate. The land area of TAs was not available, but TA Mwenemisuku is similar in size to other TAs in Chitipa. Since its population is about average for TAs in the district, its population density is likely very close to the very low population density for the district (54/km^2). A hot spot of change analysis reveals that while some districts in the northern region experienced significant forest and natural vegetation loss from 1990–2010, Chitipa and Karonga experienced no dramatic change [5].

Mapping these proportions allows us to view the MHFR as not conforming to administrative boundaries, and reveals that it has the largest contiguous area of community forest and woodlot opportunities in the country, high forest management of natural forest opportunities, and high priority for food security and biodiversity intervention [39]. This leads us to examine the interventions that have been conducted in the MHFR to pursue these opportunities and protect its forests.

2.2.2. Conservation Activities Inventory

The conservation activities inventory aims to remedy the lack of accurate accounting of the past and current conservation activities in the MHFR. The search for forestry conservation activities in support of forestry policies was conducted through an online search and through personal communications with government officials, representatives of various conservation-oriented NGOs, and faculty at academic institutions in Malawi and the United States (US). The inventory of conservation activities in the Misuku Hills was further guided by a historical summary of community-based forest management activities nationwide [40]. The most insightful sources of information came from NGO project reports and personal communications with representatives of NGOs and sponsoring agencies who have operated in the Misuku Hills, as well as a current US Peace Corps Volunteer who lives and works in the Misuku Hills performing environmental conservation activities.

Since the vast majority of the land area of MHFR is on customary land and not in the montane evergreen public forest reserves, an ecosystem services assessment was conducted in the representative village on customary land to determine the extent and variety of services reaped by residents in these typically overlooked areas within the MHFR.

2.3. Chikutu Village Ecosystem Services Inventory

Chikutu village is located in the MHFR to the east of public forest reserves and just outside the eastern boundary of TA Mwenemisiku in TA Kilupula in Karonga district. TA Kilupula, like the aforementioned Karonga district in general, is split north to south between coastal lake plains and hills

and scarps. Chikutu is located deep in the lightly populated hills and scarps to the west of the lake plains. It is accessible by an unimproved, and at times impassible, dirt road. In ideal conditions it takes a 4 × 4 capable vehicle or motorbike approximately two hours to scale the hills to reach Chikutu from the main M1 highway paralleling the lake shore to the east.

This area around Chikutu is less populated than the area around the forest reserves to the west and represents one of the last hideouts in Malawi, where residents could directly reap ecosystem services from largely intact natural forests. If there is anywhere in Malawi where Malawians can still reap an array of benefits from a relatively intact natural forest on customary land, this is the place. It provides a lesson for the larger MHFR, the vast majority of which is on customary land.

The unique topographical and population dichotomy of northern Karonga makes Chikutu an interesting case. Chikutu, and other villages in the area, could be facing pressure to deliver forest goods to the much more highly populated areas in the coastal plains that are almost exclusively agricultural lands with greatly diminished forest resources.

Google Maps® designates this area as the Matipa Complex Forest. It is not clear how this designation was made, as there is no discernable local knowledge of this designation or reference to it in any forestry policy or conservation plans.

2.3.1. Ecosystem Services Assessment Photovoice Exercise

Photovoice is a praxis-based qualitative tool that enables participants to record, reflect, and produce knowledge on their community needs, experiences, strengths, and concerns through specified photographic techniques [41–43]. Participants use photography to represent their perspectives and lived experiences on a given topic and collectively discuss and analyze photos to inform community projects and advocate for their interests. Regarded as a tool to give agency to disempowered and marginalized groups in transforming their realities, Photovoice has been used in several disciplines, such as urban planning, education, public health, and sociology [44–49]. Because of the wide appeal of participatory photographic methods, it has been used with children, youth, and adults in various settings, ranging from youth programs, women's groups and organizations, to public health organizations [50–53].

In the context of this research project, Photovoice was used to provide deeper insight into the context of rural resource dependent communities and the ways in which groups derive value from their relationships with forest ecosystems. Few studies on ecosystem services assessments have utilized Photovoice as a research method [54,55], which makes this work unique and fills a significant gap in the literature.

Prior to conducting the Photovoice ecosystem services assessment, a number of necessary permissions were obtained. The Principal Investigator (PI) applied for and was granted the necessary permission to conduct research in Malawi from the National Committee on Research in the Social Sciences and Humanities under the Malawi National Commission for Science and Technology (Ref No: NCST/RTT/2/6). Once on site, the PI and co-PI met with TA Kilupula to inform him of our activities and seek his permission, which was granted. TA Kilupula oversees 16 Group Village Headmen (GVH), and hundreds of Village Headmen/women in northern Karonga, including the GVH in Chikutu. The PI and co-PI also informed the GVH in Chikutu of our arrival date and research prior to the data collection visit.

The co-PI is a Malawian who has lived in northern Karonga his entire life. He is an extremely well-respected member of the community, is fluent in the handful of languages spoken in the region, and is an employee of the Ministry of Health of Malawi. The PI has known the co-PI for nearly 20 years, two of which (1998–2000) were spent working together at a rural hospital in northern Karonga. Prior to fieldwork, the PI and co-PI met many times in Malawi to discuss the purpose of the study and to refine the Photovoice methods and procedures.

Photovoice involved community members photographing the lands and natural elements around their villages that they perceived as essential to their health and livelihood. The exercise replicated the Misuku Hills biodiversity and livelihood transect walk conducted in 2015 with Village Natural Resource Management Committee (VNRMC) members in the area around the forest reserves [56],

but added photographs of ecosystem services identified by residents. The assessment was conducted throughout the mid–late summer months when many resources are in season and available, but data on resources not available during these months were also collected.

The Photovoice methodology was applied to the ecosystem services assessment to overcome the limitations in articulation with text-based research and the asymmetrical power balance inherent in other research techniques. While allowing research participants to drive the process might frustrate the answering of a narrow set of questions and evidence is often not generalizable, it is abundantly useful for "building participant-driven practical theory about how environments impact everyday people" [49] (p. 400). The Photovoice variation used in this study combining a walking tour with picture taking replicates the method used in an informal settlement in Lusaka, Zambia [49]. This method gives a significant level of control over to participants and roots the data in lived experiences.

Upon arriving in Chikutu, we began by meeting with the Village Headman and the study participants to explain the purpose of the visit and to receive informed consent. The Photovoice participants included four men and three women of ages ranging from adolescent to adult. The field research in Chikutu proved to be an opportunity to educate residents on informed consent standards and procedures. Before the Photovoice exercise, the participants, PI, and co-PI reviewed the informed consent form that had been translated into the local language (Chitumbuka). One representative from the participants read aloud each section to ensure that any illiterate participants understood what was being consented to, and, following each section being read aloud, the co-PI reiterated the information and asked if any participants had questions. Although Chikutu is very remote, residents have had occasional contact with government officials collecting data, but none of the residents had ever completed an informed consent. After the form was signed, the PI and co-PI encouraged residents to demand informed consent from future researchers so that they would be fully aware of the risks and benefits of participating in research.

Once the Photovoice ecosystem services inventory walk commenced, the participants pointed out a resource, a photograph was taken of the resource, and its local name and common uses were recorded. The participants were given slight prompts to provide a little more explanation when necessary, but at no point did the researchers independently point out a potential resource and ask "what is this?" The participants were given full control to point out the resources that were important to them for their health and livelihood and to end the exercise when they felt a full accounting had been collected.

3. Results

3.1. Malawi Forestry Policy

The data from this section are aimed at addressing the first of the three research questions: What are the forestry policy challenges and opportunities for forest conservation in Malawi?

Timeline of Malawi forestry policies and guidelines and selected other policies directly affecting forestry policies:

- 1942 *Forest Act*: Pre-independence command and control forest management
- 1994 *National Environmental Action Plan*
- 1996 *National Forest Policy*: First post-independence forest policy aimed at supporting the 1996 National Environmental Policy and the Environment Management Act
- 1997 *Forestry Act*: Enabling and enforcement legislation to support 1996 forest policy
- 2001 *National Forestry Program*: Strategic framework for linking policy and practice or to translate good intentions into real results
- 2001 *Forestry Rules*
- 2001 *Forestry (Community Participation) Rules*
- 2003 *National Forest Policy*
- 2003 *Forestry Amendment Rules*

- 2003 *Community Based Forest Management*: Supplement to the 2003 National Forestry Policy expanding on "aspects related to community based forest management, including access to resources, benefit sharing, the role of traditional leaders, and decentralization" [57] (p. 10)
- 2004 *National Environmental Policy*: Includes principles and strategies for sustainably managing forests
- 2013 *Standards & Guidelines for Participatory Forestry in Malawi*: Developed to guide the practice of participatory forestry management and establish standards for forestry extension service delivery and improved forest management
- 2016 *National Forest Policy*: Coordinates all natural resource management, including forest resources and environmental policy instruments in Malawi
- 2017 *National Forest Landscape Restoration Strategy*
- 2017 *Environment Management Act*
- 2018 *A Framework for Monitoring Progress on Malawi's National Forest Landscape Restoration*

There has been a clear evolution in forest policies under Malawi's three distinct forms of government that span its colonial demarcation as a country to its current multi-party democracy system. During the colonial era's command and control system of management (1890s to 1964), "forest guards were posted in every Traditional Authority ... to police forestry use and collect revenue for government from forestry products" [7] (p. 2). With independence from colonial rule in 1964, and under a new authoritarian one-party state, the focus turned to plantation timber production for local and international trade. Concurrently, forested land under the control of traditional leaders experienced accelerated deforestation and degradation as communities pursued extractive practices as a demonstration of political independence from a colonial system of forest management [7].

During Malawi's transition to a multi-party democracy in 1994, demand for forest goods and services far exceeded supply, putting further pressure on forest systems [58]. To address recognized environmental and forest issues in Malawi, the Forestry Policy was revised in 1996. The 1996 National Forest Policy was a departure from the traditional forest management approach, most notably with its marked move towards devolution of centralized powers to promote participatory management [57,59,60]. This new strategy emphasized "multi-stakeholder participation including local communities" [7] (p. 2). Unfortunately, democracy was also equated with deregulation and the deforestation of forest reserves for agriculture and fuelwood [61].

Many of the devolution objectives acknowledged forestry financing and enforcement challenges. To remedy these challenges, a market approach was adopted to provide economic incentives that promoted the sustainable utilization of forest resources by emphasizing local ownership and management of forests and small- and medium-scale forest-based industries. Local management of forest resources was designed to be achieved through community-based forest management practices embedded in traditional institutions and giving communities shared or exclusive decision-making rights [7]. Another notable change in the 1996 policy was the explicit recognition that forest conservation policy objectives were supporting quality of life measures for rural populations recognized as the most disadvantaged group in Malawian society [58]. The 1996 forest policy was also used to support the larger framework of the 2004 National Environmental Policy, which itself is aligned with Section 13(d) of the 1995 Constitution of Malawi outlining many environmental goals.

Subsequent enabling legislation, forestry policy updates, and participatory management guidelines all support the current 2016 National Forest Policy goal to provide "guidance to the management of forests, offer an enabling framework for all stakeholders to participate in the management of forests, and sustain the contribution of the national forest resources for the upliftment of the quality of life" [27] (Foreward). Although the recognized role of forests in supporting quality of life is still an objective of the 2016 National Forest Policy, its focus on the rural disadvantaged is no longer explicit. While the 1996 policy was emblematic of a new democracy facing a recognized threat, the 2016 policy is more outward looking and reflective of a young participatory democracy on a world stage. This is evident in its stated alignment with international agreements and conventions such as the

Rio Declaration, United Nations Framework Convention on Climate Change, the Montreal Protocol, United Nations Convention to Combat Desertification, United Nations Convention on Biological Diversity, United Nations Convention on International Trade in Endangered Species of wild fauna and flora, and the claim that the review of the policy was conducted by a wide range of stakeholders, including traditional authorities, district councils, the civil society, the private sector, statutory bodies, government departments, academia, and the general public [27].

The 2016 policy recognizes that forestry conservation is a cross-cutting issue which requires collaboration and broad participation to meet the goals of other focused policies, such as those addressing land, biodiversity, wildlife, water, energy, and population, but also the more comprehensive Malawi Growth and Development Strategy now in its third iteration. Among the policy outcomes aimed at protecting forests are financial benefits and other livelihood outcomes (e.g., food, biomass, shelter, health). Financial incentives to protect forests include eco-tourism and recreation, and also still include forest-based enterprises. The livelihood outcomes are realized in the goods residents reap on a daily basis and profit from to support their health and well-being.

The implementation and enforcement of these policies remains a significant challenge, but the Environment Management Act of 2017 aims to address these challenges. This act created an Environmental Protection Agency "with broad and substantial powers to strengthen environmental planning and risk management at national and decentralized levels" [62] (p. 2). If the same implementation challenges that have thwarted previous legislation can be overcome, this act "will be one of the most powerful legal instruments for environmental management introduced so far in Africa" [62] (p. 2). This act, like others, focuses heavily on local control of environmental resources.

3.1.1. Village Natural Resource Management Committees and Village Forest Areas

Locally developed and enforced customary laws have shown to have a greater impact on the protection of natural resources as compared to federally developed and enforced laws [63]. This is partially due to human and institutional resource constraints that continue to make government sponsored patrolling, enforcement, and prosecution a challenge. Customary control alleviates these resource constraints and aligns with the customs and rules that govern everyday life and natural resource management and sanctions in Malawi. "Locally developed and enforced resource-use rules which relate directly to the resource in question", are more easily monitored by other community members, and acknowledge a culture where subjective norms are well known within communities, weigh heavily on decision making, and traditional penalties are generally accepted [63] (p. 93).

Recognizing the necessity of local control and influence of customary law, key among the strategies to achieve the objectives of national forest policies is the establishment and support of Village Natural Resources Management Committees (VNRMC). These nationally registered committees receive technical advice from the Forestry Department officers on how to protect, control, and manage their forest resources [13]. Under Forest Rules 2001, the VNRMC has the authority to prohibit residing in protected areas, altering for agriculture, or damaging trees for any purpose (along with selected other powers). The local Forest Management Agreement created by VNRMC in consultation with Forestry Department officers governs the activities of demarcated Village Forest Areas [63].

Village Forest Areas (VFA) are areas on customary land that are actively managed by the VNRMC for forest resources or forest re-establishment. As with all customary land, and following customary law, the responsibility for allocating and overseeing the VFA lies with the traditional leadership of the Village Head, Group Village Head, or ultimately, the Traditional Authority.

During the colonial era, every village was required by law to have a VFA to oversee the conservation of wood products, water, biodiversity, and recreational facilities. "A total of 69,000 hectares of VFAs were set aside by 1940, under the control of local headmen and for the purpose of local use" [6] (p. 1). VFAs are no longer required by law, but with devolution to local level control, these VFAs remain critical to forest conservation and are often the only body overseeing forest conservation.

There were over 2000 "active" and another 1000 "trained" VNRMCs in Malawi in 2002 [6], and the scope of their activities have expanded in line with heightened knowledge of the critical role of forests in local and global ecosystems. Many VNRMCs are now tasked with reforestation, and tree planting activities often receive wide media coverage. Their influence has waxed and waned since the colonial era establishment of VFAs, but the move towards decentralization since 2008 provides guarded hope that their influence will return. Granted, it will likely take time to overcome decades of centralized control and the re-adoption of local responsibility. It is a promising sign that the large youth populations in Malawi are taking center stage as stakeholders in VFAs [64], although the national youth tree planting program has also experienced shortcomings in government administration [65].

3.2. Conservation Activity Inventory in the Misuku Hills Region

The data from this section are aimed at addressing the second of the three research questions: What conservation activities are taking place in the Misuku Hills in support of these policies?

It has been documented that forest management activities in Malawi often involve three parties: "a facilitator who catalyses the process (often coming from outside the community), the implementing agency (a local group or committee spearheading the change process) and the benefiting community" [7] (p. 6), and this holds true for the activities that have taken place in the Misuku Hills since 1999. The facilitators have often been Malawian NGOs backed by international aid organizations (Table 2). It is apparent in Table 2 that NGOs, and not government, have been the catalyst of forest conservation activities, with government officials acting in an advisory capacity. NGOs that operate in Malawi must be registered with the Registrar General in the Department of Justice and the NGO Board of Malawi. They may also voluntarily become a member of the Council of Non-Governmental Organizations in Malawi (CONGOMA).

Table 2. Inventory of sponsored forestry conservation activities in the Misuku Hills.

Date	Project	Implementing Organizations	Funders
1999–2004	COMPASS I	Development Alternatives Inc.	USAID [1]
2006–2009	COMPASS II	Development Alternatives Inc.	USAID [1]
2006–2010	IFMSLP I	LTS [2]	European Commission
2011–2014	IFMSLP II Improved Livelihood and Biodiversity Conservation Project Misuku Hills Indigenous Forest Project	GOPA [3] Subcontract to CEPF [4], AfES [5] Subcontract to CEPF [4], MBA [6], SDI [7]	European Commission
2013	Misuku Beekeeping Value Addition Project	MBA [6], SDI [7]	British High Commission
2013–2015	Promotion of Indigenous Forests in the Misuku Hills Area	MBA [6]	UNDP GEF [8]
2017	Misuku Hills Art Challenge	AfES [5], MBA [6], SDI [7]	CEPF [4]
2018	Small Producers Development Project	MBA [6], SDI [7]	IM-Swedish Development Partners

[1] United States Agency for International Development; [2] LTS historically stood for Land and Timber Services, but it is now just LTS as a stand-alone title; [3] Gesellschaft für Organisation, Planung und Ausbildung; [4] Critical Ecosystem Partnership Fund; [5] Action for Environmental Sustainability; [6] Misuku Hills Beekeepers Association; [7] During the time of the project, the organization was called Sustainable Rural Growth and Development Initiative (SRGDI), but the organization is now called Sustainable Development Initiative (SDI); [8] United Nations Development Program Global Environment Facility. COMPASS, Community Partnerships for Sustainable Resources Management; IFMSLP, Improved Forestry Management for Sustainable Livelihoods Program.

The remoteness of the Misuku Hills contributes to it being one of the last contiguously forested regions of Malawi not in a national park, but this feature has also caused it to be overlooked by conservation organizations and funding agencies operating in other regions of Malawi. Despite this, there have been a handful of forest conservation activities that have engaged the VNRMCs in the Misuku Hills charged with managing both VFAs and the three public forest reserves.

The two phases of the Community Partnerships for Sustainable Resources Management (COMPASS) project were national in scope with Misuku Hills as one among many intervention sites. The very limited documentation available on the activities and results of COMPASS I reveal that it was meant to improve natural resource management by emphasizing income generation, which is

consistent with and supporting USAID/Malawi's Strategic Objective framework of sustainable increases in rural incomes [40]. Unlike COMPASS I, there is abundant documentation of COMPASS II [66]. COMPASS II "supported decentralized environmental management and capacity building in enterprise development in order to mainstream CBNRM [community based natural resource management] as a viable rural development strategy (COMPASS II Project, 2007)" [40] (p. 24). COMPASS activities in the Misuku Hills included the support of the Mzuzu Coffee Planters Cooperative Union (MCPCU) to engage in honey production. Honey production was promoted not only for the sale of honey and beeswax products, but also for pollination of coffee crops. The accomplishment of COMPASS targets were initially monitored across 15 districts in Malawi, including Chitipa, but then reduced funding in 2007 led to only seven districts being monitored, excluding Chitipa [67]. Therefore, the effectiveness of these programs cannot be evaluated, and this lack of evaluation proves to be a theme throughout subsequent forest conservation activities.

The Improved Forestry Management for Sustainable Livelihoods Program (IFMSLP) was a Government of Malawi, two-phase, national capacity-building exercise aimed at improving "the livelihoods of forest dependent communities through improved sustainable collaborative management of forests both in forest reserves and customary land" [68] (LTS webpage). IFMSLP I and II were aimed at the implementation of the National Forestry Policy and Program through community mobilization, institution building, and local forest management planning [69,70]. One of the IFMSLP intervention sites included the area within and around the three public forest reserves in the Misuku Hills [6]. IFMSLP II faced funding and implementation delays, but it was eventually pushed forward with a reduced set of strategies [70]. It was discovered through personal communications that the delays were due to suspected government corruption which caused the funding agency to halt the project, but it did eventually resume with "competitive grants for non-state actors to enhance their role in, and to accelerate, project implementation" [70] (p. 1924).

There is a conspicuous dearth of documentation available on the activities and outcomes of the two phases of the IFMSLP, but one available document was an evaluation of IFMSLP I completed in 2011 [71]. The evaluation was critical of the lack of monitoring and evaluation, which may help explain the lack of available documentation. Despite the program setbacks and the lack of data on program activities and outcomes, there were still some identifiable results.

On a national level, the IFMSLP led to the development of the national 2013 Standards and Guidelines for Participatory Forestry in Malawi [70], as referenced in Section 3.1.1. The IFMSLP activities and outcomes specific to the Misuku Hills intervention site were uncovered through communications with NGOs who received the "competitive grants for non-state actors" to pick up the pieces from the mixed successes of IFMSLP I and a halted IFMSLP II. One tangible outcome was the creation of the Matipa Forest Management Plan (in draft form and still under review by the Forestry Department) created under the Improved Livelihood and Biodiversity Conservation Project. This plan was designed to govern the activities of the VNRMCs in this area and create a greater sense of ownership by the surrounding communities to relieve unsanctioned pressures on the forest reserve resources. It was based on and serves the larger Strategic Forest Area Plan (SFAP) for the Matipa, Mughese, and Wilindi forest reserves, with a focus on three of the five priority objectives in the SFAP. These are to (1) increase in tree planting and natural regeneration, (2) conserve the forest for water catchment protection, unique biodiversity, and cultural heritage, and (3) regularize extraction of forest resource and products from forest reserves to uplift communities' livelihoods. The creation of forest management plans for all three forest reserves was originally the responsibility of the Department of Forestry in IFMSLP I, but only one of these plans has been prepared. The Matipa Forest Management Plan includes estimates of the products and income that could be generated from the sustainable use of forest resources and a monitoring plan for patrols by local residents [72]. Responsibility for the creation of plans for the two remaining forest reserves (Mughese and Wilindi) remained with the Department of Forestry in IFMSLP II, but these plans have yet to be prepared.

The IFMSLP II also supported the creation of a number of forest management agreements and beekeeping activities under the Misuku Hills Indigenous Forest Project [73]. Seven VNRMCs composed of members from 71 villages now have co-management agreements and licenses to oversee the entire 2762 hectares of the three forest reserves in the Misuku Hills. These agreements include tree planting and regeneration on 485.92 ha in the forest reserves. These VNRMCs simultaneously manage VFAs on customary land, and there were seven VFAs established under the program (Alther, Chipala, Chiwi, Kapiyira, Lupalang'ombe, Mwenga, Nangalamu) with four of these VFAs (Alther, Chiwi, Mwenga, Nangalamu) currently with completed VFA management plans. Although there is no readily available national accounting of VFAs or their level of current activity, a forestry officer from Chitipa reported that there are 68 VFAs around the Misuku Hills, and 21 of these VFAs have management plans.

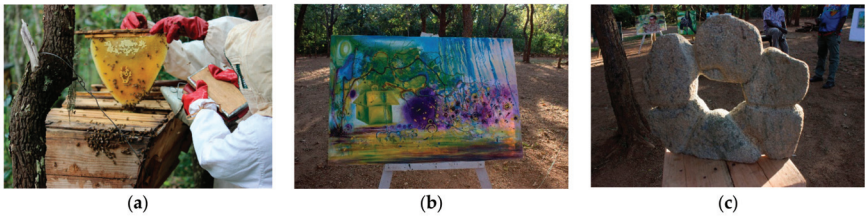
The Misuku Hills Indigenous Forest Project also included activities in and around forest reserves focused on beekeeping, candle making, and selling non-wood products. The Misuku Beekeepers Association (MBA) was the lead organization in this effort and has proven to be a prominent force for forest conservation in the Misuku Hills. MBA is a registered company comprised of more than 1500 beekeeper members with a 2:1 ratio of men to women [74]. MBA has actively contributed to the creation of forest plans, and their forest-based enterprises were further enhanced through this project. Support from this project led to MBA being chosen to represent Chitipa district at the National Agricultural Trade Fair, where they established business connections and received beekeeping product orders. These activities were estimated to have increased the income of 350 households in the area by 80%. MBA members also increased capacity in project management skills and conservation science by participating in two workshops in Mbeya, Tanzania and Nairobi, Kenya. Their participation at these workshops led the MBA being nominated by the Tropical Biology Association for a site visit and learning exchange with Save Tanzania Forests.

The Misuku Beekeeping Value Addition Project (MBVAP) and Promotion of Indigenous Forests in the Misuku Hills Area (PIFMH) project occurred simultaneously with the Indigenous Forest Project discussed above. The MBVAP was aimed at continuing to build capacity in the forest-based enterprise of beekeeping among the estimated 2500 beekeepers in the Misuku Hills who produce honey at a subsistence level. Honey was being sold unprocessed and uncertified in unreliable markets in their area, and the beeswax was just thrown away. The project supported the training of 250 members of 50 beekeeping clubs in beekeeping techniques and honey and beeswax candle making; the provision of equipment and materials; certification of honey and candles; and linking farmers to markets [74]. The reported results of the project were "overwhelming." The 50 clubs that were trained were registered with MBA. MBA acquired certification from the Malawi Bureau of Standards and used the processing equipment to create professional and standardized packaging for their Misuku Hills Honey (Figure 3). The combination of professional packaging and certification was attributed with over an 80% increase in the value of their honey. MBA honey can now be found on grocery store shelves across the country, and it is being used as an ingredient in cough syrup by a pharmaceutical company. This has reportedly led to 300 households increasing their income by 50%. Although the wax processing and candle making plant was established and most of the clubs 50 clubs were trained, inadequate funding was given as a reason why the candle making venture has yet to be realized.

The PIFMH project also promoted beekeeping, but it was focused solely on the Mughese forest reserve and included the promotion of nutritional and medicinal products and "reconnecting cultural values with existing nature" [75] (webpage). Although no evaluation report on outcomes of the PIFMH was available, its status is listed as "satisfactorily completed" [75].

The relationships built between stakeholders and organizations in all of these projects led to further collaboration in the Misuku Hills Art Challenge (Figure 4) aimed at raising "awareness of the beauty and ecological, cultural, aesthetical and economic value of Misuku Hills Forest Reserve both locally and internationally" [76] (webpage).

Figure 3. Misku Hills Honey. Source: Sustainable Development Initiative.



(**a**) (**b**) (**c**)

Figure 4. Misuku Hills Art Challenge: (**a**) Beekeeping training; (**b**) painting submission; (**c**) prize winning sculpture. Source: Sustainable Development Initiative.

The Misuku Hills Art Challenge (MiHAC) was a national competition that brought together 12 Malawian artists, photographers, and film makers to showcase the remote and often overlooked Misuku Hills and bring greater national and international attention to this Key Biodiversity Area (KBA) threatened by logging, charcoal production, and agricultural expansion. A smaller art competition was also conducted for school children in 10 schools surrounding the Misuku Hills. MiHAC was widely advertised through the national media and on multiple social media platforms, and an exhibition of the 16 paintings, 3 sculptures, 68 photographs, 3 films, and 10 children's drawings was convened in the capital city of Lilongwe with cash prizes given to the top artists.

The impacts of the project not only raised awareness of the Misuku Hills among the public, but also engaged numerous government ministries to encourage the inclusion of the Misuku Hills into policies and plans as a KBA. The Misuku Hills is recognized internationally as a KBA [32], but it is not currently recognized by the Government of Malawi as such. Participation by the Environment Affairs Department (Biodiversity Focal Point) brought attention to the need to conduct a biodiversity assessment as the first step in it being recognized as a KBA in national policies and plans.

MiHAC also introduced tourism as a new approach to forest conservation in the Misuku Hills, and tourism brought in the Ministry of Tourism as a new player in addition to forestry. The only accounting of tourism in the area estimated that the Misuku Hills typically received three local and international tourists per month, but in the six-month period following MiHAC, this rose to eight tourists per month, nearly tripling the income of VNRMCs that charged small fees to tourists [77]. The MiHAC project also brought greater attention to the production of Misuku Hills Honey and Mzuzu Coffee as potential tourist attractions. In addition to the previously discussed success of marketing Misuku Hills honey, the Misuku Hills is also where 50% of the internationally-renowned Mzuzu Coffee is produced. A small number of tourists travel to the Misuku Hills to sample the coffee and learn about the community that grows the coffee.

A number of potential donor organizations were also invited to and attended MiHAC events, and the Small Producers Development Project resulted from the interactions with a donor. A pilot project was conducted to continue the work of supporting beekeepers with financing, certification, production, and marketing, but it was reported that the donor ultimately decided that the Misuku Hills were too remote to conduct monitoring and evaluation, so they ceased supporting beekeeping activities. Again, the double-edged sword of its remoteness being part of its attraction but also creating difficulties in accessibility.

Lastly, there appears to have been a small project funded by the Tilitonse Foundation aimed at strengthening VFA plans, but no documentation on this project was available.

Although not in direct administration of the conservation activities in the Misuku Hills listed above, the Wildlife and Environmental Society of Malawi deserves mention as a major player in conservation activities in the Misuku Hills and throughout Malawi. They were credited as a contributor to many of the activities and policies identified in this study.

3.3. Chikutu Village Ecosystem Services Inventory

The data from this section are aimed at addressing the final research question: What ecosystem services are residents using that are in need of protection?

The Photovoice ecosystem services inventory took approximately three hours to complete. The residents of Chikutu village identified 16 distinct forest products in the immediate vicinity around their village (Table 3). This included seven different types of fruits, roots used for medicine, fiber and timber used for construction, vegetation that prevented soil erosion, the soil itself, mushrooms, and grasses and leaves for domestic animal feed. Figure 5 displays selected photos of identified forest products.

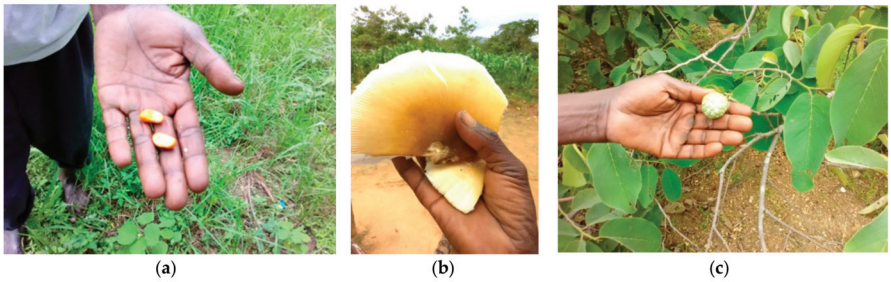
A greater volume and variety of flora were identified in the Chikutu ecosystem service Photovoice exercise than were identified in a previous participatory assessment conducted as part of the Improved Livelihood and Biodiversity Conservation Project.

Forest fruits are an essential part of the diet for rural populations in Malawi as they are a source of critical dietary nutrients (vitamin A and C, calcium, fiber, minerals) and contribute to food security, especially as a supplement in times of famine. Mushrooms also provide nutritional benefits and are sometimes preserved for food security purposes [25]. Fruits and mushrooms can be sold to persons residing in surrounding areas where forests have been degraded and these resources are scarce [13].

Table 3. Inventory of forest products.

Local Name	Type of Forest Product	Local Uses	Notes
Ndilolo	Tree [1]	Food	Nut casing consumed and used for juice
Manga	Tree	Food	Mango fruit
Munyere	Shrub	Food	Wild avocado
Miyombo	Shrub	Construction	Stems used for rope
Mulungalunga	Tree	Medicine	Roots
Masuku	Herbaceous plant	Food	Fruit
Mushombe	Bamboo	Construction	
Mufiomi	Tree	Timber	Recognized for water conservation properties
Mwina	Tree	Timber	Noted as being very dense
Malina	Grass	Timber	Also animal feed
Dongo	Soil	Food	
Ntochi	Herbaceous plant	Food	Banana
Chighughu	Grass	Erosion control	Also animal feed
Popo	Tree	Food	Papaya
Chiwowa	Fungus	Food	Mushroom
Guaves	Tree	Food	Guava

[1] Almost all trees are also used for wood fuel.



(**a**) (**b**) (**c**)

Figure 5. Selected forest goods in Chikutu: (**a**) Ndilolo (cashew-like nut); (**b**) Chiwowa (mushroom); (**c**) Munyere (wild avocado).

The remoteness and inaccessibility of Chikutu village has contributed to the abundance of these forest products, but lack of connectivity to other settlements also creates great difficulty in accessing markets. This lack of access to markets makes these goods essential as a food source and, at the same time, creates great difficulty in selling these products for profit. When asked directly about the sale of forest products, it was confirmed that they were only consumed locally. One notable absence in the identified forest products was the harvesting of wild animals and insects.

A number of ecosystem service assessments were also conducted in three villages in the lake plains area of Karonga with much higher population densities and diminished forests. While residents in these villages still appeared to be knowledgeable about forest product ecosystem services, these services were less abundant and diverse. Essentially, the less forested area had fewer identified ecosystem services.

4. Discussion

Malawi is faced with many challenges to forestry conservation and the subsequent sustainability of ecosystem services. However, as the results above revealed, Malawi has formulated—in collaboration with an array of international organizations—a number of policies and plans to meet these challenges. There have been attempts to implement these policies, but there are significant challenges to realizing their full vision and potential. The first challenge is a lack of current, reliable, and comparable data on forest cover and change, but efforts to remedy this are currently underway (Appendix A). Discussed below are a number of other challenges, as well as potential remedies discovered through this research: The challenge of good governance, the potential remedies of increased location control (e.g., Village Natural Resource Management Committees), and the promotion of forest-based enterprises. As the results of the policy inventory revealed, there is no shortage of actionable forest policies, but shortcomings in good governance has limited their implementation. The forest-based activities that have taken place in the Misuku Hills demonstrate the potential for local initiatives and control when centralized government fails. The inventory of ecosystem services revealed a previously unrecorded wealth of goods that could be sustainably marketed through forest-based enterprises. The discussion concludes with suggested directions for future research.

4.1. Good Governance

Weak institutions have been identified as one of the many factors threatening the Miombo forests of Africa [78,79]. The Democracy Index categorizes the relatively young multi-party democracy of Malawi as a *hybrid regime* [80]. The hybrid regime-type of government is characterized by a number of conditions that affect the implementation of forest policy, including serious weaknesses in political culture, functioning of government, and political participation; widespread corruption; weak civil society and rule of law; and a non-independent judiciary. Many of these threats to good governance were confirmed in a separate, albeit ideologically-driven, analysis of economic freedom [81]. Combined

with a lack of financial and human resources, these conditions certainly create challenges in the implementation and enforcement of forestry policy, and they are noted as a priority focus area in the most recent National Forestry Policy [27].

We see some of these challenges at the local level in the Misuku Hills. Among the reported lessons from one of the conservation projects in the Misuku Hills (intentionally not identified) was that corruption is a key challenge. It was reported, but not corroborated by the author, that government authorities accepted bribes to grant logging licenses to traders to cut down large trees in VNRMC co-managed forests without the consent of the VNRMC. These activities undercut the stewardship and disenfranchised the VNRMCs. Part of this can be explained by the lack of internalization of the co-management concept by government officials, despite the abundance of adopted national policies and guidelines promoting participatory forest management [82]. Throughout Malawi, residents and VNRMC members have demonstrated that they are willing to put in the effort, but they are bogged down by lack of support from the government officials with whom they co-manage forests. Even when drafts of local Forest Management Plans are created, there are significant delays in approving these plans, which demoralizes residents [82]. The Misuku Hills are a case in point. There has been a many years long delay by the Department of Forestry in approving the draft Matipa Forest Plan and finalizing the plans of the other two forest reserves, long after the local VNRMCs have done their part.

Despite these challenges, there are a great number of opportunities in good governance in Malawi. The national government has delivered on forestry policy, forest management acts and guidelines, and most recently a strategy for measuring progress on forest conservation. Furthermore, the total land area of public protected forests increased by 8% between 1998–2010 with more proposals for protected areas underway [29]. Malawi has also taken the bold step of temporarily deploying Malawi Defense Force soldiers to patrol the most threatened public forests [83]. Furthermore, it was reported that the National Tree Planting Season recently closed with 50 million trees planted on 25,000 hectares, just shy of the 60 million tree target [84].

Despite some negative and demoralizing interactions between VNRMCs and government officials, there have been positive interactions as well. The Misuku Beekeeping Value Addition Project reported "a lot of support" from the Ministry of Agriculture and Food Security, Community Development Officers, and Forestry Officers in the form of training and equipment and identifying markets [74]. The Forestry Department has served in advisory and administrative roles (see Indigenous Forest Project report), and their role will likely become more advisory with the continued movement towards central devolution to more local control.

4.2. Local Control

Malawi adopted a participatory forest management policy in 2001 (updated in 2003) and, as recently as 2013, adopted guidelines for participatory forest management to increase local control of forest conservation. There is ample guidance and authority for local control, but co-management challenges are still thwarted by a lack of policy implementation and capacity building at the local level [62,70]. This lack of implementation begins with government ministries and donors failing to fully engage and organize communities. Even in communities where VNRMCs have been organized, there have been many other challenges to their effectiveness in advancing local control. Two of these challenges are (1) a lack of empowerment to actively participate in decision-making and (2) a lack of downward accountability among leaders which has limited the devolution process [85].

Much of the community-based forestry management (CBFM) has been driven by donors, government, or NGOs and imposed on communities. While these activities may raise community awareness, they are not sustainable [70] and "undermine achievement of conservation and social goals" [86] (p. 687). They lack the community empowerment derived by involving community members in decision making and creating accountability mechanisms. COMPASS I and II are examples of imposed programs that do not properly empower communities or provide sufficient incentives for communities to continue the imposed project once the donors move on and funding ceases.

Empowerment in the decision-making process begins by understanding "the preexisting conditions and how communities understand and interpret the program" [87] (p. 338). One of these preexisting conditions includes the power relations in communities. In an evaluation of CBFM in southern Malawi, it was found that both the CNFM (community natural resource management) concept and implementation created new elites (forest committees) who largely operated as corrupt, unaccountable "village bureaucracies," alienating communities from CNRM. Widespread forest degradation and institutional breakdown ensued. Community management became committee management, and part of the problem. Rare "success" was associated with idiosyncratic leadership qualities of village heads, suggesting need for enhancing roles and leadership skills of traditional leaders in balancing the exercise of power among CNRM stakeholders, and for broad-based community empowerment so that members can demand accountability from local leaders [86] (p. 687).

Both the CBFM committee and community members must understand that the CBFM committee is working for, and accountable to, the community.

Despite these challenges, there are a great number of opportunities for local control and the local protection of forests in Malawi. In fact, with a dearth of government resources to manage and monitor forests effectively, local control is currently Malawi's only hope for forest conservation. It has been found that VFAs under participatory forest management (PFM) had higher tree species abundance and diversity than those without PFM [88]. This success was attributed to the regulation of access and the forest development work of communities who practice PFM in their designated VFAs.

As noted above, understanding the preexisting conditions is essential for the empowerment that would enhance local control. A fundamental preexisting condition that is ripe for success in its ability to engage communities and build understanding and trust is undertaking a participatory process in the inventory of local forest resources, such as the ecosystem services (ES) assessment conducted in this study in Chikutu. "Considerable indigenous knowledge and skills for managing forest goods and services are often available at village level" [16] (p. 6), and it is arguably remiss to protect forests without a locally-driven accounting of the resources that are available and in need of protection. These activities are in line with current policy. The Chikutu ES inventory supports the policy priority area five, strategy three of the National Forestry Policy noting indigenous knowledge acquisition and dissemination [27]. The Chikutu ES study found a number of services that were distinct from the more heavily studied area immediately surrounding the public forest reserves. It is only by engaging communities and respecting their knowledge to uncover these services that management priorities can be properly represented in local VFA plans.

4.3. Forest-Based Enterprises

Forest-Based Enterprises (FBEs)—interventions meant to empower communities to realize tangible benefits from forests—recognize that forest conservation and livelihood development are deeply intertwined [89,90]. FBEs tie people to local forests for their livelihoods, and this may be more realistic in the near-term as Malawi continues to defy the conventional development pathway and macro-level economic changes theorized as affecting forest conservation.

Usually, the transition from a low- to middle-income economy starts with an abundance of natural capital which is used to invest in infrastructure (produced capital) and education and health (human capital). At middle-income levels, produced capital roughly doubles its share and human capital grows rapidly to become the main asset. In Malawi, the opposite development occurred. Malawi is still highly dependent on its natural capital, which remained constant at 43% from 1995 to 2014, while human capital increased only slightly and produced capital shrank [62] (p. 5).

With human capital and produced capital near stagnation, Malawi has yet to follow the forest transition theory [91], which posits that economic development, industrialization, and urbanization causes an initial large decline in forest cover to fuel this development, followed by a slow increase in forest cover [92,93]. "In some places economic development has created enough non-farm jobs to pull farmers off of the land, thereby inducing the spontaneous regeneration of forests in old fields" [92]

(p. 23), but Malawi is still a largely agrarian-based economy, and FBEs may be asking people to be tied even more to the land instead of generating economic activity off of it, possibly perpetuating a "poverty trap" [92] when FBEs are not successful.

As Malawi continues to defy the conventional development pathway and the conditions necessary for a forest transition, FBEs may be a strategy only in areas where forests are still present. In the central and southern regions of Malawi, where the vast majority of the population lives, the near complete deforestation does not make FBEs a widespread solution to poverty alleviation and forest stewardship. The northern region (and the Misuku Hills, in particular), due to its lighter population and accompanying extant forest cover, is likely a better candidate for viable FBEs. Yet, FBEs may only be viable if the conditions that led to the deforestation of the central and southern regions are addressed; namely, a rapidly growing population of small landholders practicing largely subsistence agriculture on finite land. It is not until other developments that create technological separation, reduced population, urbanization, or all of these and other factors ensue before the people of the Misuku Hills can make FBEs more than a short-term solution. If larger external forces continue to diminish forests, there will be no resources remaining to sustain FBEs.

It is also critical to recognize that "households will not invest precious labour and time nurturing trees when there are more pressing needs for food security" [16] (p. 6). Sustainable agricultural practices must be implemented concurrently with the CBFM of "free" food stuffs from forests to ensure food security as a necessary precursor to the protection of forest resources.

There has been some successes of FBE in other regions of Malawi to protect the few remaining forests (e.g., Sustainable Management of Indigenous Forests program in Kam'mwamba, Neno District in southern Malawi, 1996–2006 (see [7])), and also in the Misuku Hills with honey production, but the remote location of the Misuku Hills is a proverbial double-edged sword as it attributes to the quality of its forest but also creates challenges in transporting goods to markets and attracting all but the most adventurous tourists. One of the goals of the Misuku Hills Art Challenge was to raise awareness of the beauty and potential of this region for tourism. Even a slight increase in tourism to this area could have a dramatic effect on increasing recognition and spurring greater infrastructure development.

There has also been some success in the changing attitudes towards the protection of goods used to support FBEs. With awareness raised as to the importance of forest conservation to FBEs, there have been community protests and bad press when trees are harvested. For example, the District Forestry Officer overseeing the Misuku Hills had to address outrage at tree harvesting in the press, even when trees were being harvested sustainably on customary land and the trees in question were planted by inhabitants [94]. This culture of protection does have its limits. For example, although charcoal production is illegal and has been widely recognized as a major contributor to deforestation in Malawi, there are many instances of persons selling charcoal in plain view of those responsible for enforcing this infringement. This burgeoning culture of conservation may be driven by not only the potential losses of cash value, but also by the highly understudied non-cash value of forests.

Non-Cash Value

Zulu 2013 offers *reciprocal altruism* as a meta-theory [95,96] to understand the non-cash incentives for forest conservation in Malawi. This theory involves the "the trading of altruistic acts in which benefit is larger than cost so that over a period of time both enjoy a net gain" [70] (p. 361). Since there are many conditions that do not make FBEs viable in most places in Malawi, non-cash benefits may be more appropriate to remedy the "generally poor results" stemming from the "heavy dependence" on cash incentives in contemporary co-management projects [70].

In his critique of the national IFMSLP (see Table 2), but also applicable to the many programs carried out in the Misuku Hills, we tend to agree with Zulu that "a narrow emphasis on cash incentives as the motivation for 'self-interested' users to participate in co-management overlooks locally significant non-cash motivations, inflates local expectations beyond ability to deliver, and often creates perverse incentives that undermine socio-ecological goals" [70] (p. 1919). The promise of cash incentives in

FBEs have been found to produce "modest early gains in institutions and capacity building and forest condition, but low and generally disappointing cash benefits." The disappointing results "burdened poor communities with conservation costs and created perverse incentives to overharvest, be dependent on the project/government, and to marginalize the local poor" [70] (p. 1919).

An additional assessment of CBFM in Malawi confirmed that many communities "also highly valued other non-cash based and environmental objectives and benefits, including the sustained access to firewood and NTFPs [non-timber forest products], social/religious services inside the forest, and continued water supply for consumption and irrigation" [82] (p. vii). Awareness of the non-cash value of forest ecosystem services appears to be high and might help explain a continued commitment to CBFM in forest reserves despite FBEs producing "disappointingly low financial benefits for poor communities burdened with conservation costs" [70] (p. 1936). In the ecosystem services assessment of Chikutu, no cash values were expressed, even when residents were explicitly asked about the potential to sell local forest products.

4.4. Future Research

This study is the first inventory and analysis of the policy potential, conservation activities, and ecosystem services in the Misuku Hills. This initial assessment aims to enable future studies to examine the impact of these policies and activities directed at protecting forests and the essential ecosystem services that forests provide to the indigenous populations in this region.

The primary suggestion on future research design is that the geographical scope of the Misuku Hills should be expanded to encompass the forested area on customary land. The larger Misuku Hills forested region on customary land has been completely ignored in research and largely ignored for inclusion in the conservation activities. Although a number of forest conservation studies were conducted in Malawi, very few have addressed the socio-ecological dynamics in remote areas such as the Misuku Hills, where forests are still abundant and small indigenous populations rely heavily on forest resources to meet daily needs.

Future research should also consider examining the dynamics between the Misuku Hills forested region and the highly populated area immediately to the east in northern Karonga. The lake plains to the east are almost completely deforested to support rice cultivation, but it is suspected that the communities in the lake plains rely heavily on the ecosystem services provided by the Misuku Hills. This dichotomy likely creates both opportunities and pressures on the Misuku Hills forested region that generate tensions that need further exploration.

Lastly, a recommendation regarding informed consent. As noted in Section 2.3.1. Ecosystem Services Assessment Photovoice Exercise, the residents of Chikutu were never previously exposed to the informed consent process. This study proved to be an opportunity to teach residents about their rights as subjects of human research and to demand informed consent from future researchers. Any future research should be prepared to confront a lack of awareness of informed consent protocols and empower residents through education about their rights.

5. Conclusions

Since independence, Malawi has enacted a plethora of forestry policies that have been developed to meet international standards, including policies that promote local control and community-based forest management. What appears to be lacking is the widespread implementation of these policies and the empowerment of communities to practice local control. Despite these challenges, the forest conservation activities in the Misuku Hills demonstrate the potential for rural communities to organize and assume stewardship of forests both on customary land and in public forest reserves. In fact, a focus on communities such as those in the Misuku Hills is necessary to protect the last remaining indigenous forests and the indigenous communities that depend on forests for their livelihood. The ecosystem services inventory conducted in Chikutu revealed that community members have extensive knowledge of forest resources, and these resources are still readily available in communities residing in Malawi's remaining forests.

Malawi continues to be an anomaly on the macro-level economic development pathway. Its poor and rapidly growing population and widespread practice of subsistence agriculture will continue to place pressure on Malawi's forests. Until there is a change in these social forces, an increase in the diversity of livelihood opportunities off the land, and improvements in state institutional capacity, local control and stewardship will be necessary to conserve and regenerate the forests of Malawi.

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Appendix A

Forest Cover Data Discrepancies and Implications

There have been a number of noted discrepancies in estimates of Malawi's forest cover, rates of deforestation, and forest land tenure designations derived from outdated data sources [6,29]. The presentation of these discrepancies below is meant to instigate a critical evaluation of published forest cover estimates and to shed light on possible recent gains in forest cover (possibly due to enacted forest policies) and current efforts to remedy widely disparate forest cover estimates. It is certainly not meant to close the case on what led to these discrepancies, nor could it as much of the information on estimate sources and methodologies cannot be obtained.

Alarmist statements from as recent as 2019 that "over the last 40 years, more than half of Malawi's forests and woodlands have vanished" [62] (p. 1) are certainly dramatic, but they mask apparent recent gains. Admittedly, these gains are not easily discernable without a more deconstructed examination of trends in Malawi's forest loss over time that reveal a guarded optimism towards recent achievements in reforestation.

One cited estimate from 2016 is that Malawi is losing forest cover at a rate of 2.8% (250,000 ha) annually [27]. The 2.8% assessment appears to have been derived from a 1993 Biomass Assessment Report (assessment conducted in 1991), but this estimate masks significant changes over time and more recent declines in the rates of forest loss. This estimate appears to have been first cited in 2006 by a Forest Conservation Officer at the Food and Agriculture Organization (FAO) Regional Office for Africa. Despite its validity being called into question in 2010 due to its use of data demonstrating a loss of forest cover at a suspiciously unwavering 165,000 ha every 5-year period from 1990–2010 [29], it was still being perpetuated in 2016.

An oft-cited comparison of maps of Malawi forest cover from 1979–1999 reveals a dramatic loss of forest cover over this period, but if any validity can be given to these maps, it appears that this dramatic change happened prior to 1990. Malawi lost 41% of forest cover between 1972 and 1990 at a 2.3% annual rate [6], and this loss of forest cover occurred almost exclusively on customary and private land [97] (as cited in [6]). Post-1990 declines in deforestation rates are being masked when including pre-1990 forest cover loss estimates. Applying the FAO forest classification system and Malawi Forestry Department data (found in Table 8.3 from the cited report), the average annual deforestation rate from

1990–2010 was <1% per year [29]. Another report produced in the same year claims that Malawi lost 0.85% per year or a total of 16.9% (659,000 ha) of its forest cover over this period [98]. The report does not cite the source of this estimate. It may be from the report above, and it is still less than the 1990–2010 1.6% estimate of the same period cited in the introduction of this paper. It appears that pre-1990 estimates of rapid deforestation using a different classification as FAO are being incorporated into more recent estimates and masking 1990–2010 decreases in deforestation rates.

It could be that the rate of deforestation in Malawi after 1990 declined simply because Malawi forests had already been diminished, and there was little forest left to lose. This would be most apparent in the central and south regions, where there is less forest cover. In Dedza district (central region), 1991–2015, almost half of the forest was lost, but it only had 2.6% forest cover in 1991. This was almost a 2% annual loss over this period, but there was not much forest area to lose [15]. This is also pertinent to the districts in the northern region where the Misuku Hills are located. Since independence, there has been a gradual migration of people to the northern region [37], and "it is these areas that have also experienced the greatest amount of deforestation since independence" [14] (p. 274). An 1972–2009 estimate found that Karonga (−579 km^2; −28%) and Chitipa (−565 km^2; −20%) were among the districts that experienced some of the greatest declines in forest area [14]. Again, this estimate included pre-1990 conditions that could be masking more recent reductions in forest cover loss. A hot spot of change analysis revealed that, while some districts in the northern region experienced significant forest and natural vegetation loss between 1990–2010, Chitipa and Karonga experienced almost imperceptible changes [5]. These are the data cited in the introduction of this paper as being the most methodologically rigorous and forthcoming.

The 1972–2009 estimate reveals that nationally "there was a loss of 12,760 km^2 (36%) of original forested area but also 11,161 km^2 of new forest establishment, resulting in a relatively modest overall net loss of 1599 km^2 (5%)" [14] (p. 269). The districts of Chitipa (+54%, +622 km^2) and Karonga (+44%, +523 km^2) were among the districts that experienced the largest percentage and net gains in mosaic land cover (defined as a mixture of cropland, forest, woodland, grassland, scrubland, and other natural vegetation). In fact, in every district that had an overall loss in forest, there was an overall gain in mosaic land cover. Of course, this calls into question the ability of the mosaic land cover to replace the losses to biodiversity and ecosystem services brought about by the loss of indigenous forest cover.

Other estimates of national forest cover reveal apparent swings. The Biomass Assessment of 1991 showed that, in 1973, "Brachystegia forests occupied 45% of total land area of Malawi (36.5% if Lake Malawi is included) while in 1990/91 land under forest cover was estimated to be 25.3% (20.5% if Lake Malawi is included)" [29] (p. 143). The trusted estimate cited in the introduction of this paper of 26.8% is within the range of other estimates (18.2 to 28.7%) of total forest land cover [99], and greatly underestimates another as high as 34% (3.2 million hectares) [29]. There has undoubtedly been a loss of forest cover since 1973, but there has also been a gain (or at least a stagnation) since 1990. The difference between the 45% estimate in 1973 and the 26.8% estimate in 2010 equates to a 40% loss, but this loss occurred completely before 1990. As cited above, Malawi lost 41% of forest cover between 1972 and 1990 [6]. This is highly contradictory to the 5% net loss cited above that takes into account regeneration and new forest establishment [14]. One explanation that could attempt to reconcile these estimates is that previous estimates did not take into account regeneration, but this is far from clear.

Despite all of the data discrepancies and the opaqueness of how they were derived, the most recent estimates are cause for measured hope. Since the decline in forest cover and deforestation rates coincides with the beginning of the slew of forest policies in the 1990s, the larger unanswered question is the degree to which forest policy interventions led to the apparent halting of deforestation.

The academic exercise and arguable futility in trying to untangle the web of past forest cover and loss estimates are currently being addressed in future plans.

As part of the process for developing Malawi's National Monitoring Framework, the US Geological Survey (USGS) with support from USAID is developing national maps of land use and land cover, as well as maps documenting on-farm tree cover for baseline year 2017, the year the National FLR

Strategy was launched. These maps will provide data on the biophysical progress of FLR interventions in Malawi (e.g., percent of tree cover), which will serve to set a baseline for monitoring biophysical progress on the agricultural technologies, forest management, and community forest and woodlot restoration interventions [100] (p. 16)

These data are not just essential for forest monitoring, but also because they will inform other monitoring activities such as the Integrated Household Survey which considers community forests and woodlots in its assessment of local resources [100].

"In 2016, the Government of Malawi made a national pledge to the African Forest Landscape Restoration Initiative (AFR100) under the Bonn Challenge to restore 4.5 million hectares of degraded and deforested land by 2030" [100] (p. 3). Malawi has taken the bold step to not only make this pledge and have an increasing number of policies to support this goal, but Malawi now also has a 2018 framework to evaluate its progress towards reaching its pledge to "increase area of community forests and woodlots to 200,000 ha by 2020 and 600,000 ha by 2030" and "improve protection and management of 2 million ha of natural forest, restore 500,000 ha of degraded forest, and establish 100,000 ha of commercial plantations by 2030" [100] (p. 4).

References

1. Bare, M.; Kauffman, C.; Miller, D.C. Assessing the impact of international conservation aid on deforestation in sub-Saharan Africa. *Environ. Res. Lett.* **2015**, *10*, 125010. [CrossRef]
2. Ordway, E.M.; Asner, G.P.; Lambin, E.F. Deforestation risk due to commodity crop expansion in sub-Saharan Africa. *Environ. Res. Lett.* **2017**, *12*, 044015. [CrossRef]
3. Dimobe, K.; Ouédraogo, A.; Soma, S.; Goetze, D.; Porembski, S.; Thiombiano, A. Identification of driving factors of land degradation and deforestation in the Wildlife Reserve of Bontioli (Burkina Faso, West Africa). *Glob. Ecol. Conserv.* **2015**, *4*, 559–571. [CrossRef]
4. Rudel, T.K. The national determinants of deforestation in sub-Saharan Africa. *Philos. Trans. R. Soc. B Biol. Sci.* **2013**, *368*. [CrossRef] [PubMed]
5. Food and Agriculture Organization of the United Nations. *Atlas of Malawi Land Cover and Land Cover Change*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2013.
6. Mauambeta, D.; Chitedze, D.; Mumba, R. *Status of Forests and Tree Management in MALAWI*; Coordination Union for Rehabilitation of the Environment: Blantyre, Malawi, 2010.
7. Food and Agriculture Organization of the United Nations. *An Integrated Approach to Improve the Management of Forests and Other Natural Resources: The Case of Malawi*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2009.
8. Gowela, J.P.; Masamba, C.R. *State of Forest and Tree Genetic Resources in Malawi*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2002.
9. Ministry of Lands and Housing. *Malawi National Land Policy*; Government of the Republic of Malawi: Lilongwe, Malawi, 2002.
10. The Program on Governance and Local Development. *The Local Governance Performance Index (LGPI) in Malawi: Selected Findings on Land*; The Program on Governance and Local Development: Gothenburg, Sweden, 2016.
11. Minde, I.J.; Kowero, G.; Ngugi, D.; Luhanga, J. Agricultural land expansion and deforestation in Malawi. *For. Trees Livelihoods* **2001**, *11*, 167–182. [CrossRef]
12. National Statistical Office. *2018 Malawi Population and Housing Census*; Government of the Republic of Malawi: Lilongwe, Malawi, 2018.
13. Forestry Research Institute of Malawi. *State of the World's Forest Genetic Resources. Country Report: Malawi*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2013.
14. Bone, R.A.; Parks, K.E.; Hudson, M.D.; Tsirinzeni, M.; Willcock, S. Deforestation since independence: A quantitative assessment of four decades of land-cover change in Malawi. *South. For.* **2017**, *79*, 269–275. [CrossRef]
15. Munthali, M.G.; Davis, N.; Adeola, A.M.; Botai, J.O.; Kamwi, J.M.; Chisale, H.L.W.; Orimoogunje, O.O.I. Local perception of drivers of Land-Use and Land-Cover change dynamics across Dedza district, Central Malawi region. *Sustainability* **2019**, *11*, 832. [CrossRef]

16. Department of Forestry. *Malawi's National Forestry Programme: Priorities for Improving Forestry and Livelihoods*; Government of the Republic of Malawi: Lilongwe, Malawi, 2001.
17. World Bank GNI per Capita, Atlas Method (Current US$). Available online: https://data.worldbank.org/indicator/NY.GNP.PCAP.CD?locations=MW&view=chart&year_high_desc=false (accessed on 28 March 2019).
18. Meijer, S.S.; Catacutan, D.; Sileshi, G.W.; Nieuwenhuis, M. Tree planting by smallholder farmers in Malawi: Using the theory of planned behaviour to examine the relationship between attitudes and behaviour. *J. Environ. Psychol.* **2015**, *43*, 1–12. [CrossRef]
19. Meijer, S.S.; Sileshi, G.W.; Catacutan, D.; Nieuwenhuis, M. Agroforestry and deforestation in Malawi: Inter-linkages between attitudes, beliefs and behaviours. *Agrofor. Syst.* **2016**, *90*, 645–658. [CrossRef]
20. Meijer, S.S.; Sileshi, G.W.; Catacutan, D.; Nieuwenhuis, M. Farmers and forest conservation in Malawi: The disconnect between attitudes, intentions and behaviour. *For. Trees Livelihoods* **2016**, *25*, 59–77. [CrossRef]
21. Chavula, J. Smoke over Dzalanyama forest. *The Nation*, 20 April 2019; 8–9.
22. Kwesiga, F.; Mwanza, S. Underexploited wild genetic resources: The case of indigenous fruittrees in Eastern Zambia. In *Improvement of Indigenous Fruit Trees of the Miombo Woodlands of southern Africa*; Maghembe, J.A., Ntupanyama, Y., Chirwa, P.W., Eds.; PrimexPrinters, ICRAF: Nairobi, Kenya, 1995; pp. 100–112.
23. Maghembe, J.A.; Ntupanyama, Y.; Chirwa, P.W. *Improvement of Indigenous Fruit Trees of the Miombo Woodlands of Southern Africa*; PrimexPrinters, ICRAF: Nairobi, Kenya, 1995.
24. Campbell, B.M. The use of wild fruits in Zimbabwe. *Econ. Bot.* **1987**, *41*, 375–385. [CrossRef]
25. Lowore, J. *Miombo Woodlands and Rural Livelihoods in Malawi*; Center for International Forestry Research: Bogor, Indonesia, 2006.
26. Hecht, J.; Kasulo, V. *Development of Forest Valuation Systems Malawi*; Cardno Emerging Markets: London, UK, 2013.
27. Ministry of Natural Resources Energy and Mining. *National Forest Policy*; Government of the Republic of Malawi: Lilongwe, Malawi, 2016.
28. Yaron, G.; Mangani, R.; Mlava, J.; Kambewa, P.; Makungwa, S.; Mtethiwa, A.; Munthali, S.; Mgoola, W.; Kazembe, J. *Economic Valuation of Sustainable Natural Resource Use in Malawi*; Government of the Republic of Malawi: Lilongwe, Malawi, 2010.
29. Ministry of Natural Resources Energy and Environment. *Malawi State of Environment and Outlook Report*; Government of the Republic of Malawi: Lilongwe, Malawi, 2010.
30. Ngwira, S.; Watanabe, T. An Analysis of the Causes of Deforestation in Malawi: A Case of Mwazisi. *Land* **2019**, *8*, 48. [CrossRef]
31. Twongyirwe, R.; Bithell, M.; Richards, K.S. Revisiting the drivers of deforestation in the tropics: Insights from local and key informant perceptions in western Uganda. *J. Rural Stud.* **2018**, *63*, 105–119. [CrossRef]
32. KBA Partnership World Database of Key Biological Areas. Available online: http://www.keybiodiversityareas.org/site/factsheet/misuku-hills-forest-reserves-iba-malawi (accessed on 11 April 2019).
33. Wangai, P.W.; Burkhard, B.; Müller, F. A review of studies on ecosystem services in Africa. *Int. J. Sustain. Built Environ.* **2016**, *5*, 225–245. [CrossRef]
34. Droissart, V.; Dauby, G.; Hardy, O.J.; Deblauwe, V.; Harris, D.J.; Janssens, S.; Mackinder, B.A.; Blach-Overgaard, A.; Sonké, B.; Sosef, M.S.M.; et al. Beyond trees: Biogeographical regionalization of tropical Africa. *J. Biogeogr.* **2018**, *45*, 1153–1167. [CrossRef]
35. BirdLife International Misuku Hills Forest Reserves. Available online: http://datazone.birdlife.org/site/factsheet/misuku-hills-forest-reserves-iba-malawi (accessed on 2 April 2019).
36. Government of Malawi. *Malawi Vegetation/Biotic Communites*; Government of the Republic of Malawi: Lilongwe, Malawi, 1979.
37. Potts, D. Rural mobility as a response to land shortages: The case of Malawi. *Popul. Space Place* **2006**, *12*, 291–311. [CrossRef]
38. National Statistical Office. *Integrated Household Survey, 2016–2017*; Government of the Republic of Malawi: Lilongwe, Malawi, 2017.
39. Ministry of Natural Resources Energy and Mining. *National Landscape Restoration Strategy*; Government of the Republic of Malawi: Lilongwe, Malawi, 2017.
40. USAID. *Community Based Natural Resource Management: Stocktaking Assessment*; United States Agency for International Development: Washington, DC, USA, 2010.
41. Wang, C.; Burris, M.A. Empowerment through Photo Novella: Portraits of Participation. *Health Educ. Behav.* **1994**, *21*, 171–186. [CrossRef]

42. Wang, C.; Burris, M.A. Photovoice: Concept, methodology, and use for participatory needs assessment. *Health Educ. Behav.* **1997**, *24*, 369–387. [CrossRef]
43. Wang, C.C.; Yi, W.K.; Tao, Z.W.; Carovano, K. Photovoice as a participatory health promotion strategy. *Health Promot. Int.* **1998**, *13*, 75–86. [CrossRef]
44. Barndt, D. Making, naming, and connecting—Reclaiming lost arts: The pedagogical possibilities of photostory production. In *Participatory Practices in Adult Education*; Campbell, P., Burnaby, B., Eds.; Lawrence Erlbaum: Mahwah, NJ, USA, 2001; pp. 31–54.
45. Gallo, M. Immigrant workers' journeys through a new culture: Exploring the transformative learning possibilities of photography. *Stud. Educ. Adults* **2001**, *33*, 109–117. [CrossRef]
46. Luttrell, W. Making culture visible: Children's photography, identity and agency. In Proceedings of the Annual Meeting of the American Sociological Association, Montreal, QC, Canada, 11–14 August 2006.
47. McAllister, C.; Wilson, P.; Green, B.; Baldwin, J. Come and take a walk: Listening to Early Head Start parents on school-readiness as a matter of child, family, and community health. *Am. J. Public Health* **2005**, *95*, 617–625. [CrossRef] [PubMed]
48. Prins, E. Participatory photography: A tool for empowerment or surveillance? *Action Res.* **2010**, *8*, 426–443. [CrossRef]
49. Harris, J.C. Vulnerable Youth's Perspectives and Priorities for Informal Settlements: Photovoice Evidence from Lusaka, Zambia. *J. Plan. Educ. Res.* **2018**, *38*, 398–412. [CrossRef]
50. Wang, C.C. Photovoice: A participatory action research strategy applied to women's health. *J. Women's Health* **1999**, *8*, 185–192. [CrossRef] [PubMed]
51. Lykes, M. Creative arts and photography action research in Guatemala. In *Handbook of Action Research*; Reason, P., Bradbury, H., Eds.; SAGE Publications, Inc.: Thousand Oaks, CA, USA, 2001; pp. 363–371.
52. McIntyre, A. Through the eyes of women: Photovoice and participatory research as tools for reimagining place. *Gender Place Cult.* **2003**, *10*, 47–66. [CrossRef]
53. Chonady, J.; Ferman, B.; Amitrani-Welsh, J.; Martin, T. Violence through the eyes of youth: A Photovoice exploration. *J. Community Psychol.* **2013**, *41*, 84–101. [CrossRef]
54. Berbés-Blázquez, M. A participatory assessment of ecosystem services and human wellbeing in rural costa rica using photo-voice. *Environ. Manag.* **2011**, *49*, 862–875. [CrossRef]
55. Pereira, E.; Queiroz, C.; Pereira, H.M.; Vicente, L. Ecosystem services and human well-being: A participatory study in a mountain community in Portugal. *Ecol. Soc.* **2005**, *10*, 14. [CrossRef]
56. Action for Environmental Sustainability. *Misuku Hills Improved Livelihood and Biodiversity Conservation Project Biodiversity Survey Report*; Action for Environmental Sustainability: Blantyre, Malawi, 2015.
57. McConnell, R.; Sibale, B.; Utila, H. *Linking Forest Programmes and Poverty Reduction Strategies, Malawi*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2007.
58. Ministry of Natural Resources. *National Forest Policy*; Government of the Republic of Malawi: Lilongwe, Malawi, 1996.
59. Kamoto, J.F.; Dorward, P.T.; Shepherd, D.D. *Decentralised Governance of Forest Resources: Analysing Devotion Policy Processes and Their Effects on Decision Making in Communal Forest Management in Malawi*; International Association for the Study of the Commons: Utrecht, The Netherlands, 2008.
60. Ministry of Local Government and Rural Development. *Revised Decentralized Environmental Management Guidelines*; Government of the Republic of Malawi: Lilongwe, Malawi, 2012.
61. Millington, S.; Kaferawanthu, M. *Analysis of Biodiversity Threats & Opportunities in Malawi*; United States Agency for International Development: Washington, DC, USA, 2005.
62. World Bank. *Malawi Country Environmental Analysis*; The World Bank: Washington, DC, USA, 2019.
63. Ministry of Mines Natural Resources and Environment. *Standards & Guidelines for Participatory Forestry in Malawi*; Government of the Republic of Malawi: Lilongwe, Malawi, 2013.
64. Reytar, K.; Ray, S.; Toh, L. Malawi is Putting its Money Where Its Forests Are. Available online: https://www.wri.org/blog/2018/12/malawi-putting-its-money-where-its-forests-are (accessed on 30 March 2019).
65. Mwale, J. Youth scheme in shambles. *The Nation*, 21 April 2019; 4–5.
66. USAID COMPASS ll: Community Partnerships for Sustainable Resources Management in Malawi. Available online: https://rmportal.net/library/content/tools/compass-ii (accessed on 3 April 2019).
67. USAID. *Final Project Report*; United States Agency for International Development: Washington, DC, USA, 2009.

68. LTS International Improved Forest Management for Sustainable Livelihoods Programme. Available online: https://www.ltsi.co.uk/project/malawi-improved-forest-management-for-sustainable-livelihoods-programme (accessed on 5 April 2019).
69. GOPA Worldwide Consultants. GOPA Project Database. Available online: https://www.gopa.de/en/projects/improved-forest-management-sustainable-livelihoods-programme-ifmslp-phase-ii (accessed on 6 April 2019).
70. Zulu, L. Bringing people back into protected forests in developing countries: Insights from co-management in Malawi. *Sustainability* **2013**, *5*, 1917–1943. [CrossRef]
71. TRANSTEC SA. *Final Evaluation of Improved Forest Management for Sustainable Livelihoods Programme*; TRANSTEC: Brussels, Belgium, 2012.
72. Action for Environmental Sustainability. *Matipa Forest Management Plan*; Action for Environmental Sustainability: Blantyre, Malawi, 2010.
73. Mazanga, G. *Misuku Hills Indigenous Forest Project Final Project Completion Report*; Sustainable Development Initiative: Blantyre, Malawi, 2016.
74. Misuku Hills Beekeepers Association. *Misuku Beekeeping Value Addition Project Completion Report*; Misuku Hills Beekeepers Association: Chitipa, Malawi, 2016.
75. UNDP Promotion of Indigenous Forests in the Misuku Hills Area. Available online: https://sgp.undp.org/spacial-itemid-projects-landing-page/spacial-itemid-project-search-results/spacial-itemid-project-detailpage.html?view=projectdetail&id=20503 (accessed on 11 April 2019).
76. Kumbani, P. Misuku Hills, hidden treasure. *The Nation*, 28 March 2017.
77. Sustainable Development Initiative. *CEPF Small Grant Final Project Completion Report*; Sustainable Development Initiative: Blantyre, Malawi, 2017.
78. Byers, B. *Conserving the Miombo Ecoregion*; WWF Southern Africa Regional Programme Office (SARPO): Harare, Zimbabwe, 2001; p. 32.
79. Campbell, B.M.; Angelsen, A.; Cunningham, A.B.; Katerere, Y.; Sitoe, A.A.; Wunder, S. *Miombo Woodlands—Opportunities and Barriers to Sustainable Forest Management*; CIFOR: Bogor, Indonesia, 2007; p. 41.
80. The Economist Intelligence Unit. *Democracy Index 2018: Me too?* The Economist Intelligence Unit: London, UK, 2019.
81. Miller, T.; Kim, A.B.; Roberts, J.M. *2019 Index of Economic Freedom*; The Heritage Foundation: Washington, DC, USA, 2019.
82. Remme, H.; Muyambi, F.; Kamoto, J.; Dengu, E. *A Technical Review of Community Based Forest Management on both Customary Land and Forest Reserves (Participatory Forest Management)*; TRANSTEC: Brussels, Belgium, 2015.
83. M'bwana, L. Malawi Government Will Continue Using Army Soldiers to Protect Forest Reserves from Further Depletion. Available online: http://www.maravipost.com/malawi-government-will-continue-using-army-soldiers-protect-forest-reserves-depletion/ (accessed on 14 April 2019).
84. Mkwapatira, M. Malawians plant over 50 million trees. *The Nation*, 22 April 2019; 3.
85. Chinangwa, L.; Sinclair, F.; Pullin, A.S.; Hockley, N. Can co-management of government forest reserves achieve devolution? Evidence from Malawi. *For. Trees Livelihoods* **2016**, *25*, 41–58. [CrossRef]
86. Zulu, L.C. Community Forest Management in Southern Malawi: Solution or Part of the Problem? *Soc. Nat. Resour.* **2008**, *21*, 687–703.
87. Chinangwa, L.L.; Pullin, A.S.; Hockley, N. Impact of forest co-management programs on forest conditions in Malawi. *J. Sustain. For.* **2017**, *36*, 338–357. [CrossRef]
88. Mtambo, C.; Missanjo, E. The Impact of Participatory Forest Management on Tree Species Abundance and Diversity in Selected Village Forest Areas in Kasungu, Malawi. *J. Ecol. Environ. Sci.* **2015**, *3*, 15–20.
89. Sunderlin, W.D.; Angelsen, A.; Belcher, B.; Burgers, P.; Nasi, R.; Santoso, L.; Wunder, S. Livelihoods, forests, and conservation in developing countries: An Overview. *World Dev.* **2005**, *33*, 1383–1402. [CrossRef]
90. Salafsky, N.; Wollenberg, E. Linking livelihoods and conservation: A conceptual framework and scale for assessing the integration of human needs and biodiversity. *World Dev.* **2000**, *28*, 1421–1438. [CrossRef]
91. Mather, A.; Needle, C. The Forest Transition: A Theoretical Basis. *Area* **1992**, *2*, 117–124. [CrossRef]
92. Rudel, T.K.; Coomes, O.T.; Moran, E.; Achard, F.; Angelsen, A.; Xu, J.; Lambin, E. Forest transitions: Towards a global understanding of land use change. *Glob. Environ. Chang.* **2005**, *15*, 23–31. [CrossRef]
93. Rudel, T.K. Is there a forest transition? Deforestation, reforestation, and development. *Rural Sociol.* **1998**, *63*, 533–552. [CrossRef]

94. Nyirongo, K. Human Activity Endanger Bird Species in Misuku. Available online: http://www.manaonline.gov.mw/index.php/national/environment/item/6955-human-activity-endanger-bird-species-in-misuku (accessed on 22 April 2019).
95. Plummer, R.; Fennell, D. Exploring co-management theory: Prospects for sociobiology and reciprocal altruism. *J. Environ. Manag.* **2007**, *85*, 944–955. [CrossRef]
96. Trivers, R.L. The evolution of reciprocal altruism. *Q. Rev. Biol.* **1971**, *46*, 35–57. [CrossRef]
97. Bunderson, W.T.; Hayes, I.M. Agricultural and environmental sustainability in Malawi. In Proceedings of the Conference on Sustainable Agriculture for Africa, Abidjan, Cote d'Ivoire, 17–21 July 1995.
98. Center for Environmental Policy and Advocacy. *National Forest Policy in Malawi*; Center for Environmental Policy and Advocacy: Blantyre, Malawi, 2010.
99. Haack, B.; Mahabir, R.; Kerkering, J. Remote sensing-derived national land cover land use maps: A comparison for Malawi. *Geocarto Int.* **2015**, *30*, 270–292. [CrossRef]
100. The Ministry of Natural Resources Energy and Mining. *A Framework for Monitoring Progress on Malawi's National Forest Landscape Restoration*; Government of the Republic of Malawi: Lilongwe, Malawi, 2018.

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Deforestation and Connectivity among Protected Areas of Tanzania

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Abstract: Protected Areas (PAs) in Tanzania had been established originally for the goal of habitat, landscape and biodiversity conservation. However, human activities such as agricultural expansion and wood harvesting pose challenges to the conservation objectives. We monitored a decade of deforestation within 708 PAs and their unprotected buffer areas, analyzed deforestation by PA management regimes, and assessed connectivity among PAs. Data came from a Landsat based wall-to-wall forest to non-forest change map for the period 2002–2013, developed for the definition of Tanzania's National Forest Reference Emissions Level (FREL). Deforestation data were extracted in a series of concentric bands that allow pairwise comparison and correlation analysis between the inside of PAs and the external buffer areas. Half of the PAs exhibit either no deforestation or significantly less deforestation than the unprotected buffer areas. A small proportion (10%; $n = 71$) are responsible for more than 90% of the total deforestation; but these few PAs represent more than 75% of the total area under protection. While about half of the PAs are connected to one or more other PAs, the remaining half, most of which are Forest Reserves, are isolated. Furthermore, deforestation inside isolated PAs is significantly correlated with deforestation in the unprotected buffer areas, suggesting pressure from land use outside PAs. Management regimes varied in reducing deforestation inside PA territories, but differences in protection status within a management regime are also large. Deforestation as percentages of land area and forested areas of PAs was largest for Forest Reserves and Game Controlled areas, while most National Parks, Nature Reserves and Forest Plantations generally retained large proportions of their forest cover. Areas of immediate management concern include the few PAs with a disproportionately large contribution to the total deforestation, and the sizeable number of PAs being isolated. Future protection should account for landscapes outside protected areas, engage local communities and establish new PAs or corridors such as village-managed forest areas.

Keywords: deforestation; isolation; protected areas; buffer areas; Tanzania

1. Introduction

Overwhelming evidence shows that Protected Areas (PAs) in the form of either National Parks, Forest Reserves or other forms of protection have lower deforestation rates than unprotected landscapes [1–5]. Establishing and managing protected areas is, thus, one of the most important policy tools for achieving environmental, natural resource conservation and climate goals. Following this premise, the United Nations Convention on Biological Diversity [6] recommends each country establish and manage protected areas to conserve biological diversity. The United Nations 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs) recognize protected areas as a key strategy for biodiversity conservation and sustainable development in the targets

they contain, such as the Aichi Biodiversity Target 11, SDG goals 14 and 15 [7]. Furthermore, an opportunity was presented for conservation of tropical forests through the United Nations Climate Agreement [8] on reducing emissions from deforestation and degradation, plus forest management and conservation, and enhancement of carbon stock (REDD+). Therefore, the most important immediate steps to achieve these goals include intensive conservation of existing protected areas, establishing additional conservation areas of tropical forests, and supporting areas of high conservation benefits in terms of carbon, biodiversity and other ecosystem services.

The United Nations [9] records more than 200,000 protected areas worldwide, of which 840 are in Tanzania. Tanzania indeed devoted a sizeable proportion of its land area (36%) for conservation, with an original goal of conserving forests, landscapes and wildlife. PAs in Tanzania are currently managed most commonly by the central government or local authorities, either as Forest Reserves, Game Controlled areas, Game Reserves, National Parks, Nature Reserves, Village Forest Reserves or Forest Plantations. Tanzanian PAs include some UNESCO world heritage sites such as the Kilimanjaro and Serengeti National Parks, Selous Game Reserve and Ngorongoro Conservation Area; and series of PAs with exceptional endemism along the Eastern Arc Mountains. Tanzanian PAs are generally regarded as biodiversity hotspot, with over 10,000 plant species, hundreds of which are nationally endemic. Of the plant and animal species, 724 are identified as "threatened" in the Red List of the International Union for Conservation of Nature (IUCN), with 276 species classified as "endangered" [10].

Other than biodiversity conservation, PAs in Tanzania are offering an increasingly diverse set of ecosystem services. Among them is the significant contribution to the national economy through tourism revenues, most popular of which is ecotourism, involving natural environments and wildlife, through which Tanzania remained the best safari destination in Africa. As a result, Tanzania's tourism sector is one of the most significant income earners. Furthermore, the sheer size (total area) and the large number and diversity of PAs in Tanzania means that their role in mitigation to climate change through carbon sequestration, and thus the potential to garner financial benefits, is enormous.

Deforestation caused by human activities such as agricultural expansion, charcoal production and illegal logging inside and within the buffer areas can undermine the ecosystem and climate benefits of PAs. Deforestation in buffer areas further undermines the connectivity among PAs, and thus lead to isolation [11], which in turn can potentially cause restriction of the ability of plant and animal species to relocate to new geographic areas as well as changing plant community structure and diversity within PAs because of herbivore concentration [12]. Consequently, conservation and connectivity of PAs have international significance as the Aichi Target 11 of the Convention on Biological Diversity demands countries have at least 17% of the land covered by well-connected PA systems by 2020 (IUCN). The Millennium Ecosystem Assessment [13] has long identified deforestation as the primary driver of biodiversity loss. Therefore, reducing deforestation and improving the connectivity of PAs play fundamental role to ensure species survival, particularly in the context of habitat protection. Habitat fragmentation and isolation that can be caused by anthropogenic activities obstruct the possibility for genes and species to move amongst protected areas [14].

Annual deforestation in Tanzania was close to 470,000 ha between 2002 and 2013 [15], which constitutes a significant contribution of the total anthropogenic emissions from the land-use change in the country. These would provide the theoretical basis for strengthening the protection of existing conservation areas, allocating additional areas of conservation and improving the connectivity of PAs. Tanzania acknowledges deforestation as a major threat to biodiversity and ecosystem services, and is committed to most of the targets in the Convention on Biological Diversity [16]. This includes a commitment to effectively manage existing protected areas (Target 11), and to significantly reduce the rate of degradation and fragmentation of ecosystems and the loss of habitats (Target 5). However, forest cover loss due to deforestation inside PAs and in their external buffer areas are often not objectively quantified and analyzed, particularly given the vast size and number of PAs in Tanzania. Studies that quantify deforestation inside of PAs and assess connectivity and isolation would be useful to understand the climate change mitigation potentials and the conservation benefits of PAs.

This study draws on the best available Landsat based remote sensing data of forest cover change for the period 2002–2013, to assess deforestation within PAs and their external buffer areas in Tanzania. The specific objectives are (1) to evaluate deforestation inside and within the buffer areas of PAs, (2) evaluate connectivity between PAs, the lack of which can potentially lead to isolation, and (3) whether and to what extent deforestation among PAs vary by PA management regimes.

2. Data and Method

2.1. Study Area

The study area covers the mostly centrally managed PAs and those located in mainland Tanzania where they are collectively known as Conservation Areas. These are sub-grouped based on management regimes as National Parks (NP), Game Reserves (GR), Game Controlled (GC) areas, Nature Reserves (NR), Forest Reserves (FR), and Forest Plantations (FP) (Figure 1). General characteristics of the management regimes are summarized in Table 1. We excluded PAs designated as village forest reserves and wildlife management areas, due to inadequate spatial coverage data and lack of accurate shape polygons. In addition, we also removed 48 small PAs (area = 0–10 ha) located either on islands or mostly mangroves near the cost as they were not adequately covered by either the shape files or the deforestation map. Additional areas that are excluded from the analysis include buffers overlapping with water bodies or territories of other countries. The study finally included 708 PAs covering a total area of nearly 31 million ha and their corresponding unprotected buffer areas of more than 60 million ha within a range of 0–10 km surrounding each PA.

Table 1. Characteristics of the six Protected Area (PA) management regimes in main land Tanzania.

PA Management Regimes	Number of PAs	Management Regime Total Area (1000 ha)	Managing Authority
Forest plantations	23	73	Tanzania Forest Services
Forest Reserves	625	9316	Tanzania Forest Services
Game Controlled Areas	19	7101	Tanzania Wildlife Management Authority
Game Reserves	19	9426	Tanzania Wildlife Management Authority
National Parks	16	4851	Tanzania National Parks Authority
Nature Reserves	6	200	Tanzania Forest Services
Total	*708*	*30,967*	Tanzania, National

2.2. Data

PA polygons: we obtained data for the location and boundary polygons of the 708 PAs from the World Database for Protected Areas (WDPA) updated January 2019 [17], managed by the United Nations Environment World Conservation Monitoring Centre (UNEP-WCMC) with support from IUCN and its World Commission on Protected Areas (WCPA) (Protectedplanet.net).

Deforestation data: we extracted data for 11 years (2002–2013) of deforestation area for all PAs and their buffer areas from a wall-to-wall deforestation map of Tanzania, developed for the purpose of Forest Reference Emission Level (FREL) of Tanzania (FREL) [15]. The wall-to-wall deforestation map was developed from changes from Landsat 7 Enhanced Thematic Mapper Plus (ETM+) (2002) to Landsat 8 Operational Land Imager (OLI) (2013), covering the entire mainland Tanzania. The deforestation map used a total of 85 Landsat 7 ETM+ (2002) and Landsat 8 (2013) images, with a resolution of 30 m. The Landsat 7 ETM+ scenes were pre-processed by the USGS to surface reflectance level using the Landsat Ecosystem Disturbance Adaptive Processing System (LEDAPS) atmospheric and topographic correction algorithm. The Landsat 8 scenes were pre-processed to surface reflectance level by the United States Geological Survey USGS internal L8SR algorithm.

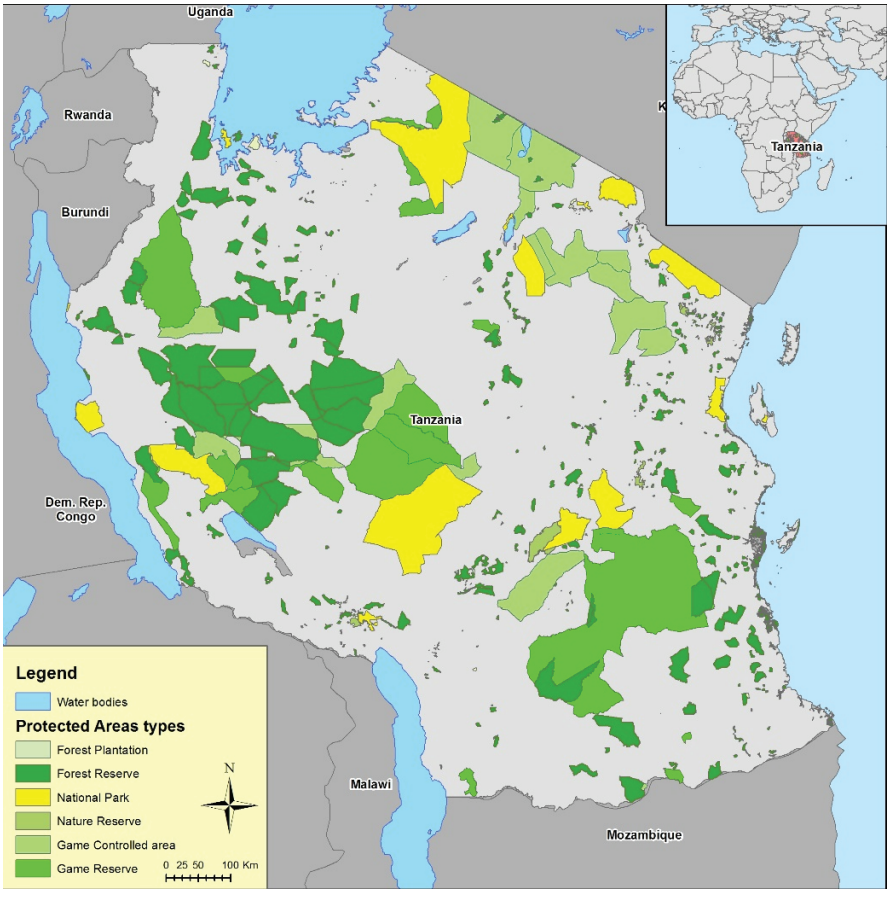

Figure 1. Location of Tanzania in Africa and Protected Areas (PAs) in Tanzania by management regimes. The different colors (except the blue which are water bodies) represent management regimes, namely (in no particular order), National Parks (NP), Game Reserves (GR), Game Controlled (GC) area, Nature Reserves (NR), Forest Reserves (FR), and Forest Plantations (FP).

The advantage of the wall-to-wall deforestation data used here over other change maps such as Global Forest Watch include, (1) Forest definition used for classification was based on predetermined national forest definition based on forest area (at least 0.5 ha), crown cover (at least 10%) and potential tree height (at least 3 m); (2) the land-use classification was monitored and evaluated by expertise with knowledge of the area, and (3) the accuracy of the deforestation map was evaluated using a combination of the National Forest Inventory (NAFORMA) plot data of the 2010 and the Regional Centre for Mapping and Resource Development (RCMRD) Land use land cover map of Tanzania.

We extracted deforestation data as land-cover change from forest to non-forest (ha) for all PAs for the period 2002–2013. We also extracted deforestation data for pairs of internal and external buffers in concentric bands of 0–0.5 km, 0.5–1 km, 1–5 km and 5–10 km measured from the boundary of each PA. Internal buffers here after refer to areas just inside the boundaries of the PAs towards the center of the PAs, while external buffers refer to areas just outside the boundaries of the PA. For the construction of the concentric bands in the external buffer zones, areas that fall either on another PA, water bodies, or outside of the territories of Tanzania were excluded. For those PAs where the internal concentric bands were not possible to construct (i.e., size of the PA smaller than the concentric band area), the

deforestation for that concentric band was estimated as the deforestation of the entire PA. Where PAs overlap, the areas are merged for total area estimation. Figure 2 shows the work flow in ArcGis on the simultaneous construction of concentric bands, and extraction of data on each PA and its corresponding concentric bands from the deforestation data, and thweir export to a worksheet. In the absence of data from field observation or measurements of the period, only visual validation was made using independent images from space imagery providers including Google Earth, Environmental Systems Research Institute (ESRI) and DigitalGlobe for selected PAs and buffer areas.

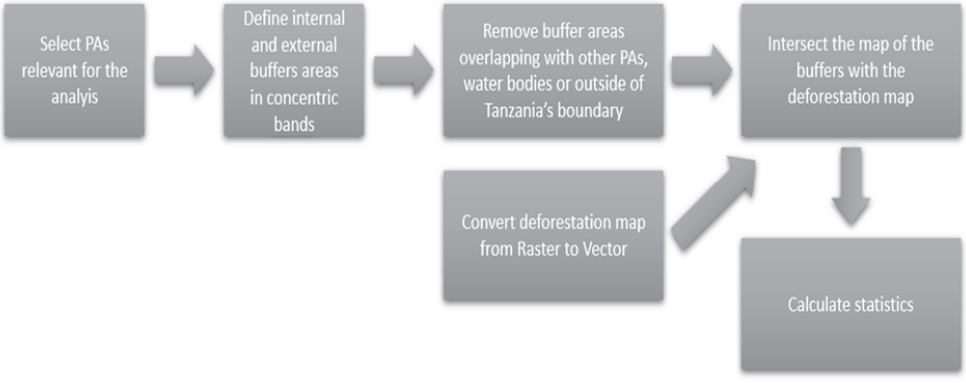

Figure 2. Work flow diagram in ArcGis for the simultaneous construction of concentric bands and extraction of data and output to worksheet.

2.3. Statistical Analysis

Deforestation inside and within the buffer areas of PAs: deforestation was defined as an area converted from forest to non-forest (ha) within each PA and estimated as the sum of the areas of individual pixels with forest-to non-forest conversion during the period 2002–2013. Proportion of the area deforested was then estimated as (a) the ratio of the area deforested to the total area of the PA, which indicates the absolute forest to non-forest conversion rate; and (b) the ratio of the area deforested to the total area of the forest within the PA at the beginning of the monitoring period, which indicates the relative forest to non-forest conversion rate. Further, proportion of the area deforested within each buffer area was calculated as the ratio of area deforested within the given concentric band (0–0.5; 0.5–1; 1–5; 5–10 kms) divided by the area of that concentric band. The metric allows pairwise comparisons and correlations analysis between the rates of deforestation inside the boundaries and that of unprotected buffer areas.

Connectivity and isolation of PAs: given the lack of indicators or quantitative criterion to define connectivity or the lack of it (isolation); we identified PAs surrounded by unprotected landscapes, and no connection to the neighboring PA(s) within at least 1 km from their boundaries. We identified such PAs as "isolated" and assessed their unprotected external buffer areas for deforestation in an increasing distance within 0–0.5; 0.5–1; 1–5; 5–10 km from their boundaries. Pairwise *t*-test and correlation analysis were used between deforestations inside boundaries of isolated PAs and the corresponding buffer areas with increasing distances to assess the pressure of activities outside the PA boundaries on the corresponding PAs.

PA management effects: we used the generalized linear model (GLM) for the analysis of variance (ANOVA) to test the variations in deforestation among the six PA management categories (FP, FR, GC, GR, NP, and NR). Since there is a considerable size variation among the PAs, the GLM considered the area-weighted mean. An alternative approach was an ANOVA accounting for PA management, PA size, and PA management by PA size interaction, but this produced the same results and thus the latter was omitted. Following ANOVA, the Duncan's multiple range test was used to compare the area-weighted mean deforestation among the six management categories. PA size effects entered the

analyses by dividing PAs into three size-based cohorts. After preliminary tests, three percentile-based cohorts were found to be sufficient. These are PAs with size less than or equal to the 25th percentile (Q1); PAs that are larger than the 25 percentile and less than or equal to the 75 percentile (Q2); PAs that are larger than the 75th percentile (Q3). These cohorts were further used to test whether PAs in the smaller cohorts are disproportionately deforested than those in the larger cohorts.

3. Results

3.1. Deforestation inside Protected Areas (PAs) and the Buffer Areas

Annual deforestation averaged 140 422 (STD = 922) ha during 2002–2013, which in absolute terms amounts to 5% of the total land area of all PAs combined. The corresponding annual forest loss within the PAs was about 0.8%. At the individual PA level, deforestation varied widely among PAs. About 23% (n = 160) of the PAs received effective and fortress type protection and thus no deforestation. This includes most National Parks and series of Forest Reserves, such as PAs along the Usambara Mountains (Figure 3). In contrast, some PAs have lost more than 50% of their forested areas during the same period (e.g., Makere South Forest Reserve). Deforestation was rather concentrated in few, larger PAs. A small proportion (10%, n = 71) of the PAs contributed more than 90% of the total deforestation during the monitoring period. However, in terms of land area, these 71 PAs represent 77% of the total protected areas. Inside deforested PAs, more deforestation in general occurred near the periphery of their boundaries than the interior. Comparing deforestation rates in the inside peripheries of PAs and their external buffer areas, 51% (n = 359) of the 708 PAs exhibited significantly lower deforestation rates. Table 2 summarizes the characteristics of deforestation among PA management regimes. Figure 3 visually demonstrates selected PAs representing highly protected and highly deforested PAs; and Figure 4 contrasting protection inside and the buffer areas.

Table 2. Summary of PA characteristics: number and size of PAs, total 11 years (2002–2013) deforestation (ha), and area deforested as percentage of PAs total management area, and PA forest area at the beginning of monitoring period.

PA Management Regime	Deforestation (ha)	Deforestation, Percent of Forested Area within PA	Deforestation, Percent of the Management Area
Forest plantations	875	1.4	1.2
Forest Reserves	806,544	12.6	8.6
Game Controlled Areas	432,280	13.4	6.1
Game Reserves	267,060	5.4	2.8
National Parks	37,875	2.2	0.78
Nature Reserves	446	0.2	0.22
Total	*1,545,080*	*9.3*	*5*

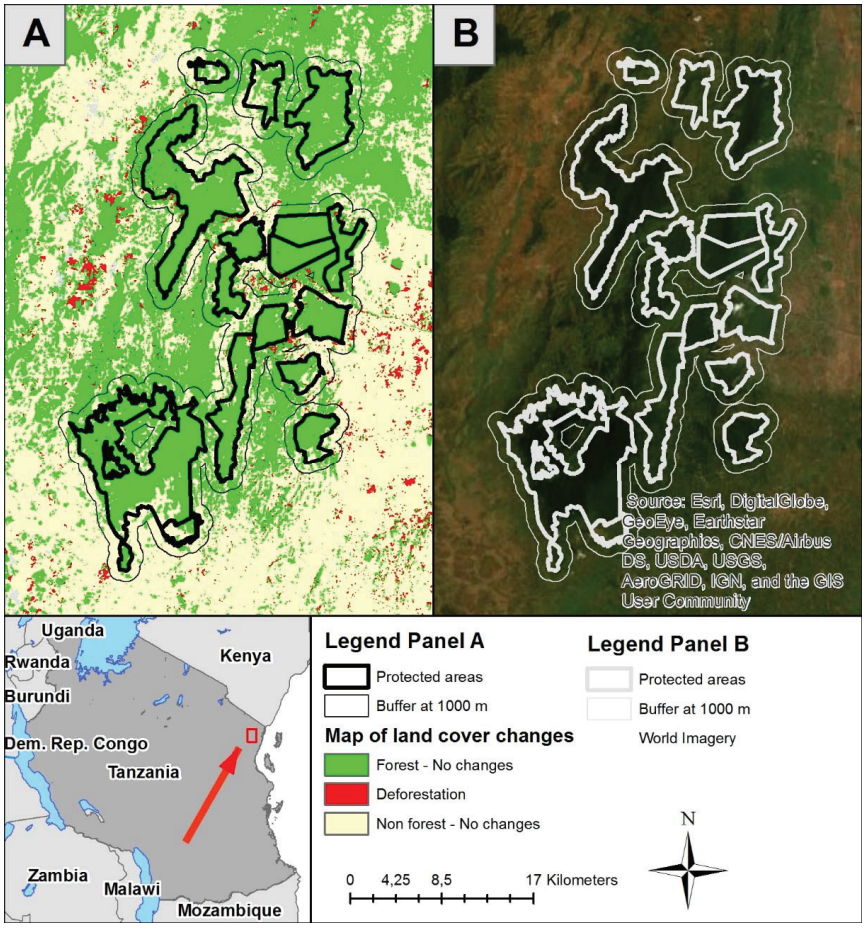

Figure 3. Series of PAs along the Usambara Mountains of northeastern Tanzania along the eastern most ranges of the Eastern Arc Mountains. Note: effective protection with few spots or no deforestation inside and the buffer areas of the PAs. The buffer area in the figure is 1 km non-overlapping zone surrounding the PA network. Panel (**A**) is. of this study; and Panel (**B**) is image from space imagery providers.

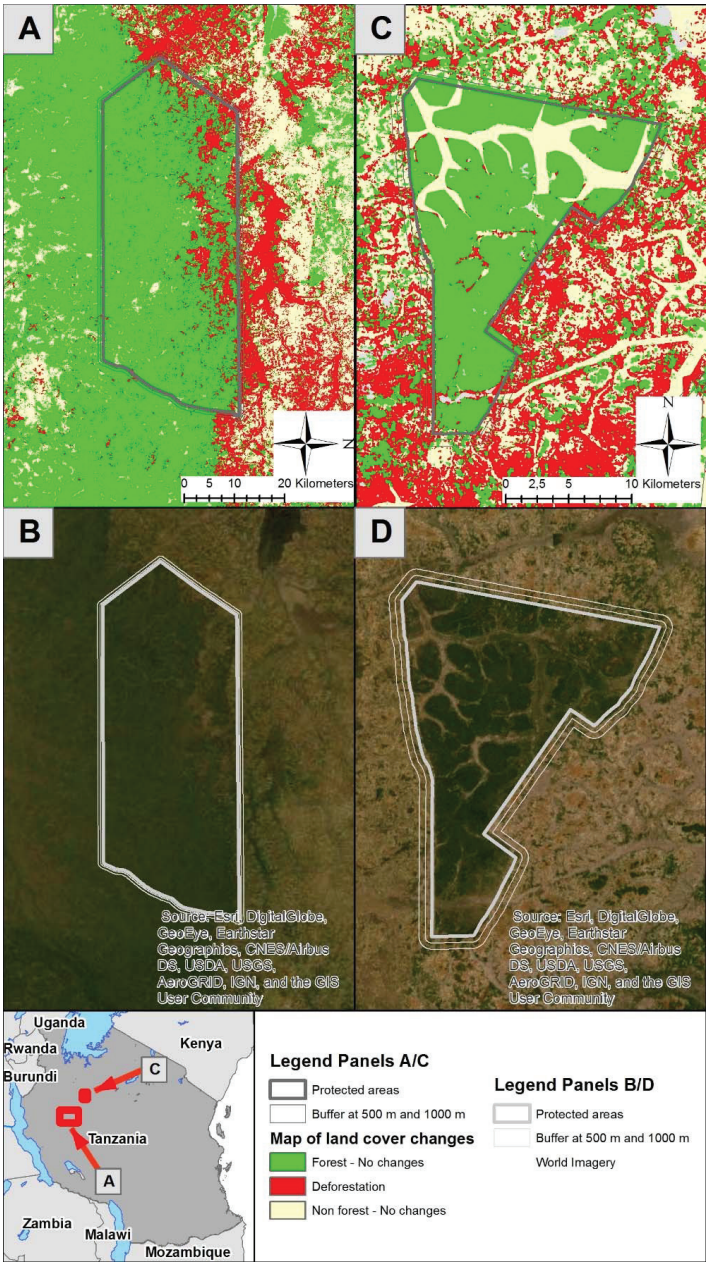

Figure 4. Example of PAs with negligible deforestation inside their boundaries (Panels (**C**,**D**), Karitu Forest Reserve) and with a sizeable and advancing deforestation inside the boundary (Panels (**A**,**B**); Ugala North Forest Reserves), in western Tanzania.

3.2. Connectivity and Isolation of PAs

The analysis on connectivity showed that 352 PAs are at least 0.5 km away from their neighboring PAs while 293 PAs are at least 1 km away from the nearest PA. In terms of management regime, these isolated PAs mostly belong to the Forest Reserves, consistent with their higher number among the different regimes. In general, in the buffer areas of PAs, deforestation rates were lower in areas closer to the external boundaries (in the buffer zone 0–1 km) than those further away, e.g., in the buffer zones 5–10 km (e.g., Figures 5 and 6). Deforestation in buffer areas as percent of the unprotected buffer areas in a range of 0–10 km was estimated at 7%. We found a strong and positive correlation ($p < 0.0001$) between deforestation inside the boundaries and deforestation in the buffer areas, although declining with distance. Figure 5 shows two isolated PAs (Matogoro West and Matogoro East), where deforestation inside is highly correlated with deforestation in the outside buffer areas. A series of PAs across Tanzania, for example those located along the central part of the Eastern Arc Mountains, shows evidence of lack of connectivity, which we defined as an indicator of isolation (Figure 6).

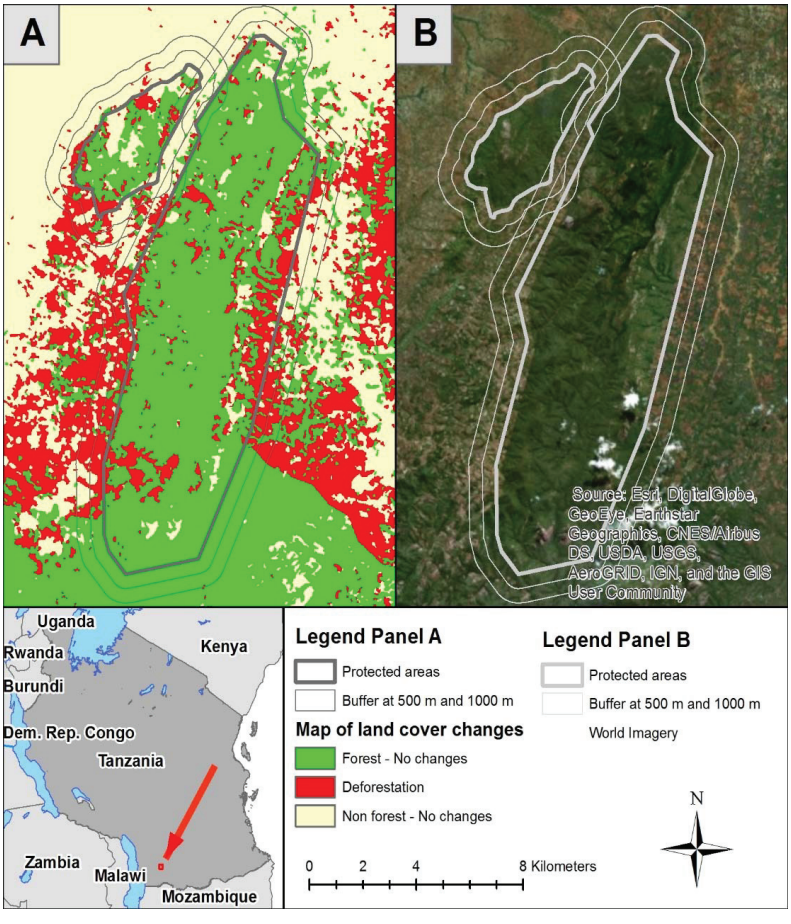

Figure 5. Deforestation in the buffer areas of two isolated PAs (Forest Reserves of Matogoro West and Matogoro East), Southern Tanzania. Panel (**A**) is of this study; and Panel (**B**) is image from space imagery providers.

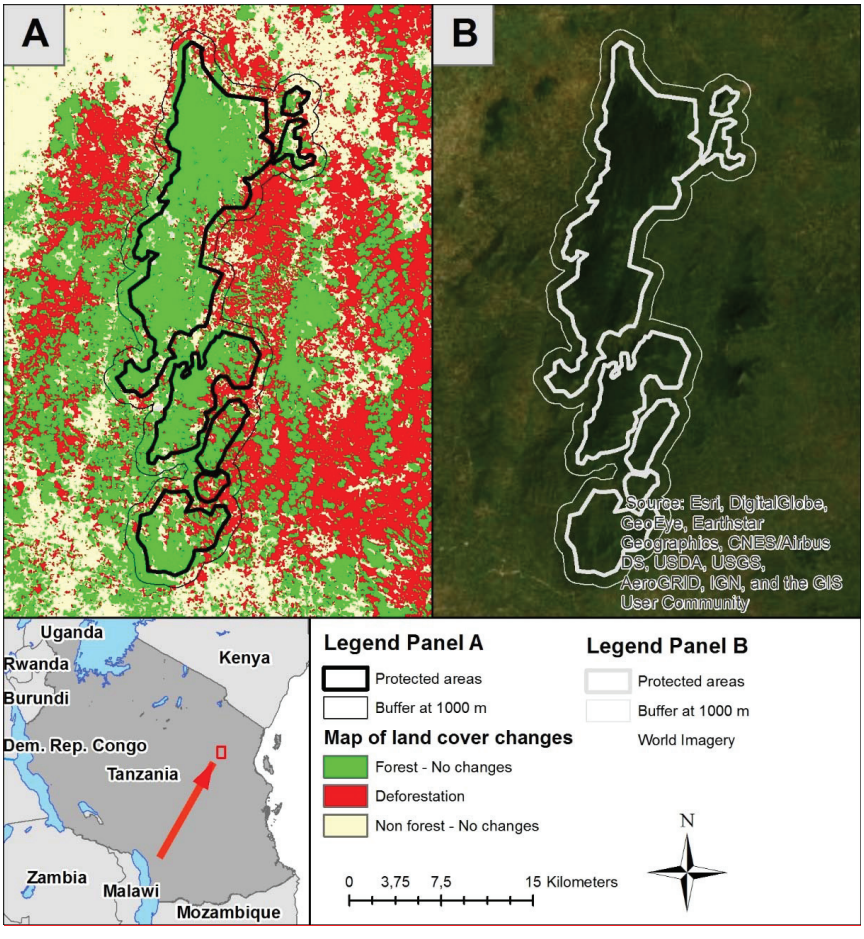

Figure 6. Deforestation inside and the buffer areas of mostly disconnected PAs (Forest Reserves) along the Eastern Arc mountains in Eastern Tanzania. PAs in figure are (North to South): Nguru North, Mamboto, Mkongo, Nderema, Pumula, Mbwegere, and MKuli Forest Reserves. Panel (**A**) is. of this study; and Panel (**B**) is image from space imagery providers.

3.3. PA Management Effects

Results of analysis of variance (ANOVA) revealed that the differences in area-weighted mean deforestation among PA management regimes are significant ($p < 0.0001$). An alternative ANOVA that considered PA management categories, PA size and interaction effects also revealed significant ($p < 0.0001$) management, size and interaction effects. Following ANOVA, the results of Duncan's means grouped the six management categories into three. Game Controlled Areas presented the highest area-weighted mean annual deforestation; followed by Forest Reserves, Game Reserves and National Parks; while Forest Plantations, and Nature Reserves exhibit the lowest (Figure 7). Therefore, most of the deforestation in Tanzanian PAs during the period occurred in Game Controlled Areas and Forest Reserves. However, this does not mean that deforestation is high in all Game Reserves or Forest Reserves; given the large variations within protection status of same management regime (Figure 7). The percentage of deforestation during the entire 11 years (deforestation as percent of total PA area) is the highest in Forest Reserves, followed by the Game Controlled areas while the lowest was in Nature

Reserves. Controlling management effects, deforestation was significantly small for the lowest size cohort (Q1) ($p < 0.05$), while there is no significant difference between the median (Q2) and the higher cohort (Q3).

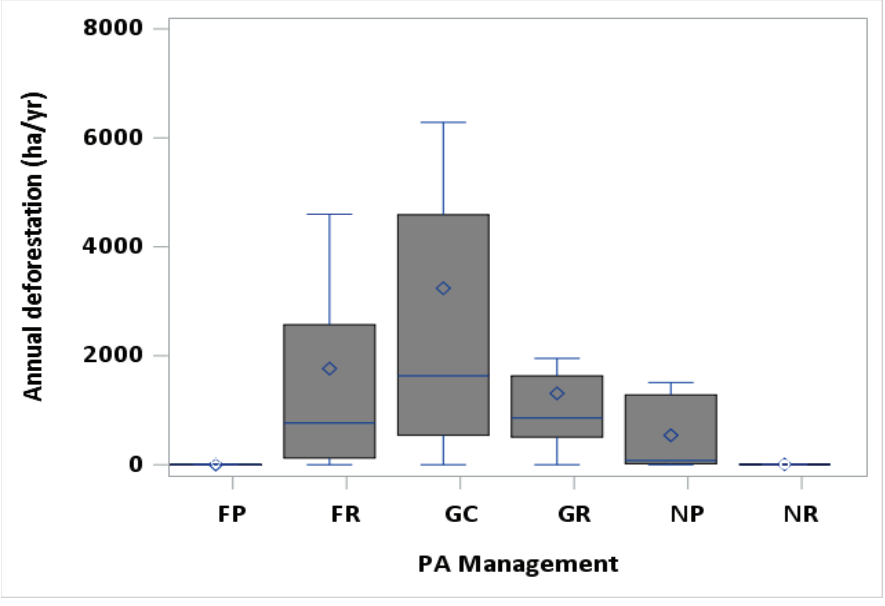

Figure 7. Area-weighted annual deforestation rates (ha/yr) in protected areas of Tanzania (*n*/; = 708) and the six PA management regimes namely Forest Plantations (FP), Forest Reserves (FR), Game Controlled areas (GC), Game Reserves (GR), National Parks (NP) and Nature Forest Reserves (NR).The central notched line is the median, and the diamonds are the area-weighted mean; and the whiskers are the lower and the upper confidence limit.

4. Discussions

4.1. Deforestation and Isolation of PAs

The estimated annual deforestation rate of 0.45% among PAs during the 11 years of the monitoring period is a significant reduction compared to an estimated annual deforestation rate of 0.63% for the unprotected buffer areas. This is further strengthened by the finding that two-thirds of the PAs have significantly less deforestation than the surrounding landscapes, including those with no or negligible deforestation inside their boundaries. This includes some of the famous National Parks and Nature Reserves with little or no deforestation, being inaccessible and fortressed. This suggests PAs have contributed in reducing the otherwise ferocious annual deforestation rate of 0.7% in Tanzania during the same period, 2002–2013 [15]. Therefore, protection can be an effective strategy for reducing deforestation, consistent with some recent studies [18]. These relatively well protected PAs represent 22% of the land area of Tanzania; meaning Tanzania has already succeeded in achieving the 17% target of its territory as protected defined by the Convention on Biological Diversity [16]. This demonstrates Tanzania's commitment to conservation as a signatory of major international biodiversity treaties, and by implementing domestic conservation laws and regulations enshrined in the National Forest Act of 2002.

However, our results showing some PAs that are deforested as much as the unprotected buffer areas and some that have lost up to 50% of their forested area during the 11 years indicates that not all PAs received similar protection status. This is common in a number of rainforest areas and regions with

large number of protected areas, where protection resulted in mixed outcomes in terms of reducing deforestation [2,3,5,19–22]. Uniquely for Tanzania, however, only few large PAs (n = 75) represent the great majority (>90%) of deforestation. These highly deforested PAs should remain a management concern, because despite their number, they represent more than two thirds of the protected area in Tanzania in terms of size.

On the other hand, more than 50% of Tanzanian PAs are well connected to one or more neighboring PAs, particularly those in western Tanzania connected to Katavi national park and those in the south western Tanzania surrounding the Selous Game reserve (Figure 1). This makes Tanzania one of the few countries fulfilling the Aichi Target of "well-connected" PAs [16]. While these results may be encouraging, we also found the remaining half, most of which are Forest Reserves (371 Forest Reserves), are isolated by at least 0.5 km, often surrounded by land use or landcover other than forests. Other studies [18,23] showed that unprotected landscapes adjacent to many protected areas have been converted to other land uses. In many cases, isolation becomes the reason for deforestation to push into the boundaries of PAs, threatening the effectiveness of PAs to maintain viable forest and protect biodiversity in the long term [14].

The significantly strong correlation between deforestation in the buffer areas and deforestation inside PAs shown in this study suggests that PAs are being influenced by human activities outside their boundaries. In particular, Forest Reserves and Game Controlled areas that are located near or inside of human dominated landscapes are subject to isolation. For instance, PAs along the Eastern Arc mountains are known for exceptional biological and conservation importance but have long been threatened by deforestation [24,25]. Our observation corroborates these previous reports, albeit the different monitoring periods, that large parts of the buffer areas of many PAs along the Eastern Arc Mountains were deforested (e.g., see Figures 5 and 6) or isolated, although well protected (Figure 3) which, in the absence of intervention, can potentially lead to further isolation and encroachment into PA territories, threatening the ecosystem services they can provide. Nevertheless, the potential for connecting those isolated PAs is immense, because most are located within short distances from each other. For instance, along series of PAs in the Usambara Mountains of northeastern Tanzania (Figure 3), developing a 1 km corridor surrounding each PA can effectively connect nearly all protected areas in that mountain range. Indeed, as shown in Figure 3, effective protection inside PAs might have prompted protection across the unprotected buffer zones surrounding those PAs. Remaining governance challenges could be designing and implementing compensation schemes for conservation-related displacements of people in buffer areas and sometimes inside PA territories [26].

4.2. PA Management Effects

Knowledge on the degree to which responsible public institutions can protect their respective natural forests and biodiversity will have a profound importance to the public and Tanzanian decision makers. At the level of PA management, Forest plantations, National Parks and Nature Reserves exhibit significantly less deforestation rate than Forest Reserves and Game Controlled areas (see also Figure 7). These results are strikingly similar to that of Uganda [22], in which Forest Reserves lost forest carbon while National Parks and wildlife Reserves gained forest carbon during 10 years monitoring period. Another study in East Africa [27] suggested that the other management regimes performed poorly as compared to National Parks in reducing deforestation. National Parks and Nature Reserves may have better protection status than Forest Reserves, most likely because they benefit from inaccessibility and fortress-type protection assisted by tourism revenues to support and strengthen protection. While these are generalized conclusions, we also see that there is a large variation in protection status within the same management regime (Figure 7). For instance, while Forest Reserves in general were deforested, there are a series of Forest Reserves, for instance in Eastern Usambara Mountains in northeastern Tanzania that are well protected and showed no or little deforestation during the period. This result is of significance because the Usambara mountains make up the Eastern Arc forests which have the highest known number of plant and animal species of any region in Tanzania.

The observed deforestation, particularly in the top 10% highly deforested PAs dominated by Forest Reserves is most likely attributed to their location leading to an increasing external pressure associated with the increasing human population in the surrounding landscapes. Giliba et al., [28] suggested that the threat against Forest Reserves is well connected to an increasing demand for household energy and the need for new land for cultivation and settlements near population areas. Visual observations show that even when PAs are well protected, they may be surrounded by recently deforested landscapes (e.g., see Figures 4–6). Such fortress-type protection may cause leakage (spillover) to neighboring buffer areas [29], and that leakage might accelerate the rate at which PAs become isolated [23]. Therefore, PA management need to consider the potential of leakage. However, given the limited field observation, and lack of histories of the PAs on their establishment, we could not ascertain whether leakage was responsible for the observed isolations in Tanzanian PAs.

PAs may be established purposely in dense forests, higher elevations, steeper slopes or long distances to roads and settlements, particularly those that have been established many years ago. Our comparison between changes inside the boundaries and the buffer areas did not consider the possible differences in land characteristics and possible biases of locations during the establishment of these PAs. However, with a current expanding infrastructure and fast-growing young population demanding agricultural land, most of the PAs are within the reach of human activities. Some of the urgent measures for management authorities and other stakeholders should therefore include reviewing existing management approaches, to consider participatory management which promotes partnerships and offers benefit sharing and other development opportunities to communities living outside PAs. Successful practices of engaging local communities exist in Tanzania and experiences can be drawn from the past participatory forest resource-management programs [30], and carefully adapted to serve PA management objectives.

4.3. Implications for the Climate Benefits of Protection

Protection in Tanzania has historically been intended for ecosystem services, such as ecotourism and biodiversity conservation. More recently, the Nationally Determined Contributions (NDCs) under the United Nations Framework Convention on Climate Change (UNFCCC) [8] entails low greenhouse gas emissions and climate-resilient development. In particular, policies such as REDD+ recognized conservation as one of the five major activities [8], providing additional opportunity for PAs. More specifically, Tanzania's recent Climate Smart Agriculture (CSA) guideline [31] recognizes landscape and ecosystem services and payments for ecosystem services as key to achieving its sustainable development goals. Furthermore, as part of its commitment under African Forest Landscape Restoration (AFR100) initiatives, in 2018 Tanzania pledged to restore 5.2 million hectares of degraded and deforested land by 2030. Tanzania can thus use this opportunity to select those buffer zones or corridors as restoration areas under such programs.

Given the large sizes and diversity of PAs, protection in Tanzania can make significant and vital contributions to emissions reduction. This study also provided evidence that strictly protected PAs are effective at reducing forest losses and thus reducing emissions. However, protection is particularly challenging and resource-intensive in countries such as Tanzania, with high forest dependence where forest-based charcoal and fuel wood are the single most important sources of household energy [32], and forest lands provide the last remaining lands for agricultural expansion [33].

Initiatives such as REDD+ and other national forest-management strategies are expected to provide a solution through providing incentives for the respective authorities and to the local communities. Consequently, Tanzania can benefit from PA managements as a national strategy and policy options to achieve its climate goals, through reducing emissions from deforestation and forest degradation inside the PAs. Protection should also consider the buffer areas through, for instance, initiating actions to restore and develop unprotected areas into corridors, through initiatives such as promoting community forest reserves, landscape restoration and conservation agriculture, and improving the connectivity of isolated PAs. Improving connectivity requires strong cooperation and partnership between the

different PA management regimes, developing approaches on how communities living adjacent to PAs can participate and share the benefits. Community engagement and benefit sharing can avoid the pitfalls of the current management in which several Forest Reserves appear isolated, surrounded by deforested or landscapes.

5. Conclusions

This study provided a quantitative assessment of deforestation in all the major PAs and their corresponding buffer areas across six PA management regimes in Tanzania. Such knowledge will contribute to understanding of the conservation and the climate change mitigation potentials of PAs. We see that the outcomes of protection in Tanzania are generally mixed, ranging from fortress-type protection with no deforestation detected to those PAs where protection did not significantly reduce deforestation. Yet, most PAs in Tanzania have been effective in reducing deforestation, despite the significant land-use pressure from outside their territories. This provides considerable support to the notion that protection remains one of the most effective policy tools to reduce deforestation, and thus protecting valuable landscapes and biodiversity, conforming to the original goal of protection. These results also demonstrate the potential that PAs can offer a considerable opportunity to achieve long-term climate goals such as the nationally determined contributions (NDCs) and climate mechanisms such as REDD+.

Despite successes in some PAs across the different management regimes, there is a clear need to strengthen protection of the few but large-area PAs with high deforestation rates and promoting connectivity of many isolated PAs through forest landscape restoration and developing corridors. The challenges are often designing and implementing win-win solutions both for the PA management and communities that can be affected by conservation. Successful participatory forest management programs that engage communities exist in Tanzania, from which experiences can be drawn and adapted to PA management.

We demonstrated the utility of a wall-to-wall land-cover change map to monitor deforestation inside PAs and the unprotected buffer areas at various distances. Given the dynamics of deforestation in Tanzania, however, there is a need for updated data and supplementary field observation to improve the utility of such data and assessments for a more assertive recommendation.

Author Contributions: B.G.: Study design, Methodology, Formal Analysis; Investigation, Original draft Preparation, Writing, Review & Editing. J.R.: Data mining and analysis, methodology, Writing Review and Editing; D.D.S.: study design, validation, writing, review and Editing; E.Z.: Study design, Review and Validation. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

References

1. Spracklen, B.D.; Kalamandeen, M.; Galbraith, D.; Gloor, E.; Spracklen, D.V. A Global Analysis of Deforestation in Moist Tropical Forest Protected Areas. *PLoS ONE* **2015**, *10*, e0143886. [CrossRef] [PubMed]
2. Pfaff, A.; Robalino, J.; Herrera, D.; Sandoval, C. Protected Areas' Impacts on Brazilian Amazon Deforestation: Examining Conservation—Development Interactions to Inform Planning. *PLoS ONE* **2015**, *10*, e0129460. [CrossRef] [PubMed]
3. Forrest, J.L.; Mascia, M.B.; Pailler, S.; Abidin, S.Z.; Araujo, M.D.; Krithivasan, R.; Riveros, J.C. Tropical Deforestation and Carbon Emissions from Protected Area Downgrading, Downsizing, and Degazettement (PADDD). *Conserv. Lett.* **2015**, *8*, 153–161. [CrossRef]
4. Collins, M.B.; Mitchard, E.T.A. A small subset of protected areas are a highly significant source of carbon emissions. *Sci. Rep.* **2017**, *7*, 41902. [CrossRef]

5. Blankespoor, B.; Dasgupta, S.; Wheeler, D. Protected areas and deforestation: new results from high-resolution panel data. *Nat. Resour. Forum* **2017**, *41*, 55–68. [CrossRef]
6. UN. Convention on Biological Diveristy. 1992. Available online: https://www.cbd.int/doc/legal/cbd-en.pdf (accessed on 28 June 2017).
7. UNEP. Protected Planet Report 2016: Data, Maps & Figures (April 2016). Available online: https://www.protectedplanet.net/c/protected-planet-report-2016/protected-planet-report-2016--data--maps-figures (accessed on 8 March 2019).
8. UNFCCC. Adoption of the Paris Agreement. Draft decision -/CP.21. Conference of the Parties Twenty-first session Paris, 30 November to 11 December 2015. Available online: http://unfccc.int/resource/docs/2015/cop21/eng/l09.pdf (accessed on 29 December 2015).
9. UNEP-WCMC, United Nations List of Protected Areas. *Supplement on protected area management effectiveness*; UNEP-WCMC: Cambridge, UK; Available online: https://www.sprep.org/attachments/VirLib/Global/2018-list-protected-areas.pdf (accessed on 8 August 2019).
10. IUCN. *IUCN Red List of Threatened Species. Version 2013.01*; IUCN: Gland, Switzerland, 2013; Available online: www.iucnredlist.org/ (accessed on 12 June 2017).
11. Bailey, D.; Schmidt-Entling, M.H.; Eberhart, P.; Herrmann, J.D.; Hofer, G.; Kormann, U.; Herzog, F. Effects of habitat amount and isolation on biodiversity in fragmented traditional orchards. *J. Appl. Ecol.* **2010**, *47*, 1003–1013. [CrossRef]
12. Griffen, B.D.; Drake, J.M. Effects of habitat quality and size on extinction in experimental populations. *Proc. R. Soc. B Boil. Sci.* **2008**, *275*, 2251–2256. [CrossRef]
13. Steve, P.; Jane, L. *Millennium Ecosystem Assessment, Ecosystems and Human Well-Being: Biodiversity Synthesis*; World Resources Institute: Washington, DC, USA, 2005.
14. Newmark, W.D. Isolation of African protected areas. *Front. Ecol. Environ.* **2008**, *6*, 321–328. [CrossRef]
15. The United Republic of Tanzania, TANZANIA'S FOREST REFERENCE EMISSION LEVEL SUBMISSION TO THE UNFCCC. 2017. Available online: https://redd.unfccc.int/files/frel__for__tanzania_december2016_27122016.pdf (accessed on 7 January 2019).
16. UNEP, Convention on Biological Diversity. 2010. Available online: https://www.cbd.int/nbsap/targets/ (accessed on 27 November 2019).
17. UNEP-WCMC. Protected Planet 2014–2019. 2019. Available online: https://www.protectedplanet.net/search?q=Tanzania (accessed on 1 February 2019).
18. Bowker, J.N.; Vos, A.; Ament, J.M.; Cumming, G. Effectiveness of Africa's tropical protected areas for maintaining forest cover. *Conserv. Boil.* **2017**, *31*, 559–569. [CrossRef]
19. Rodriguez, N.; Armenteras, D.; Retana, J. Effectiveness of protected areas in the Colombian Andes: deforestation, fire and land-use changes. *Reg. Environ. Chang.* **2013**, *13*, 423–435. [CrossRef]
20. Eklund, J.; Blanchet, F.G.; Nyman, J.; Rocha, R.; Virtanen, T.; Cabeza, M. Contrasting spatial and temporal trends of protected area effectiveness in mitigating deforestation in Madagascar. *Boil. Conserv.* **2016**, *203*, 290–297. [CrossRef]
21. Cuenca, P.; Arriagada, R.; Echeverría, C. How much deforestation do protected areas avoid in tropical Andean landscapes? *Environ. Sci. Policy* **2016**, *56*, 56–66. [CrossRef]
22. Gizachew, B.; Solberg, S.; Puliti, S. Forest Carbon Gain and Loss in Protected Areas of Uganda: Implications to Carbon Benefits of Conservation. *Land* **2018**, *7*, 138. [CrossRef]
23. Lui, G.V.; Coomes, D.A. Tropical nature reserves are losing their buffer zones, but leakage is not to blame. *Environ. Res.* **2016**, *147*, 580–589. [CrossRef] [PubMed]
24. Hall, J.; Burgess, N.D.; Lovett, J.; Mbilinyi, B.; Gereau, R.E. Conservation implications of deforestation across an elevational gradient in the Eastern Arc Mountains, Tanzania. *Boil. Conserv.* **2009**, *142*, 2510–2521. [CrossRef]
25. Green, J.M.; Larrosa, C.; Burgess, N.D.; Balmford, A.; Johnston, A.; Mbilinyi, B.P.; Platts, P.J.; Coad, L. Deforestation in an African biodiversity hotspot: Extent, variation and the effectiveness of protected areas. *Boil. Conserv.* **2013**, *164*, 62–72. [CrossRef]
26. Hall, J.M.; Burgess, N.D.; Rantala, S.; Vihemäki, H.; Jambiya, G.; Gereau, R.E.; Makonda, F.; Njilima, F.; Sumbi, P.; Kizaji, A. Ecological and Social Outcomes of a New Protected Area in Tanzania. *Conserv. Boil.* **2014**, *28*, 1512–1521. [CrossRef]

27. Pfeifer, M.; Burgess, N.D.; Swetnam, R.D.; Platts, P.J.; Willcock, S.; Marchant, R. Protected Areas: Mixed Success in Conserving East Africa's Evergreen Forests. *PLoS ONE* **2012**, *7*, e39337. [CrossRef]
28. Giliba, R.A.; Mafuru, C.S.; Paul, M.; Kayombo, C.J.; Kashindye, A.M.; Chirenje, L.I.; Musamba, E.B. Human Activities Influencing Deforestation on Meru Catchment Forest Reserve, Tanzania. *J. Hum. Ecol.* **2011**, *33*, 17–20. [CrossRef]
29. Seiferling, I.S.; Proulx, R.; Peres-Neto, P.R.; Fahrig, L.; Messier, C. Measuring Protected-Area Isolation and Correlations of Isolation with Land-Use Intensity and Protection Status. *Conserv. Biol.* **2012**, *26*, 610–618. [CrossRef]
30. Behr, D.C.; Cunningham, E.M.; Kajembe, G.; Mbeyale, G.; Nsita, S.; Rosenbaum, K.L. *Benefit Sharing in Practice: Insights for REDD+ Initiatives*; Program on Forests (PROFOR): Washington, DC, USA, 2012.
31. Climate-Smart Agriculture Guideline for the United Republic of Tanzania: A Country–Driven Response to Climate Change, Food and Nutrition Insecurity. 2017. Available online: http://www.fao.org/3/a-i7157e.pdf (accessed on 4 December 2019).
32. Felix, M.; Gheewala, S.H. A Review of Biomass Energy Dependency in Tanzania. *Energy Procedia* **2011**, *9*, 338–343. [CrossRef]
33. Nzunda, E.F.; Midtgaard, F. Deforestation and loss of bushland and grassland primarily due to expansion of cultivation in mainland Tanzania (1995–2010). *J. Sustain. For.* **2019**, *38*, 509–525. [CrossRef]

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Variation in Deadwood Microsites in Areas Designated under the Habitats Directive (Natura 2000)

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Abstract: The continuing decline in biodiversity presents a major environmental protection challenge. The conservation of sufficiently extensive and diverse habitats requires an array of coordinated actions, often involving large areas. While a set of conservation objectives have been defined for the Natura 2000 network, no universal methods of accomplishing them have been specified, and so they must be designed by individual Member States. Deadwood volume and the density of large deadwood pieces are widely used for evaluating the quality of forest habitat types designated under the Habitats Directive. In the present study, data from 5557 sample plots were used to evaluate the mean values of the two deadwood indicators as well as the ratio of deadwood volume to living tree volume for each of the 13 habitat types in Poland. In addition, a logistic regression model was constructed to evaluate the effects of terrain, site, and tree stand characteristics as well as protection type on deadwood volume in Natura 2000 areas. Mean deadwood volume varied greatly between habitat types, with the lowest values found for Central European lichen Scots pine forests (91T0–2.5 m^3 ha^{-1}) and Old acidophilous oak woods (9190–4.4 m^3 ha^{-1}), and the highest for Riparian mixed forests (91F0–43.1 m^3 ha^{-1}) and Acidophilous *Picea* forests of the montane to alpine levels (9410–55.4 m^3 ha^{-1}). The ratio of deadwood volume to living tree volume ranged from approx. 1%–17%. Additionally, the presence of large deadwood differed among habitat types: in some, there were no deadwood pieces with a diameter of ≥50 cm, while their maximum density was 6.1 pieces ha^{-1}. The logistic regression model showed that the likelihood of a habitat type to have a 'favorable conservation status' as defined by deadwood abundance (a threshold of at least 20 m^3 ha^{-1} according to Polish manuals on habitat type evaluation) increased with sample plot elevation, site fertility, and moisture, as well as stand age and volume. Positive effects were also observed for forests under strict and active protection versus managed forests. Planned efforts are necessary to enhance the quality of habitats with insufficient deadwood, especially in managed forests. Special attention should be given to areas that are readily accessible due to gentle terrain and low site moisture. Furthermore, younger stands on less fertile sites may require intervention to promote deadwood accumulation. We recommend retaining a certain proportion of mature stands until natural death and decomposition. Increasing the density of large deadwood is currently one of the most pressing conservation needs in most habitat types.

Keywords: reserve network; biodiversity; large trees; snags; coarse woody debris; regression model; habitat conditions; strict protection; managed forests

1. Introduction

Europe boasts the largest network of coordinated conservation areas in the world, known as Natura 2000, which covers more than 18% of the land area of EU Member States and almost 10% of their territorial waters. Its overarching objective is to ensure long-term conservation of valuable and endangered species and habitats [1–5] in line with the EU legislation including the 1979 Birds Directive [6] and the 1992 Habitats Directive [7]. As far as the habitat types defined under the latter directive are concerned, this means that their range should be preserved (and possibly expanded) and that they should retain their specific structure, functions, as well as characteristic species. The Natura 2000 network extends protection to a total of 231 habitat types; the greatest number of which are forest habitats (81), accounting for half of the entire Natura 2000 area [8]. The EU's special interest in forests is attributable to the fact that natural and semi-natural woodlands are among the most biologically diverse ecosystems on Earth. Although more than 1/3 of Europe is covered with forests, only 10% of their area consists of natural or semi-natural stands that significantly contribute to preserving plant and animal species [4]. While the Habitats Directive [7] laid out a number of conservation goals, it did not indicate specific ways of achieving them, with each Member States being responsible for developing its own solutions [9].

The Habitats Directive [7] requires the countries participating in the Natura 2000 network to monitor the conservation status of the natural habitats and species listed in its appendixes. The monitoring of forest sites encompasses a number of elements, such as their range, area, the species composition of all forest layers, species provenance, the age and vertical structure of vegetation, as well as soil and water conditions. It is essential to identify the factors and threats affecting a given habitat type, such as those associated with forest management [10], which could deteriorate habitat quality and decrease biodiversity. In this context, of importance is a sufficient presence of diverse microsites offered by so-called biocenotic trees, large trees, and dead trees [11,12]. Importantly, as many as 25% of species found in forests are facultatively or obligately associated with deadwood, and some of them are among the most endangered organisms of European temperate forest ecosystems [13]. Their presence is dependent not only on the quantity, but also the quality of deadwood, such as species, diameter, and decay stage [14,15]. Therefore, the removal of dead and dying trees is perceived as detrimental to most forest habitats and is being monitored on Natura 2000 sites [10]. The adoption of an appropriate deadwood management strategy requires knowledge about the ecology of saproxylic organisms, including the size and dispersal of their populations. Such information is needed to decide whether deadwood volume should be increased evenly across the entire managed forest area, but only to a limited extent, or perhaps the focus should be on a substantial improvement in the number and diversity of deadwood microsites in selected areas [16]. Investigations aiming to determine deadwood thresholds have indicated a wide range of desirable deadwood volumes [17]. Threshold values for different habitat types are also provided in guidelines for assessing Natura 2000 sites [18,19].

Currently, in Poland there are 849 special areas of conservation (SACs) with an overall area of 3.9 million ha. They represent 77 habitat types listed in Annex I to the Habitats Directive. Seventeen of them are priority habitat types, whose range is mostly or exclusively limited to the territory of the EU Member States, and so their survival depends directly on the conservation efforts undertaken by those countries. The natural habitat types identified under the Habitats Directive are classified into aquatic and waterside, heath and scrub, meadow, grassland, boggy, rocky, as well as typical forest categories [20]. This work focuses on forest habitats, and in particular on the deadwood they contain as a factor strongly affecting biodiversity. The study involved data derived from several thousand sample plots located on 312 Natura 2000 sites distributed throughout Polish lowlands, uplands, and mountains. Deadwood volume and the density of large deadwood pieces were analyzed with respect to guidelines specifying their threshold values in habitats. Logistic regression was used to determine which site, stand, and protection parameters had a significant effect on deadwood accumulation in those habitats. The results could be helpful in designing appropriate actions and strategies to improve habitat quality.

2. Materials and Methods

2.1. Data Collection

As part of the National Forest Inventory (NFI), Poland is covered with a 4 × 4 km grid of sample plots based on the 16 × 16 km ICP Forests network used in the European Union to evaluate forest damage [21]. At each node, there is an L-shaped cluster of five sample plots spaced 200 m apart (Figure 1). The exact rules for taking measurements and general reports on forest conditions are presented in ME [22] and NFI [23]. Depending on the age of the dominant tree species, the sample plots range in size from 200 to 500 m^2. In the present study, diameter at breast height (DBH) was measured for standing living and dead trees, while in the case of snags (with a height of at least 0.4 m) and downed deadwood, diameter was measured halfway along their height or length, respectively. Only standing trees with a DBH of >7 cm and downed deadwood fragments with a diameter of >10 cm at the thicker end were included in the study. Measurements were conducted for those dead trees or their fragments that grew within the sample plots prior to death. Thus, the entire length of deadwood fragments lying across sample plot borders was included. On the other hand, stumps left from management procedures were excluded.

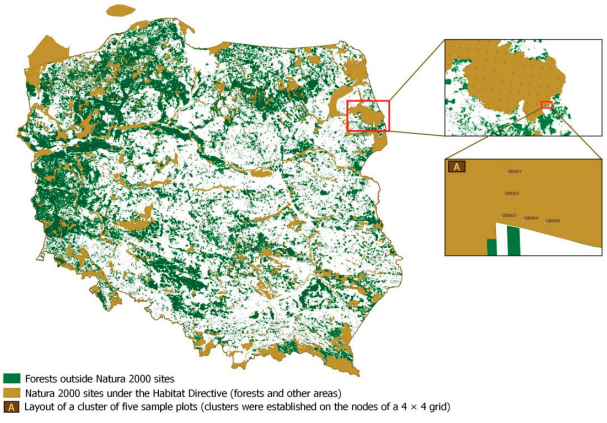

Figure 1. Sites designated under the Habitats Directive and the layout of a cluster of sample plots.

Forest ecosystems were evaluated on the basis of data obtained in the years 2010–2014 from NFI sample plots located within Natura 2000 sites under the Habitat Directive, also known as special areas of conservation (SACs). NFI measurements were conducted only for plots located on sites classified as forest areas pursuant to Polish regulations. In the study period each sample plot was measured once [23]. To determine which sample plots should be included in the study, the authors used a spatial dataset in the form of ESRI Shapefile layers including:

- vector data for the location of NFI sample plots;
- SAC database containing vector and descriptive data concerning forms of nature conservation [24]; and
- vector and descriptive data for tree stands from the Forest Data Bank [25].

These input data were integrated using Qgis 2.14 software to ensure information compatibility and generate an information layer for tree stands and sample plots within the boundaries of Natura 2000 sites. As a result, 312 Natura 2000 sites (SACs) with an overall area of 3,102,247 ha, and with a total of 5557 NFI sample plots located on them, were available for the study. Those SACs included the habitat types listed in Annex I and the habitats of species listed in Annex II. The next step involved the identification of the location and type of the various Natura 2000 habitats on the aforementioned

SACs [7], as well as the NFI sample plots within their boundaries. For that purpose, we used Standard Data Forms providing information about the habitat types present on a given site, as well as conservation plans (or drafts of those plans) specifying their location. For Natura 2000 sites without protection plans, natural habitats were identified using methodological keys based on taxonomical descriptions of tree stands [26], as well as the available literature, naturalists' notes, and manuscripts concerning a given Natura 2000 site. In total, the 312 selected Natura 2000 SACs were found to contain 15 habitat types (including four priority types) with a total area of 711,306 ha. While 1620 NFI sample plots were located within the boundaries of 14 of those habitat types (see Table 1), as many as 3937 sample plots present in Natura 2000 SACs were found in habitats not listed in Annex I to the Habitat Directive [7]; in this work the latter were designated as "no habitat type" (NHT).

Table 1. Habitats Directive forest types and the number of plots sampled.

Annex I Code	Habitat Type	Number of Sample Plots
9110	*Luzulo-Fagetum beech* forests	133
9130	*Asperulo-Fagetum beech* forests	566
9140 [1]	Medio-European subalpine beech woods with *Acer* and *Rumex arifolius*	4
9160	Sub-Atlantic and medio-European oak or oak-hornbeam forests of the *Carpinion betuli*	52
9170	*Galio-Carpinetum* oak-hornbeam forests	399
9180 *	*Tilio-Acerion* forests of slopes, screes and ravines	10
9190	Old acidophilous oak woods with *Quercus robur* on sandy plains	31
9410	Acidophilous *Picea* forests of the montane to alpine levels (*Vaccinio-Piceetea*)	58
9420	Alpine *Larix decidua* and/or *Pinus cembra* forests	0
91D0 *	Bog woodland	143
91E0 *	Alluvial forests with *Alnus glutinosa* and Fraxinus excelsior (*Alno-Padion, Alnion incanae, Salicion albae*)	132
91F0	Riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Ulmus minor*, *Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*)	49
91I0 *	Euro-Siberian steppic woods with *Quercus* spp.	7
91P0	Holy Cross fir forest (*Abietetum polonicum*)	13
91T0	Central European lichen Scots pine forests	23

[1] Habitat type 9140 was excluded from comparative habitat analyses due to the small number of plots. * Priority habitat types.

In addition, the Web Map Service made available by the Main Office for Surveying and Cartography was used with the C-GEO software package (with web connection) to assess elevation above sea level for each sample plot. Elevation was determined in accordance with the Polish system PL-KRON86-NH by means of interpolation algorithms prepared on the basis of the Numerical Terrain Model with a 1×1 m grid.

The criteria concerning deadwood volume and the density of large deadwood may differ depending on the specific characteristics of a given habitat. Those criteria are specified in manuals on habitat evaluation in Poland [10,27]. In most cases, a favorable conservation status requires a deadwood volume of >20 m^3 ha^{-1} and a density of at least 3–5 large deadwood pieces per ha; large pieces are understood as those having a diameter/DBH of >50 cm (or in some cases >30 cm) and a length/height of >3 m (Table 2). Medium-sized trees are defined as those with a diameter/DBH in the range of 30–49.9 cm, and large trees as those with a DBH of ≥ 50 cm.

In some cases, the deadwood volume threshold in a given habitat may be expressed as a proportion of stand volume rather than in absolute values. Furthermore, in some habitat types, such as 91T0, the presence of deadwood is generally undesirable given the adopted conservation priorities. This is due to the fact that large amounts of deadwood on the forest floor lead to rapid enrichment of the substrate in biogenic substances, thus increasing the competition of bryophytes and herbaceous plants to the detriment of terricolous lichens. While small amounts of deadwood are not harmful, large quantities of twigs and branches left, e.g., in the aftermath of management procedures, may cause habitat degradation [27].

2.2. Data Analysis

Data from sample plots were used to determine the mean deadwood volume for the studied habitat types. The volume of living trees and the proportion of deadwood volume to living tree volume were assessed for each habitat type to account for variation in site productivity. Then, the density and

variability of medium-sized and large deadwood pieces were evaluated. Due to NFI methodology and the definition of medium-sized and large deadwood pieces (Table 2), the diameter of logs at the thicker end was calculated based on measurements taken halfway along their length (adopting a mean taper of 1 cm per 1 m). Statistical differences between habitat types were evaluated by analysis of variance and the Kruskal–Wallis test implemented in Statistica 13 software (StatSoft, Kraków, Poland).

The factors affecting deadwood volume in the studied habitat types were evaluated using a logistic regression model [28]. The choice of that statistical tool was dictated by the uneven distribution of deadwood, whose volume varied greatly among sample plots and which was absent from approx. half of them. The logistic regression model used a dichotomous dependent variable [28]. Sample plots with a deadwood volume of >20 m^3 ha^{-1} were assigned the value of 1, with 0 assigned to other plots. The 20 m^3 ha^{-1} threshold corresponds to the favorable conservation status as defined for most of Natura 2000 habitat types. The adopted independent variables were factors that may affect deadwood volume, such as stand, terrain, and site characteristics, as well as protection type, also obtained from the NFI. The protection type variable assumed three values: active, strict, or managed forest. For the purposes of this work, 'managed forests' are defined as forest areas that are managed with no active or strict protection plans. In turn, active and strict protection plans are most often used in nature reserves and national parks. Terrain was described by two variables: elevation above sea level (m a.s.l.) and the percentage slope of sample plots (%). Tree stands were characterized by the age of the dominant tree species (years), the volume of living trees (m^3 ha^{-1}), and tree density (trees ha^{-1}). The model also included site fertility (dystrophic, oligotrophic, mesotrophic, eutrophic) and moisture (mesic, moist, boggy), as those parameters varied considerably among the studied habitat types. Another independent variable was habitat type, operationalized by assigning one of 13 Natura 2000 habitat codes, or "no habitat type" (NHT) for sample plots in habitats not included in Natura 2000.

Table 2. Deadwood volume and density indicators for the various habitat types [10,27,29,30].

Habitat Types	Parameter/Indicator					
	Deadwood (Overall Volume)			Standing or Downed Deadwood ≥3 m Long and ≥50 cm in Diameter [1]		
	Conservation Status of the Habitat					
	Favorable FV	Unfavorable–Inadequate U1	Unfavorable–Bad U2	Favorable FV	Unfavorable–Inadequate U1	Unfavorable–Bad U2
	(m^3 ha^{-1})			(pieces ha^{-1})		
9110	>20	10–20	<10	>5	3–5	<3
9130	>20	10–20	<10	>5	3–5	<3
9140	d.n.a.[5]	d.n.a.	d.n.a.	d.n.a.	d.n.a.	d.n.a.
9160	>20	10–20	<10	>5	3–5	<3
9170	>20	10–20	<10	>5	3–5	<3
9180	d.n.a.	d.n.a.	d.n.a.	d.n.a.	d.n.a.	d.n.a.
9190	>20	10–20	<10	>5	3–5	<3
9410	>20	10–20	<10	>5	3–5	<3
91D0	d.n.a.	d.n.a.	d.n.a.	>3 [2]	1–3 [2]	<1 [2]
91E0	>20	10–20	<10	>5 [1]	3–5 [1]	<3 [1]
91F0	>20	10–20	<10	>5	3–5	<3
91I0	<5% [3]	5–20% [3]	> 50% [3]	d.n.a.	d.n.a.	d.n.a.
91P0	>10% [4]	3–10% [4]	<3% [4]	d.n.a.	d.n.a.	d.n.a.
91T0	None	A small amount due to natural processes	Large amount, e.g., heaps of branches	d.n.a.	d.n.a.	d.n.a.

[1] The diameter threshold was lowered to 30 cm in habitats where trees do not normally reach 50 cm for natural reasons. Those values represent diameter at breast height (DBH) for standing trees and either DBH (if measurable) or diameter at the thicker end for downed deadwood. [2] Diameter threshold lowered to 30 cm. [3] This value refers exclusively to downed deadwood in relation to stand volume, e.g., <5% means that downed deadwood volume amounts to less than 5% of stand volume. [4] In relation to stand volume. [5] d.n.a.—not available.

The model was built using the step-wise forward method (a model constructed using the step-wise backward method arrived at the same set of significant variables). The odds ratio was calculated to characterize the effects of independent variables on the dependent variable. In the case of quantitative independent variables, an increase or decrease by one unit increased or decreased the probability for the dependent variable to assume the value of 1 by the odds ratio. In the case of qualitative variables, the odds ratio was adopted in the form of reference values for each of them. The independent variables

were tested for intercorrelations. The quality of the model was evaluated by means of Nagelkerke values and the Hosmer–Lemeshow test [31]. A successful classification test was carried out on the basis of observations used to estimate the parameters of the model [32].

3. Results

The mean deadwood volume for the entire Natura 2000 area was 12.7 m^3 ha^{-1}, with very large differences between habitat types (Kruskal–Wallis H = 235.7; $p < 0.05$). The lowest deadwood volume was found for Central European lichen Scots pine forests (91TO–2.5 m^3 ha^{-1}) and Old acidophilous oak woods (9190–4.4 m^3 ha^{-1}), and the highest for Riparian mixed forests (91F0–43.1 m^3 ha^{-1}) and Acidophilous *Picea* forests of the montane to alpine levels (9410–55.4 m^3 ha^{-1}). Furthermore, substantial variation was recorded for sample plots located within one habitat type, as reflected by very high standard error values (Table 3).

Table 3. Mean deadwood and living tree volumes and their ratio for individual habitat types.

Habitat Type	Deadwood Volume (Standard Error) (m^3 ha^{-1}) *	Living Trees Volume (Standard Error) (m^3 ha^{-1}) *	Deadwood Volume to Living Trees Volume Ratio (%)
9110	13.9 (2.9) bc	373 (18.8) BD	3.7
9130	28.4 (2.3) a	434 (10.4) B	6.5
9160	21.5 (9.3) c	478 (38.2) BE	4.5
9170	9.3 (1.5) c	327 (9.2) D	2.8
9180	25.2 (12.0) ac	439 (79.8) ABD	5.8
9190	4.4 (2.1) c	407 (45.9) BCD	1.1
9410	55.4 (13.4) a	326 (32.6) ADE	17.0
91D0	8.6 (1.5) bc	238 (14.9) A	3.6
91E0	25.1 (3.7) ab	335 (16.3) CDE	7.5
91F0	43.1 (12.5) ac	378 (36.0) BCD	11.4
91I0	7.9 (6.7) ac	335 (63.9) ABD	2.4
91P0	15.4 (9.9) ac	306 (50.8) ABD	5.0
91T0	2.5 (1.2) c	282 (26.7) ABD	0.9
NHT	9.4 (0.5) c	279 (2.9) AC	3.4

* values with different letters differ significantly at $p < 0.05$ as evaluated by the nonparametric Kruskal–Wallis test with a post hoc correction for the number of comparisons).

The mean volume of living trees for the entire Natura 2000 area was 305 m^3 ha^{-1}. Among the habitat types, the lowest values were found for bog woodland (91D0–238 m^3 ha^{-1}) and Central European lichen Scots pine forests (91T0–282 m^3 ha^{-1}). Volumes in the range of 300–400 m^3 ha^{-1} were recorded for seven habitat types, with the highest value for Sub-Atlantic and medio-European oak or oak-hornbeam forests of the *Carpinion betuli* (9160–478 m^3 ha^{-1}), with differences between habitats often reaching statistical significance (Kruskal–Wallis H = 301.7; $p < 0.05$, see Table 3). The ratio of deadwood volume to stand volume ranged from approx. 1% in 91TO and 9190 to 11.4% in 91F0 and 17.0% in 9410 (Table 3).

Medium-sized and large living trees (DBH ≥30 cm) were found in all habitat types, ranging from 94 trees ha^{-1} in 91D0 to 164 trees ha^{-1} in 91I0, with a mean value of 121 trees ha^{-1} (Kruskal–Wallis H = 147.3; $p < 0.05$) (Figure 2). Medium-sized and large deadwood was not found in Euro-Siberian steppic woods with *Quercus* spp. (91I0) and in Central European lichen Scots pine forests (91T0). In the other habitat types its mean density ranged from 2.5 pieces ha^{-1} (9190) and 2.7 pieces ha^{-1} (91D0) to 16.3 pieces ha^{-1} (9130) and 31.1 pieces ha^{-1} (9410) (Figure 3). Differences were also found when analyzing the density of large living trees only (DBH of ≥50 cm, Kruskal–Wallis H = 878.1; $p < 0.05$), which ranged from 4 trees ha^{-1} for 91T0 to 61 trees ha^{-1} for 9180, with a mean of 16 trees ha^{-1} (Figure 2). Large deadwood pieces were absent in a total of five habitat types. In the other habitat types their mean density ranged from 0.4 pieces ha^{-1} (9170) and 0.8 pieces ha^{-1} (91E0) to 5.6 pieces ha^{-1} (91F0) and 6.1 pieces ha^{-1} (9410) (Figure 3).

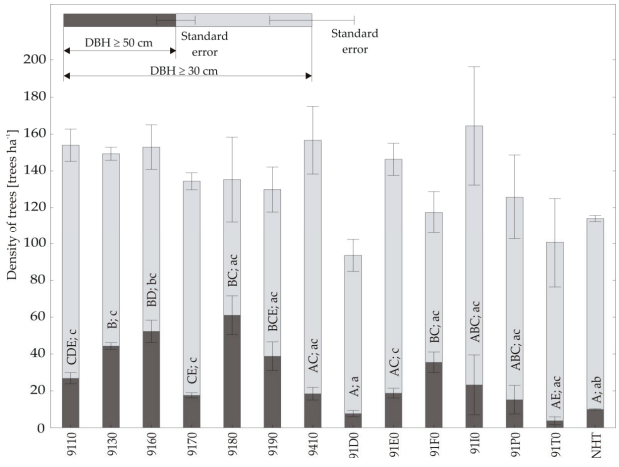

Figure 2. Density of medium-sized and large living trees. Values with different letters differ significantly at $p < 0.05$ as evaluated by the nonparametric Kruskal–Wallis test with a post hoc correction for the number of comparisons. Uppercase letters refer only to trees with DBH ≥ 50 cm while lowercase letters refer to all trees with DBH ≥ 30 cm. Note: DBH–diameter at breast height.

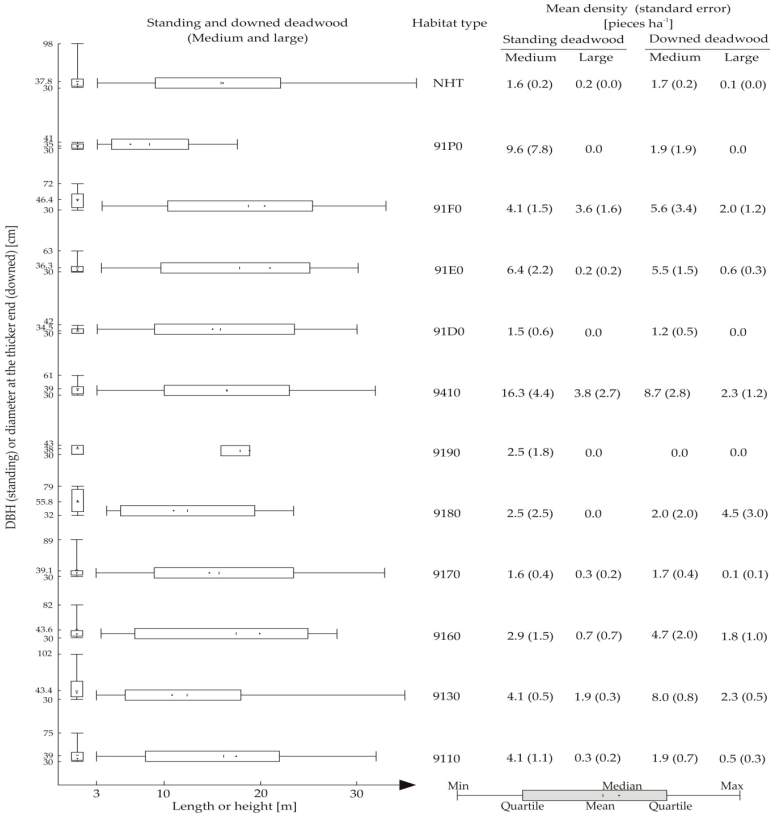

Figure 3. Characteristics of medium-sized and large deadwood in the various habitat types.

The inclusion of factors other than habitat type in the analysis (Table 4) substantially changes the picture of deadwood accumulation compared to analysis based exclusively on habitat types (Table 3). The logistic regression model indicates that deadwood volume is mostly determined by factors associated with terrain and site accessibility, type of protection, as well as soil and stand parameters (Table 4). From among the nine variables entered in the model, the slope of sample plots and living tree density failed to reach statistical significance, while elevation above sea level, protection type, site fertility and moisture (water abundance), the age of the dominant tree species, and the volume of living trees were significant. An increase in the quantitative variables (elevation, stand age, living tree volume) was associated with an increase in the odds ratio, or the likelihood of finding a favorable deadwood volume (>20 m^3 ha^{-1}) in a given habitat type. In terms of site conditions, the reference value corresponded to sites poorest in nutrients. The odds ratio increased with both site fertility and moisture; in the latter case the highest odds ratio was recorded for boggy sites. There was a substantial difference in the odds ratio between managed forests and areas subjected to either active or strict protection. A significant effect was also found for habitat type, which was the last element entered into the model. No habitat type exhibited a significant difference as compared to the reference value in the model (Central European lichen Scots pine forests–91T0).

Table 4. Logistic analysis results for the likelihood of a sample plot exhibiting a deadwood volume greater than 20 m^3 ha^{-1} (the threshold value for a favorable conservation status in most habit types).

Independent Variable [1]	β (Standard Error)	Wald's Chi-Square	Odds Ratio (95% Confidence Interval)	p *
Elevation (m a.s.l.)	0.003 (0.000)	328.052	1.003 (1.003–1.004)	<0.001
Age (year)	0.008 (0.001)	33.569	1.008 (1.006–1.011)	<0.001
Living trees volume (m^3 ha^{-1})	0.001 (0.000)	7.108	1.001 (1.000–1.001)	0.008
Protection (management) type		73.002		<0.001
Managed forests	Reference			
Active protection	0.860 (0.111)	60.058	2.363 (1.901–2.937)	<0.001
Strict protection	0.865 (0.185)	21.948	2.376 (1.654–3.413)	<0.001
Fertility		46.342		<0.001
DYSTROPHIC	Reference			
OLIGOTROPHIC	0.623 (0.224)	7.721	1.864 (1.201–2.893)	0.005
MESOTROPHIC	0.924 (0.212)	18.902	2.519 (1.661–3.820)	<0.001
EUTROPHIC	1.261 (0.212)	35.368	3.528 (2.328–5.345)	<0.001
Moisture		65.228		<0.001
MESIC	Reference			
MOIST	0.657 (0.132)	24.649	1.929 (1.488–2.501)	<0.001
BOGGY	1.320 (0.178)	55.167	3.742 (2.641–5.300)	<0.001
Habitat type		27.431		0.011
91T0	Reference			
9110	−0.760 (1.084)	0.492	0.467 (0.056–3.911)	0.483
9130	−0.526 (1.061)	0.246	0.591 (0.074–4.728)	0.620
9160	0.187 (1.126)	0.028	1.206 (0.133–10.962)	0.868
9170	−0.077 (1.065)	0.005	0.926 (0.115–7.463)	0.943
9180	0.232 (1.277)	0.033	1.261 (0.103–15.416)	0.856
9190	−1.817 (1.468)	1.533	0.163 (0.009–2.885)	0.216
9410	−0.308 (1.095)	0.079	0.735 (0.086–6.292)	0.779
91D0	−0.237 (1.088)	0.047	0.789 (0.094–6.661)	0.828
91E0	0.381 (1.077)	0.125	1.464 (0.177–12.089)	0.723
91F0	0.325 (1.111)	0.086	1.385 (0.157–12.223)	0.770
91I0	−1.025 (1.552)	0.436	0.359 (0.017–7.514)	0.509
91P0	−0.568 (1.338)	0.180	0.567 (0.041–7.802)	0.671
NHT	−0.066 (1.053)	0.004	0.936 (0.119–7.366)	0.950
Constant term	−4.721 (1.041)	20.574	0.009 (0.001–0.069)	<0.001

Quality characteristics of the model: Likelihood-ratio test: $\chi^2 = 939.5$; $p < 0.0001$; Nagelkerke's coefficient $R^2 = 0.272$. The model correctly predicted results in 85% of the cases (44% for 1 and 92% for 0); the Hosmer–Lemeshow test = 13.4; $p = 0.10$. * All the p-values are from Wald's tests.

4. Discussion and Conclusions

It is crucial to develop appropriate strategies for Natura 2000 sites to aid policymakers and managers in reaching biodiversity targets [33,34]. Despite an increase in Europe's afforestation, it is estimated that only 15% of its woodland qualifies for a favorable conservation status [35]. The study provides a general overview of the conservation status of forest habitats in Poland. The use of

a large number of sample plots made it possible to determine mean values for 13 habitat types. However, it should be noted that the status of a given habitat type may vary between different SACs. The statistical method applied by the NFI, employing a random, evenly distributed network of sample plots, precludes the evaluation of individual SACs due to an insufficient number of representative sample plots in each of them. Nevertheless, it is an excellent, objective tool providing a general characterization of Natura 2000 sites. In addition, logistic regression analysis revealed the site and stand characteristics that have a positive or negative effect on deadwood accumulation in areas designated under the Habitats Directive. Knowing the characteristics of individual SACs and the factors conducive to deadwood accumulation, one can predict deadwood volume for the various areas.

In Poland, deadwood thresholds adopted for most habitat types are 20 m^3 ha^{-1} for favorable conservation status and 10–20 m^3 ha^{-1} for unfavorable-inadequate status. While this is supported by some publications, those thresholds represent the lower limits of deadwood ranges proposed for European forests. Indeed, papers on the conservation of various saproxylic species or groups of species tend to suggest thresholds of 30–50 m^3 ha^{-1}, or even more [17,36,37]. In addition to the quantitative criterion, it is also necessary to ensure variability in deadwood types [38] as well as an adequate spatial distribution of deadwood microsites [16,39]. In some cases, a deadwood volume threshold may be expressed in terms of its proportion relative to stand volume. In the present study, the deadwood volume threshold of 20 m^3 ha^{-1} amounted to only a few percent of the mean stand volume (approx. 300 m^3 ha^{-1}).

National parks and nature reserves, which are almost exclusively subjected to strict or active protection, revealed a markedly higher likelihood of reaching the threshold deadwood volume. However, the overall area of parks and reserves is relatively small (approximately 4% of the afforested area of Poland) as compared to that of managed forests. Given the well-established differences between managed and unmanaged woodland [40–42], it is little wonder that favorable volumes of deadwood as defined under Natura 2000 are usually found in the latter. In turn, in managed forests, deadwood volume mostly depends on the adopted management principles and their implementation. Taking into account the specific features of a given site, management procedures are determined by the species composition of the stand, its functions, as well as management objectives [43]. The implementation of different felling systems, management interventions, and regeneration patterns may result in significant differences in deadwood volume between sites [44–46]. In the present study, the average deadwood volume on Natura 2000 sites was 12.7 m^3 ha^{-1}, which is more than twice higher than the mean volume reported for all Polish forests (5.9 m^3 ha^{-1}, NFI 2014). This is attributable to the fact that the Natura 2000 network primarily encompasses the best preserved woodlands in the country, including protected areas. A general assessment of Natura 2000 sites (not only forests) conducted in the years 2017–2018 as part of a periodic monitoring program revealed a declining proportion of sites with a favorable status and an increase in unfavorable-inadequate and unfavorable-bad sites [47]. In the case of some forest habitats (e.g., 91F0), general conservation status deteriorated substantially due to adverse quantitative and qualitative changes in the floristic composition, the presence of alien species, as well as hydrological disturbances [47,48]. Furthermore, it has been reported that the conservation status of many sites has been affected by excessive deadwood removal; of particular concern is the scarcity of large deadwood pieces [47].

While the management difficulty indices calculated for Polish montane and lowland forests are highly varied [49], the terrain factor was found to be significant in the model, suggesting that the higher the site elevation the higher the likelihood of finding more deadwood. A large proportion of Natura 2000 woodland sites are located in mountainous areas. Habitat types that are in part or in their entirety represented by such sites and those which are otherwise associated with steep slopes (9130, 9180, 9410) exhibited higher deadwood volumes. Additionally, monitoring reports have indicated a much better quality of forest habitats in the Alpine biogeographical region as compared to the continental region. While the conservation status of mountainous sites is usually classified as favorable or unfavorable-inadequate, that of sites in the continental region is more often deemed

unfavorable-inadequate or unfavorable-bad [47]. In managed forests, higher deadwood accumulation is significantly promoted by harvesting and skidding difficulty as well as by a less dense road network [50,51], entailing higher operating costs. Site accessibility also plays a role in lowland areas, but probably to a lesser extent [52].

While the mean deadwood volume varied considerably between different habitats, terrain and stand characteristics were of primary importance. The presented model indicated a significant contribution of stand age: the older the stand, the higher the likelihood of the site reaching the deadwood volume threshold. Since the Natura 2000 network has a relatively short history in Poland, the age structure of stands at the time of their inclusion continues to play a major role in habitat evaluation. Indeed, in the case of some habitat types this may partially explain the low deadwood volume and density of large dead trees. A good case in point are boggy coniferous forests, which were often represented by young stands at the time of their inclusion in Natura 2000, and so they have not had the time to accumulate enough large deadwood [27]. Nevertheless, stand structure analysis indicates quite high current mean densities of living trees with DBH ≥30 cm for all habitat types. Although boggy coniferous forests still reveal lower values, in the coming years they should add more large deadwood as long as they are appropriately managed. Moreover, although trees with DBH ≥50 cm are found in all habitat types, their distribution is much more irregular than that of medium-sized trees. This may be attributable to many factors, such as the adopted rotation period in managed forests or site conditions that determine the growth capacity of trees in individual habitat types. Large deadwood, which is particularly important for supporting biodiversity, is scarce or absent in many habitats. Since deadwood is deemed a crucial structural forest indicator [12], an improvement in that parameter is a crucial target that should be pursued with a view to enhancing the quality of Natura 2000 forest habitats.

In the present study, the habitat type with the greatest mean deadwood volume was Acidophilous *Picea* forests of the montane to alpine levels, although the high standard error points to an irregular distribution pattern with local aggregations attributable to frequent biotic and abiotic disturbances [53]. It should be noted that disturbances fulfill an important role in biodiversity promotion as long as the dying and dead trees are retained in the ecosystem, which is often the case in this habitat type due to its location in poorly accessible mountainous regions within the boundaries of Polish national parks. The diverse array of niches afforded by deadwood provide suitable microhabitats, shelter, and nutrition for a variety of species, increasing their numbers in a given area [54,55]. Other habitat types also contain trees which currently tend to exhibit high mortality, such as *Fraxinus excelsior* L., which occurs as an accompanying species in habitat types 91E0 and 91F0 [52,56].

The above notwithstanding, it should be noted that deadwood is not desirable in some habitats (91T0 and 91I0) as it may interfere with the conservation of the priority species occurring in them [27] due to the chemical properties of decomposing wood and its role in nutrient cycling and soil forming processes [57–59]. Indeed, both in 91T0 and 91I0 the mean deadwood volume is among the lowest with no medium- or large-sized deadwood despite the presence of large trees. However, a decision to protect certain species (e.g., rare lichens) by removing deadwood from a given habitat to prevent site eutrophication should be compensated on other sites as some saproxylic organisms have very specific requirements concerning deadwood type and other site conditions, such as insolation [60,61].

The applied regression model indicates that, in addition to protection type, deadwood volume is mostly influenced by terrain conditions, site fertility and moisture, stand age, and living tree volume. Analysis involving a dichotomous dependent variable for deadwood volume with a threshold value of 20 m^3 ha^{-1} shows that appropriate deadwood management should mitigate the effects of the aforementioned independent variables, or at least decrease their odds ratio. The factors that were found significant in the model were generally attributable to the "forces of nature." No sizable effects of management interventions were found for readily accessible terrain and for sites characterized by low growing stock. Thus, it is necessary to design a strategy for those habitats where deadwood is desirable and where standard management procedures and natural disturbances are insufficient to ensure

favorable conservation outcomes. Particularly problematic is the scarcity of large deadwood. Therefore, in managed forests fragments of saw timber stands should be left to die naturally and decay. Further monitoring is necessary as the evaluation of the Natura 2000 network depends both on its duration in individual Member States and on the adopted conservation principles for the included areas.

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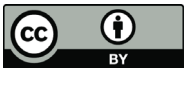
References

1. Pellegrino, D.; Schirpke, U.; Marino, D. How to support the effective management of Natura 2000 sites? *J. Environ. Plan. Manag.* **2017**, *60*, 383–398. [CrossRef]
2. Rouillard, J.; Lago, M.; Abhold, K.; Röschel, L.; Kafyeke, T.; Mattheiß, V.; Klimmek, H. Protecting aquatic biodiversity in Europe: How much do EU environmental policies support ecosystem-based management? *Ambio* **2018**, *47*, 15–24. [CrossRef]
3. Van der Sluis, T.; Bloemmen, M.; Bouwma, I.M. *European Corridors: Strategies for Corridor Development for Target Species*; ECNC: Tilburg, The Netherlands; Alterra: Wageningen, The Netherlands, 2004.
4. Mézard, N.; Sundseth, K.; Wegefelt, S. *Natura 2000 Protecting Europe's Biodiversity*; European Commission: Oxford, UK, 2008.
5. Van der Sluis, T.; Foppen, R.; Gillings, S.; Groen, T.; Henkens, R.; Hennekens, S.; Huskens, K.; Noble, D.; Ottburg, F.; Santini, L.; et al. How much biodiversity is in Natura 2000? In *The "Umbrella Effect" of the European Natura 2000 Protected Area Network*; Alterra Report 2730B; European Union Wageningen, Alterra Wageningen UR: Wageningen, The Netherlands, 2016.
6. The Birds Directive. *Council Directive 79/409/EEC on the Conservation of Wild Birds (SPAs)*; The Birds Directive: Brussels, Belgium, 1979.
7. The Habitats Directive. *The Habitats Directive Establishing Natura 2000 and Requiring Member States to Designate Special Areas of Conservation (SACs)*; The Habitats Directive: Brussels, Belgium, 1992.
8. Winkel, G.; Blondet, M.; Borrass, L.; Frei, T.; Geitzenauer, M.; Gruppe, A.; Jump, A.; De Koning, J.; Sotirov, M.; Weiss, G.; et al. The implementation of Natura 2000 in forests: A trans- and interdisciplinary assessment of challenges and choices. *Environ. Sci. Policy* **2015**, *52*, 23–32. [CrossRef]
9. Wilk, T.; Jujka, M.; Krogulec, J.; Chylarecki, P. *Important Bird Areas of International Importance in Poland*; Ogólnopolskie Towarzystwo Ochrony Ptaków: Marki, Poland, 2010.
10. Mróz, W. (Ed.) *Monitoring Siedlisk Przyrodniczych: Przewodnik Metodyczny, Part IV*; GIOŚ: Warsaw, Poland, 2015.
11. Stokland, J.N.; Siitonen, J.; Jonsson, B.G. *Biodiversity in Dead Wood*; Cambridge University Press: Cambridge, UK, 2012.
12. Lindenmayer, D.B.; Laurance, W.F. The ecology, distribution, conservation and management of large old trees. *Biol. Rev.* **2017**, *92*, 1434–1458. [CrossRef] [PubMed]
13. Bütler, R.; Lachat, T.; Larrieu, L.; Paillet, Y. Habitat trees: Key elements for forest biodiversity. In *Integrative Approaches as an Opportunity for the Conservation of Forest Biodiversity*; European Forest Institute: Joensuu, Finland, 2013; p. 84.
14. Horák, J.; Kout, J.; Vodka, Š.; Donato, D.C. Dead wood dependent organisms in one of the oldest protected forests of Europe: Investigating the contrasting effects of within-stand variation in a highly diversified environment. *For. Ecol. Manag.* **2016**, *363*, 229–236. [CrossRef]
15. Biedermann, P.H.; Vega, F.E. Ecology and evolution of insect–fungus mutualisms. *Annu. Rev. Entomol.* **2020**, 65. [CrossRef] [PubMed]

16. Komonen, A.; Müller, J. Dispersal ecology of deadwood organisms and connectivity conservation. *Conserv. Biol.* **2018**, *32*, 535–545. [CrossRef] [PubMed]
17. Müller, J.; Bütler, R.A. Review of habitat thresholds for dead wood: A baseline for management recommendations in European forests. *Eur. J. Res.* **2010**, *129*, 981–992. [CrossRef]
18. Winter, S.; Borrass, L.; Geitzenauer, M.; Blondet, M.; Breibeck, R.; Weiss, G.; Winkel, G. The impact of Natura 2000 on forest management: A socio-ecological analysis in the continental region of the European Union. *Biodivers. Conserv.* **2014**, *23*, 3451–3482. [CrossRef]
19. Alberdi, I.; Nunes, L.; Kovac, M.; Bonheme, I.; Cañellas, I.; Rego, F.C.; Dias, S.; Duarte, I.; Notarangelo, M.; Rizzo, M.; et al. The conservation status assessment of Natura 2000 forest habitats in Europe: Capabilities, potentials and challenges of national forest inventories data. *Ann. Sci.* **2019**, *76*, 34. [CrossRef]
20. European Commission. The interpretation manual of European Union habitats. In *Nature and Biodiversity*; European Commission DG Environment: Brussels, Belgium, 2013.
21. Talarczyk, A. National forest inventory in Poland. *Balt. For.* **2014**, *20*, 333–341.
22. Ministry of the Environment. *Instrukcja Wykonywania Wielkoobszarowej Inwentaryzacji Stanu Lasu*; Ministry of the Environment: Warsaw, Poland, 2010.
23. NFI. Wielkoobszarowa inwentaryzacja stanu lasu. In *Wyniki za Okres 2009–2013*; Biuro Urządzania Lasu i Geodezji Leśnej: Sekocin Stary, Poland, 2014.
24. Central Register of Forms of Nature Conservation. Available online: http://crfop.gdos.gov.pl/CRFOP/ (accessed on 15 March 2020).
25. Forest Data Bank. Available online: https://www.bdl.lasy.gov.pl/portal/ (accessed on 15 March 2020).
26. Pawlaczyk, P.; Herbich, J.; Holeksa, J.; Szwagrzyk, J.; Świerkosz, K. Rozpoznawanie Siedlisk Przyrodniczych na Podstawie Danych Opisu Taksacyjnego Lasu. Manuscript. 2003. Available online: https://www.kp.org.pl/pdf/algorytmy_lesne_n2k.pdf (accessed on 15 March 2020).
27. Mróz, W. (Ed.) *Monitoring Siedlisk Przyrodniczych: Przewodnik Metodyczny, Part I*; GIOŚ: Warsaw, Poland, 2010.
28. Larose, D.T. *Data Mining Methods and Models*; Wydawnictwo Naukowe PWN: Warsaw, Poland, 2008.
29. Mróz, W. (Ed.) *Monitoring Siedlisk Przyrodniczych: Przewodnik Metodyczny, Part II*; GIOŚ: Warsaw, Poland, 2012.
30. Mróz, W. (Ed.) *Monitoring Siedlisk Przyrodniczych: Przewodnik Metodyczny, Part III*; GIOŚ: Warsaw, Poland, 2012.
31. Stanisz, A. *Przystępny Kurs Statystyki*; StatSoft: Krakow, Poland, 2007.
32. Menard, S. *Applied Logistic Regression Analysis*; Sage University Paper Series on Quantitative Applications in the Social Sciences 106; SAGE: Thousand Oaks, CA, USA, 2001.
33. Campagnaro, T.; Trentanovi, G.; Sitzia, T. Identifying habitat type conservation priorities under the habitats directive: Application to two Italian biogeographical regions. *Sustainability* **2018**, *10*, 1189. [CrossRef]
34. Rubio-Salcedo, M.; Martínez, I.; Carreno, F.; Escudero, A. Poor effectiveness of the Natura 2000 network protecting Mediterranean lichen species. *J. Nat. Conserv.* **2013**, *21*, 1–9. [CrossRef]
35. EEA. *European Forest Ecosystems. State and Trends, Report 5*; European Environment Agency: Luxembourg, 2016.
36. Haase, V.; Topp, W.; Zach, P. Eichen-Totholz im Wirtschaftswald als Lebensraum für xylobionte Insekten. *Zeitschrift für Ökologie und Naturschutz* **1998**, *7*, 137–153.
37. Kraus, D.; Krumm, F. (Eds.) *Integrative Approaches as an Opportunity for the Conservation of Forest Biodiversity*; European Forest Institute: Joensuu, Finland, 2013; p. 284.
38. Andringa, J.I.; Zuo, J.; Berg, M.P.; Klein, R.; van Veer, J.; de Geus, R.; Beaumont, M.; Goudzwaard, G.; Hal, J.; Broekman, R.; et al. Combining tree species and decay stages to increase invertebrate diversity in dead wood. *For. Ecol. Manag.* **2019**, *441*, 80–88. [CrossRef]
39. Venier, L.A.; Hébert, C.; De Grandpré, L.; Arsenault, A.; Walton, R.; Morris, D.M. Modelling deadwood supply for biodiversity conservation: Considerations, challenges and recommendations. *For. Chron.* **2015**, *91*, 407–416. [CrossRef]
40. Keren, S.; Diaci, J. Comparing the quantity and structure of deadwood in selection managed and old-growth forests in South-East Europe. *Forests* **2018**, *9*, 76. [CrossRef]
41. Vlad, R.; Sidor, C.G.; Dinca, L.; Constandache, C.; Grigoroaea, D.; Ispravnic, A.; Pei, G. Dead wood diversity in a Norway spruce forest from the Calimani National Park (Eastern Carpathians). *Balt For.* **2019**, *25*, 238–248.
42. Kara, F.; Lhotka, J.M. Comparison of unmanaged and managed Trojan Fir-Scots pine forests for structural complexity. *Turk. J. Agric.* **2020**, *44*, 62–70. [CrossRef]

43. Burger, J.A. Management effects on growth, production and sustainability of managed forest ecosystems: Past trends and future directions. *For. Ecol. Manag.* **2009**, *258*, 2335–2346. [CrossRef]
44. Paletto, A.; De Meo, I.; Cantiani, P.; Ferretti, F. Effects of forest management on the amount of deadwood in Mediterranean oak ecosystems. *Ann. Sci.* **2014**, *71*, 791–800. [CrossRef]
45. Joelsson, K.; Hjältén, J.; Gibb, H. Forest management strategy affects saproxylic beetle assemblages: A comparison of even and uneven-aged silviculture using direct and indirect sampling. *PLoS ONE* **2018**, *13*, e0194905. [CrossRef]
46. Koivula, M.; Vanha-Majamaa, I. Experimental evidence on biodiversity impacts of variable retention forestry, prescribed burning, and deadwood manipulation in Fennoscandia. *Ecol. Process.* **2020**, *9*, 11. [CrossRef]
47. Babiak, T.; Bajerowski, W.; Cieśla, A.; Kolada, A.; Gawryś, R.; Korzeniak, J.; Kowalczyk, T.; Lewczuk, M.; Małecki, B.; Parkoła, R.; et al. Typy siedlisk przyrodniczych. In *Monitoring Siedlisk Przyrodniczych Oraz Gatunkow Roślin i Zwierząt w Latach 2017–2018. Biuletyn Monitoringu Przyrody*; Cieśla, A., Mionskowski, M., Kornatowska, B., Müller, I., Zajączkowska, M., Eds.; Biblioteka Monitoringu Środowiska GIOŚ: Warsaw, Poland, 2018; Volume 19, pp. 1–187.
48. Perzanowska, J.; Korzeniak, J.; Chmura, D. Alien species as a potential threat for Natura 2000 habitats: A national survey. *Biodivers. Conserv.* **2019**, *11*, e8032. [CrossRef]
49. Kocel, J.; Kwiecień, R.; Młynarski, W.; Mionskowski, M. Wskaźnik stopnia trudności gospodarowania leśnictw Lasów Państwowych. *Sylwan* **2012**, *156*, 403–413.
50. Angelstam, P.; Mikusiński, G.; Fridman, J. Natural forest remnants and transport infrastructure: Does history matter for biodiversity conservation planning? *Ecol. Bull.* **2004**, *51*, 149–162.
51. Sefidi, K.; Darabad, F.E.; Azaryan, M. Effect of topography on tree species composition and volume of coarse woody debris in an Oriental beech (*Fagus orientalis* Lipsky) old growth forests, northern Iran. *iFor. Biogeosci. For.* **2016**, *9*, 658. [CrossRef]
52. Kapusta, P.; Kurek, P.; Piechnik, Ł.; Szarek-Łukaszewska, G.; Zielonka, T.; Żywiec, M.; Holeksa, J. Natural and human-related determinants of dead wood quantity and quality in a managed European lowland temperate forest. *For. Ecol. Manag.* **2020**, *459*, 117845. [CrossRef]
53. Holtmeier, F.K.; Broll, G. Subalpine forest and treeline ecotone under the influence of disturbances: A review. *J. Environ. Prot.* **2018**, *9*, 815. [CrossRef]
54. Thom, D.; Seidl, R. Natural disturbance impacts on ecosystem services and biodiversity in temperate and boreal forests. *Biol. Rev.* **2016**, *91*, 760–781. [CrossRef]
55. Bujoczek, M.; Rybicka, J.; Bujoczek, L. Effects of disturbances in a subalpine forest on its structural indicators and bird diversity. *Ecol. Ind.* **2020**, *112*, 106126. [CrossRef]
56. Kowalski, T. *Chalara fraxinea* sp. nov. associated with dieback of ash (*Fraxinus excelsior*) in Poland. *For. Pathol.* **2006**, *36*, 264–270. [CrossRef]
57. Błońska, E.; Lasota, J.; Piaszczyk, W. Carbon and nitrogen stock in deadwood biomass in natural temperate forest along a soil moisture gradient. *Plant Biosyst. Int. J. Deal. Asp. Plant Biol.* **2019**, *154*, 213–221. [CrossRef]
58. Piaszczyk, W.; Błońska, E.; Lasota, J. Soil biochemical properties and stabilisation of soil organic matter in relation to deadwood of different species. *FEMS Microbiol. Ecol.* **2019**, *95*, fiz011.
59. Přívětivý, T.; Janík, D.; Unar, P.; Adam, D.; Král, K.; Vrška, T. How do environmental conditions affect the deadwood decomposition of European beech (*Fagus sylvatica* L.)? *For. Ecol. Manag.* **2016**, *381*, 177–187. [CrossRef]
60. Seibold, S.; Bässler, C.; Baldrian, P.; Reinhard, L.; Thorn, S.; Ulyshen, M.D.; Weiß, I.; Müller, J. Dead-wood addition promotes nonsaproxylic epigeal arthropods but effects are mediated by canopy openness. *Biol. Conserv.* **2016**, *204*, 181–188. [CrossRef]
61. Seibold, S.; Bässler, C.; Brandl, R.; Büche, B.; Szallies, A.; Thorn, S.; Ulyshen, M.D.; Müller, J. Microclimate and habitat heterogeneity as the major drivers of beetle diversity in dead wood. *J. Appl. Ecol.* **2016**, *53*, 934–943. [CrossRef]



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Article

The Institutional Structure of Land Use Planning for Urban Forest Protection in the Post-Socialist Transition Environment: Serbian Experiences

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Abstract: In recent decades, Serbia has been undergoing a period of post-socialist transition that has significantly altered the value system underlying spatial development due to alteration of ownership frameworks and land use rights. In consequence, issues have arisen of how to strike a balance between the various interests involved in the distribution of spatial resources and how to control the outcomes of public policies. Land use planning has been identified as an efficient instrument for implementing the public policy value framework. The objective of this paper is to identify the key points of land use planning in relation to urban forest management of significance for the maintenance of urban forests in the environment of post-socialist institutional transformation in Serbia. Seen as an institutional structure, the practice of land use planning in Serbia is the product of a stable interaction between the set of interrelated rules, procedures and organisational units that allows spatial development outcomes that take into account and safeguard land resources and, ultimately, urban forests. The research was carried out in relation to the concept of institutional transformation across three scales: macro/governance, meso/coordination and micro/agency: (a) components of the regulatory framework; (b) procedures for cooperation between stakeholders; and (c) specific activities of land use planning practice. As a result, the concept of Land use Planning for Urban Forest Protection (LUPUFP) in Serbia was established. It identifies components of institutional structure of importance for regulating system changes in the post-socialist transition environment and steering them towards the establishment of a value framework that allows the agenda of saving urban forests to be implemented.

Keywords: urban forest; institutional design; land use planning; Serbia; governance

1. Introduction

The research objective of this paper is to provide a critical overview of the institutional framework of the development planning system in relation to urban forest management, particularly land use planning, in the post-socialist environment in Serbia, in order to highlights components of importance to be used by institutional design for re-establishing a stable interaction inside the institutional structure that promotes a value system aimed at saving urban forests. As a result, this paper presents an improvement of the current land use planning system in Serbia by proposing the concept of Land Use Planning for Urban Forest Protection (LUPUFP), focusing on three major components: urban forests, land use planning and post-socialist environment in Serbia.

The problems of urban growth in the 21st century emphasise the importance of managing land resources in order to achieve sustainable development [1–4]. As a limited resource, land in cities, especially urban forests as compact large greenfield land, is particularly affected by new

construction requirements that are directly reflected on environmental problems such as "heat islands", flooding and air pollution. Therefore, the network of woodlands, groups of trees and individual trees located in a city that include forests, street trees, trees in parks and gardens and trees in derelict corners [5], in terminology known as urban and peri-urban forests, play a crucial role in meeting global commitments on sustainable development as well as adaptation to climate change and mitigation of its impacts. These requirements represent a particular challenge for local governments that are expected to make land use more efficient for planning compact cities and mixed-land use [1].

As it was indicated in recent research, urban forest services enhance nine of the seventeen Sustainable Development Goals (SDGs) [6,7]. These SDGs are 1: No poverty; 2: Zero hunger; 3: Good health and well: being; 6: Clean water and sanitation; 7: Affordable and clean energy; 8: Descent work and economic growth; 11: Sustainable cities and communities; 13: Climate action; and 15: Life on land.

These analyses included five categories that were considered to be urban forest (peri-urban forest and woodlands, city parks and urban forests > 0.5 ha, pocket parks and gardens with trees, trees on streets or in public squares and other green spaces with trees) where the category of peri-urban forest and woodlands was scored with the highest score, suggesting that it contributes to human health and well-being, climate change mitigation, climate change adaptation, biodiversity and landscapes, economic benefits and a green economy, land and soil degradation, watershed protection, resilience to flooding events, food and nutrition security, wood security, recreation, education, social cohesion and social security and equity. Further, it should be noted that the positive effects of urban forests ecosystems are confirmed within numerous studies [8–11] where it is specifically stressed that in regard to the public's perceptions of the effectiveness of the ecosystems services "environmental knowledge plays a key role in fostering pro-environmental behaviours" [12] (p.171).

Land use planning is a key mechanism for reducing pressure on land resources, which facilitates the implementation of environmental protection policies and steers choices in the direction of nature protection. This intention has been affirmed in the Curitiba Declaration on Cities and Biodiversity [13], where the issue of integrating biodiversity into urban planning is placed within the context of establishing the appropriate regulatory mechanisms and implementing tools, as well as decision-making instruments that will ensure the integration of nature/biodiversity and the urban structure. Land use planning directly serves the green agenda for ecological health and management of natural ecosystems on the local level, which aims at preserving green open spaces in cities for biodiversity protection and recreation [14]. The importance of integrating green structure planning in city development planning is also borne out by the findings of a survey of 23 European cities [15] that have met green policy targets by employing land use planning as the key instrument.

The achievement of the saving urban forests agenda has been challenged in post-socialist transition Serbia. Namely, after the year 2000, with the transition of the socioeconomic system from a socialist orientation to that of the market and democracy, and the start of the process of joining the European Union, significant institutional changes were initiated in Serbia. Following major challenges are of particular importance for this research.

Firstly, ownership relations over land have changed, thus establishing a new relationship of strengths of power in society and the consequent plurality of interests in the process of creating public policies concerning the use of land resources.

Secondly, with entering into the process of joining the European Union, the principle of subsidiarity, which transfers competencies to the local level, is an important principle in decision-making on public policies, thus giving the highest responsibility and commitment to local authorities in selecting and promoting the agenda. This is particularly challenging for post-socialist transition countries that do not have developed expert capacities at the local level.

Thirdly, global demands for the implementation of sustainable development promote the concept of governance, which implies the development of horizontal and vertical coordination mechanisms at different levels of the institutional structure. These demands entail a fundamental change in

the concept of decision-making in post-socialist countries, which up to now was hierarchical rather than collaborative.

Harmonization of the above components of institutional changes represents a huge challenge for the transition society, in the selection of a value framework for operation and the regulation of all domains of public policies. This is, beyond doubt, a highly sensitive institutional redesign process that will create instability and insecurity. Models that have proven successful in other situations cannot be applied, and locally-specific answers are expected to be created. In this context, the country must develop its own path of institutional transformation that will satisfy the demands of the new environment of post-socialist transition and the EU accession process, while, at the same time, retaining the positive experiences of the past. That is why this paper will investigate the current institutional framework of the development planning system in Serbia, which is in the function of achieving the agenda 'saving urban forests'. According to the concept of institutional transformation [16–25] the values are embedded in the institutional system and are a result of a balance between its components. With the disturbance of the stability of the institutional system, due to the transition process, which is induced by the influences that came into the system from the outside, an institutional transformation and consequently a distortion of the value framework of public policies and related agendas are inevitable.

Following an introductory section, the paper will first outline the theoretical framework in three important domains: land use planning, urban forest management and the concept of institutional transformation. The methodological section that follows relies on the key conclusions of the previous section to be used as the basis for the selection of methodological instruments and definition of key research questions. The analysis section comprises a detailed presentation of the institutional system of land use planning in relation to urban forest management from the national to local level, according to the concept of institutional transformation, illustrated by examples of the land use planning practice of two medium-sized cities. Within the discussion and conclusion section, as the first step in institutional design, the components of the presented institutional system are highlighted as the basis for the development of the Land use Planning for Urban Forest Protection (LUPUFP) concept.

1.1. Theoretical Background

1.1.1. Land Use Planning

In the last decades it has been emphasised that land use planning represents a significant management tool for dealing with unprecedented challenges that lie ahead of the accelerated urbanization process of cities [14,26]. Land use planning is a local development instrument that is complemented by regulations introduced hierarchically within vertical power relations. In general, land use planning is regulatory in character and is used by governments as a legal instrument intended to achieve public/common interest or public policy [27]. It essentially aims at controlling the use of and rights to land, both public and private [28], by applying various regulatory measures, such as protected areas, building codes and rezoning. More specifically, the purpose of the land use plan is to regulate the land as a category of usage, while the purpose of regulatory measures is to change ownership rights [29].

Contemporary development planning, and consequently land use planning, is a political and democratic process that mediates the conflicts over land use, not just a technical tool [30]. Contemporary planning has abandoned the traditional position of technical activity, where plans are understood as documents, to become a collaborative practice jointly undertaken by planners and local communities. This is consistent with the concept of safeguarding green areas, where traditional land use planning is seen as a passive, technical, regulative and rigid planning instrument that is lacking the capacity to protect spatial resources [15,31]. In contrast, the collaborative planning practice predominantly rooted in strategic spatial planning is considered to allow the articulation of a more coherent and coordinated long-term spatial logic for land use regulation [17]. Collaborative strategic planning practice looks at the distribution of spatial resources through process orientation, social inclusion and a multilevel

approach. From this point of view, the distribution of land use is seen as a policy conditioned by the design of appropriate governance institutions and proactive management activities [16,32]. In this context, decision-making is the key mechanism for establishing the value framework for public policy, and consequently selecting objectives relevant for the protection of spatial resources. The practice of strategic planning has proven to be a highly successful instrument for redistributing land in favour of larger open green areas, such as the development of a new urban forest, 'Parkbos', in Ghent, Belgium [33].

1.1.2. Urban Forest Management

Contemporary global development policies, which prioritize climate change issues in addition to sustainability, assign particular importance to urban forests in the context of adaptation to climate change and mitigation of its impacts. In addition to the Sustainable Development Goals (SDGs) the EU's current strategic framework [34,35] promotes an integrated landscape approach, which links protected spaces with other sectoral interests.

The Framework for Assessing and Monitoring Forest Governance [36] suggests six principles of good governance as cornerstones for a stable institutional structure for managing forest land: accountability, effectiveness, efficiency, fairness, participation and transparency. These principles intersect three key pillars: (1) policy, legal, institutional and regulatory frameworks; (2) the planning and decision-making process; and (3) implementation, enforcement and compliance. The second pillar is of immediate significance for development planning processes, emphasising as it does how important it is to "examine the extent, characteristics and quality of participation of a range of stakeholders in forest governance and the capacity of different stakeholder groups to engage in governance processes. Components under this pillar also consider the transparency of forest-related decision-making and resource allocation and the degree of accountability of governance mechanisms and processes" [36] (p. 13).

Similarly, in the domain of multi-disciplinary research into urban forest governance, Lawrence et al. [37] defined the analytical framework as a research tool. This framework is proposed to comprise four variables for researching the institutional system: (1) policies including national, regional or local policies, plans and programmes that affect urban forestry; (2) planning and regulations, which comprise planning and legal requirements specific to the case; (3) ownership of the land; and (4) access and use rights, such as the right to walk/cycle and/or make use of products from the urban forest. The proposed framework is only a starting model for studying urban forest governance which, according to the authors, should be elaborated on to achieve a deeper understanding of the ways to ultimately make our cities more sustainable.

The importance of stakeholder involvement in policy making to protect natural areas is also acknowledged by the Natura 2000 network, the core pillar in the EU's biodiversity conservation policy [34] and one of the largest networks of protected areas in the world. Although member states are free to align national regulations with EU instruments [34,35], the expected changes reach deep into the institutional foundations of public policy decision-making by legitimising a broad range of stakeholders and, consequently, introducing a multitude of varied interests that need to be harmonised [38–41]. This primarily affects the local decision-making level, the most effective forum for exercising the concept of public interest, as the issues at hand are specific and easy to operationalise.

1.1.3. Concept of Institutional Transformation

According to the concept of institutional transformation, values are embedded in institutional systems and are the result of the established balance between system components [18,19]. From a normative perspective, values and commitments generated in interaction shape undermine and augment formal and official regimes [23]. The concept of institutional transformation additionally describes in detail the procedures and interactions within processes of interest that can be used to

identify challenges in public administration, the formation of interests, the development of policies and links, and the implementation of administrations' programmes in the planning process [21–23].

The orientation of planning practice depends on the values built into the institutional structure. In other words, the dominant ideology informs beliefs, values and systems, which in turn shape institutions, which, ultimately, result in policies [42]. As such, land use planning, the regulation of the use of space, reflects the ideology of defining and using space.

Socioeconomic changes under the influence of external factors initiate the process of institutional transformation [24], which inevitably alters the behaviour of political and economic actors [22] and, consequently, leads to changes in public policy. In essence, institutional transformation takes place in the domain of changes to the value framework, and as such directly shapes the development of society over time. Institutional transformation disrupts what is termed 'stable interaction' within the institutional structure as the guarantee of the established value framework. Stable interaction reduces uncertainty in decision-making by securing stable outcomes, dubbed 'equilibria'. Institutional transformation, therefore, must aim at establishing these stable interactions within the institutional system and so reduce uncertainty.

Institutional design, as a normative aspect of institutional transformation, is an integral and essential part of the planning practice [22]. Institutional design determines the success and quality of interventions by agents (individuals and organisations), and so also determines the success of the planning practice [22,25]. The operation of institutions, from the national to the local level, affects the role and success of planning. Institutions create elements of order and predictability, impose orderliness on societal relationships, reduce flexibility and variability in behaviour, and limit options for one-sided exercise of personal interests [19,24]. Striking a balance between differences in land use interests is a matter of policy choice and the design of appropriate institutions and proactive management activities [22]. Consequently, it can be considered that institutional design is a useful method for changing planning practice.

The behaviour of political and economic actors is conditioned by sets of regularised practices with a rule-like quality [24] that also affect policy outcomes. The so-called regulatory regime of land use management is of crucial importance for the application of planning practice as the source of environmental protection policies [25]. The regulatory regime provides a framework for action within which agencies enjoy autonomy in choosing their modes of operation and create room for exerting influence on the value framework.

From a planning perspective, three general concepts should be viewed as the key elements to be addressed by the institutional design [22]:

(a) The first is the concept of governance, which is the most appropriate at the macro-level as it involves society as a whole and is linked to constitutional and legal amendments. This is the level of institutional design to which belong requirements for institutional change encountered by Serbia in its EU accession process.
(b) The second concept is that of coordination, at the meso-level, which pertains to the domain of planning and comprises procedures which facilitate the development and implementation of policies, programmes, projects and plans associated with professional planners' fields of practice.
(c) The third is the concept of agency, which occurs at the micro-level and involves intra-organisational design, the ordering of smaller working units and groups and the processes and interactions within and between them. This level directly entails managing planning processes and policy, the plan or project implementation [22].

That being said, institutional analysis does not focus on norms, rules and practices as integral elements of institutions, but, rather, on their mutual interaction within the context that conditions action [25]. The emphasis here is on understanding relationships between activities and the institutional context that generate practices and a power structure that subsequently determine relationships and changes. Institutional analysis, therefore, observes relationships between systems within an institution,

individual processes within and between those systems, what the constituent units of an institution are, which rules or norms govern their relationships, etc. [19,20]. According to Alexander [22] (p. 213), "institutional design means designing institutions: the devising and realisation of rules, procedures and organisational structures that will enable and constrain behaviour and action so as to accord with held values, achieve desired objectives or execute given tasks". Institutional analysis, as an initial step of institutional design, will be in this research applied to the land use planning practice related to urban forest management in Serbia.

2. Materials and Methods

In accordance with the presented theoretical framework, the critical re-assessment of the institutional structure of land use planning in the post-socialist environment of Serbia related to urban forest management, will highlight the following two aspects: (a) on the one hand, understanding the institutional and regulatory context of the planning process and (b) the other on discerning the relationships between dominant stakeholders in this process that reflect value-based approaches.

Furthermore, the research is based on qualitative assessment on three scales that correspond to the levels of institutional design [22]:

1. The macro-level entails assessing the regulatory framework for the development planning system related to urban forest management in Serbia from two aspects:

    (a) Overview and assessment of the institutional and legal framework for urban forest protection standards at all levels of administrative organisation: national, regional and local. In this assessment the position of urban forest protection standards within basic land use planning documents is also included.
    (b) Overview and assessment of the value framework for urban forest protection in national policy documents. This phase of the research relies on reviewing and analysing both the primary literature (laws, strategies and other public documents) and secondary sources dealing with issues of the planning system for urban forest protection.

2. The meso-level looks at the procedures for cooperation between institutions of the land use planning process on the local level, related to urban forest management in Serbia. Institutions are observed from the national to the local levels through the lens of multilevel governance. The focus is on the procedures for collaboration between institutions in the process of the 'General zoning plan' production, as well as policy-making procedures, and is observed in two aspects:

    (a) Identification of the organisational structure, with particular attention to the position, powers and roles of the relevant institutions.
    (b) Arrangements for collaboration that includes insight into both the horizontal and the vertical levels. This segment of the research relies primarily on a review of primary literature that sets out organisational powers while also considering secondary documents devoted to how land use planning and urban forest management policies are made.

    The micro-level entails a detailed review and assessment of the land use planning process in relation to urban forest protection in selected examples of land use planning practice on the local level. It is focused on analysis of activities of concrete cases of planning practices, where formal and informal institutional arrangements in the planning process are observed. The cases of planning practice are concrete solutions for the use of space viewed through the enacted policies and regulations. The accent here is on the description and analysis of the procedure of land use planning in terms of decision-making by the stakeholders (public, private and civil sector) involved that employ various mechanisms, instruments and actions. Both policy-related and regulatory planning solutions are analysed equally. This part of the research relies on both a critical analysis of the actual land use plan development process (particularly the planning

procedure for the 'General Zoning Plan') and the concrete examples of the general zoning plans (a result of the planning process) as undertaken by planners. Examples include the land use planning processes of two Serbian cities: Bor and Vrnjačka Banja. The criteria for the selection of the cases were the following.

(a) Medium-sized cities (in order to avoid the overly complex problems that are characteristic of large cities).
(b) The dominant planning agenda is 'saving urban forests'. Bor is a town where the urban environment is exposed to the impacts of copper and gold mines situated in the immediate vicinity, and Vrnjačka Banja is an urban environment purposefully developed as a spa.
(c) The planning processes started after the year 2000, following the introduction of Serbia's new socioeconomic framework.

The methodological procedure shown is seen as suitable for institutional assessment as it emphasises case development factors linked to the context, in the same manner as institutional theory links norms and procedures to the broader institutional landscape [43].

3. Results

In socialist Yugoslavia, green open spaces were considered a public resource and were, as such, accorded particular attention by urban planners. After World War II, with the institutionalisation of socialism in Yugoslavia, land policy that determined land use was based on the ideological belief in common or 'social' property, as opposed to the private ownership of land. The fundamental political, social and economic reforms pursued at the time, accompanied by the establishment of a new constitutional and legal order by the communist regime, declared which cities and urban settlements stood to be social property and excluded them from legal transactions. In consequence, any extension of the urban territory automatically made new land socially owned. Land use plans served as direct instruments for these transformations and were employed to put public interest into effect in actual space [44,45].

Although the trend under state socialism was to make forest land socially owned as well, forests could be owned by the state, cooperatives or private individuals. Nevertheless, all forests, regardless of ownership, were declared to be of general interest to the community and were placed under government protection [46]. This made the preservation of forests and forest land a matter of public interest, and a system of safeguards was designed and implemented across all levels of governance to attain this objective.

Difficulties encountered by post-socialist countries in transitional processes [47] are inseparably linked to the crucial issues of changes to the value system and established norms [48,49]. Private property, instituted by the changes as a new form of land ownership, has brought about a major shift in traditional patterns of land use planning. Private interests, needs and expectations of how land is to be used have gained legitimacy and so become major factors in land-related policy-making. Consequently, development land has come to be a fundamental resource for a city's economic growth. In these circumstances, pressure has increased to allow construction on greenfield land, where developers do not incur additional costs when investing. Therefore, in a democratising society facing privatisation and the construction of market institutions, land use planning has become both a tool to safeguard property rights and interests of various land use stakeholders and an instrument to correct for market failure [44].

Institutional changes characteristic of post-socialist transition altered the value basis for planning, which also caused a shift in the planning paradigm [50]. Lacking a common planning system model they could employ, post-socialist countries have developed their own approaches to institutional transformation [51]. The experiences of post-socialist countries have shown that no changes were

possible to planners' modes of operation that would allow them to protect the public interest without an institutional foundation being laid first [52].

The issue of public interest in planning has remained ill-defined in Serbia following the democratic changes of 2000. Urban plans have endeavoured to protect interests by defining public land, public areas and public buildings, but the protection of other, privately owned land remained subject to political decision-making and mechanisms intended to safeguard public interest. As such, issues including protection of public spaces, the environment, public health and security, energy efficiency, etc., topics that the public sector is not interested in addressing [53,54], remained within the remit of regulatory regimes of land use governance, primarily at the national level.

By contrast, the EU accession process has placed a number of new demands before the practice of environmental planning. Serbia formally became a candidate country for EU membership in March 2012, starting a negotiations procedure to align the country's regulatory framework with EU law through 34 chapters. Chapter 27 envisages the creation of a sustainable environmental management system, which cuts across all policy sectors and constitutes a value framework for their formulation [55]. In addition to the requirements of the negotiations process, other instruments pertaining more directly to the preservation of green open spaces also affect the harmonisation of the Serbian regulatory framework with the European context. One major such document is the European Landscape Convention [56], ratified by Serbia in 2011 [57]. An innovation introduced in the Convention is the understanding of landscape as a dynamic category that evolves with societal change. This approach means that landscape-related planning activity can no longer be subject only to deliberation by specialised technical bodies, but that landscape development policies must be enacted through democratic dialogue wherein all stakeholders are able to present their perceptions and views of the future of landscape [56].

On the other hand, the changes brought about by transition commenced a decentralisation process in which the local level became involved in decision-making about environmental protection policies. The EU accession process explicitly requires the adoption of standards to allow equal participation of all the various stakeholders in decision-making and reduce the scope for conflict between interests and preferences for protected spaces [58], as is confirmed in the ARHUS convention ratified by Serbian law [59]. This accords with the concept of governance, which promotes the establishment of diverse forms of cooperation, partnership agreements, delegation of authority and greater powers of the local community. Good governance entails the management of protected areas pursuant to the principles and values chosen by all stakeholders. As part of societal and cultural heritage, these principles are modified in accordance with globally recognised requirements and become integral parts of constitutions, laws and other legal enactments that regulate nature protection. However, most powers and responsibilities remain within the remits of governments and their agencies [60].

3.1. Macro-Level: Regulatory Framework for Development Planning System Related to Urban Forest Management in Serbia

3.1.1. Institutional and Legal Framework for Urban Forest Protection Standards

As yet, Serbia has not enacted legislation that specifically supports planning for the system of green spaces as a separate and autonomous domain. The Law on the Protection and Improvement of Green Spaces has remained at the drafting stage for a number of years [61,62]. Furthermore, a project by the Serbian Association of Landscape Architects, supported by the Ministry of Environmental Protection, that besides requiring spatial and urban plans to acknowledge and recognise existing greenery, green spaces, spaces close to nature and ecosystems, stressed the importance of the institutional framework at the local government level related to management, maintenance and reconstruction of urban green spaces [63].

The lack of an appropriate statutory and planning basis is compounded by the absence in Serbia of guidelines and recommendations for planning green spaces. Plans and regulations do not recognise the expression 'urban forest', but rather define forest land in urban contexts as 'town forests', an echo

of the German *Stadtwald* better suited to a general understanding of the urban forestry concept [64,65]. Terms of importance for urban forests formally employed in the green spaces planning system are defined in the Forests Law [66]; these are (a) 'forest', an area of land in excess of 5 acres (500 square metres) covered by forest trees and (b) 'forest land', the land on which are located structures facilitating the attainment of the generally beneficial effects of forests.

In Serbia, the powers for managing, safeguarding and improving forests in urban areas (see Table 1) in essence reside predominantly within two policy departments: the environment and planning. At the national level, the responsible institutions are the Government of Serbia and the Nature Conservation Institute, tasked with conservation activities, as well as the Ministry of Environmental Protection and the Ministry of Construction, Transportation and Infrastructure. These ministries are charged with the development of the national statutory framework for planning and protecting urban forests. The key regulations for urban forests protection are a set of planning laws that govern norms for establishing land use balance in the context of the regulation of property rights to land (i.e., public, private and cooperatively owned property). The relevant nature conservation laws govern standards for the protection, management and use of urban forests.

There is no regional governance level in Serbia, so only the Provincial Nature Conservation Institute (with powers in the Province of Vojvodina) is the only formal regional body. At the local level, urban forests are managed by local state-owned enterprises, established independently by local authorities depending on their size, status and resources. However, powers are often dispersed amongst different organisations and departments, as well as between various levels of governance. So, for instance, in Belgrade, the capital city, the state-owned enterprise manages 32.322,70 hectares of forests, while an additional 611 hectares of forests in the territory of Belgrade are owned and managed by the city itself [65] (p. 339).

Nevertheless, local land use planning has the greatest impact on urban forest protection. Land use planning, one of the most important components of planning in Serbia, is regulated chiefly by the Planning and Construction Law [67], which envisages two spatial governance instruments: Spatial Plans, more focused on the strategic orientation of development, and Urban Plans, more land use oriented with some elements of an integrated approach. Urban Plans are the most common instruments of local land use planning and are divided into three categories: (a) General Urban Plans, mostly oriented towards strategic aspects; (b) General Zoning Plans; and (c) Detailed Zoning Plans, mainly devoted to technical aspects. Land use maps and technical parameters, such as rules of planning and rules of construction, are integral parts of Urban Plans. These land use maps are effective instruments for designating land of public interest, as they formally distinguish between development land (land designated for construction) and other land, which is as a rule publicly held [67]. The Serbian planning system is characterised by a tradition of land use planning [68] that is based exclusively on regulation and where plans are rigid instruments that set out long-term land use, architectural and aesthetic standards, and landscape and natural resource protection rules [69].

Table 1. Institutional and legal framework for standards of urban forest protection in Serbia.

Territorial Organisation	Institutions	Laws	Standards of Protection
National level	Government of Serbia	Government Order on the Environmental Network [70] Government Order on Safeguards [71]	Environmentally significant areas Area safeguards
	Ministry of Construction, Transportation and Infrastructure	Law on the Spatial Plan of the Republic of Serbia [72]	Land use balance at the national level
		Planning and Construction Law [67]	Change in intended use of forest land to development land
		Expropriation Law [73]	Determination of land of public interest
		Public Property Law [74]	Resources of general interest (national level)
			Resources in general use (local level)
			Right to use public property
		Utilities Law [75]	Management and maintenance of public green surfaces
	Ministry of Environmental Protection	Nature Conservation Law [76]	Natural resources and natural values
			Protected areas
		Environmental Protection Law [77]	Forest development plans and forest management rules
			Safeguards and options for use as defined by plans
		Forests Law [66]	Ban on sale of publicly-owned forests
			Prohibited activities
			Conditions for change in intended use
		Environmental Impact Assessment Law [78]	Preventive protection measures
		Strategic Environmental Impact Assessment Law [79]	Preventive protection measures
	Serbian Nature Conservation Institute		Safeguards and conditions for their implementation
Regional level*	Vojvodina Urban Planning Institute		Vojvodina Regional Spatial Plan
	Vojvodina Nature Conservation Institute		Protection programmes Safeguards and conditions for their implementation
	Special-purpose areas (no administrative powers)		Spatial plans for special purpose areas
Local level	Local authorities' departments	Local authority spatial plan	Land use balance at the local level
		General Urban Plan	Land use Zoning Building codes
		General Zoning Plan	
		Detailed Zoning Plan	
	State-owned enterprises tasked with developing natural resources		Development and maintenance programmes

* Serbia is not formally divided into administrative regions. The only part of the country with territorial and administrative autonomy is the Province of Vojvodina.

3.1.2. Value Framework for Urban Forest Protection in Serbia

Achieving land use balance is a core task of the planning process in Serbia. So, for instance, the first Spatial Plan of the Republic of Serbia provided for three key categories of land use as the bases for striking balance in spatial development: agriculture, forests and land for other uses [80]. There are many benefits to preserving forest land and, consequently, the biodiversity of Serbia's ecosystems. With a total surface of 670.598,81 hectares of protected area in Serbia [46] (p. 88), forest and forest land account for more than 40%.

Table 2 presents an overview of the basic value framework for urban forest protection in Serbia. It reveals the extent to which strategic documents address issues of planning and managing urban forests. The key words used in this assessment were: 'urban forests', 'forest parks', 'forests', 'town forests' and 'forest land'. Clearly, the expression 'urban forests' is not recognised in any of the documents considered. The phrase 'town forests' was employed in only one of the instruments, the National Strategy for Sustainable Use of Natural Resources [81], while most of the remaining documents made use of the phrases 'forests' and 'forest land'. The highlight here is that forests are recognised as notable finite natural resources that are important for preserving biodiversity, amongst other considerations. As such, the policy documents provide significant frameworks that guide forest development and protection, in particular to ensure alignment with EU rules and institutional strengthening. Indirectly, it is noteworthy for urban forests protection that the value framework acknowledges the social and cultural functions of forests (in addition to protective and regulatory ones).

3.2. Meso-Level: Formal Cooperation Procedures between Institutions for Land Use Planning Related to Urban Forest Management in Serbia

3.2.1. Organisational Structure

The organisational structure of institutions for land use planning related to urban forest management in Serbia is analysed through three aspects: position, powers and roles.

Position: Institutions of formal importance for land use planning related to urban forest management reside at the national and the local level (Figure 1). There are no institutional powers at the regional level, except for the Autonomous Province of Vojvodina, and as such these cannot be considered to be a general rule. The Serbian Government and Parliament are the supreme institutions, and both are formally the establishing entities for specialised expert organisations responsible for urban forest protection. As such, the Government of Serbia is responsible for the Nature Conservation Institute, while Parliament has responsibility over 'Srbijašume', the Socially Owned Enterprise (SOE) charged with forest management. In addition, the central public administration includes a number of ministries responsible for sectoral duties in relation to land use planning related to urban forest management, such as the Ministry of Construction, Transportation and Infrastructure; the Ministry of Environmental Protection; and other government departments whose remits include urban forest protection issues.

There are also two key groups of institutions at the local level, city administrations and city assemblies. The administrations include a number of departments tasked with urban forest management, while city assemblies formally establish local SOEs that directly perform urban forest management duties.

Table 2. The value framework for urban forest protection in Serbia.

Policy Document	Values: Urban Forest
National Sustainable Development Strategy [82]	Sets out strategic objectives for management and use of forests and forest land, mandates an institutional framework for safeguarding the protective functions of forests, and provides a model for inter-sectoral cooperation in the development of plans.
National Strategy for Sustainable Use of Natural Resources [81]	Defines the concept of 'forests' and 'forest land'; highlights the significance of forests as finite biological resources used, amongst other purposes, for sports, recreation and tourism; and cites the overexpansion of tourism capacity and infrastructure as a threat. Lays out the ultimate objective of sustainable development—balance between the use of all forest functions to ensure lasting multifunctionality in the provision of material goods and other ecosystem services. Advocates the introduction of institutional and economic measures to preserve and advance the recreational and health-related functions of forests and forest ecosystems. Envisages the creation of 5000 hectares of new town and suburban forests (by 2020).
Forestry Development Strategy [83]	Introduces the fundamental objective of safeguarding and enhancing forests and developing forestry as an industry. Particularly advocates the preservation, advancement, sustainable use, and acknowledgment of the protective, social, cultural and regulatory functions of forests and reform and advancement of institutions in the forestry sector.
Biodiversity Strategy, 2011–2018 [84]	Provides an overview of the state of biodiversity, safeguards and the legal, institutional and financial framework for preserving biodiversity; defines strategic areas, goals and activities and includes an action plan. Divides forests by how mixed they are and provides recommendations to achieve the objectives of reducing loss of habitat, including forests, by 2020, and instituting protection of 17% of all land and water areas subject to safeguards. The strategy sets out a framework for measures to prevent adverse impacts of genetically modified species of trees and allochthonous and invasive species on forests and biodiversity. Also advocates development of forest certification programmes and best sustainable forestry practices based on an ecosystem-wide approach.
National Environmental Protection Programme [85]	Advocates the preservation, improvement and extension of existing forests and enhanced monitoring in line with international frameworks.
Law Ratifying the Convention on Biological Diversity [86]*	Advocates the preservation and sustainable use of biological diversity and all its components. Requires biodiversity issues to be considered when any national decisions are being made to preserve and sustainably use biological resources and measures to be adopted to avoid and minimise adverse impacts on biodiversity.
Law Ratifying the European Landscape Convention [57]*	Sets out the principles that each country should adjust to suit its national law and incorporate into spatial development policies. The Convention defines 'landscape' as a dynamic category that comprises areas of action of both natural and human resources, and advocates dialogue in enacting landscape development policies, especially at the local level to facilitate practical implementation.
Law Ratifying the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters [60]*	This convention, also referred to as the Aarhus Convention, guarantees the right to access information, participate in decision-making, and access justice in environmental matters. It establishes principles that public administration should adhere to when communicating with the public on environmental issues so as to safeguard the right of everyone, whether belonging to present or future generations, to live in an environment adequate to his or her health and well-being.

* Although these documents have legal force, they in effect ratify international instruments and are not binding in urban forest management practice.

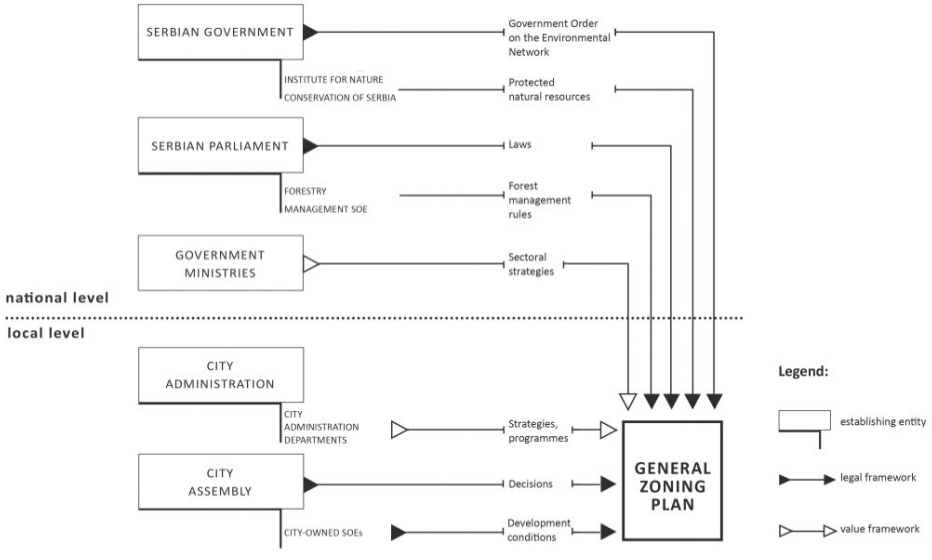

Figure 1. Formal cooperation procedures between institutions for land use planning related to urban forest management in Serbia (source: Authors).

Powers: National-level institutions are responsible for the regulatory framework binding on all levels of governance. Here, the Parliament enacts legislation proposed by the line ministries, while the Government is able to adopt 'Government orders', which carry the force of secondary legislation that elaborate on existing regulatory arrangements. The Nature Conservation Institute is specifically charged with assessing the value of natural resources and assigning protected status to 'natural resources of national importance', while the forest management SOE is responsible for regulating forest management at the national level. Documents designating 'protected natural resources' and setting out 'forest management rules' constitute a legally binding framework for land use planning at all territorial levels. Apart from legally binding decisions, the various ministries are responsible for enacting strategic documents that set out the value framework.

At the local level, it is the city assembly that is responsible for decision-making. Decisions are drafted by the city administration through its sectoral departments. In addition to these, the city assembly may incorporate local SOEs responsible for preparing 'development conditions', which regulate norms for the use of space by sector. Apart from legally binding documents, departments of city administration also prepare documents setting out values, such as strategies, action plans and programmes.

Roles: The key role in the governance system is played by Parliament, the Serbian National Assembly, which is the country's legislature. Its local counterpart is the City Assembly. The executive power is vested in Cabinet Ministries at the national level, and in Departments of City Administrations at the local level. Institutions important for enacting legally binding documents specifically aimed at urban forest management are the national Nature Conservation Institute and forest management SOE and local SOEs.

3.2.2. Arrangements for Collaboration

At the horizontal level, collaboration takes place between legislative and executive institutions responsible for land use planning related to urban forest management that are at the same time the key pillars of democratic society. National arrangements in this regard are mirrored at the local level. Particularly important for land use planning related to urban forest management is close horizontal

collaboration between national and local parliaments with specialised nature and forest conservation institutions, which these legislative bodies have formal responsibility for as their incorporating entities. Their horizontal cooperation results in sectoral standards that safeguard land covered by urban forests.

Vertical collaboration between institutions of land use planning related to urban forest management is defined by the national regulatory framework which is legally binding for all lower levels of governance. Within the land use planning system itself, legislation mandates compliance with plans enacted at higher levels (i.e., plans are vertically conditioned).

3.3. Micro-Level: Activities in Land Use Planning Practice

Amendments to the Planning and Construction Law [87] established the General Zoning Plans as the binding planning documents for central built-up areas at the local level. These plans are defined as operational instruments that allow direct implementation, meaning that they set out conditions for construction. They define the intended use and status of land (publicly-owned and other); typology of construction, regulation, capacities and infrastructure; and set out safeguards and development rules. The General Zoning Plans are hierarchically linked with higher-level plans, the National Spatial Plan and the Local Spatial Plan, which provide strategic guidelines for urban development.

The procedure for preparing urban plans is governed by the latest Planning and Construction Law [67]. This is identical for all planning levels in this category (Figure 2). The planning process is preceded by the local parliament's 'Initiative for planning'. The actual process of producing the planning document is entrusted to an expert organisation, which may be a public enterprise or a private company. Various public institutions become involved at various stages of the development of the plan, as do civil or private-sector actors. At the outset of the process, when the 'Concept of the plan' is defined, binding conditions are obtained from the relevant national-level SOEs and institutions, which, for urban forest management, are the Nature Conservation Institute, the forest management SOE and local SOEs tasked with public utilities and environmental protection. Public participation is ensured at two points in the planning process: once at the very beginning, to verify the overall concept, and once at the end, to vet the proposed plan. Immediately before the proposed plan is put up for 'Public viewing', it is at the stage termed 'Inspection of the plan' by the Planning Commission, an expert body established by the local government. After the 'Inspection of the plan' and 'Public viewing' phases, the 'Plan finalization' follows, after which it is sent to the local assembly for 'Adoption of the plan'. The plan may be amended by the local assembly before it is enacted, and the amendments may significantly impact some aspects of the plan.

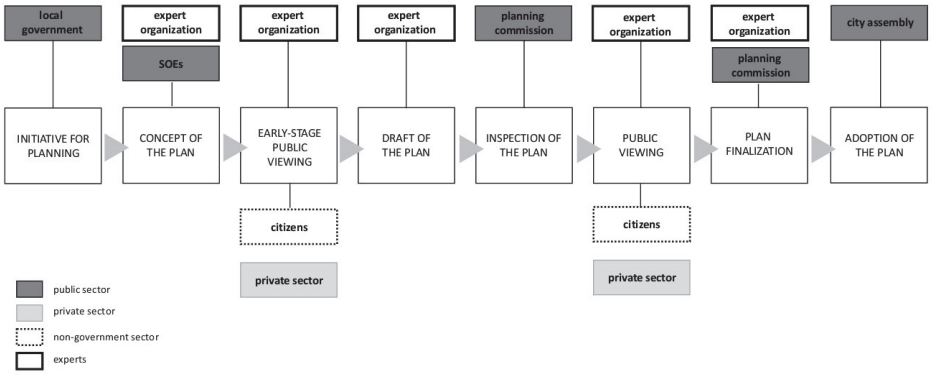

Figure 2. Formal and informal arrangements in the planning procedure (Source: Authors, based on [88]).

Strategic Environmental Impact Assessments (SEA) is yet another key tool for nature conservation. These are defined by the relevant legislation [77], and assessment is mandatory if a decision is made to

produce it at the same time as the Initiative to develop a plan. Even though these assessments were first introduced as early as 2004 as a new environmental protection tool, until 2010 this was only a parallel procedure. The new regulations made them a mandatory and integral component of spatial plans; for urban plans, depending on the scope of each document, formal decisions are made to prepare or not to prepare impact assessments. The SEA aims at describing, evaluating and assessing the likely impact of the General Zoning Plan on the environment and envisages measures to mitigate adverse effects. It is developed in parallel with the draft of the plan and is subject to expert verification by the Planning Commission.

In terms of the transparency and collaborative nature of planning procedures, the practice of public participation does not differ much from that employed in the later stages of the socialist period. Until the enactment of the Planning and Construction Law [87], members of the public could become involved only at the end of the process, once the plan had already been developed, which meant that public comments could pose an issue and draw out the planning process. The 2014 the Planning and Construction Law introduced the option of 'Early-stage public viewing' at the very outset of the planning process.

Within the presented planning model, we can identify formal and informal positions that influence the issue of forest management and preservation:

(a) The formal influence is implemented through

- plans of higher order,
- conditions of institutes for environmental protection and
- conditions of SOEs for managing forest land;

(b) The informal influence is implemented through

- capacity of experts in relation to urban forest management and preservation in various positions of the planning procedure—local councillor, expert responsible for a plan creation, expert in the planning commission, expert from the civil sector and expert from the private sector; and
- capacity of nonexpert stakeholders in relation to urban forest management and preservation in various positions of the planning procedure—local councillor, civil sector and private sector.

3.3.1. Examples of the Land Use Planning Practice Related to Urban Forest Management in Serbia

The General Zoning Plans of two medium-sized Serbian cities were chosen for this assessment of the institutional structure of land use planning related to urban forest management at the micro-level. These are the General Zoning Regulation Plan for Vrnjačka Banja [89] and the General Zoning Plan for the Town of Bor [90].

General Zoning Plan for the Town of Vrnjačka Banja

Vrnjačka Banja is one of Serbia's major spas and a tourist resort of key national importance. Tourism is the city's chief industry, and as such development strategies focus on improving tourism capacities and the quality of the tourist offering.

The General Zoning Plan is based on the Spatial Plan of Serbia [72] and the Spatial Plan of the Municipality of Vrnjačka Banja [91]. A specific feature of this plan is the Government Order Establishing the Area of the Vrnjačka Banja Spa [92], which defined the boundaries of the 182-hectare spa zone, which contains a number of hot and mineral water springs harnessed for use in public baths and medical establishments. In that sense, it should be stressed that forests and forest land are recognised as critical for protection of mineral water springs. A number of the objectives set out in the higher-level plans are of strategic importance for the development of Vrnjačka Banja, including preventing continued degradation of space, addressing threats to natural resources, combating unpermitted construction and

use of space contrary to intended purposes and revitalising areas, in particular those with perspectives for development.

The immediate reason for enacting the General Zoning Plan for Vrnjačka Banja was the need to take stock of new structures due to wide-ranging changes in the field resulting from not just legal but also illicit construction. The primary objectives of the Plan are to safeguard the city's character as a spa town, increasing the extent of green spaces in the broader territory of the city, especially in naturally green areas and plots of agricultural land that divide commercial zones from housing and central facilities.

The SEA is an integral part of the General Zoning Plan. The SEA concluded that the plan placed substantial emphasis on the sustainability of urban planning, zoning and construction. It also concluded that environmental protection considerations were complied with and incorporated into all aspects of the plan so as to allow the necessary development to proceed with minimum consequences for the environment.

The General Zoning Plan for Vrnjačka Banja covers an area of 2.318,97 hectares (see Table 3). One of the Plan's objectives is to protect forests, agricultural land and biodiversity in general. The summary of the current state of publicly-owned green spaces identifies only two uses: forests and forest parks. The General Zoning Plan introduces a forest park with an overall area of 150,3 hectares (see Figure 3). The purpose of this specific type of land use is to preserve forest configurations, ensure they can receive the required care and maintenance and permit them to be used for purposes of tourism and recreation.

Table 3. General Zoning Plan for Vrnjačka Banja: aspects relevant to land use planning related to urban forest management.

General Zoning Plan	**Vrnjačka Banja**
Area covered	2.318,97 hectares
Existing use	Forests (public use)
Planned use	Forest park
Area/percentage of total area covered by plan	150,3 hectares/6.5%
Objective of change of use to forest park	Forest configurations entailing additional attention in terms of maintenance, care and protection with a minimum of park facilities. The primary objective is to maximise the protection of forests and greenery in general, safeguard autochthonous vegetation, landscape configurations, and characters of areas. These zones most commonly integrate recreational and tourism-related facilities of central and boundary areas. These areas are designed for tourism and/or meeting the needs of the residential population of all ages.
Development rules	Construction of appropriate hydraulic engineering structures to provide protection from torrential flooding and floods; Provision of discreet lighting and street furniture as designed; Scheduled maintenance as part of park care projects; Provision of cafe and restaurant facilities (construction of 1 to 3 buildings of up to 150 square metres)
Restrictions	Change in intended use of space, construction of structures, tree felling and unplanned removal of vegetation, earth moving works, vehicle movements, waste disposal
Implementation conditions/instruments	Urban Planning Design required. General Zoning Plan required for Forest Park 1 (10,46 ha), Forest Park 2 (17,31 ha) and Forest Park 3 (34,91 ha)
Protection zones	Sanitary Protection Zone 2
Protection conditions	Greenery of major importance for the character of the area (Borjak) Conditions issued by the Kraljevo Cultural Heritage Institute (Forest Park 1 as whole)

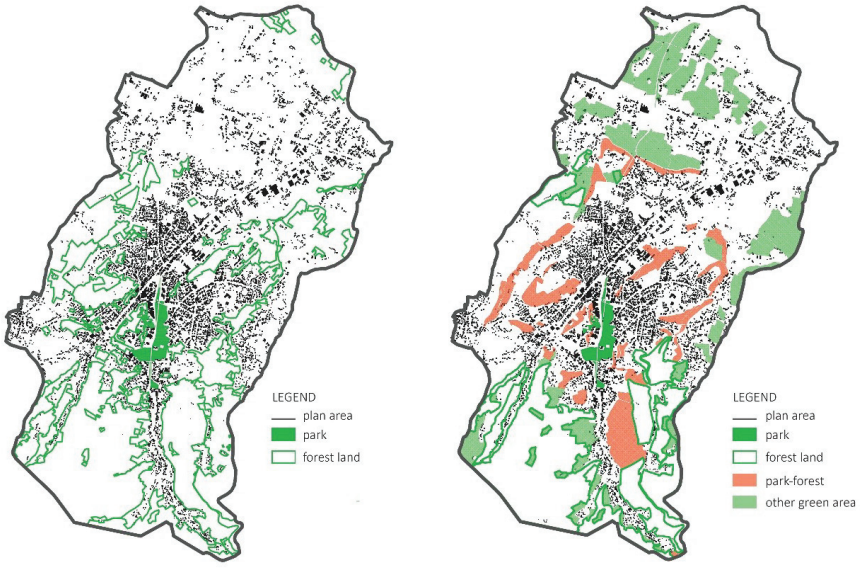

Figure 3. General Zoning Plan for Vrnjačka Banja: green spaces land use plan, current vs. planned state (source: Authors).

The plan also lays down rules for development in the forest parks and sets out conditions for particular types of constructions (catering and hydraulic engineering facilities). The plan bans any changes to the intended use of space, construction of structures, tree felling and unplanned removal of vegetation (except where required to protect plant health, as assessed by the relevant local SOE), earth moving works (except where envisaged by the project designs) and unrestricted vehicle movements and waste disposal. Detailed Zoning Plans are mandated for the three forest parks (Forest Park 1, of 10,46 ha; Forest Park 2, 17,31 ha; and Forest Park 3, 34,91 ha), whereas urban planning designs are required for any interventions within the planned forest parks. Apart from the development rules applicable to all planned forest parks, special requirements were introduced for the Borjak Forest Park (34,91 ha) to take account of the greenery of major importance for the character of the area there, as well as for the forest park near the central city park due to the need to protect cultural heritage monuments.

General Zoning Plan for the Town of Bor

Bor is located close to a major copper and gold mining and smelting facility. Rapid industrialisation in the latter half of the 20th century made the city an important centre for Eastern Serbia. Current and future development of the area is based on mining and industry and the accompanying manufacturing and services sectors.

The General Zoning Plan is based on the Spatial Plan for the Municipality of Bor [93] and the General Urban Plan of Bor [94]. Specific issues are regulated by the local Development Land Decision [95] and the Decision on Public Development Land [96], which determine which development land can be owned publicly or held otherwise: (1) development land intended for public use, comprising infrastructure and buildings (utilities facilities, urban greenery and other public structures and areas of general interest, such as those devoted to education, child protection, healthcare, social welfare, culture, sports and recreation, etc.) and (2) areas intended for other uses, meaning all other structures and areas (housing, businesses, services, etc.).

Higher-level plans designate Bor as a (sub)regional hub with a catchment area covering a number of surrounding municipalities. Bor is an industrial centre with well-developed industry and significant prospects for continuing development of the nonferrous metals sector based on the mining and

processing of copper and gold ores. The Spatial Plan of Serbia envisages increasing the forested area of the Municipality of Bor from 45% to 49.2% of the total land surface, or to 3.570 hectares. The new forests are planned to take the place of poorer quality agricultural land. The General Zoning Plan sets out priorities for development in all areas; for environmental protection, they entail the implementation of the Municipality of Bor Sustainable Development Strategy and revitalisation of degraded land.

The General Zoning Plan applies to the entire territory of the town of Bor, which is divided into seven spatial units and does not comprise the mining and smelting facilities. The area covered amounts to 1312,20 hectares (Table 4). The plan aims at providing an urban planning framework for buildings and areas of public interest. It sets out the requirements for the reconstruction of the town core and other spaces, construction of public, commercial and other facilities, improved protection of the environment, cultural heritage, natural and man-made settings and other issues. Green areas are a major consideration of the Plan, especially in the town core and as part of housing complexes containing multi-dwelling units. These green areas are planned to account for 0.85% of the entire area covered (or 11,2 hectares).

Table 4. General Zoning Plan for the Town of Bor: aspects relevant to land use planning related to urban forest management.

General Zoning Plan	**Town of Bor**
Area covered	1312,20 ha
Existing use	Urban greenery (public use)
Planned use	Forest park
Area/percentage of total area covered by plan	11,2 ha/0.85%
Objective of change of use to forest park	Conversion of a forest, including a zoo, into a forest park. Development of recreation and tourism facilities
Development rules	Basic natural characteristics to be retained Minimum development: - Passive recreation zone: basic equipment, walking paths, lawns to be used for recreation purposes - Active recreation zone: maximum percentage of paved and built-up areas: 2.5% of total - Activity zone: additional equipment (cycle paths, running paths, miniature golf course, children's playground, restaurants, etc.); maximum percentage of paved and built-up areas: 5% of total Part of forest may be developed as park Only natural materials to be used for all paths, minimum lighting Only natural materials (wood and stone) to be used for benches and rest areas Parking spaces to be sited at the main approaches to the forest Endeavour to restrict movement to pedestrians only Provide signage and development and maintenance programmes
Restrictions	-
Implementation conditions/instruments	Appropriate technical documentation must be developed for newly planned green areas and reconstruction of existing ones. The Plan repealed the Zoning Plan for 'Section 3'—Forest Park (Municipal Official Journal Nos. 19/94, 4/01 и14/03).
Protection zones	-
Protection conditions	-

The SEA as an integral part of the Plan concludes that attaining the objectives of the plan will not seriously threaten natural and environmental values, and recommends close adherence to the guidelines of the Plan and the SEA with regard to the environment, spatial development and use of natural resources.

The objectives of the General Zoning Plan for Bor include safeguarding and improving the state of green areas and protective greenery, developing sports and recreation spaces and making the urban

environment more attractive with the aim of attaining public values and interests of the urban area. The plan identifies two intended uses of publicly-owned green areas: Urban greenery (within the limits of urban development land) and Other greenery (for areas other than urban development land), which also includes forests (Figure 4). In Section 4, the General Zoning Plan introduces forest parks as a separate intended use of land, with a total area of approximately 11.2 hectares. The existing forest, which includes a zoo, is planned to be converted into a forest park designed for recreation. The plan mandates that the fundamental purpose of green areas be respected and that the key natural characteristics of the space be retained in their entirety (including vegetation, elevations, bodies of water and the like). This includes preserving autochthonous vegetation and minimum interventions in terms of introducing additional developments.

Figure 4. General zoning plan for Bor: green spaces land use plan, current vs. planned state (source: Authors).

The plan sets out development rules for the forest parks and provides conditions for development of passive and active recreation and activity zones, indicates which facilities can be constructed, regulates materials to be used in covering paths and walkways, stipulates how vehicular access is to be controlled and gives pedestrians priority within the forest parks. The creation of the newly-planned green areas and reconstruction of existing ones (which applies to the Section 4 forest park) requires the development of the appropriate technical documentation. This location is not subject to any specific restrictions.

4. Discussion and Conclusions

Land is a fundamental yet finite resource for urban development, and, as such, is directly exposed to the influence of complex socioeconomic factors. In these circumstances, urban planning must rise to the challenge of addressing the manifold development priorities that stem from public policies. Land use planning consequently becomes an efficient instrument for implementing the value framework of public policies through the definition of ways in which land can be utilised. According to the concept of institutional transformation, values are inherent to the institutional system and are the result of a balance struck between its elements. With the disturbance of the stability of the institutional system, induced by the influences outside the system, there is an institutional transformation and a distortion of the value framework of public policies and accompanying agendas, such as “saving urban forests”.

The key factors that influence the transformation of the institutional system in Serbia are as follows.

(a) The shift in the economic system to embrace open market principles, directly leading to altered ownership of land and, thereby, to a new balance of power in society. This has brought about a fundamental change in perspectives of public property and promoted the diversification of interests related to land use. While it was formerly beyond question, public interest, as a category defined by ideological norms, is now a matter of political agreement that reflects the balance of power in society.
(b) Acceptance of the global value framework and the principle of sustainability as the dominant development concept, which occasioned the development of horizontal and vertical coordination mechanisms at all levels of institutional structure. This is significantly different in relation to top-down decision-making practice that was dominant in a socialist society, where communication mechanisms were exclusively in the function of carrying out the decisions made at the highest level.
(c) Acceptance of European integration, where a primary value concept is the principle of subsidiarity, whereby responsibility for decision-making on shared issues is transferred to the lowest possible tier of social organisation. It has introduced democratic dialogue as a means of determining the value orientation of future spatial development. This presents a major challenge for local authorities that should demonstrate the ability to carry out democratic dialogue within the community and the choice of development goals.

Despite a sound and well-developed tradition of nature and forest land protection under socialism, these key factors listed above, have significantly eroded the stability of the previous institutional structure and initiated a process of institutional transformation. As a result, the position of land use planning as a robust mechanism for mediating conflicts over land use and a regulatory instrument for policy implementation is highlighted.

Given the objective of this paper, to provide a critical overview of the institutional framework of land use planning in relation to urban forest management in the post-socialist environment of Serbia, we have defined the components of importance, presented below, for establishing a stable interaction inside the institutional structure for promotion of a value system aimed at saving urban forests. As a first step of institutional design, these components represent key aspects of the concept of land use planning for urban forest protection (LUPUFP) in the Serbian post-socialist transition environment.

The analysis was conducted across three scales: macro/governance, meso/coordination and micro/agency. This included the analysis of system components from the national to local level, illustrated by examples of the land use planning practice of two medium-sized cities. Accordingly, the analysis has identified the major institutional changes regarding:

(a) Regulatory structure and the value framework of public policies. This aspect of institutional analysis is aimed at examining the macro-level, which is in Serbia determined by significant macro-societal processes that take place due to the adoption of national and supranational constitutions [22]. It includes two aspects: (a) an institutional and legal framework for urban forest protection standards and (b) a value framework for urban forest protection. Serbia's planning system is hierarchically organised, from higher to lower levels of governance. Legislative changes have aimed at reducing the number of planning levels to promote efficiency and effectiveness in implementing plans. However, planning has failed to keep up with the pace of legislative change, which has in practice led to unclear planning procedures and misalignment between the outcomes of planning at various spatial levels. These circumstances have caused confusion between the national, regional and local levels as to their respective powers and roles. Further, the practice of land use planning related to urban forest management is subject to a variety of laws enacted by administrative authorities in numerous sectors. One issue here is the lack of alignment between urban forest protection standards introduced by the various regulations, which has caused problems with interpretation and implementation at the local level. On the other hand, the value framework for urban forest protection is formally implemented through the legislative framework and the standards for protection envisaged by it. A major issue here is

the set of policy documents the implementation of which is not formalised and is therefore not mandatory. The multitude of formal and informal policy documents at the national level, not sufficiently aligned with one another, prevent both the establishment and the implementation of a clear value framework. As a basic drawback, the absence of a terminological framework and the identification of urban forests as a separate category of urban green land are observed, leaving at the local level a space for different interpretations, as is shown in the cases of the General zoning plans of Vrnjačka Banja and Bor. In addition, the underdeveloped capacities of local SOEs, due to the lack of expert profiles in the formation of employees, as well as the burden on the public service of many utilities, represent an obstacle in the formulation of requirements as well as the implementation of protection measures. Thus, as was illustrated in both of the General Zoning Plans of Vrnjačka Banja and Bor, standards defined on the national level serve as guidelines for particular land use planning processes; however, LUPUFP is not yet recognised as a concept. Consequently, the key components of the regulatory framework for the establishment of the LUPUFP system are

- Retaining the hierarchy of the planning system;
- Setting clear planning procedures and defining expected outcomes of planning at various spatial levels;
- Harmonising different regulations that envisage urban forest protection standards;
- Establishing a clear relationship between formal and informal policy documents;
- Mutual alignment of the multitude of policy documents;
- Formalising relationships between legally binding and nonbinding policies at the national and local governance levels.

(b) Procedures for cooperation between institutions. The next level of institutional analysis (the meso-level) involves planning and implementation structures and processes [22]. Serbia's traditional hierarchical planning system, which entails complex inter-organisational networks, requires cooperation at the horizontal and vertical levels aimed at the development and implementation of policies, programmes, projects and plans. The top-down approach, which emphasised the national decision-making level and an expert-driven approach to policy-making, is slowly opening up to bottom-up initiatives and the acknowledgment of particular interests in decision-making. This has been accompanied by a new set of regulatory reforms that aim at decentralising public administration and placing responsibility for making spatial planning decisions at the local level. This type of institutional transformation entails a reform process wherein the regulatory system is carefully harmonised both horizontally and vertically. The preconditions for these changes are a clear political orientation and the provision of appropriate professional capacity. As such, institutional design must be based on firm foundations, including institutions and regulations, which both define policies for urban forest protection and ensure decision-making procedures aimed at safeguarding the public interest. From the urban forest management perspective, the institutional structure is strictly divided between the national and the local level of governance. Each institutional level possesses a distinct unit charged with issues of nature conservation, including forests, whereby the communication between them is very weak. Also, the strict sectoral division between governance units at the same level poses a problem for horizontal communication. As was illustrated in cases of the General Zoning Plans of Vrnjačka Banja and Bor, there is a noticeable absence of horizontal communication between the sectors dealing with the "saving urban forest" agenda, as the requirements for defining planning measures such as "restrictions", "protection zones" and protection conditions" are not obligatory. This clearly shows that, for example, climate change issues, drinking water protection, energy efficiency, healthy environment, etc. are irreconcilable, and therefore they are dependent of the expertise of the organisations involved in the development of the plan as well as the knowledge of the local community. The value framework for the agenda of saving urban forests requires firm

regulations for stakeholder involvement in making decisions on urban forests, indicating that various control mechanisms are necessary. The weaknesses of such a system lie in the rigidity of its mechanisms and their uncritical application in locally specific situations. Implementation of the public policies and safeguarding the adopted value framework is contributed by units specialised in nature and forest protection at all levels. As was illustrated in Vrnjačka Banja and Bor, bottom-up initiatives for forest protection and development from the local level that are recognised within land use planning processes, such as particular local decisions, reflect the adjustment of the institutional structure in order to promote the concept of LUPUFP. Consequently, the key components for the establishment of the LUPUFP system related to the procedures for cooperation between institutions are

- Strengthening vertical coordination between specialised nature and forest protection units at the national as well as local levels;
- Establishing procedures and mechanisms for horizontal communication between sectors at the same level of governance;
- Establishing procedures and mechanisms for bottom-up communication by decision-makers;
- Creating preconditions for efficient multi-stakeholder cooperation;
- Establishing firm regulations to control the impact of market forces;
- Defining legal procedures that acknowledge control mechanisms;
- Ensuring more flexibility in the application of control mechanisms in locally specific situations;
- Retaining specialised units and their instruments for implementing nature and forest protection instruments;
- Establishing mechanisms for horizontal and vertical coordination of policy implementation instruments.

(c) Activities in land use planning practice. This level of analysis pertains to intra-organisational design, addressing organisational subunits and small semiformal or informal social units, processes and interactions [22]. Also, it directly examines the extent of stakeholder participation related to the legal framework, the effectiveness of processes, and the space for the involvement of civil society [36] in relation to urban forest management. Land use planning at the local level in Serbia in general is noticeably top-down oriented, with strict control conducted by public sector, and mainly subordinate to the attainment of public sector interests. The participation of stakeholders from the private and civil sectors is partial and insufficient. The role of expert organisations does not enjoy a sufficiently clear position in the decision-making system. Substantial responsibility—and power—is given to the planning commission as an expert body of the local government. Accordingly, their position is sensitive to the influence of various interests. Furthermore, the structure of the commission does not include experts from the domain of urban forest management. As was illustrated in the example of the General zoning plan of Vrnjačka Banja, the formal institutional framework, particularly in the domain of top-down coordination and standards for protection, serves as a base for urban forest protection that was recognised as a crucial resource for further spa protection and development. In the example of Bor, where urban forest protection is not specially required outside of the formal standards, the informal institutional structure gives space for informal institutional actions for urban forest protection and bottom-up initiatives that are in line with the requirement for 'fostering pro-environmental behaviours'. Consequently, the key components for the establishment of the LUPUFP system related to the activities in the land use planning practice are

- Establishing collaborative planning, which entails informed decision-making about the directions of urban development at key stages of plan production;
- Clarifying the roles of experts in the decision-making system and ensuring their independence from political decision-making;

- Clearly defining policies and regulatory mechanisms at the national level;
- Standardising the various categories of land use at the national level;
- Retaining mechanisms that acknowledge the regulatory norms and hierarchy of the planning system;
- Harmonising regulations across various sectors;
- Strengthening the positions and capacities of local public sector experts;
- Establishing a clear methodology for the development and content of urban plans.

These three groups of components constitute possible guidelines for preserving the robust tradition of land use planning related to urban forest protection by the establishment of the concept of LUPUFP in Serbia. The complexity of the subject, rooted as it is in differing sectors of expertise, certainly calls for deeper consideration of the myriad components of the system in the future. The findings presented in this paper have no ambition to include all the components of the system, but to provide some valuable insight into the practice of land use planning as one of the most efficient instruments for protecting green land in cities and that adheres to the agenda of saving urban forests.

The concept of LUPUFP is in line with current recommendations for the safeguarding and sustainable management of forests and other green areas in cities as crucial components for the health and well-being of citizens, promoted by the most influential documents such as Agenda 2030, the Paris Agreement and the New Urban Agenda. Related to that, the main contribution of this research is in the promotion of the relevance of the concept of LUPUFP in accordance to the importance of ecosystem services especially, as outlined by the FAO report regarding the nine SDGs.

The conducted research also contributes to the concept of institutional transformation, which is verified through the system of the land resource management of society in the environment of post-socialist transition. The results of this research presents the specific, practical and applicable path of institutional redesign that leads to the establishment of a concept of LUPUFP as an experience that may assist other countries in the region seeking answers in the process of developing their own models.

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References and Notes

1. United Nations (UN). *Transforming Our World: The 2030 Agenda for Sustainable Development*; Resolution A/RES/70/1; United Nation: New York, NY, USA, 2015.
2. United Nations Framework Convention on Climate Change (UNFCCC). Paris Agreement. 2015. Available online: https://unfccc.int/sites/default/files/english_paris_agreement.pdf (accessed on 22 June 2018).
3. United Nations Human Settlements Programme (UN HABITAT). New Urban Agenda. A/RES/71/256. United Nations, 2017. Available online: http://habitat3.org/wp-content/uploads/NUA-English.pdf (accessed on 22 April 2018).
4. World Commission on Environment and Development (WCED). *Our Common Future*; University Press: Oxford, UK, 1987.
5. Food and Agriculture Organization of the United Nations (FAO UN). Urban and Peri-Urban Forestry-Definition. Available online: http://www.fao.org/forestry/urbanforestry/87025/en/ (accessed on 22 December 2018).

6. Food and Agriculture Organization of the United Nations. *Guidelines on Urban and Peri-Urban Forestry*; FAO Forestry Paper No. 178; Salbitano, F., Borelli, S., Conigliaro, M., Chen, Y., Eds.; Food and Agriculture Organization of the United Nations: Rome, Italy, 2016.
7. Edreny, T. Strategically growing the urban forest will improve our world. *Nat. Commun.* **2018**, *9*, 1160. [CrossRef] [PubMed]
8. Hurokawa, H.K. Sustainability and the Urban Forest: An Ecosystem Services Perspective. *Nat. Resour. J.* **2011**, *51*, 233–259. [CrossRef]
9. Zhou, W.; Cao, F.; Wang, G. Effects of Spatial Pattern of Forest Vegetation on Urban Cooling in a Compact Megacity. *Forests* **2019**, *10*, 282. [CrossRef]
10. Kim, G. Assessing Urban Forest Structure, Ecosystem Services, and Economic Benefits on Vacant Land. *Sustainability* **2016**, *8*, 679. [CrossRef]
11. Jim, C.Y.; Chen, W. Ecosystem services and valuation of urban forests in China. *Cities* **2009**, *26*, 187–194. [CrossRef]
12. Gungor, B.S.; Chen, J.; Wu, S.R.; Zhou, P.; Shirkey, G. Does Plant Knowledge within Urban Forests and Parks Directly Influence Visitor Pro-Environmental Behaviors. *Forests* **2018**, *9*, 171. [CrossRef]
13. Curitiba Declaration on Cities and Biodiversity; Curitiba, Brazil. 2007. Available online: https://www.cbd.int/doc/meetings/city/mayors-01/mayors-01-declaration-en.pdf (accessed on 22 December 2018).
14. United Nations Centre for Human Settlements (UNCHS). *An Urbanizing World: Global Report on Human Settlements*; Oxford University Press for UNCHS: Oxford, UK, 1996.
15. Baycan-Levent, T.; Nijkamp, P. Planning and Management of Urban Green Spaces in Europe: Comparative Analysis. *J. Urban Plan. Dev.* **2009**, *135*, 1–12. [CrossRef]
16. Rivolin, U.J. Planning Systems as Institutional Technologies: A Proposed Conceptualization and the Implications for Comparison. *Plan. Pract. Res.* **2012**, *27*, 63–85. [CrossRef]
17. Albrechts, L.; Alden, J.; Pires, A. (Eds.) *The Changing Institutional Landscape of Planning*; Ashgate: Aldershot, UK, 2001.
18. Selznik, F. Institutionalism 'Old' and 'New'. *Adm. Sci. Q.* **1996**, *2*, 270–277. [CrossRef]
19. March, J.G.; Olsen, J.P. Elaborating the new institutionalism. In *The Oxford Handbook of Political Institutions*; Rhodes, R.A.W., Binder, S.A., Rockman, B.A., Eds.; Oxford University Press: Oxford, UK, 2006; pp. 1–20.
20. Healey, P. Institutionalist analysis, communicative planning, and shaping places. *J. Plan. Educ. Res.* **1999**, *19*, 111–121. [CrossRef]
21. Pierre, J. Models of Urban Governance: The Institutional Dimension of Urban Politics. *Urban Aff. Rev.* **1999**, *34*, 372–396. [CrossRef]
22. Alexander, E.R. Institutional Transformation and Planning: From Institutionalization Theory to Institutional Design. *Plan. Theory* **2005**, *4*, 209–223. [CrossRef]
23. Richard Scott, W. Institutional theory. In *Encyclopedia of Social Theory*; Ritzer, G., Ed.; Sage Publications: Thousand Oaks, CA, USA, 2005; pp. 408–414.
24. Hall, P.A. Historical Institutionalism in Rationalist and Sociological Perspective. In *Explaining Institutional Change: Ambiguity, Agency and Power*; Mahoney, J., Thelen, K., Eds.; Cambridge University Press: New York, NY, USA, 2009; pp. 204–225.
25. Healey, P. An institutional model of the development process. *J. Prop. Res.* **1992**, *9*, 33–44. [CrossRef]
26. United Nations Human Settlements Programme (UN HABITAT). *Planning Sustainable Cities: Global Report on Human Settlements*; Earthscan: London, UK, 2009.
27. European Commission (EC). *The EU Compendium of Spatial Planning Systems and Policies*; Office for Official Publications of the European Community: Luxembourg, 1997.
28. United Nations Economic Commission for Europe (UNECE). *Spatial Planning: Key Instrument for Development and Effective Governance with Special Reference to Countries in Transition*; United nations: Geneva, Switzerland, 2008.
29. Hopkins, L.D. *Urban Development: The Logic of Making Plans*; Island Press: Washington, DC, USA, 2001.
30. Organisation for Economic Co-operation and Development (OECD). *Land-Use Planning Systems in the OECD: Country Fact Sheets*; OECD Publishing: Paris, France, 2017.
31. European Environment Agency (EEA). *Urban Sprawl in Europe: The Ignored Challenge*; EEA Report No 10/2006; European Commission Joint Research Centre/European Environment Agency: Copenhagen, Denmark, 2006.

32. Sandström, C.; Lindkvist, A.; Öhman, K.; Nordström, E.M. Governing Competing Demands for Forest Resources in Sweden. *Forests* **2011**, *2*, 218–242. [CrossRef]
33. Buizer, M.; Van Herzele, A. Combining deliberative governance theory and discourse analysis to understand the deliberative incompleteness of centrally formulated plans. *For. Policy Econ.* **2012**, *16*, 93–101. [CrossRef]
34. European Commission (EC). *The EU Biodiversity Strategy to 2020*; Publications Office of the European Union: Luxembourg, 2011.
35. Commission of the European Communities (CEC). White Paper, Adapting to Climate Change: Towards a European Framework for Action. 2009. Available online: https://ec.europa.eu/health/ph_threats/climate/docs/com_2009_147_en.pdf (accessed on 8 March 2019).
36. Food and Agriculture Organization of the United Nations (FAO UN). *Framework for Assessing and Monitoring Forest Governance*; The Program on Forests (PROFOR) and Food and Agriculture Organization of the United Nations (FAO): Rome, Italy, 2011.
37. Lawrence, A.; De Vreese, R.; Johnston, M.; van den Bosch, C.C.K.; Sanesi, G. Urban forest governance: Towards a framework for comparing approaches. *Urban For. Urban Green.* **2013**, *12*, 464–473. [CrossRef]
38. Laktić, T.; Pezdevšek Malovrh, Š. Stakeholder Participation in Natura 2000 Management Program: Case Study of Slovenia. *Forests* **2018**, *9*, 599. [CrossRef]
39. Tacconi, L. Developing environmental governance research: The example of forest cover change studies. *Environ. Conserv.* **2011**, *38*, 234–246. [CrossRef]
40. Faggin, J.M.; Behagel, J.H.; Arts, B. Sustainable Forest Management and Social-Ecological Systems: An Institutional Analysis of Caatinga, Brazil. *Forests* **2017**, *8*, 454. [CrossRef]
41. Young, O.R. *The Institutional Dimensions of Environmental Change. Fit, Interplay, and Scale*; Cambridge University Press: Cambridge, MA, USA, 2012.
42. Campbell, H.; Marshall, R. Utilitarianism's Bad Breath? A Re-Evaluation of the Public Interest Justification for Planning. *Plan. Theory* **2002**, *1*, 163–187. [CrossRef]
43. Suddaby, R.; Lefsrud, L. Institutional theory, old and new. In *Encyclopedia of Case Study Research*; Mills, A.J., Durepos, G., Wiebe, E., Eds.; Sage Publications: London, UK, 2010.
44. Zeković, S. Urban land planning in Serbia. *Arhitektura i Urbanizam* **2002**, *9*, 11–17.
45. Živanović Miljković, J. Urban Land Use regulation in Serbia: An analysis of its effects on property rights. In *A Support to Urban Development Process*; Bolay, J.C., Maričić, T., Zeković, S., Eds.; EPFL & IAUS: Belgrade, Serbia, 2018; pp. 129–147.
46. Nonić, D. *Organisation and Operation of the Forestry Service*; Univerzitet u Beogradu, Šumarski fakultet: Beograd, Serbia, 2010.
47. Committee on Spatial Development (CSD). *European Spatial Development Perspective: Towards a Balanced and Sustainable Development of the Territory of the European Union*; Office for the Official Publications of the European Communities: Luxembourg, 1999.
48. Beauregard, R.A. Epilogue: Globalization and the city. In *Change and Stability in Urban Europe*; Anderson, H., Jorgensen, G., Joye, D., Ostendorf, W., Eds.; Ashgate: Aldershot, UK, 2001; pp. 251–262.
49. Pallagst, K.M.; Mercier, G. Urban and regional planning in Central and Eastern European countries–from EU requirements to innovative practices. In *The Post-Socialist City: Urban form and Space Transformations in Central and Eastern Europe after Socialism*; Stanilov, K., Ed.; Springer: New York, NY, USA, 2007; pp. 473–490.
50. Maruna, M.; Čolić, R.; Milovanović Rodić, D. A New Regulatory Framework as both an Incentive and Constraint to Urban Governance in Serbia. In *A Support to Urban Development Process*; Bolay, J.C., Maričić, T., Zeković, S., Eds.; EPFL & IAUS: Belgrade, Serbia, 2018; pp. 80–108.
51. Stanilov, K. Urban planning and the challenges of post-socialist transformation. In *The Post-Socialist City: Urban form and Space Transformations in Central and Eastern Europe after Socialism*; Stanilov, K., Ed.; Springer-GeoJournal Library: Dodrecht, The Netherlands, 2007; pp. 413–425.
52. Tsenkova, S. Urban Futures: Strategic planning in post-socialist Europe. In *The Post-Socialist City: Urban form and Space Transformations in Central and Eastern Europe after Socialism*; Stanilov, K., Ed.; Springer-GeoJournal Library: Dordrecht, The Netherlands, 2007; pp. 447–471.
53. Petovar, K. Professional Associations as an Actor in the Enactment of Spatial Planning Decisions. In *Actors of Social Changes in Space: Spatial Transformation and Quality of Life in Croatia*; SvirčićGotovac, A., Zlatar, J., Eds.; Institut za društvena istraživanja: Zagreb, Croatiam, 2012; pp. 99–114.

54. Vujošević, M.; Petovar, K. Public interest and actor strategies in urban and spatial planning. *Sociologija* **2006**, *48*, 357–382. [CrossRef]
55. Vlada RS (Vlada Republike Srbije) Pregovaračka poglavlja, Poglavlje 27: Životna sredina [Chapters of the Acquis. Chapter 27: Environment]; Pregovarački tim za vođenje pregovora o pristupanju Republike Srbije Evropskoj uniji. 2018. Available online: http://www.eu-pregovori.rs/srl/pregovaracka-poglavlja/poglavlje-27-zivotna-sredina/ (accessed on 26 December 2018).
56. Council of Europe (CE). *European Landscape Convention*; European Treaty Series No. 176; Council of Europe: Strasbourg, France, 2000.
57. Zakon o potvrđivanju Evropske konvencije o predelu [Law Ratifying the European Landscape Convention]. 2011. Available online: http://predelisrcasrbije.rs/dokumenta.html (accessed on 23 December 2018).
58. Resolution H1: General Guidelines for the Sustainable Management of Forests in Europe. Ministerial Conference on the Protection of Forests in Europe, Helsinki. 1993. Available online: https://www.foresteurope.org/docs/MC/MC_helsinki_resolutionH1.pdf (accessed on 11 January 2019).
59. Zakon o potvrđivanju Konvencije o dostupnosti informacija, učešću javnosti u donošenju odluka i pravu na pravnu zaštitu u pitanjima životne sredine [Law Ratifying the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters]. 2009. Available online: https://www.poverenik.rs/sr-yu/me%C4%91unarodni-dokumenti/1735-zakon-o-potvrdjivanju-konvencije-o-dostupnosti-informacija-ucescu-javnosti-u-donosenju-odluka-i-pravu-na-pravnu-zastitu-u-pitanjima-zivotne-sredine.html (accessed on 11 September 2018).
60. Lockwood, M. Good governance for terrestrial protected areas: A framework, principles and performance outcomes. *J. Environ. Manag.* **2010**, *91*, 754–766. [CrossRef] [PubMed]
61. Crnčević, T.; Manić, B.; Marić, I. Zeleni zidovi urbanih prostora u kontekstu klimatskih promena–pregled najnovijih okvira i iskustava [Green Walls of Urban Spaces in the Context of Climate Change-An Overview of the Latest Frameworks and Experiences]. *Arhitektura i Urbanizam* **2015**, *41*, 40–48.
62. Crnčević, T.; Sekulić, M. Green Roofs in the Context of Climate Change-A review of recent experiences. *Arhitektura i Urbanizam* **2012**, *36*, 57–67.
63. Vujičić, D.; Tubić, Lj.; Todorović, D.; Šabanović, V.; Tutundžić, A.; Jeftović, A.; Jadžić, N. *Sustainability of Green Space Legislation*; Udruženje pejzažnih arhitekata Srbije: Beograd, Serbia, 2018.
64. Lukić, N. Urban Forests and Greening in the Republic of Serbia–Legal and Institutional Aspects. *South-East Eur. For.* **2013**, *4*, 51–55. [CrossRef]
65. Gudurić, I.; Tomićević, J.; Konijnendijk, C.C. A comparative perspective of urban forestry in Belgrade, Serbia and Freiburg, Germany. *Urban For. Green.* **2011**, *10*, 335–342. [CrossRef]
66. Zakon o šumama [Forests Law]. 2015. Available online: https://www.paragraf.rs/propisi/zakon-o-sumama-republike-srbije.html (accessed on 20 January 2018).
67. Zakon o planiranju i izgradnji [Planning and Construction Law]. 2018. Available online: https://www.paragraf.rs/propisi/zakon_o_planiranju_i_izgradnji.html (accessed on 22 Jun 2018).
68. Trkulja, S.; Tošić, B.; Živanović, Z. Serbian Spatial Planning among Styles of Spatial Planning in Europe. *Eur. Plan. Stud.* **2012**, *20*, 1729–1746. [CrossRef]
69. Reimer, M.; Panagiotis, G.; Blotevogel, H. *Spatial Planning Systems and Practices in Europe*; Routledge: New York, NY, USA, 2014.
70. Uredba o ekološkoj mreži [Government Order on the Environmental Network]. 2010. Available online: http://www.zzps.rs/novo/kontent/stranicy/propisi_podzakonski_akti/uredba%20o%20ekoloskoj%20mrezi.pdf (accessed on 6 February 2019).
71. Uredba o režimima zaštite [Government Order on Safeguards]. 2012. Available online: http://www.zzps.rs/novo/kontent/stranicy/zastita_prirode_o_zasticenim_podrucjima/uredba_rezimi_zastite.pdf (accessed on 6 February 2019).
72. Zakon o prostornom planu Srbije [Law on Spatial Plan of Serbia]. 2010. Available online: https://www.mgsi.gov.rs/sites/default/files/ZAKON%20O%20PROSTORNOM%20PLANU%20RS%20OD%202010%20DO%202020.pdf (accessed on 12 December 2018).
73. Zakon o eksproprijaciji [Expropriation Law]. 2016. Available online: https://www.paragraf.rs/propisi/zakon_o_eksproprijaciji.html (accessed on 6 February 2019).
74. Zakon o javnoj svojini [Public Property Law]. 2018. Available online: https://www.paragraf.rs/propisi/zakon_o_javnoj_svojini.html (accessed on 6 February 2019).

75. Zakon o komunalnim delatnostima [Utilities Law]. 2018. Available online: https://www.paragraf.rs/propisi/zakon_o_komunalnim_delatnostima.html (accessed on 6 February 2019).
76. Zakon o zaštiti prirode [Nature Conservation Law]. 2018. Available online: https://www.paragraf.rs/propisi/zakon_o_zastiti_prirode.html (accessed on 6 February 2019).
77. Zakon o zaštiti životne sredine [Environmental Protection Law]. 2018. Available online: https://www.paragraf.rs/propisi/zakon_o_zastiti_zivotne_sredine.html (accessed on 6 February 2019).
78. Zakon o proceni uticaja na životnu sredinu [Environmental Impact Assessment Law]. 2009. Available online: https://www.paragraf.rs/propisi/zakon_o_proceni_uticaja_na_zivotnu_sredinu.html (accessed on 7 February 2019).
79. Zakon o strateškoj proceni uticaja na životnu sredinu [Strategic Environmental Impact Assessment Law]. 2010. Available online: https://www.paragraf.rs/propisi/zakon_o_strateskoj_proceni_uticaja_na_zivotnu_sredinu.html (accessed on 7 February 2019).
80. Stojković, S. *Spatial Plan of the Republic of Serbia*; Službeni glasnik: Beograd, Srbija, 1996.
81. Nacionalna strategija održivog korišćenja prirodnih resursa i dobara [National Strategy for Sustainable Use of Natural Resources]. 2012. Available online: http://www.zzps.rs/novo/kontent/stranicy/propisi_strategije/S_prirodnih%20resursa.pdf (accessed on 6 February 2019).
82. Nacionalna strategija održivog razvoja [National Sustainable Development Strategy]. 2008. Available online: http://www.zurbnis.rs/zakoni/Nacionalna%20strategija%20odrzivog%20razvoja.pdf (accessed on 6 February 2019).
83. Strategija razvoja šumarstva Republike Srbije [Serbia Forestry Development Strategy]. 2006. Available online: https://www.fornetserbia.com/doc/shared/Strategija_razvoja_sumarstva.pdf (accessed on 6 February 2019).
84. Strategija biološke raznovrsnosti Republike Srbije za period 2011. do 2018. godine [Serbia Biodiversity Strategy, 2011 to 2018]. 2011. Available online: http://www.zzps.rs/novo/kontent/stranicy/propisi_strategije/strategija_bioloske_raznovrsnosti.pdf (accessed on 8 February 2019).
85. Nacionalni program zaštite životne sredine [National Environmental Protection Programme]. 2010. Available online: http://www.zzps.rs/novo/kontent/stranicy/propisi_strategije/Nacionalni_program_zastite_%20zs.pdf (accessed on 11 February 2019).
86. Zakon o potvrđivanju Konvencije o biološkoj raznovrsnosti [Law Ratifying the Convention on Biological Diversity]. 2001. Available online: http://www.vojvodinasume.rs/wp-content/uploads/2012/04/sertifikacija/Zakon%20o%20potvrdjivanju%20KONVENCIJE%20O%20BIOLOSKOJ%20RAZNOVRSNOSTI.pdf (accessed on 11 February 2019).
87. Zakon o planiranju i izgradnji [Planning and Construction Law]. 2014. Available online: https://www.mgsi.gov.rs/sites/default/files/ZAKON%20O%20PLANIRANJU%20I%20IZGRADNJI%20PRECTEKST%202015.pdf (accessed on 11 February 2019).
88. Graovac, A.; Danilović Hristić, N.; Stefanović, N. Technical and logical methods for improving the process of urban planning in Serbia. *Spatium* **2017**, *38*, 27–34. [CrossRef]
89. Plan generalne regulacije Vrnjačke Banje [General Zoning Plan of Vrnjačka Banja2016. Available online: http://vrnjackabanja.gov.rs/privreda/urbanizam/plan-generalne-regulacije?alphabet=lat (accessed on 15 March 2019).
90. Plan generalne regulacije gradskog naselja Bor [General Zoning Plan of the Town of Bor]. 2018. Available online: http://bor.rs/wp-content/uploads/2018/02/Nacrt-Bor-Knjiga-I-Planska-resenja-konacno.pdf?script=lat (accessed on 16 March 2019).
91. Prostorni plan opštine Vrnjačka Banja [Spatial Plan of the Municipality of Vrnjacka Banja]. 2011. Available online: https://vrnjcispa.biz/baze-i-registri/vazeci-planovi/prostorni-plan-opstine-vrnjacka-banja (accessed on 15 March 2019).
92. Uredba o utvrđivanju područja Banje [Government Order Establishing the Area of the Vrnjačka Banja Spa]. 1997. Available online: http://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/eli/rep/sgrs/vlada/uredba/1997/26/2/reg (accessed on 15 March 2019).
93. Prostorni plan opštine Bor [Spatial Plan of the Municipality of Bor]. 2014. Available online: http://bor.rs/wp-content/uploads/2018/02/PPO-Bor-Knjiga-1_januar-2014.pdf?script=lat (accessed on 16 March 2019).
94. Generalni urbanistički plan Bora [General Urban Plan of Bor]. 2015. Available online: http://bor.rs/wp-content/uploads/2018/02/Knjiga-I_Plan.pdf?script=lat (accessed on 16 March 2019).

95. Odluka o građevinskom zemljištu [Decision on Development Land]. Službeni list opštine Bor, br. 3/1983.
96. Odluka o javnom građevinskom zemljištu [Decision on Public Development Land]. Službeni list opštine Bor, br. 2/2016.

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Timber Distribution Dynamics in Scientifically Managed Community Forests: Learning from Nepal

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Abstract: In a bid to address growing timber demand, irregular shelterwood system-based scientific forestry gained momentum in Nepal in 2000. While timber production, in general, is said to have witnessed an increase, the outcomes linked to equitable distribution among users remain unclear, suggesting the need for context-specific studies on the performance of scientific forestry in terms of timber distribution among users. Taking the case of the Western Terai Region of Nepal, this paper provides an in-depth analysis of the patterns and implications of timber distribution under community forestry systems where scientific forest management (SciFM) is practiced. The study deployed focus group discussions (n = 4), key informant interviews, and a review of timber distribution processes for the past six fiscal years (2013–2019), the periods before and after the implementation of SciFM. For data analysis, a deductive approach was used; analytical themes were framed along the lines of timber-harvesting trends, timber distribution structure and processes, and timber distribution patterns based on wellbeing. The study revealed a substantial increase in timber harvesting; considering the base year, harvest increased by 45% in the second year and by 56% in the third year. This was, however, characterized by a 40% decrease in the average volume of timber for users within the community forest user group. Ninety-seven percent of the timber produced in this system was distributed among middle- and high-class groups, with only 3% available for poor households—this puts to question the intended objective of providing sufficient timber, especially to poor users. The paper concludes that technocentric efforts linked to increasing timber sufficiency (e.g., through SciFM) have failed to address the needs of the poorest of the poor, as elite capture prevails. We also call for future studies to explore pathways to deal with the hydra-headed nature of elite capture.

Keywords: silviculture; timber distribution; benefit-sharing; elite; community forestry

1. Introduction

With more than four decades of practice in community forestry (CF), Nepal stands as a notable example of decentralized forest management in the Global South [1–3]. The foundation of CF was laid within the framework of the 1976 National Forestry Plan and the Forest Sector Master Plan of 1988 [4]. Further provisions such as the Forest Act of 1993, the 1995 Forest Regulation, and, recently, the Forest Act of 2019, backed up this process. The 2019 Forest Act defines community forests (CFs) as "any part of national forest that has been handed over to users for the development, protection, utilization, and management of forest resources" [5]. As an autonomous body, community forest users have the right to develop, use, and manage the forest and sell and distribute forest products by fixing the prices

themselves [1]. With its primary objectives to enhance forest conservation, it sought to empower forest users to manage forests for their livelihoods [6,7].

The outcomes of CFs in terms of ecological restoration [8,9], livelihood improvement through income generation [10–13], and community development [14–16] have been investigated. However, its contribution to the national economy was rated as low, considering that timber—a main income generator—was still in insufficient supply [17–19]. It has also been criticized for being protection-focused [20,21]. This drawback led to the introduction of scientific forest management (SciFM), a silviculture system-based forest management approach to enhance forest productivity and contribute to the local and national economy [22]. This system largely focused on timber harvesting [23,24], where the forest management plan allows community forest user groups (CFUGs) to cut mature green trees alongside dead, decay, dying, and deformed trees (4Ds), as opposed to the previous plan that restricted timber harvesting to only 4Ds. Thus, the traditional protection-oriented forest management focused only on removing 4Ds. This has created over-mature forests with different age categories [25]. SciFM gained momentum after the enactment of the revised forest policy in 2000 [26,27], which was initiated with the aim of removing over-mature trees to meet the current timber and fuelwood demand and promote natural regeneration. Equally, it stresses the need to increase production and productivity, considering local demand, while commercializing the forest for prosperity [28]. To date, it has been implemented in 285 community forest user groups (CFUGs) across Nepal [29]. CFs are primarily selected based on their timber production potential [26]. Similarly, the selection is guided by the maturity of the forests, their poor regeneration conditions, and dense canopy cover. In the Terai sal (*Shorea robusta*) forest, SciFM is applied through an irregular shelterwood system [30,31]. In this system, the forest area, considered one compartment, is divided into eight subcompartments, assuming an 80-year rotation age and a 10-year regeneration interval [32]. Different activities are carried out in different subcompartments; for instance, regeneration felling, intermediate felling, and final felling are conducted in one of the subcompartments, whereas in other subcompartments, activities such as thinning and cleaning are conducted.

Studies on SciFM to date, in Nepal, have largely concentrated on silviculture practices [33–35], stakeholders' opinion [27,31,36], users' participation [37–39], and their financial implications [26]. Recent scientific evidence points to the fact that SciFM has commodified CFs towards timber production by emphasizing the economic rationale and controlling access to forest products (e.g., timber) for the poor and marginalized [26]. However, issues linked to the dynamics of timber distribution and its implications at the user level are yet to be explored. Timber has always been one of the key income sources in community forestry in Nepal [14,15], making it a major source of contestation in the Terai region of Nepal, particularly around its distribution. The Terai region is a lowland region of Nepal that lies south of the outer foothills of the Himalayas, the Sivalik Hills, and north of the Indo-Gangetic Plain. It occupies 2,016,998 ha of the total land area of the country. The region is located in a subtropical climate zone characterized by hot and humid summers, intense monsoon rain, and dry winters [22,40]. Recent studies on timber have focused on its income potential and contribution [14].

The studies by Basnyat [23,26] and Yadav [41] have signaled some plausible inferences: (1) Increasing timber production in Nepal's CFs is not unconnected to technocentric interventions (e.g., through SciFM), (2) an increase in timber production is a necessary but insufficient condition to meet household livelihoods and poverty needs in scientifically managed CFs of Nepal, and (3) dealing with the hydra-headed nature of elite capture is, without doubt, a perennial and seemingly unresolved problem in Nepal's CFs. Taking the case of Western Terai, this paper provides an in-depth analysis of the patterns and implications of timber distribution under community forestry systems where scientific forest management (SciFM) is practiced. Particularly, it deals with two key questions: (i) how does the CFUG institution function in the timber harvesting and distribution process?, and (ii) what is the timber distribution pattern at the user level after SciFM implementation in community forests? An understanding of timber harvesting and distribution dynamics at the CFUG level could provide relevant insights on issues of equity with regard to timber distribution and benefit-sharing.

Equity in practice in community forests is always an issue of contestation. The Forest Act 2019 and the revised Community Forest Development Guideline of 2014 devolved forest management rights to the community, including reinvestment rights to CFUGs, and clearly stipulates how CFUGs should reinvest their income in community development, forest development, women, and pro-poor activities [14]. Equally, there is the heterogeneity of committee members, where representation in terms of caste, class, culture, and gender is assured [42]. However, several studies have argued that the poor and marginalized benefit less [43–45]. The structural and procedural arrangements in community forest user groups allow elite domination [46]. Usually, the local elite who hold power and wealthier households are selected more frequently than poor and marginalized users for the executive committees [46–49], which are the key decision-making bodies in CFUGs.

Thus, the evidence from this study could further substantiate the need to revisit the governance architecture of Nepal in order to deal with systemic hold-ups that breed inequity. This represents a scientific and policy exigency if SciFM is to meet its intended objectives. The findings will equally be a significant learning avenue for other CBFM regimes in this region that are revisiting community forest governance.

2. Materials and Methods

2.1. Case Study in Community Forest User Groups

The case study was conducted in the Bijaya CFUG, located in the Madhyabindu municipality of Nawalpur district in the western Terai region of Nepal (Figure 1). The CFUG is located at the midpoint of the east–west highway. The CFUG covers a total forest area of 161.72 ha, including 153.72 ha of productive forest. The forest is dominated by productive hardwood Sal (*Shorea robusta* Roth) forest managed under the irregular shelterwood system, with eighty years of cutting cycle. The operational plan under SciFM covers 153.72 out of the 161.72 ha of total forest (Table 1). Its implementation began in 2016.

Table 1. Description of the study site.

CFUG Name	Handover Date as CF	Total Forest Area (ha)	Total HHs Involved	SciFM Started Date	Forest Type	Major Forest Species
Bijaya Community Forest, Nawalpur Nepal	2011	161.72	358	2016	Terai mixed hardwood natural forest	*Shorea robusta* (≤80%) Roth, *Syzigium cumini* (L.) Skeels., *Terminalia chebula* Retz., *Terminalia belerica* (Gaertn.) Roxb.

CFUG: Community Forest Users' Group; CF: Community Forest; HHs: Households; SciFM: Scientific Forest Management.

The forest is managed by 358 households, represented by mixed groups of community and wellbeing ranking. The CFUG has categories of users based on their wellbeing ranking, which is characterized by the presence or absence of concrete houses, business, jobs, and landed property. The rich users are those who have 4- to 5-story concrete houses, stable businesses and jobs, and private vehicles. The middle category of users has 1- to 2- or 3-story concrete houses, some businesses or jobs, and is engaged in agriculture. Poor users have houses made of timber-plank walls, tin roofs, labor jobs, and no registered landed property.

Terai forest is a mixed hardwood forest dominated by Sal (*Shorea robusta*) species. The majority of the forest is natural, with mature stands. In our case study site, more than 80% of the forest is dominated by the Sal species, which is one of the key hardwood species of the Terai forest, with a high market value. Similarly, Sal timber is one of the major income sources of the Bijaya CFUG, which contributes approximately 80% of the total annual income of the CFUG. In the case of the Bijaya CF, an 80-year rotation, with a 10-year regeneration period, is in practice under an irregular silviculture system. The SciFM forest area, i.e., 153.72 ha of forest that is considered as one compartment, is divided into eight subcompartments, i.e., from C1S1 to C1S8 (Figure 1). Based on the availability of mature

trees and accessibility of harvesting, C1S5 was selected as a regeneration felling subcompartment that has comparatively more mature trees.

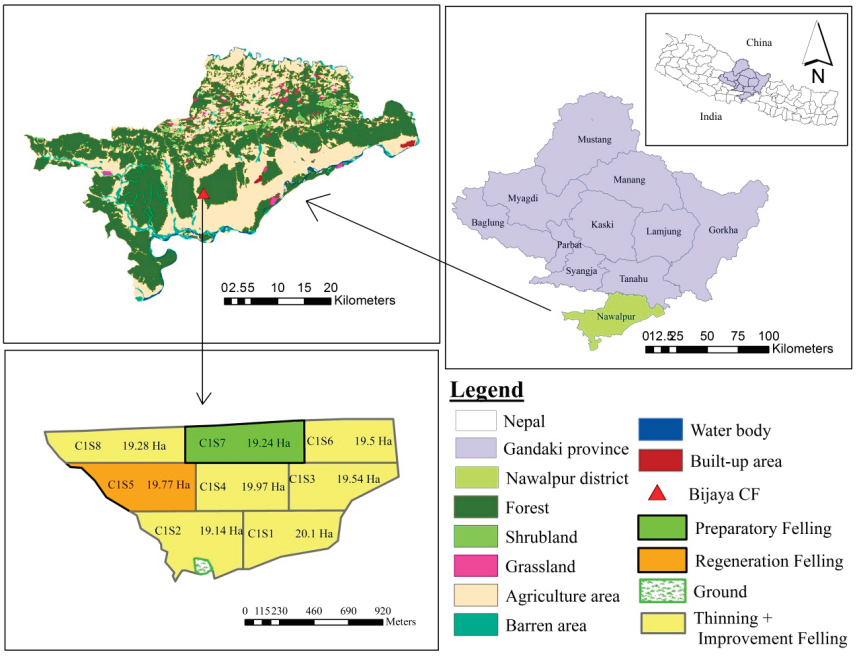

Figure 1. Location map of the study area (Source: Operational plan of the community forest user group (CFUG), 2016).

2.2. Data Collection

To obtain the relevant data for the study, we categorized the data collection process based on our objectives and the intended results. We collected data to analyze (i) timber harvesting and distribution structure and process, (ii) timber-harvesting trends, (iii) timber distribution patterns, and (iv) timber distribution based on the users' wellbeing category. For this, we used a descriptive and narrative approach comprised of the analysis of timber harvesting and distribution structure and institutional setup and the established process adopted for timber distribution at the CFUG level. Similarly, we analyzed timber harvesting and distribution patterns for the last six fiscal years (2013/2014 to 2018/2019), comparing it before and after SciFM implementation. Equally, we categorized the CFUG based on the wellbeing (rich, middle, and poor class) of the users and analyzed the timber distribution pattern amongst these groups in the community forest after the implementation of SciFM. The analysis provides an average result for the three fiscal years (2016/2017, 2017/2018, and 2018/2019). The detailed process and instruments used are discussed below. We began by undertaking a review of timber distribution processes for the last six fiscal years (2013 to 2019) in the targeted community forest user group. This led to the generation of data on the timber supply pattern. Similarly, relevant governance documents (the CFUG's operational plan, minutes, and timber sales records) were reviewed to understand relevant information at the user level of the institutional setup and forest management activities of Bijaya Community Forest.

For data collection, two key instruments were employed: a focus group discussion guide (8 items) and a key informant interview guide (12 items). These instruments were developed to capture issues linked to timber harvesting, decision-making and timber distribution, institutions and processes linked to timber supply, the role of users and divisional forest officers (DFOs), and the executive committee.

In total, we conducted four focus group discussions (FGDs): one with CFUG EC members (11 members; 6 males and 5 females), one with general users (15 users in the mixed group), one FGD with Dalits and Janjatis (Dalits are usually lower caste people, representing marginalized and disadvantaged groups with poor social status; Janjatis refer to Adivasi, a general term in Nepal meaning primitive ethnic groups; 10 user households), and one with Brahmin and Chhetri (Brahmin and Chhetri generally represent the higher caste groups, with strong social status; they usually lead in decision-making positions; 10 user households). Each FGD lasted between two hours and two hours and thirty minutes. The discussions were carried out with open-structure questions, and the information obtained was recorded on field notes used for further analysis. Discussions focused on the status of forest consumption and timber distribution patterns at the household level before and after the implementation of SciFM. Equally, we discussed user roles in timber harvesting and distribution and the relationship between the user's wellbeing class and timber distribution.

From each focus group, we identified key informants and conducted in-depth interviews with them to profoundly unearth some issues that might not have been openly discussed. We primarily focused on how timber is distributed and how timber distribution decisions are made, who leads the decision making, and why. In the case of timber harvesting and distribution structure and processes, we focused on how the EC and members associated with EC were extensively involved in the timber distribution process at the CFUG level, and there was no role for other users in this process. Importantly, we analyzed the criteria for selecting the timber received by user households. In all, there were eight key informant interviews (KIIs): three from executive committee members, three from general users, including women members, and two from ethnic group members. This process helped us to gain insight into each of the key stakeholders' impression of the SciFM implementation, particularly on timber distribution and the associated benefits (Figure 2). It was easy to organize the respondents since the first author has worked with these groups over the years. We explained the motives behind the research to the participants, and they were assured of confidentiality. Field notes were used to record the data. The data obtained were transcribed and coded. Based on the coded data, we summarized this information in the narratives presented in the results section. All of the informants selected were between the ages of 35–60 years, and they were considered to be experienced enough to share their views on the situation as it unfolded over the years.

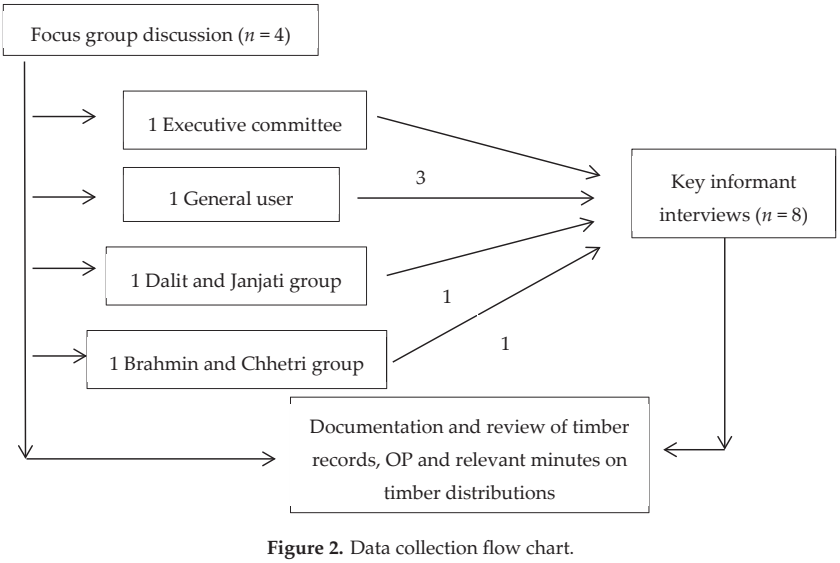

Figure 2. Data collection flow chart.

Similarly, the timber supply records before SciFM (fiscal year 2013/2014, 2014/2015, and 2015/2016) and after the implementation of SciFM (2016/2017, 2017/2018, and 2018/2019) were collected and minutely reviewed. Equally, the wellbeing ranking of household members was categorized as poor, medium, and rich based on the operation plan in order to investigate timber supply patterns at each level. The documents on timber records, like CFUG minutes, bills of timber sales, audit reports, and timber distribution, were reviewed. First, we recorded the total timber harvested on an annual basis for all the six years, followed by the record of the timber distribution to users and other stakeholders in each fiscal year from 2013 to 2019. The information from these records, coupled with the interviews and FGDs, guided the derivation of issues linked to inequitable distribution of timber among different groups of users in order to understand the hydra-headed nature of elite capture in the entire process.

2.3. Data Analysis

Timber Supply Analysis

We adopted a deductive approach [50,51], as the research questions were developed following analytical themes prior to data collection. The themes were framed along the lines of timber-harvesting trends, timber distribution structure and processes, and timber distribution patterns based on wellbeing. Based on these themes, thematic analysis and narratives were employed in the analysis. This was characterized by the transcription of the participants' diverse opinions, including the use of direct quotes and extracts from field notes, to shed light on the discussion. The data obtained from focus group discussions, KII and CFUG minutes, timber distribution records, the CFUG operational plan, and the constitution were reviewed, coded, and entered into MS Excel and the Statistical Package for Social Science (SPSS). First, the timber harvesting and distribution structure and processes at the CFUG level were minutely analyzed. Then, the total amount of timber harvested in each fiscal year was calculated, and it was analyzed and presented in terms of average annual timber harvested before and after SciFM implementation. Then, the timber distribution pattern to user households and other stakeholders was calculated and presented. It was calculated by the total share of timber between users and other stakeholders as per the annual timber distribution records maintained at the CFUG. Equally, the share of timber between the different stakeholders was calculated in percentage by comparing it with the total harvested timber. Finally, within the user's category, we calculated timber distribution between wellbeing rankings. In this procedure, the data were processed and reviewed to verify accuracy before being analyzed using basic descriptive statistics. The results are presented in the form of graphs, tables, and figures, with narrative discussion and individual quotes. All the analysis is further categorized based on the timber demand and supply pattern before and after the implementation of SciFM. While developing the results and discussion along with analyzing the quantitative data, the quantitative information and data obtained from FGD and KII were equally articulated and presented, essentially in the form of quotes and statements. Equally, this information assisted in the quantification of data obtained from the CFUG records.

3. Results

3.1. Timber Harvesting and Distribution Dynamics at the CFUG Level

Our result depicts a substantial increase in timber harvesting after SciFM implementation in the CFUG, with an increasing trend in the first three years of SciFM implementation. This was, however, characterized by a 40% decrease in the average volume of timber for users within the community forest user group. Ninety-seven percent of the timber produced in this system was distributed amongst middle- and high-class groups, with only 3% available for the poor households. Similarly, the results show that the timber harvesting and distribution structure is dominated by the elite and well-off groups. This has created an avenue for the elite and decision-makers around timber governance to reap benefits after the implementation of SciFM.

3.1.1. Timber Harvesting and Distribution Structure and Processes

The results here describe the institutional structure and process adopted by the Bijaya CFUG for timber harvesting and distribution at the user level. Additionally, it compares and contrasts the bureaucratic processes and complexities around timber harvesting and distribution.

Timber harvesting is one of the key activities of CFUGs that is carried out annually. It is the key source of income for the CFUGs. Though the amount of timber to be harvested is mentioned in the CFUG operational plan (OP), CFUGs need formal permission from the District Forest Office to harvest timber. They have to pass through a series of steps that need to be consciously followed by the CFUG to procure a harvesting permit [52]. According to Puri et al. [53], each year, CFUGs follow at least nine steps before they get final approval from the DFO for distribution and sale of the timber from their CFUGs. To achieve this, CFUGs visit this service at least 20 times to get through this process. During this process, the involvement of the executive committee (EC) with the forest authority is significant, where the forest authority is directly or indirectly involved throughout the harvesting process. This shows that the decision of forest product harvesting in CFUGs, particularly timber, still hinges on the forest authority [54] and the nexus between the EC and the forest authority. Additionally, the process is further complicated if the timber has to be sold to people other than community forest users.

Case of Bijaya Community Forest User Group on Timber Distribution Structure and Processes

In the case of timber distribution in the Bijaya CFUG, the EC is the main institutional structure that makes the decisions on timber distribution. However, the CFUG also has a monitoring committee that monitors the needs of the users based on timber demand applications, analyses them, and presents them to the EC for the final decision (Figure 3).

In the Bijaya CFUG, we found the monitoring committee to be a subset of the EC, which comprised the members from the EC. It usually monitors cases of timber demand by the users and ensures that it will not be misused. Generally, the EC opens the timber call and collects the timber demand from the users. This is minutely analyzed, verified, and assessed through user household visits by the monitoring committee formed for this purpose. After finalizing the user households that are eligible to get timber, the committee forwards the list to the executive committee for a final decision. Finally, the EC, through its meeting, finalizes the list and the amount of timber to be distributed to users. The timber distribution criteria are as follows: (i) first come first serve to the schedule, i.e., the user who applies first can claim timber first, (ii) users have to initiate building their house before they claim timber, and they have to show proof of it, (iii) the users who want to build multistory houses will be supplied more timber, and (iv) the timber is graded into A, B and C grades and it is priced as follows: Grade A = NRs1000/cft Grade B = NRs900/cft, and Grade C = NRs800/cft.

The price of the timber is finalized from the meeting of the CFUG, where all the users agree on the price. However, such a meeting is usually dominated by rich and middle-class users who dominate the decision-making. Similarly, the amount of timber to be distributed to the users depends on the annual demand obtained from them. However, after the implementation of SciFM, the CFUGs need to provide 25% of the remaining timber, after fulfilling user demand, to *Apurti*, and the remaining 75% is sold to contractors through an open tender. *Apurti* is a formal committee in the Divisional Forest Office, named "District Ban Paidawar Apurti Samiti", which distributes timber to the general population in the district, collecting the surplus timber from CFs and government-managed forests. One of the executive committee members briefly presented the situation:

> *"The timber demand from users is increasing annually, and we have tried our best to fulfill it. We give priority to those users who have already started constructing their houses. Equally, after SciFM implementation, we are also selling timber to contractors. When we sell to contractors, we receive substantial income and this is an opportunity for us to increase our income".*

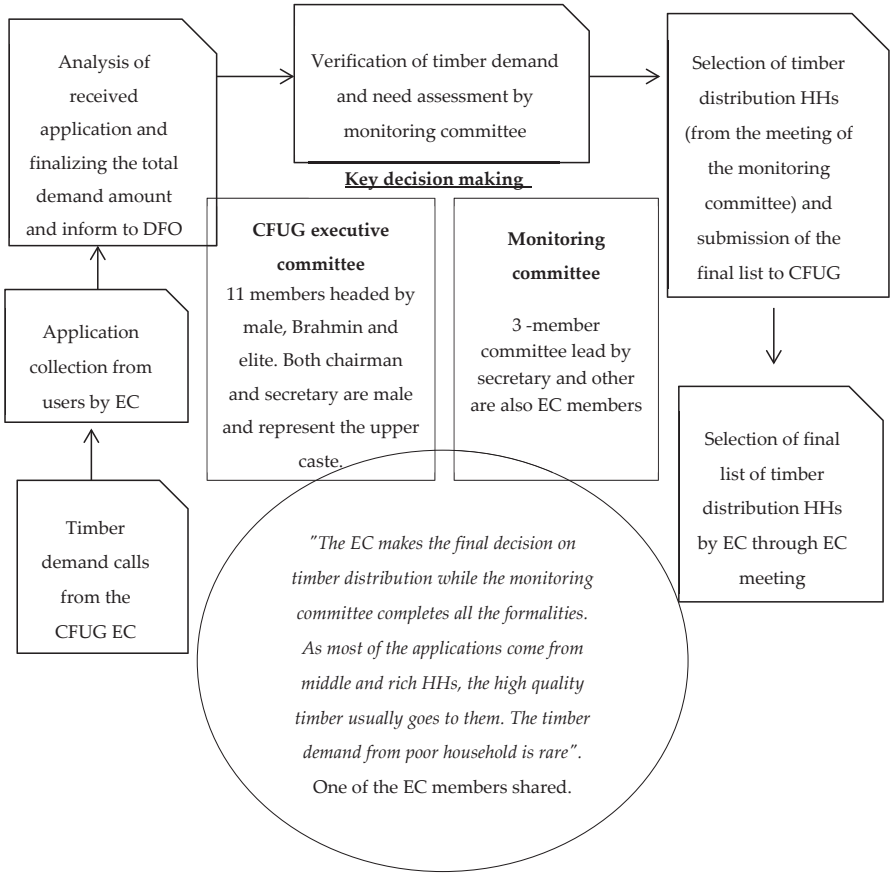

Figure 3. Timber distribution decision-making process at the CFUG level.

3.1.2. Timber-Harvesting Trend

We found a substantial increment in timber harvesting after the implementation of SciFM. Before SciFM implementation, the three-year (fiscal year 2013/2014, 2014/2015, and 2015/2016) average timber harvest was 1567.7 cft/year. This increased by 3.5-fold after SciFM implementation, i.e., 5912.16 cft/year within three fiscal years (2016/2017, 2017/2018, and 2018/2019; Figure 4). Similarly, after SciFM, the annual timber harvest showed an increasing trend. In the fiscal year 2016/2017, it stood at 3481.9 cft. This increased to 6282.83 cft in the fiscal year 2017/2018 and 7971.77 cft in the fiscal year 2018/2019. With reference to the year 2016/2017, the first year of the SciFM implantation, in the second year (2017/2018), the harvesting increased by 45%, and, in the third year, it increased by 56%. The increase in timber harvesting after SciFM, compared with before SciFM implementation, is due to the irregular shelterwood system employed in scientifically managed community forests. This system allowed harvesting of all mature trees in felling subcompartments except some mother trees (around 20–25 mother trees/ha). Equally, all 4Ds are also removed from all other compartments.

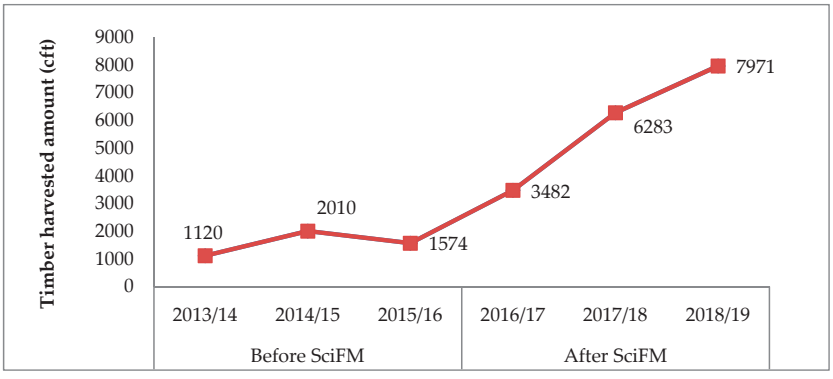

Figure 4. Timber harvesting trend before and after scientific forest management (SciFM).

3.1.3. Timber Distribution Pattern

We found a difference in the volume of timber distribution before and after SciFM implementation. Before SciFM implementation, the total harvested timber distributed to the user households was 1567.7 cft/year on average. However, after SciFM implementation, the harvested timber was shared with timber for the contractors and *Apurti*. The average share of timber for contractors was 1613.15 cft/year and 703.91 cft/year for the *Apurti*. Furthermore, an increasing trend in the distribution of timber to the users in each fiscal year (3595.1 cft/year) was observed. However, it is lower than the average amount of the annual harvesting of the timber in the CFUG after SciFM (5912.16 cft/year on average).

On average, we found a 40% decrease in the distribution of timber to the users than that of actual annual harvesting of timber in the CFUG after SciFM implementation (Table 2). Additionally, an increasing trend in the supply of the timber to contractors and *Apurtis* in each of the fiscal years were observed. Thus, in terms of timber supply, the involvement of other stakeholders besides users, such as contractors and *Apurti*, had increased after SciFM implementation in CFUGs. The proportion of timber distributed to contractors increased from 14% in the year 2016/2017 to 31% in 2018/2019, while that for the *Apurtis* increased from 3% to 19% within the same period (Table 2). The result points towards an interesting fact that there is a decreasing amount of timber supply to users and an increasing amount of supply to contractors and *Apurtis* although the timber harvesting amount has increased annually after SciFM implementation. This raises a question as to whether the implementation of SciFM was meant to serve the needs of these bodies or to narrow the supply gap for the peasant forest users. The total volume of timber distributed to users seems to be on the increase; the percentage share of timber to users was found to be on the decline, i.e., the total volume of timber distributed to users in fiscal year 2016/2017, 2017/2018, and 2018/2019 was 83%, 61%, and 50%, respectively. Although, in general, an increase in supply was observed even for users, this did not favor the lower wealth class, as will be discussed below.

Table 2. Timber distribution pattern before and after SciFM implementation at the CFUG level.

Forest Management Intervention	Fiscal Years	Total Amount of Timber Harvested (cft)	Timber Distributed (cft)			% of Timber Distributed		
			Users	Contractor	Apurti	Users	Contractor	Apurti
Before SciFM implementation	2013/14	1120	1120	0	0	100	0	0
	2014/15	2010	2010	0	0	100	0	0
	2015/16	1574	1574	0	0	100	0	0
After SciFM implementation	2016/17	3482	2905	482	95	83	14	3
	2017/18	6283	3809	1857	617	61	30	9
	2018/19	7971	4071	2501	1400	50	31	19

3.2. Timber Distribution Based on Users' Wellbeing Category

We categorized the CFUGs based on the wellbeing (rich, middle, and poor classes) of the users and analyzed the timber distribution pattern amongst these groups in the community forests after the implementation of SciFM. The analysis provides an average result for the three fiscal years (2016/2017, 2017/2018, and 2018/2019) after the implementation of SciFM. According to the CFUGs' wellbeing category, the rich class of people has their own private businesses in city centers like Kathmandu and other cities of Nepal. They are involved in jobs. This group of users rarely attends CFUG meetings and other events. The key positions and decision-making are largely occupied by middle-class users, who are heavily involved in CFUG activities. More than 90% of decision-making positions, including in the EC, are occupied by middle-class users. Poor users are key forest dependents, and they are mainly tasked with daily labor and have weak representation in the ECs.

Timber Distribution Based on the Wellbeing Category

On the basis of distribution across wellbeing groups, the middle-class users consume a higher portion of timber, followed by the rich and poor users (Figure 5). We found 88% of timber was consumed by middle-class users in the last three years of SciFM implementation. This user group dominates CFUGs in terms of user numbers and also dominates the decision-making bodies, like the EC and subcommittees. Only 3% of timber is distributed to poor households.

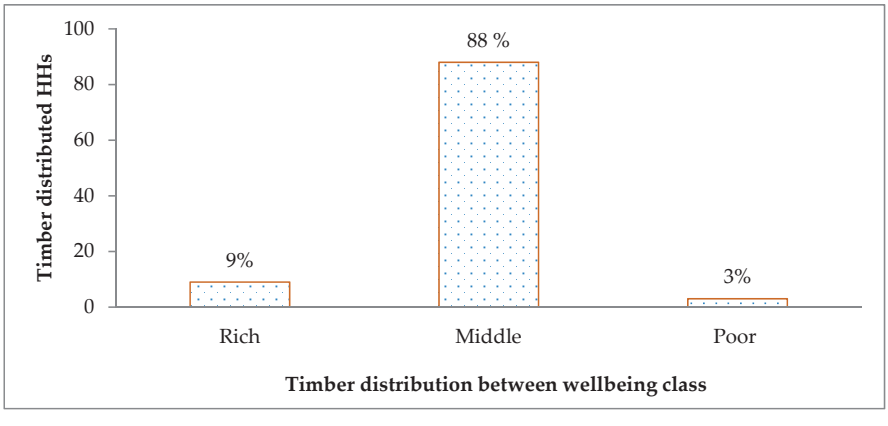

Figure 5. Timber distribution between wellbeing classes after SciFM implementation.

One of the users (representing poor households) shared his plight,

"We cannot afford to buy timber from the CFUG, it is for those users who can construct good houses and can influence the decision to their favor. How can we build a concrete house, which is the prerequisite to getting timber from our CFUG?"

In the same light, the predominantly middle-class executive members justified their actions by indicating that fewer valid requests are received from the low-class users:

"I agree, the majority of the timber goes to middle-class households. This can be clearly seen from this year's timber demand—there were very few timber demands from poor households. The problem is from the fixing of the price as there is always a meager voice of marginalized and poor groups while fixing prices. The middle class dominates the decision-making process. Equally, the timber distribution criteria discourage them and they cannot afford it. We should rethink the timber distribution system and address the concern of poor and marginalized groups. I am planning to put these issues in the

upcoming EC meeting. There is a misuse of timber by this privileged group (middle class), and the elite also benefit from the provisions developed for poor and marginalized groups."

4. Discussion

SciFM implementation in Nepal has been echoed as a solution towards the established misfortune linked to passive forest management and a blanket policy approach, which contributes to the significant loss of forest resources and timber importation of more than 80% of the timber necessary to meet its domestic demands [55]. Traditional protection-oriented forest management was focused on removing dead, dying, and deformed trees, causing the forest area to be dominated by over-mature trees with a lack of proper age class [25]. This, on the one hand, limited the forest product supply to the local people, and, on the other hand, led to poor forest management. Thus, SciFM implementation was viewed as an approach to enable the forestry sector of Nepal to self-sustain its timber demands [27]. In line with this, our result contributes to this discussion and provides a clear picture of the current implementation of SciFM, concerning the pattern of timber distribution in the lowland region of Nepal. Additionally, it argues for CFUG governance, focusing on the CFUGs' institutional structure and functioning, which largely favor the local elite when it comes to decision-making and its implications in SciFM implementation. The elite in this paper refer to a small and dominant group of community members who hold or influence community forest user group decision-making in their favor or as per their interest.

Timber Harvesting and Distribution: How the Elite Dominate While Neglecting Concerns of the Poor

Community forestry has been criticized for being less productive [12,20,21,56]. Thus, the application of the SciFM scheme sought to increase forest product supply, particularly timber supply. Our result depicts a substantial increase in timber harvesting, with an increasing trend in the first three years of SciFM implementation. Along the same lines, Khanal and Adhikari [24] find that SciFM intervention has increased the harvesting of forest products from community forests. Similarly, the arguments by many scholars like Bampton and Cammaert [57] and Joshi et al. [31] also support that SciFM implementation is timber-focused. Equally, Basnyat et al. [23] describe Nepal's SciFM as timber-centric; users obtain a considerable amount of timber, and they invest time to harvest timber from the forest.

However, we found a decrease in the average volume of timber supply to users by about 40% after SciFM implementation, although the total volume of timber distributed to users seems to be on the increase. Likewise, after SciFM, timber was sold more to outside stakeholders than to users, e.g., contractors and the *Apurti*, and, interestingly, as the annual harvesting of the timber increases, the timber sales with these agencies increases. The remaining timber, after fulfilling the demand of users, is auctioned to contractors—this explains the largely skewed supply towards *Apurtis*. However, huge differences in the timber transaction amount between users and contractors and *Apurtis* have created some timber governance irregularities and provided a hidden opportunity to directly involve stakeholders. Equally, CFUGs take this as an opportunity to increase their annual income. This indicates that although the benefits after SciFM exceeds traditional protection-oriented management systems [24], CFUGs prioritize timber sales to contractors and outside stakeholders instead of fulfilling user demands and local needs. One of the CFUG committee members succinctly presents the situation:

"Though the annual allowable timber harvesting has noticeably increased after we initiated SciFM in our forest, timber distribution issues have been encountered. Last year, 2665 cft of timber was put for auction by the CFUG. However, the auction price (NRs 1200–1300/cft) put by the contractor was far less than the market price of the timber (the market amount is around NRs2000–2200/cft). We suspected that there should be some issues as the difference in the market and auction rates could benefit middlemen, while the CFUG loses about NRs 2.6 million. Thus, we dissolved that auction process and reopened it, and, finally, we sold at the market price of NRs 2000–2200/cft".

This shows that the timber distribution process has created an avenue for the elite and decision-makers around timber governance to reap benefits after the implementation of SciFM. The complicated bureaucratic process during timber harvesting and the chain of involvement of forest technicians while allowing timber-harvesting decisions, the extensive involvement of the EC, no role for users in the timber distribution process at the CFUG level, and, importantly, the criteria for selecting how much timber to be received by user households, largely ignores poor community forest users in favor of forest technicians and the local elite. This has consciously or unconsciously created a narrative around timber—"timber is not for poor and marginalized households; it is a business for the elite". Basnyat [26] supports this view by stating that CFUGs give first priority to selling timber on the market or to the local elite while neglecting local user demand, particularly the poor and marginalized groups. Both elite capture and bureaucratic control govern this process. Thus, this system could ultimately decrease user participation in decision-making and forest management activities [31,39,58].

Among the wellbeing classes, timber benefits substantially remain within the elite and dominating class. For example, 97% of timber each year is distributed to the dominating middle class and rich class user households. However, very little timber is provided to poor households. On the other hand, the decision-making bodies, like the EC, are dominated by the elite users, where out of 10 members of the EC, 8 are from middle class user households, who are the key elite in CFUGs. Elite capture issues in CFs have been extensively reported, revealing how well-off users manipulate and capture timber transactions to the detriment of poor and marginalized groups [57,59,60]. Although there is no clear policy and guideline for the equitable distribution of timber, CFUGs usually collect timber demand applications and authenticate them by visiting user households to check whether they actually need the timber or not. Based on that and reviewing the history of the users, including how many times and what quantity of timber the users have received before, the committee finally decides on timber distribution. There is no specific and established timber distribution criterion based on the user's category. It all depends on the CFUG's committee decision.

In this situation, SciFM implementation in community forestry, with its key focus on timber and income, ends up benefitting the elite and well-off groups, while ignoring the poor and their livelihood concerns. This leads to the reinvention of elite domination around timber governance and justifies the hydra-headed nature of elite capture. Several studies have illustrated that the well-off groups and powerful local elite dominate the executive committees of CFUGs more frequently than the poor and disadvantaged [47–49,61]. This is equally relevant in the Nepalese context as the institutional structure of community forest user groups places the whole authority of decision-making power in the hands of the few members of the executive committee [47,62]. Evidence suggests that community forestry benefits have flowed less to marginalized and disadvantaged households than to the middle class and wealthy households [41]. On the other hand, the reluctance of forest bureaucracy and the local elite to transfer power to the poor locals [63], as they have captured the decision-making process, is evident in Nepal [39,64]. As local groups begin to have mature, well-defined policies, institutions, and practices [3,7], they could potentially contribute to redefining community forestry positions by contributing substantially to local livelihood and poverty reduction.

Overall, we found that SciFM intervention in community forest has some positive implications, although several limitations have been demonstrated by recent studies; it is accused of having decreased user power and user participation and posing threats of recentralization [31,39,65]. SciFM has focused on timber harvesting and employed technical aspects that could be a burden to forest users [27,38]. Additionally and most importantly, it could create opportunities for the local elite while neglecting the concerns of the poor [26]. We see SciFM intervention as an opportunity for timber-based enterprises, as envisioned by the Forest Policy 2015 and Forest Act 2019. It could be the vehicle for decreasing timber import and fulfilling national timber demand [32]. Most importantly, it could be the vehicle for poverty reduction through reinvestment in livelihood improvement and community development. There is a strong nexus between community forests, community livelihoods, and poverty reduction [6]. However, several studies have argued that there are no expected results produced by CFs in terms

of poverty reduction [43,44]. The poorer households are found to have received fewer benefits from CFs [43,45], and it is argued that the rules of equality in sharing costs and access to benefits have unexpectedly resulted in unfair outcomes, as poor and vulnerable groups need more and specific forest products than the wealthier households do. Similarly, the protection-oriented forest management practices, which only allowed limited harvesting of forest products and did not reach their full potential, have resulted in poor socioeconomic benefits for rural livelihood improvement and poverty reduction. Thus, SciFM intervention provides a great opportunity to establish the narrative that CFs can substantially contribute to poverty reduction. However, with signs of unequal distribution of timber under SciFM, it remains questionable whether increases in timber production would essentially contribute to improving the wellbeing of all CFUG members. This leads us to share the position that governance issues linked to equitable resource distribution and benefit-sharing should be prioritized. Furthermore, the current arrangement has prioritized timber production and supplies to the market over the demands of users—this contradicts the very essence of instituting SciFM. Finally, along with timber governance that includes equitable distribution among users, the capital for reinvestment in a new forest (regeneration felling, regeneration growths, and its management) is required and is important for the sustainable management of SciFM in community forestry. Together, the CFUGs' commitment and collective action matter a lot.

5. Conclusions

While SciFM is applauded for having contributed to increasing timber production, several questions relating to the volume of timber harvested and its pattern of distribution among user groups still beg for clarity. In this paper, we explored the dynamics of timber distribution under community forestry systems where scientific forest management is practiced in Nepal's Terai region. We conclude that despite the increase in timber after SciFM initiation, questions linked to equity in the distribution amongst different wealth groups remain unanswered. As a step towards seeking solutions here, SciFM as a process should be firmly institutionalized. With a substantial increase in timber harvesting (56% increase by the third year), one would have expected the household supply gap to be narrowed substantially. However, this gap was narrowed for middle and rich households, who enjoyed up to 97% of the timber, as opposed to just 3% for the poor households. The present lethargy could be traced from the significant representation of the former groups in the decision-making body, giving them the opportunity to make decisions that suit their interest. By way of conclusion, we argue that the technocentric efforts linked to increasing timber sufficiency (e.g., through SciFM) is a necessary but insufficient condition to meet the needs of the poorest of the poor, as elite capture persists. Though timber harvesting increased after SciFM for the CFUGs, its distribution and effective management need collective planning and an equity approach. Similarly, governance issues linked to equitable resource distribution and benefit-sharing should be prioritized. Further research should explore pathways to deal with the hydra-headed nature of elite capture. Policywise, the current institutional setup should be revised to accommodate a significant representation of poor and indigenous users. This will reflect their needs and aspirations during the decision-making processes linked to timber allocation and change the current narrative, which attributes timber to middle and rich households.

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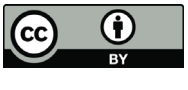
References

1. Dhakal, M.; Masuda, M. Local pricing system of forest products and its relations to equitable benefit sharing and livelihood improvement in the lowland community forestry program in Nepal. *For. Policy Econ.* **2009**, *11*, 221–229. [CrossRef]
2. Kimengsi, J.N.; Bhusal, P.; Aryal, A.; Fernandez, M.V.B.C.; Owusu, R.; Chaudhary, A.; Nielsen, W. What (De) Motivates Forest Users' Participation in Co-Management? Evidence from Nepal. *Forests* **2019**, *10*, 512. [CrossRef]
3. Kimengsi, J.N.; Bhusal, P. Community forestry governance: Lessons for Cameroon from Nepal? *World Dev.* **2020**. under review.
4. Nagendra, H.; Karmacharya, M.; Karna, B. Evaluating forest management in Nepal: Views across space and time. *Ecol. Soc.* **2005**, *10*, 24. [CrossRef]
5. GoN—Government of Nepal. *Forest Act*; Ministry of Forests and Environment, Department of Forests: Kathmandu, Nepal, 2019.
6. Pokharel, B.K.; Branney, P.; Nurse, M.; Malla, Y.B. Community forestry: Conserving forests, sustaining livelihoods and strengthening democracy. *J. For. Livelihood* **2007**, *6*, 8–19.
7. Ojha, H.; Pokharel, B. Democratic innovations in community forestry—What can politicians learn? *Participation* **2005**, *7*, 22–25.
8. Pandit, R.; Bevilacqua, E. Forest users and environmental impacts of community forestry in the hills of Nepal. *For. Policy Econ.* **2011**, *3*, 345–352. [CrossRef]
9. Niraula, R.R.; Gilani, H.; Pokharel, B.K.; Qamer, F.M. Measuring impacts of community forestry program through repeat photography and satellite remote sensing in the Dolakha district of Nepal. *J. Environ. Manag.* **2013**, *126*, 20–29. [CrossRef]
10. Adhikari, B.; Williams, F.; Lovett, J.C. Local benefits from community forests in the middle hills of Nepal. *For. Policy Econ.* **2007**, *9*, 464–478. [CrossRef]
11. Kanel, K.R.; Niraula, D.R. Can rural livelihood be improved in Nepal through community forestry? *Banko Janakari* **2004**, *14*, 19–26. [CrossRef]
12. Kanel, K.R.; Dahal, G.R. Community forestry policy and its economic implications: An experience from Nepal. *Int. J. Soc. For.* **2008**, *1*, 50–60.
13. Paudel, G. Forest resource income variation in mid-hills of Nepal: A case study from two CFUGs of Parbat district, Nepal. *Int. J. Environ.* **2015**, *12*, 1–10. [CrossRef]
14. Bhandari, P.K.C.; Bhusal, P.; Paudel, G.; Upadhyaya, C.P.; Chhetri, B.B.K. Importance of Community Forestry Funds for Rural Development in Nepal. *Resources* **2019**, *8*, 85. [CrossRef]
15. Chhetri, B.B.K.; Lund, J.F.; Nielsen, Ø.J. The public finance potential of community forestry in Nepal. *Ecol. Econ.* **2012**, *73*, 113–121. [CrossRef]
16. Pokharel, R.K. Development of community infrastructure through community forestry funds: What infrastructure gets priority? *Banko Janakari* **2010**, *20*, 44–50. [CrossRef]
17. Food and Agriculture Organization of the United Nations. *Contribution of the Forestry Sector to National Economies, 1990–2006*; Food and Agriculture Organization of the United Nations (FAO): Rome, Italy, 2008.
18. Banjade, M.R. Discourse and discursive practices over timber in Nepal. *J. For. Livelihood* **2012**, *10*, 58–73. [CrossRef]
19. Lebedys, A.; Li, Y. *Contribution of the Forestry Sector to National Economies, 1990–2011*; Food and Agriculture Organization of the United Nations (FAO): Rome, Italy, 2014; p. 166.
20. Nurse, M.; Malla, Y. *Advances in Community Forestry in Asia*; Regional Community Forestry Training Center for Asia and the Pacific: Bangkok, Thailand, 2005; pp. 1–6.
21. Gautam, A.P. Equity and livelihoods in Nepal's community forestry. *Int. J. Soc. For.* **2009**, *2*, 101–122.
22. Ministry of Forests and Soil Conservation. *Scientifc Forest Management Guideline*; Ministry of Forests and Soil Conservation, Singhadarbar: Kathmandu, Nepal, 2014.
23. Basnyat, B.; Treue, T.; Pokharel, R. Silvicultural madness: A case from the "Scientific Forestry" initiative in the community forests of Nepal. *Banko Janakari* **2018**, *27*, 54–64. [CrossRef]

24. Khanal, Y.; Adhikari, S. Regeneration promiotion and income generation through scientific forest management in community forestry: A case study from Rupendehi District, Nepal. *Banko Janakari* **2018**, *4*, 36–44.
25. Yadav, N.P.; Yadav, K.P.; Yadav, K.K.; Thapa, N. Facilitating the Transition from Passive to Active Community Forest Management: Lessons from Rapti Zone, Nepal. *J. For. Livelihood* **2009**, *8*, 51–66. [CrossRef]
26. Basnyat, B. Commodifying the community forestry: A case from scientific forestry practices in Western Hills of Nepal. *J. For. Res. Res.* **2020**, *2*, 69–75. [CrossRef]
27. Bhusal, P.; Awasthi, K.R.; Kimengsi, J.N. User's opinion in scientific forest management implementation in Nepal—A case study from Nawalparasi district. *Cogent Environ. Sci.* **2020**, *6*, 1778987. [CrossRef]
28. Paudel, G.; Bhusal, P. Are community forests in the recentralization pressure? *Community For. Bull.* **2018**, *18*, 46–52.
29. Baral, S.R.; Dhakal, S.R. *Nepalma Baigyanik Ban Byabasthapan: Bartaman Abastha, Samasya ra Sujhab*; Babarmahal: Kathmandu, Nepal, 2018.
30. Department of Forests. *Scientific Forest Management Guideline*; Ministry of Forests and Environment, Department of Forests: Kathmandu, Nepal, 2015.
31. Joshi, O.; Parajuli, R.; Kharel, G.; Poudyal, N.C.; Taylor, E. Stakeholder opinions on scientific forest management policy implementation in Nepal. *PLoS ONE* **2018**, *13*, e0203106. [CrossRef] [PubMed]
32. Subedi, V.R.; Bhatta, K.D.; Poudel, I.P.; Bhattarai, P. Application of silvicultural system, yield regulation and thinning practices in natural forests: Case study from western Terai. *Banko Janakari* **2018**, *4*, 92–97. [CrossRef]
33. Paudel, G.; Khanal, P.P.; Cedamom, E.; Basyal, M. Prospects of Application of Shelterwood System in Mature Pine Stands in the Hills of Kavre District. *Kalpabriksh* **2017**, *1*, 162–176.
34. Cedamon, E.; Paudel, G.; Basyal, M.; Nuberg, I.; Shrestha, K. Applications of single-tree selection guideline following a DBq approach on Nepal's community forests. *Banko Janakari* **2018**, *3*, 104–112. [CrossRef]
35. Gilmour, D. Silviculture and community forestry: Looking backwards, looking forwards. *Banko Janakari* **2018**, *4*, 6–14. [CrossRef]
36. Poudyal, B.H.; Maraseni, T.; Cockfield, G. Scientific Forest Management Practice in Nepal: Critical Reflections from Stakeholders' Perspectives. *Forests* **2020**, *11*, 27. [CrossRef]
37. Rutt, R.L.; Chhetri, B.B.K.; Pokharel, R.; Rayamajhi, S.; Tiwari, K.; Treue, T. The scientific framing of forestry decentralization in Nepal. *For. Policy Econ.* **2015**, *60*, 50–61. [CrossRef]
38. Baral, S.; Meilby, H.; Chettri, B.B.K.; Basnyat, B.; Rayamajhi, S.; Awale, S. Politics of getting the numbers right: Community forest inventory of Nepal. *For. Policy Econ.* **2018**, *91*, 19–26. [CrossRef]
39. Basnyat, B.; Treue, T.; Pokharel, R.K.; Lamsal, L.N.; Rayamajhi, S. Legal-sounding bureaucratic re-centralisation of community forestry in Nepal. *For. Policy Econ.* **2018**, *91*, 5–18. [CrossRef]
40. Banjade, M.R.; Paudel, N.S.; Karki, R.; Sunam, R.; Paudyal, B.R. *Putting Timber in the Hot Seat: Discourse, Policy and Contestations over Timber in Nepal*; ForestAction Discussion Paper Series 11: 2; ForestAction: Kathmandu, Nepal, 2011.
41. Yadav, B.D.; Bigsby, H.; MacDonald, I. The relative distribution: An alternative approach to evaluate the impact of community level forestry organisations on households. *Land Use Policy* **2015**, *42*, 443–449. [CrossRef]
42. Department of Forests. *Community Forest Development Guideline*; Ministry of Forests and Environment, Department of Forests: Kathmandu, Nepal, 2014.
43. Devkota, B.; Thwaites, R.; Race, D. Community forestry, rural livelihoods and poverty reduction in Nepal. In *Community Forestry in Nepal: Adapting to a Changing World*; Thwaites, R., Fisher, R., Poudel, M., Eds.; Earthscan: London, UK; New York, NY, USA, 2018.
44. Shrestha, K.K. *Dilemma of Justices: Collective Action and Equity in Nepal's Community Forestry*; Adroit: New Delhi, India, 2016.
45. Malla, Y.B.; Neupane, H.R.; Branney, P.J. Why aren't poor people benefiting more from community forestry? *J. For. Livelihood* **2003**, *3*, 78–92.
46. Agrawal, A.; Gupta, K. Decentralization and participation: The governance of common pool resources in Nepal's Terai. *World Dev.* **2005**, *33*, 1101–1114. [CrossRef]
47. Agrawal, A.; Chhattre, A. Explaining success on the commons: Community forest governance in the Indian Himalaya. *World Dev.* **2006**, *34*, 149–166. [CrossRef]

48. Ostrom, E. *Building Trust to Solve Commons Dilemmas: Taking Small Steps to Test an Evolving Theory of Collective Action Workshop in Political Theory and Policy Analysis*; Indiana University and Centre for the Study of Institutional Diversity Arizona State University: Arizona, AZ, USA, 2008.
49. Adhikari, B.; Di Falco, S. Social inequality, local leadership and collective action: An empirical study of forest commons. *Eur. J. Dev. Res.* **2009**, *21*, 179–194. [CrossRef]
50. Woiceshyn, J.; Daellenbach, U. Evaluating inductive vs. deductive research in management studies. *Qual. Res. Organ. Manag. Int. J.* **2018**, *13*, 183–195. [CrossRef]
51. Gwan, S.A.; Kimengs, J.N. Urban expansion and the dynamics of farmers' livelihoods: Evidence from Bamenda, Cameroon. *Sustainability* **2020**, *12*, 5788. [CrossRef]
52. GoN. *Guidelines for Collection and Sale of Timber and Fuelwood from Community Forests (in Nepali)*; Ministry of Forests and Soil Conservation: Kathmandu, Nepal, 2015.
53. Puri, L.; Nuberg, I.; Ostendorf, B.; Cedamon, E. Locally Perceived Social and Biophysical Factors Shaping the Efective Implementation of Community Forest Management Operations in Nepal. *Small Scale For.* **2020**, *19*, 291–317. [CrossRef]
54. Shrestha, K.; McManus, P. The politics of community involvement in conservation and use of forest resources: Lessons from community forestry in Nepal. *Aust. For.* **2018**, *71*, 135–146.
55. Khatri, P. Timber Worth Billions of Rupees Decays in Nepal Annually. 2016. Available online: http://therisingnepalorgnp/news/16232 (accessed on 15 March 2017).
56. Acharya, K.P. Sustainability of support for community forestry in Nepal. *For. Trees Livelihoods* **2003**, *13*, 247–260. [CrossRef]
57. Bampton, J.; Cammaert, B. How Can Timber Rents Better Contribute to Poverty Reduction through Community Forestry in the Terai Region of Nepal? *J. For. Livelihood* **2007**, *6*, 28–47.
58. Kurashima, T.; Matsuura, T.; Miyamoto, A.; Sano, M.; Chann, S. Considering the Practical Rationality of Experimental Operation in Developing Countries: Reality and Challenges under a Rigid Community Forestry System in Cambodia. *Forests* **2015**, *6*, 3087–3108. [CrossRef]
59. Iversen, V.; Chhetry, B.; Francis, P.; Gurung, M.; Kafle, G.; Pain, A.; Seeley, J. High value forests, hidden economies and elite capture: Evidence from forest user groups in Nepal's Terai. *Ecol. Econ.* **2006**, *58*, 93–107. [CrossRef]
60. Persha, L.; Andersson, K. Elite capture risk and mitigation in decentralized forest governance regimes. *Glob. Environ. Chang.* **2014**, *24*, 265–276. [CrossRef]
61. Dhakal, B.; Bhatta, B. An institutional model to explain utilisation problem of community forest products. *Int. J. Soc. For.* **2010**, *2*, 23–48.
62. Andersson, K.; Agrawal, A. Inequalities, institutions, and forest commons. *Glob. Environ. Chang.* **2011**, *21*, 866–875. [CrossRef]
63. Hansen, P.L. Second Generation Community Forestry: A Study of the Pro-poor Focus in Community Forestry in Nepal Master Thesis International Development Studies. Master's Thesis, Institute for Society & Globalisation Roskilde University, Denmark, Roskilde, October 2007.
64. Lund, J.F.; Baral, K.; Bhandari, N.S.; Chhetri, B.B.K.; Larsen, H.O.; Nielsen, O.J.; Puri, L.; Rutt, R.L.; Treue, T. Who benefits from taxation of forest products in Nepal's community forests? *For. Policy Econ.* **2013**, *38*, 119–125. [CrossRef]
65. Sunam, R.K.; Paudel, N.S.; Paudel, G. Community forestry and the threat of recentralization in Nepal: Contesting the bureaucratic hegemony in policy process. *Soc. Nat. Resour.* **2013**, *26*, 1407–1421. [CrossRef]



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What Is Threatening Forests in Protected Areas? A Global Assessment of Deforestation in Protected Areas, 2001–2018

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Abstract: The protection of forests is crucial to providing important ecosystem services, such as supplying clean air and water, safeguarding critical habitats for biodiversity, and reducing global greenhouse gas emissions. Despite this importance, global forest loss has steadily increased in recent decades. Protected Areas (PAs) currently account for almost 15% of Earth's terrestrial surface and protect 5% of global tree cover and were developed as a principal approach to limit the impact of anthropogenic activities on natural, intact ecosystems and habitats. We assess global trends in forest loss inside and outside of PAs, and land cover following this forest loss, using a global map of tree cover loss and global maps of land cover. While forests in PAs experience loss at lower rates than non-protected forests, we find that the temporal trend of forest loss in PAs is markedly similar to that of all forest loss globally. We find that forest loss in PAs is most commonly—and increasingly—followed by shrubland, a broad category that could represent re-growing forest, agricultural fallows, or pasture lands in some regional contexts. Anthropogenic forest loss for agriculture is common in some regions, particularly in the global tropics, while wildfires, pests, and storm blowdown are a significant and consistent cause of forest loss in more northern latitudes, such as the United States, Canada, and Russia. Our study describes a process for screening tree cover loss and agriculture expansion taking place within PAs, and identification of priority targets for further site-specific assessments of threats to PAs. We illustrate an approach for more detailed assessment of forest loss in four case study PAs in Brazil, Indonesia, Democratic Republic of Congo, and the United States.

Keywords: protected areas; deforestation; tree cover loss; global forest

1. Introduction

Protected Areas (PAs) are a key strategy for safeguarding global biodiversity and ecosystem services. As of 2018, there were more than 230,000 terrestrial PAs worldwide, protecting 14.9% of the earth's surface and inland waters outside of Antarctica [1], and 5.2% of global tree cover (Figure 1). The extent of PAs has increased substantially since the 1990s, and under the Convention on Biological Diversity, nations committed to further increasing the land area in PAs to 17% by 2020. Despite this, PAs are under increasing threat from anthropogenic activities, including encroachment for settlements, agriculture, mining, logging, and poaching and bushmeat hunting [2]. Worldwide almost one-third of PAs are under intense human pressure, determined as the combined influence of built environments,

agriculture, human population, and transportation infrastructure [3]. Moreover, less than half of PAs are free of any human pressure, and this pressure has increased since the 1990s [4].

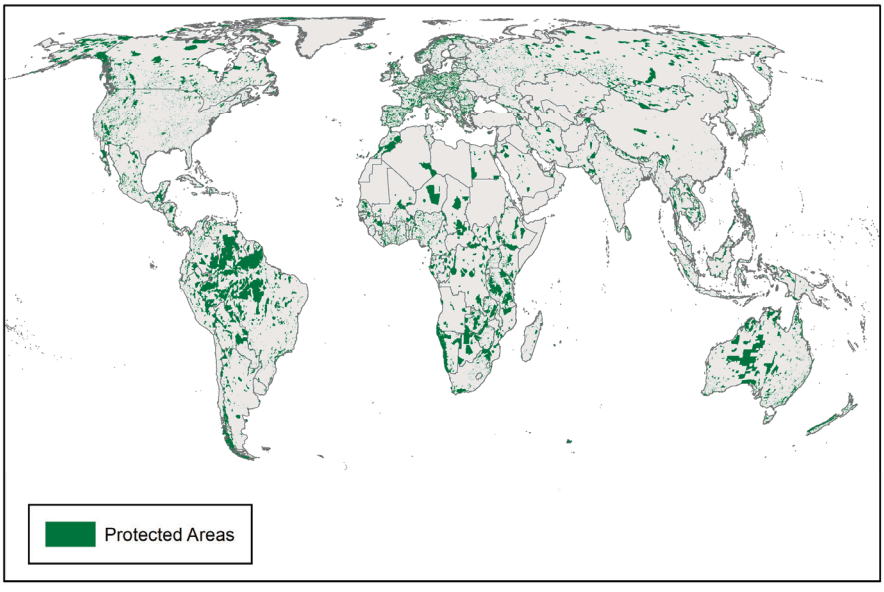

Figure 1. Location of Protected Areas (PAs) based on World database on Protected Areas [5].

Globally, between 2001 and 2012, 3% of PA forests and 5% of all forests were converted to other land cover types [6]. While the lower rate of forest loss in PAs relative to the global average may suggest that PAs are effective in preventing some, if not all, forest loss, several studies have shown that PAs are preferentially located in areas that have a lower risk of deforestation [7–10]. The locations of PAs are biased towards areas with lower potential agricultural revenues and limited access, in order to minimize conflict with extractive industries and thus reduce the cost of acquisition and establishment [11]. Nevertheless, studies controlling for these confounding factors generally demonstrate that PAs do provide additional protection beyond what would have been expected in the absence of their designation [12,13].

Here, we examine global tree cover loss in PAs globally over 2001–2018, providing the most up-to-date report on forest conversion trends in PAs. Previous analyses of forest loss have been restricted to national or regional scales (e.g., References [8,14]), and/or have not been recently updated (e.g., Reference [7]). We highlight regions and countries where PAs are succeeding and failing to prevent forest loss, a proxy for their ability to safeguard intact habitats and protect other provisioning and regulating ecosystem services. Next, we examine the land cover following tree cover loss in PAs, and variations in follow-up land cover over space and time. In particular, we measured the magnitude (extent) of forest to agricultural land conversion in PAs, as agriculture has been shown to be a dominant driver of deforestation in the tropics [15,16] and globally [17]. Our analysis provides useful information about what may be causing forest loss in PAs and informs the development of PA management and enforcement strategies that are tailored to the agents of change on the ground. Our global assessment should be considered a screening tool to identify priority regions for further detailed investigation of threats to PAs.

2. Materials and Methods

To conduct our analysis, we took advantage of three recently published, or recently updated, spatially explicit datasets (Table 1), (1) protected areas from the World Database on Protected Areas (WDPA) [5], (2) 30 m resolution Global Forest Change (GFC) data representing tree cover loss annually, from 2001–2018 [18], and (3) 300 m resolution land cover maps for the years 2005, 2010, and 2015 from the European Space Agency–Climate Change Initiative (ESA-CCI) [19].

Table 1. Summary of spatial datasets used.

Parameter	Years Represented	Spatial Resolution	Reference	Version
Protected Areas (WDPA [1])	2017	Vector	[5]	1.5
Tree Cover Loss (GFC [2])	Annual 2001–2018	30 m	[18]	1.6
Land Cover (ESA-CCI [3])	2005, 2010, 2015	300 m	[19]	2.0.7

[1] World Database on Protected Areas; [2] Global Forest Change; [3] European Space Agency-Climate Change Initiative.

From the WDPA, we excluded marine PAs, PAs which have been proposed but not formally designated, and those without spatial information (e.g., only provided as point data). We examined forest loss trends in a given PA beginning the year after which it was formally designated, and in the ~10% of cases where the establishment year was not provided, we assumed that the PA had been established prior to 2001. We included all PA types in our analysis (Supplementary Table S1), including those designated in the International Union for Conservation of Nature (IUCN) categorization system as "Not Applicable", "Not Assigned", and "Not Reported". These categories include some important types of protection, including lands managed by indigenous communities in Brazil and United Nations Educational, Scientific and Cultural Organization (UNESCO) Biosphere Reserves in Guatemala. However, these may be left uncategorized according to the IUCN typology due to reporting errors. We isolate trends in PAs which are more strictly protected according to the IUCN categorization system (strict nature reserves, wilderness areas, and national parks), in recognition of the fact that less stringent PA categories may support forest management and other types of sustainable land use change that would result in forest loss. Within IUCN category IV, it is recognized that active management, or modifications to the ecosystem (e.g., halting natural succession, providing supplementary food, or artificially creating habitats) will take place. Specifically, IUCN Category IV sites allow sustainable management of natural resources to maintain culturally defined ecosystems with unique biodiversity, but are not designed for industrial harvest levels [5], and Category VI areas allow the sustainable use of natural resources to promote ecosystem services. In the case where PA polygons overlapped, we assumed the most stringent level of protection. We converted the vector shapefile to a raster grid with spatial resolution of 30 m.

The GFC dataset [18] mapped tree cover loss, defined as the conversion from forest to non-forest, during the 2000–2018 period. We refer to this as forest loss, under the assumption that loss in PAs is predominantly natural forest loss as opposed to loss of planted trees or plantations. We restrict our analysis to areas with greater than or equal to 50% canopy cover in the year 2000 [18]. We tabulated forest loss through three time periods: 2001–2004, 2005–2009, and 2010–2014. We then categorized each forest loss pixel to a land cover class in the year immediately following each of these periods: 2005, 2010, and 2015, respectively. Previous research demonstrated that the land cover following forest loss does not change substantially in a 1–10-year period after the loss occurred. Our approach is based on a period of 1–4 years after forest loss [20]. For a given PA, we excluded any tree cover loss that occurred prior to the year of PA establishment. We additionally report loss in PAs from 2015 to 2018, though we cannot assign a follow-up land cover to this loss, as the most recent land cover map is from the year 2015.

We use the land cover type following forest loss to categorize the cause of deforestation. We acknowledge that subsequent land cover is only a proxy for the complex and dynamic causes of deforestation, but more detailed investigation of these underlying causes is not possible at the

scale of our analysis. We reclassified the 22 land cover categories presented in the European Space Agency Climate Change Initiative (ESA-CCI) land cover dataset to seven categories (Supplementary Table S2) [21]. Our reclassification schema consolidated forest categories (e.g., broadleaf tree cover, needleleaf tree cover), shrubland categories (e.g., shrubland, mosaic herbaceous cover), grassland, and 'other' land cover types (e.g., urban, bare land, water bodies, snow cover). We retained three separate agriculture categories: cropland (including both rainfed and irrigated cultivated crops), mosaic cropland (>50% cropland mixed with trees, shrubs, and herbaceous cover), and mosaic vegetation (<50% cropland and >50% mixed trees, shrubs, and herbaceous cover). The mapped cropland land cover categories have reported accuracies of 73%–89%, except for the mosaic vegetation category. This land cover type has a reported accuracy of just 59%, largely due to commissions of the other cropland categories. Notably, ESA-CCIs agriculture category includes areas used for crop cultivation but does not include areas used for livestock grazing (pasture land or managed grasslands). ESA-CCI does include a grassland category, but does not differentiate natural grasslands from managed grasslands, as this is difficult at global scales using mid-resolution satellite imagery [22]. We resampled the landcover dataset to a 30 m pixel raster grid, matching the resolution of the forest loss map.

To gauge the robustness of our approach to classifying the land cover following forest loss using global-scale data, we compared our results to two previous studies which investigated drivers of deforestation using nationally and regionally specific datasets (Supplementary Table S3). We aggregated several land cover categories in order to facilitate comparison according to Supplementary Table S3. In Indonesia, the authors of Reference [15] found that about 67% of deforestation nationally was followed by agriculture and 40% of deforestation events in PAs were followed by agriculture. We found a similar proportion of forest loss to agriculture nationally (61%) and in PAs (38%). In South America, the authors of Reference [16] reported that 20% of deforestation was followed by agriculture and another 69% followed by pasture lands from 2001 to 2005. We estimated that 44% of forest loss was followed by agriculture, and another 44% was followed by grassland. The differences in Brazil may be partially explained by the challenge of differentiating natural grasslands from managed grassland or pastureland. The results of these robustness checks provide confidence that we can broadly track agriculture as a driver of forest loss using the global land cover dataset, though differentiating pastureland as a driver of forest loss remains difficult with currently available land cover maps (Supplementary Tables S4 and S5). We address the implications of this challenge in more detail in the Discussion Section.

We examined case studies of forest loss in PAs in four countries: Brazil, Indonesia, Democratic Republic of Congo, and the US (Supplementary Figure S1). We selected these countries because each has some of the highest forest loss globally and we wanted to include representation across continents and biomes (Supplementary Table S4). In each case, we investigated forest loss trends in a PA with one of the highest rates of forest loss nationally. We visualized forest cover and loss for each selected PA, examined the Landsat time series from 2000 to 2016 in Google Earth, and available high-resolution satellite imagery in the PA over the study period. We do not aim to provide a systematic validation of our approach to tracking forest loss and following land cover in PAs, but rather use these case studies to explore areas of concern in more detail with higher resolution satellite imagery.

3. Results

3.1. Ongoing Forest Loss in Protected Areas

From 2001 to 2018, 12.2% of global forest area (401.3 million hectares (Mha) of 3289.4 Mha) and 4.1% of protected forest area (25.5 Mha of 628.1 Mha) experienced forest loss. Total forest loss generally increased continuously from 2001 to 2018, with a notable spike in 2016 likely due to a spike in forest fires [23]. Forest loss in PAs followed a strikingly similar trend, suggesting that PAs are not exempt from the underlying climatic and macroeconomic forces that drive forest loss globally (Figure 2).

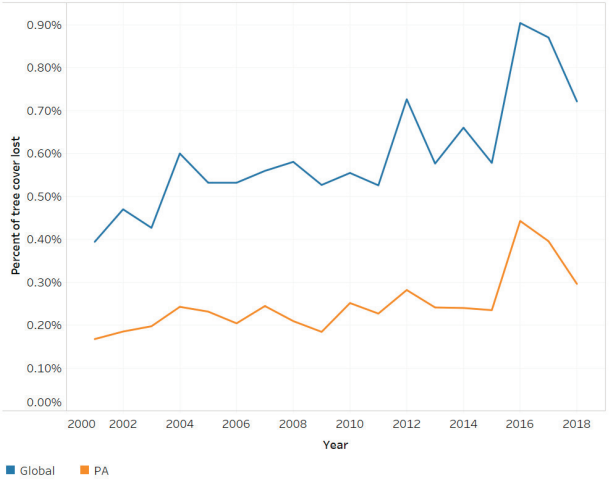

Figure 2. comparison of tree cover loss worldwide, and within PAs: 2001–2018 (% of tree cover lost). The distance between the global trend and PA trend is representative of (1) the effectiveness of PAs promoting natural resource conservation, and (2) the impact of location bias of PAs [9,11].

South and Central America are responsible for the largest proportion, 32%, of forest loss in PAs over the study period, followed by North America (20%), Eastern Europe (18%), and Africa and the Middle East (12%). Forest loss in PAs increased across several regions over the study period, including Eastern Europe, Southeast Asia, Africa, and the Middle East, and in particular, in South and Central America (Figure 3). Specifically, Brazil is found to be the largest contributor to this increase in tree cover loss over time, with exceptionally high amounts of tree cover loss in 2016–2017. We also find that no regions experienced a substantial decline in forest loss in PAs over 2001–2018. Total and proportional forest loss by country is shown in Figure 4 (omitting countries with less than 1000 ha of tree cover in PAs) and presented in Supplementary Table S4.

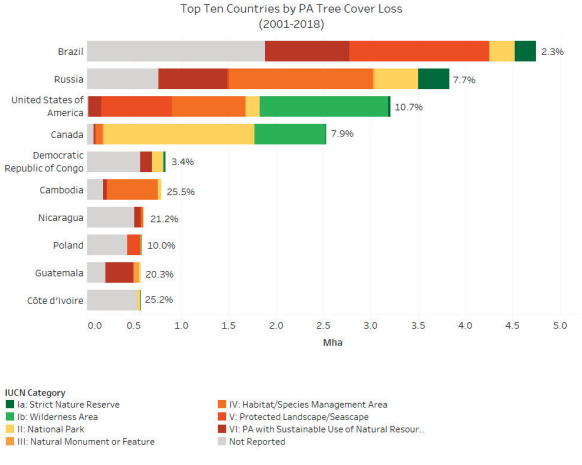

Figure 3. Top 10 countries with tree cover loss in PAs, by Union for Conservation of Nature (IUCN) category from 2001–2018. Bars represent tree cover loss in Mha, percentage is proportion of total PA tree cover lost in each country between 2001–2018. (See Supplementary Table S4 for full list of country-level results).

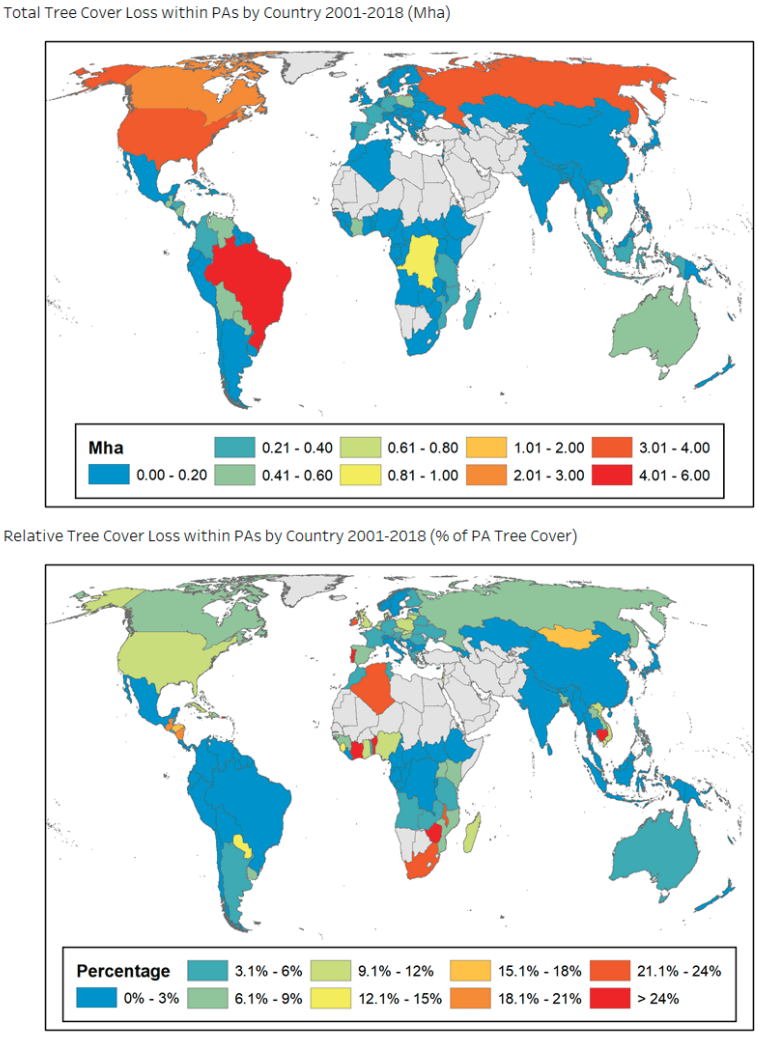

Figure 4. Top: total tree cover loss in PAs by country from 2001–2018 (Mha). Bottom: percentage of tree cover lost within PAs from 2001–2018.

Forest loss by IUCN PA classification follows expected trends, with stricter categories of PA experiencing less loss than categories which allow some form of sustainable use (Figure 5, which shows annual PA tree cover loss by country (left) and by IUCN Category (right) with trendlines shown for reference). Categories Ia (Strict nature reserve), Ib (Wilderness Area), and III (National Monuments) have low annual forest loss and no noticeable trend over time. On the other hand, less strict categories, including IV (Habitat and Species Management Areas) and VI (Protected area with sustainable use of natural resources), experienced higher, and somewhat increasing, forest loss during the period between 2001 and 2018. However, PAs which do not fit into the IUCN classification scheme have both the highest amounts of tree cover loss, and the highest rate of increase in tree cover loss over time, but without more detailed management information, we cannot determine whether this is sanctioned clearing. Concerningly, National Parks (category II) should also be very strictly protected, but forest loss in these PAs doubled over the 2001–2018 period.

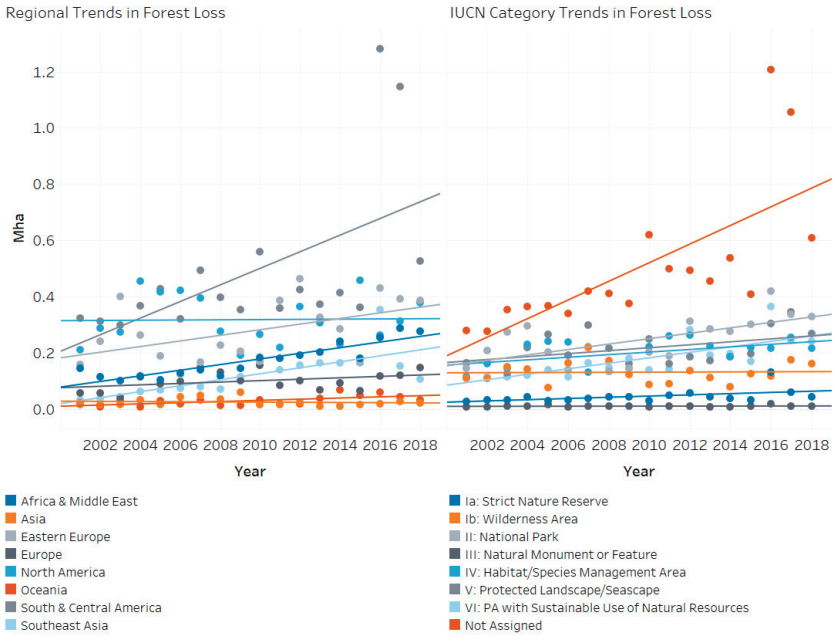

Figure 5. Left: historical trend in tree cover loss in PAs by region. Right: historical trend in tree cover loss by IUCN Category.

3.2. Land Cover Following Forest Loss in Protected Areas

Globally, across all PAs, shrubland is the dominant land cover following forest loss over 2001–2014, comprising almost half (47%) of all observations. Shrublands comprise a broad land cover category that could include re-growing forest, agricultural fallows, or pasture lands in some regional contexts. The proportion of forest loss in PAs followed by agriculture, including both cropland and mosaic cropland, is 22% (Figure 6). Another 14% of forest loss in PAs is followed by mosaic vegetation (which has the potential to be interspersed with small scale agriculture), and 6% by grassland. The remaining 11% of forest loss is followed by 'other' land uses including urban areas, water bodies, and bare areas. The proportion of forest loss followed by shrubland is the only category that significantly increased over 2001–2014, from about 35% in 2001 to more than 50% in 2014. On the other hand, mosaic cropland and grassland categories have decreased over the study period (Figure 6).

Additionally, PA tree cover loss varies by regions (Figure 7). Early in the study period, South and Central America, Africa and the Middle East, and North America experienced the greatest proportion of tree cover loss followed by shrubland (42%, 19%, and 18% of global total, respectively) (shown in Figure 7). In later periods, the share of tree cover loss followed by shrubland declined in South and Central America, and North America (to 28% and 12%, respectively), while it continued to increase in Africa and the Middle East and Southeast Asia (from 19% in 2001 to 23% in 2014, and from 5% in 2001 to 23% in 2014, respectively).

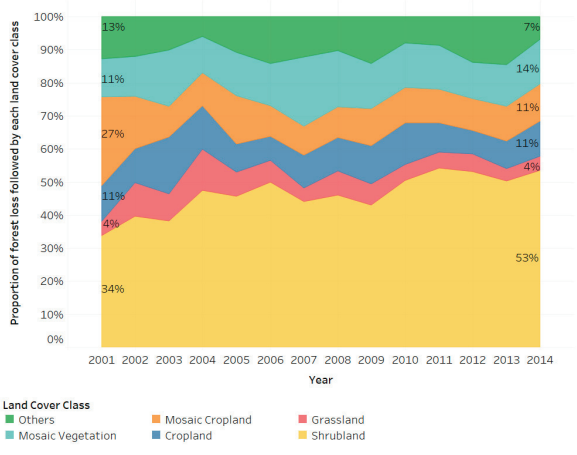

Figure 6. The proportion of forest loss within PAs followed by each land cover category, globally from 2001 to 2018, with the first and last year proportion labeled for reference.

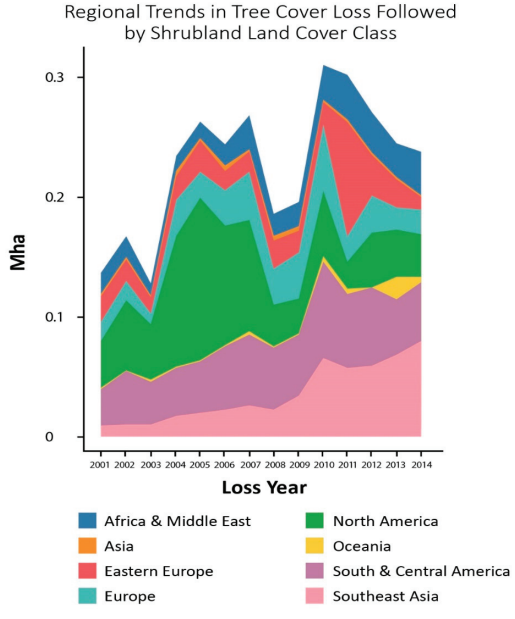

Figure 7. Calculated regional distribution of tree cover loss followed by shrubland from 2001 to 2014 (Mha).

3.3. Case Studies

We identified four case studies to illustrate varying drivers of land conversion, based on those countries and PAs with significant tree cover loss. For these PAs, in Brazil, Indonesia, Democratic Republic of Congo, and the United States, we examined high spatial resolution orthoimages to develop a more detailed understanding of the land cover following loss in these cases. This is not intended as a systematic validation of our analysis, but rather an illustration of how the global analysis can be followed by more detailed investigation with higher resolution satellite imagery.

Brazil's Triunfo do Xingu Environmental PA (IUCN Category V) has recently been noted as a hotspot of deforestation due to pasture expansion, with more than 14,000 hectares of protected land converted to pasture over a six month period in 2018, and over 350,000 ha converted since 2006 [24]. Our analysis found that from 2001 to 2018, over 560,000 ha had experienced tree cover loss. Based on our global analysis, almost 40% of loss in this PA is followed by shrubland and grassland, and another 40% by mosaic agriculture from 2001 to 2015. Using high-resolution imagery from Google Earth, we observed that the forest loss in this PA appears to be organized along roads and settlements and in rectilinear configurations characteristic of agriculture and pastureland, with substantial grassland cover. This configuration suggests that indeed much of the grassland and shrubland cover following loss is managed for livestock grazing and emphasizes the challenge of distinguishing managed and unmanaged grasslands [22,25].

In 2016, just two PAs hosted 40% of forest loss in Indonesian PAs: Tanjung Puting National Park (IUCN Category II) had tree cover loss of about 470 km^2 of 3250 km^2 of total tree cover, and Sebangau National Park (IUCN Category II) which had tree cover loss of about 460 km^2 of 5700 km^2 of total tree cover, both peat forest PAs in the Central Kalimantan region. As the majority of this loss occurred after 2015, we do not have results from our global analysis about the subsequent land cover. However, more detailed examination of loss patterns in Sebangau National Park (Figure 8) suggests that forest loss is generally followed by grassland or shrubland. This largely conforms to findings from previous research highlighting the important role of fires, generally anthropogenic in origin but unintentionally impacting large expanses of peat forests, in driving deforestation across Central Kalimantan since 2015 [15].

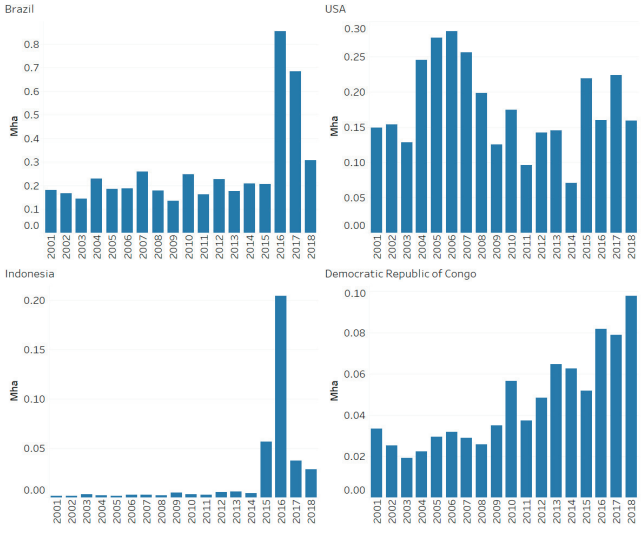

Figure 8. Historical trends in tree cover loss within PAs across selected countries from 2001 to 2018, note the y-axis is not consistent across each graph (Mha).

Democratic Republic of Congo has the fifth highest rate of forest loss in PAs and experienced a steadily increasing rate of forest loss in PAs over 2001–2018. The majority of this loss occurred in PAs categories without an IUCN category ("Not applicable"). We examined loss in the Sankuru Nature Reserve, which was created in 2007 to protect Bonobo habitat and is managed by local communities [26]. Our global analysis found that more than 90% of forest loss in Sankuru was followed by crop land, including mosaic agriculture (in total we found that 1100 km^2 of 26,700 km^2 of tree cover was lost).

Our detailed examination of imagery on google earth confirmed that the majority of the land cover in areas of loss was small-scale agriculture along roads and near urban areas.

Between 2001 and 2018, 11.4% of global forest loss in PAs occurred in the US, where loss remained relatively stable over time (Figure 8). We examined forest loss trends in Nowitna National Wildlife Refuge (IUCN Category IV) in Alaska, which regularly experiences wildfires and associated forest loss. Between 2001 to 2015, we found that out of about 5700 km^2 of forest cover within this PA, more than 1200 km^2 of forest cover was lost. Our global analysis found that nearly all the forest loss in this PA was followed by shrubland and grassland (99.6%). High-resolution imagery suggests that forest loss in Nowitna does appear to be caused by wildfires, which leave burn scars and are followed by a mosaic vegetation dominated by shrubland and grassland categories (Figure 9).

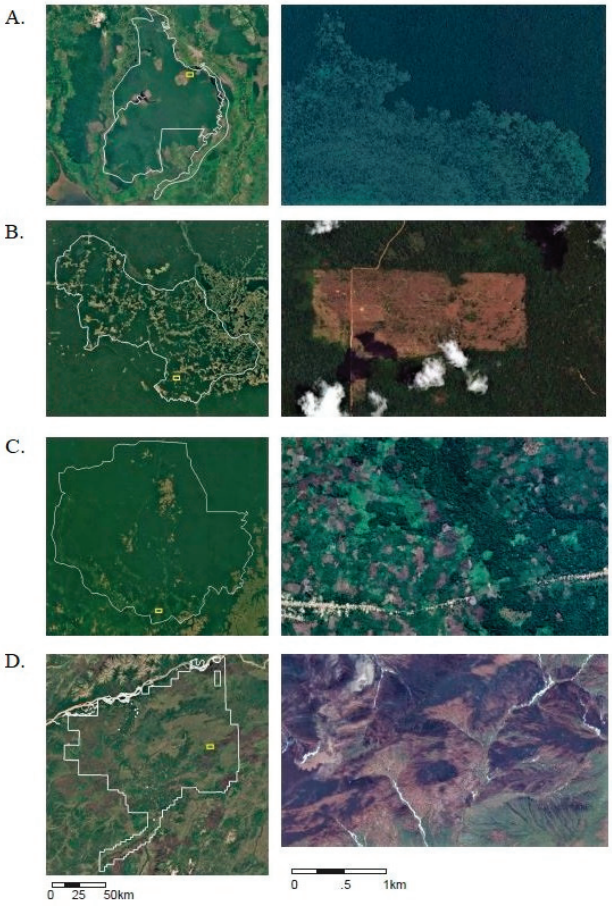

Figure 9. Selected PA imagery showcasing deforestation events across case studies: (**A**) Sebangau National Park in Indonesia, (**B**) Triunfo do Xingu Environmental PA in Brazil, (**C**) Sankuru Nature Reserve in Democratic Republic of Congo, and (**D**) Nowitna National Wildlife Refuge in the United States. Images were collected from Google Earth and represent the years 2018 or 2019. Zoomed out images on the left are from the United States Geological Survey (USGS) and the National Aeronautics and Space Administration's (NASA) Landsat program, while zoomed in images on the right are satellite imagery products from Digital Globe.

4. Discussion

Between 2001 and 2018, two trends took place simultaneously. The absolute area of protected tree cover increased due to countries designating additional land as PAs. Conversely, the annual rate of tree cover loss inside PAs nearly doubled during this time period. The highest loss in tree cover within PAs occurred in 2016, when 0.44% of protected forests experienced loss. Globally, it seems that forests in PAs face the same economic, natural, and social pressures as non-protected forests, as shown by the consistency in trends of forest loss between the two forests categories (Figure 2). This is despite PAs being in areas which should experience fewer human pressures of deforestation [9,11].

In the tropics, the extent of forest loss in PAs increased notably over the study period, and occurred largely in Indonesia, Brazil, and the Democratic Republic of Congo. Global land cover maps demonstrate that shrublands and grasslands were the dominant land cover following forest loss in PAs in the tropics. Our case study analysis demonstrated that this loss corresponds to areas impacted by fires, for example in Indonesian peat lands, and may also correspond to pasture land, for example in Brazil. In many countries in the tropics, agriculture was also a dominant land cover following forest loss, particularly in Sub-Saharan Africa.

In the northern hemisphere, the United States, Canada, and Russia contribute large total amounts of protected tree cover loss. Unlike in the tropics, forest loss in PAs in these countries did not increase noticeably over time. But similarly, shrublands were also the dominant land cover following forest loss over the study period. It is likely that most of this loss corresponds to natural occurrences such as fire, pests, or storm blowdown, which have been shown to be dominant drivers of deforestation in these regions outside of PAs [17]. Indeed, our US case study identified wildfire as a dominant driver of loss.

PAs that do not fit within IUCN categorization schema, which comprise roughly one-third of all PAs, have the highest rates of tree cover loss. These PAs include indigenous lands and UNESCO reserves. There is evidence that indigenous land tenure recognition is effective at preventing deforestation [27]. On the other hand, the majority of uncategorized PAs do not have any active management authority. It is possible that a lack of clear authority over these PAs may be one reason for higher rates of tree cover loss in these uncategorized PAs as a whole.

An important limitation of our assessment of land cover following forest loss in PAs is the reliance on a global mid-resolution land cover dataset. We used a global approach to allow for direct comparisons across regions, and to identify specific regions (within and across countries) where further investigation is needed. However, global land cover datasets do not necessarily address land use and may struggle, for example, to differentiate grazing and pasture lands from shrublands or grasslands [22]. This limits our ability to reliably track pasture expansion into PAs in some geographies where it is important, including in Brazil. Also, mosaic land cover classes such as shrubland/mosaic natural vegetation according to the global map could actually be agroforestry or mixed cropland/agroforestry. This limits our ability to track small-scale and mixed agriculture classes in geographies where those are dominant land cover transitions, such as Central Africa.

We used a case study approach to gauge availability and usefulness of the additional information available via high-resolution imagery from Google Earth to identify and track drivers of forest loss in PAs. This was not intended as a validation of the global approach, but rather an exploration of the potential utility of this emerging technology for more in-depth examination of drivers of forest loss in hotspots of deforestation or priority conservation areas. We found that the spatial and temporal resolution of the imagery available on Google Earth helped inform possible reasons for forest loss, including wildfire, small-scale agriculture, and pasturelands.

Finally, the ESA-CCI dataset represents land cover at 300 m resolution, so pixels with a small proportion of a given land cover category may not be represented, even if they are identified in the 30 m resolution tree cover loss dataset (also discussed in Reference [20]). This will impact our results in areas with highly heterogenous land cover, or small and isolated deforestation events such as targeted logging operations. Recent studies report that logging is the most common driver of loss in intact, but not necessarily protected, forests globally [28]. Logging is difficult to detect via satellite imagery

because in many cases, sufficient canopy cover remains following logging that land cover is still classified as forest. High-spatial resolution and frequent satellite imagery may be able to detect the most evident indications of logging, including access roads, skid trails, and tree fall gaps. However, research suggests that these may comprise as little as 20% of the total area impacted by logging activities [29]. Because we use a relatively coarse resolution land cover map, very small-scale or ephemeral forest disturbances—even isolated tree cover loss events in the GFC loss map—will be reported as followed by forest cover. Future research with higher resolution imagery could support investigation of the role of logging in PAs globally.

Despite limitations, by calculating tree cover loss at the PA level, we now have a comprehensive global dataset that can be used to compare outcomes across PAs, to identify the specific characteristics of PAs which limit the rate of tree cover loss over time, and to evaluate the impact of PAs on reducing tree cover loss. There is a growing literature aimed at measuring the impact of human pressure on PAs [3]. This dataset can complement future studies which aim to assess the impacts of socio- and macro-economic factors on ecosystem degradation within PAs. Also, as the land use sector is increasingly recognized for its important role in stabilizing future climate, this research can inform assumptions of land available for agriculture. Given that agriculture is occurring in PAs in some regions, despite their designation, researchers and modelers may not want to assume that all protected land will remain in a natural state to more accurately represent land cover dynamics globally.

5. Conclusions

Though PAs are a key strategy for safeguarding global biodiversity and ecosystem services, they remain under threat from a range of direct and indirect drivers of forest loss [2–4,6]. We found that between 2001 and 2018, global PAs lost 25.5 Mha of forest, or 4.1% of their forested area. This study aimed to improve our understanding of why this loss occurred by examining the land cover following forest loss in PAs. We found that shrubland was the dominant land cover following forest loss in PAs and became increasingly dominant over the study period. This may reflect the fact that the shrubland category encompasses a range of land cover types and land uses, including burned and regenerating forests, fallow lands, and possibly pasture lands, that have been shown to have extensive impacts in key deforestation hotpots globally [15–17]. Agriculture was not the most prominent land cover following forest loss events in PAs globally, but agriculture was shown to be prominent in key geographies—many in Sub-Saharan Africa, including Nigeria, Ghana, and Côte d'Ivoire (Supplementary Table S4). Our analysis improves our understanding of the causes of forest loss in PAs globally and at regional/national scales and can be used to broadly inform strategies to improve PA management and enforcement that are tailored to these agents of change.

Supplementary Materials: The following are available online at http://www.mdpi.com/1999-4907/11/5/539/s1: Table S1: IUCN Definition of Protected Area Classifications, Table S2: Reclassification schema to simplify the ESA-CCI land cover dataset, Table S3: Comparison of land cover following deforestation results from this study and previous studies [15,16]. Shown as percent of total deforested area. Figure S1: Location of case studies. Table S4: Total tree cover estimates (1000 ha), tree cover loss estimates from 2001–2018 (1000 ha), relative tree cover loss from 2001 to 2018 (%), tree cover loss followed by agricultural land type (industrial, mosaic, and total) from 2001 to 2014 (1000 ha), and proportion of total tree cover loss followed by agriculture (%) within PAs at the national level. Supplementary analysis on agricultural suitability and tree cover loss. Figure S2: Relationship between agricultural suitability and land cover class following deforestation event within all IUCN categories, and within more stringent IUCN categories (categories Ia, Ib, and II). Figure S3: Agricultural suitability map.

Author Contributions: Each author contributed substantially to the completion of this work. Conceptualization was performed by C.M.W., A.S., K.G.A., and D.G.; data curation, investigation and software development were performed by J.C., K.H.E., and R.M.; the formal analysis was completed by C.M.W. and J.C.; the methodology was developed by C.M.W., A.S., K.G.A., J.C., and D.L.; project administration at RTI was overseen by C.M.W. and D.L.; project administration at US EPA was overseen by D.G. and A.S.; supervision was completed by D.L., A.S., and D.G.; data validation was completed by C.M.W. and K.H.E.; visualization was completed by C.M.W., K.G.A., and J.C.; the original draft paper was written by C.M.W., K.G.A., and J.C.; the review and editing was completed by C.M.W., K.G.A., J.C., D.L., K.H.E., D.G., and A.S. All authors have read and agreed to the published version of the manuscript.

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References

1. UNEP-WCMC. *User Manuel for the World Database on Protected Areas and World Database on Other Effective Area-Based Conservation Measures: 1.5*; UNEP-WCMC: Cambridge, UK, 2018. Available online: http://wcmc.io/WDPA_Manual (accessed on 31 December 2019).
2. Lindsey, P.A.; Nyirenda, V.R.; Barnes, J.I.; Becker, M.S.; McRobb, R.; Tambling, C.J.; Taylor, W.A.; Watson, F.G.; t'Sas-Rolfes, M. Underperformance of African protected area networks and the case for new conservation models: insights from Zambia. *PLoS ONE* **2014**, *9*, e94109. [CrossRef]
3. Jones, K.R.; Venter, O.; Fuller, R.A.; Allan, J.R.; Maxwell, S.L.; Negret, P.J.; Watson, J.E. One-third of global protected land is under intense human pressure. *Science* **2018**, *360*, 788–791. [CrossRef]
4. Geldmann, J.; Joppa, L.N.; Burgess, N.D. Mapping change in human pressure globally on land and within protected areas. *Conserv. Biol.* **2014**, *28*, 1604–1616. [CrossRef]
5. UNEP-WCMC. *User Manual for the World Database on Protected Areas and World Database on Other Effective Area-Based Conservation Measures: 1.6.*; UNEP-WCMC: Cambridge, UK, 2019.
6. Heino, M.; Kummu, M.; Makkonen, M.; Mulligan, M.; Verburg, P.H.; Jalava, M.; Räsänen, T.A. Forest loss in protected areas and intact forest landscapes: A global analysis. *PLoS ONE* **2015**, *10*, e0138918. [CrossRef] [PubMed]
7. Pressey, R.; Whish, G.; Barrett, T.; Watts, M. Effectiveness of protected areas in north-eastern New South Wales: Recent trends in six measures. *Biol. Conserv.* **2002**, *106*, 57–69. [CrossRef]
8. Andam, K.S.; Ferraro, P.J.; Pfaff, A.; Sanchez-Azofeifa, G.A.; Robalino, J.A. Measuring the effectiveness of protected area networks in reducing deforestation. *Proc. Natl. Acad. Sci. USA* **2008**, *105*, 16089–16094. [CrossRef] [PubMed]
9. Joppa, L.N.; Pfaff, A. High and far: biases in the location of protected areas. *PLoS ONE* **2009**, *4*, e8273. [CrossRef]
10. Jones, K.W.; Lewis, D.J. Estimating the counterfactual impact of conservation programs on land cover outcomes: The role of matching and panel regression techniques. *PLoS ONE* **2015**, *10*, e0141380. [CrossRef]
11. Venter, O.; Magrach, A.; Outram, N.; Klein, C.J.; Possingham, H.P.; Di Marco, M.; Watson, J.E. Bias in protected-area location and its effects on long-term aspirations of biodiversity conventions. *Conserv. Biol.* **2018**, *32*, 127–134. [CrossRef]
12. Burivalova, Z.A.; Allnutt, F.T.; Rademacher, D.; Schlemm, A.; Wilcove, D.S.; Butler, R.A. What works in tropical forest conservation, and what does not: Effectiveness of four strategies in terms of environmental, social, and economic outcomes. *Conserv. Sci. Pract.* **2019**, *1*. [CrossRef]
13. Bebber, D.P.; Butt, N. Tropical protected areas reduced deforestation carbon emissions by one third from 2000–2012. *Sci. Rep.* **2017**, *7*, 14005. [CrossRef] [PubMed]
14. Brun, C.; Cook, A. R.; Lee, J.S.H.; Wich, S. A.; Koh, L. P.; Carrasco, L. R. Analysis of deforestation and protected area effectiveness in Indonesia: A comparison of Bayesian spatial models. *Glob. Environ. Chang.* **2015**, *31*, 285–295. [CrossRef]
15. Austin, K.G.; Schwantes, A.; Gu, Y.; Kasibhatla, P.S. What causes deforestation in Indonesia? *Environ. Res. Lett.* **2019**, *14*, 024007. [CrossRef]
16. De Sy, V.; Herold, M.; Achard, F.; Beuchle, R.; Clevers, J.; Lindquist, E.; Verchot, L. Land use patterns and related carbon losses following deforestation in South America. *Environ. Res. Lett.* **2015**, *10*, 124004.
17. Curtis, P.G.; Slay, C.M.; Harris, N.L.; Tyukavina, A.; Hansen, M.C. Classifying drivers of global forest loss. *Science* **2018**, *361*, 1108–1111. [CrossRef] [PubMed]
18. Hansen, M.C.; Potapov, P.V.; Moore, R.; Hancher, M.; Turubanova, S.; Tyukavina, A.; Thau, D.; Stehman, S.; Goetz, S.; Loveland, T.R. High-resolution global maps of 21st-century forest cover change. *Science* **2013**, *342*, 850–853. [CrossRef] [PubMed]
19. ESA. Land Cover CCI Product User Guide Version 2. *Technol. Rep.* **2017**. Available online: maps.elie.ucl.ac.be/CCI/viewer/download/ESACCI-LC-Ph2-PUGv2_2.0.pdf (accessed on 10 April 2017).

20. Pendrill, F.; Persson, U.M. Combining global land cover datasets to quantify agricultural expansion into forests in Latin America: Limitations and challenges. *PLoS ONE* **2017**, *12*, e0181202. [CrossRef]
21. ESA-CCI. Land Cover State Products in GTiff Format at 300-Meter Resolution. 2015. Available online: https://www.esa-landcover-cci.org/?q=webfm_send/112 (accessed on 14 September 2015).
22. Ali, I.; Cawkwell, F.; Dwyer, E.; Barrett, B.; Green, S. Satellite remote sensing of grasslands: from observation to management. *J. Plant Ecol.* **2016**, *9*, 649–671. [CrossRef]
23. Weisse, M.; Goldman, L.; Global Tree cover loss rose 51 percent in 2016. *World Resour. Inst.* **2017**. Available online: http://www.wri.org/blog/2017/10/global-tree-cover-loss-rose-51-percent-2016 (accessed on 30 September 2019).
24. Gaworecki, M. Pasture expansion driving deforestation in Brazilian protected area. *Mongabay Ser.* **2018**. Available online: https://news.mongabay.com/2018/10/pasture-expansion-driving-deforestation-in-brazilian-protected-area/ (accessed on 30 September 2019).
25. Ogle, S.M.; McCarl, B.A.; Baker, J.; Del Grosso, S.J.; Adler, P.R.; Paustian, K.; Parton, W.J. Managing the nitrogen cycle to reduce greenhouse gas emissions from crop production and biofuel expansion. *Mitig. Adapt. Strategy Glob. Chang.* **2016**, *21*, 1197–1212. [CrossRef]
26. Volckhausen, T. Bonobo conservation stymied by deforestation, human rights abuses. *Mongabay* **2019**. Available online: https://news.mongabay.com/2019/10/bonobo-conservation-stymied-by-deforestation-human-rights-abuses/ (accessed on 30 October 2019).
27. Busch, J.; Ferretti-Gallon, K. What Drives Deforestation and What Stops It? A Meta-Analysis. *Rev. Environ. Econ. Policy* **2017**, *11*, 3–23. [CrossRef]
28. Scullion, J.J.; Vogt, K.A.; Drahota, B.; Winkler-Schor, S.; Lyons, M. Conserving the Last Great Forests. A Meta-Analysis Review of the Drivers of Intact Forest Loss and the Policies and Strategies to Save Them. *Front. For. Glob. Chang.* **2019**, *2*, 62. [CrossRef]
29. Pearson, T.R.; Bernal, B.; Hagen, S.C.; Walker, S.M.; Melendy, L.K.; Delgado, G. Remote assessment of extracted volumes and greenhouse gases from tropical timber harvest. *Environ. Res. Lett.* **2018**, *13*, 065010. [CrossRef]

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The Impact of COVID-19 on the Management of European Protected Areas and Policy Implications

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Abstract: The COVID-19 pandemic led to many European countries imposing lockdown measures and limiting people's movement during spring 2020. During the summer 2020, these strict lockdown measures were gradually lifted while in autumn 2020, local restrictions started to be re-introduced as a second wave emerged. After initial restrictions on visitors accessing many Nature Protected Areas (PAs) in Europe, management authorities have had to introduce measures so that all users can safely visit these protected landscapes. In this paper, we examine the challenges that emerged due to COVID-19 for PAs and their deeper causes. By considering the impact on and response of 14 popular European National and Nature Parks, we propose tentative longer-term solutions going beyond the current short-term measures that have been implemented. The most important challenges identified in our study were overcrowding, a new profile of visitors, problematic behavior, and conflicts between different user groups. A number of new measures have been introduced to tackle these challenges including information campaigns, traffic management, and establishing one-way systems on trail paths. However, measures to safeguard public health are often in conflict with other PA management measures aiming to minimize disturbance of wildlife and ecosystems. We highlight three areas in which management of PAs can learn from the experience of this pandemic: managing visitor numbers in order to avoid overcrowding through careful spatial planning, introducing educational campaigns, particularly targeting a new profile of visitors, and promoting sustainable tourism models, which do not rely on large visitor numbers.

Keywords: biodiversity conservation; conflict; national parks; management; pandemic; public health; wellbeing

1. Introduction

Nature Protected Areas (PAs) are important because of their high biodiversity value and the socio-economic benefits they provide for people [1]. In addition to their crucial role in biodiversity conservation, most PAs in Europe are recognized as multifunctional landscapes providing multiple benefits and ecosystem services. These may range from provisioning services, for example in working farmed landscapes, to regulating services, from water and air quality regulation to carbon storage, but also a very wide range of cultural ecosystem service benefits [2] ranging from psychological restoration [3–5] and improved physiological health [6–8] to better social relations [9–12], and spiritual development [13,14]. Whilst, to a certain extent, many of these benefits may be available to people from a local urban and peri-urban green space, countries designate a suite of high-quality nature protected areas that are of exceptional quality for biodiversity conservation, and provision of the above provides a wide range of benefits to people, and high profile sites such as National Parks are typically extremely popular with visitors. These protected landscapes, therefore, have a crucial role in improving physical and mental health [15], assisting in the improvement of people's wellbeing [16,17], and protecting local social and cultural values [18].

Europe is the region with the largest number of PAs internationally [19]. European PAs are of various sizes with overlapping designations such as the Ramsar Convention, the NATURA 2000 network, the Emerald network, and nationally designated parks [20]. PAs are a significant source of income for local communities living inside or near their boundaries. This is in part due to the high number of visitors they attract [21]. In Europe, Schägner et al. [22] estimated that 449 national parks attract over 2 billion visitors with a total value of €14.5 billion annually. These estimates represent only a fraction of the actual value of tourism in European Protected Areas considering that Europe has over 100,000 Protected Areas [23].

The COVID-19 pandemic led many European countries to impose lockdown measures to limit people's movement [24]. These measures were aimed at reducing the spread of the virus but also decreased significantly the number of people visiting outdoor spaces [25], including PAs,

particularly those located in more remote areas, as is often the case for many larger PAs. In European countries, where strict lockdown restrictions were imposed, a reduction in visitor numbers was initially observed (e.g., [26,27]). Likewise, the number of visitors increased rapidly as soon as these restrictions were eased [27–29].

These changes in visitor numbers are expected to have posed significant management issues for PAs in Europe. As we write this paper (October 2020), lockdown measures that had been lifted during the past summer are gradually being re-introduced in several European countries. Central and regional government authorities are looking into ways of containing the virus' transmission, focusing significantly on measures that are enforced locally. During the lockdown, most people only had access to green spaces near where they lived and access to more remote sites was limited to those living nearby. In the case of popular and high-profile PAs, such as national and regional parks, coming out of strict lockdown in late spring and summer 2020 resulted in a steep increase in visitor numbers. Therefore, the management authorities in these areas needed to introduce new measures to enable all users to visit them safely. However, a key issue for popular nature Protected Areas is that the requirements of nature conservation and public health safety may, at times, be difficult to balance.

In normal times, PA staff manage to channel visitors in a way that minimizes disturbance of more sensitive species, such as ground-nesting birds in the nesting season, or fragile ecosystems, such as high altitude montane habitats. This normally means encouraging visitors to spend most of their time in less sensitive locations, often leading to the creation of busier 'honeypot sites', where crowds may occur. However, social distancing regulations that have been implemented in response to COVID-19 involve avoiding crowded locations, so visitors spread out more evenly across the PA, thus increasing the likelihood of human disturbance of species and habitats. In addition to the challenges presented solely by the increase in visitor numbers, visitor behavior can also conflict with landscape and nature conservation.

In this paper, we present an early analysis of how COVID-19 has impacted European PAs so far. We focus on two key issues: (a) the challenges that COVID-19 presented to the management of PAs in Europe, especially on the ability of PAs to perform their functions of conserving nature and providing nature-based benefits to visitors, and (b) review indicative measures that have been implemented across different parks in the region to tackle these challenges. In the discussion section we analyze the problems and their deeper causes, consider what lessons can be learned from the COVID-19 pandemic, and propose tentative longer-term solutions going beyond the current short-term measures.

2. Materials and Methods

In order to capture the key challenges faced by PAs due to COVID-19 and the measures applied to address them, we followed a two-stage approach: we initially surveyed the existing limited academic and grey literature and websites of park authorities to identify measures that had been introduced by park authorities across Europe during the first months of the pandemic. We then organized two workshops with key informants from the management bodies of a selected sample of European nature PAs.

Our study sample was selected based on three broad criteria: (a) high profile sites were targeted which are popular with visitors (including sites which have been awarded the EUROPARC Federation Charter of Sustainable Tourism) as they were more likely to prove very popular after the lockdown was eased and so particularly challenging to manage regarding the trade-off between visitor management and nature conservation; (b) geographical spread across a diverse range of European countries from West to East, North to South; (c) varying national regulations on COVID-19.

For the selection of the final participant PAs (Table 1), we decided to narrow down our research to eight countries which reflected a range of government responses to the pandemic from strict lockdown to softer measures (criterion c). The eight countries were the UK, Spain, Italy, Estonia, Germany, Poland, Slovenia, and Sweden. During the first months of the pandemic, the UK, Spain, and Italy were three of the most badly affected countries in Europe by the virus and strict lockdown restrictions were imposed restricting significantly people's movement [30–32]. Germany also had a large number of cases but the death rate was lower compared to other countries and restrictions were less severe compared to the UK, Spain, and Italy [33,34]. Estonia, Poland, and Slovenia had a lower fatality rate [35] and restrictions on movement were also imposed [36–39] but were eased earlier compared to other countries. Finally, Sweden was the only country in our study which did not impose strict lockdown restrictions compared to the rest of the European countries. Although no strict measures were imposed in Sweden, it is considered that a large majority of people followed social distancing recommendations while the most vulnerable self-isolated voluntarily [40].

After determining the sample of eight countries, a call was announced inviting park authorities to participate in workshops focusing on the impacts of COVID-19. Two workshops were organized (co-hosted with the EUROPARC Federation) three months apart (1 July and 6 October 2020) with invited representatives of the management of 14 selected sites in order to explore with them the challenges that parks face due to the pandemic. All sites were included in the study, as they are all popular visitor destinations, they spread across multiple European countries, and they face new challenges due to COVID-19. The 14 sites also represent two different types of designations according to the IUCN categories (II and V). (IUCN Categories are described in detail on the IUCN website: https://www.iucn.org/theme/protected-areas/about/protected-area-categories). Details of the participating parks are given in Table 1 below. Fourteen attendees participated in the first workshop representing 13 parks and 16 attendees in the second workshop also representing 13 parks.

The first workshop took place during the first COVID-19 peak when a potential 6-month pandemic was considered likely. At the time of the second workshop, the second peak had begun and it appeared that a 12-month crisis or longer was probable.

Table 1. Nature Protected Areas (PAs) participating in the workshops.

Name	Country & Region	IUCN Protection Level
Matsalu National Park	Estonia	II
Eifel National Park	Germany (Nord-Rhein Westphalen)	II
Black Forest (Schwarzwald) National Park	Germany (Baden-Württemberg)	II
Prealpi Giulie Natural Park	Italy (Friuli Venezia Giulia)	V
Tatra National Park *	Poland (Carpathians)	II
Triglav National Park	Slovenia (Upper Carniola)	II & V
Sierra Espuña Regional Park	Spain (Murcia)	V
Sierra Nevada National Park	Spain (Andalusia)	II
Las Batuecas-Sierra de Francia Natural Park **	Spain (Castilla y León)	V
Garajonay National Park	Spain (Canary Islands)	II
Kullaberg Nature Reserve	Sweden (Skåne Province)	V
Söderåsen National Park	Sweden (Skåne Province)	II
Peak District National Park	UK (England)	V
Snowdonia National Park *	UK (Wales)	V

* attended first workshop only, ** attended second workshop only.

The first workshop focused on the main positive and negative impacts of the PAs on their local communities prior to the COVID-19 pandemic, and on the main challenges that COVID-19 had presented to them, with a particular focus on changes in visitor numbers and the impact on local people. Participants were then asked about the measures they had implemented to cope with the impact of COVID-19 on the PA and local people, and about their plans to reduce or manage the negative impacts in the future. The second workshop then focused more on the tensions and conflicts between stakeholder groups created by the PA and the COVID-19 pandemic. Participants were asked whether

COVID-19 had caused new or increased existing tensions and conflicts in their PA (e.g., between local people, between visitors, or between visitors and local people). Finally, it covered any research done by the PA management in the past that could explain why tensions or conflicts had emerged (for example, a social impact assessment).

Both workshops were recorded and facilitated by experienced colleagues who took notes during the workshop. Online polls were also conducted during the workshops to obtain quantitative data using the Zoom video-conferencing platform, and further qualitative comments were collected regarding the above discussion topics using Mentimeter.

The notes and the recordings were then analyzed by researchers experienced in qualitative data analysis to identify key emergent themes focusing on two main broad topic areas: (a) the challenges in the management of the PAs due to the pandemic and (b) actions to overcome these challenges. The findings of both qualitative and quantitative data analysis are presented below in Section 3.

3. Results

3.1. Challenges Due to COVID-19 in European Nature Parks

A range of challenges caused by COVID-19 was identified by participants (Table 2). In all 14 parks, an increase in visitors was observed especially during the summer compared to the same period the previous year. An increase in weekday visitors was also noted in certain parks. The increase in visitors led to overcrowding incidents and park authorities had to introduce very quickly new social distancing measures and recommendations that would ensure that all users were able to safely enjoy the area. In countries with strict lockdown restrictions (UK, Italy, Spain), the initial low visitation numbers (due to strict travel regulations) were followed by a significant increase in visitors during the summer. In the case of Swedish sites, an increase in visitors was noticed at the beginning of the pandemic (as no restrictions on movement were imposed), which continued throughout the summer months. Similarly, at the German sites, where the movement of people within specific regions was not significantly restricted, a gradual increase in visitors was observed from the beginning of the health emergency in the country. It should be noted that some participant parks experienced an almost 100% increase in visitors on certain days relative to expectations for that time of year. A possible explanation for this increase suggested by the participants was that people felt safer in outdoor and more remote locations, such as the ones protected by National Parks and nature reserves across Europe, compared to indoor and urban spaces. Furthermore, in some countries, the weather was relatively mild in spring 2020 (UK, Germany, and Sweden), which may also have resulted in a significant increase in visitors where people's movement was allowed.

A second important challenge was that the increase in visitors was often combined with incidents of problematic behavior, which is defined here as behavior that conflicts with either the conservation aims of the PA or the widely accepted social norms of behavior within the local communities around the PA. Although irresponsible behavior does occur in PAs, our analysis revealed that such issues became more frequent during the first months of the pandemic.

During the second workshop, park authorities were asked to specify which behaviors had become more frequent at their sites during the pandemic period (Figure 1). Parking and road congestion was the most frequently mentioned issues, which was partly due to the greatly increased number of tourists visiting the parks and a tendency to drive rather than commute by public transport or join organized groups with coaches to reach the parks. Illegal parking became a common problem in several PAs, with rangers having to routinely monitor for illegal behavior. A second important problem mentioned by respondents was linked to waste management issues, such as littering. Workshop participants noted that the observed increase in problematic behavior may be linked to a different profile of people visiting the areas due to COVID-19, who were unaware of the main regulations that are in place and of widely accepted norms of behavior in conservation areas. This was noted across most sites irrespective of the geographical region. Finally, the mountainous parks in the sample expressed concern over

increased visits from inexperienced hikers in the winter and the anticipated increased demand for first-aid provisions and search and rescue missions. This is expected both due to a decrease in or ban on guided tours due to social distancing regulations and due to more visitors attempting mountain hiking as an alternative to traveling abroad or elsewhere domestically.

Table 2. Challenges in managing European PAs due to COVID-19.

Challenge	Key Issue
Overcrowding	A significant increase in (mainly domestic) visitors was reported especially as soon as people were allowed to travel further from their home
Problematic behavior by PA users	An increase in problematic behavior when using the PA was observed. This referred to a range of issues including waste management and disturbance e.g., littering and dog/human waste, noise nuisance, illegal/unauthorized activities e.g., camping
Parking and traffic issues	Incidents of irresponsible parking were reported including parking in non-designated areas and parking in a way that disturbed people and nature. Traffic was increased as people accessed parks with their own car avoiding public transport and organized groups
Social distancing	Changes were needed in how certain activities were being run, such as guided tours and visitor centers, to ensure social distancing
Conflicts	Conflicts between local people, and between visitors and locals emerged because of overcrowding and the fear of virus transmission, and over behavioral issues
Cancellation of educational and cultural activities	Several activities which are organized regularly in the parks, such as guided tours and festivals, had to be canceled or limited to a very low number of participants

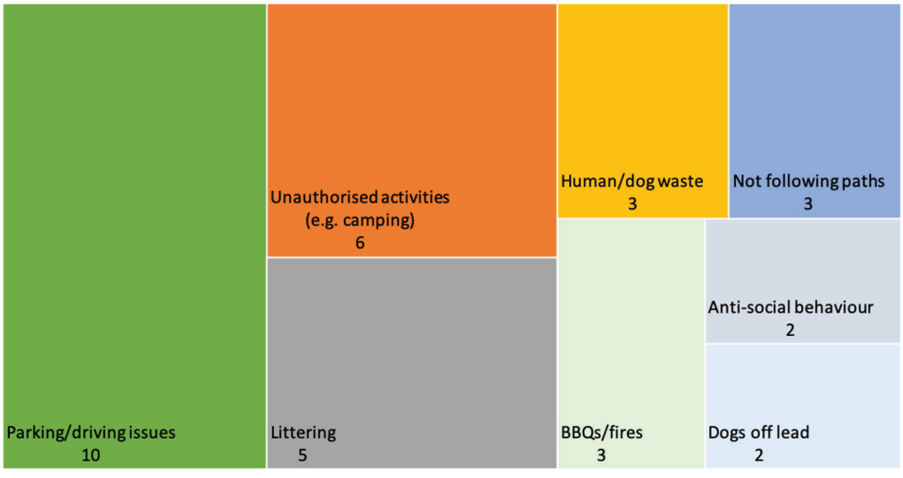

Figure 1. Frequency of problematic behavior during the first seven months of the pandemic mentioned by park authorities in the workshops.

Overcrowding incidents and irresponsible behavior also led to conflicts between local residents, and between locals and visitors at several sites. Conflicts between residents tended to arise in cases where behavior, which otherwise would be considered unremarkable or unproblematic, was perceived to contravene emergency restrictions and social distancing recommendations, or where attempts to modify behavior to conform to the new situation led to new conflicts and tension that did not normally arise. Examples of this included local people going for a walk or cycling in their local area and either being criticized for this or not being recognized as local.

Conflicts between visitors and locals arose over either local norms of behavior between locals and visitors, such as inconsiderate parking or littering or in some areas, because visitors were considered 'transmitters' of the virus and locals would prefer the government to have restricted access to the park until they felt safe. Incidents of vandalism and placement of signs on the road stating that visitors were not welcome were also reported.

Another important issue that was mentioned by several parks was the cancellation of or changes to educational and cultural activities, such as school visits, guided tours, and festivals. Although demand for such activities was high during the summer, due to new social distancing rules, several park authorities decided to limit the number of people participating in these activities or cancel them entirely to limit virus transmission. Apart from the wider social and economic impact of having reduced environmental education and cultural activities at the different sites, a related issue was people choosing to go on their own in the park instead of with a guided tour. This also led to a higher number of cars trying to access the PAs (instead of groups using coaches or public transportation).

Collectively, the coincidence of large increases in visitor numbers, attempts to social distance and avoid crowds, lack of availability of organized tours, as well as new types of visitors less aware of the susceptibility to disturbance of many natural systems, all contributed to increasing the risk and extent of disturbance in remoter more sensitive areas of PAs, as well as more general threats to the tranquility, quality, and integrity of the protected landscapes.

3.2. COVID-19 Measures in Order to Overcome the New Challenges

Different measures were introduced in the parks in order to address the new challenges (Table 3). To address overcrowding, several PAs proceeded with measures limiting access for visitors with different levels of restrictions depending on the virus transmission rates. These measures were often guided by the restrictions imposed at a higher level of administration, either by a regional or central government. In Sweden for example, no restrictions were imposed as the national guidelines did not limit people's movement. On the contrary, at the UK sites, these measures tended to be stricter compared to Sweden (e.g., complete closure of facilities and parking areas) but as lockdown measures were eased, a larger number of visitors were able to access these protected landscapes.

As visitor numbers increased, a key task for all park authorities was to introduce new measures in order to ensure social distancing. A variety of tools were introduced including a one-way system on popular and narrow paths; restricting the number of participants on guided tours; restricting the number of people allowed within facilities (e.g., restaurants, visitor centers, restrooms), and counting the number of visitors entering the area. New measures to maintain good hygiene and limit the spread of the virus were also introduced in PAs. These included enhanced cleaning and waste disposal measures, such as placing hand sanitizers in key locations, cleaning toilet facilities and frequently touched surfaces regularly, and banning cash payments (allowing only contactless payments). Protection of staff was also a key priority with the provision of PPE equipment and installing plexiglass barriers in customer-facing facilities such as restaurants and visitors' centers. A mobile application was also used at one site, which assisted in people having an overview of how many users were on a trail at the same time and reminded them of the current recommendations due to COVID-19.

Table 3. Measures to tackle new challenges due to COVID-19.

Challenge	Measures
Overcrowding	Closure of major facilities, closure of parking areas, cease advertising/promoting the PA to visitors, temporary closure of specific honeypot sites, online updates on car park capacity and overcrowding incidents, replace guided tours and school visits with online educational programs
Irresponsible users	Information campaigns including signs on local notice boards, key entrance points, information on websites, and social media (e.g., Twitter and Facebook). Use of social media to promote appropriate pro-environmental behavior in the PA. Increased number of rangers or increased presence of local police. Fix damaged or vanadalized signage as soon as possible.
Parking and traffic issues	Information campaigns letting people know when a car park is full and also about responsible parking. Increased number of rangers. Introduce new regulations. Towing vehicles away
Conflicts	Information campaigns including signs, information on websites and social media (e.g., Twitter and Facebook). Increased number of rangers.
Social distancing	Banning social gatherings, restricted number of people on guided tours, restrictions on the number of people within facilities (e.g., restaurants, visitor centers, restrooms), establishing one-way system on popular paths, rigorous and enhanced cleaning regimes and waste collection e.g., at visitor centers, placing hand sanitizers in key locations, regular cleaning of toilet facilities, and banning of cash payment (allowing only contactless payments). Protection of staff was also a key priority with the provision of PPE equipment and installing plexiglass in key facilities such as restaurants and visitor centers.
Cancellation of educational and cultural activities	Online learning, a limit on the number of people who are able to attend guided tours

Regarding the increase in problematic behavior at some sites, which was partly attributed to the different profiles of new users, most park authorities recognized that it was necessary to inform and educate people on permissible activity within the PA and on responsible behavior. Several information campaigns were initiated by the park authorities. These included leaflets informing people of key regulations at key entrance points and also clear signage promoting the dispersal of visitors from the main car parks. Information about regulations was also widely promoted via the websites of the PA authorities and also via social media such as Facebook and Twitter.

The number of rangers patrolling the PAs was also increased in several parks whilst one PA noted that rangers preferred to patrol in pairs as they anticipated more hostile responses from visitors, who were asked to comply with social distancing regulations. Another PA liaised with the local police to enhance their presence in the PA area. Similar measures were introduced to tackle illegal parking, insufficient car parking capacity, and traffic incidents. Several park authorities also informed people of parking and traffic issues via social media. In one park, the parking fee was increased in order to discourage visitors while in other parks, the possibility of introducing a parking fee charge is currently being considered in order to reduce obstructive and illegal parking and manage traffic.

Another key challenge that emerged from our analysis refers to conflicts between in- and out-of-area users in certain PAs. This was mainly because several lockdown restrictions had a geographical component to them with people only allowed to travel up to a certain distance (such as a 5 mile (8 km) limit in Wales, UK) or allowed to travel only within specific regions (Germany and Spain). Although no measures were recorded to tackle this specific challenge, the combined measures mentioned above aimed to reduce conflicts as management authorities tried to reduce issues of overcrowding and problematic behavior, which tended to cause local communities to complain. Regarding the broader social conflicts among residents of the different PAs or the economic impacts of discouraging visitors, no measures were noted at the local level, as such, issues would normally be beyond the remit of park authorities, falling rather to state entities such as the police or government.

As far as the reduction of educational activities is concerned, this is regarded as one of the most important challenges for park authorities. One park mentioned that they have reverted to online learning instead of face-to-face educational activities, while in most parks, some activities have resumed but with a reduced number of participants.

Finally, at this stage of the pandemic, it should be noted that PA management authorities were largely focused on coping with the short-term impacts of the pandemic, with few comments made on its long-term implications and its impacts on the management of the PAs, which are still largely unclear.

4. Discussion

Although strict restrictions for COVID-19 were eased during summer 2020 across Europe it is clear that the pandemic is not over at the time of writing this paper. On the contrary, in September 2020, Europe entered a second wave of the pandemic and indeed such pandemics might become more frequent in the future [41]. Thus, similar to other parts of the world, it is important to reflect on what has happened in these first months of the pandemic and propose ways that will facilitate the long-term management of such PAs in times of public health crises and associated restrictions and uncertainty [42]. There are two broad categories of management challenges: visitor number management and visitor behavior management.

COVID-19 so far has had significant impacts on the management of PAs across the world. In the United States, an increase in visitors was observed in outdoor spaces creating a number of challenges similar to the ones identified in this paper for Europe [42]. Conversely, in other parts of the world, different concerns have been raised with African PAs seeing a significant reduction of tourism in wildlife reserves [43] leading to reduced financial resources for park authorities and raising concerns about illegal practices.

The increase in visitor numbers to European PAs during the pandemic comes as awareness of PAs has been increasing over time [44] and people are increasingly visiting areas of natural beauty in order to improve their wellbeing [16,17,45]. PAs benefit physical and mental health [45–47] by providing people with the opportunity to come closer to nature [48–51]. In addition, a significant increase in users of outdoor spaces [52] has also been documented during the pandemic that appears to be motivated by people trying to find relatively remote places where they felt safe from the virus.

Indeed, Nature Parks are promoted as a national and regional asset, and so it is not therefore irrational or unreasonable for people to choose to visit such locations when advised to avoid crowded and indoor spaces by the Government. Additionally, travel restrictions have reduced alternative options for people to travel to, such as urban areas or destinations abroad. However, the potential conflict between the rights of visitors to access a national asset versus the right of local residents to be safe in their local area during a pandemic adds an additional dimension to existing tensions between visitors and local residents over access to and competition for local resources.

As noted, this increase in visitors has led to the emergence of new conflicts or exacerbation of existing tensions due to overcrowding incidents and problematic behavior by visitors in several European PAs. Park authorities across Europe had to react quickly to these challenges and introduced several measures. These tools aimed to manage the number of visitors in PAs whilst also accommodating new social distancing measures. Our review revealed that the severity and extent of these measures varied across locations but overall a significant effort has been invested by management authorities to face the challenges brought by the pandemic.

Regarding conflicts, the designation of PAs in Europe has often resulted in conflicts of interest between diverse users and local residents [53,54], especially as competition for space has intensified [55] due to increased tourism [56,57]. Thus, democratizing access to PAs and minimizing disturbance to natural systems was a major challenge for European PAs before the pandemic. Overcrowding in PAs [58–60] often resulted in increased noise levels and disturbance of tranquility [61] causing disruptions in the life of local communities and distortion of human ties [55,62] as well as disturbing wildlife and ecosystems. As a result, the pandemic intensified tensions between locals and visitors in

many cases. People living inside or in close proximity to PAs felt under threat from growing crowds of tourists both because of the potential transmission of the virus [44] but also because of overcrowding incidents interrupting how people enjoy nature.

In the past, this has meant focusing people's attention on honeypot sites with high visitor capacity and low sensitivity to disturbance and creating buffer zones around PAs. COVID-19 and the need for social distancing make this solution problematic under the current circumstances. Indeed, well-established measures to minimize disturbance to wildlife by clustering visitors in parks, and social distancing measures to keep people apart, appear to be in conflict and need to be balanced against each other to establish a satisfactory equilibrium between nature protection and public health protection. The pandemic has in effect reduced safe limits in terms of visitor densities at popular sites thereby increasing pressure in less busy locations, but with other risks such as increased disturbance of wildlife and ecosystems, degradation of the quality of natural spaces for other visitors and local residents, and possibly also greater public safety risks, as people visit less closely managed locations where accident risks are greater.

This brings us to our first policy recommendation for the long-term management of European PAs. Future solutions will require careful spatial planning which also takes into consideration issues of social equity in accessing PAs [45]. Incidents of overcrowding can be controlled by the careful distribution of visitors within a PA (both temporal and spatial). This solution would minimize the need to reduce the number of visitors (thus having also a minimum impact on the local economy). We should note, however, that this approach may be difficult to apply in certain areas where a significant part of the land is privately owned and so access rights are limited. Furthermore, some areas of habitat, ecosystems, and wildlife are more sensitive to human disturbance than others (such as areas of ground-nesting birds). Issues of public safety, protecting disturbance-sensitive environments, and land access rights, therefore need to be balanced.

Many management authorities are heavily constrained and have limited space to distribute visitors within the territory. As well as local management strategies, this problem can be alleviated in the future by increasing provision through the designation of additional PAs which are established on land which is publicly accessible. Such a solution would be in accordance with the new EU Biodiversity Strategy, where it has been announced that 30% of land and 30% of waterways will be protected by 2030 [19].

Another important issue we highlight in our study is that the increased number of visitors was also accompanied in certain cases by an increase in contentious or problematic behavior by PA users. Our study revealed that this is probably at least in part linked to a new profile of visitors coming to these areas during the pandemic. A possible explanation is that people coming from more urban areas having a limited sense of nature connectedness and may not necessarily have developed norms of environmental behavior and are unaware of the recommendations for responsible use of the park. Consequently, a new approach may be needed, targeting new groups visiting parks around Europe, while also managing conflicts between different users. Cultural sensitization and education of new visitors are necessary, possibly supported by enforcement of regulations. Although changing behavior is an extremely challenging task, it could be an opportunity to identify which tools are the most efficient in terms of altering people's behavior, when they come to visit a PA. Indeed, the arrival of a new profile of visitors could provide a window of opportunity for PA management to reach new audiences. Whilst some new visitors may only value PAs temporarily for the access to outdoor space they provide during the pandemic and then return to their former practices, a proportion of them may well be open to new experiences in natural spaces and be open to developing a greater sense of connection to nature.

As documented in our study, park authorities have invested significant time in introducing measures to manage overcrowding and visitor behavior during the COVID-19 pandemic. However, a lot of these authorities have limited powers to enforce certain measures, such as fines for illegal parking. Also, in many cases, government guidelines on COVID-19 may overrule regulations introduced by management authorities of PAs. Therefore, a second recommendation is that closer collaboration is needed between park authorities and more centralized institutions in order to propose measures, which ensure that PAs continue to benefit the wellbeing of local communities and visitors.

Tackling overcrowding and resolving conflicts in PAs necessitates also finding a balance between local economic development and the wellbeing of locals. Recreational activities within PAs are a major source of income for locals [63]. Sustainable tourism has been at the core of management plans for many PAs in Europe [64] allowing local communities to maintain an income [65,66], which often compensates for economic losses due to the PA designation. However, several PAs currently function at a maximum visitor capacity during peak periods. Reducing visitor demand to manage COVID-19 outbreaks would also imply a reduction in income for local communities, especially for those working in the hospitality and recreation sectors and, therefore, may necessitate the development of lower-impact and higher quality tourism experiences for visitors, combined with a more holistic rural development policy to reduce reliance solely on tourism.

Our third policy recommendation is, therefore, that local economies in PAs cannot rely on models with a maximum visitor capacity in order to be sustainable and must avoid scenarios of 'over-tourism'. The number of visitors needs to be managed to a level where economic benefits continue to flow but the well-being of locals is safeguarded while visitors' experience remains satisfactory. There are various tools to conduct carrying capacity studies and model alternative scenarios of visitor numbers. Furthermore, overcrowding can be an issue both for locals and visitors and thus studies should be exploring the views of these different users when determining capacity levels [58–60]. A wide application of such assessments in PAs, taking also into consideration social distancing measures, would allow management authorities to specify the optimum number of visitors in a PA but also the distribution of these visitors within the PA [67].

The challenges presented by the pandemic will persist possibly for several years as there are multiple impacts of this pandemic that will be experienced in the future, and indeed future pandemics remain a possibility. Consequently, it is important that park authorities carefully consider these challenges in order to manage PAs in a sustainable and resilient way. As noted, at this stage in the pandemic, PA management authorities were largely focused on coping with the short-term impacts of the pandemic, with few comments made about the longer-term implications of the pandemic and its impacts on the management of the PAs, which still are largely unclear. These long-term impacts will depend on a wide range of factors such as the medium to long-term impact on the economy and the future actions of governance actors.

5. Conclusions

This study has explored the impacts and challenges that the COVID-19 pandemic presented to a range of European nature PAs and their local communities, and the measures they implemented to mitigate those impacts and associated conflicts. We have also considered the lessons that might be learned from the pandemic experience to inform longer-term PA management, particularly where the pandemic exacerbated existing tensions, such as between local people and visitors.

The pandemic crisis has made the job of PA management more complex and shifted the balance of priorities in trying to achieve a balance between on the one hand nature and landscape conservation, and on the other maintaining accessibility for the visiting public. Indeed the large influxes of visitors during the periods when lockdown regulations were more relaxed demonstrates the importance of such landscapes to people and their well-being, all the more so during this period of the health crisis. Focusing people's attention on outdoor recreation and its many benefits makes logical sense whilst social distancing measures are needed but presents challenges to PA managers in managing disturbance. In consequence, PA management bodies and local communities will need support during such crises where their income becomes more variable and unpredictable, social relations become strained, and nature conservation more difficult to manage.

Overcrowding incidents and an increase in problematic behavior and use of the PAs by visitors were the most significant challenges and also led to an increase in conflicts between locals and visitors. As a response to these challenges, park authorities were quick to respond and find ways to tackle them. Through the use of social media, education campaigns, and a number of other tools, they have tried to

keep the PAs open while keeping visitors and locals safe, assisting also in the recovery of the local economy. However, as European communities are now experiencing a second wave of the pandemic, it is important that longer-term solutions are introduced by management authorities. In consequence, careful management of the spatial distribution of visitors in PAs might be necessary for the future along with educational campaigns targeting groups with a new profile of visitors which has emerged during the pandemic. Thus, although COVID-19 has introduced many challenges for PAs in Europe, it can also be seen as an opportunity to promote new and more sustainable ways to manage protected landscapes.

The pandemic has proved longer-lasting than anticipated, and enhanced global mobility may mean that such a health crisis may become more frequent in the future and so lessons from this pandemic may be worth learning for the longer term, even if the situation normalizes somewhat as the pandemic subsides. Indeed some of the conflicts such as between locals and visitors were pre-existing and exacerbated by the crisis, and the impacts of greater visitor numbers and new types of visitors may constitute a warning at a time when the popularity of nature Protected Areas is increasing and governments actively seek to encourage people to visit them. The advent of new types of visitors to the PAs studied, whilst presenting problems, also presents an opportunity to engage new audiences and foster a sense of connectedness to nature among a broader spectrum of the public.

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References

1. Millennium Ecosystem Assessment (MEA). *Ecosystems and Human Well-Being: Synthesis*; Island Press: Washington, DC, USA, 2005; p. 160.
2. McGinlay, J.; Parsons, D.J.; Morris, J.; Graves, A.; Hubatova, M.; Bradbury, R.B.; Bullock, J.M. Leisure activities and social factors influence the generation of cultural ecosystem service benefits. *Ecosyst. Serv.* **2018**, *31*, 468–480. [CrossRef]
3. Kaplan, S. The restorative benefits of nature: Toward an integrative framework. *J. Environ. Psychol.* **1995**, *15*, 169–182. [CrossRef]
4. Hartig, T.; Evans, G.W.; Jamner, L.D.; Davis, D.S.; Gärling, T. Tracking restoration in natural and urban field settings. *J. Environ. Psychol.* **2003**, *23*, 109–123. [CrossRef]
5. White, M.P.; Pahl, S.; Ashbullby, K.J.; Herbert, S.; Depledge, M.H. Feelings of restoration from recent nature visits. *J. Environ. Psychol.* **2013**, *35*, 40–51. [CrossRef]
6. English, J.; Wilson, K.; Keller-Olaman, S. Health, healing and recovery: Therapeutic landscapes and the everyday lives of breast cancer survivors. *Soc. Sci. Med.* **2008**, *67*, 68–78. [CrossRef]
7. Jordan, M. Back to nature. *Therapy Today* **2009**, *20*, 26–28. Available online: http://about.brighton.ac.uk/staff/profiles/jordan/therapy-today.pdf (accessed on 24 September 2020).
8. Hanski, I.; Von Hertzen, L.; Fyhrquist, N.; Koskinen, K.; Torppa, K.; Laatikainen, T.; Karisola, P.; Auvinen, P.; Paulin, L.; Mäkelä, M.J.; et al. Environmental biodiversity, human microbiota, and allergy are interrelated. *Proc. Natl. Acad. Sci. USA* **2012**, *109*, 8334–8339. [CrossRef]
9. Kuo, F.E.; Sullivan, W.C. Aggression and Violence in the Inner City. *Environ. Behav.* **2001**, *33*, 543–571. [CrossRef]
10. O'Brien, L.; Murray, R. *A marvellous Opportunity for Children to Learn: A Participatory Evaluation of Forest School in England and Wales*; Forest Research: Surrey, UK, 2006; p. 52.
11. Morris, J.; Urry, J. *Growing Places: A study of Social Change in The National Forest*; Forest Research: Surrey, UK, 2006; p. 48.

12. Weinstein, N.; Balmford, A.; DeHaan, C.R.; Gladwell, V.; Bradbury, R.B.; Amano, T. Seeing Community for the Trees: The Links among Contact with Natural Environments, Community Cohesion, and Crime. *Bioscience* **2015**, *65*, 1141–1153. [CrossRef]
13. Bhagwat, S.A. Ecosystem Services and Sacred Natural Sites: Reconciling Material and Non-material Values in Nature Conservation. *Environ. Values* **2009**, *18*, 417–427. [CrossRef]
14. Lewicka, M. Place attachment: How far have we come in the last 40 years? *J. Environ. Psychol.* **2011**, *31*, 207–230. [CrossRef]
15. Buckley, R.; Brough, P.; Hague, L.; Chauvenet, A.; Fleming, C.M.; Roche, E.; Sofija, E.; Harris, N. Economic value of protected areas via visitor mental health. *Nat. Commun.* **2019**, *10*, 5005–5010. [CrossRef] [PubMed]
16. Naidoo, R.; Gerkey, D.; Hole, D.; Pfaff, A.; Ellis, A.M.; Golden, C.D.; Herrera, D.; Johnson, K.; Mulligan, M.; Ricketts, T.H.; et al. Evaluating the impacts of protected areas on human well-being across the developing world. *Sci. Adv.* **2019**, *5*, eaav3006. [CrossRef] [PubMed]
17. Jones, N.; Malesios, C.; Kantartzis, A.; Dimitrakopoulos, P. The role of location and social impacts of Protected Areas on subjective wellbeing. *Environ. Res. Lett.* **2020**, *15*, 114030. [CrossRef]
18. Stolton, S.; Hockings, M.; Dudley, N.; MacKinnon, K.; Whitten, T. *Reporting Progress in Protected Areas: A Site-Level Management Effectiveness Tracking Tool*, 2nd ed.; World Bank/WWF Alliance by WWF International: Gland, Switzerland, 2007; p. 15.
19. European Commission. *EU Biodiversity Strategy for 2030. Bringing Nature Back into Our Lives*; Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Brussels, Belgium, 2020; p. 25. Available online: https://ec.europa.eu/info/sites/info/files/communication-annex-eu-biodiversity-strategy-2030_en.pdf (accessed on 21 September 2020).
20. EEA (European Environment Agency). *Protected Areas in European Overview*; Report no. 5; EEA: Copenhagen, Denmark, 2012; p. 136. Available online: https://www.eea.europa.eu/publications/protected-areas-in-europe-2012 (accessed on 21 September 2020).
21. Balmford, A.; Green, J.M.H.; Anderson, M.; Beresford, J.; Huang, C.; Naidoo, R.; Walpole, M.; Manica, A. Walk on the Wild Side: Estimating the Global Magnitude of Visits to Protected Areas. *PLoS Biol.* **2015**, *13*, e1002074. [CrossRef] [PubMed]
22. Schägner, J.P.; Brander, L.; Maes, J.; Paracchini, M.L.; Hartje, V. Mapping recreational visits and values of European National Parks by combining statistical modelling and unit value transfer. *J. Nat. Conserv.* **2016**, *31*, 71–84. [CrossRef]
23. EEA (European Environment Agency). Nationally Designated Protected Areas, Indicator Assessment. 2017. Available online: https://www.eea.europa.eu/data-and-maps/indicators/nationally-designated-protected-areas-10/assessment (accessed on 28 September 2020).
24. European Commission Joint Research Centre. ECML Covid Measures Database. 2020. Available online: https://covid-statistics.jrc.ec.europa.eu/Measure/DashboardMeasures?view=1 (accessed on 28 September 2020).
25. Our World in Data. Google Mobility Trends. How Has the Pandemic Changed the Movement of People Around the World? 2 June 2020. Available online: https://ourworldindata.org/covid-mobility-trends (accessed on 28 September 2020).
26. Manenti, R.; Mori, E.; Di Canio, V.; Mercurio, S.; Picone, M.; Caffi, M.; Brambilla, M.; Ficetola, G.F.; Rubolini, D. The good, the bad and the ugly of COVID-19 lockdown effects on wildlife conservation: Insights from the first European locked down country. *Biol. Conserv.* **2020**, *249*, 108728. [CrossRef]
27. Jones, N.; McGinlay, J.; Holtvoeth, J.; Gkoumas, V.; Malesios, C.; Kontoleon, A. *Snowdonia National Park: Exploring Views of Local Communities Regarding the Social Impacts of the National Park, Changes Due to COVID-19 on Everyday Life and Potential Management Options during the Pandemic*; University of Cambridge/Project FIDELIO: Cambridge, UK, 2020; p. 13. Available online: https://www.fidelio.landecon.cam.ac.uk/publications (accessed on 19 October 2020).
28. Derks, J.; Giessen, L.; Winkel, G. COVID-19-induced visitor boom reveals the importance of forests as critical infrastructure. *For. Policy Econ.* **2020**, *118*, 102253. [CrossRef]
29. Jones, N.; McGinlay, J. *The Impact of COVID-19 Restrictions on Local Communities of Peak District National Park and Management Options during the Pandemic*; University of Cambridge/Project FIDELIO: Cambridge, UK, 2020; p. 20. Available online: https://www.fidelio.landecon.cam.ac.uk/publications (accessed on 19 October 2020).

30. Remuzzi, A.; Remuzzi, G. COVID-19 and Italy: What next? *Lancet* **2020**, *395*, 1225–1228. [CrossRef]
31. Pepe, E.; Bajardi, P.; Gauvin, L.; Privitera, F.; Lake, B.; Cattuto, C.; Tizzoni, M. COVID-19 outbreak response, a dataset to assess mobility changes in Italy following national lockdown. *Sci. Data* **2020**, *7*, 230. [CrossRef]
32. Hunter, D.J. Covid-19 and the Stiff Upper Lip—The Pandemic Response in the United Kingdom. *N. Engl. J. Med.* **2020**, *382*, e31. [CrossRef]
33. Armbruster, S.; Klotzbücher, V. *Lost in Lockdown? COVID-19, Social Distancing and Mental Health in Germany*. Diskussionsbeiträge, No. 2020-04; Albert-Ludwigs-Universität Freiburg, Wilfried-Guth-Stiftungsprofessur für Ordnungs- und Wettbewerbspolitik: Freiburg im Breisgau, Germany, 2020. Available online: https://www.econstor.eu/bitstream/10419/218885/1/1698957106.pdf (accessed on 28 September 2020).
34. Mutz, M.; Gerke, M. Sport and exercise in times of self-quarantine: How Germans changed their behaviour at the beginning of the Covid-19 pandemic. *Int. Rev. Sociol. Sport* **2020**. [CrossRef]
35. World Health Organization (WHO). WHO Coronavirus Disease (COVID-19) Dashboard. WHO, 2020. Available online: https://covid19.who.int/?gclid=EAIaIQobChMIntvg3cWL7AIVj-ntCh1QGQ7_EAAYASAAEgJoPfD_BwE (accessed on 28 September 2020).
36. Bojanowska, A.; Kaczmarek, L.D.; Kościelniak, M.; Urbańska, B. Values and well-being change amidst the COVID-19 pandemic in Poland. *PsyArXiv* **2020**. [CrossRef]
37. Sutrop, M.; Simm, K. Developing guidelines for the distribution of scarce medical resources during the COVID-19 pandemic. The Estonian case. *Trames. J. Humanit. Soc. Sci.* **2020**, *24*, 251–268. [CrossRef]
38. Estonian Government. Special Notice: As of Tomorrow, Movement Restrictions between the Islands and the Mainland Estonian Will Be Lifted. *News*, 7 May 2020. Available online: https://www.kriis.ee/en/news/special-notice-tomorrow-movement-restrictions-between-islands-and-mainland-estonia-will-be (accessed on 28 September 2020).
39. Republic of Slovenia. Coronavirus Disease COVID-19. Available online: https://www.gov.si/en/topics/coronavirus-disease-covid-19/ (accessed on 28 September 2020).
40. Kamerlin, S.C.L.; Kasson, P.M. Managing Coronavirus Disease 2019 Spread with Voluntary Public Health Measures: Sweden as a Case Study for Pandemic Control. *Clin. Infect. Dis.* **2020**, 864. [CrossRef] [PubMed]
41. Griffin, D.; Denholm, J. This Isn't the First Global Pandemic and It Won't be the Last. Here's What We've Learned from 4 Others Throughout History. *The Conversation*, 16 April 2020. Available online: https://theconversation.com/this-isnt-the-first-global-pandemic-and-it-wont-be-the-last-heres-what-weve-learned-from-4-others-throughout-history-136231 (accessed on 7 September 2020).
42. Jacobs, L.A.; Blacketer, M.P.; Peterson, B.A.; Levithan, E.; Russell, Z.A.; Brunson, M. Responding to COVID-19 and future times of uncertaintly: Challenges and opportunities associated with visitor use, management and research in parks and protected areas. *Parks Steward. Forum* **2020**, *36*, 483–488. [CrossRef]
43. Newsome, D. The collapse of tourism and its impact on wildlife tourism destinations. *J. Tour. Future* **2020**. [CrossRef]
44. Nürnberg, M.; Edrmann, K.-H. Naturbewusstsein 2019: Bevölkerungsumfrage zu Natur und biologischer Vielfalt. Bundersministrerium für Umwelt, Naturschutz und nukleare Sicherheit. 2019. Available online: https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/naturbewusstseinsstudie_2019_bf.pdf (accessed on 3 November 2020).
45. Jones, N.; Graziano, M.; Dimitrakopoulos, P.G. Social impacts of European Protected Areas and policy recommendations. *Environ. Sci. Policy* **2020**, *112*, 134–140. [CrossRef]
46. Romagosa, F. Physical health in green spaces: Visitors' perceptions and activities in protected areas around Barcelona. *J. Outdoor Recreat. Tour.* **2018**, *23*, 26–32. [CrossRef]
47. Burdon, D.; Potts, T.; McKinley, E.; Lew, S.; Shilland, R.; Gormley, K.; Thomson, S.; Forster, R. Expanding the role of participatory mapping to assess ecosystem service provision in local coastal environments. *Ecosyst. Serv.* **2019**, *39*, 101009. [CrossRef]
48. Lopes, R.; Videira, N. A Collaborative Approach for Scoping Ecosystem Services with Stakeholders: The Case of Arrábida Natural Park. *Environ. Manag.* **2016**, *58*, 323–342. [CrossRef] [PubMed]
49. Lopes, R.; Videira, N. How to articulate the multiple value dimensions of ecosystem services? Insights from implementing the PArticulatES framework in a coastal social-ecological system in Portugal. *Ecosyst. Serv.* **2019**, *38*, 100955. [CrossRef]

50. Kenter, J.O.; Bryce, R.; Davies, A.; Jobstvogt, N.; Watson, V.; Ranger, S.; Solandt, J.-L.; Duncan, C.; Christie, M.; Crump, H.; et al. *The Value of Potential Marine Protected Areas in the UK to Divers and Sea Anglers*; UNEP-WCMC: Cambridge, UK, 2013; p. 125.
51. Bennett, N.J.; Di Franco, A.; Calò, A.; Nethery, E.; Niccolini, F.; Milazzo, M.; Guidetti, P. Local support for conservation is associated with perceptions of good governance, social impacts, and ecological effectiveness. *Conserv. Lett.* **2019**, *12*, 12640. [CrossRef]
52. Venter, Z.S.; Barton, D.N.; Gundersen, V.; Figari, H.; Nowell, M. Urban nature in a time of crisis: Recreational use of green space increases during the COVID-19 outbreak in Oslo, Norway. *Environ. Res. Lett.* **2020**, *15*, 104075. [CrossRef]
53. Jentoft, S.; Pascual-Fernandez, J.J.; Modino, R.D.L.C.; Ramallal, M.E.G.; Chuenpagdee, R. What Stakeholders Think About Marine Protected Areas: Case Studies from Spain. *Hum. Ecol.* **2012**, *40*, 185–197. [CrossRef]
54. Gallo, M.; Špela, P.M.; Laktić, T.; De Meo, I.; Paletto, A. Collaboration and conflicts between stakeholders in drafting the Natura 2000 Management Programme (2015–2020) in Slovenia. *J. Nat. Conserv.* **2018**, *42*, 36–44. [CrossRef]
55. Hogg, K.; Gray, T.; Noguera-Méndez, P.; Semitiel-García, M.; Young, S. Interpretations of MPA winners and losers: A case study of the Cabo De Palos- Islas Hormigas Fisheries Reserve. *Marit. Stud.* **2019**, *18*, 159–171. [CrossRef]
56. Hattam, C.; Mangi, S.C.; Gall, S.C.; Rodwell, L.D. Social impacts of a temperate fisheries closure: Understanding stakeholders' views. *Mar. Policy* **2014**, *45*, 269–278. [CrossRef]
57. Povilanskas, R.; Armaitienė, A.; Dyack, B.; Jurkus, E. Islands of prescription and islands of negotiation. *J. Destin. Mark. Manag.* **2016**, *5*, 260–274. [CrossRef]
58. Leung, Y.-F.; Spenceley, A.; Hvenegaard, G.; Buckley, R. (Eds.) *Tourism and Visitor Management in Protected Areas: Guidelines for Sustainability*; Best Practice Protected Area Guidelines Series No. 27; IUCN: Gland, Switzerland, 2018; p. 120.
59. Davis, D.; Tisdell, C. Recreational scuba-diving and carrying capacity in marine protected areas. *Ocean Coast. Manag.* **1995**, *26*, 19–40. [CrossRef]
60. Santana-Jiménez, Y.; Hernandez, J.M. Estimating the effect of overcrowding on tourist attraction: The case of Canary Islands. *Tour. Manag.* **2011**, *32*, 415–425. [CrossRef]
61. Scholtz, M.; Saayman, M. Diving into the consequences of stakeholders unheard. *Eur. J. Tour. Res.* **2018**, *20*, 105–124.
62. Trivourea, M. People and the Mediterranean Monk Seal (Monachus monachus): A Study of the Socioeconomic Impacts of the National Marine Park of Alonissos, Northern Sporades, Greece. *Aquat. Mamm.* **2011**, *37*, 305–318. [CrossRef]
63. Pham, T.T.T. Tourism in marine protected areas: Can it be considered as an alternative livelihood for local communities? *Mar. Policy* **2020**, *115*, 103891. [CrossRef]
64. EUROPARC Federation. *European Charter for Sustainable Tourism in Protected Areas*; EUROPARC Federation: Regensburg, Germany, 2020. Available online: https://www.europarc.org/library/europarc-events-and-programmes/european-charter-for-sustainable-tourism/ (accessed on 7 September 2020).
65. Dang, X.; Gao, S.; Tao, R.; Liu, G.; Xia, Z.; Fan, L.; Bi, W. Do environmental conservation programs contribute to sustainable livelihoods? Evidence from China's grain-for-green program in northern Shaanxi province. *Sci. Total. Environ.* **2020**, *719*, 137436. [CrossRef] [PubMed]
66. Katikiro, R.E. Improving alternative livelihood interventions in marine protected areas: A case study in Tanzania. *Mar. Policy* **2016**, *70*, 22–29. [CrossRef]
67. Kostopoulou, S.; Kyritsis, I. A Tourism Carrying Capacity Indicator for Protected Areas. *Anatolia* **2006**, *17*, 5–24. [CrossRef]

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Stakeholders' Social Network in the Participatory Process of Formulation of Natura 2000 Management Programme in Slovenia

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Abstract: Stakeholder participation has become an important driving force in policy decision-making and implementation, particularly in the nature conservation sector, where complex interactions and conflict of interest between stakeholders are common. A stakeholder analysis, which was complemented with a social network analysis, was used to examine the cooperation and conflict network between stakeholders, their institutions, and sectors in the case of the formulation of the Natura 2000 Management programme in Slovenia for the period 2015–2020 (PUN). Using data from a web survey (n = 167), cooperation and conflict networks were analysed while using degree centrality, indegree centrality, betweenness centrality, and blockmodeling. The results of the stakeholder analysis showed that the highest number of stakeholders that are involved in the participatory process of PUN was from the forestry and hunting sector, followed by the agriculture and nature conservation sector. The results of the cooperation network showed that the network is highly centralized, with only few institutions taking a central position in the PUN process (Institute for Nature Conservation, Ministry of Environment and Spatial Planning, Chamber of Agriculture and Forestry, Ministry of Agriculture, Forestry and Food, and the Slovenian Forest Service). Moreover, the nature conservation sector was, on average, a sector with the highest concentration of power. In addition, in the cooperation network, which was fragmented across sectors, there were institutions that belonged to the same sector, which tended to cooperate with each other. The analysis of the conflict network showed that institutions with a central position in the cooperation network also had a central role in the conflict network. In addition, conflicts between institutions more frequently appeared among institutions from different sectors. The exceptions were institutions from the fishery and water sector, as this sector seemed to have many conflicts within it. Based on a blockmodeling, four groups of institutions were identified according to their cooperation network (core institutions, semi-core institutions, semi-periphery institutions, and periphery institutions). Our finding suggested that the participatory process of formulating PUN needs to be improved in such a way that in the future various stakeholders, especially excluded local ones, are more actively involved and a balance of the power between the stakeholders involved achieved.

Keywords: social network analysis (SNA); cooperation and conflict networks; stakeholders' involvement; participatory process; Natura 2000 management Programme

1. Introduction

Natura 2000 is the core pillar of European Union's (EU) biodiversity conservation policy [1–3]. It refers to an EU-wide ecological network of protected areas that extends across national borders, administrative levels, policy sectors, and socio-economic contexts [4]. The network is established and managed according to the legally binding provisions of the EU's Birds and Habitat Directive [5,6]. The Directives are transposed into national legislation, but the EU gives member states the freedom to choose the most appropriate means to achieve their goals. The Directives do not require management plans to be drawn up for Natura 2000 sites, but the Habitat Directive recommends their use as a means of ensuring the conservation status of sites [7,8]. The preparations of sites-level management plans are promoted in most member states as the main tool to identify conservation measures at site level despite soft regulation [9]. Additionally, the Directives do not require public or stakeholder participation in the process of management planning, although the guidelines emphasize the importance and benefits of such participation [10]. In other words, the Directives indirectly recognize the importance of public participation and the need for stakeholder involvement in the establishment and management of Natura 2000 sites [8,11–14].

The implementation of the objectives of the directives at the national level has changed the power and relationships between stakeholders in the decision-making process with the involvement of new stakeholders in the nature conservation system [7,15,16]. National legislation defines the role of the main stakeholders in nature conservation and establishes a multi-level governance system of Natura 2000 [16–18]. In addition, in the implementation of the nature conservation policy, the inter-institutional cooperation between different stakeholders from different sectors (e.g., forestry, agriculture, fishery, and nature protection) is a key factor for the success of participatory decision-making process across several jurisdictional levels [19–21].

The process of designation, implementation, and management of the Natura 2000 sites is complex and cumbersome process. A large number of stakeholders and institutions have a direct or indirect role in these processes regarding the land designated as Natura 2000 sites [22–27]. However, there are no regulatory rules on stakeholder participation [28,29], as the Habitats Directive does not clearly establish participatory approaches. It states that conservation measures shall take into account human (economic, social and cultural) needs and local characteristics, but site designation is only based on (ecological) scientific criteria, while social criteria are not even mentioned. For this reason, participatory approaches were initially ignored in many EU member states and technocratic approaches dominated, privileging conservation experts and marginalizing socio-economic stakeholders [10,13,14,24]. In addition, the numerous conflicts that were related to the Natura 2000 sites designation, implementation, and management emerged as a result of the absence of stakeholders' involvement and participation in these processes [13,19,30–33]. The identified conflicts were related to the conflicting stakeholders' interests, values, and perceptions, as well as to different and competing land use principles [14,19,26,31,34–40]. The involvement of and cooperation with various stakeholders as well as stakeholder participation and coordination between institutions was highlighted as an important instrument for increasing the acceptance of Natura 2000 in order to prevent further conflicts and improve the implementation and thus the conservation results [41].

According to Elsasser [42], several degrees of participation are possible, ranging from »passive« participation (with the modest claim that stakeholders are informed about the decisions made by others, and the decision-making process thus become transparent) to »interactive« participation, which requires a joint decision and perhaps shared liability. Passive and interactive participation can be seen as two poles of a continuum. In most cases, the process of designation, implementation, and management of the Natura 2000 sites will tend to follow an approach with different possibilities for stakeholders to influence the outcome.

For this reason, stakeholder analysis has gained increasing attention in nature conservation policy and it is now an integral part of participatory processes [43]. Many authors have highlighted he importance of stakeholder analysis [43–48], as it is a technique that intends to identify all groups of

stakeholders, organised or not, who have a common interest in a particular issue, the conflicts of interest between them, and the possible coalitions [49]. In addition, stakeholder analysis enables us to identify the key stakeholders and reveal their role, intentions, connections, interests, behaviour, influence, power, and position that they have in the decision-making process [46,50]. Stakeholder analysis in the case of Natura 2000 mainly focuses on participation in the implementation of Natura 2000 [14,23,31,51,52], while few studies focus on stakeholder analysis in the case of the formulation of Natura 2000 management plans [9,14,21].

Social network analysis (SNA) has often been used to identify interactions between stakeholders or institutions based on the role and influence they have in their networks, as it usually deals with the connectivity and interactions between stakeholders or institutions, to enhance stakeholder analysis [53]. Importantly, the SNA approach can reveal the position of each stakeholder participating in the network and it can also help in optimizing the flow of information [54]. The SNA has been widely used in nature conservation-related studies [22,29,47,55–58], yet there has been limited focus on the specific interactions among stakeholders (cooperation and conflicts) in the case of the formulation of the Natura 2000 management programme. However, the studies focusing on cooperation, see e.g., [11,37,56], reported that the participatory processes were less participatory than expected, being centralized around a small number of public authorities, with the low involvement of NGOs and private stakeholders. The pre-existing power of public authorities probably inhibits the ability of NGOs to collaborate with private stakeholders. Moreover, studies also revealed a lower level of cooperation of stakeholders in the network with other institutions, which indicates a clear top-down approach to the participatory process. To the best of our knowledge, the existing studies on the formulation of the Natura 2000 management programme fails to study conflict networks between stakeholders.

In order to fill the above mentioned gaps, this paper aims to analyse the participatory process of the formulation of the Natura 2000 Management Programme for the period 2015–2020 in Slovenia (PUN) using stakeholder analysis in combination with the SNA in order to (a) identify the main institutions in cooperation and conflict network and analyse their position and power in this network structure; (b) analyse sectors' involvement in the formulation of PUN and frequency of their cooperation and conflicts; and, (c) to cluster institutions based on cooperation network using a blockmodeling approach.

The results could be useful in informing the institutions that are responsible for Natura 2000 planning and management, as well as policy decision-makers about the failure of the existing participatory process and thus improve the quality of future processes. Furthermore, the results may be useful for policy decision makers at the national and EU level to develop guidelines for such participatory processes.

2. Materials and Methods

2.1. Stakeholders' Involvement in the Process of the Formulation of Natura 2000 Management Programme (2015-2020) in Slovenia

The process of the formulation of PUN started in 2012. The main focus was on: the preparation of detailed conservation objectives for Natura 2000 sites in Slovenia; the identification of measures to achieve conservation objectives, which are implemented in sectoral management plans (forestry, hunting, fishery, and water sector); and, those responsible for their implementation—institutions, which are responsible for the planning and implementation of nature protection measures in accordance with Slovenian legislation. The activities necessary for the adoption of this operational programme were supported by the LIFE + project 11 NAT/SI/880, whose coordinating partner was the Ministry of the Environment and Spatial Planning (MESP—responsible for the preparation of legislation regarding the environment) and whose project partners were the Institute of the Republic of Slovenia for Nature Conservation (IRSNC—responsible for nature conservation), the Slovenia Forest Service (SFS—responsible for forest management planning for state and private forests and elaboration of regional hunting management plans), the Fisheries Research Institute of Slovenia (FRIS—responsible for preparing fishery management plans in fishing areas), the Institute for Water of the Republic of Slovenia

(IWRS—was responsible for water related land management), and the Chamber of Agriculture and Forestry of Slovenia (CAFS—the organisation which represents all natural persons/private individuals and legal entities from the fields of agriculture, forestry, and fishing in the Republic of Slovenia; their employees provide services in agriculture and forestry extension). The Slovenian Water Agency from 2015 combines the implementation of professional, administrative, and developmental tasks, which were carried out by the Institute for Water of the Republic of Slovenia during the time of the participatory process of designation PUN.

The communication plan was prepared at the beginning of the process by an outsourced company and the project partners. The plan included a stakeholder analysis, different ways of involving stakeholders from different sectors at each stage with the aim of providing information, consultation, and participatory decision-making on the management of Natura 2000 sites in the future. The first draft of PUN 2015–2020 was prepared in collaboration with the project partners and additional experts on habitat types (forest or grassland habitats, etc.), and plant and animal species (birds, bugs, amphibians, etc.) from different institutions (e.g., universities, institutes, and NGOs). The draft was discussed with key stakeholders during six targeted roundtables (public meetings) in different parts of the country with representatives of different sectors (forestry and hunting, agricultural, fishery and water, nature conservation, and "others") (see Table 1). The amended draft of PUN was the subject of intragovernmental consultation, which consisted of consultation meetings with all ministries and their public bodies, as well as the Chamber of Commerce. The PUN 2015–2020 draft was adopted on April 2015. Following its adoption, eight workshops were organized for stakeholders, representatives of the above-mentioned sectors, and management organizations of nature parks to spread the information about PUN.

Table 1. Division of stakeholders by sector.

Sector	Number of Participants in PUN	%	Number of Respondents	%
Forestry and hunting	181	22.20	68	40.72
Agriculture	366	44.90	45	26.95
Fishery and water	34	4.13	8	4.79
Nature conservation	169	20.77	39	23.35
"Others"	65	8.00	7	4.19
Total	815	100.00	167	100.00

PUN: Natura 2000 Management programme in Slovenia for the period 2015–2020.

In the elaboration of the PUN, there has been a switch from increased information-communication with stakeholders in the past (gathering objective information to understand the problem, alternatives opportunities and/or solution) to consultation with key stakeholders (stakeholder feedback on analysis, alternatives, and/or decisions) although the adopted approach was still a top-down approach [19].

2.2. Data Collection

The study is based on a web questionnaire with a link being sent via e-mail using the 1KA web survey program (https://www.1ka.si) to all identified stakeholders who have participated in PUN. A preliminary list of stakeholders involved in PUN was drawn up on the basis of a list of participants in the workshops and reports of LIFE + project 11 NAT/SI/880. Eight hundred and fifteen stakeholders were identified as a study population. For 48 stakeholders, the contacts could not be found and were therefore excluded from the study. Therefore, the questionnaire was sent to 767 identified stakeholders by e-mail. The stakeholders came from different institutions (i.e., ministry, public forest administration, NGOs, university and research institutions, private forest owners, and farms associations) and they were divided into five main groups according to the sector to which they belong to (forestry, agriculture,

water and fishery, nature protection, and "other"—including the spatial planning and energy sector, regional development agencies) (Table 1). Dillman's Tailored Design Method [59] was adopted in order to maximize response rates and reduce survey errors. Two reminders were sent to those who had not replied within two and four weeks after the original deadline. The response rate was 34.8%, with 266 completed questionnaires, 99 of which were not suitable for the SNA, because the respondents skipped answering this part of the questionnaire (incomplete survey). Consequently, 167 questionnaires were used for the SNA.

The questionnaire consisted of six sections seeking information on: (1) nature protection policies; (2) the participatory process and the relations between stakeholders; (3) the influence of stakeholders on the process; (4) SNA of stakeholders in a cooperation network; (5) conflicts and SNA of stakeholders in a conflict network; and, (6) the socio-demographic characteristics of stakeholders. Two sections focused on stakeholders' networks in a PUN process that consists of two parts—cooperation network and conflict network. In the fourth section, a question was asked with that aimed to gather information regarding the stakeholders' cooperation in a network. In the question, the respondents were asked to identify the institutions they contacted during the participatory process from a drop-down list of institutions. The data that were gathered for creating and analysing the cooperation network were measured at the individual level of a stakeholder and then aggregated at the level of organizations/institutions. The data for creating and analysing the conflict network included a question from section five. The respondents were asked whether they had noticed a conflict and if, from the drop-down list of institution, they selected which institutions were involved in the conflict.

2.3. Data Analysis

The data that were obtained from the survey related to stakeholders' cooperation and conflicts in the formulation of PUN were transferred into a matrix scheme and used for the SNA. The conflict network is based on the question, whether the person has noticed a conflict and, if so, which institutions were involved in the conflict. The person could identify several conflicts. No meaningful direction can be deduced since there is no indication of the direction here and the person's institution could not be involved in the conflict, and therefore the conflict network is treated as an undirected network. On the other hand, the cooperation network is based on the question, with which institutions a certain person has cooperated (these answers were then attributed to the institution of this person). In the SNA it is customary to direct the tie in such cases (when these are perception based ties) from the person reporting cooperation to the one being reported to be involved in one, although cooperation is, in its core, undirected. Such coding reduces the bias due to the different types of reporting. An undirected network was only chosen for cooperation for the graphical representation (disregarding the direction of ties—who started communication/contact) to simplify the illustration, since only such a representation enables only drawing one tie between each connected institutions. In all other analysis, the cooperation was treated as a directed network. The centrality of the institutions and the blockmodeling solution were analysed in order to describe the general aspects of the cooperation and conflict network.

The position of an individual institution in the network was analysed while using two measures of centrality (degree and betweenness). The structural importance of an institution is usually assessed by the degree of centrality (DC), which takes the ties that an institution shares directly with another institution into account [60]. In other words, DC is defined as the number of institutions that are in direct contact with a particular institution and that have the capacity to directly communicate with others [61]. In a directed network, a DC distinction into indegree centrality (IDC) can be made. In present study, the IDC was only calculated for the cooperation network and not for the conflict related network, since only the cooperation network was directed. In our case, the IDC is related to the concept of prestige and it depends on the number of incoming ties. The IDC is the number of ties that an institution has that have been initiated by other institutions and can be used to estimate the importance of a particular institution in the social network. An institution is considered to be

prestigious if it is particularly visible to the stakeholders in the network; this means that the others recognize the institution.

The Betweenness centrality (BC) is calculated as the proportion of the shortest paths between the node pairs that pass through the node of interest [62] and measures the influence that an institution has on the dissemination of information in the network. Therefore, it identifies those institutions that play the role of intermediators in the decision-making process [63]. Thus, these institutions have power in controlling information. According to Borgatti, et al. [64], the interpretation of BC works well for many social relations, but falls apart when we consider negative ties, such as conflict. It is difficult to know what to make of measures like BC when applying them to negative networks. In this study, BC has not been used for conflict network due to the above-mentioned facts.

The sum of squares homogeneity generalized blockmodeling with only complete blocks was used to find groups and ties between institutions in the directed cooperation network [65]. Blockmodeling is a technique that partitions the network in such a way that blocks, that is, ties between two clusters of institutions (or between institutions of the same cluster), follow a certain pattern. The network includes both institutions that participated in the study and those that did not. These later institutions cannot have outgoing ties in the network, as they did not have the opportunity to report them. They represent a kind of missing data. A blockmodeling approach for linked networks was used to blockmodel the entire network, keeping these two groups separate, that is, institutions, that participated in the survey, and those, that did not, could not be placed in the same cluster, in order to find groups and ties between institutions in the directed cooperation network. The number of groups was selected based on the review of solutions at different number of clusters and was set at 4 for participating institutions and 3 for non-participating institutions in a network.

The graphical elaboration and the main statistical features, network centralities, and blockmodeling were realized with the social network software Pajek [66–68] and the R statistical program [69], mainly using SNA packages [70], igraph [71], and blockmodeling [72].

3. Results

3.1. Basic Information about Institutions in a Network - Stakeholders' Analysis

The survey results of the PUN participatory process for the SNA included 167 stakeholders from different institutions and sectors, which were, for the purpose of our stakeholder analysis, categorized into five groups by sectors, according to the categorisation that was done in PUN: forestry and hunting sector (yellow vertices in Figure 1), the agriculture sector (green vertices in Figure 1), the fishery and water sector (blue vertices in Figure 1), the nature conservation (purple vertices in Figure 1), and "Others" (red vertices in Figure 1).

As Table 1 shows, the group with the highest number of respondents is the forestry and hunting sector (40.72%), followed by the agriculture sector (26.95%) and nature conservation sector (23.35%), which is in contradiction with the number of stakeholders actually included in the formulation process of PUN, in the case of the forestry and hunting and agriculture sector. Therefore, the forestry sector is overrepresented in our study when compared to the agricultural sector. The sectors with the lowest number of respondents are the fishery and water sector (4.79%) and "Others" (4.19%).

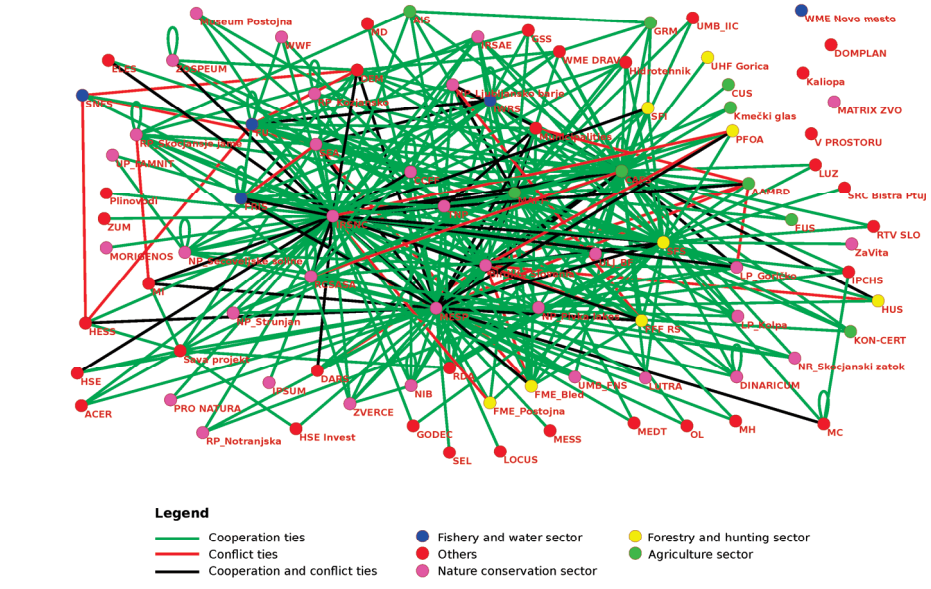

Figure 1. Cooperation and conflict network of the institutions in participatory process of formulation of Natura 2000 Management programme in Slovenia for the period 2015–2020 (print in colour).

3.2. Cooperation and Conflict Network of Institutions – Locating Central Institutions

Figure 1 shows the cooperation and conflicts networks as an undirected network between 88 institutions (some institutions are united as one institution, due to their small number of stakeholders, e.g., the municipalities, the Regional development agencies (RDA), or the fishery associations in the Fishery union), of which 5,68% had no ties with others. The network has 360 edges (undirected ties) in total, of which there are 299 edges that represent cooperation (coloured green in Figure 1), 21 edges that represent both cooperation and conflicts between institutions (coloured black in Figure 1), and 40 edges that represent conflicts (coloured red in Figure 1). Consequently, the cooperation network has 320 edges, of which there are 22 loops (which means that there is cooperation between co-workers from the same institution). The average degree for the cooperation network was 7.45, which means that, on average, each institution was connected to more than seven others. In addition, the conflict network consists of 61 edges and 0 loops, with an average degree 1.38, meaning that, on average, each institution was in conflict with some more than one other institution.

As reported in Table A1 (which summarized the top 10 DC values of institutions in the undirected network of cooperation), the institution with the highest DC is the IRSNC (DC = 57), followed by the MESP (DC = 55), CAFS (DC = 47), the Ministry of Agriculture, Forestry, and Food (MAFF) (DC = 44), SFS (DC = 38), and the NGO BirdLife Slovenia (DC = 18). Furthermore, a high number of institutions (35.23%) show rather low values of DC (DC lower than 2). Given these differences between the institutions that are related to the number of direct connections with others, it can be said that the cooperation network is a highly centralized network (see Figure 1), where one stakeholder (IRSNC) plays a key and central role.

BC was studied in order to obtain more detailed information on the cooperation structure of the network (see Table A2). The results showed that the central position in the cooperation network again belongs to the IRSNC (BC = 985.06), followed by the MESP (BC = 884.61), CAFS (BC = 585.87), MAFF

(BC = 451.97), and SFS (BC = 386.92). Institutions with higher BC values were potentially more inclined to play the role of intermediator.

A careful comparison of the DC and BC values showed that some central institutions (IRSNC, MESP CAFS, MAFF, and SFS) in the cooperation network had strong, immediate ties with various other institutions, and exercised a "bridging" function in the network.

Furthermore, the analysis of the DC, with its subdivision into IDC, was also calculated for the directed cooperation network (see Table A3). IRSNC was the institution with the highest concentration of power, which is mainly explained by the highest values of IDC, namely for IRSNC (IDC = 22), followed by MESP (IDC = 17), the NGO BirdLife Slovenia and the Slovenian Environment Agency (SEA) (for both institutions IDC = 14, respectively), and the Centre for Cartography of Fauna and Flora (IDC = 13).

The analysis of the conflict network between institutions (see Table A4) showed that the institution with the highest DC was IRSNC (DC = 19), followed by MESP (DC = 13), the NGO BirdLife Slovenia (DC = 9), CAFS (DC = 7), SEA, MAFF, and the Agency for agriculture markets and rural development (AAMRD) (for all three institutions DC = 5, respectively). The results are not surprising in the case of IRSNC and MESP, as they were the most active powerful in the cooperation network and, thus, in contact with many other stakeholders from different institutions and sectors. Each contact has the potential to bring new conflict. The NGO BirdLife Slovenia is one of the most powerful NGOs in this process, which has fully represented and argued its position in a few different sectoral workshops. Consequently, they came into conflict with other institutions with opposing views. The CAFS was a representative of landowners/farmers who have strong reservations about Natura 2000, because they were affected by the new forms of farming, management, and restrictions, and were excluded from the Natura 2000 sites designation phase. The SEA is responsible, among others, for the implementation of legislation and administrative procedures in the case of nature conservation conditions and permits for the construction of facilities and assessing the acceptability of these facilities as interventions in Natura 2000 sites. They have been in conflict with other institutions due to this responsibility. The MAFF is as the Ministry the charge of the agriculture, forestry, and fishery sector. In the process of formulation of PUN, MAFF participated in the intragovernmental consultation of the amended draft of PUN. They did not give their consensus to PUN until the draft PUN was harmonized with the forestry sector (SFS as a public forestry service). The AAMRD is an institution that is responsible for Rural Development Program implementation and it has been in conflict with other institutions due to their dissatisfaction with the financial incentives and compensatory measures.

3.3. Frequency of Cooperation and Conflict among Sectors

Table 2 shows the average cooperation network centrality values, while taking the different sectors into account. The nature conservation sector was a sector with, on average, the highest concentration of power (IDC = 5.88), followed by the fishery and water sector (IDC = 4.80), the forestry and hunting sector (IDC = 4.63), and the agriculture sector (IDC = 4.33) and the sector "others" (IDC = 2.55). The small differences in the values between the sectors show that all sectors had an impact and a significant role in the process of the formulation of PUN, but the impact was higher for sectors with IDC values above 4 than for the sector "others". The agriculture sector was most connected (DC = 12.78), followed by the nature conservation sector (DC = 9.70), forestry and hunting (DC =9.25), fishery and water sector (DC = 8.60), and the sector "others" (DC = 3.15). Regarding BC, the agriculture sector is the sector with the highest value of BC (BC = 115.96), followed by the nature conservation sector (BC = 62.05), the forestry and hunting sector (BC = 49.43), the fishery and water sector (BC = 10.80), and the sector "others" (BC = 1.28), respectively.

Table 2. Basic centrality values of the cooperation network by sectors.

Sector	BC	DC	IDC
Forestry and hunting	49.43	9.25	4.63
Agriculture	115.96	12.78	4.33
Fishery and water	10.80	8.60	4.88
Nature conservation	62.05	9.70	5.88
"Others"	1.28	3.15	2.55

The results on the frequency of cooperation between all institutions (n = 88) from different sectors in the participatory process of the formulation of PUN are very clear: institutions that belong to the same sector tend to show more mutual cooperation (Figure 2). The values presented in the matrix in Figure 2 represent the percentage of institutions from column clusters with which an average institution from row clusters repositions cooperation. The matrix is not symmetrical, as cooperation is measured as an asymmetric (directed) relation. The cooperation process in the case of the formulation of PUN was clearly fragmented across sectors. For example, institutions that represent the fishery and water sector hardly interact with other sectors and vice versa. Most of the cooperation of this sector was with institutions within their sector and far less with institutions within the nature conservation sector. Additionally, institutions from the forestry and hunting sector mostly interacted with institutions within their sector, while the agriculture and nature conservation sector more often interacted with institutions from other sectors.

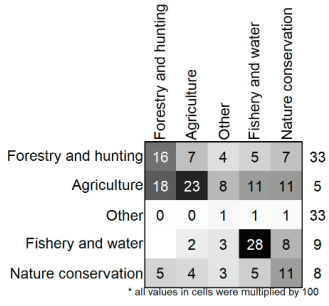

Figure 2. The matrix of cooperation among sectors in the participatory process of formulation of PUN.

The conflict between the institutions in the participatory process of the formulation of PUN appears between institutions from different sectors (Figure 3). The strongest conflicts occurred in the forestry and hunting sector and in the nature conservation sector, as well as between the agriculture and the nature conservation sector. Less frequent conflicts occurred between the agriculture sector and the forestry and hunting sector. The exceptions were institutions from the fishery and water sectors. This sector seems to have had many conflicts within its own sector, as well as conflicts with "other" sectors (i.e., Power plant Maribor—DEM and Water power plant Sava—HESS), which are related to the restrictions and limitations on the construction of dams for hydro-electric power, fish passes, and nature conservation sector.

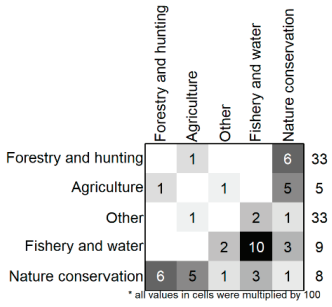

Figure 3. The matrix of conflicts among sectors in the participatory process of the formulation of PUN.

3.4. Partitioning the Institutions Based on Their Cooperation Network

The results partitioning the institutions based on their ties in the cooperation network are presented in the form of a partitioned matrix (Figure 4). The black square in the matrix indicates that the column institution reported cooperation with the row institution. The institutions that participated in the survey have black labels and they are positioned in the top and left part of the matrix. The institutions that did not participate in the survey have red labels and are only positioned in columns in the right part of the matrix. Since they have not responded to the survey, there is no row entry for them. The blue lines partition the units into clusters and ties into blocks. The thicker blue lines separate the participating and non-participating units.

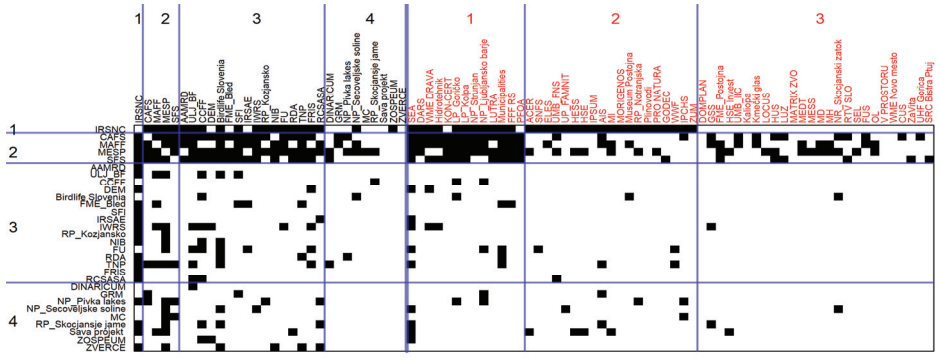

Figure 4. Results of homogeneity generalized blockmodeling of the cooperation network with removed isolates (print in colour).

Based on blockmodeling, four groups of institutions whose stakeholders participated in survey and three groups of institutions whose stakeholders did not participate in the survey were identified. These were identified and named according to their cooperation network. First, we will look at the clusters of participating institutions. Cluster 1 is well-connected with incoming and outgoing ties to most other clusters and, therefore, it was labelled "core institutions". Cluster 2 was named "semi-core institutions", while internally it is well-connected and has a lot of outgoing ties and has much less incoming ties from other clusters. Cluster 3 was named "semi-periphery institutions", as it is internally very sparsely connected and generally has fewer ties than previous clusters. Cluster 4 was named "periphery institutions" due to having the fewest ties, especially no ties within itself.

Cluster 1 only contains one institution, but it is the most important—IRSNC. This institution reported ties to: a) all institutions from cluster 2 of the participants; b) to most institutions from cluster 3

(except for the DEM, Forest enterprise Bled—FME Bled, and the Inspectorate of the Republic of Slovenia for Agriculture, Forestry, Food, and the Environment—IRSAE); c) to almost all institutions from cluster 1 of the non-participants (except for the Institute for inspection and certification in agriculture and forestry in Maribor—KON-CERT and the Private forest owners association—PFOA); and, d) to all institutions from cluster 2 of the non-participants. They also reported ties to some of the institutions from cluster 3 of the participants (i.e., IRSNC cooperated with NP Sečoveljske soline and ZOSPEUM), while they are unconnected with institutions from the last cluster of non-participants. On the other hand, most other institutions participating in the network reported cooperation with them.

Cluster 2 included four institutions that are fully connected. They are also well connected with institutions from cluster 1 of non-participants (i.e., MAFF from cluster 2 is connected to all institutions from cluster 1 of non-participants, except LUTRA, and CAFS is connected to all of them), with IRSNC from cluster 1 of participants and with cluster 3 from participants (i.e., SFS is connected with all of them, except with RP Kozjansko and FU), while most of them also report some ties with institutions from other clusters.

The 16 institutions from cluster 3 of participants have a relatively low number of incoming ties (some of them also have none), while most of them reported ties with IRSNC from clusters 1, with cluster 2 of the participants (i.e., CAFS, MAFF, MESP, and SFS), with cluster 3 of the participant (i.e., ULJ_BF, CCFF, NGO BirdLife Slovenia, FRIS, TNP, etc.) and cluster 1 of the non-participants (i.e., SEA, Hidrotehnik, WME Drava, LP Goričko, Lutra, etc.), as well as some sporadic ties to institutions from other clusters.

The nine institutions from cluster 4 of the participants have a relatively low number of incoming ties (some also none—i.e., ZVERCE), while most of them reported ties with institutions from cluster 2 of the participants (i.e., CAFS, MESP, MAFF, and SFS), and some of them with IRSNC from cluster 1 of the participants. They have some sporadic ties to institutions from other clusters and no ties to institutions from cluster 4 of the participants.

The incoming ties of cluster 1 of non-participants (non-participants could not report outgoing ties, although most of them probably have them) are very similar to the incoming ties of cluster 3 of participants. The core institution (IRSNC) reported ties to all institutions in this cluster (except KON-CERT and PFOA) and most other institutions from cluster 2 of participants reported ties to at least some institutions in this cluster. They have only sporadic incoming ties from other institutions. We assume that their outgoing ties would match those from participants of the semi-periphery, had they reported them.

A core institution named each unit from the second non-participants cluster, while they only have sporadic incoming ties from other clusters. In this sense, they are a true periphery. Institutions from the third non-participants cluster have some ties from "semi-core institutions", but other clusters very rarely mention them.

4. Discussions

Nature conservation policy and decision-making on nature conservation issues are characterized by complex interactions between different stakeholders from different institutions and sectors [13] in the EU. Traditionally, the nature conservation policy in Slovenia has been based on a centralized top-down approach whit decision–making power distributed among a few institutions [48]. With the implementation of the Natura 2000 network and the formulation of the management programme—PUN in Slovenia, a participatory approach has spread in nature conservation policies to respond to the need to involve stakeholders from different institutions that are essential for the fulfilment of EU nature conservation objectives.

A detailed stakeholder analysis of the participatory process of the formulation of PUN in Slovenia showed many individual stakeholders from different institutions and sectors who participated in the process facilitated the process. The highest number of stakeholders came from forestry and hunting, followed by agriculture and the nature conservation sector. This can be explained by the fact that

SFS and CAFS are institutions with a large number of stakeholders in the forestry and agricultural sector. Despite the fact that many stakeholders participated in the PUN, only one institution had a key role—IRSNC—and a few institutions had important roles (CAFS, MAFF, MESP, and SFS) in the decision-making process, while some of the institutions had a peripheral position, either due to their willingness not to participate in a participatory process or because of the lack of information and opportunities to join the network. Furthermore, the results of previous studies show Manolache et al. [56] and Blicharska et al. reported similar findings [37], where the participatory process was centralized around a small number of public authorities, with a low level of participation by NGOs and private stakeholders. Moreover, the same studies found a lower level of cooperation between stakeholders in the network periphery with other institutions, which indicates the clear top-down approach of the participatory process. In our case, landowners and farmers had a central representative (CAFS) with an important role in the process, while other representatives of them were on the periphery of the network (i.e., PFOA). Additionally, in our case, NGO involvement was not as low as reported in previous studies, but they had less power to influence the process than the public authorities.

From the results of the SNA analysis, it can be concluded that the cooperation network of the participatory process of the formulation of PUN is a highly centralized network. In the cooperation network, one institution (IRSNC) is dominant and in a central position; consequently, with the highest power in the decision-making process, while the ministries (MESP and MAFF), CAFS, and SFS were in a sub-dominant position, but still central position. The dominant and central position of the IRSNC in a cooperation network is not surprising, since the IRSNC, as a national expert institution for nature conservation, was ultimately able to organize workshops and coordinate nature conservation measures among stakeholders. Besides the IRSNC, MESP, MAFF, and CAFS played important roles in transferring information and, consequently, in the PUN influencing decision-making process. MESP was primarily responsible for the content and financial management of the entire project, for informing the partners and monitoring the progress of the activities and providing professional guidance to the partners. The MAFF, as a ministry in charge of agriculture, forestry, and fishery sector, participated in intragovernmental consultation of the amended draft of PUN, while CAFS participated in the network as representative of farmers and landowners, as a project partner. Influential institutions were, in addition to those already mentioned (IRSNC, MESP), the NGO BirdLife Slovenia and CCFF, both of which were involved as external experts on birds, flora, and fauna. All of these institutions were very powerful and, consequently, important, due to their roles in the process of formulation of PUN. The results were confirmed by a previous study undertaken by Laktić and Pezdevšek Malovrh [38], in which the stakeholders stated, during the face-to-face interviews, that the ultimate decision-making power in the PUN process lies with MESP and IRSNC. Anyhow, the results might be contradictory with the logic of bargaining theory, where it is argued that a central position of institution can, in fact, undermine an institution's (bargaining) power, e.g., if other (peripheral) institutions have influence, but only little interest in an outcome. Therefore, a central position does not guarantee the highest power [73].

Furthermore, the results of the blockmodeling confirmed the results of the SNA analysis, as the IRSNC was perceived as the most important institution in the participatory process of the formulation of PUN. According to the results of the blockmodeling, the IRSNC was cooperating with almost all institutions from different clusters—cluster 2, cluster 3, cluster 1 of non-participants and cluster 2 of non-participants. In addition to IRSNC, CAFS, MAFF, MESP, and SFS are also considered as important actors in mobilizing the network and bringing together other stakeholders from different institutions. However, these stakeholders have to exert a lot of energy to maintain a large number of ties and, therefore, these ties are often weak [47]. Moreover, central institutions are crucial for a participatory process, as their links are used to disseminate information and possibly mobilize other stakeholders from different institutions to act, although there is no guarantee that they can significantly influence those to whom they are tied. On the other hand, it can be said that these institutions have had control over information and communication, and have been able to restrict the communication/participation

of others. This situation has led to information asymmetry in the formulation of PUN and the exclusion of some institutions from the decision-making process. Therefore, the weakest point of the cooperation network was related to the imminent exclusion of peripheral institutions from the decision-making process. Therefore, these institutions had no central role and power to influence the decision-making process. Therefore, others might have voiced their interests and points of view. According to [63], this lack strengthens the institutional power of others and can lead to a decrease in inclusiveness, partial delegitimization, and a general weakening of the decision-making process. If a stakeholder is weakly or not at all connected to other stakeholders, this does not mean that his or her opinion is unimportant [55]. Therefore, it is suggested to involve these stakeholders more actively in the dialogue and decision-making process on nature conservation policy in the future.

The Natura 2000 network has important implication on many sectors competing for or using the same land. Therefore, Natura 2000 management plans must take the interests and views of a large number of stakeholders from different institutions and sectors into account. In addition, Natura 2000 management plans should be well integrated into other sectors and policies, as they are directly or indirectly affected by decisions taken within the Natura 2000. As a result conflicts of interest arise. The conflict network showed a similar position of the institutions in the participatory process of the formulation PUN as a cooperation network. IRSNC and MESP were the institutions with central positions in a conflict network, as they lead and organized the PUN process, due to their role in the nature conservation system in Slovenia. Thus, they were in contact with many other stakeholders from different institutions and sectors. Each contact has the potential to bring a new conflict. Among IRSNC and MESP, there is also an NGO, BirdLife Slovenia, and representatives of farmers and landowners (CAFS), who took a central position in the conflict network. The NGO BirdLife Slovenia was very active in the cooperation network, where it had many contacts with other institutions and, consequently, often came into conflicts with others due to different opinions on conservation measures related to birds. In addition, the NGO BirdLife Slovenia participated in various sectoral workshops, which led to conflicts with different sectors. CAFS, representing farmers and landowners, was in conflict mainly because of the amount of compensation for payments for restrictions in Rural Development Programme and the reduction of the number of allowed cuttings due to the delayed harvest date.

According to the structure of the cooperation and conflict networks, in the case of PUN, it can be said that it is a more favorable structure for a top-down decision-making process than a bottom-up one, which means that the transformation from a state government dominating the nature conservation approach to a more collaborative governance form might not be enduring. This is not surprising, as Slovenia has been traditionally dominated by a policy of command and control with dominated state institutions in the past, and this still affects the institutional capacity to develop an adequate participatory process for interaction between stakeholders from different levels, which consequently influences the legitimacy of the decision-making process. Many studies provided evidence that a top-down implementation approach prevailed in most EU countries, which causes conflicts with various stakeholders (mainly land users) who felt excluded [13,14]. This led to a "participatory" shift towards more socially inclusive and participatory bottom-up approaches, as reported in Weiss et al. [13].

The results regarding cross-sectoral cooperation between institutions in the participatory process of the formulation of PUN were predictable. The cooperation process in the formulation of PUN in Slovenia was clearly cross-sectoral, as institutions that belong to the same sector tend to have more mutual cooperation. The reason for the sectoral fragmentation in our research lies in the fact that workshops (round tables) and meetings for institutions within a sector were separately organized, which ensures the intra-sectoral exchange of knowledge and enables the sectoral prioritization of objectives. According to the results, the nature conservation sector was in a dominant position with the greatest influence on framing the policy process of the formulation of PUN, as Natura 2000 is a core pillar of nature conservation policy in the EU. As many stakeholders from different institutions and sectors were involved in the participatory process of the formulation of PUN, a lot of time and resources were needed to design the policy, often without achieving a satisfactory compromise between

the different interests, as there are advocacy coalitions networks organized around shared normative commitments and causal beliefs in each political subsystem [74]. These coalitions are resistant to change and conflicts between them can create polarized policy problems. According to the results of our study, such problems occur, for example, between forestry and nature conservation coalitions over the amount of deadwood and the restrictions of the construction of forest roads between agriculture and nature conservation over appropriate mowing periods or over Natura 2000 payments in the Rural development programme. Previous studies have often shown that nature conservation and forestry coalitions are in opposition to each with respect to the implementation of Natura 2000 [13]. For instance, Ferlin et al. [75] found that the cause of the conflict between nature conservation and the forestry sector in Slovenia can be traced to divergent conceptions of what is "appropriate" nature conservation in forestry—either segregation from areas that are actively managed (as seen by the MESP) or integrated activities within sustainable management, as seen by SFS and MAFF. Moreover, many studies describe conflicts between competing nature conservation and land use policy advocacy coalitions and provided evidence that land use policy coalitions have resisted expansion of the Natura 2000 network and increased enforcement in many EU countries [34–36,76–78]. Thus, the pro and contra coalitions appear to exist in most EU Member States [13]. In our study, the exception was the fishery and water sector, where there appeared to be many more intra-sectoral conflicts than conflicts with other sectors. In this case, intra-sectoral conflicts could merge due to the fact that, in the process of the formulation of PUN, institutions from the fishery sector and institutions from the water sector were merged into one sector. Another explanation could be found in the fact that different legal and policy frameworks specific for each sector regulate both sectors separately. It is therefore expected that each sector will have to ensure the implementation of its own objectives and measures and represent different interests and values that may cause conflict.

However, policy enforcement of PUN and practical management at local level might be limited due to the observed structure of the cooperation network, where the lack of power and involvement of stakeholders from the local level (landowners' representatives, except CAFS, land users, municipalities, rural development agencies, and other concerned social groups) is noticed. Moreover, some institutions of the network took a peripheral position. This finding is in line with the study done by Laktić and Pezdevšek Malovrh [38], which show that the main limit of the PUN was related to stakeholders' involvement, where some groups of stakeholders felt excluded from the process or were only involved only in the final stage. They argued that one reason for that could be found in the fact that only the interests of privileged stakeholders were included in the decision-making process, while other marginalized stakeholders were only informed regarding the results of the process in the final stage. For policy decision-makers, it is necessary to balance the involvement of all stakeholders' groups from different institutions and to combine participation with co-responsibility in order to improve the perceived influence of the institutions. Especially, as more frequent participation of local level stakeholders is needed in the initial phase and should be based on consensus decision-making and involvement is a good example of this, which would improve future PUN participation processes. The Austrian Forest Forum, where landowners have had the opportunity to participate in the dialog process via an internet platform or through written statements. In addition, landowners in the Austrian Forest Forum were kept informed through a Forest Dialog Newsletter [79].

When interpreting the results of this study, it should be noted that the approach has some limitations. The SNA approach in this study is based on whether or not the connections/ties between institutions exist. The strength of these connections was not considered, although it was recorded, because the strength of the tie was reported at individual (and not organizational) level and as most reported ties very similar strength (participants did not report weak ties). Therefore, tie strengths were not taken into account; it use would not add much information, while it would significantly increase the complexity of the presented results. The analysis only considers the cooperation and conflict network of the formulation of PUN of stakeholders from different institutions that participated in the survey. Based on the responses of the respondents (n = 167), the present study does not reveal

the opinions of the silent majority, or their future behaviour. Due to confidentiality concerns, the non-respondents were not followed up, so that the differences with the respondents were not estimated. However, the number of respondents in the survey was large enough to represent an important part of the network. The 167 stakeholders came from 34 different institutions, representing 38.64% of all (88) institutions involved in the process of the formulation of PUN. The representativeness of the sample was checked by examining the distribution of respondents to see whether they were randomly distributed across sectors. As shown in Table 1, responses of the forestry sector are over-represented when compared with the agriculture sector. However, the distribution across categories of stakeholders from different sectors can be considered to be comparable, as it is able to take into account the interests of all sectors (Table 1). In addition, the authors consider that the SNA is sufficient to identify relevant stakeholders that are located in the core of the network or that represent specific group categories in the network. After all, 167 stakeholders have revealed with whom they were involved in the process of the formulation of PUN. Therefore, their answers reveal not only their activities or only their ties, but also those with whom they cooperated. Since the importance of stakeholders in the network is primarily judged by how they are seen by others, we were able to identify the most important stakeholders, even if they (or their employees) did not participate in the survey. With regard to the methodology adopted and the survey questionnaires, SNA have the advantage of being simple and easy to apply. The limitations of the survey methods applied are typical for questionnaires, such as incomplete answers or the low reliability of answers to certain questions. Another example of the limitations in this study is the classification of stakeholders and their institutions into sectors. Some institutions, such as MESP, MAFF, and ULJ BF, cover more than one sector. As the survey was anonymous, the respondents were asked to indicate their institution. The institutions indicated were grouped into sectors according to the criteria of dominance of stakeholders from a particular sector. For example, most of the MAFF stakeholders work in the agriculture sector and less in the forestry sector. Therefore, in our study, MAFF is grouped with the agriculture sector. The limitations of SNA and blockmodeling are also that the number of respondents influences the results. In this case, SFS and CAFS are institutions with many stakeholders (employees) involved in the process of the formulation of PUN and also many of them have responded to our survey. Consequently, their importance in the process might be somewhat exaggerated. Therefore, the analysis should be extended in the future studies to include a qualitative assessment of the network. A combination of the qualitative and quantitative approach would provide better insight into stakeholder participation in the case of the formulation of PUN.

5. Conclusions

In recent decades, the number of studies analysing participatory processes in natural resource management have rapidly increased [8,22,26,35,36,41,46,55,57,74,80,81]. Nevertheless, the analysis of the relationship between stakeholders and decisions taken during the formulation process of Natura 2000 management plans remains within the scope of the study. The present study attempts to contribute to the scientific debate in this area, focusing on the stakeholders' analysis and relationships (cooperation and conflicts) between the stakeholders during the participatory process of the formulation of Natura 2000 management programme in Slovenia. The results identify institutions and sectors that have a central position in a cooperation and conflict network and, thus, have the highest power to influence a decision-making process. In addition, institutions that acted in isolation and passively participated in the formulation of the Natura 2000 management programme or were separated from the network. Understanding the participation planning failures and integrating the perspectives of the periphery or marginalised group of stakeholders from different institutions into the future participatory processes of the formulation of Natura 2000 management programme could lead to better management plan enforcement at the local level and defuse potential conflicts. Therefore, it is important for policy decision makers to empower different groups of stakeholders from different institutions and sectors in further participatory processes and balance the interventions of different groups of stakeholders during the negotiation process. Furthermore, the study showed the usefulness of the methodology in

identifying relevant stakeholders and institutions that are involved in the decision-making process of the formulation of PUN.

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Appendix A

Table A1. Top 10 in the degree of centrality values (DC) for institutions in the undirected network of cooperation.

Nº	Institution (Acronym)	Sector	DC
1	IRSNC	Nature conservation	57
2	MESP	Nature conservation	55
3	CAFS	Agriculture	47
4	MAFF	Agriculture	44
5	SFS	Forestry and hunting	38
6	NGO BirdLife Slovenia	Nature conservation	18
7	TNP	Nature conservation	17
8	FU, IWRS	Fishery and water	16
9	CCFF	Nature conservation	15
10	ULJ_BF, SEA	Nature conservation respectively	14

Table A2. Top 10 in the betweenness centrality values (BC) for institutions in the undirected network of cooperation.

Nº	Institution (Acronym)	Sector	BC
1	IRSNC	Nature conservation	985.06
2	MESP	Nature conservation	884.61
3	CAFS	Agriculture	585.87
4	MAFF	Agriculture	451.97
5	SFS	Forestry and hunting	386.92
6	TNP	Nature conservation	34.55
7	FU	Fishery and water	33.79
8	NGO BirdLife Slovenia	Nature conservation	32.10
9	SEA	Nature conservation	22.84
10	Sava projekt	Other	19.82

Table A3. Top 10 indegree centrality values (IDC) for institutions in directed network of cooperation.

Nº	Institution (Acronym)	Sector	IDC
1	IRSNC	Nature conservation	22
2	MESP	Nature conservation	17
3	NGO BirdLife Slovenia, SEA	Nature conservation respectively	14
4	CCFF	Nature conservation	13
5	ULJ_BF	Nature conservation	11
6	MAFF	Agriculture	10
7	FRIS, Municipalities, TNP	Fishery and water, Nature conservation, Other	9
8	SFS, RCSASA, NP Ljubljansko barje, NP Goričko CAFS, SFI	Forestry and hunting, Nature conservation, Nature conservation, Nature conservation, Agriculture, Forestry and hunting	8
9	IWRS	Fishery and water	7
10	FFFRS, RDA, FU, NIB, AIS, WME DRAVA	Forestry and hunting, other, Fishery and water, Nature conservation, Agriculture and, other	6

Table A4. Top 10 in the degree of centrality values (DC) for institutions in undirected network of conflicts.

Nº	Institution (Acronym)	Sector	DC
1	IRSNC	Nature conservation	19
2	MESP	Nature conservation	13
3	NGO BirdLife Slovenia	Nature conservation	9
4	CAFS	Agriculture	7
5	SEA, MAFF, AAMRD	Nature conservation, Agriculture, Agriculture	5
6	Municipalities, FFF RS, DEM	Other, Forestry and hunting, Other	4
7	HESS, SNFS, FME Bled, NP Goričko, NP Ljubljansko barje, MI, FU, SFS, PFOA, FRIS	Other, Fishery and water, Forestry and hunting, Nature conservation, Nature conservation, other, Fishery and water, Forestry and hunting, Forestry and hunting, Fishery and water	3
8	DARS, IWRS, HUS, RCSASA	Other, Fishery and water, Forestry and hunting, Fishery and water, Nature conservation	2
9	CCFF, ELES, FME Postojna, SFI, HSE, MC, RP Škocjanske jame, TNP, ZOSPEUM	Nature conservation, Other, Forestry and hunting, Forestry and hunting, Fishery and water, Other, Nature conservation, Nature conservation, Nature conservation	1
10	The Rest		0

References

1. Jones-Walters, L.; Čivić, K. European protected areas: Past, present and future. *J. Nat. Conserv.* **2013**, *21*, 122–124. [CrossRef]
2. Jones-Walters, L.; Çil, A. Biodiversity and stakeholder participation. *J. Nat. Conserv.* **2011**, *19*, 327–329. [CrossRef]
3. Keulartz, J. European Nature Conservation and Restoration Policy—Problems and Perspectives. *Restor. Ecol.* **2009**, *17*, 446–450. [CrossRef]
4. Louette, G.; Adriaens, D.; Adriaens, P.; Anselin, A.; Devos, K.; Sannen, K.; Van Landuyt, W.; Paelinckx, D.; Hoffmann, M. Bridging the gap between the Natura 2000 regional conservation status and local conservation objectives. *J. Nat. Conserv.* **2011**, *19*, 224–235. [CrossRef]

5. European Commission. *Directive 2009/147/EC of the European Parliament and of the Council on the Conservation of Wild Birds*; European Commission: Brussels, Belgium, 1992.
6. European Economic Community. *European Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora*; European Economic Community: Brussels, Belgium, 1992.
7. Beunen, R.; de Vries, J.R. The governance of Natura 2000 sites: The importance of initial choices in the organisation of planning processes. *J. Environ. Plan. Manag.* **2011**, *54*, 1041–1059. [CrossRef]
8. Winter, S.; Borrass, L.; Geitzenauer, M.; Blondet, M.; Breibeck, R.; Weiss, G.; Winkel, G. The impact of Natura 2000 on forest management: A socio-ecological analysis in the continental region of the European Union. *Biodivers. Conserv.* **2014**, *23*, 3451–3482. [CrossRef]
9. Kovács, E.; Kelemen, E.; Kiss, G.; Kalóczkai, Á.; Fabók, V.; Mihók, B.; Megyesi, B.; Pataki, G.; Bodorkós, B.; Balázs, B.; et al. Evaluation of participatory planning: Lessons from Hungarian Natura 2000 management planning processes. *J. Environ. Manag.* **2017**, *204*, 540–550. [CrossRef]
10. Louette, G.; Adriaens, D.; Paelinckx, D.; Hoffmann, M. Implementing the Habitats Directive: How science can support decision making. *J. Nat. Conserv.* **2015**, *23*, 27–34. [CrossRef]
11. Apostolopoulou, E.; Drakou, E.G.; Pediaditi, K. Participation in the management of Greek Natura 2000 sites: Evidence from a cross-level analysis. *J. Environ. Manag.* **2012**, *113*, 308–318. [CrossRef]
12. Stringer, L.C.; Paavola, J. Participation in environmental conservation and protected area management in Romania: A review of three case studies. *Environ. Conserv.* **2013**, *40*, 138–146. [CrossRef]
13. Weiss, G.; Sotirov, M.; Sarvašova, Z. *Implementation of Natura 2000 in Forests*; European Forest Institute—What Scienec Can Tell Us; Sotirov, M., Ed.; European Forest Institute: Joensuu, Finland, 2017; pp. 39–58. Available online: http://www2.efi.int/files/attachments/publications/wsctu7_2017.pdf (accessed on 9 February 2020).
14. Blondet, M.; de Koning, J.; Borrass, L.; Ferranti, F.; Geitzenauer, M.; Weiss, G.; Turnhout, E.; Winkel, G. Participation in the implementation of Natura 2000: A comparative study of six EU member states. *Land Use Policy* **2017**, *66*, 346–355. [CrossRef]
15. Ferranti, F.; Turnhout, E.; Beunen, R.; Behagel, J.H. Shifting nature conservation approaches in Natura 2000 and the implications for the roles of stakeholders. *J. Environ. Plan. Manag.* **2014**, *57*, 1642–1657. [CrossRef]
16. Šobot, A.; Lukšič, A. The Impact of Europeanisation on the Nature Protection System of Croatia: Example of the Establishment of Multi-Level Governance System of Protected Areas NATURA 2000. *Soc. Ekol. Časopis Ekološku Misao Sociol. Istraživanja Okoline* **2016**, *25*, 235–270. [CrossRef]
17. Cent, J.; Grodzińska-Jurczak, M.; Pietrzyk-Kaszyńska, A. Emerging multilevel environmental—A case of public participation in Poland. *J. Nat. Conserv.* **2014**, *22*, 93–102. [CrossRef]
18. Kamphorst, D.A.; Bouwma, I.M.; Selnes, T.A. Societal engagement in Natura 2000 sites. A comparative analysis of the policies in three areas in England, Denmark and Germany. *Land Use Policy* **2017**, *61*, 379–388. [CrossRef]
19. Gallo, M.; Pezdevšek Malovrh, Š.; Laktić, T.; De Meo, I.; Paletto, A. Collaboration and conflicts between stakeholders in drafting the Natura 2000 Management Programme (2015–2020) in Slovenia. *J. Nat. Conserv.* **2018**, *42*, 36–44. [CrossRef]
20. Kluvánková-Oravská, T.; Chobotová, V.; Banaszak, I.; Slavikova, L.; Trifunovova, S. From Government to Governance for Biodiversity: The Perspective of Central and Eastern European Transition Countries. *Environ. Policy Gov.* **2009**, *19*, 186–196. [CrossRef]
21. Young, J.C.; Jordan, A.; Searle, K.R.; Butler, A.; Chapman, D.S.; Simmons, P.; Watt, A.D. Does stakeholder involvement really benefit biodiversity conservation? *Biol. Conserv.* **2013**, *158*, 359–370. [CrossRef]
22. Brescancin, F.; Dobšinská, Z.; De Meo, I.; Šálka, J.; Paletto, A. Analysis of stakeholders' involvement in the implementation of the Natura 2000 network in Slovakia. *For. Policy Econ.* **2018**, *89*, 22–30. [CrossRef]
23. Cent, J.; Mertens, C.; NiedziałKowski, K. Roles and impacts of non-governmental organizations in Natura 2000 implementation in Hungary and Poland. *Environ. Conserv.* **2013**, *40*, 119–128. [CrossRef]
24. Ferranti, F.; Beunen, R.; Speranza, M. Natura 2000 Network: A Comparison of the Italian and Dutch Implementation Experiences. *J. Environ. Policy Plan.* **2010**, *12*, 293–314. [CrossRef]
25. Geitzenauer, M.; Hogl, K.; Weiss, G. The implementation of Natura 2000 in Austria—A European policy in a federal system. *Land Use Policy* **2016**, *52*, 120–135. [CrossRef]
26. Lovrić, M.; Lovrić, N.; Schraml, U.; Winkel, G. Implementing Natura 2000 in Croatian forests: An interplay of science, values and interests. *J. Nat. Conserv.* **2018**, *43*, 46–66. [CrossRef]

27. McCauley, D. Sustainable development and the 'governance challenge': The French experience with Natura 2000. *Eur. Environ.* **2008**, *18*, 152–167. [CrossRef]
28. Rauschmayer, F.; Van den Hove, S.; Koetz, T. Participation in EU Biodiversity Governance: How Far beyond Rhetoric? *Environ. Plan. C Gov. Policy* **2009**, *27*, 42–58. [CrossRef]
29. De Meo, I.; Brescancin, F.; Graziani, A.; Paletto, A. Management of Natura 2000 sites in Italy: An exploratory study on stakeholders' opinions. *J. For. Sci.* **2016**, *62*, 511–520. [CrossRef]
30. Julien, B.; Lammertz, M.; Barbier, J.M.; Jen, S.; Ballesteros, M.; de Bovi, C. Voicing interests and concerns: NATURA 2000: An ecological network in conflict with people. *For. Policy Econ.* **2000**, *1*, 357–366. [CrossRef]
31. Winkel, G.; Blondet, M.; Borrass, L.; Frei, T.; Geitzenauer, M.; Gruppe, A.; Jump, A.; de Koning, J.; Sotirov, M.; Weiss, G.; et al. The implementation of Natura 2000 in forests: A trans- and interdisciplinary assessment of challenges and choices. *Environ. Sci. Policy* **2015**, *52*, 23–32. [CrossRef]
32. Baynham-Herd, Z.; Redpath, S.; Bunnefeld, N.; Molony, T.; Keane, A. Conservation conflicts: Behavioural threats, frames, and intervention recommendations. *Biol. Conserv.* **2018**, *222*, 180–188. [CrossRef]
33. Šorgo, A.; Špur, N.; Škornik, S. Public attitudes and opinions as dimensions of efficient management with extensive meadows in Natura 2000 area. *J. Environ. Manag.* **2016**, *183*, 637–646. [CrossRef]
34. Paavola, J. Protected Areas Governance and Justice: Theory and the European Union's Habitats Directive. *Environ. Sci.* **2004**, *1*, 59–77. [CrossRef]
35. Sarvašova, Z.; Šalka, J.; Dobšinska, Z. Mechanism of cross-sectoral coordination between nature protection and forestry in the Natura 2000 formulation process in Slovakia. *J. Environ. Manag.* **2013**, *127*, 65–72. [CrossRef] [PubMed]
36. Sotirov, M.; Lovrić, M.; Winkel, G. Symbolic transformation of environmental governance: Implementation of EU biodiversity policy in Bulgaria and Croatia between Europeanization and domestic politics. *Environ. Plan. C Gov. Policy* **2015**, *33*, 986–1004. [CrossRef]
37. Blicharska, M.; Orlikowska, E.H.; Roberge, J.M.; Grodzinska-Jurczak, M. Contribution of social science to large scale biodiversity conservation: A review of research about the Natura 2000 network. *Biol. Conserv.* **2016**, *199*, 110–122. [CrossRef]
38. Laktić, T.; Pezdevšek Malovrh, Š. Stakeholder Participation in Natura 2000 Management Program: Case Study of Slovenia. *Forests* **2018**, *9*, 599. [CrossRef]
39. Vuletić, D.; Krajter Ostoić, S.; Kiš, K.; Posavec, S.; Avdibegović, M.; Blagojević, D.; Marić, B.; Paladinić, E. Conflicts between forestry and nature protection - case studies of two Nature Parks in Croatia. *Period. Biol.* **2009**, *111*, 467–478.
40. Marić, B.; Avdibegović, M.; Blagojević, D.; Bećirović, D.; Brajić, A.; Mutabdžija, S.; Delić, S.; Pezdevšek Malovrh, Š. Conflicts between forestry and wood-processing industry in Bosnia-Herzegovina: Reasons, Actors and Possible Solutions. *South-East Eur. For.* **2012**, *3*, 41–48. [CrossRef]
41. Reed, M.S. Stakeholder participation for environmental management: A literature review. *Biol. Conserv.* **2008**, *141*, 2417–2431. [CrossRef]
42. Elsasser, P. Rules for participation and negotiation and their possible influence on the content of a National Forest Programme. *For. Policy Econ.* **2002**, *4*, 291–300. [CrossRef]
43. Blanc, S.; Lingua, F.; Bioglio, L.; Pensa, R.G.; Brun, F.; Mosso, A. Implementing Participatory Processes in Forestry Training Using Social Network Analysis Techniques. *Forests* **2018**, *9*, 463. [CrossRef]
44. Lienert, J.; Schnetzer, F.; Ingold, K. Stakeholder analysis combined with social network analysis provides fine-grained insights into water infrastructure planning processes. *J. Environ. Manag.* **2013**, *125*, 134–148. [CrossRef] [PubMed]
45. dos Muchangos, L.S.; Tokai, A.; Hanashima, A. Stakeholder analysis and social network analysis to evaluate the stakeholders of a MSWM system—A pilot study of Maputo City. *Environ. Dev.* **2017**, *24*, 124–135. [CrossRef]
46. Reed, M.S.; Graves, A.; Dandy, N.; Posthumus, H.; Hubacek, K.; Morris, J.; Prell, C.; Quinn, C.H.; Stringer, L.C. Who's in and why? A typology of stakeholder analysis methods for natural resource management. *J. Environ. Manag.* **2009**, *90*, 1933–1949. [CrossRef]
47. Prell, C.; Hubacek, K.; Reed, M. Stakeholder Analysis and Social Network Analysis in Natural Resource Management. *Soc. Nat. Resour.* **2009**, *22*, 501–518. [CrossRef]
48. Nastran, M. Stakeholder analysis in a protected natural park: Case study from Slovenia. *J. Environ. Plan. Manag.* **2014**, *57*, 1359–1380. [CrossRef]

49. Mitchell, R.K.; Agle, B.R.; Wood, D.J. Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. *Acad. Manag. Rev.* **1997**, *22*, 853–886. [CrossRef]
50. Brugha, R.; Varvasovszky, Z. Stakeholder analysis: A review. *Health Policy Plan.* **2000**, *15*, 239–246. [CrossRef]
51. Geitzenauer, M.; Blondet, M.; de Koning, J.; Ferranti, F.; Sotirov, M.; Weiss, G.; Winkel, G. The challenge of financing the implementation of Natura 2000—Empirical evidence from six European Union Member States. *For. Policy Econ.* **2017**, *82*, 3–13. [CrossRef]
52. Grodzinska-Jurczak, M.; Cent, J. Expansion of Nature Conservation Areas: Problems with Natura 2000 Implementation in Poland? *Environ. Manag.* **2011**, *47*, 11–27. [CrossRef]
53. Bodin, Ö.; Crona, B.; Ernstson, H. Social networks in natural resource management: What is there to learn from a structural perspective? *Ecol. Soc.* **2006**, *11*, 8. [CrossRef]
54. Alexander, S.M.; Andrachuk, M.; Armitage, D. Navigating governance networks for community-based conservation. *Front. Ecol. Environ.* **2016**, *14*, 155–164. [CrossRef]
55. Paletto, A.; Hamunen, K.; De Meo, I. Social Network Analysis to Support Stakeholder Analysis in Participatory Forest Planning. *Soc. Nat. Resour.* **2015**, *28*, 1108–1125. [CrossRef]
56. Manolache, S.; Nita, A.; Ciocanea, C.M.; Popescu, V.D.; Rozylowicz, L. Power, influence and structure in Natura 2000 governance networks. A comparative analysis of two protected areas in Romania. *J. Environ. Manag.* **2018**, *212*, 54–64. [CrossRef] [PubMed]
57. Lovrić, M.; Lovrić, N.; Schraml, U. Modeling policy networks: The case of Natura 2000 in Croatian forestry. *For. Policy Econ.* **2019**, *103*, 90–102. [CrossRef]
58. Bodin, Ö.; Crona, B.I. The role of social networks in natural resource governance: What relational patterns make a difference? *Glob. Environ. Chang.* **2009**, *19*, 366–374. [CrossRef]
59. Dillman, D.A. *Mail and Internet Survey: The Tailored Design Method*, 2nd ed.; John Wiley & Sons: Hoboken, NJ, USA, 2007.
60. Crona, B.; Bodin, Ö. What you know is who you know? Communication patterns among resource users as a prerequisite for co-management. *Ecol. Soc.* **2006**, *11*, 7. [CrossRef]
61. Freeman, L.C. Centrality in social networks conceptual clarification. *Soc. Netw.* **1978**, *1*, 215–239. [CrossRef]
62. Newman, M.E.J. A measure of betweenness centrality based on random walks. *Soc. Netw.* **2005**, *27*, 39–54. [CrossRef]
63. Paletto, A.; Ferretti, F.; De Meo, I. The role of social networks in forest landscape planning. *For. Policy Econ.* **2012**, *15*, 132–139. [CrossRef]
64. Borgatti, S.P.; Everett, M.G.; Johnson, J.C. *Analyzing Social Networks*, 2nd ed.; SAGE Publications Ltd.: London, UK, 2013; p. 384.
65. Žiberna, A. Generalized blockmodeling of valued networks. *Soc. Netw.* **2007**, *29*, 105–126. [CrossRef]
66. Batagelj, V.; Mrvar, A. *Pajek—Analysis and Visualization of Large Networks*; Graph Drawing Software; Jünger, M., Mutzel, P., Eds.; Springer: Berlin/Heidelberg, Germany, 2004; pp. 77–103.
67. Batagelj, V.; Mrvar, A. *Pajek—Program for Large Network Analysis. Connections. 5.07*; University of Ljubljana: Ljubljana, Slovenia, 2019.
68. Wouter De, N.; Mrvar, A.; Batagelj, V. *Exploratory Social Network Analysis with Pajek: Revised and Expanded Edition for Updated Software*, 3rd ed.; Cambridge University Press: Cambridge, MA, USA, 2018.
69. R Core Team. *R: A Language and Environment for Statistical Computing, 3.3.1*; R Core Team: Vienna, Austria, 2018.
70. Butts, C.T. Sna: Tools for Social Network Analysis, 2.4. *J. Stat. Softw.* **2008**, *24*, 1–51.
71. Csardi, G.; Nepusz, T. The Igraph Software Package for Complex Network Research. *Interj. Complex Syst.* **2006**, *1695*, 1–9.
72. Žiberna, A. *Blockmodeling 0.3.3: An R Package for Generalized and Classical Blockmodeling of Valued Networks, 0.3.3*; University of Ljubljana: Ljubljana, Slovenia, 2018.
73. Muthoo, A. *Bargaining Theory with Applications*; Cambridge University Press: Cambridge, MA, USA, 1999; p. 376.
74. Tikkanen, J.; Leskinen, L.; Leskinen, P. Forestry Organization Network in Northern Finland. *Scand. J. For. Res.* **2003**, *18*, 547–559. [CrossRef]

75. Ferlin, F.; Golob, A.; Habič, Š. Some principles for successful forest conservation management and forestry experiences in establishing the Natura 2000 network. In *Legal Aspects of European Forest Sustainable Development, Proceedings of the 7th International Symposium, Zlatibor Mountain, Serbia, 11–15 May 2005*; Schmithüsen, F., Herbst, P., Nonic, D., Jovic, D., Stanisic, M., Eds.; Swiss Federal Institute of Technology, ETH: Zlatibor Mountain, Serbia, 2005; p. 11.
76. Borrass, L.; Sotirov, M.; Winkel, G. Policy change and Europeanization: Implementing the European Union's Habitats Directive in Germany and the United Kingdom. *Environ. Politics* **2015**, *24*, 788–809. [CrossRef]
77. Börzel, A.T. *Coping with Accession to the European Union: New Modes of Environmental Governance in Southern, Central and Eastern Europe*; Palgrave Macmillan UK: London, UK, 2009.
78. Börzel, T.A.; Buzogány, A. Governing EU accession in transition countries: The role of non-state actors. *Acta Politica* **2010**, *45*, 158–182. [CrossRef]
79. Hogl, K.; Pregernig, M.; Weiss, G. What is new about new forest owners? A typology of private forest ownership in Austria. *Small-Scale For. Econ. Manag. Policy* **2005**, *4*, 325–342. [CrossRef]
80. Saarikoski, H.; Tikkanen, J.; Leskinen, L.A. Public participation in practice—Assessing public participation in the preparation of regional forest programs in Northern Finland. *For. Policy Econ.* **2010**, *12*, 349–356. [CrossRef]
81. Mauerhofer, V. Public participation in environmental matters: Compendium, challenges and chances globally. *Land Use Policy* **2016**, *52*, 481–491. [CrossRef]

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What (De)Motivates Forest Users' Participation in Co-Management? Evidence from Nepal

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Abstract: The co-management concept has been echoed in scientific literature for over two decades. Emphasis has been tailored towards an understanding of structural and functional issues linked to its application and the outcomes thereof. However, a crucial aspect which still begs for scientific and policy edification, concerns the motivational drivers of actors' participation in co-management arrangements. Studies contend that actors are motivated to participate in co-management based on their perceived benefits (e.g., income). Conclusions from these lines of argument further raise a theoretical quagmire, requiring further grounding, with regards to context-specific (de)motivators of users' participation in co-management. The case of Nepal is pertinent. Although Nepal has a rich community-based forest management history, scientific investigations have virtually ignored the motivational drivers of participation in the co-management of natural resources (forests). Against this background, this paper seeks to explore the following: (i) the decision-making and monitoring structure of rules regulating the co-management of forests, (ii) the implications of this system on users' motivation to participate, and (iii) the motivational drivers of users' participation in co-management. To achieve this, five focus group discussions and 10 key informant interviews were conducted in five villages (Kunjo, Titi, Parshyang, Cchayo, and Taglung) within the Annapurna Conservation Area (ACA). We further employed narratives, framework, and thematic analyses to discuss the decision-making structure and motivational aspects of co-management. The results point to the following conclusions: (1) Despite the rather top-down decision-making setting, users remain motivated to participate in co-management. (2) Interestingly, the motivation by actors to participate is not largely driven by users' perceived benefits. The results present another twist, a deviation from the previously understood rationale, which should be factored into co-management theory development. However, the paper equally makes a succinct request for further studies, including quantitative investigations, to ground this assertion.

Keywords: participation; co-management; forest users; benefits; ACA; Nepal

1. Introduction

1.1. Co-Management in Natural Resources

In the 1990s, a new wave of decentralized natural resource management gained popularity in most countries of the Global South. Prior to this, conservation area management for most nations

assumed a leviathan approach, in which state agencies forced down their conservation agenda on local people [1–4]. This state-driven management approach failed in several contexts to address the goals of preserving biodiversity and the related social complexities in the tropics [5], leading to negative repercussions on the socio-ecological dynamics of conservation sites [6–9]. Fringe communities adjacent to conservation areas suffered physical displacement, crop raiding, and livestock loss. This precipitated anti-conservation activities such as poaching, logging, and agricultural encroachment [10].

The new dispensation of decentralization saw the introduction of numerous forms of participatory natural resource management models [11–14], which were implemented through several forms of community-based models. One such model is the co-management approach. Co-management refers to a negotiation process involving two or more stakeholders who define and guarantee a fair sharing of the decision-making arrangements; planning; and management functions, rights, obligations, and benefits thereof in the management of natural resources [15–18]. This approach sought to fuse two usually opposing objectives—human development and natural resource conservation—to derive a mutually beneficial relationship in which both objectives are achieved as championed by their respective stakeholders. A distinction is made between community management and co-management; whereas the former implies that natural resources are exclusively managed by local communities, the latter (co-management) involves several players (state, local authorities, non-governmental organizations, local communities, etc.), making the communities just one of the players in the process [19]. Co-management is premised on a partial devolution to local communities, which almost invariably occurs in response to pressure from international institutions challenging the order which was marked by centralization [19]. It could take the form of informal, quasi-formal, or formal arrangements [9,18]. The latter is usually met with lukewarm participation by state actors, who are generally not willing to undertake effective and binding power-sharing arrangements [20–22]. Irrespective of the resource status, actors involved in co-management processes seek to promote their agenda [23,24]. This model mirrors the relationship and formal agreement between the state and community actors [19,25] who are all motivated (albeit at different levels) to participate in this process.

1.2. Motivational Drivers of Participation

The philosophy of participation is no longer new in the natural resource management and rural development lexicon of most societies [26–29]. Viewed as a catalyst of social change [30], participation has not only been spread through technology transfer in rural development research, but also by challenging state control in the management of natural resources [19,31]. Participation involves three interconnected, but different processes: (1) the involvement of local people in decision-making; (2) the inclusion of local people's perspectives into programs; and (3) the assurance of peoples' participation in benefit sharing from the process [32].

The application of participatory methodologies in natural resource governance has been acknowledged by development practitioners as an effective mechanism for managing existing conflicts, while minimizing the tendency for future conflicts to occur [33]. Despite this acknowledgment, participation has been described in some cases as a new form of tyranny [34], especially in cases where tokenism predominates, shielding the dominance of elites who end up capturing the entire resource management process and the benefits thereof [26]. In this regard, those who participate in the management of natural resources are hardly the true representatives of stakeholders who are directly affected by the decisions being made [35]. Agrawal's typology [27] presents a useful tool to appreciate different forms of participation. Apart from the eight rungs of citizens' participation [26], Agrawal identified six levels of participatory behavior, ranging from "nominal participation" (simple membership in a group), to "interactive (empowering) participation", denoting a situation where participants have a voice and influence the decisions and subsequent course of action (Table 1). In principle, people's perceived benefits could improve their participation, placing them within the active and interactive participation strata. However, several factors (beyond perceived benefits) could shape people's decision to participate in these arrangements.

Table 1. Agrawal's typology of participation.

Form of Participation	Characteristic Features
Nominal participation	Membership in the group
Passive participation	Being informed of decisions ex post facto; or attending meetings and listening in on decision-making, without speaking up
Consultative participation	Being asked an opinion in specific matters without guarantee of influencing decisions
Activity-specific participation	Being asked to (or volunteering to) undertake specific tasks
Active participation	Expressing opinions, whether solicited, or taking initiatives of other sorts
Interactive (empowering) participation	Having voice and influence in the group decision-making

Adapted from [27].

A significant body of literature shows that the driving forces behind participation in natural resource management are contextual; people are motivated to participate due to their embedded socio-cultural, economic, and political benefits [36,37]. Some of the widely documented drivers include cultural benefits, financial benefits, incentives, and prior established links with conservation agents, among others [38,39]. The literature on what motivates people to participate in co-management arrangements is negligible, at least in the context of Nepal. We contribute to unlocking this "black box" by analyzing the range of factors that (de)motivate forest users' participation in co-management in the context of the Annapurna Conservation Area of Nepal. An understanding of these drivers is essential to inform future community-based forest management arrangements, for which Nepal is reputed.

1.3. Community-Based Forest Management in Nepal

As a country, Nepal exhibits significant heterogeneity, encompassing groups of different socio-economic class and interests. This heterogeneity coincides with the diversity in community-based forest management groups [40] and forest dependency [41]. Such disparities are also reflected in the attitudes and behavior of individuals towards community-based practices [1,42]. Before the introduction of different forms of community-based forest management in Nepal in the late 1970s, forests were managed in the form of traditional or indigenous systems through informal co-operation between the communities and forest officials [43]. Upon the recognition of the failure of centralized forestry to conserve forests, different models of community-based forest management were introduced, including a complete devolution model, Community Forestry, and involving greater management autonomy by communities through Community Forestry User Groups (CFUGs) with the supervision and technical facilitation of District Forest Offices (DFOs) [40,41,44]. The leasehold forestry model focused on meeting the twin objectives of regenerating degraded forests and alleviating rural poverty [40,45,46]. This model involves collaboration between the government and the communities, in which resources are shared equally between the two actors [40]. Community-Based Conservation (CBC) was developed, which recognizes the role of local people in planning, decision-making, implementation, and monitoring of the conservation works [47]. This last model is used for conservation areas in Nepal. In Nepal, it is steered by the Annapurna Conservation Area Project (ACAP) and implemented through Conservation Area Management Committees (CAMCs) and relevant sub-committees [44].

In the context of Nepal, while scientific evidence on the governance arrangements and outcomes of community-based forest management have been investigated around conservation areas [44,48], very little is known regarding forest users' motivation to participate in co-management arrangements [49]. For instance, an earlier study in Nepal contends that people are motivated to participate because of their perceived income benefits [37]. This contention virtually ignores intrinsic motivational elements as drivers of participation. Studies are therefore needed to fill this gap, and to inform future co-management policies. Using the case of ACAP, we contribute to bridging this knowledge gap by exploring the drivers of (de)motivation of forest users' participation in co-management. Against this background, the objectives of the paper are threefold: to analyze (i) the decision-making and monitoring structure of rules regulating forest co-management in ACAP, Nepal, (ii) the implications of this system on users' motivation to participate, and (iii) the motivational drivers of users' participation

in co-management. The next sections of this paper are organized as follows. Section 2 outlines the study area, methods employed in data collection, and data analysis. Section 3 presents the results of the co-management arrangements, drivers of forest users' motivation to participate in forest management activities, and their implications thereof in the context of Nepal. Section 4 discusses the results, and Section 5 provides the conclusions.

2. Materials and Methods

2.1. Study Area

The Annapurna Conservation Area Project (ACAP) (Figure 1) is the first and largest protected area in Nepal [46,47,50]. Launched in 1986, it covers an estimated area of 7629 km^2 and is home to over 100,000 people who live in five districts [46]. The ACAP area is an example *par excellence*, of a site that sought to empower local communities to participate in natural resource management. In this regard, it was the first protected area that refrained from using military interventions in enforcing natural resource conservation rules. The goal of ACAP is to achieve sustained balance between nature conservation and the socio-economic improvement of communities in the Annapurna region. This broad vision is overseen by the National Trust for Nature Conservation (NTNC), an independent regulatory body [46].

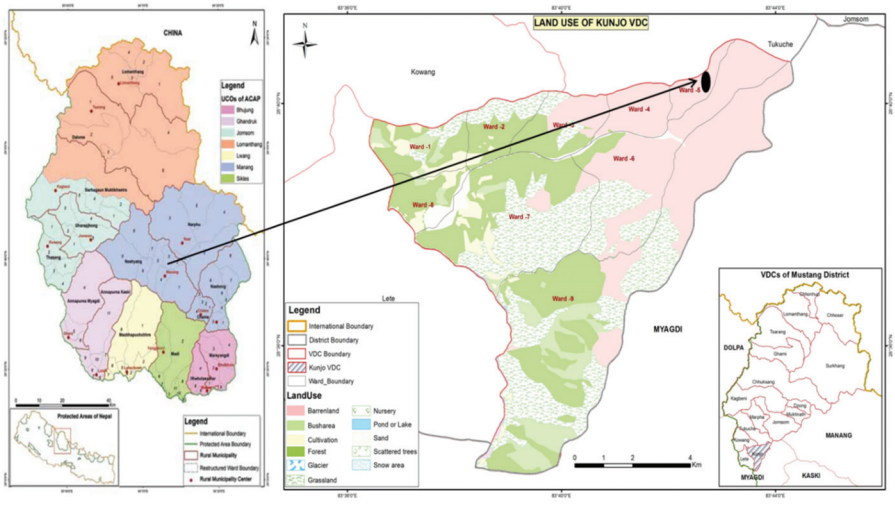

Figure 1. Location of the ACAP (Annapurna Conservation Area Project) area in Nepal.

Agriculture and tourism based businesses are the key livelihood activities of communities in the ACAP area. They cultivate crops; keep livestock; and collect wood, fuelwood, and non-timber forest products (NTFPs) such as mushroom from the forest. Crops are grown on terraced fields spread around the settlements. The major crops are barley, buckwhite, maize, vegetables, potatoes, and apples. Cultivation is supplemented by animal husbandry, involving the rearing of cows, yaks, goats, and horses. Similarly, hotel and trekking businesses are other important livelihood activities that run throughout the year.

Co-management efforts in the ACAP area were initiated in 1986 through the establishment of Conservation Area Management Committees (CAMCs), guided by the integrated community-based conservation and development approach. This is a broad-based and inclusive committee involving representatives of all-natural resource user groups, women, and youth groups, including the lower caste. In principle, it serves as a platform for the planning and organization of co-management activities

in the ACAP area. Within the ACAP area, five villages were purposively selected for the study to include Kunjo, Titi, Parshyang, Taglung, and Chhayo. These villages, based on pre-field studies, were judged to effectively mirror co-management activities (in the context of forest resources) that were of interest in this study. They were equally chosen based on their level of organization and representation in CAMC activities. The villages account for an estimated 153 households (Table 2) in the Lower Mustang District (CAMC work plan, 2015). Another key consideration was the proximal nature of these villages to the ACAP forest area, they are all found within 3 km of the ACAP forest area. Such proximity was judged to be crucial in guiding their level of interaction with the forest. To ensure representativeness, we targeted all the classes of people in this study including poor, very poor, middle class, and rich households.

Table 2. Description of study site.

Village	Total no. of HHs	Average HH Size	Distance from the Forest (km)	No. of FMSCs and WGSCs	Effective Year	Leadership Gender
Kunjo Parshyang	21 33	4 4	1.5 1	FMSC–1 WGSC–1	2014–2019	FMSC: 11 members, 9 males (1 Dalit) and 2 females (Dalits) WGSC: All females
Titi	13	5	1	FMSC–1 WGSC–1	2014–2019	FMSC: 18 members, 12 males (5 Dalits) and 6 females (6 Dalits) WGSC: All females
Taglung	19	3	2–3	FMSC–1 WGSC–1	2014–2019	FMSC: 11 members, 9 males (1 Dalit) and 2 females WGSC: All females
Chhayo	28	5	2–3	FMSC–1 WGSC–1	2014–2019	FMSC: 9 members, 7 males (4 Dalits) and 2 females (2 Dalits) WGSC: All females

Source: Authors' compilation. Note: Effective year denotes the valid period of membership and leadership status. HHs= Households; FMSCs= Forest management sub-committees; WGSCs=Women group sub-committees.

2.2. Data Collection

This paper is a product of an in-depth qualitative investigation on governance in community-based forest management in Nepal, within the framework of the Sustainable Tropical Forestry (SUTROFOR) field study (for details, see https://sutrofor.eu). The design and validation of the research instruments for this study was completed between January and February 2019, while data collection took place in February and March 2019. Two key instruments were used, focus group discussion (FGD) and semi-structured interview guides. The FGD consisted of 14 open-ended questions with a focus on respondents' knowledge and appreciation of the co-management decision-making and monitoring structure in the forest sector, and the (de)motivational factors of users' participation in co-management. The interview guide (12 items) focused on issues linked to the decision-making ladder, the level of participation of members, the level of (non)inclusive representation within CAMCs, their motivation to participate, and other related governance issues to be addressed within CAMCs and Forest Management Sub-Committees (FMSCs). The research tools were initially tested and further refined before effective data collection began.

Prior to the start of data collection, relevant governance documents (CAMC operational rules and management plans) were reviewed to gain further insights on the institutional set up and forest management activities of the ACAP area. The data collection process began with focus group discussions which were conducted with five key actor groups: 1 forest management sub-committee (FMSC), 2 women groups, 1 youth group, and 1 Dalit (lower caste) group. These groups consisted of between 8 and 10 participants who were all given an opportunity to express themselves and to share their views on the co-management process. Each FGD lasted between one hour and one hour thirty minutes. From each focus group, we identified key informants and conducted in-depth interviews with them to profoundly unearth some issues which might not have been openly discussed. In all, there were ten key informant interviews (KIIs): 3 from the Dalits, 3 from FMSC members, 2 from women groups, 1 from the youth group, and 1 interview conducted with the Chairperson of the

CAMC. The latter was conducted to gain insight into the Chairperson's impression of the management setup and their relationship with the National Trust for Nature Conservation (NTNC), the overall decision-making body in the Annapurna Conservation Area Project (ACAP) (Figure 2).

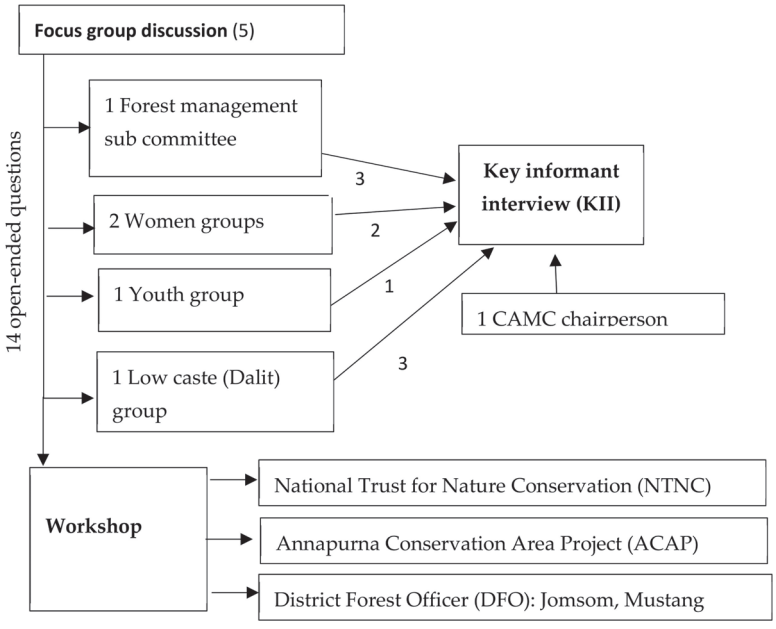

Figure 2. Data collection chart. Note: CAMC = Conservation Area Management Committee.

To further triangulate the information obtained from lower and mid-level stakeholders, the team organized an enlarged workshop session with the NTNC and the Divisional Forest Officials (DFOs) in Jomsom to discuss key governance aspects with regards to the decision-making and monitoring structure, the challenges involved in the implementation of ACAP activities through CAMCs, and the key motivational factors of members' participation in co-management. We used a local translator to interpret the information. In addition, three of the co-authors (Prabin, Anand, and Anisha) are Nepali and supported the translation process. The enlarged stakeholder workshop with NTNC and DFOs was organized in the English Language. Field notes were used to record the FGDs and interviews. The data obtained were transcribed. Based on this, we analyzed the results through narratives, framework, and thematic analysis. Focus here was on the co-management decision-making structure (including roles and interests of actors), the implications of the current structure on users' participation, and the motivational drivers of users' participation in forest management activities.

3. Results

3.1. Decision-Making and Monitoring Structure

The governance and decision-making structure (Figure 3) in the Annapurna Conservation Area Project (ACAP) show three segments: The first segment (a) which indicates a strong flow and counter flow in decision making involves the National Trust for Nature Conservation (NTNC), ACAP, and the Conservation Area Management Committees (CAMC). Here, key decisions, policies and management plans are developed and agreed upon by the NTNC/ACAP. This is done by considering inputs from the CAMC with regards to the lessons learnt in the implementation of management plans and in coordinating sub-committees and forest users during the process. The second segment (b) links the

CAMC and the sub-committees (forest management and women sub-committees). This segment shows a break in the counter flow of information between the women sub-committee and the CAMC, suggesting a timid role played by women in the whole governance ladder (decision making, policy development, monitoring, and regulation instruments). However, both sub-committees reserve the right to manage and use resources in the ACAP. The third segment (c) further shows a break in the flow and counter flow of information between the sub-committees and the general users. While the forest management sub-committee prevails on the general users with regards to the decisions coming from above, this is not the case with the women sub-committee members who themselves experience a break in the upward flow of their views to the ACAP through the CAMC.

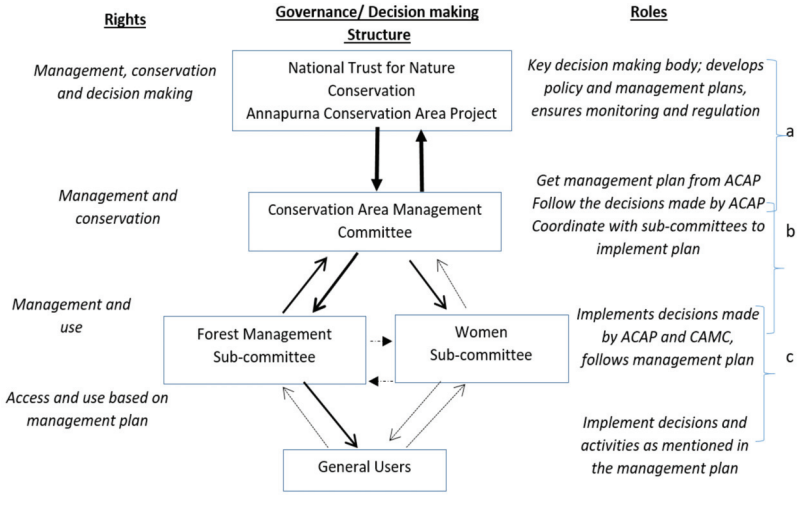

Figure 3. Governance/decision making structure, roles, and rights of co-management actors in ACAP. Note: Bold arrow represents strong decision-making role; the strength decreases as the thickness of arrow decreases. The decision making flow is grouped into three segments a, b, and c as explained above.

The above structure portrays a series of defects in the co-management arrangement. Firstly, co-management generally leads to the development of stakeholder platforms in which ideas and interests are discussed and agreed upon mutually by the parties involved. In the case of the ACAP, there is no clear platform that facilitates the interaction between actors from all three identified segments.

A strong downward spiraling of policies, decisions, and monitoring mechanisms are introduced. While the members of the sub-committees and ACAP are to be chosen from among the general users, the criteria for selection is not clear and well documented; this brings into question the legality of the representatives in these committees. It is then possible to predict a situation of limited users' participation, based on the fragmented upward feedback situation. Segment (c) represents a potential demotivating factor for users' effective participation in co-management.

Case of Decision Making in Timber Harvesting

The case of timber harvesting in the Annapurna Conservation Area Project (ACAP) (Figure 4) indicates a flow of information from the users through sub-committees to the ACAP. Here, users prepare their applications based on the need for timber, this is channeled through the forest management sub-committees (FMSCs) to the Conservation Area Management Committees (CAMC). The CAMC then consults with ACAP to request approval. Following approval, timber harvest passes is issued to the users, specifying the quota to be harvested and the duration. While this structure shows a strong incorporation of needs at the bottom, it still does not clearly depict a co-management structure.

For instance, the rights, obligations, commitments, activities, and monitoring mechanisms are to be negotiated and agreed upon by all actors. However in this case, the influence and decisions are largely coming from ACAP. The issue of joint visioning, decision making, and the assignment of roles and responsibilities is not effectively operational at this level. Equally, the breakage of the flow of information explains why forest users are not fully clear about the reasons behind the acceptance or rejection of their application to harvest timber. This suggests the need for a common platform to deliberate and agree on governance, management, and use issues. Several cases of the rejection of harvesting applications were observed in the ACAP area that were linked to unclear and irregular top-bottom information flow and a weak counter flow from the bottom. Consequently, most timber harvesters do not trust the current decision-making ladder and feel that they benefit very little in the arrangement. This has implications on their motivation to participate as discussed subsequently.

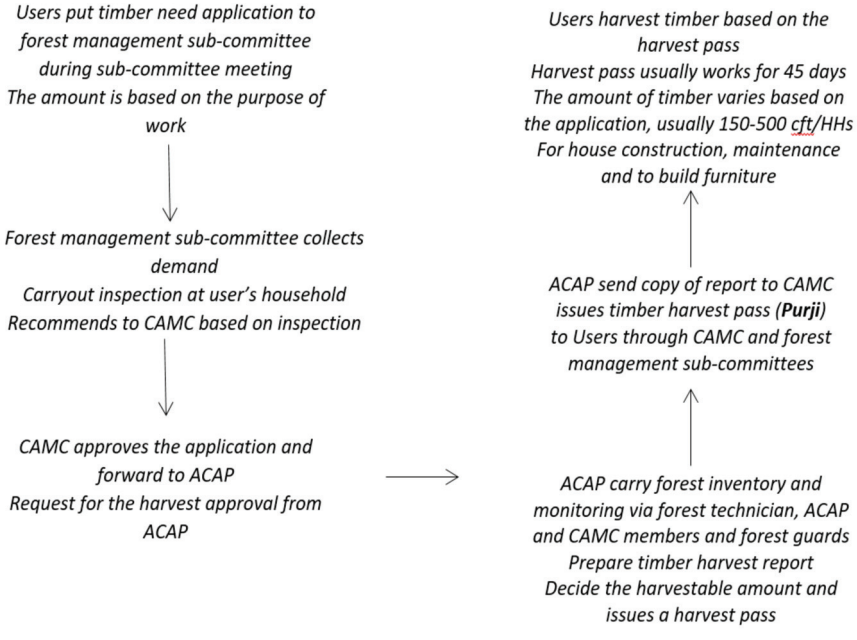

Figure 4. Flow of decision making in timber harvesting process.

3.2. Motivational Drivers of Participation in Co-Management

The motivational drivers of participation in this context are grouped under three categories: economic, social, and ecological (Figure 5).

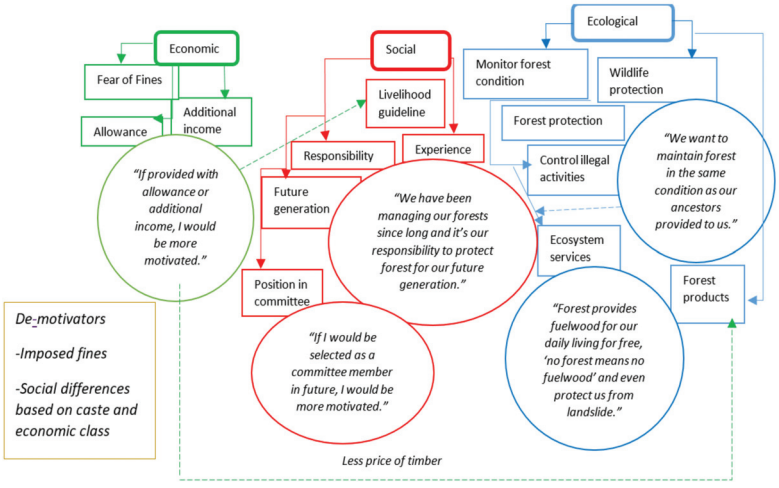

Figure 5. The web of drivers for forests users' (de)motivation to participate in co-management.

3.2.1. Economic Motivation

A few respondents argued that they are motivated to participate since they gain some income from timber extraction and other activities. Some of these activities include providing labor in fulfilling programs in forest conservation and management activities, community development, tourism development, alternative energy, conservation education, and women's development based on their operational plan (Table 3). This applies mainly to people from disadvantaged groups or those with low economic status. The latter base their motivation to participate on the allowances they secure during participation in forest management activities.

Table 3. Benefits received by the users.

Forest Products	Annual Need per HH	Amount (per Local Market)
Timber	40 cft	NRs 200/cft **
Fuelwood	50 Bhari *	NRs 250/Bhari
Fodder	18 Bhari	-
Bamboo (Nigalo)	30 Bhari	NRs 50/Bhari
Leaf litter	100 Bhari	-
NTFPs	Household use	-

* Bhari is a local measurement unit and 1 Bhari = 25 kg. ** This amount can be changed by the general assembly; NTFPs = Non-timber forest products; cft = cubic feet; NRs = Nepalese Rupees; HH = Household. Source: conservation area management plan, 2017.

The additional income users generate from selling forest products, especially when royalty rates to the CAMC and the Forest Management sub-committee (FSMC) are lowered, also represents another motivational aspect. While they felt motivated to participate, very few of the members (especially the youths) showed interest in joining the management committees. Furthermore, while users are aware of the prohibited acts, there is no clear reporting process of illegal activities and their corresponding fines and penalties. This uncertainty creates fear among general users that they may commit a prohibited act without realizing it.

3.2.2. Social Motivation

The general users in the conservation area rely on forest products for subsistence purposes and for generating cash income in support of their agricultural activities. The latter can be attributed to the

fact that a majority of the users consider agriculture as their main source of livelihood. According to respondents, the co-management guidelines, programs, and activities provide a clear plan and vision to protect and manage the forest. This stability and security in their livelihood motivate them to participate in co-managing the forest. Social prestige as community leaders is another important element that triggers people's participation. Some people have used their representation to further grow in the political landscape of Nepal. Having a sense of responsibility to protect the forest for future generations is by far the most recurrent driver of participation, as raised in the focus group discussions and interviews. Participants acknowledge the hard work exerted by their great grandfathers in managing the forest area they are utilizing today, and they want to do the same. As such, some of the users develop a sense of commitment to lead the community and to serve as CAMC or sub-committee members. However, social differences based on caste and economic class demotivates groups, especially the marginalized groups: the poor, women, and the lower caste (Dalits). This translates into nominal and/or passive participation in decision-making and implementation. The demotivated groups are more dependent on the forest, indicating a dire need for their increased inclusion in the decision-making and management spheres.

3.2.3. Ecological Motivation

In relation to ecological issues, users are motivated to participate because of their awareness that it promotes forest and wildlife monitoring and protection. ACAP has been investing in awareness and capacity building for conservation; users now understand that despite getting less direct forest benefits, they enjoy other ecosystem benefits. However, victims of human–wildlife conflicts (crop damage and livestock depredation) are demotivated by this activity since it negatively affects their livelihood. Users of the conservation area prove to have high local environmental awareness despite their limited educational background. They were able to demonstrate knowledge on different ecosystem services, how it impacts their everyday lives, and the benefits they can derive from their environment.

While the general trend of motivation to participate is skewed towards the acquisition of benefits, forest products such as timber, fuelwood, and NTFPs [51], this does not apply in the case of ACAP. Here, a greater number of participants expressed their motivation to participate. Surprisingly, this was not strongly linked to such benefits; rather, they had intrinsic motivation to protect the forest, suggesting that economic incentives are not always the key motivator for participation in natural resource co-management.

4. Discussion

The nuanced link between actors' motivation to participate and the forces shaping their motivation is a subject of much interest in most Global South countries, where community-based forest management models have been introduced. We contributed to the search for clarity through a qualitative investigation by exploring the following: (i) the decision-making and monitoring structure in the co-management of ACAP, (ii) the implications of this system on users' motivation to participate, and (iii) the motivational drivers of users' participation in co-management.

Economic incentives; feeling of belonging and cultural identity; social cohesiveness; and a desire to control and have access to natural resources are the key motivational factors for people's participation in the co-management of natural resources [51]. While roles seem to be clearly defined, the decision-making and monitoring structure is largely vertical in nature (top-down). This does not allow room for the horizontal arrangement that co-managements work to produce. ACAP and the CAMC wield the exclusive power to make decisions, which are then forced down through sub-committees to the users. The sub-committees and users do not know how plans are made and implemented nor the scientific basis behind such formulated plans. The legal arrangements also detach them from claiming the position in decision making as most of the decisions are made by ACAP, with inputs from the CAMC. While there is a strong top-down information flow (national to sub-regional), there are a series of breaks in the flow and counter flow of information between local and sub-regional-level

actors. Such a situation could represent a demotivating element for users. However, our study observes that the top-down decision-making structure, although being a flaw, does not largely affect users' motivation to participate. Zhu argues that the success of co-management is governed by the soundness of the institutional set up, and the decision-making structure that can address the interest of the local power actors who depend on the resources and have been managing those resources [52]. Therefore, the opinion of ground-level actors (users) is very important while formulating or implanting co-management policies [38]. In our case, the decision-making structure discourages users from participating in sharing their views and defending their interests. This may slowly decrease the interest of users to voice their opinion, eventually demotivating them. The decision-making structure sidelines users who are judged to be ignorant; this will lead to unfair negotiation and agreements where local knowledge and practices are ignored [44].

Connected to this is the unclear selection of committee representatives. In the co-management approach, the stakeholders negotiate over their ideas and interest for equal partnership in management functions, entitlements, and responsibilities for given natural resource in a specified territory [25,53]. The information break suggests that policies and decisions are forced on the community from the governing authority. De Pourcq [54] depicts this as the extreme form of the co-management arrangement in which the state agency has total control despite its consultation with user groups. Surprisingly, this form of governance structure and practice did not feature as a key demotivating factor. Field evidence proves that people remain motivated to participate; this could also be attributed to the lack of a clear understanding by the users about the co-management principles and activities. Rasmussen [55] contends that people generally accept the principles of conservation as long as they do not run counter to ideas about who may control resources. So, the voices of the stakeholders should be heard and incorporated to build a sense of collective ownership and participation.

A key motivational driver, largely intrinsic, as observed in this study, is the sense of responsibility to protect the forests for future generations. This finding resonates those of [56] in which non-cash motivations were top drivers of co-management practice. Caution should be applied, however, because the reliance on people's behavior (in this case reason for motivation) without factoring costs and benefits, may nuance our understanding of people's co-management behavior [57]. The remoteness of the study site may well be a factor that is responsible for such closeness with nature. Given the increasing trend of population growth and the expansion of communities, it remains questionable whether economic incentives will not override people's intrinsic motivation to participate [51]. The results, therefore, contradict the whole idea behind the co-management philosophy where co-management is seen as the sharing of power and responsibility between actors (communities and governments and/or states and/or NGOs) [32,58]. Specifically, our results contradict those of Bajracharya [47], who held that Community-Based Conservation (CBC) involves the local people in planning, decision-making, implementation, and monitoring of conservation works. Our work further contradicts the results in [46], which highlight the role of ACAP in empowering local communities to participate in natural resource management. However, our results resonate with the results in [26] and [9], that in resource management, the elite in the society mostly end up controlling the entire resource management processes.

5. Conclusions

As a power and responsibility sharing process that is geared towards achieving the twin objectives of conservation-area management and livelihood sustenance, co-management has been applied for more than two decades, in several contexts, with mixed outcomes [16,18,22]. A crucial element in this process is the creation of an institutional set up (a platform) where multiple state and non-state actors can negotiate and arrive at a consensus with regards to their rights and obligations in the collective management of resources of interest. At the heart of the failure in most co-management arrangements is a weak local institutional set up, which does not provide an avenue for a strong community voice in the process [22], including the state's (un)willingness to improve [20]. This explains why emphasis on the need to craft an institutional levelling process characterized by the reconstitution of state and

community driven institutions (and their actors) in a more meaningful bottom-up process has been the subject of much interest [9,59]. In this paper, we argue that there is a weak co-management scheme (largely top-down) in the context of the Annapurna Conservation Area, the largest conservation area in Nepal. Furthermore, the decision making in the current institutional setting does not deter users to participate, as they remain intrinsically motivated. Though several motivational forces collectively drive users' participation, there is no strong external factor that encourages participation.

While several studies have investigated co-management processes and their outcomes, the motivational drivers of user's participation in this process lends itself very much to scientific and policy edification. A recent study by Akwah Neba et al. [60] investigated the supply and demand component of civil society organizations in participatory processes. The authors contend that five key factors shape the effectiveness of civil society's influence in forest management, namely, access to information; funding autonomy; length of time since establishment; the experience of a civil society organization and its ability to advance the interests of the represented constituency; and the independence and discretionary right to say no to interventions [60].

As the tenure of ACAP is over, and discussions are underway to define the future management approach for this area, it is germane to rethink the future co-management structure and functioning [61]. The major thrust of this study was in identifying the motivational factors of forest users' participation in co-management. Interestingly, the motivation by actors to participate is not largely driven by users' perceived benefits. This represents another twist, a deviation from the previously understood rationale that should be factored into co-management theory development. Based on the observed non-inclusion of underprivileged groups, two possible scenarios are envisaged: (i) a further deprivation and exclusion of marginalized groups, leading to their uncontrolled extraction of forest resources, or (ii) a more hopeful situation that ensures a greater inclusion of marginalized groups. In this study, we equally make a succinct request for further studies to (i) quantitatively investigate the determinants of forest user's motivation in co-management, (ii) identify pathways to ensure a meaningful reconstruction of local institutions to ensure an effective co-management negotiation process, and (iii) investigate conditions under which the state's willingness for meaningful and fairer negotiations in co-management can be enhanced. This paper challenges future research to further situate these issues in the context of local power play and social learning.

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References

1. Agrawal, A.; Gibson, C.C. Enchantment and disenchantment: The role of community in natural resource conservation. *World Dev.* **1999**, *27*, 629–649. [CrossRef]
2. Brockington, D.; Wilkie, D. Protected areas and poverty. *Philos. Trans. R. Soc. B Biol. Sci.* **2015**, *370*, 20140271. [CrossRef] [PubMed]
3. Kimengsi, J.N.; Balgah, R.A. Repositioning Local Institutions in Natural Resource Management: Perspectives from Sub-Saharan Africa. *Schmollers Jahrb. J. Contextual Econ.* **2017**, *137*, 149–172. [CrossRef]
4. Jagger, P.; Sellers, S.; Kittner, N.; Das, I.; Bush, G.K. Looking for Medium-term Conservation and Development Impacts of Community Management Agreements in Uganda's Rwenzori Mountains National Park. *Ecol. Econ.* **2018**, *152*, 199–206. [CrossRef]

5. Chhotary, V.; Stoker, G. *Governance Theory: A Cross-Disciplinary Approach*; Palgrave Macmillan: Basingstoke, UK; New York, NY, USA, 2009; pp. 1–15.
6. Mishra, H.R. Balancing human needs and conservation in Nepal's Royal Chitwan Park. *Ambio* **1982**, *11*, 246–251.
7. Hough, J. Michiru Mountain Conservation Area: Integrating conservation with human needs. In *Resident People and National Parks: Social Dilemmas and Strategies in International Conservation*; University of Arizona Press: Arizona, AZ, USA,, 1991.
8. Rao, M.; Rabinowitz, A.; Khaing, S.T. Status review of the protected-area system in Myanmar, with recommendations for conservation planning. *Conserv. Biol.* **2002**, *2*, 360–368. [CrossRef]
9. Haller, T.; Acciaioli, G.; Rist, S. Constitutionality: Conditions for crafting local ownership of institution-building processes. *Soc. Nat. Resour.* **2016**, *29*, 68–87. [CrossRef]
10. Terborgh, J.; van Schaik, C.; Davenport, L.; Rao, M. (Eds.) *Making Parks Work: Strategies for Preserving Tropical Nature*; Island Press: Washington, DC, USA, 2002.
11. Ribot, J.C. Decentralization, participation, and accountability in Sahelian forestry legal instruments of political-administrative control. *Africa* **1999**, *69*, 23–65. [CrossRef]
12. Ribot, J.C. Democratic decentralization of natural resources. In *Beyond Structural Adjustment the Institutional Context of African Development*; Palgrave: Basingstoke, UK, 2003; pp. 159–182.
13. Kimengsi, J.N.; Ngala, M.P. Revisiting participatory forest management and community livelihoods in the Kilum-Ijim Montane forest landscape of Cameroon. *Int. J. Glob. Sustain.* **2018**, *2*, 39–55. [CrossRef]
14. Lund, J.F.; Rutt, R.L.; Ribot, J. Trends in research on forestry decentralization policies. *Curr. Opin. Environ. Sustain.* **2018**, *32*, 17–22. [CrossRef]
15. Borrini-Feyerabend, G.; Farvar, M.T.; Nguinguiri, J.C.; Ndangang, V. Co-Management of Natural Resources: Organising. In *Negotiating and Learning by Doing*; Kasparek Verlag: Heidelberg, Germany; GTZ and IUCN: Heidelberg, Germany, 2000.
16. Armitage, D.; Marschke, M.; Plummer, R. Adaptive co-management and the paradox of learning. *Glob. Environ. Chang.* **2008**, *18*, 86–98. [CrossRef]
17. Schultz, L.; Duit, A.; Folke, C. Participation, adaptive co-management, and management performance in the world network of biosphere reserves. *World Dev.* **2011**, *39*, 662–671. [CrossRef]
18. Plummer, R.; Baird, J.; Dzyundzyak, A.; Armitage, D.; Bodin, Ö.; Schultz, L. Is adaptive co-management delivering? Examining relationships between collaboration, learning and outcomes in UNESCO biosphere reserves. *Ecol. Econ.* **2017**, *140*, 79–88. [CrossRef]
19. Ballet, J.; Koffi, K.J.M.; Komena, K.B. Co-management of natural resources in developing countries: The importance of context. *Econ. Int.* **2009**, *4*, 53–76.
20. Li, T.M.; Sabogal, M. The Will to Improve: Governmentality, Development, and the Practice of Politics. *Anthropologica* **2010**, *52*, 210.
21. Meek, C.L. Forms of collaboration and social fit in wildlife management: A comparison of policy networks in Alaska. *Glob. Environ. Chang.* **2013**, *23*, 217–228. [CrossRef]
22. Kimengsi, J.N.; Aung, P.S.; Pretzsch, J.; Haller, T.; Auch, E. Constitutionality and Adaptive Co-Management of Tropical Protected Areas: Reflections from Cameroon and Myanmar. *Int. J. Commons* **2019**. in review.
23. Guerbois, C.; Dufour, A.B.; Mtare, G.; Fritz, H. Insights for integrated conservation from attitudes of people toward protected areas near Hwange National Park, Zimbabwe. *Conserv. Biol.* **2013**, *27*, 844–855. [CrossRef]
24. Fischer, A.; Wakjira, D.T.; Weldesemaet, Y.T.; Ashenafi, Z.T. On the interplay of actors in the co-management of natural resources—A dynamic perspective. *World Dev.* **2014**, *64*, 158–168. [CrossRef]
25. Carlsson, L.; Berkes, F. Co-management: Concepts and methodological implications. *J. Environ. Manag.* **2005**, *75*, 65–76. [CrossRef]
26. Arnstein, S.R. A ladder of citizen participation. *J. Am. Inst. Plan.* **1969**, *35*, 216–224. [CrossRef]
27. Agarwal, B. Participatory exclusions, community forestry, and gender: An analysis for South Asia and a conceptual framework. *World Dev.* **2001**, *29*, 1623–1648. [CrossRef]
28. Kimengsi, J.N.; Balgah, R.A.; Gwan, S.A. Enhancing Community Participation for Rural Development in Central Ejagham of Cameroon: Challenges and Prospects. *Int. J. Community Dev.* **2016**, *4*, 20–32. [CrossRef]
29. Evans, K.; Flores, S.; Larson, A.M.; Marchena, R.; Müller, P.; Pikitle, A. Challenges for women's participation in communal forests: Experience from Nicaragua's indigenous territories. *Women's Stud. Int. Forum* **2017**, *65*, 37–46. [CrossRef]

30. Fals Borda, O.; Rahman, M.A. Action and Knowledge: Breaking the Monopoly with Participatory Action-Research. Apex Press: New York, NY, USA, 1991.
31. Barnaud, C. Equité, jeux de pouvoir et légitimité: Les dilemmes d'une gestion concertée des ressources renouvelables, mise à l'épreuve d'une posture d'accompagnement critique dans deux systèmes agraires des hautes terres du Nord de la Thaïlande. PhD. Thesis, Université de Paris-Nanterre, Nanterre, France, 2008.
32. United Nations. *Popular Participation in Decision Making for Development*; UN Department for Economics and Social Affairs: New York, NY, USA, 1975.
33. FAO. Forests and Gender Equality: Participatory Forestry. 2014. Available online: http://www.fao.org/3/a-i3880e.pdf (accessed on 18 March 2019).
34. Cooke, B.; Kothari, U. *Participation: The New Tyranny?* Zed Books: London, UK, 2001.
35. Marshall, B.K.; Jone, R.E. Citizen participation in natural resource management: Does representativeness matter? *Sociol. Spectr.* **2005**, *25*, 715–737. [CrossRef]
36. Coulibaly-Lingani, P.; Savadogo, P.; Tigabu, M.; Oden, P.C. Factors influencing people's participation in the forest management program in Burkina Faso, West Africa. *For. Policy Econ.* **2011**, *13*, 292–302. [CrossRef]
37. Ranjit, Y. Determinants of People's Participation in Forest Protection and Management: A Study in Kaski, Nepal. *Econ. J. Dev. Issues* **2014**, *17–18*, 175–186. [CrossRef]
38. Islam, K.K.; Rahman, G.M.M.; Fujiwara, T.; Sato, N. People's participation in forest conservation and livelihoods improvement: Experience from a forestry project in Bangladesh. *Int. J. Biodivers. Sci. Ecosyst. Serv. Manag.* **2013**, *9*, 30–43. [CrossRef]
39. Raufirad, V.; Hunter, R.; Khalili, R.; Bagheri, S. Drivers of local people's participation in sustainable natural resource management: A case study in central Iran. *Local Environ.* **2017**, *22*, 880–893. [CrossRef]
40. Adhikari, R.B.; Baral, R.N.; Hancock, J.; Kafley, G.; Koirala, P.; Reijmerinck, J.; Shapiro, B. Regenerating Forests and Livelihoods in Nepal: A New Lease on life: Unfolding the Experience of 20 Years Poverty Alleviation through Leasehold Forestry in the Himalayas; CABI: Wallingford, UK, 2015; pp. 1–270.
41. Paudel, N.S.; Bhusal, P.; Thompson, P.; Sultana, P.; Adhikary, A.; Bhandari, K. Transforming Forest Conflicts: Learning from North-South Conflicts over Community Forests in Terai Region of Nepal. *J. For. Livelihood* **2018**, *16*, 1. [CrossRef]
42. Acharya, K.P.; Oli, B.N. Impacts of community forestry in rural livelihoods: A case study form Bharkhore CF, Parbat district. *Banko Janakari* **2004**, *14*, 46–50. [CrossRef]
43. Gautam, A.P.; Shivakoti, G.P.; Webb, E.L. A review of forest policies, institutions, and changes in the resource condition in Nepal. *Int. For. Rev.* **2004**, *6*, 136–148. [CrossRef]
44. Rutt, R.L.; Chhetri, B.B.K.; Pokharel, R.; Rayamajhi, S.; Tiwari, K.; Treue, T. The scientific framing of forestry decentralization in Nepal. *For. Policy Econ.* **2015**, *60*, 50–61. [CrossRef]
45. Sterk, A.; Johnson, A.; Durst, P.B. *Leasing Degraded Forest Land: An Innovative Way to Integrate Forest and Livestock Development in Nepal*; FAO: Rome, Italy, 1998.
46. Bajracharya, S.B.; Gurung, G.B.; Basnet, K. Learning from Community Participation in Conservation Area Management. *J. For. Livelihood* **2007**, *6*, 54–66.
47. Bajracharya, S.B.; Furley, P.A.; Newton, A.C. Effectiveness of community involvement in delivering conservation benefits to the Annapurna Conservation Area, Nepal. *Environ. Conserv.* **2005**, *32*, 239–247. [CrossRef]
48. Christensen, M.; Heilmann-Clausen, J. Forest biodiversity gradients and the human impact in Annapurna Conservation Area, Nepal. *Biodivers. Conserv.* **2009**, *18*, 2205–2221. [CrossRef]
49. Chhetri, B.; Johnsen, F.; Konoshima, M.; Yoshimoto, A. Community forestry in the hills of Nepal. Determinants of user participation in forest management. *For. Policy Econ.* **2013**, *30*, 6–13. [CrossRef]
50. Bajracharya, S.B.; Furley, P.A.; Newton, A.C. Impacts of Community-based Conservation on Local Communities in the Annapurna Conservation Area, Nepal. *Biodivers. Conserv.* **2006**, *15*, 2765–2786. [CrossRef]
51. Ruiz-Mallén, I.; Schunko, C.; Corbera, E.; Rös, M.; Reyes-García, V. Meanings, drivers, and motivations for community-based conservation in Latin America. *Ecol. Soc.* **2015**, *20*, 33. [CrossRef]
52. Zhu, T.; Krott, M.; Chen, H. Co-management implementation forested national reserves: Contradicting cases from China. *For. Policy Econ.* **2014**, *38*, 72–80. [CrossRef]
53. Gutiérrez, N.L.; Hilborn, R.; Defeo, O. Leadership, social capital and incentives promote successful fisheries. *Nature* **2011**, *470*, 386–389. [CrossRef]

54. De Pourcq, K.; Thomas, E.; Arts, B.; Vranckx, A.; Léon-Sicard, T.; Van Damme, P. Conflict in protected areas: Who says co-management does not work? *PLoS ONE* **2015**, *10*, e0144943. [CrossRef] [PubMed]
55. Rasmussen, M.B.; French, A.; Conlon, S. Conservation Conjunctures: Contestation and Situated Consent in Peru's Huascaran National Park. *Conserv. Soc.* **2019**, *17*, 1–14. [CrossRef]
56. Zulu, L. Bringing People Back into Protected Forests in Developing Countries: Insights from Co-Management in Malawi. *Sustainability* **2013**, *5*, 1917–1943. [CrossRef]
57. Gilmour, P.W. Factors and Processes Affecting Co-Management of Natural Resources. Ph.D. Thesis, The University of Melbourne, Melbourne, Australia, 2013.
58. Berkes, F.; George, P.; Preston, R. Co-management: The evolution of the theory and practice of joint administration of living resources. *Alternatives* **1991**, *18*, 12–18.
59. Haller, T.; Belsky, J.M.; Rist, S. The Constitutionality Approach: Conditions, Opportunities, and Challenges for Bottom-Up Institution Building. *Hum. Ecol.* **2018**, *46*, 1–2. [CrossRef]
60. Akwah Neba, G.; Walters, G.; Jung, H.-Y. Examining the Supply and Demand of Effective Participation and Representation. In *Global Forest Governance and Climate Change (Palgrave Studies in Natural Resource Management)*; Nuesiri, E.O., Ed.; Palgrave Macmillan: Cham, Switzerland, 2018.
61. Silva França, C.S.; Kyei, E.O.; Aragundi, G.S.; Rutt, R.L. Making sense of conservation behaviors in Mustang, Nepal. *Banko Janakari* **2019**, *29*, 1–22.

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Evaluation of the Operational Environment Factors of Nature Conservation Policy Implementation: Cases of Selected EU and Non-EU Countries

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Abstract: The complex policy decision-making situation around nature conservation requires examination of the operational environment. This study develops and tests a three-phase analytical framework for the evaluation of operational environment factors influencing nature conservation policy implementation. The four important operational environment factors (legal, policy, economic, and social) have been identified, to build up a framework. The framework was tested in selected countries and includes experts' opinions. Experts (n = 44) from five EU countries (Bulgaria, Croatia, Italy, Slovakia, and Slovenia) and four non-EU countries (Bosnia and Herzegovina, North Macedonia, Montenegro, and Serbia) defined and evaluated the factors and sub-factors that affect the operational environment related to nature conservation policy implementation. The results show policy changes arising from the new governance requirements introduced by changed political regime and Europeanization are key driving factors for changes in the nature conservation operational environment. For nature conservation, these wide-reaching changes have led to new political and legal frameworks, new institutional set-ups and multilevel governance frameworks, new establishment of protected areas and Natura 2000 network, and the re-allocation of financial resources and inclusion of non-state actors in policy decision-making. However, there are also some challenges and unsolved problems that need further attention from policy decision-makers and institutions, especially related to the institutional gap, sustainable financing of nature conservation, transposition of the EU Directives into legal systems, designation of sites or improving their implementation, implementation of innovative funding schemes, and a transparent participatory process. This

analytical framework can be applied to various problems related to any environmental issues or other policy implementation or management, and other sectors where public decision-making is combined with stakeholders' engagement.

Keywords: biodiversity conservation; nature conservation policy; operational environment; legal; policy; economic and social factors; evaluation framework; protected areas; Natura 2000 network

1. Introduction

Environmental and nature conservation awareness in today's sense began to grow in the second half of the 20th century, when the consequences of human activity in nature became more apparent [1]. Therefore, nature conservation has become a political issue at the global level [2,3].

In order to achieve nature conservation objectives of European wildlife and natural habitats, laws on nature protection have been adopted and PAs were established. Later on the Emerald Network at the national level has been set up in each contracting party of the Bern Convention, which involves also all the EU states [4]. In order to fulfil its obligations arising from the Bern Convention, the EU implemented the "Habitats" Directive [5] in 1992, which together with "Birds" Directive [6] set up the EU's network of PAs called Natura 2000. Natura 2000 is at the moment the largest network of PAs in the world and the core pillar of the EU's nature conservation policy [3,7,8]. Therefore, it is considered an important legal policy framework in achieving a favourable conservation status of nature in the EU Biodiversity Strategy by 2020 [9].

In a broader context, the Natura 2000 network is just one in a wide range of EU policies and legislation related to nature conservation to which the EU member countries must adhere. In the case of legally binding legislation specifically, it is required that the individual EU member countries translate them into national legislation (transposition) while leaving the details of implementation to the national authorities (enforcement) [8].

In the case of EU acceding countries, membership in the EU requires the adoption, implementation and enforcement of the 'acquis communautaire'—the body of the EU law and regulation [10]. The 'acquis' consists of different thematic chapters, where environmental law and regulation constitute one of them. Transposing the environmental chapter does not require a simple transformation of 'acquis communautaire', but also the development and adoption of institutions and structures by which legally binding legislation can be effectively implemented [10,11]. This process is commonly known as Europeanization of domestic environmental governance, which has led to changed policies, values, and norms while empowering new stakeholders in policy decision-making, leading to effective environmental governance [10,12]. On the other hand, in these countries, traditional command-and-control policy decision-making by state actors still dominates quite often as a consequence of post-socialistic governance type [11,13].

The implementation of EU nature conservation policy—de facto, not necessarily de jure—did not harmonize with traditional domestic nature conservation policies in the most of the EU member countries [14]. It introduced several new (in)formal rules such as the required participation of a broad range of stakeholders, and cooperation between government actors from various sectors and across several jurisdictional levels [13,15,16]. Moreover, the implementation and success of nature conservation policies depends on a range of various factors from the operational environment " ... political, economic and socio-psychological factors related to the design of the instrument as well as to the historical, local and sectoral contexts have an influence on the success of any conservation programme" [8].

The analysis of operational environments of the nature conservation policies and adjusting to changes in the environments are crucial parts of effective policy implementation [17–19]. Several factors can be expected to influence the behaviour of nature conservation policy implementation

actors and outputs. These factors correspond to the different dimensions of the conservation—e.g., social, cultural, economic, policy, environmental, but also institutional and individual-level ones [20]. According to Blicharska, et al. [21] to achieve a good functionality of the nature conservation, there is a need for knowledge not only on the ecological conservation and management issues, but also on key social, economic, political, and managerial realities potentially influencing policy implementation. Many previous studies have shown that national implementation of nature conservation policies differs across the EU [7–9,22–25]. Differences in implementation pathways are related to differences in policy culture in each country and consequently policy integration [14,26–29], financing of conservation measures and compensation payments [29–33], management practices [34,35], institutional factors [3,13,23,29,36–38], social factors [3,15,39–45], and environmental factors [46,47]. In a recent review of studies related to nature conservation, Popescu, et al. [48], and Blicharska, Orlikowska, Roberge and Grodzinska-Jurczak [21], concluded that research related to ecological factors prevail, while social, economic, and policy ones are underrepresented.

Studies focusing on national and sub-national operational environment factors related to nature conservation policies implementation are available in central-eastern European countries and south-eastern European countries, but most studies fail to systematically evaluate the whole operational environment factors related to nature conservation policies implementation [7,12,14,39,40,49–53]. To fill the above-mentioned gaps, this research aims to develop a framework to analyse the operational environment factors that affected nature conservation policies implementation in selected EU and non-EU member countries. Selected EU members' countries were Italy (IT), Slovakia (SK), Slovenia (SI), Bulgaria (BG), and Croatia (CRO), and non-EU members' countries were Serbia (SRB), Montenegro (MNE), North Macedonia (NM), and Bosnia and Herzegovina (BiH). These countries were selected as they were involved in COST Targeted Network TN1401 "Capacity Building in Forest Policy and Governance in Western Balkan Region (CAPABAL)". In addition, these countries represent good cases as in these countries political, legal, economic and social operational environment changed considerably in a relatively short period, making a substantial impact on nature conservation. These differences influence nature conservation policy implementation in selected countries and make a cross-country comparison interesting. The results of this study are useful for understanding the influences that operational environmental factors have on nature conservation policy implementation in selected countries and are likely to be relevant for policy decision-makers, institutions responsible for management and planning of PAs, and other stakeholders to increase the quality of future nature conservation policy implementation processes.

2. Materials and Methods

To identify operational environment factors, while explicitly addressing different political and socio-economic context in case countries, this study developed a three-phase analytical framework for analyzing the operational environment factors related to nature conservation policies implementation. The literature review in the introduction showed that institutional theories and governance theory are frequently used to explain nature conservation policy implementation. Our analytical framework draws on these findings, and the factors are therefore based on neo-institutional theory [54]. They are complemented by governance elements (participation) because the implementation of nature conservation policies is highly dependent on stakeholder engagement. As a tool, framework identifies the elements and general relationships among them that one needs to consider for institutional analysis. They provide a general set of variables that can be used to analyze all types of institutional arrangements [55]. The institutional environment is dynamic and constantly changing, so neo-institutionalism tries to find a balance between actors and structure. It seeks to answer the question of whether historical, social, and political outcomes are the result of the intentions, motivations, and behavior of actors; or whether these are shaped by political institutions, power hierarchies, and cultural conventions [54]. The proposed framework is based on the basic elements of these theories namely rules (legal and political), institutions (political, economicl) and governance

elements (participation), and it is applicable for different regions and conditions both across Europe and worldwide as it uses general factors to analyze the institutional setting. Simultaneously, it allows a better understanding of the country/region specific situation by using sub-factors. It was developed in a series of steps involving nature conservation experts and applied in selected countries as described in more detail below.

2.1. Phase 1—Identification of Operational Environment Factors and Sub-Factors

To be able to analyze the main operational environment factors that affected nature conservation policies implementation in selected countries four groups of operational environment factors were identified: (1) Legal—including sub-criteria such as international conventions and agreements, national legal framework, PA legal status, Emerald network, Transposition of the EU "Birds" and "Habitats" Directives, Natura 2000 management plans; (2) Policy—including sub-criteria such as policy framework and institutional set-up; (3) Economic—including sub-criteria such as financing mechanisms of PAs and Natura 2000 and compensatory measures for Natura 2000; and (4) Social—including sub-criteria such as stakeholders' involvement in establishment and management of PAs and stakeholders' involvement in the implementation of Natura 2000 network. As legal and policy factors often overlap they were merged into one category in our study, which is commonly done also in other studies [56]. As these general factors do not enable detailed analysis of the operational environment of each country a preliminary list of sub-factors under each factor was prepared. The general factors and sub-factors were selected based on the theoretical background and literature review [9,21,48], where it was found that mainly legal issues, governance settings, policy integration, conservation priority setting, management, and participation evaluation have influence on nature conservation policy implementation.

The identified list of factors and sub-factors was discussed afterwards among researchers, university professors, and nature conservation experts. After that, it was modified in order to clarify the defined factors and sub-factors. Based on these factors and sub-factors, a template was developed as a semi-structured, problem-centred interview. The template included basic information about the aim of the study and a brief explanation of factors to ensure a common understanding among the experts.

2.2. Phase 2—Expert Selection and Data Collection

The prepared template was sent by e-mail to nature conservation experts in each country to get the information about the influence of operational environmental factors on nature conservation policy implementation. When selecting the experts, a priority was given to participants who were experienced with respect to nature conservation in their country or have an institutional influence on nature conservation policy formulation or implementation (Table 1). The experts (n = 44) have filled the template based on their expertise and the information gaps have been filled with information of other experts who had a good overview of nature conservation policies implementation in the country or other literature sources. The data were collected between March and May 2019.

Table 1. Experts involved in the data collection.

Country	Name of Institution/Organization/Association	Total No. of Experts
IT	Council for agricultural research and economics (CREA) (1), Forestry officials of the Regions and Autonomous Provinces (2), Forest consultants involved in the drafting of Natura 2000 site management plans (2)	5
SK	Faculty of Forestry (2), National Forestry Centre (1), State Nature Conservancy (6), Ministry of Agriculture and Rural Development (1)	10
SI	Faculty of Forestry (1), Ministry of Environment and Spatial Planning (3)	4

Table 1. *Cont.*

Country	Name of Institution/Organization/Association	Total No. of Experts
BG	University of Forestry (1), Ministry of Environment and Water (1), Executive Forest Agency (2)	4
CRO	Faculty of Forestry University of Zagreb (2), State forest company Hrvatske šume Ltd. (1), Ministry of Agriculture (1)	4
SRB	Public enterprise "Srbijašume" (1), Public enterprise "Vojvodinašume" (1), Institute of Forestry (1), Ministry of Agriculture and Environmental Protection (1)	4
MNE	Institute of Forestry of Montenegro-Natura 2000 expert for forest habitats (1), Ministry of Sustainable Development and Tourism (1), Ministry of Agriculture and Rural Development (1), Public Enterprise National Parks of Montenegro (1)	4
NM	Public Forest Enterprise (1), Faculty of Forestry (1), National Association of Private Forest Owners (1), NGO Connecting Natural Values and People - CNVP Macedonia (1), Ministry of Agriculture, Forestry and Water Management (1)	5
BiH	Public Forest Enterprise (1), Faculty of Forestry (1), National Park Una (1), Ministry of Agriculture, Water Management and Forestry of the Federation of Bosnia and Herzegovina (1)	4

2.3. Phase 3—Qualitative Content Analysis

A qualitative content analysis was applied on collected information about operational environment factors that influence nature conservation policies implementation. The qualitative content analysis includes contextual information, latent content, as well as formal aspects of the analysis information [57]. For analysis, we first identified and coded the parts of the documents that include general codes (factors) and then codes related to the sub-factors. Coded elements were extracted into a standardized Excel table, which enables a simplified overview of relevant operational environment factors and sub-factors and their interpretation and cross-country comparison in terms of influence on nature conservation policy implementation.

3. Results

3.1. Legal and Policy Factors

3.1.1. International Conventions and Agreements

In the analyzed countries, the main drivers for nature conservation came from the international environment as all countries are signatories of the most important international conventions and agreements related to nature conservation such as Ramsar Convention, Convention on International Trade in Endangered Species of Wild Flora and Fauna, Boon Convention, Bern Convention, Convention on biological diversity, United Nation Framework Convention on climate change and European Landscape Convention. All these conventions and agreements have been ratified by specific laws or decrees (Italy, Slovenia, Croatia, Bulgaria, Serbia, North Macedonia, and Bosnia and Herzegovina) and/or were implemented in Nature Conservation Act (Slovakia, Bulgaria, and Montenegro).

3.1.2. National Legal Framework of Nature Conservation

All analyzed countries have a legal framework in place to ensure and support nature conservation (Table A1). Strategies that influence nature conservation exist in all countries. They are mainly related to sustainable development (Italy, Slovakia, Slovenia, Croatia, Serbia, Montenegro, and North Macedonia), environmental protection (Slovakia, Bulgaria, Croatia, Republic of Srpska, Federation

of Bosnia and Herzegovina), environmental and climate changes (Bulgaria and North Macedonia), nature protection (Croatia, Bulgaria, North Macedonia, Republic of Srpska), biodiversity (Italy, Slovakia, Slovenia, Bulgaria, Serbia, Montenegro, North Macedonia, Republic of Srpska, Federation of Bosnia and Herzegovina), and forestry (Italy, Slovakia, Croatia, Bulgaria, Serbia, Montenegro, North Macedonia, Republic of Srpska). Moreover, from the aspect of nature conservation, national programs related to this area are also very significant in some analyzed countries. They are mainly related to environmental protection—National environmental protection programs (Slovenia, Serbia, Republic of Srpska, Federation of Bosnia and Herzegovina); and forestry—National forest programs (Italy, Slovenia, Bulgaria, Montenegro, and Federation of Bosnia and Herzegovina).

The main laws that regulate nature conservation in the countries analyzed are nature protection, nature conservation law, environmental protection law, or biological diversity law. Apart from specific nature conservation-related laws all countries also have a number of ordinances, decrees, rulebooks, that further regulate specific nature conservation issues. Additionally, all analyzed countries have also adopted specific legislation governing the proclamation of PAs, mainly national parks (see Section 3.1.4).

All analyzed countries also have other sectoral laws that are relevant for nature conservation—such as forest law, water law, game management and hunting law—as nature conservation has an indispensable position in the context of other cross-sectoral policies, especially related to forest sector and therefore cannot be seen as an isolated policy sector [58].

3.1.3. Institutional Set-Up

Strong institutional set-up is one of the key prerequisites for effective nature conservation policy implementation. Table 2, summarize the institutional set-up in analyzed countries. Evidently, not all of the institutions are presented in all countries, which potentially create a gap for the successful nature conservation policy implementation.

In all analyzed countries, one central authority plays the most important role in nature conservation. In most of the analyzed countries, the Ministry of Environment with jurisdiction over environmental protection is responsible for nature conservation policies, including PAs and Natura 2000 sites. There are exceptions in Montenegro, Bosnia and Herzegovina, and the Republic of Srpska where other ministries are responsible for environmental protection and nature conservation policies (e.g., Ministry of Foreign Trade and Economic Relations in Bosnia and Herzegovina and Ministry of Spatial Planning; Civil Engineering and Ecology of the Republic of Srpska in Republic of Srpska; and Ministry of Sustainable Development and Tourism in Montenegro). Only in Slovakia and Serbia there is an independent Ministry of Environment or Ministry of Environmental Protection, while in other analyzed countries the Ministry of Environment has broader competences, e.g., protection of land and sea, spatial and physical planning, energy, water, tourism.

The presence of Institutes for nature conservation varies from country to country. They exist in Italy, Slovakia, Slovenia, Bulgaria, Croatia, Serbia, and Bosnia and Herzegovina. In countries like Croatia, Montenegro, and North Macedonia, they have experienced changes in relation to formally independent institutes as in most countries' government adopted a decree merging institutes to some other institution. All countries, except Bosnia and Herzegovina and North Macedonia, have Environmental agencies in place at the national level and also regional level as in case of Italy, with similar duties being the collection, integration and processing of environmental data and submission of reports to the European Environmental Agency as European Environmental Agency member countries. In the case of Bosnia and Herzegovina and North Macedonia they are a part of European Environmental Agency partnership network as cooperating countries.

One of the institutional mechanisms that could substantially contribute to the funding of nature conservation, particularly its tasks, is an environmental fund. This funds usually receives finances from different sources (e.g., environmental or eco-taxes, national or regional budgets, regulation fees). An environmental fund exists in all analyzed countries, except Italy, North Macedonia, and Montenegro.

In all analyzed countries, Ministry responsible for nature conservation plays an important role in monitoring of different types of PA and are responsible for the approval of management plans and programs for PA. Although governance by government is a predominant form of governance in analyzed countries, all analyzed countries have established public institutions (PA authorities) for management of PA at the national, regional or local levels. Unlike in other countries, Montenegro and Slovakia have one central public institution at the national level for management of all PAs. In Italy, Slovenia, Croatia, Bulgaria, North Macedonia, Serbia, and Bosnia and Herzegovina, separate public institutions are set up with the responsibility to manage a specific PA. Moreover, in some analyzed countries, the government can delegate PAs management responsibility to other actors, both public and private ones. The transfer of management by delegation is possible "de jure" in Slovakia, Slovenia, Bulgaria, Serbia, Montenegro, and North Macedonia. Delegation can be done either on a contract basis (Slovakia) or by a legal act, at the designation of PA (Slovenia, Bulgaria, Croatia, Serbia, North Macedonia, and Montenegro). Delegation to different types of actors (e.g., NGO, local association, local municipalities or counties, public enterprises, private companies, and churches or monasteries) was found in some analyzed countries (Slovenia, Serbia, North Macedonia, Montenegro, and Croatia).

3.1.4. Legal Status of Protected Areas

The idea of setting aside areas to safeguard for nature conservation was initiated in most of the analyzed countries in the middle of the 20th century, by designating the first national park (Table 2).

Table 2. Legal status of protected areas and their coverage.

Country	Year of the Establishment of First NP	No. of NP	Existence of Other Statutory Designated Categories of PA	% of the Country's Territory Covered by PAs
IT	1922	24	Yes	9.5
SK	1949	9	Yes	23.4
SI	1981	1	Yes	14.0
BG	1992	3	Yes	5.3
CRO	1949	8	Yes	8.5
SRB	1960	5	Yes	7.5
MNE	1952	5	Yes	12.5
NM	1948	3	Yes	8.9
BiH	1962	4	Yes	2.7

Legal protection of national park is in majority of the analyzed countries provided by law on national parks (Italy, Slovenia, Serbia, North Macedonia, Montenegro, and Bosnia and Herzegovina) or Protected areas law (Bulgaria). In countries like Italy, Bulgaria, Serbia, and Republic of Srpska, laws regarding national parks/protected areas exist on a country/entity level. In Italy, Slovenia, Montenegro, North Macedonia, and the Federation of Bosnia and Herzegovina, specific laws on the establishment of individual national park exist. In Slovakia and North Macedonia national park establishment in terms of activities granted and prohibited is regulated by nature conservation/protection law, while the national park itself is created by the government ordinance/law. In Croatia, PAs are established by the government or parliament ordinance.

Other statutory designated categories of PA also exist in these countries, mostly harmonized with the IUCN categorization. According to the national data, PAs cover between 2.7% in Bosnia and Herzegovina and 23.4% in Slovakia of the country's territory.

3.1.5. Emerald Network

The Emerald network of the Council of Europe is declaratory complementary to the Natura 2000 network outside EU.

The creation of the Emerald Network was started with a help of different pilot projects in all analyzed countries, except Italy. The main purpose of those projects was to initiate the process, create the expert teams, and set up a database of pilot project sites and proposed Areas of Special Conservation Interests (Table 3).

Table 3. Status of the Emerald network.

Country	Emerald Network Status	Approved by Standing Committee of Bern Convention	Approved by the National Authority
IT	Emerald network is not implemented.	-	-
SK, SI, BG, CRO [1]	Participated as pilot countries in the first round of Emerald projects; Emerald network is implemented (Areas of Special Conservation Interests)	Yes	No
SRB, MNE, NM, BiH	Proposed Areas of Special Conservation Interests, officially nominated	No	No

[1] Areas of Special Conservation Interests were approved by the national authority.

In Slovakia, Slovenia, Croatia, and Bulgaria, the pilot project of Emerald network creation started in 1999, but stopped, due to the countries' orientation to the EU process and implementation of the Natura 2000 network. All relevant data and results gained within the Emerald pilot project were used for the implementation of Natura 2000 that later became the formal contribution to the Emerald network.

In case of Croatia, Serbia, Montenegro, North Macedonia, and Bosnia and Herzegovina, EU CARDS Regional Project "Development of Emerald Network in South-Eastern Europe" was implemented with the financial contribution of the European Environmental Agency to the Council of Europe [59]. Further activities in these countries were performed under the EU IPA projects [60]. As a result of these projects, countries have nominated their candidate sites. All future activities in these countries related to the Emerald network are dependent on the further national allocation of money.

3.1.6. Transposition of the EU Birds and Habitats Directives

The countries involved in this study are at different stages of transposition of the "Birds" and "Habitats" Directives into national legislation (Table 4), considering the country's status regarding the EU accession. EU Member States countries have transposed the Directives and implemented Natura 2000 network. This network has been implemented gradually, starting in 1997 in Italy, followed by other countries joining the EU afterwards (Slovenia and Slovakia in 2004, Bulgaria in 2007 and Croatia in 2013).

The EU candidate and potential candidate countries have, in compliance with the acquis obligations, to implement and enforce environmental policies in their legal framework, but enforcement and implementation of the nature conservation policy are still at the early stage because there are still significant gaps in transposition and site designation. For example, these countries have designated Emerald network sites (future Natura 2000 sites), but more effort should be put into the selection of Special Protection Areas (SPAs) and Sites of Community Importance (SCI) under the Directives. In countries like Montenegro, North Macedonia, and Bosnia and Herzegovina, potential SPAs and SCI sides are proposed, while in SRB only potential SPAs are proposed. These proposed sites will in the future act as potential sites for inclusion in the Natura 2000 network.

In most of the analyzed countries, the "Habitats" Directive is mainly transposed through the Law on nature protection/conservation (Slovakia, Slovenia, Serbia, Montenegro, North Macedonia, and Bosnia and Herzegovina) and its decrees (as in case of Serbia, Italy, Slovenia, Croatia, and the Federation of Bosnia and Herzegovina). The "Birds" Directive is also transposed by the Law on nature protection/conservation (Italy, Slovenia, Croatia, Serbia, and North Macedonia) and Law on Game and

Hunting (Italy, Serbia, and Bosnia and Herzegovina) and Forest Law (Croatia). In Bulgaria, Natura 2000 sites are not considered as PAs, they are called protected sites and therefore designated under the biological diversity law, not the protected areas law. Therefore, also the Directives are transposed through the biological diversity law.

According to EEA [61], the Natura 2000 network now covers 18.0% of EU's land territory in EU-28. Currently, the Natura 2000 network covers 37.2% of land territory in Slovenia, followed by Croatia (36.7% of the land territory), Bulgaria (34.4% of the land territory), and Slovakia (30.0% of the land territory). These countries are also ranked as countries with the highest share of Natura 2000 area within EU-28. In Italy, the Natura 2000 network covers about 19.0% of country's land territory. In analyzed 'new' member states in Eastern and Southeastern Europe, the share of national land territory under Natura 2000 is well above the EU average. In the rest of the study area, larger Natura 2000 sites were designated as a consequence of overlapping with (but sometimes also exceeding) existing nature PA, but in the old member states, like Italy, smaller sites were established [8].

Table 4. Status of the Natura 2000 network [61].

Country	No. SPA	No. SCI	% of the Country's Territory under Natura 2000	% of the Forests inside Natura 2000
IT	631	2.335	19.0	35.0
SK	41	642	30.0	48.8
SI	31	324	37.2	71.0
BG	119	233	34.4	56.5
CRO	38	741	36.7	36.0
	No. pSPA	**No. pSCI**		
SRB [1]	43	-	-	-
MNE [2]	X	X	16.0	9.0
NM [1]	3	6	-	-
BiH [1]	1	72	18.7	-

[1] Data about Natura 2000 coverage of country territory and % of forest inside Natura 2000 are not available. [2] Some SPA and SCI sides are proposed but the process is not finished.

Forests are of crucial importance for Natura 2000. According to the European Commission [62] it has been estimated that the Natura 2000 network includes approximately 375,000 km^2 of forests, which is about 50% of the total Natura 2000 network and about 21% of total forest resource in EU. In Slovakia, Slovenia, and Bulgaria, forest is included in more than half of all proposed Natura 2000 sites (48.8%, 71.0%, and 56.5% respectively) [63,64]. The high percentage of forests in Natura 2000 reflects not only the wide distribution of forests in these countries but also their overall importance for biodiversity. In Croatia, forests cover approximately 36.0% of Natura 2000 network and in Italy 35.0% of the Natura 2000 network [65].

3.1.7. Management Plans for Natura 2000 Network

After the designation of the Natura 2000 sites, policy enforcement and practical management becomes the primary task for national authorities [8]. According to the "Birds" and "Habitats" Directives, the preparation of management plans for the Natura 2000 sites is not obligatory, but the "Habitats Directive" recommends their use as a means to secure the beneficial conservation status of the sites. In spite of the soft regulation, the preparation of site-level management plans is promoted in all selected EU countries as the main tool to identify conservation measures at the site level (Table 5). Some of the analyzed EU countries consider the development of a management plan for sites as a legal obligation (Slovenia, Slovakia), or/and make a possibility to include specific management measures in other sectoral plans related to management and use of natural resources (forests, water) or include them in contractual obligations, as recommended by Article 6 of the "Habitats Directive" (Slovenia, Bulgaria, Croatia). In Italy, according to the Decree no. 224 (2002), there is a legal obligation to define the

conservation measures for the Natura 2000 sites, while management plan is an additional instrument aimed to protect threatened species and habitats.

Natura 2000 management plans are prepared under the responsibility of the ministry responsible for nature conservation in almost all analyzed EU members' countries, except Croatia, assisted by facilitators (experts), with the provision of EU financial sources and the national budget. In Croatia, directives are implemented in forest management plans under the responsibility of the Ministry of Agriculture. These management plans are developed at the national (Slovakia, Slovenia, Bulgaria) or regional/local level (Italy).

Table 5. Synthetic overview of legal requirements in Natura 2000 management planning.

Country	Legal Obligation for Management Plans	Management Plans are Developed
IT	No	Yes (R)
SK, SI	Yes	Yes (N)
BG	No	Yes but not for all sites (N)
CRO	No	No

N: national level, R: regional level.

3.2. Economic Factors

There are numerous economic factors that must be considered in the analyses of nature conservation policies. The most noticeable is funding as this was identified in many studies as "the biggest issue", and that it is the key factor of further development of nature conservation [8,32,66].

3.2.1. Financing Mechanisms of Protected Areas

Well-developed legal frameworks are in place in the analyzed countries (see Section 3.1), which underline the need for and importance of funding of PAs. All analyzed countries have ratified international conventions, which call in some way for contracting parties to allocate funds for nature conservation. Therefore, in analyzed countries laws (mainly nature protection/conservation law) and decrees related to PAs prescribe different financing mechanisms.

Financial resources for PAs may be generated by different sources (Table 3); most commonly these are external sources and market-based fees for goods and services.

In all analyzed countries, financing of PAs is ensured from the state budget funds, through the ministries responsible for nature conservation. To a much lesser extent, financing comes from municipal budget (Slovenia, Croatia, Serbia, Montenegro, North Macedonia, and Bosnia and Herzegovina) or province/regional budget (Italy, Croatia, Serbia, and Bosnia and Herzegovina) in the case where the PAs are established by the municipality or province/regions. In addition, Slovenian law on nature conservation permits a possibility of public/private partnership on the management of PAs. Moreover, in countries like Slovakia, Serbia, Montenegro, North Macedonia, and Bosnia and Herzegovina, international assistance and funding or private voluntary donations (Slovakia, North Macedonia, and Bosnia and Herzegovina) of PA is provided. In Slovakia, Croatia, and Serbia, the Environmental Protection Fund is established to provide financial support for environmental protection and sustainable development to applicants in the form of grants or loans in support of projects and activities aimed at achieving environmental policy goals at national, regional, or local levels.

PA management bodies are offered the possibility to supplement their budget financing through income-generating activities—market-based fees for goods and services (e.g., entrance fees in PAs, entrance fees in visitor or information centres, informational materials, tourism activities, etc.), such revenues represent in most cases a fairly small share from their total annual budget (Italy, Slovakia, Slovenia, Croatia, Serbia, North Macedonia, and Bosnia and Herzegovina), except when income is generated from management of lands and resources inside the PAs (Italy, Slovakia, Slovenia, Bulgaria, Serbia, Montenegro, North Macedonia, and Bosnia and Herzegovina) or concessions of management or resource use rights (Bulgaria, Croatia, Serbia). Another financing opportunity of PAs is represented

by the existence of grants that can be accessed through projects, which becomes a quite common and important source of funds in all analyzed countries.

In countries like Slovakia, Bulgaria, Croatia, North Macedonia, Montenegro, and Bosnia and Herzegovina, a general characteristic of financing nature conservation and PAs is their large dependency on external funding sources, which finance various nature conservation projects. The European Fund for Southeast Europe has also played an important role in financing different activities in Slovakia. In addition, external funding also comes from EU funds (Italy, Slovakia, Slovenia, and Bulgaria), or EU-accession funds (Croatia, North Macedonia, and Bosnia and Herzegovina). Moreover, in Italy, Croatia, Montenegro, and North Macedonia, innovative instruments—such as payments for ecosystem services (hereafter PES)—have been developed and represent a financing source of PAs.

3.2.2. Financing Mechanisms of the Natura 2000 Network

The EU's integrated approach to financing Natura 2000 has resulted in a complex funding structure [30]. In accordance with the Treaty on the Functioning of the EU [67], the responsibility for implementing and financing environmental policy, including the Natura 2000 network, lies with the Member States. Article 8 of the "Habitats" Directive states that in a case in which the respective Member States face exceptionally high costs, these costs can be co-financed by any relevant EU co-financing instrument and foresees the need to develop a prioritized action framework [5]. According to the aforementioned article, implementing institutions have two options for funding the necessary measures in the Natura 2000 network: to use either their existing state nature conservation budgets or the EU co-financed instruments.

National public funding is the most frequently mentioned source of financing Natura 2000 objectives and measures in all analyzed EU member countries (Table 6), because funding of nature conservation measures is prescribed by nature protection/conservation law. In Slovakia and Croatia, national environmental protection funds have been mentioned as an important additional source of financing Natura 2000 objectives and measures.

Table 6. Overview of funding instruments for Natura 2000 objectives and measures for 2014–2020 in analyzed EU member countries.

Funding Instruments	Country				
	IT	SK	SI	BG	CRO
National public funds	X	X	X	X	X
National environmental protection fund	-	X	-	-	X
European Agricultural Fund for Rural Development	X	X	X	X	X
European Agricultural Guarantee Fund	X	-	-	-	-
European Regional Development Fund	X	X	X	X	X
European Social Fund	X	-	-	X	-
European Maritime and Fisheries Fund	X	X	X	X	X
Cohesion Fund	X	X	-	X	-
Financial Instrument for the Environment (LIFE/LIFE+)	X	X	X	X	X
Framework Programme for Research and Innovation (FP7, Horizon 2020)	X	X	X	X	X
Public/Private Partnership financing schemes	X	-	X	-	-

Moreover, the objectives and measures of Natura 2000 in analyzed EU member countries are supported through the European structural and investment funds, with the majority of their investment being handed out through national governmental institutions (Table 6).

In analyzed countries objectives and measures of Natura 2000 were co-funded through several EU instruments. These available EU-level funding instruments can cover only a small amount of the estimated costs of the implementation of Natura 2000 and its measures. Therefore, in countries like

Slovakia and Croatia National environmental protection funds promote advances in environmental protection through the award of credits or other financings.

Additionally, in Slovenia the legislation on nature conservation allows public/private partnership on the management of Natura 2000 sites. Such is the case in the management of Sečoveljske soline Landscape Park. In Italy, 76 Natura 2000 sites located in the WWF Oasis are managed by WWF in accordance with the national and regional/provincial guidelines.

In the EU candidate and potential candidate countries, initial work on the establishment of Natura 2000 network started in the frame of the different project, mostly financed by EU IPA program (Serbia, North Macedonia, Montenegro, and Bosnia and Herzegovina), foreign governments (Bosnia and Herzegovina), bilateral aid agencies (North Macedonia and Bosnia and Herzegovina), and NGOs (WWF in Montenegro).

The transposition of the "Habitats" Directive requires compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected (Article 6). Therefore, different compensation measures are assured in current EU funding programs (2014–2020), such as European Structural and Investment Funds, the Rural Development Fund, the Cohesion Policy Funds, and the European Maritime and Fisheries Fund.

As regards the compensatory measures included in the Rural Development Programme 2014–2020, that are relevant for Natura 2000 three measures have been identified in analyzed EU member countries. The most widely used measures for the conservation or recovery of natural habitats and species are the agri-environment and climate payment measures (M10) which exists in all of the analyzed countries. In Italy and Slovakia, payments for Natura 2000 areas in combination with the Water Framework Directive (M12), which is aimed at activities on agricultural land (M12.1) and forest land (M12.2), also exists. In particular, the measure M12.2 (Payments Natura 2000 for forest areas) has been implemented in five regions (Basilicata, Liguria, Marche, Piemonte, Umbria) in Italy. Forest-environmental and climate commitment payment measures (M15) are included in Bulgaria, Slovakia, and certain regions of Italy. In addition, in Slovenia a budgetary forest fund was established in 2016 based on the changes in the organizational structure of the state forest management body and the adoption of the Management of State Forest Act (Article 33). The forest fund intended to cover compensation measures in private forests within Natura 2000 areas, in accordance with the Natura 2000 management program and program of investments in forests, based on the national forest program prepared by the public forestry service in accordance with the forest act.

3.3. Social Factors

Stakeholder participation, cooperation, and their ability to influence the policy decision-making process are, as identified in numerous studies (e.g., [8,40–42,52]), the key factors for policy implementation success.

3.3.1. Stakeholders' Involvement in the Establishment and Management of Protected Areas

Views about PAs and stakeholders' participation (mainly local population and public) in decision making concerning the establishment and management of PAs have changed considerably over the last decades in all analyzed countries.

As former socialist states with communist experiences, each of the analyzed countries, (with the exception of Italy), has its own peculiarities in the development of participatory decision-making related to nature conservation matters [68]. In these countries, a self-management system was based on decentralized powers of local authorities, but the true decision-making power was never given to the local people in the areas of nature conservation and PAs. After becoming independent in the early 1990s, countries started to implement international agreements related to nature conservation and EU nature conservation policies. Consequently, the concept of participation changed, and PAs started being treated differently. Moreover, in these countries, the legal framework has changed, which requires increased stakeholder involvement in PAs management. Therefore, in these countries, a shift from the

'traditional paradigm' in which PAs were established by the central government, to the 'new paradigm', where the cooperation among different stakeholders (i.e., local stakeholders, NGOs, private companies, regional, and local authorities) in the governance of PAs has taken place. As a result, local stakeholders are no longer passive recipients of the top-down approach; rather, they are active partners. In Italy, the participatory process is related to the administrative decentralization established by Decree no. 616 (1977). The legal competences in agriculture, forestry, and land management have been transferred to the regions and autonomous provinces. Regarding nature conservation, Law no. 394 of 1991 states the statute of each public authority delegated to the management of the parks establishes the criteria of public participation in the decision-making process. Generally, the local public administrations—e.g., provinces and municipalities—are involved in the environmental governance, while the involvement of other stakeholder changes from case to case (from information to collaboration).

In the case of Italy, Croatia, Montenegro, and North Macedonia, establishment and management of PAs has been mostly characterized as a top-down approach, although PAs' establishment and management followed participatory procedures in these countries. In Slovakia, Slovenia, Bulgaria, Serbia, and Bosnia and Herzegovina, also a top-down approach in establishment and management of PAs prevails, but in some cases a bottom-up approach has been applied. In countries like Serbia, North Macedonia, Montenegro, and Bosnia and Herzegovina, the participatory approach is a relatively new concept for PAs as most of the PAs were established with very low participation of other stakeholders; especially on the local level. This practice has been changing mostly in the case of management of PAs in these countries, but the value of involving different stakeholders has yet to be fully recognized. Certain changes are evident in these countries as well as Slovakia and Slovenia because the legal framework has changed, which necessitates increased stakeholder involvement in the management of PAs (Table 7).

Local stakeholder involvement is a known important factor in the establishment and management of PAs, and their participation in the decision-making process is ensured in almost every analyzed country (Table 7).

Table 7. Overview of the participatory process in the case of protected areas.

Country	Approach	Participatory Process Organized	Local Stakeholders Involved
IT	Top-down	Variable from case to case	Variable from case to case
SK, SI, BG, SRB [1], BiH	Different from case to case (from top-down to bottom-up)	Variable from case to case	Yes
CRO, MNE, NM	Top-down	Yes	Yes

[1.] Local stakeholders were involved in the case of national park; but in the case of other PAs, local stakeholders' involvement depends on activities of PA managers.

3.3.2. Stakeholders' Involvement in the Implementation of the Natura 2000 Network

The habitats directive as the legal basis for the Natura 2000 network does not pay attention to the issue of public participation. This leaves countries with considerable leeway as to how they deal with the new possibility of participatory approaches to the implementation of the Natura 2000 network [41,69]. In all analyzed countries, the participatory process has been applied (Table 8); however, performance is still low in terms of engaging key stakeholders and sharing decision-making power with them.

In all analyzed EU countries public actors have ultimate decision-making power. Therefore, the process of implementing the Natura 2000 network was a controversial top-down process in a majority of EU analyzed countries. An exception is Italy, where most of the implementation responsibilities and tasks were, according to the Decree no. 357 of 1997, delegated to the regions and autonomous provinces. Consequently, the approach differed from one region to another.

Table 8. Overview of the participatory process in the case of the Natura 2000 network.

Country	Approach	Degrees of Involvement [1]
IT	From top-down to bottom-up	Consultation Information
SK, SI, BG, CRO	Top-down	Co-decision Collaboration Information

[1] A four-level system was adopted by Herwig (2008) [69] which distinguishes between four degrees of involvement: information, consultation, collaboration, co-decision.

The analyzed countries varied in their implementation styles regarding the degree of stakeholders' involvement. For example, in countries like Slovakia, Slovenia, Bulgaria, and Croatia, almost all degrees of involvement, except consultation, were adopted during Natura 2000 network implementation. In Italy, consultation and information were the primary degrees of stakeholder involvement adopted during Natura 2000 network implementation.

4. Discussion

The cross-country analysis of national nature conservation systems and policy implementation reveals several similarities and only a few differences among the analyzed countries. What makes these systems similar is first that they are a part of strong EU nature conservation efforts and second, that the EU acquis has provided opportunities and financial (material) benefits to environmental state authorities and non-state actors through funding and capacity building projects supported by the European Commission and other old EU Member States. However, analyzed countries differ in socio-economic and political contexts backgrounds. The differences exist mostly in the institutional set-up and the method with which the countries transposed international obligations (non-EU countries) together with EU legislation (EU members' countries) into their respective national legislation, primarily regarding management plans for PAs.

4.1. Socio-Economic and Political Context as the Main Driver of Nature Conservation Changes

All analyzed countries, except Italy, share a similar history in terms of regime changes. They have transitioned from socialism to democratization with a more recent period of Europeanization. Changes after the political and economic transition in the 1990s shifted public focus to both nature conservation and the use of natural resources in these countries. Moreover, the changes made nature conservation a higher priority within the state, which resulted in the expansion of PAs. The transition to democracy led to new political and legal frameworks while also bringing change to institutional settings. Accession to the EU became an additional layer in the transition process that brought new policy elements, such as the Natura 2000 network.

The legal issues of nature conservation are dealt with in a comprehensive political and legislative process that spans from the international and European level down to the national legal framework. Despite the fact that a legal framework of nature conservation was in place in all analyzed countries even before the negotiation process with the EU started, the gap between national nature conservation systems and the EU's requirement was quite wide. It required the adoption of a whole set of new legal rules. The Environmental Protection or Nature Conservation Act established new environmental principles and the legal basis for nature protection. Based on the new legal framework in each of the analyzed countries, all important nature conservation-related international conventions and agreements have successfully been transposed and several types of PAs have been established in harmony with the IUCN. Therefore, PAs are one of the most important nature and forest conservation measures in all of the analyzed countries. Moreover, countries have successfully transposed the "Habitats" and "Birds" Directives into national legal order that fulfills the requirements under the acquis but the implementation process needs to be improved. Also, the comprehensive evaluation of the Directives

(known as the "Fitness Check") undertaken by the European Commission highlighted that the full potential of Directives can only be accomplished by substantially improving their implementation [70].

After the changes in the political system and following the EU requirements, each of the analyzed countries began to adapt their respective institutional context of nature conservation gradually. According to our study, which is in line with observations of Kluvánková-Oravská et al. (2009) [13] and Falkner et al. (2008) [28], an institutional misfit was inevitable because there was a need to change crucial domestic institutions. The primary approach of eliminating this misfit has been through the incremental-transformation type since some institutions already existed, albeit most were rearranged, merged, and given more resources. In Italy, nature conservation policy has changed from a centralized first phase—where the main actor was the Ministry of Environment—to a second decentralized phase where the main actors are regions and autonomous provinces. In almost all analyzed countries, a well-rounded institutional set-up exists, which include a central authority for the environment, a ministry related to environment or nature conservation/protection, institutes for nature conservation, and management authorities for PAs (public institutions) at the national, regional, or local levels. Additionally, in some countries these institutional set-ups are complemented by a specialized environmental agency and an environmental fund.

In countries like Croatia, Montenegro, North Macedonia, and Bosnia and Herzegovina not all of the institutions are represented, which potentially creates a gap for the successful implementation of nature conservation policy. These findings are in line with observations of other studies [14,60] where it was found that strengthening institutional structures and administrative capacities are necessary to ensure continued and long-term efficiency.

4.2. Economic Factors as the Major Obstacle of Nature Conservation Development

By establishing a network of PAs, analyzed countries governments become responsible for funding the conservation and maintenance of these areas. Many of these pledges to fund PAs are enforced by national policies. In all analyzed countries, financing of PAs is ensured from the state budget funds and it is expected that these funds will remain at the core of long-term funding. Although the PA management institutions have the possibility to supplement their budget through income generated activities, such revenues represent a fairly small share of their total annual budget in analyzed countries. For that reason, current sources of PA funding in analyzed countries are not sufficient to maintain and expand PA networks; therefore, financial constraints act as a major obstacle for effective nature conservation development in PAs both now and in the future. In order to overcome this, it is important that countries develop and expand the innovative PA financing mechanisms that have emerged in some of the analyzed countries. Noted innovative financing mechanisms with high potential in the analyzed countries include grants or loan schemes, public/private partnership and PES. In other studies (e.g., [71–73]) PES specifically has shown high potential as a mechanism to generate funding for PAs and nature conservation in general and therefore could be applied also in our analyzed countries; especially as those kinds of innovative mechanism already exist. Such mechanisms definitely offer the greatest chance of substantially increasing PA funding in the future. Additionally, they can help stimulate broader improvements in PA management and sustainability. Moreover, in the analyzed countries other opportunities to improve the financial sustainability of PAs also exist; particularly, in some analyzed countries a delegation of PAs management to other actors is possible de jure. In many cases, these actors seek to mobilize different financial resources mainly through commercial and market-based activities. While there are many opportunities in analyzed countries to improve PAs financial sustainability, there are also some challenges that need to be overcome. Notable among these challenges is the common dependence of PAs on international funding assistance and funding from projects. This opportunity is important not only for EU countries, but also countries which are in the process of EU integration as they have opportunities to be involved in the EU project. However, this possibility is often held back by the limited capacity of the PA staff and the possibility of the state institutions to ensure co-financing of projects. The same limitations were reported in other studies (see

e.g., [66,74]). Based on that it can be said that diversification of funding is a solution to ensuring the long-term financial sustainability of PAs.

The responsibility of implementing and financing the Natura 2000 lays with the EU member states. Therefore, national public funding is the most frequently mentioned source of financing Natura 2000 objectives and measures in all analyzed EU member countries as well as the scientific literature [9,23,30,32,75]. Additionally, the EU offers funding opportunities for Natura 2000 through a so-called 'integrated approach'. Currently, the financing of Natura 2000 is delivered through several EU instruments in all analyzed EU countries. The availability of funding to cover the costs of Natura 2000 implementation is frequently insufficient in analyzed countries. This lack of funding is viewed as a major obstacle for the effective implementation of Natura 2000 not only in analyzed countries but also in other EU countries (see e.g., [20,23,24,30]). Since the use of EU funds seems to be hardly guided by the aim of compensating for the disadvantages of the Natura 2000 designation for forest owners, their effectiveness and efficiency is questionable. A better understanding of the reasons behind this use of EU funds requires an in-depth analysis.

In addition, in some analyzed countries additional innovative funding instruments have been developed. For example, in Slovakia and Croatia National environmental protection funds help finance management costs, and public/private partnerships in Slovenia and Italy offset the price of maintaining PAs. These innovative financing instruments are also suggested by the European Commission, although such instruments are covering a rather small portion of the total financing requirements. This claim for innovative financing mechanisms is also supported by the scientific literature [16,75]. In analyzed EU candidate and potential candidate countries, with the EU Accession, huge financial resources have become available for different nature conservation-related projects. The incoming EU funds started to play an important role in financing nature conservation activities. In addition, foreign governments, bilateral aid agencies, and NGOs were noted as funding sources, but they play minor roles.

4.3. Stakeholders' Engagement and Participation—Main Failure of Effective Nature Conservation Implementation

On the European level, there are no legally binding obligations to organize a participatory process in establishing either PAs or Natura 2000 network. This in turn leaves the countries unlimited freedom to introduce elements of participation on their own. In analyzed countries, the participatory process was dependent on the national political context and the historical development of participatory approaches in public policy, which was also reported in other studies [15,37].

The analysis of participatory processes shows that they are in an initial phase in the case of PAs. To a certain extent it can be said that, a shift from the 'traditional paradigm' in which PAs were established by the central government, to the 'new paradigm', where the cooperation among different actors (i.e., local stakeholders, NGOs, private companies, regional, and local authorities) in the governance of PAs has happened in analyzed countries. This shows a positive trend from a command-and-control approach in establishing the PAs towards a participatory approach, not only in analyzed countries, but also in other EU countries [14,76–78]. This paradigm shift is the result of a growing social demand for a direct involvement of citizens in environmental governance. Concerning the management planning of PAs, a wide variety of actors from different levels are most of the times, at least de jure, involved in the process. However, not all of the requisite conditions for successful participation were created (i.e., equally engagement of stakeholders, communication with some of key stakeholders) in analyzed countries, as quite often still a top-down approach was applied in final decision-making. Other studies [51,79–81] also show the same conditions for successful participation (i.e., stakeholders' engagement, planning, and implementing the communication) were not achieved. Therefore, both managers of PAs and actors need to develop their capacities for successful stakeholder participation.

The situation is slightly better in case of Natura 2000 network implementation. In the implementation of the Natura 2000 network, analyzed EU Member countries differ in their

implementation style with regard to stakeholder involvement through both the level of involvement and the approach that was adopted. However, the overall impression is that, the level of participation is strictly linked to the stakeholders' power to influence the final decision in the participatory process. According to the results, the ultimate decision-making power was held by public actors (ministries related to nature conservation) and they were the ones deciding who may participate in what form by aiming to fulfil legal requirements rather than empowering the stakeholders. In all analyzed countries, the initial process was a controversial top-down conservation science-based approach. Only later and mainly in response to the need to manage the substantial conflicts, the implementation approach shift to a more socially inclusive and participatory bottom-up approach came about [8]. Sotirov et al. (2015) [14] called such effect "symbolic transformation", where informal institution and practical behavior did not change in line with formal domestic policy and institution. Many studies have shown similar problems regarding the influence and the power of stakeholders that emerged as a consequence of the adopted top-down approach [13,29,37,38,40,41].

The degree of stakeholder participation varied among analyzed countries and even from one Natura 2000 site to another (Italy). The results point out that public actors have been involved through the co-decision during the participatory process with the supervision of the ministry responsible for nature conservation. Non-state actors have been involved through consultation or collaboration. The general public and local stakeholders have been involved mainly through information. Other transition countries (the Czech Republic, Poland, Romania, and Hungary) have shown similar problems with regards to stakeholders' participation [13,27,38,39,42].

4.4. Methodological Viewpoints

When interpreting the results of this study, it should be noted that the analytical framework for evaluation of operational environment factors related to nature conservation policy implementation included a relatively small number of experts mainly from state-level institutions and included only a few local experts. The results may thus not be considered as statistically representative for the case countries. However, the number of experts (4–10 experts in each country) was big enough to show that the developed framework is functional and provides aspired results. In comparison to other studies—e.g., [82–85]—the total number of experts was satisfactory. In addition, the background and expertise profiles of experts varied between countries, which may have affected the results. However, the experts were selected based on their experiences in the field of nature conservation and consulted to objectively evaluate the operational environment factors. Moreover, the present study does not reveal the opinion of the local stakeholders or the general public. A strength point of the study concerns the large number of different countries involved in the analysis (n = 9), addressing different political and socio-economic context. Besides, the analyzed countries differentiate regarding EU membership status. These differences among countries allowed a wider comparison of the nature conservation policy at national level in a context of increasing Europeanization.

The developed analytical framework for evaluation of operational environment factors influencing nature conservation policy implementation showed to be functional as the methodological approach followed rather similar procedures in different countries. The use of the common framework and factors enabled comparisons between countries. Therefore, presented framework may be used and replicated in other countries. In the future, the developed framework needs to be tested in different socio-economic and political contexts by including additional case studies countries to allow for a more comprehensive applicability. The weakest point of the developed framework is that the framework allows including only the most important general factors and sub-factors in the analysis (based on a literature review, but including expert opinion), but did not allow countries to modify them; therefore, inclusion of country-specific sub-factors was limited. Diverging factors such as environmental factors, ownership structures and resource rights, resource management, as well as perceptions, attitudes and values of various stakeholders can be additional factors that potentially might influence nature

conservation policy implementation. Therefore, these factors might be included in the future in an analytical framework, for a broader applicability and robustness of the proposed framework.

5. Conclusions

This study developed and tested a new analytical framework for the evaluation of four separate operational environmental factors (legal, policy, economic, and social) that influence the implementation of nature conservation policy in several EU and non-EU countries.

Our analysis has shown that the legal framework is well established in all countries taking into account international, national, sub-regional, and regional obligations in nature conservation. Therefore, in all analyzed countries, legislative framework related to nature conservation is very complex as numerous new strategies and laws related to nature conservation have been adopted and integrated into different sectors. In all analyzed countries, a well-rounded institutional framework exists in analyzed countries—but still not all of the required institutions—are represented, which potentially creates a gap for the successful implementation of nature conservation policy.

Economic factors were seen as the major obstacle for nature conservation development. In all analyzed countries, diversification of funding of PAs exists and may be seen as a prerequisite for ensuring the long-term financial sustainability of PAs, even if financing of PAs is nowadays ensured mainly from state budget. This is evidence that there are many opportunities in the analyzed countries to improve PAs' financial sustainability (from state budget funding to market-based funding), but there are also some challenges that need to be overcome. Establishment of PAs is often dependent on international funding assistance and funding from projects, and PAs staff has a limited capacity for implementing these projects. With regard to Natura 2000, even though the EU offers funding opportunities for Natura 2000 through a so-called 'integrated approach', the availability of funding to cover the costs of Natura 2000 implementation and further management is frequently insufficient in analyzed countries. This lack of funding is viewed as a major obstacle for the effective implementation of the Natura 2000. Thus, in some analyzed countries, additional innovative funding instruments have been developed as for example national environmental protection funds and public/private partnership.

Stakeholders' engagement and participation has shown as the main failure of effective nature conservation implementation since not all the requisite conditions for successful participation were created in analyzed countries. Commonly, a top-down approach was applied in final decision-making and not all stakeholder groups were engaged. It can be concluded that there is a possibility for improvement in terms of continuity and transparency of participatory processes, especially by involving the general public and non-state actors from the beginning and throughout the whole policy decision-making process.

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Appendix A

Table A1. National legal framework relevant for nature conservation.

Regulation Area	National Legislation	Country									
		IT	SK	SI	BG	CRO	SRB	MNE	NM	BiH RS [2]	BiH FBiH
Sustainable development	National sustainable development strategy	X	X	X	-	X	X	X	X	-	-
Environmental protection	Environmental protection strategy	-	X	-	-	X	-	-	-	X	X
	Environmental and climate change strategy	-	-	-	X	-	-	-	X	-	-
	National environmental protection program	-	-	X	-	-	X	-	-	X	X
	Environmental protection law	X	X	X	X	X	X	X	X	X	X
Nature protection	National strategy for nature protection	-	-	-	X	X	-	-	X	X	-
	Nature protection/conservation law	X	X	X	-	X	X	X	X	X	X
Biodiversity conservation	Biodiversity conservation strategy	X	X	X	X	-	X	X	X	X	X
	Biodiversity law/biological diversity law	-	-	-	X	-	X	X	-	-	-
Protected areas	Protected areas act or decree	X	-	X	X	X	X	X	X	-	X
	Law on national parks	X	-	X	X	-	X	X	-	X	X
Forestry	Forestry development strategy	-	X	-	X	X	X	X	X	X	-
	National forest program	X	-	X	X	-	-	X	-	-	X
	Forest law	X	X	X	X	X	X	X	X	X	-
Water resources	Law on water	X	X	X	X	X	X	X	X	X	X
Game management	Law on game and hunting	X	X	X	X	X	X	X	X	X	X

[1 2] The complex BiH political set-up has led to an absence of the nature conservation legislation at the national level. Hence, nature conservation is regulated through the laws adopted and implemented at the entity level (Republic of Srpska—BiH RS, the Federation of BiH —FBiH and Brčko District as separate district).

Table 2. Main institutions responsible for nature conservation.

Institutions	Country								
	IT	SK	SI	BG	CRO	SRB	MNE	NM	BiH
Ministry	X	X	X	X	X	X	X	X	X
Institutes for nature conservation	X	X	X	X	-	X	-	-	X
Environmental funds	-	X	X	X	X	X	-	-	X
Environmental agency	X	X	X	X	X	X	X	-	-
Public institution (protected area authority)	X	X	X	X	X	X	X	X	X

Table 3. Overview of financing mechanisms according to the source of funds in protected areas.

Source of Funds	Country								
	IT	SK	SI	BG	CRO	SRB	MNE	NM	BiH
External sources									
State budget	X	X	X	X	X	X	X	X	X
Province/regional budget	X	-	-	-	X	X	-	-	X
Municipal budget	-	-	X	-	X	X	X	X	X
Environmental protection funds	-	X	-	X	X	X	-	-	X
International assistance/funding (agencies, foreign governments)	-	X	-	-	-	X	X	X	X
Private voluntary donations/private foundations	-	X	-	-	-	-	-	X	X
Public/private partnership	-	-	X	-	-	-	-	-	-
Market-based fees for goods and services									
Tourism charges (entrance fees, parking)	X	X [1]	X	-	X	X	-	X	X
Management of land and resources inside PAs	X	X	X	X	-	X	X	X	X
PES	X	-	-	-	X	-	X	X	-
Revenues generated in performing activities (providing lodging, food and beverage, guiding tourists)	X	X	X	-	X	X	-	X	X
Concession of management or resource use rights	-	-	-	X	X	X	-	-	-
Funds provided for implementation of projects	X	X	X	X	X	X	-	X	X

[1] Fee is collected only for parking. According to the legislation entrance fees into national park and PA cannot be charged.

References

1. Evans, D. Building the European Union's Natura 2000 network. *Nat. Conserv.* **2012**, *1*, 11–26. [CrossRef]
2. Šobot, A.; Lukšič, A. The Impact of Europeanisation on the Nature Protection System of Croatia: Example of the Establishment of Multi-Level Governance System of Protected Areas NATURA 2000. *Soc. Ekol. Časopis Ekološku Misao I Sociol. Istraživanja Okoline* **2016**, *25*, 235–270. [CrossRef]
3. Kati, V.; Hovardas, T.; Dieterich, M.; Ibisch, P.L.; Mihok, B.; Selva, N. The challenge of implementing the European network of protected areas Natura 2000. *Conserv. Biol.* **2015**, *29*, 260–270. [CrossRef] [PubMed]
4. Federation, E. Bern Convention & Emerald Network. Available online: https://www.europarc.org/european-policy/bern-convention/ (accessed on 25 April 2019).
5. EEC. *European Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora*; EEC: Brussels, Belgium, 1992.
6. EC. Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds. In *2009/147*; EC: Brussels, Belgium, 2009.
7. Lovrić, M.; Lovrić, N.; Schraml, U.; Winkel, G. Implementing Natura 2000 in Croatian forests: An interplay of science, values and interests. *J. Nat. Conserv.* **2018**, *43*, 46–66. [CrossRef]
8. EFI. *Natura 2000 and Forests-Assessing the State of Implementation and Effectiveness*; EFI: Joensuu, Finland, 2017.
9. Geitzenauer, M.; Hogl, K.; Weiss, G. The implementation of Natura 2000 in Austria—A European policy in a federal system. *Land Use Policy* **2016**, *52*, 120–135. [CrossRef]
10. Carmin, J.; Vandeveer, S.D. Enlarging EU Environments: Central and Eastern Europe from Transition to Accession. *Environ. Politics* **2004**, *13*, 3–24. [CrossRef]
11. Börzel, A.T. *Coping with Accession to the European Union: New Modes of Environmental Governance in Southern, Central and Eastern Europe*; Palgrave Macmillan: London, UK, 2009.
12. Dimitrova, A.; Buzogány, A. Post-Accession Policy-Making in Bulgaria and Romania: Can Non-state Actors Use EU Rules to Promote Better Governance? *JCMS J. Common. Mark. Stud.* **2014**, *52*, 139–156. [CrossRef]
13. Kluvánková-Oravská, T.; Chobotová, V.; Banaszak, I.; Slavikova, L.; Trifunovova, S. From Government to Governance for Biodiversity: The Perspective of Central and Eastern European Transition Countries. *Envion. Policy Gov.* **2009**, *19*, 186–196. [CrossRef]
14. Sotirov, M.; Lovrić, M.; Winkel, G. Symbolic transformation of environmental governance: Implementation of EU biodiversity policy in Bulgaria and Croatia between Europeanization and domestic politics. *Environ. Plan. C Gov. Policy* **2015**, *33*, 986–1004. [CrossRef]
15. Rauschmayer, F.; Van den Hove, S.; Koetz, T. Participation in EU Biodiversity Governance: How Far beyond Rhetoric? *Environ. Plan. C Politics Space* **2009**, *27*, 42–58. [CrossRef]
16. Paavola, J. Protected Areas Governance and Justice: Theory and the European Union's Habitats Directive. *Environ. Sci.* **2004**, *1*, 59–77. [CrossRef]
17. Kotler, P. *Marketing Management*, 13th ed.; Pearson Education Limited: Edinburg, UK, 2009.
18. Ansoff, H.I.; Kipley, D.; Lewis, A.O.; Helm-Stevens, R.; Ansoff, R. *Implanting Strategic Management*, 3rd ed.; Springer: Cham, Switzerland, 2018.
19. Dess, G.G.; Miller, A. *Strategic Management*; McGraw-Hill International Editions: New York, NY, USA, 1993.
20. Fernandes, J.P.; Guiomar, N.; Gil, A. Identifying key factors, actors and relevant scales in landscape and conservation planning, management and decision making: Promoting effective citizen involvement. *J. Nat. Conserv.* **2019**, *47*, 12–27. [CrossRef]
21. Blicharska, M.; Orlikowska, E.H.; Roberge, J.M.; Grodzinska-Jurczak, M. Contribution of social science to large scale biodiversity conservation: A review of research about the Natura 2000 network. *Biol. Conserv.* **2016**, *199*, 110–122. [CrossRef]
22. Grodzinska-Jurczak, M.; Cent, J. Expansion of nature conservation areas: Problems with Natura 2000 implementation in Poland? *Environ. Manag.* **2011**, *47*, 11–27. [CrossRef]
23. Ferranti, F.; Beunen, R.; Speranza, M. Natura 2000 Network: A Comparison of the Italian and Dutch Implementation Experiences. *J. Environ. Policy Plan.* **2010**, *12*, 293–314. [CrossRef]
24. Winkel, G.; Blondet, M.; Borrass, L.; Frei, T.; Geitzenauer, M.; Gruppe, A.; Jump, A.; de Koning, J.; Sotirov, M.; Weiss, G.; et al. The implementation of Natura 2000 in forests: A trans- and interdisciplinary assessment of challenges and choices. *Environ. Sci. Policy* **2015**, *52*, 23–32. [CrossRef]

25. Julien, B.; Lammertz, M.; Barbier, J.M.; Jen, S.; Ballesteros, M.; de Bovi, C. Voicing interests and concerns: NATURA 2000: An ecological network in conflict with people. *For. Policy Econ.* **2000**, *1*, 357–366. [CrossRef]
26. McCauley, D. Sustainable development and the 'governance challenge': The French experience with Natura 2000. *Eur. Environ.* **2008**, *18*, 152–167. [CrossRef]
27. Mocsari, J. The Implementation of the Habitats Directive in Hungary. Missing Details Behind the Big Picture. Available online: http://www.oeue.net/papers.asp (accessed on 25 May 2019).
28. Falkner, G.; Treib, O. Three Worlds of Compliance or Four? The EU-15 Compared to New Member States. *J. Common. Mark. Stud.* **2008**, *46*, 293–313. [CrossRef]
29. Apostolopoulou, E.; Drakou, E.G.; Pediaditi, K. Participation in the management of Greek Natura 2000 sites: Evidence from a cross-level analysis. *J. Environ. Manag.* **2012**, *113*, 308–318. [CrossRef]
30. Geitzenauer, M.; Blondet, M.; de Koning, J.; Ferranti, F.; Sotirov, M.; Weiss, G.; Winkel, G. The challenge of financing the implementation of Natura 2000–Empirical evidence from six European Union Member States. *For. Policy Econ.* **2017**, *82*, 3–13. [CrossRef]
31. Hily, E.; Garcia, S.; Stenger, A.; Tu, G. Assessing the cost-effectiveness of a biodiversity conservation policy: A bio-econometric analysis of Natura 2000 contracts in forest. *Ecol. Econ.* **2015**, *119*, 197–208. [CrossRef]
32. Sarvašová, Z.; Ali, T.; Đorđević, I.; Lukmine, D.; Quiroga, S.; Suárez, C.; Hrib, M.; Rondeux, J.; Mantzanas, K.T.; Franz, K. Natura 2000 payments for private forest owners in Rural Development Programmes 2007–2013—A comparative view. *For. Policy Econ.* **2019**, *99*, 123–135. [CrossRef]
33. Sarvašová, Z.; Quiroga, S.; Suárez, C.; Ali, T.; Lukmine, D.; Đorđević, I.; Hrib, M. Understanding the drivers for Natura 2000 payments in forests: A Heckman selection analysis. *J. Nat. Conserv.* **2018**, *46*, 28–37. [CrossRef]
34. De Meo, I.; Brescancin, F.; Graziani, A.; Paletto, A. Management of Natura 2000 sites in Italy: An exploratory study on stakeholders' opinions. *J. For. Sci.* **2016**, *62*, 511–520. [CrossRef]
35. Beunen, R.; de Vries, J.R. The governance of Natura 2000 sites: The importance of initial choices in the organisation of planning processes. *J. Environ. Plan. Manag.* **2011**, *54*, 1041–1059. [CrossRef]
36. Borrass, L.; Sotirov, M.; Winkel, G. Policy change and Europeanization: Implementing the European Union's Habitats Directive in Germany and the United Kingdom. *Environ. Politics* **2015**, *24*, 788–809. [CrossRef]
37. Cent, J.; Grodzińska-Jurczak, M.; Pietrzyk-Kaszyńska, A. Emerging multilevel environmental governance–A case of public participation in Poland. *J. Nat. Conserv.* **2014**, *22*, 93–102. [CrossRef]
38. Cent, J.; Mertens, C.; NiedziałKowski, K. Roles and impacts of non-governmental organizations in Natura 2000 implementation in Hungary and Poland. *Environ. Conserv.* **2013**, *40*, 119–128. [CrossRef]
39. Stringer, L.C.; Paavola, J. Participation in environmental conservation and protected area management in Romania: A review of three case studies. *Environ. Conserv.* **2013**, *40*, 138–146. [CrossRef]
40. Laktić, T.; Pezdevšek Malovrh, Š. Stakeholder Participation in Natura 2000 Management Program: Case Study of Slovenia. *Forests* **2018**, *9*, 599. [CrossRef]
41. Blondet, M.; de Koning, J.; Borrass, L.; Ferranti, F.; Geitzenauer, M.; Weiss, G.; Turnhout, E.; Winkel, G. Participation in the implementation of Natura 2000: A comparative study of six EU member states. *Land Use Policy* **2017**, *66*, 346–355. [CrossRef]
42. Kovács, E.; Kelemen, E.; Kiss, G.; Kalóczkai, Á.; Fabók, V.; Mihók, B.; Megyesi, B.; Pataki, G.; Bodorkós, B.; Balázs, B.; et al. Evaluation of participatory planning: Lessons from Hungarian Natura 2000 management planning processes. *J. Environ. Manag.* **2017**, *204*, 540–550. [CrossRef] [PubMed]
43. Dimitrakopoulos, P.G.; Jones, N.; Iosifides, T.; Florokapi, I.; Lasda, O.; Paliouras, F.; Evangelinos, K.I. Local attitudes on protected areas: Evidence from three Natura 2000 wetland sites in Greece. *J. Environ. Manag.* **2010**, *91*, 1847–1854. [CrossRef] [PubMed]
44. Pietrzyk-Kaszyńska, A.; Cent, J.; Grodzińska-Jurczak, M.; Szymańska, M. Factors influencing perception of protected areas—The case of Natura 2000 in Polish Carpathian communities. *J. Nat. Conserv.* **2012**, *20*, 284–292. [CrossRef]
45. Jones, N.; Filos, E.; Fates, E.; Dimitrakopoulos, P.G. Exploring perceptions on participatory management of NATURA 2000 forest sites in Greece. *For. Policy Econ.* **2015**, *56*, 1–8. [CrossRef]
46. Howes, M.; Wortley, L.; Potts, R.; Dedekorkut-Howes, A.; Serrao-Neumann, S.; Davidson, J.; Smith, T.; Nunn, P. Environmental Sustainability: A Case of Policy Implementation Failure? *Sustainability* **2017**, *9*, 165. [CrossRef]

47. Siebert, R.; Toogood, M.; Knierim, A. Factors Affecting European Farmers' Participation in Biodiversity Policies. *Sociol. Rural.* **2006**, *46*, 318–340. [CrossRef]
48. Popescu, D.V.; Rozylowicz, L.; Niculae, M.I.; Cucu, L.A.; Hartel, T. Species, Habitats, Society: An Evaluation of Research Supporting EU's Natura 2000 Network. *PLoS ONE* **2014**, *9*, e113648. [CrossRef]
49. Lovrić, M.; Lovrić, N.; Schraml, U. Modeling policy networks: The case of Natura 2000 in Croatian forestry. *For. Policy Econ.* **2019**, *103*, 90–102. [CrossRef]
50. Gallo, M.; Pezdevšek Malovrh, Š.; Laktić, T.; De Meo, I.; Paletto, A. Collaboration and conflicts between stakeholders in drafting the Natura 2000 Management Programme (2015–2020) in Slovenia. *J. Nat. Conserv.* **2018**, *42*, 36–44. [CrossRef]
51. Rodela, R.; Udovč, A. Participation in nature protection: Does it benefit the local community? A Triglav National Park case study. *Int. J. Biodivers. Sci. Manag.* **2008**, *4*, 209–218. [CrossRef]
52. Brescancin, F.; Dobšinská, Z.; De Meo, I.; Šálka, J.; Paletto, A. Analysis of stakeholders' involvement in the implementation of the Natura 2000 network in Slovakia. *For. Policy Econ.* **2017**, *78*, 107–115. [CrossRef]
53. Nonić, D.; Avdibegović, M.; Nedeljković, J.; Radosavljević, A.; Ranković, N. *Održivo upravljanje u šumarstvu i zaštiti prirode. Glasnik Šumarskog Fakulteta, Specijalno Izdanje Povodom Naučnog Skupa "Šume Srbije i Održivi Razvojoj"*; University of Belgrade, Faculty of Forestry: Belgrade, Serbia, 2014; pp. 113–140.
54. Arts, B. Forests policy analysis and theory use: Overview and trends. *For. Policy Econ.* **2012**, *16*, 7–13. [CrossRef]
55. Ostrom, E. Background on the Institutional Analysis and Development Framework. *Policy Stud. J.* **2011**, *39*, 7–27. [CrossRef]
56. Fozer, D.; Sziraky, F.Z.; Racz, L.; Nagy, T.; Tarjani, A.J.; Toth, A.J.; Haaz, E.; Benko, T.; Mizsey, P. Life cycle, PESTLE and Multi-Criteria Decision Analysis of CCS process alternatives. *J. Clean. Prod.* **2017**, *147*, 75–85. [CrossRef]
57. Krippendorff, K. *Content Analysis: An Introduction to Its Methodology*, 2nd ed.; SAGE Publications: Thousand Oaks, CA, USA, 2004; p. 422.
58. Sarvašova, Z.; Šalka, J.; Dobšinska, Z. Mechanism of cross-sectoral coordination between nature protection and forestry in the Natura 2000 formulation process in Slovakia. *J. Environ. Manag.* **2013**, *127*, S65–S72. [CrossRef]
59. Directorate of Culture and of Cultural and Natural Heritage. *Development of the Emerald Site Network in the West-Balkana under the CARDS Program*; Council of Europe: Strasbourg, France, 2007; p. 38.
60. Vasiljević, M.; Pokrajac, S.; Erg, B. *State of Nature Conservation Sytems in South-Eastern Europe*; IUCN: Gland, Switzerland; Belgrade, Serbia, 2018; p. 58.
61. EEA. *The Natura 2000 Barometer*; EEA: Kobenhavn, Denmark, 2019; Available online: https://www.eea.europa.eu/data-and-maps/dashboards/natura-2000-barometer#tab-based-on-data (accessed on 7 May 2019).
62. European Commission. *Natura 2000 and Forests, Part I–II*; European Union: Brussel, Belgium, 2015; p. 114.
63. Petkovšek, M. Slovenian Natura 2000 network in numbers. *Varst. Narave* **2017**, *30*, 99–126.
64. Kapusta, P. Forests and Protected Areas. Available online: https://www.enviroportal.sk/indicator/detail?id=1103 (accessed on 1 October 2019).
65. Mariano, A.; Gasparini, P.; De Natale, F.; Romano, R.; Ammassari, P.; Liberati, D.; Ballin, M.; Vitullo, M. *Italy-Global Forest Resources Assessment 2015–Country Report*; FAO: Rome, Italy, 2015; p. 105.
66. Emerton, L.; Bishop, J.; Thomas, L. *Sustainable Financing of Protected Areas: A Global Review of Challenges and Options*; IUCN: Gland, Switzerland; Cambridge, UK, 2006; p. 109.
67. Communities, C.O.T.E. *Treaty on European Union*; Office for Official Publication of the European Communities: Luxembourg, 1992; p. 260.
68. Elliott, C.; Udovč, A. Nature conservation and spatial planning in Slovenia: Continuity in transition. *Land Use Policy* **2005**, *22*, 265–276. [CrossRef]
69. Herwig, U. Public Participation in the Establishment and Management of the Natura 2000 Network—Legal Framework and Administrative Practices in Selected Member States. *J. Eur. Environ. Plan. Law* **2008**, *5*, 35–68.
70. Ministry of Environment and Spatial Planning. *Support for the Organization of Bilateral Dialogues with Slovenia in the Context of Action 5 of the Action Plan for Nature, People and the Economy*; Ministry of Environment and Spatial Planning: Ljubljana, Slovenia, 2018; p. 66.

71. Perrot-Maître, D. *The Vittel Payments for Ecosystem Services: A Perfect" PES Case?* International Institute for Environment and Development: London, UK, 2006; p. 24.
72. Marino, D.; Pellegrino, D. Can Payments for Ecosystem Services Improve the Management of Natura 2000 Sites? A Contribution to Explore Their Role in Italy. *Sustainability* **2018**, *10*, 665. [CrossRef]
73. Schomers, S.; Matzdorf, B. Payments for ecosystem services: A review and comparison of developing and industrialized countries. *Ecosyst. Serv.* **2013**, *6*, 16–30. [CrossRef]
74. Jones-Walters, L.; Čivić, K. European protected areas: Past, present and future. *J. Nat. Conserv.* **2013**, *21*, 122–124. [CrossRef]
75. Klassert, C.; Möckel, S. Improving the Policy Mix: The Scope for Market-Based Instruments in EU Biodiversity Policy. *Environ. Policy Gov.* **2013**, *23*, 311–322. [CrossRef]
76. Niedziakowski, K.; Paavola, J.; Jedrzejewska, B. Participation and Protected Areas Governance: The Impact of Changing Influence of Local Authorities on the Conservation of the Bialowieza Primeval Forest, Poland. *Ecol. Soc.* **2012**, 17. [CrossRef]
77. Keulartz, J. European Nature Conservation and Restoration Policy—Problems and Perspectives. *Restor. Ecol.* **2009**, *17*, 446–450. [CrossRef]
78. Ferranti, F.; Turnhout, E.; Beunen, R.; Behagel, J.H. Shifting nature conservation approaches in Natura 2000 and the implications for the roles of stakeholders. *J. Environ. Plan. Manag.* **2014**, *57*, 1642–1657. [CrossRef]
79. Nastran, M. Stakeholder analysis in a protected natural park: Case study from Slovenia. *J. Environ. Plan. Manag.* **2014**, *57*, 1359–1380. [CrossRef]
80. Nastran, M. Why does nobody ask us? Impacts on local perception of a protected area in designation, Slovenia. *Land Use Policy* **2015**, *46*, 38–49. [CrossRef]
81. Nastran, M.; Pirnat, J. Stakeholder participation in planning of the protected natural areas: Slovenia. *Sociol. I Prost.* **2012**, *50*, 141–164. [CrossRef]
82. Dwivedi, P.; Alavalapati, J.R.R. Stakeholders' perceptions on forest biomass-based bioenergy development in the southern US. *Energy Policy* **2009**, *37*, 1999–2007. [CrossRef]
83. Pezdevšek Malovrh, Š.; Kurttila, M.; Hujala, T.; Kärkkäinen, L.; Leban, V.; Lindstad, B.H.; Peters, D.M.; Rhodius, R.; Solberg, B.; Wirth, K.; et al. Decision support framework for evaluating the operational environment of forest bioenergy production and use: Case of four European countries. *J. Environ. Manag.* **2016**, *180*, 68–81. [CrossRef] [PubMed]
84. Grošelj, P.; Zadnik Stirn, L. The environmental management problem of Pohorje, Slovenia: A new group approach within ANP–SWOT framework. *J. Environ. Manag.* **2015**, *161*, 106–112. [CrossRef] [PubMed]
85. Huber, P.; Hujala, T.; Kurttila, M.; Wolfslehner, B.; Vacik, H. Application of multi criteria analysis methods for a participatory assessment of non-wood forest products in two European case studies. *For. Policy Econ.* **2019**, *103*, 103–111. [CrossRef]

forests

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The Organization of Nature Conservation in State-Owned Forests in Poland and Expectations of Polish Stakeholders

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Abstract: *Research Highlights:* The presented findings result from the first large-scale research conducted in Poland in relation to the State Forests—the most important place for the protection of Polish nature. They may constitute an important contribution to the improvement of the nature conservation system. *Background and Objectives:* The current model of organization of nature conservation in the State Forests in Poland is not fully effective. In regard to the growing influence of society on nature protection and the need to improve the existing system of nature conservation, this study poses the question: what are the expectations of various stakeholders as for the organization of nature conservation in the State Forests? The aim of the article is to present these expectations, to broadly discuss them, and to present recommendations for the future. *Materials and Methods:* The survey was conducted in 2013, among 41 various stakeholder groups in Poland. The choice of the surveyed groups was determined by their legal competence and/or practical experience in nature conservation in the State Forests. *Results:* A total of 77.9% of the respondents supported the concept of transferring full responsibility for nature conservation to foresters, while 51.1% supported financing of nature conservation tasks exclusively by the State Forests. In total, 46.8% of respondents believed that foresters should determine the principles and methods of nature conservation. The presented expectations of the Polish stakeholders differ from the current real situation, however, they still cannot be considered as a complete solution. *Conclusions:* The results indicate a need for a broader discussion and perhaps, consequently, a reorganization of the functioning of nature conservation in state-owned forests in Poland, considering the social expectations and trust in foresters. This can be inspiring also for other countries with a high proportion of state-owned forests.

Keywords: State Forests; nature protection; financing; decision making; responsibility; implementation of protective measures; Poland

1. Introduction

1.1. The State-Owned Forests in the World and in Poland

Forests, not only in Poland but also worldwide, are regarded as the most important centers of terrestrial biodiversity [1–3]. Among them, the state-owned forests (and generally lands) are very important for nature conservation [4–10]. On the one hand, this is due to well-preserved natural resources that are worth protecting (e.g., [11]). On the other hand, the creation of protected areas on state lands reduces social conflicts related to the limitation of the possibilities to use nature resources (e.g., [8,12–15]). It is noteworthy, that in 2006 about 11.5% of the world's forests were in protected areas [3], in the case of Europe, in 2018 it was 17% (of the state forests), and e.g., in Austrian Federal Forests as much as 50% [6].

Public ownership of forests, including State ownership, concerns approximately 76% of the world's total forest area—about 3040 million ha. The share varies from region to region: it is the lowest in Europe (44%), average in North America, Latin America-Caribbean, and Asia-Pacific (68%, 64% and 67%, respectively), and the highest in Africa, Central Asia, and Russian Federation (99%, 100% and 100%, respectively) [16]. In Europe, 35 companies, enterprises, and agencies (from 24 countries) that sustainably manage state forests are associated in the European State Forest Association (EUSTAFOR). For example, in Norway it is Statskog (about 1 million ha), in France the Office National Des Forêts (about 6.7 million ha), and in Romania Romsilva (about 3.2 million ha) [17].

The State Forests National Forest Holding (in short: The State Forests; this abbreviation will also be used in the text for forests managed by the State Forests), established in Poland in 1924, is also a member of EUSTAFOR. It is the largest institution managing state-owned forests from all countries within the European Union. In 2018, with about 26,400 employees, this institution managed 7.1 million ha of woodlands (and 0.5 million ha of other lands), which account for 76.9% of the total area of Polish forests, 96.7% of the total area of state-owned forests in Poland [18], and over 3.3% of forest area in the EU [19].

Polish forests managed by the State Forests are an important source of timber and other commercial products. For example, in 2018, the harvested yields reached 43.30 million m^3 of wood and at least 4500 tonnes of fruit and 3200 tonnes of mushrooms [18]. Wood products account for 9.3% of the value of Polish exports, and the importance of the wood sector in Poland's national economy is greater than the average one in the European Union. At the regional and local level, the forest-wood sector is a stimulator of development, especially in rural regions, with a total employment standing at about 500,000 people [20]. The State Forests operate on the principle of financial self-sufficiency and cover their costs with their own revenues ([21], sect. 50.1), with a positive financial result, e.g., in 2018, the net profit amounted to about PLN 540 million [22]. Conducting a sustainable forest management requires that the State Forests should meet both people's needs and economic factors, while protecting forests and biodiversity ([21], sect. 6.1.1a). However, in practice, this involves a number of smaller and larger conflicts between various stakeholders, especially between the "demand for timber" and the "conservationists position". These trade-offs between different demands towards State Forests are specific not only to Poland, but also e.g., to Germany [23].

1.2. The Importance of the State Forests for the Protection of Polish Nature

As early as in 2004, Polish law concerning forests (including the State Forests) was classified as restrictive, as compared to other countries and regions of the world [4]. This is of vital importance for nature conservation in those areas. The adopted model of sustainable forest management (Forest Act [21], sect. 7.1), implementing the integrative approach to nature conservation [5], allows to protect or shape forests with a high biodiversity on a large scale. Forests in Poland are relatively well-preserved, biologically diverse, supporting over 60% of species recorded in Poland. This results in a large number of protected areas and objects in the State Forests, covering 24.3% of the area of Poland (based on [18,24]), often disproportionately higher than on the remaining 75.7% of the area of Poland (Table 1). Out of the 10 legal forms of nature conservation (Nature Conservation Act [25], sect. 6.1), only national parks are excluded from the structure of the State Forests. The state-owned forests located in the latter, cover a much smaller area, about 192,000 ha ([24]) and are managed according to different rules [25]. Among the forms of nature conservation put into practice by the State Forests and listed in Table 1, those with numbers 2, 3, 8 correspond most closely to the integrative approach for nature preservation, while those with numbers 1, 5, 6, 7, and 9 to the segregative approach. In the case of number 4 the approach may vary, depending on the situation of the object of protection (partly after: [26]). The forms of nature conservation listed in Table 1 cover a total of 70.6% of the area managed by the State Forests (unpublished data, made available by Directorate-General of the State Forests, in short: DGSF).

Table 1. Forms of nature conservation in the State Forests (SF) compared to Poland in general, at the end of 2018 (based on [24,27], and information from the General Directorate of Environmental Protection).

No.	Form of Nature Conservation	Objects in the SF		All Objects in Poland	
		Number	Share of the SF's Surface	Number	Share of the Country's Surface
1	Nature reserve	1284	1.62%	1501	0.54%
2	Landscape park	122	17.25%	123	8.07%
3	Landscape protection area	386	33.80%	386	22.39%
4	Natura 2000 (SPAs)	133	29.14%	145	15.71%
	Natura 2000 (SACs)	708	21.86%	849	11.16%
5	Natural monument	11,167	-	35,022	-
6	Ecological area [1]	8316 [1]	0.39%	8206 [1]	0.18%
7	Documentation site of inanimate nature	124	0.02%	182	<0.01%
8	Landscape-nature protected complex	164	0.60%	331	0.38%
9	Buffer zone (around sites of selected species)	3798	2.01%	3827	0.49%

[1] Different methods of counting in the State Forests and in Poland in general.

It is noteworthy, that for private owners (of forests) in Poland, biodiversity conservation is neither an ethical priority nor a financial benefit [28,29]. There is a common lack of will, habits, or social need for environmental protection and undertaking activities aimed at it [30]. Hence, so far, not private but state ownership of land/forest is a pillar of nature conservation in Poland [28,31]. This is why the organization of nature conservation in the State Forests is so crucial for the effectiveness of nature conservation in the whole country.

1.3. Current Organization of Nature Conservation in the State Forests

According to Professor Olaczek (Polish authority in the field of nature conservation), the current organization of nature conservation in Poland and in the State Forests is imperfect. The biggest deficiencies and shortcomings are the bureaucracy, related costs, conflicting solutions, and managing of protected areas "at a distance", discouraging foresters, scientists, and also local governments from nature conservation [32].

The organization of nature conservation in the State Forests is regulated by the Nature Conservation Act [25] and Forest Act [21]. The most important competences and activities of various institutions, concerning different forms of nature conservation in the State Forests (from Table 1), are presented in Figure 1. Among listed institutions, the so-called organs of nature conservation i.e., persons having special legal and practical competences in issues related to nature conservation were distinguished ([25], sect. 91).

Not all solutions in the organization of nature conservation in the State Forests are permanent—some can be realized in different variants (dotted lines in Figure 1). For example, supervisory bodies of nature reserves, natural monuments, ecological areas, documentation sites, and landscape-nature protected complexes are determined in the legal acts establishing those objects ([25], sect. 15.3, 44.2). In practice, district forest managers of the State Forests may be designated.

Below, focus is placed on three practical aspects of the actual organization of nature conservation in the State Forests: determination of protective measures; responsibility for the protected areas and objects; financing of nature conservation tasks.

The determination of principles and methods of nature conservation in the state forests means the decision-making process on the design of nature conservation. Among the forms of nature conservation listed in Table 1, only nature reserves, Natura 2000 sites, and landscape parks have protection plans, prepared by the Regional Director of Environmental Protection, the Minister of the Environment or the director of the landscape park, respectively ([25], sect. 20, 28, 29; see Figure 1). Foresters may comment on draft plans ([25], sect. 19.1a, 28.3, 29.2, 29.5), but these comments do not have to be taken into

account. In all the other cases (forms of nature conservation), decisions about protective measures are added to the legal acts establishing those objects and areas ([25], sect. 23.2, 44.2) or are made ad hoc by the units that established the given form of nature conservation. In practice, conservation plans are still lacking in many cases, as there is no money to draw them up, and in addition, some organs of nature conservation are overloaded with responsibilities and are not keeping up with their realization [32]. In communes, on the other hand, the knowledge about protected objects (No. 5–8 in Table 1) is often incomplete and incorrect, which means that there are no grounds to determine methods of their protection [33]. Foresters from the State Forests can have more influence on the design of nature conservation only in the case of drafting a conservation plan for a nature reserve. However, such a solution is rarely used (Figure 1). Foresters set their own rules for nature conservation in areas outside the protected objects (29.4% of the area managed by the State Forests), implementing the integrative approach to nature conservation ([21], sect. 7.1), though the Minister of the Environment may still introduce some adjustments when approving them ([21], sect. 22.1).

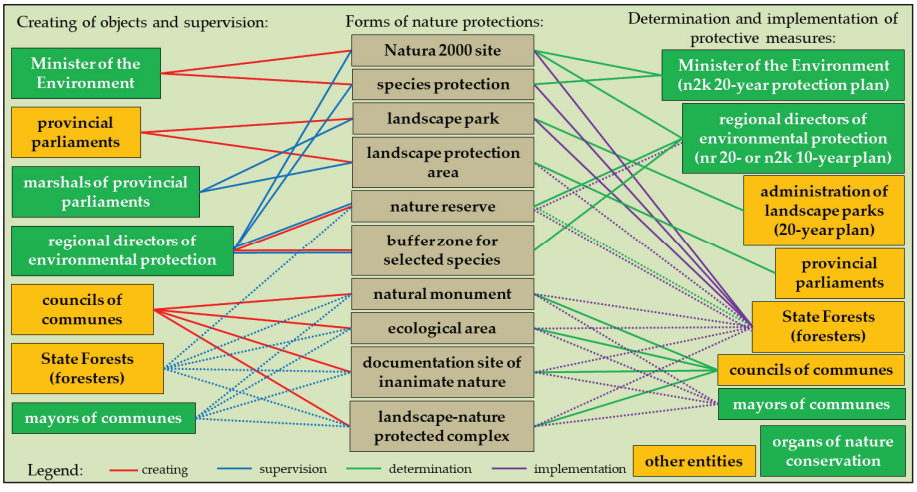

Figure 1. Organization of nature conservation in the State Forests (solid line—permanent solution, dotted line—possible solution).

In this article, the responsibility for protected areas and objects includes the organization and implementation of protective measures. The organization of protective measures means organizing people (workers), equipment, and materials necessary to carry out the protective measures, as well as the enforcement of legal acts associated with this form of nature conservation. This is usually the responsibility of the entity that supervises the given form of nature conservation (Figure 1). Out of the forms of nature conservation listed in Table 1, only landscape parks have their own administration ([25], sect. 105, 107), and it is independent of the structure of the State Forests in the same area. The implementation of protective measures consists of realizing them in the field, and it is often done by specialized companies selected through a tender procedure. In practice, the entities responsible for protective measures often do not have sufficient resources to organize and implement them [32]. For example, systematic protective measures were carried out in only 55% of communes examined by the Supreme Audit Office [33]. The organization and implementation of protective measures is very often delegated to employees of the State Forests. This is always the case within the borders of landscape parks and Natura 2000 sites ([25], sect. 32.4, 105.5; Figure 1). In the case of other forms of nature conservation, foresters carry out protective measures if they are included in forest management plans, on the basis of information from available legal acts (e.g., those establishing the given forms of nature conservation in the State Forests) ([21], sect. 6.1.11). Additionally, foresters

are responsible for the organization of nature conservation in areas outside the protected objects, when realizing the model of sustainable forest management.

In relation to the current financing of nature conservation, the State Forests should in theory be granted designated subsidies from the government budget to perform the tasks delegated by the governmental administration. This applies particularly to the preparation and implementation of protection plans for nature reserves supervised by this institution, as well as to the protection of plant and animal species ([21], sect. 54.5). In reality, 2008 was the last year in which funds for this purpose were provided: 0.57 million PLN [34]. In the same year, direct costs of nature conservation covered by the State Forests reached 5.09 million PLN [35]. In 2018, no designated subsidies from the government budget were transferred, and direct costs of nature conservation covered by the State Forests amounted to 17.18 million PLN [22]. We should add to these sums costs of lost profits due to the restrictions on forest management in protected areas. The annual expenditure of the State Forests on nature conservation in the broad sense—including environment-friendly methods of forest management—was estimated to reach at least about 500–700 million PLN [34,36]. Additionally, the government budget should participate in the financing of Natura 2000 sites ([25], sect. 39). Apart from designated subsidies from the state budget, funds for nature conservation should also theoretically be provided by some organs of public administration ([25], sect. 4.2), e.g., those that establish the forms of nature conservation and determine the necessary protection measures. In practice, a much greater role in funding nature conservation in the State Forests is played by foreign (especially EU) and Polish environmental protection funds. Nature protection projects implemented by the State Forests (both within and outside the protected areas) have co-financing from the Operational Programme Infrastructure and Environment in the total amount of 42.05 million PLN in 2014–2020 (based on [37]), and from the LIFE fund in 2010–2020—a total of approx. PLN 39.05 million PLN (based on [38]). In the latter case, the National Fund for Environmental Protection and Water Management (from Poland) also provides financial support for the State Forests in the total amount of 20.31 million PLN.

1.4. The Influence of Society on Nature Conservation in the State Forests

The influence of society on nature conservation in forests may depend on historical, political, legal, economic, and social factors. In the group of political and legal factors—at international and national level—the Aarhus Convention [39] on access to information, public participation in decision-making, and access to justice in environmental matters is worth mentioning. This Convention on a global scale is one of the important steps towards social involvement in environmental resource management [40] and towards meeting societal demands in nature conservation in forests. However, it applies currently only to Europe and a few Asian countries [41]. The extension of policy and legal tools for public participation in nature conservation has a particular effect on public forests, where there is no conflict with the rights of private owners to their land. Social pressure and preferences for nature conservation in state forests are characteristic e.g., for Austria [6] or for Germany [23,42], where—according to the state forestry representatives—non-governmental environmental organizations are even unable to compromise on their demands for nature conservation [42].

In Poland, the influence of society (various stakeholders) on nature conservation in forests began to be more noticeable only after the collapse of socialism in the second half of the 1980s. The change of the political system allowed the creation of numerous non-governmental organizations (NGOs), including those dealing with nature and environmental protection [43,44]. In relation to the visible development of environmental NGOs, the public awareness of the influence on forest nature conservation has also increased. Additionally, Poland signed the abovementioned Aarhus Convention [39]. It means that the procedures related to social involvement in the environment protection need to be followed, and this applies also to forests [45].

The Polish society can influence nature conservation in state-owned forests in various ways. For example, it can suggest new areas and objects to be protected. The effectiveness of such proposals depends on their merits and a positive decision of the relevant organs and institutions. The society

(as well as various institutions, organizations, local governments, etc.) has also the right to consult legal acts concerning environmental protection, nature conservation, and forestry, e.g., proposals of strategies, acts of the Parliament, and resultant ordinances published on the website of the Government Legislative Centre [46]. The society (various stakeholders) can submit comments and proposals concerning projects of protection plans for protected areas ([25], sect. 19.1a, 28.4, 29.6), and thus participate in their management. In some cases, representatives of the society have a right to decide on the fate of selected forms of nature conservation. This applies to local governments' agreements to create a landscape park or landscape protection area ([25], sect. 16.4, 23.3). Public consultation is also required for proposals of forest management plans in individual forest districts of the State Forests. The forest management plan is a document predicting forest management activities for a period of 10 years ahead, approved by the Minister of the Environment ([21], sect. 22.1), and the nature conservation programme constitutes an integral part thereof. Thus the influence of the society (various stakeholders) on nature conservation in the State Forests is potentially quite remarkable according to Polish law, although in reality it started to become effective as late as in the 21st century and in practice (e.g., in the case of forest management plans' consulting) it is still rather weak [47]. However, looking at it more broadly, there is a growing pressure for nature conservation in state forests, especially from non-governmental organizations and some academics [32]. Their expectations can be characterized in simple words as follows: within the boundaries of nature conservation forms, implemented protection should be as restrictive as possible (as in the segregative approach to nature conservation), whereas outside their boundaries forest management should be as gentle as possible for nature (as in the integrative approach) [48]. However, the full spectrum of social expectations regarding nature conservation in the State Forests has not yet been recognized.

1.5. The Purpose of the Study

The review of the information presented above allows for some important facts to be noted. Firstly, the area of the State Forests is of crucial importance for nature conservation in Poland. Secondly, the current organization of nature conservation in the State Forests is not perfect. Although foresters have the knowledge and skills to properly manage nature in area of state-owned forests (the numerous protected areas and objects are a proof thereof—Table 1), they have little influence on the decision-making process of nature conservation design in most of the area they manage, and the bodies that should deal with it often fail to fulfil their responsibilities. The organization and implementation of protective measures in practice is often passed on to foresters, without financial means to do so, however. Thirdly, expectations of various stakeholders with regard to nature conservation and its organization in the State Forests are insufficiently recognized.

In regard to both the growing influence of society on nature protection and the need to improve the existing system of nature conservation, this study poses the question: what are the expectations of various stakeholders as to the organization of nature conservation in the State Forests? Three main elements were taken into account: determination of protective measures, responsibility for the protected areas and objects, and financing of nature conservation tasks. The aim of the article is to present these expectations, to broadly discuss them, and to present recommendations for the future. For these reasons, attempts have been made to answer further questions: how far do stakeholders' proposals differ from current solutions? May the system proposed by stakeholders be considered ideal? What may affect the solutions they chose? To what extent could the presented results and discussion be useful for other countries with a similar forest ownership structure and/or nature conservation organization?

The determination of "how to protect it, how to organize it?" is as important as the issue of "what and where to protect?" in the state forests. Stakeholders' expectations on this issue may have a significant impact on the foresters' work, especially if they are legalized under the procedures related to social involvement in the protection of the environment. That is why it is particularly important to identify in detail the various stakeholders and their needs. The presented findings result from the first extensive research ever conducted in Poland in relation to the State Forests—the most important

place for the conservation of Polish nature. They may constitute an important contribution to the improvement of the nature conservation system. It should also be emphasized, that the analyzed issues (the organization of nature conservation) are universal, associated with forest biodiversity protection in any country where it is implemented. It is also worth noting that the presented results concern state-owned forests, which are quite rarely an object of studies [6], and thus allow to fill the research gap in this respect.

2. Materials and Methods

To investigate the stakeholders' expectations concerning the organization of nature conservation in the State Forests in Poland, an original questionnaire was used in a survey conducted in 2013.

The choice of the surveyed groups (Table A1 in Appendix A) was determined by their legal competence and/or practical experience in nature conservation in the State Forests. They were designated on the basis of the following:

1. Eight legal acts and 51 regulations in force in 2012—among others the Nature Conservation Act [25] and Forest Act [21]. For example, the Nature Conservation Act [25] indicates the so-called organs of nature conservation, i.e., persons who have legal competence in issues related to nature conservation. These include the Minister of the Environment, the General Director of Environmental Protection, province governors (voivodes), regional directors of environmental protection, heads (marshals) of provincial parliaments (sejmiks), directors of national parks, heads (starosts) of counties (powiats), and mayors of rural, urban-rural, and urban communes (gminas) ([25], sect. 91). From among the listed organs of nature conservation, the survey (Table A1 in Appendix A) omitted only those which competence concerned exclusively urban areas, i.e., areas beyond the management of the State Forests (authorities of urban counties and communities);
2. descriptions of 5347 non-governmental organizations and their field branches [49] dealing with "Ecology and protection of animals and natural heritage"—only organizations described as practically acting for the benefit of forests or considered very likely to do so, were selected for the survey;
3. articles published in the years 2008–2012 in the following periodicals (of these, all entities which operated in the field of nature conservation in the State Forests in its broadest sense, were selected out):

    a. "Głos Lasu" ("The Voice of Forest")—free monthly magazine for foresters published by the State Forests,
    b. "Las Polski" ("The Polish Forest")—independent paid bi-weekly "for foresters and forest friends",
    c. "Studia i Materiały Centrum Edukacji Przyrodniczo-Leśnej w Rogowie" ("Proceedings of the Center for Nature and Forestry Education")—scientific periodical publishing post conference materials, concerning among others, nature protection in forests at the end of events co-organized by the State Forests,
    d. "Chrońmy Przyrodę Ojczystą" ("Let's Protect Our Native Nature")—bimonthly for natural scientists and naturalists amateurs, published independently from the State Forests, containing scientific and popular science articles.

A total of 41 stakeholder groups were selected, and out of them, a total of 6746 respondents to the survey, one questionnaire was in fact to be sent to every single organization, regional and local government, etc. (Table A1 in Appendix A). Depending on the type of respondent, the questionnaire was addressed individually to one person (individual respondent) or to the most important person in a given unit/institution (collective respondent). In the case of 3246 individual questionnaires one answer to each question was foreseen. In the case of the remaining 3500 collective addressees (research units;

NGOs and their branches; councils of all rural and urban-rural communes; councils of all rural counties; regional nature conservation councils; socio-scientific councils of all forest promotion complexes), it was possible for a larger number of people within a given unit to answer the questionnaire questions. However, only a few socio-scientific councils of forest promotion complexes, NGOs, and research units used this possibility.

A total of 6746 questionnaires were sent and 1608 responses were received (23.8%) (Table A1 in Appendix A). In case of any doubts, the filled questionnaires were verified and supplemented by e-mail and phone in 2013 and 2014 (the questionnaires were not anonymous, respondents provided their e-mail addresses). In the printed or on-line questionnaire (depending on the group of respondents), the following semi-open three questions with answer variants were included:

Q1: Principles/methods of nature conservation in the area of the State Forests should be determined by:

- the State Forests,
- organs of nature conservation (e.g., the Minister of the Environment, the Regional Director of Environmental Protection, the mayor),
- other bodies (which?).

Q2: Responsibility for the areas and objects of protected nature in the State Forests should be borne by:

- the managing body—the State Forests,
- organs of nature conservation (e.g., the Minister of the Environment, the Regional Director of Environmental Protection, the mayor),
- other bodies (which?).

Q3: Who should finance nature conservation tasks in the State Forests?

- the State Forests from their own funds,
- the government budget,
- another source (which?).

Numbers of received answers to the questions listed above are presented in Table A1 (in Appendix A).

The answers to each question were first divided into variants, where identical or almost identical answers were treated as one variant. Then the analysis was conducted in two ways. First, the different variants of answers for a given question were counted and compared to the sum of all answers to that question. In this way, information was obtained as to what proportion of all the respondents to the survey chose a given variant of response. Secondly, a choice of response variants was identified at the level of individual stakeholder groups. For this purpose, the number of responses under a given variant provided by stakeholders belonging to one group was compared to the sum of responses provided by that group.

Next, the hierarchical cluster analysis was carried out on the variant most frequently chosen by respondents in each answer ("the State Forests"). The PAST program was used for this purpose (version 4.03 [50,51]). From the 'Multivariate' menu, 'Clustering' option was selected, followed by 'Classical'. The cluster distinguishing algorithm was set as 'Single linkage' (nearest neighbor), where clusters are joined basing on the smallest distance between the two groups [52]. The distances between objects were counted as Euclidean distances. In this way, the 'dendrogram' was obtained as a result of grouping the respondents according to the similarity of their answers.

Answers to the additional questions posed for the purpose of the work were based on both long-term own observations about the situation of nature conservation in state forests in Poland, as well as the available literature and studies on Poland and other regions of the world.

Although the research was carried out a few years ago, it has not lost any of its validity and relevance, because to date nothing has changed in the organization system of nature conservation

in the State Forests. The results obtained are related to the current situation in Poland (in the State Forests).

3. Results and Discussion

3.1. Determination of Principles and Methods of Nature Conservation

The first question (Q1) investigated stakeholders' opinion on who should determine the principles/methods of nature conservation in the area of the State Forests. This question was answered by 1605 respondents (Table A1 in Appendix A), in 17 variants (V). Most frequently, they chose the following responses: "the State Forests" (V1—46.8%, for proportions in individual groups of respondents, see Table 2) and "organs of nature conservation" (V2—40.0%). Apart from these two variants, more than 1% of respondents answered: "organs of nature conservation in consultation/agreement with the State Forests" (V3—5.0%) and "the State Forests in agreement with nature conservation organs/guards" (V4—4.9%). The remaining variants of answers were submitted by 0.1%–0.6% respondents. In total, 59.4% of respondents believed that the principles/methods of nature conservation in the area of the State Forests should be determined by the State Forests, either independently or in cooperation with other entities.

Table 2. The four most frequently chosen variants to answer Question 1 (who should determine the principles/methods of nature conservation in the area of the State Forests?).

Groups of Respondents	V1 (%)	V2 (%)	V3 (%)	V4 (%)
Research units	30.0	60.0	-	10.0
NGOs	39.5	36.8	5.3	5.3
Mayors of rural and urban-rural communes	54.5	38.0	2.9	2.8
Councils of rural and urban-rural communes	55.0	39.0	1.6	2.4
Heads (starosts) of rural counties	43.0	43.6	5.0	4.5
Boards of rural counties	45.0	37.6	8.3	2.8
Councils of rural counties	37.8	45.1	4.9	6.1
Province governors (voivodes)	44.4	33.3	-	11.1
Boards of provinces (voivodeships)	20.0	30.0	40.0	10.0
Heads (marshals) of provincial parliaments	10.0	60.0	30.0	-
Environmental committees of provincial parliaments	100.0	-	-	-
Regional directors of environmental protection	-	100.0	-	-
Regional nature conservation councils	-	33.3	-	-
Agency for Restructuring and Modernization of Agriculture	-	100.0	-	-
State regional sanitary inspectors	16.7	83.3	-	-
Directors of national parks	14.3	64.3	14.3	7.1
Directors of landscape parks and their complexes	17.8	35.6	17.8	24.4
Councils of landscape parks	25.0	-	25.0	50.0
Executive Board and Supervisory Board of the National Fund for Environmental Protection and Water Management	-	-	-	100.0
Executive boards and supervisory boards of provincial funds for environmental protection and water management	-	90.0	-	10.0
Provincial heads of State Hunting Guard or units performing their duties	14.3	42.8	14.3	14.3
Environmental Project Coordination Centre	-	-	100.0	-
Authors of scientific publications	-	50.0	-	-
Socio-scientific councils of forest promotion complexes	45.2	41.9	6.5	3.2
Branches of Forest Management and Geodesy Office	-	100.0	-	-
Representatives of selected forest journals	-	-	-	-

Currently (see Section 1.3) foresters have a limited influence on establishing nature protection rules, especially within the boundaries of protected areas (70.6% of the area managed by the State Forests). Meanwhile, the largest group of stakeholders (46.8% of respondents) expects the setting of nature conservation rules to be the exclusive task of the State Forests' foresters. Local self-governments prevailed among the supporters of such a solution. On the other hand, a particular skepticism about this option was expressed by members of the administration of protected areas (national parks and landscape parks), selected organs of regional authorities (at the level of province), as well as representatives of research units and regional directors of environmental protection (Table 2). These stakeholders, along with representatives of provincial funds for environmental protection

and water management, as well as regional authorities (at the level of counties), preferred nature conservation rules to be created by organs of nature conservation (40.0% of respondents), showing a mistrust towards foresters. This overlaps only to a limited extent with the current organization system of nature conservation, in which the principles of protection are most often determined by the entities which established a given form of nature conservation (Figure 1). It is noteworthy that e.g., some German foresters consider the existing rules and programs regarding strictly protected forest reserves as an expression of mistrust towards them and their forest management skills [23].

The presented proposals did not include one that seems very valuable: foresters cooperating with scientists. This cooperation should be applicable particularly to those forms of nature conservation which represent the segregative approach to nature preservation (e.g., nature reserves). In the case of forms representing the integrative approach to nature preservation (e.g., landscape parks), cooperation should be extended to include representatives of local communities. In both cases, a supporting role could be attributed to NGOs. This would implement the model of co-management (management distributed among different state- and non-state actors [53]), with the establishment of rules and methods of protection being, of course, only a part of this management [54]. It is noteworthy that the application of a full model of co-management increases environmental awareness, reduces social conflicts, and reduces the costs covered by the government budget [12,55]. It is also worth noting that the statements concerning the establishment of protection rules were strongly polarized, indicating only one group of entities in charge of. Only 13.2% of stakeholders saw the need for cooperation between at least two parties. This seems to result from a lack of good mutual communication experienced by individual stakeholders in Poland. If the current organization of nature conservation in the State Forests is continued, the situation may only get worse. As an example, the opinion of NGOs from 2019 can be given that in recent years the previously good cooperation with foresters has deteriorated in many cases [48]. This may be related to the abovementioned opinion of Professor Olaczek about the current system discouraging foresters, scientists, and also local governments from nature conservation [32]

3.2. Responsibility for the Protected Areas and Objects

The next question (Q2) concerned the responsibility for areas and objects of protected nature in the State Forests. This question was answered by 1608 respondents (Table A1 in Appendix A), in 15 variants (V). Most frequently, they chose the response: "the managing body—the State Forests" (V1—77.9%, for proportions in individual groups of respondents, see Table 3). The threshold of 1% of respondents was exceeded also for the following responses: "organs of nature conservation" (V2—14.0%), "the managing body—the State Forests—and organs of nature conservation" (V3—4.7%), as well as "the managing body—the State Forests—and other entities, depending on signed contracts/competences determined in legal acts" (V4—1.2%). The remaining variants of answers concerning responsibility for nature conservation in the State Forests were submitted by 0.1%–0.4% respondents. In total, 85.4% of respondents believed that responsibility for areas and objects of protected nature located on land managed by the State Forests should be borne by the State Forests, either independently or in cooperation with other entities.

Table 3. The four most frequently chosen variants to answer Question 2 (who should be responsible for the areas and objects of protected nature in the State Forests?).

Groups of Respondents	V1 (%)	V2 (%)	V3 (%)	V4 (%)
Research units	60.0	40.0	-	-
NGOs	61.1	27.8	5.6	2.8
Mayors of rural and urban-rural communes	88.6	9.0	1.5	-
Councils of rural and urban-rural communes	84.2	10.6	3.5	0.4
Heads (starosts) of rural counties	71.9	18.0	6.7	-
Boards of rural counties	68.5	19.4	5.6	-
Councils of rural counties	69.5	23.2	2.4	-
Province governors (voivodes)	66.7	22.2	11.1	-
Boards of provinces (voivodeships)	30.0	40.0	10.0	10.0
Heads (marshals) of provincial parliaments	10.0	50.0	30.0	10.0
Environmental committees of provincial parliaments	-	100.0	-	-
Regional directors of environmental protection	40.0	40.0	-	20.0
Regional nature conservation councils	33.3	33.3	33.4	-
Agency for Restructuring and Modernization of Agriculture	-	100.0	-	-
State regional sanitary inspectors	83.3	16.7	-	-
Directors of national parks	86.7	-	-	-
Directors of landscape parks and their complexes	47.8	15.6	20.0	16.6
Councils of landscape parks	37.5	-	50.0	-
Executive Board and Supervisory Board of the National Fund for Environmental Protection and Water Management	-	-	100.0	-
Executive boards and supervisory boards of provincial funds for environmental protection and water management	70.0	10.0	20.0	-
Provincial heads of State Hunting Guard or units performing their duties	28.6	57.1	14.3	-
Environmental Project Coordination Centre	-	100.0	-	-
Authors of scientific publications	50.0	25.0	-	-
Socio-scientific councils of forest promotion complexes	61.3	29.0	6.5	-
Branches of Forest Management and Geodesy Office	100.0	-	-	-
Representatives of selected forest journals	100.0	-	-	-

Currently (see Section 1.3) foresters are often responsible (in practice) for the organization of protective measures and their implementation. The largest group of stakeholders (77.9% of respondents) expects such a solution to be valid always, even though currently it is not the case in all situations (see Figure 1). The high support for this solution was mostly due to the opinion of local self-governments members, but also e.g., national parks directors, state regional sanitary inspectors, and representatives of provincial funds for environmental protection and water management (Table 3). This opinion was the least common e.g., among directors and councils of landscape parks, regional directors of environmental protection, and selected organs of government at the regional level (provinces). The listed stakeholders (excluding landscape park authorities) would prefer to delegate the responsibility for protected areas and objects to organs of nature conservation (14.0% of respondents), which is a solution partly functioning at present (Figure 1).

The organization of protective measures and their implementation exclusively by foresters is a proven solution [32], but its full implementation in relation to protected areas and objects should be correlated with securing financial appropriate resources. This solution may also be completed by the possibility to delegate the implementation of protection tasks to non-governmental organizations, which would apply for funds from external funding sources. Apart from reducing own costs, the State Forests could thus improve relations with this group of stakeholders [56], which, in recent years, have slightly deteriorated [48]. In cases of joint management of a protected area, the need to define precisely the responsibility is emphasized by Vokou et al. [55]. The current organs of nature conservation should in turn supervise all of the above activities, in the sense of controlling of whether and how they have been implemented and with what effect.

3.3. Financing of Nature Conservation Tasks

The last question (Q3), concerning the financing of nature conservation tasks in the State Forests, was answered by 1604 respondents (Table A1 in Appendix A), in 20 response variants (V). Most frequently, they chose the following responses: "the State Forests from their own funds" (V1—51.1%, for proportions in individual groups of respondents, see Table 4) and "the government budget" (V2—37.3%). The threshold of 1% of respondents was exceeded also for three other responses: "the State Forests from their own funds and the government budget" (V3—5.1%), "the State Forests from their own funds and external aid funds" (V4—1.9%), "the State Forests from their own funds, the government budget, and external aid funds" (1.7%). The remaining variants of funding nature conservation in the State Forests were submitted by 0.1%–0.4% respondents. In total, 61.4% of respondents believed that the State Forests should participate in the funding either independently or in cooperation with other entities.

Table 4. The four most frequently chosen variants to answer Question 3 (who should finance nature conservation tasks in the State Forests?).

Groups of Respondents	V1 (%)	V2 (%)	V3 (%)	V4 (%)
Research units	20.0	60.0	10.0	-
NGOs	30.8	56.4	-	2.6
Mayors of rural and urban-rural communes	55.4	39.6	3.1	0.1
Councils of rural and urban-rural communes	51.4	42.4	4.3	-
Heads (starosts) of rural counties	52.0	31.4	6.9	2.3
Boards of rural counties	46.3	37.0	7.4	3.7
Councils of rural counties	50.6	32.5	9.6	-
Province governors (voivodes)	44.4	44.4	11.1	-
Boards of provinces (voivodeships)	40.0	20.0	20.0	-
Heads (marshals) of provincial parliaments	30.0	20.0	10.0	10.0
Environmental committees of provincial parliaments	-	100.0	-	-
Regional directors of environmental protection	60.0	20.0	20.0	-
Regional nature conservation councils	33.3	33.3	-	-
Agency for Restructuring and Modernization of Agriculture	100.0	-	-	-
State regional sanitary inspectors	66.7	33.3	-	-
Directors of national parks	66.7	-	-	6.7
Directors of landscape parks and their complexes	42.8	19.8	9.9	19.8
Councils of landscape parks	87.5	12.5	-	-
Executive Board and Supervisory Board of the National Fund for Environmental Protection and Water Management	-	-	-	-
Executive boards and supervisory boards of provincial funds for environmental protection and water management	60.0	10.0	10.0	-
Provincial heads of State Hunting Guard or units performing their duties	28.6	42.9	28.6	-
Environmental Project Coordination Centre	-	-	-	-
Authors of scientific publications	-	75.0	-	-
Socio-scientific councils of forest promotion complexes	31.2	50.0	9.4	-
Branches of Forest Management and Geodesy Office	-	100.0	-	-
Representatives of selected forest journals	-	-	-	-

Currently (see Section 1.3) the funds for nature conservation should be secured in the budget by the government and organs of public administration, and outside the boundaries of the protected objects—by the State Forests themselves. Meanwhile, a majority of stakeholders (51.1%) expect that all the costs of nature conservation tasks (also in protected areas) should be covered only by the State Forests, which is a solution that is largely in practice at present. This answer was chosen more frequently e.g., by members of local self-governments (at commune and county level) as well as directors of national parks and regional directors of environmental protection. On the other hand, a particular skepticism about this was expressed by representatives of research units as well as councils of forest promotion complexes and NGOs. These stakeholders expect all the costs of nature conservation tasks to be covered rather by the government budget (37.3% of respondents), which, in turn, is a narrower solution than the current one.

It is surprising that only a very small proportion of stakeholders' responses took into account external aid funds for environmental protection. In practice they provide important support for Polish nature conservation in recent years (see Section 1.3). Therefore, it seems that they should be taken into account as far as possible when financing nature conservation tasks both within and outside the protected areas. In the former case, the State Forests should also be granted real subsidies from the government budget (covering direct costs of nature conservation), because they carry out tasks important for Polish nature and society which implies costs and losses.

3.4. Factors Affecting the Solutions Chosen by Stakeholders

As it was shown in the previous subsections, the "State Forests" (exclusively) were the most frequent (in general) answer chosen by respondents. However, depending on the stakeholder group and on the question, this variant was more or less accepted (Table 5).

Table 5. Proportions of respondents suggesting that the State Forests should be the only entity responsible for determination of nature conservation's principles, undertaking responsibility for the nature conservation and responsible for its financing.

Groups of Respondents	Group Code	Principles Q1 (%)	Responsibility Q2 (%)	Financing Q3 (%)
Research units	A	30.0	60.0	20.0
NGOs	B	39.5	61.1	30.8
Mayors of rural and urban-rural communes	C	54.5	88.6	55.4
Councils of rural and urban-rural communes	D	55.0	84.2	51.4
Heads (starosts) of rural counties	E	43.0	71.9	52.0
Boards of rural counties	F	45.0	68.5	46.3
Councils of rural counties	G	37.8	69.5	50.6
Province governors (voivodes)	H	44.4	66.7	44.4
Boards of provinces (voivodeships)	I	20.0	30.0	40.0
Heads (marshals) of provincial parliaments	J	10.0	10.0	30.0
Environmental committees of provincial parliaments	K	100.0	-	-
Regional directors of environmental protection	L	-	40.0	60.0
Regional nature conservation councils	M	-	33.3	33.3
Agency for Restructuring and Modernization of Agriculture	N	-	-	100.0
State regional sanitary inspectors	O	16.7	83.3	66.7
Directors of national parks	P	14.3	86.7	66.7
Directors of landscape parks and their complexes	R	17.8	47.8	42.8
Councils of landscape parks	S	25.0	37.5	87.5
Executive boards and supervisory boards of provincial funds for environmental protection and water management	T	-	70.0	60.0
Provincial heads of State Hunting Guard or units performing their duties	U	14.3	28.6	28.6
Authors of scientific publications	W	-	50.0	-
Socio-scientific councils of forest promotion complexes	X	45.2	61.3	31.2
Branches of Forest Management and Geodesy Office	Y	-	100.0	-
Representatives of selected forest journals	Z	-	100.0	-

The dendrogram (Figure 2) prepared on the basis of the data from Table 5 shows which stakeholder groups answered similarly (taking into account the answers to all three questions), and which differently. The smaller the distance, the more similar the concepts of nature conservation organization in the State Forests. The concepts presented by stakeholders K, Z, Y, and N are the least similar to the others, while the most similar to each other are those presented by stakeholders E, F, G, and H. In the first case it was determined by the fact that these were single respondents. In the second case, three groups of respondents (out of four) come from the same social circle (rural counties). A great similarity of concept can also be seen in pairs O-P, C-D, B-X, and Y-Z, of which the first, third, and fourth are the least dependent on each other.

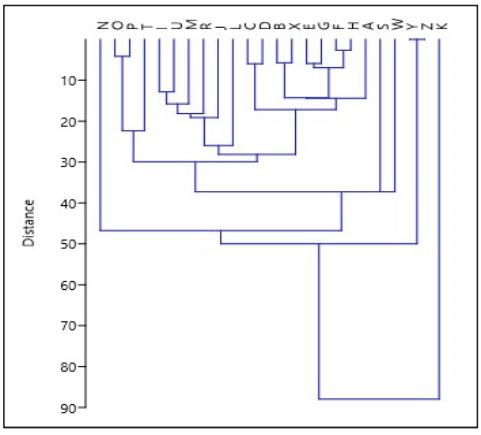

Figure 2. Dendrogram showing the results of the hierarchical cluster analysis (codes A–Z according to Table 5).

However, it should not be forgotten that apart from the answer "the State Forests" (exclusively), stakeholders also chose other response variants in which the State Forests were equally present. In total, 59.4% of respondents in case of Q1 (Principles), 85.4% in the case of Q2 (Responsibility) and 61.4% in the case of Q3 (Financing) chose the State Forests, either independently or in cooperation with other entities.

As the State Forests (foresters) were the most frequent answer chosen by respondents, an attempt to determine what factors could have influenced that is made below.

The expectation to have foresters' involvement in the nature conservation organization increased may result from the intensive forest education of the society since the beginning of 2004. It annually involves about 3–4 million people. Forest education comprises explanation of e.g., principles of sustainable forest management and activities in the field of nature conservation carried out by the State Forests [57]. The support of respondents may indicate an increase in public confidence in foresters' activities, associating them not only with tree felling, but also with care for biodiversity.

Another factor may be the trust in foresters resulting from tradition and/or frequent mutual contacts. Foresters have always been a respected and valued social group in Poland, particularly important in local communities. Actually, local self-governments have quite a lot to do with foresters, which could positively affect the evaluation of their work. There are also other examples. Sanitary inspectors are aware of the involvement of foresters in nature conservation, because they consult the project of forest management plan (including nature conservation programme) for each forest district ([21], sect. 6.1.11). Representatives of provincial funds for environmental protection and water management associate foresters with grant applicants and later beneficiaries of the grants transferred by those funds for nature conservation and environmental education of the society (e.g., [58]). In general, public trust in foresters is high: in 2018, in a public survey, the activity of the State Forests was evaluated positively by 84% of Poles, 86% believed that foresters are honest, and about 89%, that they are competent [59]. In 2014 (one year after the author's survey) it was 81%, 86%, and 86%, respectively [60].

The next factor may be the recognition of foresters' contribution to nature conservation in forests. Many stakeholders are aware of the foresters' contribution to nature conservation in Poland, protective tasks carried out by them, as well as of the large number of protected objects on the land managed by the State Forests (see Table 1). Polish foresters have a very rich practical experience in protecting and shaping forest ecosystems, which should neither be ignored nor underestimated [61]. The directors of national parks also appreciate the financial help from the foresters, as the State Forests partly fund the protective measures and scientific research within national parks ([21], sect. 58.2–3, [22]).

External 'evidence' of the integration of nature conservation into forest management may be another factor. The State Forests are subject to external forest management quality control in respect of e.g., biodiversity conservation, to receive certificates from the Forest Stewardship Council (FSC–[62]) and Programme for the Endorsement of Forest Certification (PEFC–[63]). In 2013, the holding also received from the UNESCO the prestigious Sultan Qaboos Prize for Environmental Preservation, for outstanding contributions to the management or preservation of the environment [64].

The stakeholders' willingness to free from responsibility and expenses related to nature conservation may also be important. For the vast majority of the legally determined organs of nature conservation, nature conservation is an addition to numerous principal duties, associated with spatial management, economy, and community at the level of commune, county, or province (authorities) or to duties in the field of environmental protection (regional directors of environmental protection) [25,45]. Additionally, and quite often, the local self-governments are not prepared in respect of knowledge and staff to conduct nature conservation tasks ([65]—problem no. 12, [33]). Another problem is funds, which are insufficient, not only at the national level (government budget) but also regionally (budget of regional director of environmental protection) and locally (budget of commune) [13,32,33]. Hence a perspective of getting rid of responsibility in nature conservation probably appeared beneficial for the interviewed stakeholders.

Noting the shortcomings of the current nature conservation system may be another factor. Stakeholders have mostly proposed solutions that are currently working in practice, although in theory (in law) they are often considered a possible option only. However, they are more effective than basic solutions. This is in particular the case of the implementation and financing of nature conservation tasks.

The last factor may be the belief that the State Forests are a rich institution. The State Forests are perceived by the society as a wealthy company: in 2018, for example, the average monthly salary of a forester was almost twice as high as the average monthly salary in the entire national economy [22,66]. Therefore, according to many stakeholders, the State Forests can afford to finance nature conservation tasks.

However, some stakeholders preferred different organizational solutions in nature conservation than those involving foresters from the State Forests. The expectation of foresters being relieved of the burden of nature conservation organization may result from the comprehension of the heavy burden currently born by foresters—especially in terms of financing nature conservation. A particular understanding in this point was shown in the group of scientists, underfunded in Poland, who represented not only scientific institutions, but also participated in socio-scientific councils of forest promotion complexes and NGOs. It should be noted, however, that the study involved mainly less radical organizations, which cooperate with the State Forests.

Another factor may be the conviction about one's own competence and irreplaceability in nature conservation—less willingness to transfer to foresters the competence to determine nature conservation principles (or sometimes also to implement them) may be due to a conviction about greater abilities in this field among nature conservation officials, regional directors of environmental protection, scientists, or directors of landscape parks. This results sometimes in decisions on protective tasks being taken by people who have not been in contact with the object in question [32].

Publicizing negative stories by the media may be the next factor. The media publicize primarily conflicts (appearing in various regions and with different intensity) between foresters and some scientists and/or environmental organizations on the scope and restrictiveness of nature conservation in relation to forest management. This can unilaterally affect public opinion.

Another factor may be the negative stereotype of a forester. A reason for associating the State Forests with protection recommendations less frequently can be the still functioning negative stereotype concerning foresters, suggesting that tree felling harms nature and foresters in their work make decisions based only on economic reasons. This stereotype can further aggravate if a given group of stakeholders only rarely gets in touch with foresters or is unable to verify the various publicized pieces of information

in the field. It is noteworthy, that e.g., in Germany foresters also report that they are experiencing increasingly critical public opinion, especially with regard to harvest operations [23].

The last factor may be lack of trust in foresters resulting from mindsets and mutual contacts—forest management in the State Forests takes into account the needs of various interest groups (e.g., related to the forest-wood industry), as well as the necessity to maintain the stability and the good sanitary condition of the forest. Decisions made in this direction are most often contrary to the expectations of people and institutions orientated towards nature conservation, leading to their distrust of foresters as people potentially responsible for this protection. In recent years this has been the case, for example, for some NGOs [48].

3.5. Lessons for Poland and Other Countries

According to Sutherland et al. [67], on the global scale, the increase in number of protected areas was faster than our abilities to manage them properly. One of the elements of management is the organization of nature conservation. Not always and not everywhere the organization of nature conservation works properly [23], which may be influenced by historical circumstances, among others. For example, in Central and Eastern European transition countries nature conservation is still affected by the post-socialistic model of governance and it operates in a rather ineffective way [68]. On the basis of the presented research background (Introduction), the results obtained and the discussion carried out, several proposals can be formulated for both Poland and other countries with a similar structure of forest ownership and/or similar system of nature conservation organization.

The first proposal is to support and improve the organization of nature conservation in state forests (this would apply to Poland and probably some other countries). It is noteworthy, that the type of forest ownership affects the forest nature conservation, and this impact may vary depending on the country and culture [4,69,70]. For example, in Poland, because of our history, lack of appropriate policy, public awareness, initiative, and differentiation between conventional forms of nature conservation and nature conservation on private land, the latter is implemented on a very small scale [71]. The organization of nature conservation in state-owned forests (not only in Poland) will therefore be of fundamental importance for nature protection in particular countries for a long time to come. It is noteworthy, that within the European Union, management of protected areas is more advanced in countries of Western Europe than of Central-Eastern Europe, so the former should share their experiences with the countries that joined the Union later [72], i.e., also Poland.

The second proposal is to increase the foresters' rights to organize nature conservation (Poland). The great trust put by stakeholders in foresters, as well as the actual the State Forests' contribution to nature conservation in Poland, can be a basis for changing the current law. This would in majority concern the establishment of nature conservation rules for protected areas and objects. A similar action in other countries would have to be preceded by analogous studies of public trust in this type of solution.

The third proposal is to conduct regular surveys on public confidence in foresters, and periodically more detailed surveys among key stakeholders (Poland/other countries). The importance of public trust and awareness with respect to foresters' competence in planning and implementation of sustainable forest management was noted, e.g., by Franklin and Johnson [73]. The same applies to nature conservation in its more restrictive form. The knowledge of both the public attitudes and that of the individual stakeholders towards the foresters' work may be important for forest managers to shape development strategies (e.g., for the State Forests in Poland), as well as for possible organizational and legal changes in nature conservation. The social moods regarding the role to be played by the State Forests are also not without significance. According to a recent survey, 23% of Poles believe that the primary task of the State Forests should be nature conservation [59].

The fourth proposal is to increase people's knowledge and awareness of the foresters' work for nature conservation (Poland/other countries), through forest education and information actions. This may reduce the number and intensity of conflicts between foresters and different social groups

(in the context of nature conservation in forests), as well as increase public confidence in foresters as decision-makers in the field of nature conservation. It is noteworthy, that e.g., German foresters also indicate making the public more aware of the benefit of forest management for nature conservation as very important in future [23]. Education is also needed in the field of nature conservation itself—to form responsible attitudes and understanding for protection necessity, including its positive consequences for people [32]. It is noteworthy, that in Poland, as well as in some other countries, the procedures related to social involvement in protection of the environment need to be followed, and it results in an equally strong stress placed by the society and environmental organizations on tightening of regulations related to the use of forest and nature conservation [74].

The fifth proposal is to increase the role of scientists (Poland), mainly as a support for foresters in establishing principles and methods of nature conservation in state forests. According to Zamora (in [75]), a stronger and more trustful relationship between protected areas managers (but also decision-makers) and scientists is fundamental to enhance effective management. At the same time, it would be necessary to provide resources and capacity needed to conduct research actions for nature conservation in state forests.

The next proposal is to develop good communication in the field of nature conservation in state forests (Poland/other countries). Depending on the situation and needs it may be organized at different levels: between scientists and decision-makers [7,8,76–79], scientists, decision-makers and other stakeholders, e.g., the local communities [12,28,73,77,80,81], between the bodies that manage the protected areas [7], between scientific communities [80], or between foresters and NGOs [48]. Communication process allows to reduce social conflicts and achieve better compromises [23]. It is important because the problem of conflicts over the use of natural resources within protected areas concerns many regions of the world, not excluding Poland (e.g., [8,12,14,15,28]).

The last proposal is to search for various sources of financing nature conservation in state forests (Poland/other countries). The problem of insufficient funding of nature conservation is observed not only in Poland, but also in other countries, e.g., Germany [7,23], United Kingdom [40], Greece [55], Switzerland [9], and the Netherlands [7]. In case of Natura 2000, none of the European countries have created a financial solution that would satisfy all stakeholders [13]. Examples of funding sources include subsidies from the state [55], income from admission fees [55,75], tourism and recreation, as well as sale of local products [55], market-based mechanisms [82], or external aid funds for environmental protection [8]. It should be noted that NGOs are well experienced in fundraising for nature conservation tasks [83], so establishing cooperation with them is worthwhile.

3.6. Limitations

The studies presented have three basic limitations:

- the limited number of questions and their simplicity—it results from the fact that they were part of a much more extensive survey. This allowed to collect a relatively high percentage of answers to the questions asked. However, if we were to focus exclusively on these issues and ask much more detailed questions, additional results could be obtained;
- lack of anonymity of the questionnaires—maybe if the questionnaires were anonymous, there would be more answers, but this would not allow for their verification. Perhaps this is why the questionnaires were not filled by organizations that most frequently oppose foresters in respect of nature conservation, and it is difficult to establish meaningful dialogue with them;
- limited group of stakeholders—the study focused on stakeholders who have legal competence and/or practical experience in nature protection in the State Forests. Therefore, other stakeholders, for whom nature conservation may also be relevant (in a positive or negative sense), were not questioned. In the future, it would also be worthwhile to examine the opinions of other stakeholders (e.g., those related to the wood industry or tourism) about the organization of nature conservation in state forests.

4. Conclusions

The aim of this article was to present current solutions as well as expectations of the selected Polish stakeholders in respect of organization of nature conservation in state-owned forests in Poland. Three aspects were taken into account: determination of protective measures, responsibility for the protected areas and objects, and financing of nature conservation tasks on land managed by the State Forests. In a survey conducted in 2013 among 41 various stakeholders' groups, 77.9% of the respondents supported the concept of transferring full responsibility for nature conservation to foresters, while 51.1% supported financing of nature conservation tasks exclusively by the State Forests. In total, 46.8% of respondents believed that foresters should determine the principles and methods of nature conservation.

Proposals concerning the organization of nature conservation in the State Forests, presented by the stakeholders, vary from the current solutions, although to a different extent, depending on the activities. The solutions proposed would definitely more often than it is currently the case involve the State Forests' foresters in the organization of nature conservation in Poland, especially in terms of establishing the principles of nature conservation and its financing. The organization of nature conservation in the State Forests proposed by stakeholders (the most frequently chosen answers to the questions asked) is much better than the current one in terms of simplicity of solutions. In fact, it reduces the number of bureaucratic contacts between offices/institutions and foresters, as well as potential conflicts between authors of protection recommendations and their contractors. In addition, it provides that the protection rules would be established by people who have the closest, often daily contact with protected areas and objects, as well as the knowledge and practice in forest protection and management. In favor of the solution proposed by stakeholders is also the fact that the Polish State Forests are managed in a sustainable way, taking into account the needs of biodiversity protection. Completing that with competences in the field of nature conservation organization would be a solution consistent with the State Forests' activity model. However, the presented solutions have also some shortcomings and several improvements could be proposed, as indicated in the text of this article.

The most important observation, however, is that the stakeholders have expressed quite a high trust in the foresters. This trust, as well as the actual foresters' contribution to nature conservation in Poland, can be the basis for changes in the current law towards increasing their powers, especially in terms of determination of protective measures. The presented problems, as well as some proposals, are universal, and may be inspiring also for other countries with a high contribution of state-owned forests in their efforts to improve the system of nature conservation organization.

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Appendix A

Table A1. Groups of stakeholders and numbers of responses to questions Q1–Q3.

Groups of Respondents	No. of Questionnaires Sent	No. of Responses to Q1	No. of Responses to Q2	No. of Responses to Q3
Research units [1]	120	10	10	10
NGOs and their branches [1]	426	38	36	39
Mayors of all rural and urban-rural communes (gminas)	2169	723	726	720
Councils of all rural and urban-rural communes [1]	2169	251	254	253

Table A1. *Cont.*

Groups of Respondents	No. of Questionnaires Sent	No. of Responses to Q1	No. of Responses to Q2	No. of Responses to Q3
Heads (starosts) of all rural counties (powiats)	314	179	178	175
Boards of all rural counties	314	109	108	108
Councils of all rural counties [1]	314	82	82	83
Province governors (voivodes)	16	9	9	9
Boards of provinces (voivodeships)	16	10	10	10
Heads (marshals) of provincial parliaments (sejmiks)	16	10	10	10
Environmental committees of provincial parliaments	16	1	1	1
Regional directors of environmental protection	16	5	5	5
Regional nature conservation councils [1]	16	3	3	3
Minister of the Environment	1	0	0	0
General Director of Environmental Protection	1	0	0	0
National Nature Conservation Council	1	0	0	0
Minister of Agriculture and Rural Development	1	0	0	0
Minister of Infrastructure and Development	1	0	0	0
Parliamentary (Sejm) Committee of Environmental Protection, Natural Resources, and Forestry	1	0	0	0
Prime Minister	1	0	0	0
Public Benefit Works Council	1	0	0	0
National Board of Water Management	1	0	0	0
Agency for Restructuring and Modernization of Agriculture	1	1	1	1
General Inspector of Environmental Protection	1	0	0	0
National Committee for Environmental Impact Assessment	1	0	0	0
State regional sanitary inspectors	16	6	6	6
Directors of national parks	23	14	15	15
Directors of landscape parks and their complexes	122	90	90	91
Councils of landscape parks	122	8	8	8
Executive Board and Supervisory Board of the National Fund for Environmental Protection and Water Management	1	1	1	1
Boards and supervisory boards of provincial funds for environmental protection and water management	16	10	10	10
Provincial heads of State Hunting Guard or units performing their duties	15	7	7	7
Environmental Project Coordination Centre Norway Grants	1	1	1	1
Selected political parties	2	0	0	0
Selected authors of scientific publications (not employed by research units)	6	0	0	0
Socio-scientific councils of all forest promotion complexes [1]	14	4	4	4
Branches of Forest Management and Geodesy Office	25	31	31	32
Selected centers for rehabilitation of protected animals or animal parks	12	1	1	1
Forest-nature expert evaluation office	3	0	0	0
Representatives of selected forest journals	1	0	0	0
Total	3	1	1	1
	6746	**1605**	**1608**	**1604**

[1] For those respondents, the questionnaires enabled individual members of the given unit to present their own opinions; only few socio-scientific councils of forest promotion complexes, NGOs, and research units used this possibility.

References

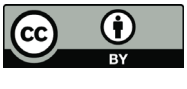
1. Food and Agriculture Organization of the United Nations. *Enhancing the Socioeconomic Benefits from Forests*; State of the world's forests; FAO: Rome, Italy, 2014; ISBN 978-92-5-108269-0.
2. Schultze, J.; Gärtner, S.; Bauhus, J.; Meyer, P.; Reif, A. Criteria to evaluate the conservation value of strictly protected forest reserves in Central Europe. *Biodivers. Conserv.* **2014**, *23*, 3519–3542. [CrossRef]
3. U.S. Agency for International Development. *Biodiversity and Development Handbook*; Russell, D., Ed.; USAID: Washington, DC, USA, 2015.

4. Siry, J.P.; Cubbage, F.W.; Newman, D.H. Global Forest Ownership: Implications for Forest Production, Management, and Protection. In Proceedings of the XIII World Forestry Congress, Buenos Aires, Argentina, 18–23 October 2009.
5. Schulz, T.; Krumm, F.; Bücking, W.; Frank, G.; Kraus, D.; Lier, M.; Lovrić, M.; van der Maaten-Theunissen, M.; Paillet, Y.; Parviainen, J.; et al. Comparison of integrative nature conservation in forest policy in Europe: A qualitative pilot study of institutional determinants. *Biodivers. Conserv.* **2014**, *23*, 3425–3450. [CrossRef]
6. Getzner, M.; Meyerhoff, J.; Schläpfer, F. Willingness to Pay for Nature Conservation Policies in State-Owned Forests: An Austrian Case Study. *Forests* **2018**, *9*, 537. [CrossRef]
7. Wätzold, F.; Mewes, M.; van Apeldoorn, R.; Varjopuro, R.; Chmielewski, T.J.; Veeneklaas, F.; Kosola, M.-L. Cost-effectiveness of managing Natura 2000 sites: An exploratory study for Finland, Germany, the Netherlands and Poland. *Biodivers. Conserv.* **2010**, *19*, 2053–2069. [CrossRef]
8. Winter, S.; Borrass, L.; Geitzenauer, M.; Blondet, M.; Breibeck, R.; Weiss, G.; Winkel, G. The impact of Natura 2000 on forest management: A socio-ecological analysis in the continental region of the European Union. *Biodivers. Conserv.* **2014**, *23*, 3451–3482. [CrossRef]
9. Kaeser, A.; Zimmermann, W. Influencing factors on the implementation of forest reserves in Switzerland. *Biodivers. Conserv.* **2014**, *23*, 3501–3517. [CrossRef]
10. Goswami, R.; Mariappan, M.; Singh, T.S. Conservation effectiveness across state and community forests: The case of Jaintia Hills, Meghalaya, India. *Curr. Sci.* **2016**, *111*, 380–387. [CrossRef]
11. Bergès, L.; Avon, C.; Verheyen, K.; Dupouey, J.-L. Landownership is an unexplored determinant of forest understory plant composition in Northern France. *For. Ecol. Manag.* **2013**, *306*, 281–291. [CrossRef]
12. Pecurul-Botines, M.; Di Gregorio, M.; Paavola, J. Discourses of conflict and collaboration and institutional context in the implementation of forest conservation policies in Soria, Spain. *Biodivers. Conserv.* **2014**, *23*, 3483–3499. [CrossRef]
13. Grodzińska-Jurczak, M.; Strzelecka, M.; Kamal, S.; Gutowska, J. Effectiveness of Nature Conservation—A Case of Natura 2000 Sites in Poland. In *Protected Area Management*; Sladonja, B., Ed.; InTech: London, UK, 2012; pp. 183–202, ISBN 978-953-51-0697-5.
14. Sodhi, N.S.; Lee, T.M.; Sekercioglu, C.H.; Webb, E.L.; Prawiradilaga, D.M.; Lohman, D.J.; Pierce, N.E.; Diesmos, A.C.; Rao, M.; Ehrlich, P.R. Local people value environmental services provided by forested parks. *Biodivers. Conserv.* **2010**, *19*, 1175–1188. [CrossRef]
15. Szell, A.B.; Hallett IV, L.F. Attitudes and Perceptions of Local Residents and Tourists towards the Protected Area of Retezat National Park, Romania. *Int. J. Humanit. Soc. Sci.* **2013**, *3*, 18–34.
16. *Who Owns the Forest? Forest Ownership and Tenure in the UNECE Region. (Extract)*; Lawrence, A. (Ed.) FAO-UNECE: Rome, Italy, 2018.
17. EUSTAFOR—Members. Available online: https://eustafor.eu/about-eustafor/members (accessed on 15 March 2020).
18. Leśnictwo [Forestry]. Statistical Yearbook. 2019. Available online: https://stat.gov.pl/obszary-tematyczne/roczniki-statystyczne/roczniki-statystyczne/rocznik-statystyczny-lesnictwa-2019,13,2.html (accessed on 15 March 2020).
19. FOREST EUROPE. State of Europe's Forests 2015. In Proceedings of the Ministerial Conference on the Protection of Forests in Europe Forest Europe, Madrid, Spain, 20–21 October 2015; Liaison Unit Madrid: Madrid, Spain, 2015.
20. Ratajczak, E. Stan i perspektywy rozwoju sektora leśno-drzewnego [State and prospects for the development of the forest-wood sector]. In *Wielofunkcyjna Gospodarka Leśna Wobec Oczekiwań Przemysłu Drzewnego i Ochrony Przyrody [Multifunctional Forest Management in Relation to the Expectations of the Wood Industry and Nature Protection]*; Szabla, K., Ed.; PTL: Darłówko, Poland, 2019; pp. 47–59, ISBN 978-83-954196-0-7.
21. The Forest Act, 1991 [Dz. U. 1991.101.444]. Available online: http://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU19911010444/U/D19910444Lj.pdf (accessed on 4 March 2020).
22. Directorate-General of the State Forests. *Sprawozdanie Finansowo-Gospodarcze za 2018 rok [Report on Financial and Economic State of State Forests in 2018]*; DGLP: Warsaw, Poland, 2019; p. 45.
23. Maier, C.; Winkel, G. Implementing nature conservation through integrated forest management: A street-level bureaucracy perspective on the German public forest sector. *For. Policy Econ.* **2017**, *82*, 14–29. [CrossRef]

24. Ochrona Środowiska [Environment]. Statistical Yearbook. 2019. Available online: https://stat.gov.pl/obszary-tematyczne/srodowisko-energia/srodowisko/ochrona-srodowiska-2019,1,20.html (accessed on 15 March 2020).
25. The Nature Conservation Act. 2004 [Dz. U. 2004.92.880]. Available online: http://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20040920880/U/D20040880Lj.pdf (accessed on 20 March 2020).
26. Bollmann, K.; Braunisch, V. To integrate or to segregate: Balancing commodity production and biodiversity conservation in European forests. In *Integrative Approaches as an Opportunity for the Conservation of Forest Biodiversity*; Kraus, D., Krumm, F., Eds.; European Forest Institute: Freiburg, Deutschland, 2013; pp. 18–31, ISBN 978-952-5980-06-6.
27. Zajączkowski, G.; Jabłoński, M.; Jabłoński, T.; Kowalska, A.; Małachowska, J.; Piwnicki, J. *Raport O Stanie Lasów W POLSCE 2018 [Report on the Condition of Forests in Poland in 2018]*; CILP: Warsaw, Poland, 2019.
28. Kamal, S.; Grodzinska-Jurczak, M. Should conservation of biodiversity involve private land? A Q methodological study in Poland to assess stakeholders' attitude. *Biodivers. Conserv.* **2014**, *23*, 2689–2704. [CrossRef]
29. Kamal, S.; Kocór, M.; Grodzińska-Jurczak, M. Quantifying Human Subjectivity Using Q method: When Quality Meets Quantity. *Qual. Sociol. Rev.* **2014**, *3*, 61–79.
30. Grodzińska-Jurczak, M. The relation between education, knowledge and action for better waste management in Poland. *Waste Manag. Res.* **2003**, *21*, 2–18. [CrossRef] [PubMed]
31. Olaczek, R. Ochrona leśnej przyrody i różnorodności biologicznej [The protection of forest wildlife and biodiversity]. In *Wizja Przyszłości Polskich Lasów I Leśnictwa Do 2030 r. [A Vision of the Future of Polish Forests and Forestry until 2030]*; Grzywacz, A., Ed.; PTL: Spała, Poland, 2012; pp. 77–95, ISBN 978-83-931417-3-9.
32. Olaczek, R. O niespójności w systemie ochrony przyrody w Polsce [Of the incoherence inside the system of nature conservation in Poland]. In *Ochrona Przyrody W Polsce Wobec Współczesnych Wyzwań Cywilizacyjnych [Nature Conservation in Poland and Current Civilizational Challenges]*; Mirek, Z., Nikel, A., Eds.; KOP PAN: Kraków, Poland, 2014; pp. 239–255, ISBN 978-83-937002-3-3.
33. NIK (Supreme Audit Office). *Lokalne Formy Ochrony Przyrody—Informacja O Wynikach Kontroli [Local Forms of Nature Conservation—Information on the Results of Inspections] (Report No. 197/2017/P/17/049/KSI)*; NIK (Supreme Audit Office): Warsaw, Poland, 2018; p. 67.
34. Referowska-Chodak, E. Czy leśnikom wypada mówić o kosztach ochrony przyrody? [Is it proper for foresters to talk about the cost of nature conservation?]. *Studia I Mater. Cent. Edukac. Przyr. -Leśnej* **2017**, *50*, 26–36.
35. Directorate-General of the State Forests. *Sprawozdanie Finansowo-Gospodarcze Za 2008 Rok [Report on Financial and Economic State of State Forests in 2008]*; DGLP: Warsaw, Poland, 2009; p. 34.
36. Grzywacz, A. *Miejsce I Rola Wielofunkcyjnego Leśnictwa W Systemie Ochrony Przyrody W POLSCE [The Place and Role of Multifunctional Forestry in the System of Nature Protection in Poland]*; SITLiD: Warsaw, Poland, 2008; pp. 133–148.
37. Centrum Koordynacji Projektów Środowiskowych [Environmental Projects Coordination Centre]. Available online: http://ckps.lasy.gov.pl (accessed on 10 April 2020).
38. Wronka, M. *Polskie Projekty LIFE [Polish LIFE Projects]*; NFOŚiGW: Warsaw, Poland, 2019; p. 146.
39. Aarhus Convention: Convention on access to information, public participation in decision-making, and access to justice in environmental matters, adopted on 25 June 1998 in Aarhus. Polish version: 2003 [Dz. U. 2003.78.706]. Available online: http://isap.sejm.gov.pl/DetailsServlet?id=WDU20030780706 (accessed on 20 March 2020).
40. Young, J.C.; Butler, J.R.A.; Jordan, A.; Watt, A.D. Less government intervention in biodiversity management: Risks and opportunities. *Biodivers. Conserv.* **2012**, *21*, 1095–1100. [CrossRef]
41. UNECE Map of Parties of the Arrhus Convention. Available online: https://www.unece.org/env/pp/aarhus/map.html (accessed on 15 July 2020).
42. Maier, C.; Lindner, T.; Winkel, G. Stakeholders' perceptions of participation in forest policy: A case study from Baden-Württemberg. *Land Use Policy* **2014**, *39*, 166–176. [CrossRef]
43. Kimla, P. Polish environmental movements during the political transformation (1980–1989). *Ecol. Saf.* **2016**, *10*, 463–472.
44. Szulecka, J.; Szulecki, K. Polish Environmental Movement 1980-2017: (De) Legitimization, Politics & Ecological Crises. *Ssrn J.* **2017**. [CrossRef]

45. The Social Involvement in Environmental Protection Act, 2008 [Dz. U. 2008.199.1227]. Available online: http://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20081991227/U/D20081227Lj.pdf (accessed on 20 March 2020).
46. Website of the Polish Government Legislative Centre. Available online: http://www.rcl.gov.pl (accessed on 13 March 2020).
47. Jaszczak, R.; Wajchman, S. Udział i rola czynnika społecznego w tworzeniu planów urządzenia lasu w Polsce [Participation and role of the social factor in developing forest management plans in Poland]. *Sylwan* **2014**, *158*, 231–240. [CrossRef]
48. Kepel, A. Oczekiwania środowisk przyrodniczych wobec gospodarki leśnej [Naturalists' expectations towards forest management]. In *Wielofunkcyjna Gospodarka Leśna Wobec Oczekiwań Przemysłu Drzewnego I Ochrony Przyrody [Multifunctional Forest Management in Relation to the Expectations of the Wood Industry and Nature Protection]*; Szabla, K., Ed.; PTL: Darłówko, Poland, 2019; pp. 167–187, ISBN 978-83-954196-0-7.
49. Official Database of Polish Non-Governmental Organizations. Available online: http://bazy.ngo.pl (accessed on 20 September 2012).
50. Hammer, Ø.; Harper, D.A.T.; Ryan, P.D. Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontol. Electron.* **2001**, *4*, 9.
51. Hammer, Ø. Past 4—The Past of the Future. Available online: https://folk.uio.no/ohammer/past/ (accessed on 16 June 2020).
52. Hammer, Ø. PAST PAleontological STatistics ver. 4.03—Reference Manual. Available online: https://folk.uio.no/ohammer/past/past4manual.pdf (accessed on 18 June 2020).
53. Borrini-Feyerabend, G. Governance of protected areas – innovation in the air. *Policy Matters* **2003**, *12*, 92–101.
54. Prato, T.; Fagre, D.B. Protected area management. In *Encyclopedia of Natural Resources: Land*; Wang, Y., Ed.; CRC Press: New York, NY, USA, 2014; pp. 385–388, ISBN 978-1-4398-5245-3.
55. The Natura-2000 Committee (2010–2013) members; Vokou, D.; Dimitrakopoulos, P.G.; Jones, N.; Damialis, A.; Monokrousos, N.; Pantis, J.D.; Mazaris, A.D. Ten years of co-management in Greek protected areas: An evaluation. *Biodivers. Conserv.* **2014**, *23*, 2833–2855. [CrossRef]
56. Buraczewski, A.; Grygier, P. Koszty gospodarki leśnej oraz potrzeby i kierunki ich racjonalizacji [Forest management costs and the needs and directions for their rationalisation]. In *Strategia Rozwoju Lasów I Leśnictwa W Polsce Do Roku 2030 [Forest and Forestry Development Strategy in Poland until 2030]*; IBL: Sękocin Stary, Poland, 2011; pp. 267–291, ISBN 978-83-62830-01-5.
57. Mrowińska, I. *Raport Z Działalności Edukacyjnej Lasów Państwowych 2018 [Report on the Educational Activities of the State Forests 2018]*; CILP: Warsaw, Poland, 2019.
58. Provincial Fund for Environmental Protection and Water Management in Olsztyn. *Sprawozdanie Z Działalności Wojewódzkiego Funduszu Ochrony Środowiska I Gospodarki Wodnej W Olsztynie Za Rok 2014 [Report on Activities of Provincial Fund for Environmental Protection and Water Management in Olsztyn in 2014]*; WFOŚiGW: Olsztyn, Poland, 2015.
59. Rutkowski, A. Lekko w górę [Slightly upwards]. *Głos Lasu [Voice For.]* **2019**, *2*, 6–9.
60. Turczyk, M. Jak nas widzą [How they see us]. *Głos Lasu [Voice For.]* **2014**, *12*, 8–9.
61. Zakład Ochrony Przyrody i Krajobrazu IOŚ-PIB. *Ocena Skuteczności Ochrony Przyrody W Lasach Państwowych – Etap Iii [Assessment of the Effectiveness of Nature Protection in The State Forests—Stage III] (Grant No. 60-OP-BO-6146/12)*; IOŚ-PIB: Warsaw, Poland, 2015; p. 157.
62. FSC International. Database of FSC Certificates. Available online: https://info.fsc.org/certificate.php (accessed on 30 March 2020).
63. PEFC International. Database of PEFC Certificates. Available online: https://www.pefc.org/find-certified (accessed on 30 March 2020).
64. UNESCO. Website of the UNESCO Sultan Qaboos Prize. Available online: https://en.unesco.org/mab/awards#sultan-qaboos (accessed on 10 April 2020).
65. Polish State Council for Nature Conservation (PROP). Najważniejsze problemy ochrony przyrody w Polsce [The main problems of nature conservation in Poland]. 2007. Available online: http://www.salamandra.org.pl/component/content/article/36-prawo/170-problemy-ochrony-przyrody.html?directory=177 (accessed on 30 March 2020).

66. Komunikat Prezesa Głównego Urzędu Statystycznego w sprawie przeciętnego wynagrodzenia w gospodarce narodowej w 2018 r. [Communication from the President of the Central Statistical Office on the average salary in the national economy in 2018] [MP 2019.154]. Available online: https://stat.gov.pl/sygnalne/komunikaty-i-obwieszczenia/lista-komunikatow-i-obwieszczen/komunikat-w-sprawie-przecietnego-wynagrodzenia-w-gospodarce-narodowej-w-2018-roku,273,6.html (accessed on 30 March 2020).
67. Sutherland, W.J.; Adams, W.M.; Aronson, R.B.; Aveling, R.; Blackburn, T.M.; Broad, S.; Ceballos, G.; Côté, I.M.; Cowling, R.M.; Da Fonseca, G.A.B.; et al. One Hundred Questions of Importance to the Conservation of Global Biological Diversity. *Conserv. Biol.* **2009**, *23*, 557–567. [CrossRef] [PubMed]
68. Kluvánková-Oravská, T.; Chobotová, V.; Banaszak, I.; Slavikova, L.; Trifunovova, S. From government to governance for biodiversity: The perspective of central and Eastern European transition countries. *Environ. Pol. Gov.* **2009**, *19*, 186–196. [CrossRef]
69. Gao, H.; Ouyang, Z.; Chen, S.; van Koppen, C.S.A. Role of culturally protected forests in biodiversity conservation in Southeast China. *Biodivers. Conserv.* **2013**, *22*, 531–544. [CrossRef]
70. Negrões, N.; Revilla, E.; Fonseca, C.; Soares, A.M.V.M.; Jácomo, A.T.A.; Silveira, L. Private forest reserves can aid in preserving the community of medium and large-sized vertebrates in the Amazon arc of deforestation. *Biodivers. Conserv.* **2011**, *20*, 505–518. [CrossRef]
71. Kamal, S.; Grodzinska-Jurczak, M.; Kaszynska, A.P. Challenges and opportunities in biodiversity conservation on private land: An institutional perspective from Central Europe and North America. *Biodivers. Conserv.* **2015**, *24*, 1271–1292. [CrossRef]
72. Cogălniceanu, D.; Cogălniceanu, G.-C. An enlarged European Union challenges priority settings in conservation. *Biodivers. Conserv.* **2010**, *19*, 1471–1483. [CrossRef]
73. Franklin, J.F.; Norman Johnson, K. Lessons in policy implementation from experiences with the Northwest Forest Plan, USA. *Biodivers. Conserv.* **2014**, *23*, 3607–3613. [CrossRef]
74. McDermott, C.; Cashore, B.; Kanowski, P. *Global Environmental Forest Policies*, 1st ed.; Earthscan: London, UK, 2010; ISBN 978-1-84977-492-5.
75. Rodríguez-Rodríguez, D. New Issues on Protected Area Management. In *Protected Area Management*; Sladonja, B., Ed.; InTech: London, UK, 2012; pp. 19–42, ISBN 978-953-51-0697-5.
76. Seavy, N.E.; Howell, C.A. How can we improve information delivery to support conservation and restoration decisions? *Biodivers. Conserv.* **2010**, *19*, 1261–1267. [CrossRef]
77. Young, J.C.; Waylen, K.A.; Sarkki, S.; Albon, S.; Bainbridge, I.; Balian, E.; Davidson, J.; Edwards, D.; Fairley, R.; Margerison, C.; et al. Improving the science-policy dialogue to meet the challenges of biodiversity conservation: Having conversations rather than talking at one-another. *Biodivers. Conserv.* **2014**, *23*, 387–404. [CrossRef]
78. Hanson, T.; Wiles, G.J.; Gaydos, J.K. A novel public–private partnership model for improving the listing of endangered species. *Biodivers. Conserv.* **2016**, *25*, 193–198. [CrossRef]
79. Nesshöver, C.; Livoreil, B.; Schindler, S.; Vandewalle, M. Challenges and solutions for networking knowledge holders and better informing decision-making on biodiversity and ecosystem services. *Biodivers. Conserv.* **2016**, *25*, 1207–1214. [CrossRef]
80. Winkel, G.; Jump, A. Perspectives on forest conservation: Building evidence at the frontier between policy and conservation science. *Biodivers. Conserv.* **2014**, *23*, 3359–3372. [CrossRef]
81. Wyborn, C.; van Kerkhoff, L.; Dunlop, M.; Dudley, N.; Guevara, O. Future oriented conservation: Knowledge governance, uncertainty and learning. *Biodivers. Conserv.* **2016**, *25*, 1401–1408. [CrossRef]
82. Alvarado-Quesada, I.; Hein, L.; Weikard, H.-P. Market-based mechanisms for biodiversity conservation: A review of existing schemes and an outline for a global mechanism. *Biodivers. Conserv.* **2014**, *23*, 1–21. [CrossRef]
83. Anyango-van Zwieten, N.; Lamers, M.; van der Duim, R. Funding for nature conservation: A study of public finance networks at World Wide Fund for nature (WWF). *Biodivers. Conserv.* **2019**, *28*, 3749–3766. [CrossRef]



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Land Use and Access in Protected Areas: A Hunter's View of Flexibility

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Abstract: Anthropologists sometimes ask what flexible practices mean when used in instances of land use and access among protected area regimes which control the land and the indigenous or local people who claim rights to the land. In the Mount Cameroon National Park (MCNP), West Africa, this question comes with urgency because of the historical disputes associated with defining access and user-rights to land within this park. In this case, we present an ethnographic study using a transect walk with a native Bakweri hunter to map and analyze his opinions about land use and access into the park. The findings show that, despite State prohibitions for this park, customary practices still occur for mutual reasons, whereas, in situations of disputes, other practices continue on the land unnoticed. We conclude that this flexibility is indicative of reciprocal negotiations and cultural resilience that preserve not only the biodiversity of the park but also the culturally relevant needs of people.

Keywords: anthropology; land use and access; flexibility; Bakweri; Mount Cameroon National Park; protected areas; conservation

1. Introduction

Systems of land use and access have evoked a lot of interest among anthropologists investigating human–environmental interactions [1–7]. While these authors contribute to knowledge about alternative forms of land use, questions still remain about how people act flexibly on the land amidst systems for protected areas. Movement and flexibility enable people to respond better to changes in their physical and social environment [8]. Therefore, in this article, we further engage with flexibility along the lines of [9] study of land access, which explores how local people make use of multiple sets of rights in disputable situations. This provides us with an alternative view on conflict of law (*conflit de droit*) [10]. With the notion that humans affect the natural state of land [11–13], through land uses that trigger State intervention [14,15], we argue that an analysis of flexibility gives new insights about land use and access in exclusionary environments of conservation.

At such locations, the formation of power creates segregation where practices of social groups exist [5]. It eventually leads to what the authors of Reference [16] described as 'land claims' by people detached from their land. Circumstances of this nature influence flexible behaviors that are an indirect outcome of institutional despotism [17] and a conflict of language (*conflit de langage*)' [10] where elements of exclusion and capitalist accumulation exist. Failure to address these lapses hinders the effectiveness of plans to recognize the customary rights of people residing at the fringes of protected areas.

Mount Cameroon National Park (MCNP) is an example for which we can explore the notion of flexibility. MCNP was created in 2009 as part of the government's Permanent Forest Estate (PFE)

initiative, dedicating it under State protection [18], in commitment to the 1992 UN Convention on Biodiversity. The park includes six vegetation types including the lowland forest at elevations of 0–800 m, sub-montane rain forest at 800–1600 m, upper montane rain forest at 1600–1800 m, montane scrub at 1800–2400 m, montane grassland at 2000–3000 m, and sub-alpine grassland at 3000–4095 m [19] (p. 81). Considering that mammals such as drills, chimpanzees, preuss monkeys, and forest elephants remain endangered, the State implemented a 1994 forestry and wildlife law and a 2014 co-management plan to ensure park management, but with lapses due to the top–bottom nature of management [20,21] and the use of discussion forums, in which the local people have a minor influence on decision-making [22]. MCNP also includes four cluster conservation zones: Buea, Muyuka, Bomboko, and the West Coast [22] (p. 3), which are rich in biodiversity that the local communities partly use as a means of support for their living.

In the MCNP example, the Bakweri people rely on Mount Cameroon for a livelihood through the gathering of wild fruits such as the *Dacryodes edulis* (G. Don) H. J. Lam (bush pear) and other native spices like *Irvingia gabonensis* (Aubry-Lecomte ex O-Rorke) Baill. (African mango) used to complement farm income. Further, local communities around MCNP have, for several decades, interacted with groups from other parts of Cameroon who live as settlers and farmers working in cocoa farms and plantations created by the German colonial authorities in the 1880s [23]. However, while the Bakweri still largely rely on natural forests which entail conserving various products of cultural importance on the one hand, on the other hand, State mechanisms for conservation comes with challenges.

For instance, though the United Nations Declaration on the Rights of Indigenous People (UNDRIP) adopted in 2007 emphasized ending activities that exploit indigenous people [24], the restriction of indigenous access to land by the park administration still takes many micropolitical forms, and State authorities defy certain claims of local knowledge. It is noted that Mount Cameroon has long been of ancestral value to the Bakweri and a source of retaining spiritual intervention to protect the land [25]. Thus, while the park should represent what the authors of Reference [26] called 'free-range land' preserved for its spiritual importance to the society, the State uses strict rules to define land use rights. This is why there are resentments between the park regime and local land users [21].

According to the authors of Reference [27], the Bakweri are one of the early groups of the Bantu-speaking people in coastal Cameroon, who settled on the slopes of Mount Cameroon for its fertile volcanic soils, one of the reason for the Bakweri land problem that started an armed resistance against the German military from 1891 to 1894, resulting in land expropriation and displacement of the Bakweri who had been undergoing an endless struggle to retain their lands [28,29]. Also, although legalities exist regulating the rights for locals to use forests, there are no standard verdicts for them to exercise their customary rights in the park [21].

Considering this prejudiced space for defining land use and access, we need to examine whether individual accounts of interacting in the park could offer constructive knowledge for exercising customary practices in protected areas. To do so, we worked with a Bakweri hunter named Mola Njie, during an ethnographic inquiry among 17 villages of the MCNP between August to December 2017 (see also References [20,21]). This study targets three objectives: (1) demonstrate that land use and access in this park is reminiscent of the historical and fragmentary nature of State power, (2) using an example of a hunter's land use, show how flexibility helps in meeting the livelihood needs in protected areas, and (3) analyze the parallels and contrasts between the case of the MCNP and experiences reported elsewhere for showing that resistance to and cooperation with State administrative power can occur simultaneously among the same people.

1.1. Anthropological Critique of Flexible Land Use Practices

The notion of flexibility has been crucial in understanding changing land use practices among rural people. The empirical example of the MCNP shows avenues for anthropological analysis of flexibility. It was particularly challenging to devise a method where the anthropological analysis of flexibility does not overlook the dynamics of inequality and micro practices of resistance.

1.2. Local Reaction to Colonization of Nature

With an ethos of flexibility, and with regards to land use and access in Cameroon's protected areas, the authors of Reference [7] examined the alternatives and trade-offs of conservation when people are removed from lands of traditional value to make space for the protection of nature. In this example, the World Wildlife Fund introduced the Integrated Conservation Development Projects (ICDPs), for the Korup National Park. This was aimed at recognizing the equality of rural people as partners in executing plans for conserving areas that involve traditional lands. However, in practice, the Korup Project had little regards for recognizing indigenous people as decision-makers. The Korup Project was equally criticized for prohibiting gathering, hunting, and fishing activities of the local people living in areas defined by the boundary between Cameroon and Nigeria, which the local population relied on for livelihood. As such, many of the locals expressed their wishes to disobey State orders for the simple reason that these orders use procedures which are aimed at seizing lands and traditional user-rights in the name of conservation [7].

Such protests often lead to serious problems in governing Cameroon's national parks, where the exclusionary nature of protected area regimes is based on State laws that often do not take into consideration the traditional rights of people but create disputes between local people and park managers [6]. Consider also the Pygmies of Cameroon, whose livelihoods were affected by the establishment of national parks, prompting their exclusion from the benefits of development [30]. It is in this vein that park authorities almost always fail to truly integrate the beliefs and knowledge systems of the local people within the very institutional fabric of land use and access in protected areas. The authors of Reference [31] noted that excluding local communities from protected areas also undermines the objectives of conservation by creating disputes between local people and park management authorities. In their analysis of MCNP, they showed that local resistance against biodiversity conservation manifested in the everyday struggle for adaptive livelihoods. Such a struggle has been a result of many factors. For instance, population growth, disrupted kinship systems and rights to use and access of resources, loss of property, and no compensation, prompting the locals to set fire to portions of the forest, clearing plots for farming, extraction of honey, and hunting, despite warnings from park authorities.

The above narratives, at large, lay underneath the complicities of what the authors of Reference [3] termed 'colonization of nature', where institutional forms of power exert a conquest of the land, which is also similar to what the authors of Reference [32] specified as 'resistance as thought and symbol', a line of action conceived in constant dialogue or communication towards social justice. These conceptions raise the empirical question of whether locals engage in support, opposition, or both towards the park regime, through flexible use of protected areas. Among the Bakweri, for instance, the dynamic nature of power has been an issue of inequality between actors and locals with claims of rights to land use who become victims of resource governance on the one hand, and State authorities who administer the land (see also Reference [20,21] for more on relations among the actors). Before the coming of the MCNP, the Bakweri had for many generations settled on the slopes of Mount Cameroon as hunter-gatherers, and later as agriculturalists [27]. Many of them, living previously in small enclaves on the mountain, had established territories but later became victims of historical and fragmentary State power, such as the German colonizers who became legal owners of lands formerly occupied by ethnic groups after the Bakweri wars in the 1890s. This led not only to the removal of people from their land but also to the establishment of plantation agriculture [28] and the introduction of State systems for territorial management. Such practices incited land disputes which continued in Cameroon [10,29].

In effect, the Bakweri engaged with the land in similar ways to that of the people with whom the authors of Reference [9] worked: amidst regime efforts to regulate local land ownership, people employ flexible means of retaining land use rights. They continue to find ways for asserting the sovereignty of ownership and rights to their lands around Mount Cameroon [33]. The first move, in 1946, was to create the Bakweri Land Committee (BLC), an assembly of traditional rulers, notables, and elites, aimed at regaining control over Bakweri lands. Following a series of petitions launched by

the BLC to the Trusteeship Council of the United Nations in New York, the Colonial Office in London, and colonial authorities in Nigeria, British colonialists adamantly ceded plantations to a newly created Cameroon Development Corporation (CDC) in 1946 as a public body, though the CDC only opened grounds for land privatization to various enterprises based on a Presidential Decree in 1994 [29].

Following Cameroon's independence in 1961, a subsequent 1974 land tenure law distinguished State lands and private lands, eradicating all former claims for Bakweri land and confiscating these lands [33]. These processes bifurcated traditional authority into 'subjects', where they became custodians of the State, instead of a kinship basis for custodianship of the land [34,35]. In legal terms, the 1974 land tenure law defined State lands as lands "not classed into the public or private property of the State and other public bodies [. . .] which the State can administer in such a way as to ensure rational use and development, and can be allocated by grant, lease, or assignment on conditions to be pursued by decree" [29] (p. 122).

Beneath the 1974 law, private lands "guarantee their owners the right to freely enjoy and dispose of them" [29] (p. 122). In spite of another petition by the BLC to the African Commission on Human and People's Rights in 2002 for violating the rights of the Bakweri over ancestral land occupied by the CDC, the decision came with domestic remedies giving the local courts the green light to resolve the dispute. This case raised several issues about the competence of local courts to handle such disputes. Despite these petitions, a prolonged and unresolved problem of land use and access continues to exist between the Bakweri and State authorities.

Another explanation for this flexibility through the Bakweri land problem can be linked to structural adjustment initiatives in Cameroon. From the 1980s, economic crises arose following a fall in the prices of export products. Thus, an alliance between State authorities and agents of structural adjustment, such as the International Monetary Fund (IMF) and the World Bank, emerged to rationalize the agro-forestry sectors in Cameroon [20]. A much implicit outcome of the structural adjustment was the promulgation of a State forest reform in 1994 for governing the use of forests following the Cameroon government's signing of the 1993 UN Convention on Biological Diversity. The 1994 forestry law in Cameroon grants user-rights to locals, stating that it recognizes the right for local people to harvest forest resources for personal use, with the exception of those resources under State protection. However, the State reserves the power to permanently or temporarily suspend this right when there is a need of public interest [36]. This again reflects the historical and fragmentary nature of State power.

We can, therefore, note that the coming of colonial and State authorities did alter the traditional basis for land use and access. Although land reforms were introduced for the partial exploitation of forest resources, the criteria for doing so gave little clarity for the customary rights of the people. The upshot of this fragmentary power over the land likens to the authors of Reference [37]'s notion of 'land-grab', where people become part of labor practices in the search for jobs on land they previously had entitlements to, now placed under regime control. This reflects the current situation of land use and access on the MCNP, which warrants a further discussion about flexibility and its role in achieving local needs in protected areas. Previous analysis of villages around the MCNP showed that, in spite of discussion forums (village committees) through which locals partake in the State's agenda for resource management, the seeming co-existence of State land use and customary practices often result in dynamic and micro-practices of inequality yielded in the paradoxical nature of co-management and disputes over land claims [20,21]. Nonetheless, understanding that the dynamics of land use and access can also include acts of territoriality [8,15,26,38–40] to satisfy basic needs and preserve cultural practices, in this article, we examine whether the above remarks might apply to the MCNP and to what extent it meets livelihood needs in protected areas.

2. Materials and Methods

We used an ethnographic inquiry with the aid of a transect walk, site mapping, and narrative analysis to make sense of various sites in the Buea and West Coast clusters of the MCNP. We relied on the opinions of a single key informant given that previous studies focusing on discussion forums

(forest management committees), through which locals partake in the State's agenda for resource management, yielded little analysis about the nature of land use and access in the MCNP [20–22]. According to the authors of Reference [41], in ethnographic research, a transect walk involves a walk through a site with a willing resident who is requested to share personal experiences about historical and culturally significant areas.

The transect walk comprised of the following phases: (1) a preparatory phase, which included acquiring background information through the study of maps and leaflets and obtaining authorization from the technical staff at the office of the MCNP in Buea, (2) getting an orientation about the terrain from local knowledgeable people, and (3) a journey to the MCNP guided by the selected native hunter. Being in his late forties, the hunter belongs to the Bakweri group, and lives in one of the communities at the southwestern slope of Mount Cameroon known today as Buea town, which is located approximately less than 7 km from Bova village. His community comprises of Bakweri people who engage in various forms of economic activities with traders from regions elsewhere. Having spent more than 25 years of living in the area with his relatives, and now with his family of two children, Mola Njie has performed on many occasions not just as a leading tour guide but as a member of several committees dealing with the management of the park and its surrounding villages. To him, hunting has been a practice he did from childhood, though it gradually became limited due to new laws restricting the exploitation of wildlife in protected areas. As such, acquiring a First School Living Certificate at his childhood age enabled him to become involved with other activities for a living, such as being an educator and facilitator for tourism in Buea, furthering his career as a professional driver, and working for the Buea Council within the last fifteen years. The MCNP authorities, however, permit the hunting of animal species considered by law as not endangered. This takes place in forests not under state protection such as those on privately owned land and community land, which enables him hunt part time. (4) The next phase included briefing sessions with a team of tour guides during the walk, and (5) conducting interviews with the hunter aimed at ascertaining his perceptions of land use and access by the local people into the park. We made notes during the walk and used tools which included a camera, a voice recorder, and Global Position System (GPS) equipment, for recording field observations and recording geographical coordinates of important sites which were indicated by the hunter (Figure 1).

A transect walk has the merit of enabling the researcher to cope with challenges in interactive platforms and of disclosing different viewpoints about a given area [42–44]. A transect walk is also a useful means for site mapping [42]. Anthropologists have used site mapping in participatory research to examine community needs and match them with bureaucratic decisions, and to identify knowledge of the state of situations based on the perspectives of the local people it claims to represent [45–47]. In this study, we adopted similar thinking to illustrate the hunter's knowledge of land use and access on the MCNP using open-ended questions which targeted: (a) the hunter's knowledge of traditional land use and access on Mount Cameroon a few years before and after the creation of the MCNP, (b) how the MCNP influences the land use attitudes of the people living close to the boundary of the park, and (c) determining to what extent officials of the park and members of the local community cooperate in the use of the MCNP. Our inspiration for the chosen methods we used came from the authors of Reference [48]'s views about obtaining data through face-to-face interactions of societal experience to describe how encounters are socially and culturally organized in particular situational settings.

Consistent with the authors of Reference [48]'s description of socially and culturally organized interaction in situational settings, we focused on tracking the hunter's movement and meanings of the stories he told while visiting various sites in the park. For us to provide a descriptive analysis of these accounts, we adapted the author of Reference [49]'s descriptive concepts on the application of narrative analysis (Table 1). This approach enabled us to derive meaning from relevant accounts of the hunter.

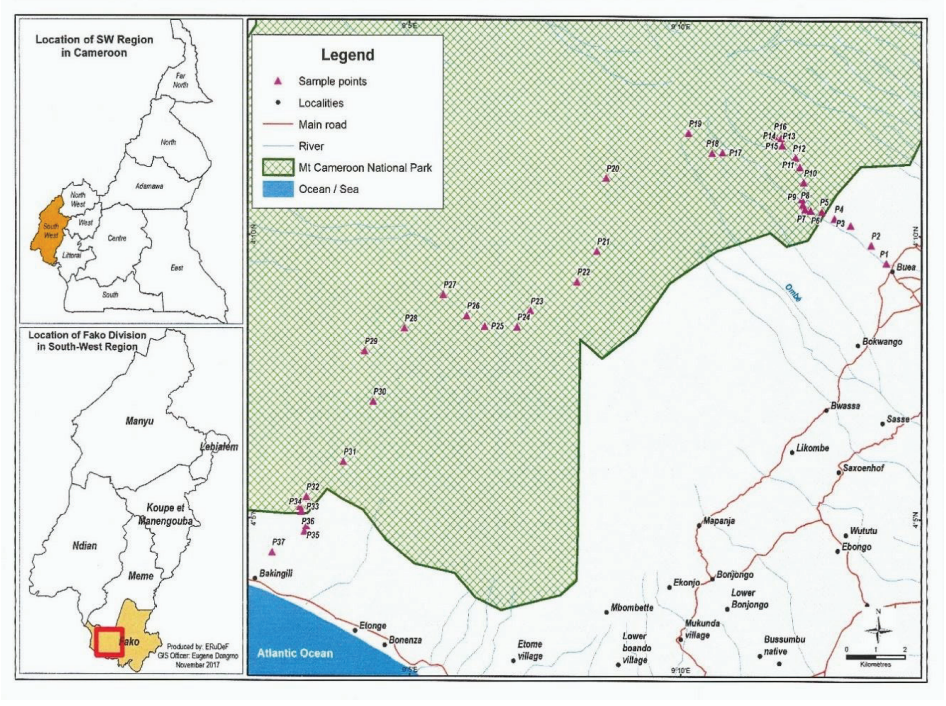

Figure 1. Location of sites on the Buea and West Coast of Mount Cameroon National Park (MCNP) where we collected data. Note, we designed the map using the points (P) collected on the Buea and West Coast clusters of MCNP during fieldwork.

Table 1. Using Riessman's [49] (p. 2–5) concepts in the narrative analysis of ethnography.

Concept	Description	Authors' Use
Thematic analysis	The content or what is said in a story	We used field notes to document the hunter's account of how MCNP supports the livelihood of people in nearby villages.
Structural analysis	Focus on telling, i.e., the way the story is told	We identified the most mentioned topics/themes in the hunter's narratives and their possible implications.
Interactional analysis	Dialogue process between the teller and listener	We focused on the hunter's understanding of beliefs connected to MCNP. On a visit to State territories, we exchanged questions about the type and value of forest products known to villagers.
Performative analysis	Doing rather than telling	Tracking movements with the hunter from one territorial site to another using Global Positioning System (GPS) equipment. Understanding performative instructions from the hunter and collecting photographs on various sites.
Concept	Description	Authors' usage.
Thematic analysis	The content or what is said in a story	We used field notes to document the hunter's account of how MCNP supports the livelihood of people in nearby villages.

3. Results

3.1. A Hunter's Way of Knowing the Land

The key informant in question, Mola Njie, is a man whose parents and close relatives were hunters. He therefore had the opportunity to hunt prior to the creation of the MCNP. Thus, his knowledge of the terrain was an added merit to our study. Before meeting Mola Njie, we had learned from a land surveillance expert about the assistance he gave to a group of researchers back in 1999 when Mount Cameroon erupted. We present below the hunter's narrative of land use and access in the park, with a particular focus on some of the products he described during fieldwork (Table 2). In the discussion section, we then compare our findings on flexibility in the park with information from cases reported on the subject in the literature.

Table 2. Distribution of forest products and their use.

Forest Product	Hunter's Use Description
Wulule	Ceremonial use
Ewulavaco	Medicinal use
Mondadwani	Body strength
Ewula-maija	Blood source/supply
rau-rau	Leaf used as a food bag
Prunus Africana bark	Medicinal use
Elephant dung	Medicinal use
Lyen la ngomo'o (a huge rock on the MCNP)	A spiritual figure

3.2. Adapting Local Land Use to the Park Regime

Here, we use the word 'informal' to refer to 'unnoticed forms' of land use and access into the park by the local people despite State prohibitions. An example of such incursions into the park is seen during the practices of traditional camping and the gathering of forest products in parts of the sub-montane forest, close to the park boundary. These practices, among others, differed from what occurred in remote parts of the park, where people use the land rather for rituals and tourism activities. In the paragraphs below, we describe these forms of land use at localities indicated on the map (Figure 2) as GPS points (P).

Our results indicated evidence of forest products which had been gathered and the setting up of traditional camps in the park. The area between P5 and P9 on the map (Figure 2), are sites of such camps which have been constructed in the sub-montane rain forest close to the park boundary. Here, we see the remains of plants of traditional importance which are used for medicinal and household needs. According to Mola Njie, many medicinal plants in this territory rarely grow in the local communities, which in effect explains the reason why people in need of such plants are obliged to trespass and collect them specifically for use in rituals and village cleansings. To name just a few of such plants in *Mokpwe* (Bakweri language), we have: the *Wulule*, which is used during family ceremonies called *Yoya'a etumba* and the elephant dance festival by the *Maale sacred society*, the *Ewula vaco*, which is a grass used for the treatment of wounds, and the *Monda dwani*, which is a sugarcane consumed as an alternative source of body strength during exhausting farm work. Mola Njie also talked about the *Ewula-maija,* which is a plant he consumes as tea, and as a source of blood supply. Furthermore, people also use a peace plant picked from this area to mark land boundaries and to prevent conflicts between landowners. These examples are part of the flexibility, which the hunter describes as an informal way of using the land, even when the State does not formally approve such activities in protected areas.

Figure 2. Land use on the MCNP comprising tourism development (**top**), an ancestral cave (**middle**), and a traditional camp (**bottom**).

Walking through the forest, Mola Njie remembered his youthful days when he visited the mountain to harvest a leaf (*rau-rau)*. When asked about this leaf, he noted that technological development and the introduction of plastic papers in grocery stores were gradually replacing the habit of using the leaf for storing doughnuts (*puff-puff* and *akra*), as he put it:

> "When we close after school, we go to the bush and get leaves to sell *puff-puff* and *akra*. All those things when they tie it on this leaf, you enjoy it. It gives the food a different taste."

To Mola Njie, although State conservation laws prohibit the unauthorized entry of people to the park, one reason for acts of trespassing was due to the closeness of 'village land' to the boundary of the park. These are farmlands which are used by the local population who live in nearby communities. For this reason, the authorities of the park carry out periodic arrests for unauthorized incursions into the park.

There are habitats of trees such as the Mahogany, the Iroko, and the Whitewood close to P8 (Figure 2). While holding a leaf from one of these trees, Mola Njie explained that periods before the advent of the MCNP, these habitats were a source of firewood and materials used for house construction. Nowadays, State forestry laws prohibit the extraction of wood on this site. To Mola Njie, the management regime assists him with 'user-rights' under conservation agreements. These rights allow individuals to cultivate tree species in villages, similar to the ones found at P8, to reduce logging in the protected areas. The regime's provision of user-rights enables him to have alternatives for cultivating and harvesting various tree species away from the park. The flexibility, in this case, consists of local acceptance of alternatives provided by the State, while at the same time, they continue accessing areas inside of the park.

Portions of the sub-montane rain forest consist of land for cultivating *Prunus Africana* (a plant for cancer treatment). To Mola Njie, the collection of *Prunus Africana* on Mount Cameroon goes back to the 1970s, when no restrictions existed, and this tree was used for the treatment of many other illnesses. The park regime, using what Mola Njie called a '*Prunus Africana* bark trade', collaborates with a partner agency, Mount Cameroon Prunus Management Company (MOCAP), through which locals gain employment as a harvester of the *Prunus Africana* bark. According to Mola Njie, this initiative offers a flexible choice for him to become a village member of harvesters' unions through which he obtains basic needs. Under this system, union members plan income-generating activities from which he acquires a drinkable water supply and healthcare services. This shows that the State was able to accommodate flexible access regimes to the areas inside the park.

On entry into a traditional camp at P30, Mola Njie pulled out a bottle of water from his bag and while staring up at the sky, as if to say the night is near, he recounts how he worked as a contracted harvester of *Prunus Africana* bark in the year 2006 for a pharmaceutical company, Plantecam. The traditional camp consisted of sticks from the forest, positioned into the ground with piles of wood for resting, and a fireplace in the middle of the camp (Figure 2). He narrated how he spent days on the mountain during harvesting activity and stated that he and his colleagues used the camp for shelter after lengthy periods of trekking and transporting *Prunus Africana* barks down the slopes of the mountain.

We also identified accounts of human activity in the wildlife forest of the park, as well as rituals and stories about hunting. The wildlife forest is located on the West Coast of the MCNP between P25 and P28 (Figure 2). This area represents a habitat for forest elephants, monkeys, and chimpanzees. According to Mola Njie, elephants are of spiritual importance to the Bakweri. They symbolize mid-way communication between 'the living' and 'the dead'. Mola Njie actually abides by this belief in elephant spirituality and explained that this spiritual relationship enabled him to avoid hostilities with elephants when visiting the wildlife forest. Since this area is a few kilometers from the boundary of the park and the village settlements, the elephants come to feed on crops grown on nearby farms. When they do, they leave behind dung, which, to Mola Njie, is a useful form of traditional medicine which is used for the treatment of stomach aches if taken after boiling it in water. This explains why there is a tendency for the local population to collect dung under situations which are unnoticed by the authorities of the park.

To Mola Njie, the appearance and state of the dung gives an idea of the size and location of an elephant in the park. Such knowledge is important for it enables one to avoid any confrontations with elephants while in the wildlife forest. We see a further indication of this knowledge in the hunter's ability to determine an elephant's location based on the number of insects on the dung. A greater number of insects gives the idea that an elephant is nearby. The hunter also associates larger sizes of dung to adult elephants. In Mola Njie's view, the use of such knowledge helps him avoid any

confrontations with the elephants and enables him to move about the forest without disturbing these animals. Consequently, while the park authority prohibits the free entry of the local population into the park, we see that there are other means of using the land to satisfy livelihood needs. The fact that this means of engaging with the land takes place in ways that protect elephants while acquiring the dung for medicinal needs, is indicative of the aspects of flexibility in using protected areas.

Ritual needs are one of the evident explanations for the traditional use of the park. As [50] puts it, religious systems are ultimately a study of the people themselves and are the strongest elements which influence the lives of Africans. As such, we cannot understand the concerns of the Bakweri without knowing the traditional beliefs, attitudes, and practices that underpin their religions. The results of the interviews showed that rituals are connected to beliefs in a spiritual being and to the protector of Mount Cameroon, known as *Efassa moto*. To the hunter, this spiritual being is a source of strength and protection to the Bakweri. Consequently, he maintains the necessity of using the land on the mountain for rituals. An example of practicing a ritual was at P11 (Figure 2), where a huge rock known as the 'dancing stone' (*Lyen la ngomo'o*) was located. Mola Njie perceived this stone to symbolize a spiritual figure which has been worshipped by past generations of the Bakweri. He equally stated that the officials of the park actually support this form of worship because it ensures the safety of visitors to the park.

At the site of the rock, Mola Njie requested that we harvest a fern plant and perform a dance to invite *Efassa moto* to protect us on the mountain. The ritual entailed dancing to the tune of music sung by the hunter with the phrase: *Lyen la ngomo'o Iye Iye.* This song praises the Bakweri ancestors and spiritual beings on the land while also requesting them to protect visitors to the park from danger. To the hunter, there are beliefs that in past years, people who failed to perform the dancing stone ritual went missing on the mountain and were never found. In this manner, the authorities of the park cooperate with local land users to maintain this form of flexibility in order to ensure the safety of visitors in the park.

We also visited an ancestral cave which was located a few kilometers from P18 and here, Mola Njie explained that he and his forefathers used the cave for shelter during the hunting seasons and the ancestral worships (Figure 2). Nowadays, this site is maintained as a tourist attraction. Another reason for maintaining ritual beliefs in the park is related to the volcanic eruptions of this mountain, which recently erupted in 1959, 1982, 1999, and 2000, leading to the destruction of biodiversity. To Mola Njie, volcanic eruptions are a sign of *Efassa moto's* resentment against the people's failure to perform rituals on the mountain. As such, when the lava flows damage crops on the land, the Bakweri perform rituals using animal sacrifices as a request for *Efassa moto* to restore environmental stability. These examples are indicative of how local land users are flexible in pursuing their traditional use of the land.

On the issue of hunting, areas close to the P8 site were a hunting attraction before the creation of the MCNP. Here, Mola Njie recalls his youthful encounter with a tree that represents a camping spot for bush rabbits (he called the spot *postman-poto* or *Loka*), as he explained:

> "When I used to come here to hunt, the rabbit slept on this tree all day. At six o'clock in the evening, the rabbit would come down from the tree in search of food. Upon returning in the morning, the rabbit would make a screaming sound aimed at deceiving any predator that it was descending from the tree, whereas it was climbing up the tree to sleep. The predator would then arrive later beneath the tree, just to realize that the rabbit had returned to its nest."

Another hunting site is located in the montane grassland section of the park. Here, Mola Njie took us closer to a patch of grass where he explained the practice of hunting and trapping of an antelope at site P18, stating that:

> "There was a bush with two exit holes in the middle of two footpaths. In this bush, there was an enclosure where antelopes sheltered during cold weather. Two men had to stand on both sides of the exit holes to get an antelope trapped using sharp sticks."

In trapping the antelope, to him, the process was difficult because success was based on how careful and silently the hunter approached the animal. Due to this difficulty, Mola Njie sold a mature antelope at about 65,000 francs (99,44 euros) a few years before the creation of the MCNP. We should note, however, that nowadays, the park authority does not approve of such means of land use in this protected area.

The remote parts of the park consist of lands used for tourism development (Figure 2). Thus, although the regime prohibits hunting on the land, it promotes tourism by cooperating with some members of the local communities in activities that generate income. We observed footpaths that had been created on the land and newly constructed huts to be used by tourists. According to the hunter, a few years before 2009, the local people used these footpaths during bee farming, as he recounted:

> "Back in the days before the MCNP, we trekked for long distances to the Savannah grasslands where we lit fires to get the bees out of their holes in order to collect the honey."

In perspective, Mola Njie referred to footpaths as 'shortcuts' that were crucial before the creation of the park. Footpaths were shorter connections between villages which were located around Mount Cameroon. In recent years, mainly tourists and village inhabitants employed to perform in income-generating activities for the regime make use of these footpaths.

At the montane grassland, a road developed for tourism activity linked the points P23 and P25 (Figure 2) to one of the adjacent villages, i.e., from Bonakanda village in Buea through P25 to a place at P29 known as Mann-Spring lodge. Constructed in 2015, this road facilitated the transportation of equipment to furnish the tourist lodge at Mann-Spring. Mola Njie maintained that Mann-Spring lodge was a former camping spot used by Bakweri hunters before the arrival of a German Botanist, Gustav Mann, who, in 1862, found a spring in the area while collecting plants. Tourism is an example of flexibility where the hunter can cooperate with park authorities in using protected areas for his benefit. Mola Njie names a few friends of his, who were employed by the regime as tour operators, guides, and porters, adding that although they earn some money from tourism in the park, most of the finances from tourism go to the State treasury. Mola Njie expressed the need for initiatives that can be sponsored with funds from such finances in order to achieve the basic needs of the local people.

4. Discussion

The previous sections demonstrated the fragmentary nature of State power and its influence in shaping practices of land use and access. In doing so, we used the case of the MCNP to explain a native hunter's knowledge of flexibility in land use and access, underlining how local people adapt to new ways of State control without abandoning their land use practices. There are connections between the case of the MCNP and experiences elsewhere in the literature.

The authors of Reference [7]'s study of the Korup National Park revealed how State power beneath the influence of foreign donors (conservationists) transformed the Korup landscape by removing people from the land, adopting forestry laws, and prohibiting the continuity of traditional land use. Similarly, in the Boumba-Bek national park, the park regime detached the Baka pygmies from the benefits of land use [30]. In the case of the MCNP, these patterns of institutional power depict a land conquest [3] and the exclusionary nature of protected area regimes [6,10]. Here, park authorities utilize State forestry laws and co-management plans to prevent the unofficial use of the park. Through these mechanisms, the regime retains the power to sanction people who violate State laws for protected areas.

A reaction to the above means of State control are acts of resistance [31,32]. Here, flexibility is shaped by how the local population uses alternative means to meet their needs in situations of dispute [9]. For instance, in the Korup case, the local population shared a common view of disobeying State laws in resentment of procedures that expropriate village land [7]. In another case, when the government of the Dominican Republic issued protection laws over the Ebano Verde area, the locals of El Arroyazo and La Sal began gathering forest resources without authorization from the State due to inadequate compensation from the regime [15]. Furthermore, the Laponian World Heritage area

in Sweden involved several parties (non-governmental agencies, business representatives, and local people) with varied interests seeking managerial control over the land, making it hard for the local Saami to exercise their rights. Saami reindeer herders argued for indigenous control over the management of Laponia and asked for a majority of seats in the management board, though this came under opposition from State officials and politicians [14].

The hunter's account about the Bakweri displays a subtler form of resistance. He reveals the often-untold use of sites by locals who are close to the park boundary for gathering forest products for medicinal and traditional needs. Previous experiences of open resistance by the Bakweri turned out to be unsuccessful when they tried to change the official rules of the regime to something similar to that of the Laponia case. Therefore, the silent continuation of traditional land use practice in ignorance of the law can be classified as acts of subtle resistance.

In contrast, flexibility in maintaining cultural continuity might not always be classified as resistance, but the general sense of creating space for attaining other needs. For instance, in Siberia, land use and acquisition among the Evenki are conceivable by an individual's good performance on the land, in what Anderson called 'power, sovereignty, and license without sanctions, nor land exclusions' [38] (p. 120). The Yamal-Nenets in the Tundra exert a flexible behavior on the land by using ancient practices of local hunting and fishing as alternative subsistence to reindeer herding in spite of a contemporary economy where the Soviet and post-Soviet territorial organization governs economic activities [8]. Among the Saami in Finnish Lapland, flexibility can be perceived through attitudes of telling very little about place names to outsiders so as to defend the land against external encroachment [40].

The MCNP case presents another picture to the above narrative, which we observe as acts of cultural resilience. Consistent with the author of Reference [50]'s assertion about religious systems that define people, our analysis showed that the park continues to be a place of spiritual importance which the hunter has much regard for through ritual practices in the worship of a spiritual beings that keep people away from dangers. Within this form of resilience, people tend to accommodate new knowledge of land use such as alternative ways of cultivating trees without necessarily abandoning their traditions. This analysis seems consistent with the authors of Reference [8]'s conclusion about the Yamal-Nenets, who adjust new elements to their own needs without changing their traditional ways of living on the land.

The author of Reference [26] distinguished between free-range land and lands with strict rules of acquisition. Instead of both categories existing as distinct in different cultural settings as Casimir implied, the MCNP case showed that both categories co-exist on the same piece of land, where the space for flexibility among land users is informed by collaboration and reciprocity. According to the hunter, park authorities work together with locals to implement conservation plans through income activities, such as in the Prunus management scheme and tourism development. This, in return, supports the economic needs of people, enabling them to earn income which they use to obtain basic needs for their families. Further, the regime partly endorses valuable ritual practices, such as the dancing stone, to secure the safety of people performing various tasks of State interests in the park.

The hunter's narrative and its analysis show how the Bakweri operate in two simultaneous ways, by collaborating with the State regime where it provides positive alternatives to using parklands, while at the same time continuing culturally embedded practices silently as acts of subtle resistance to the regime.

5. Conclusions

Considering the frictions between human activities in parks, this study underlined the need to examine flexible land use and access in exclusionary systems of protected areas. Previous anthropological studies on land use and related practices have not given much attention to how the notion of flexibility in land use and access occurs in dispute situations where locals and park regimes co-exist on the land. To address this question, we used the example of the MCNP to explore the historical and fragmentary nature of State power, a hunter's testimonies of flexibility, and connections

between the MCNP case and experiences elsewhere. The results showed that the current state of land use and access on the MCNP is reminiscent of institutional power and historical patterns of State fragmentation—mechanisms that continue to enable the regime to exercise control on the land. This leads to a situation of reciprocity where the State involves the locals in the park through income activities in return for attaining conservation needs; whereas, the locals welcome the good things about the State giving access to the park, and simultaneously practice covert forms of resistance through trespassing where access to the parklands is prohibited. Therefore, resistance to and cooperation with State power can occur simultaneously among the same people.

Thus, this article shows that land use and access in protected areas are more flexibly negotiated than it may seem from reading existing literature. A more fine-grained analysis of local flexibility in accessing parklands indicates that a national park does not have only good or only bad consequences for local livelihoods. The hunter's knowledge and practice reveal that the Bakweri flexibly accommodate new forms of land use regulations without abandoning their traditional ways of using the land. Here, the flexible use of the land is driven by cultural resilience to preserve one's spiritual connection to the land, as well as by acts of reciprocity between park authorities and locals. Thus, in exclusionary forms of conserving protected areas, flexibility can involve practices that locals convey to resist as well as comply with regimes for their benefit.

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References

1. Anderson, D.G.; Ikeya, K. Parks, Property, and Power: Managing Hunting Practice and Identity within State Policy Regimes. In *Senri Ethnological Studies*; Anderson, D.G., Ikeya, K., Eds.; National Museum of Ethnology: Osaka, Japan, 2001; Volume 59, pp. 1–200.
2. Campbell, B. Changing Protection Policies and Ethnographies of Environmental Engagement. *Conserv. Soc.* **2005**, *3*, 280–322.
3. Ingold, T. *Being Alive: Essays on Movement, Knowledge, and Description*, 1st ed.; Routledge: London, UK, 2011; pp. 1–288.
4. Kopnina, H.; Shoreman-Ouimet, E. *Environmental Anthropology Today*, 15th ed.; Routledge: New York, NY, USA, 2011; pp. 1–301.
5. Li, T.M. Politics, Interrupted. *Anthropol. Theory.* **2019**, *19*, 29–53. [CrossRef]
6. Pemunta, N.V.; Pascal, M.A.O. The Tragedy of the Governmentality of Nature: The Case of National Parks in Cameroon. In *National Parks: Sustainable Development, Conservation Strategies, and Environmental Impacts*; Smith, J., Ed.; Nova Science Publishers: New York, NY, USA, 2013; pp. 1–56.
7. Schmidt-Soltau, K. The Costs of Rainforest Conservation: Local Responses Towards Integrated Conservation and Development Projects in Cameroon. *J. Contemp. Afr. Stud.* **2006**, *22*, 93–117. [CrossRef]
8. Stammler, F. Reindeer Nomads Meet the Market. Culture, Property and Globalisation at the End of the Land. *Halle Stud. Anthropol. Eurasia* **2005**, *6*, 1–379.

9. Plueckhahn, R. Rethinking the Anticommons: Usufruct, Profit, and the Urban. Available online: https://culanth.org/fieldsights/rethinking-the-anticommons-usufruct-profit-and-the-urban (accessed on 10 July 2019).
10. Oyono, P.R. The Foundations of the Conflit de Langage Over Land and Forests in Southern Cameroon. *Afr. Study Monogr.* **2005**, *26*, 115–144.
11. Cristina da Silva, T.; Campos, L.Z.; Balée, W.; Medeiros, M.F.; Peroni, N.; Albuquerque, U.P. Human Impact on the Abundance of Useful Species in a Protected Area of the Brazilian Cerrado by People Perception and Biological Data. *Landsc. Res.* **2017**, *44*, 75–87. [CrossRef]
12. Ficek, R.E. Cattle, Capital, Colonization: Tracking Creatures of the Anthropocene In and Out of Human Projects. *Curr. Anthropol.* **2019**, *60*, 260–271. [CrossRef]
13. Poirier, N. Culture and Conservation: Beyond Anthropocentrism. *J. Ecol. Anthropol.* **2016**, *18*, 1–3. [CrossRef]
14. Dahlstrom, A.N. *Negotiating Wilderness in a Cultural Landscape: Predators and Saami Reindeer Herding in the Laponian World Heritage Area*; Uppsala University Library: Uppsala, Sweden, 2003; Volume 32, pp. 1–535.
15. Holmes, G. Defining the forest, defending the forest: Political Ecology, Territoriality, and Resistance to a Protected Area in the Dominican Republic. *Geoforum* **2014**, *53*, 1–10. [CrossRef]
16. Koot, S.; Büscher, B. Giving Land (Back)? The Meaning of Land in the Indigenous Politics of the South Kalahari Bushmen Land Claim, South Africa. *J. South. Afr. Stud.* **2019**, *45*, 357–374. [CrossRef]
17. Mamdani, M. *Citizen and Subject: Contemporary Africa and the Legacy of Late Colonialism*, 1st ed.; Princeton University Press: Princeton, NJ, USA, 1996; pp. 1–353.
18. Mertens, B.; Shu, G.N.; Steil, M.; Tessa, B. Interactive Forest Atlast of Cameroon. Available online: http://pdf.wri.org/interactive_forest_atlas_of_cameroon_version_3_0.pdf (accessed on 15 July 2019).
19. Awung, N.S. Assessing Community Involvement in the Design, Implementation and Monitoring of REDD+ Projects: A Case Study of Mount Cameroon National Park—Cameroon. Ph.D. Thesis, University of New York, New York, NY, USA, 2015; pp. 1–357. Available online: http://etheses.whiterose.ac.uk/11152/1/Final%20full%20thesis%20for%20submission%20Nov%202015.pdf (accessed on 21 March 2020).
20. Nebasifu, A.A.; Atong, N.M. Rethinking Institutional Knowledge for Community Participation in Co-management. *Sustainability* **2019**, *11*, 5788. [CrossRef]
21. Nebasifu, A.A.; Atong, N.M. Expressing Agency in Antagonistic Policy Environments. *Environ. Sociol.* **2019**, *6*, 154–165. [CrossRef]
22. Awung, N.S.; Marchant, R. Quantifying Local Community Voices in the Decision-making process: Insights from the Mount Cameroon National Park REDD+ Project. *Environ. Sociol.* **2018**, *4*, 135–252. [CrossRef]
23. Laird, S.A.; Awung, G.L.; Lysinge, R.J. Cocoa farms in the Mount Cameroon region: Biological and cultural diversity in local livelihoods. *Biodivers. Conserv.* **2007**, *16*, 2401–2427. [CrossRef]
24. Bellier, I.; Hays, J. *Scales of Governance and Indigenous Peoples' Rights*, 1st ed.; Routledge: London, UK, 2019; pp. 1–294.
25. Jong, V. Landscapes, Visual Arts, and Ecocritism: A Reflection on the Scenic Apertures of Mount Fako in Cameroon. *Interdiscip. Stud. Lit. Environ.* **2010**, *17*, 792–796.
26. Casimir, M.J. The Dimensions of Territoriality: An Introduction. In *Mobility and Territoriality: Social and Spatial Boundaries among Foragers, Fishers, Pastoralists and Peripatetics*; Michael Casimir, M.J., Rao, A., Eds.; Bloomsbury Publishing PLC: London, UK, 1992; pp. 1–416.
27. Ardener, E. *Coastal Bantu of the Cameroons: Western Africa Part. XI*, 1st ed.; Routledge: London, UK, 2017; pp. 1–120. [CrossRef]
28. Fowler, I.; Fanso, V. *Encounter, Transformation and Identity: Peoples of the Western Cameroon Borderlands, 1891–2000*; Berghahn Books: Oxford, UK, 2009; pp. 1–254.
29. Ndiva, K. Asserting Permanent Sovereignty Over Ancestral Lands: The Bakweri Land Litigation Against Cameroon. *Annu. Surv. Int. Comp. Law* **2007**, *13*, 103–156. Available online: http://digitalcommons.law.ggu.edu/annlsurvey/vol13/iss1/6 (accessed on 15 January 2020).
30. Pemunta, N.V. The Governance of Nature as Development and the Erasure of the Pygmies of Cameroon. *GeoJournal* **2013**, *78*, 353–371. [CrossRef]
31. Akem, E.S.; Savage, O.M. Strategies of Resistance and Power Relations in the Mount Cameroon National Park. *Int. J. Dev. Res.* **2019**, *9*, 25501–25507.
32. Scott, J.C. *Weapons of the Weak: Everyday forms of Pleasant Resistance*; Yale University Press: New Haven, CT, USA; London, UK, 1985; pp. 1–392.

33. Konings, P. Chieftaincy and Privatisation in Anglophone Cameroon. In *The Dynamics of Power and the Rule of Law: Essays on Africa and Beyond, in Honour of Emile Adriaan B. van Rouveroy van Nieuwaal*; Binsbergen, W., Pelgrim, R., Eds.; African Studies Centre: Leiden, The Netherlands, 2003; pp. 79–99.
34. Geschiere, P. Chiefs and Colonial Rule in Cameroon: Inventing Chieftaincy, French and British Style. *Afr. J. Int. Afr. Inst.* **1993**, *63*, 151–175. [CrossRef]
35. Pemunta, N.V.; Fonmboh, N.M. Experiencing Neoliberalism from Below: The Bakweri Confrontation of the State of Cameroon over the Privatisation of the Cameroon Development Corporation. *J. Hum. Secur.* **2010**, *6*, 38–54. [CrossRef]
36. Republic of Cameroon. Law No 94/01 of 20th January 1994. Available online: http://www.droit-afrique.com/upload/doc/cameroun/Cameroun-Loi-1994-01-regime-forets-faune-peche.pdf (accessed on 22 March 2020).
37. Li, T.M. Centering Labor in the Land Grab Debate. *J. Peasant Stud.* **2011**, *38*, 281–298. [CrossRef]
38. Anderson, D. *Identity and Ecology in Arctic Siberia: The Number One Reindeer Brigade*; Oxford University Press: London, UK, 2002; pp. 1–272.
39. Githitho, A.N. The Sacred Mijikenda Kayas of Coastal Kenya: Evolving Management Principles and Guidelines. In *Conserving Cultural and Biological Diversity: The Role of Sacred Natural Sites and Cultural Landscapes, Proceedings of the Tokyo Symposium, Aichi, Japan, 30 May–2 June 2005*; Schaaf, T., Lee, C., Eds.; UNESCO Division of Ecological and Earth Sciences: Paris, France, 2006.
40. Mazzullo, N. Sápmi: A Symbolic Re-appropriation of Lapland as Saami Land. In *Máttut-máddagat: The Roots of Saami Ethnicities, Societies and Spaces/Places*; Äikäs, T., Ed.; University of Oulu: Oulu, Finland, 2009; pp. 174–185.
41. Taplin, D.H.; Scheld, S.; Low, S. Rapid Ethnographic Assessment in Urban Parks: A Case Study of Independence National Historical Park. *Hum. Organ.* **2002**, *61*, 80–93. [CrossRef]
42. Betru, T.; Tolera, M.; Sahle, K.; Kassa, H. Trends and Drivers of Land Use/Land Cover Change in Western Ethiopia. *Appl. Geogr.* **2019**, *104*, 83–93. [CrossRef]
43. Kiffner, C.; Arndt, Z.; Foky, T.; Gaeth, M.; Gannett, A.; Jackson, M.; Lellman, G.; Love, S.; Maroldi, A.; McLaughlin, S.; et al. Land Use, REDD+ and the Status of Wildlife Populations in Yaeda Valley, Northern Tanzania. *PLoS ONE* **2019**, *14*, 1–22. [CrossRef]
44. Valencia, M.R.; Davidson-Hunt, I.; Berkes, F. Social–ecological Memory and Responses to Biodiversity Change in a Bribri Community of Costa Rica. *Ambio A J. Hum. Environ.* **2019**, *48*, 1470–1481. [CrossRef]
45. Anthias, P. Ambivalent Cartographies: Exploring the Legacies of Indigenous Land Titling through Participatory Mapping. *Crit. Anthropol.* **2019**, *39*, 222–242. [CrossRef]
46. Chapin, M.; Lamb, Z.; Threlkeld, B. Mapping Indigenous Lands. *Annu. Rev. Anthropol.* **2005**, *34*, 619–638. [CrossRef]
47. Maman, S.; Lane, T.; Ntogwisangu, J.; Modiba, P.; Vanrooyen, H.; Timbe, A.; Visrutaratna, S.; Fritz, K. Using Participatory Mapping to Inform a Community-Randomized Trial of HIV Counselling and Testing. *Field Methods* **2009**, *21*, 368–387. [CrossRef]
48. Garcez, P.M. Microethnography. In *Encyclopedia of Language and Education*; Hornberger, N., Corson, D., Eds.; Springer: Dordrecht, The Netherlands, 1997; pp. 187–196. [CrossRef]
49. Riessman, C.K. Narrative Analysis. In *Narrative, Memory and Everyday Life*; University of Huddersfield: Huddersfield, UK, 2005; pp. 1–7.
50. Mbiti, J.S. *African Religions and Philosophy*, 2nd ed.; Heinemann: Oxford, UK, 1990; pp. 1–288.

forests

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Tree Community Composition and Dispersal Syndrome Vary with Human Disturbance in Sacred Church Forests in Ethiopia

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Abstract: *Research Highlights*: Variations in species composition across church forests in northern Ethiopia were driven more by variations in human disturbance and community forest management than forest size. The degree of human disturbance acted as an environmental filter that selected for weedy, exotic, and wind-dispersed species regardless of forest size. *Background and Objectives*: Forest fragmentation can profoundly influence the long-term persistence of forests on the landscape. Habitat fragmentation can increase edge effects and limit dispersal between forest patches. In the South Gondar Administrative Zone in northern Ethiopia, many of the remaining forests are small sacred church forests governed by the Ethiopian Orthodox Tewahido Church. *Materials and Methods*: We examined the drivers of woody plant species composition across 46 church forests in this region, including the influence of elevation, forest size, distance between forests, human disturbance, the presence of a wall, and the importance of local/individual community forest management at the Woreda level. We also examined how dispersal syndromes are influenced by increasing distance between forests and the extent of human disturbance within forests. *Results*: We found that elevational zone, distance between forests, the degree of human disturbance and Woreda had the greatest effect on species composition. Forest size and the presence of a wall were not significant drivers of species composition in these forests. *Conclusions*: We propose connecting forests through corridors or scattered trees to increase dispersal between forests, and greater on-the-ground protection efforts to restrict people and cattle from leaving the main trails within sacred forests

Keywords: abiotic dispersal; animal dispersal; distance–decay; forest fragmentation; sacred forest; sacred grove; South Gondar Administrative Zone

1. Introduction

Human impacts on natural habitats are profound, with more than 50% of Earth's land cover modified by humans [1], and 46% of the IUCN Red Listed species at risk of extinction due to land-use change [2]. Habitat fragmentation, whereby previous contiguous forest is reduced to smaller patches of forests with increasing distances between patches, is considered one of the most significant drivers of species diversity decline [3–6]. Forest fragmentation has significant and negative impacts on species richness, abundance, and diversity worldwide (Turner 1996 and citations therein, Cardelús et al.

2019). Patterns in species composition and turnover across forest fragments provide a mechanistic understanding of community structure drivers across a landscape [7], such as whether the distance between fragments or fragment size plays a larger role. This information can inform more targeted forest management practices [6,8].

Habitat fragmentation can increase disturbances in forests through the increasing degrees of edge effects, such as increased wind and temperature, decreased humidity, and decreased soil moisture [9–12]. Because the extent of edge effects increases as forest size decreases, small fragments can have a subset of the environments from large fragments made up of mostly edge habitat [13]. Forest size can, therefore, act as an environmental filter with small forests dominated by disturbance-prone species, such as weedy, exotic, or ruderal species [14,15]. The loss of core forest habitat can also lead to the loss of functional redundancy in the system [16]. For example, in Switzerland, increased cover of agricultural land reduced functional diversity by selecting for ruderal plants and generalist birds while filtering out long-lived plants, such as trees and shrubs, and birds with more forest-specific requirements, such as invertebrate feeding and tree-nesting birds [15]. In the Brazilian Atlantic forest, smaller fragments had a greater proportion of ruderal plants and plants that rely on abiotic means of dispersal, with fewer species that supply fruits for vertebrate frugivores [14].

Fragment connectivity can influence plant community composition due to differences in dispersal and pollination syndromes [17,18]. The distance–decay rate can be higher for plants that rely on animals for dispersal or pollination [17,19]. For example, the rate of decay in species similarity with increasing distance in North American spruce-fir forests was highest for animal-dispersed species (i.e., berry-fruited and nut-bearing species) than for wind-dispersed species (i.e., plumose-seeded or spore-bearing plants) [17]. In tropical forests, there is an above-average proportion of angiosperms that are dependent on animals for pollination (>94%, Ollerton, Winfree and Tarrant 2011) and dispersal (35%–100%, Howe and Smallwood 1982). As a result of the high dependence of plant species on animals for dispersal and pollination, habitat fragmentation in tropical forests can have a large influence on genetic diversity as mating patterns shift towards increased selfing [20]. Thus, limited dispersal among fragments could have profound consequences for the continued persistence of fragmented forests on the landscape, particularly if within-fragment regeneration is also limited.

In the South Gondar Administrative Zone of northern Ethiopia, forests are highly fragmented. A long history of converting forests to agriculture and pasture has left a mosaic of thousands of small forest patches (1022 forests average size 5.2 ha ± 0.44, Cardelús et al. 2017) that are scattered across the landscape (average distance between forests is 2.1 km ± 0.03, Cardelús et al. 2017). These forests are sanctuaries or "arks" (*sensu* Laurance et al. 2012) for many plant and animal species that have almost disappeared from the region [21]. Not only are they essential refuges for biodiversity, they are also an integral component of the Ethiopian Orthodox Tewahedo Church (EOTC); in fact, the church is the reason for the long-term persistence of these patches on the landscape (at least 80 years, Scull et al. 2017). These sacred church forests are sites of prayer, community events, social gatherings, homes for religious members, and funerals [21,22]. There is reciprocity between the forests and the communities that reside in them as the community respects and protects the church forest as common property, and relies on the ecosystem services provided by the forests (shade, firewood, pollinators, cleaning air and water) [21–24]. In turn, the native taxa depend on adequate management of the forests by the community to ensure their persistence into the future [21,23–25]. The church forests are conserved through a hybrid model of protection: they are owned by the state but controlled by the EOTC and the local community [22]. Because local communities have agency over the management of church forests as found in common property models [26,27], differences in the relationship of the local community to the forest could result in variations in forest health, management, and ecosystem services provided.

Overall there is a high degree of human disturbance in these forests (56%) as measured as the percent of the forest made up of non-native and weedy taxa, buildings, graves, trails, clearings (see Cardelús et al. 2019 for details on how this was calculated). This influences the species richness of trees and seedlings, such that forests with a high degree of disturbance from trails, buildings, and plantings

of exotic species, have lower tree species richness, density, and biomass, and lower seedling richness and density [28]. Efforts to demarcate the church boundary and in some cases reduce disturbance from people entering the forest to gather firewood or animals to graze include the erection of a small wall around the forest [22,29]. Forests with walls had significantly higher seedling species richness and density but had no effect on the tree community [29]. While patterns of richness and abundance are important at highlighting trends, knowing the compositional variation can highlight species at risk and bring to focus more targeted conservation efforts.

Here we examine variations in species composition of woody plants (trees and shrubs) across 46 sacred church forests in the South Gondar region of northern Ethiopia. We examined the influence of elevation, forest size, degree of human disturbance, the presence of a wall, and the importance of local communities on forest management using Woredas, or districts, on species composition. We predicted that elevation would have a significant effect on species composition as it has affected various forest parameters such as woody species richness, tree density, and species composition [28,30]. We examined whether changes in species composition were more influenced by distance between forests (distance–decay relationships) or differences in forest sizes for all plant species and for plant species with varying dispersal syndromes. We predicted that the similarity of tree species across forests would decline with distance from each other and forest size, and that the rate of decline would vary across dispersal syndrome; we predicted that the rate of decline in similarity for animal dispersed species would be faster than for abiotic dispersed species, such as wind or ballistic as found previously [17]. If forest size acts as an environmental filter, disturbance-prone species will dominate small forests, such as weedy and exotic taxa, with few animal-dispersed long-lived species. Alternatively, the degree of human disturbance could act as the environmental filter driving differences in species composition regardless of forest size. Thus, we examined the influence of forest size and percent human disturbance on dispersal syndrome. Given previous research that walls have no significant effect on tree communities [29], we did not predict that the presence of a wall would have a large impact on plant species composition. However, we did predict that Woreda would influence plant communities because of the large role played by the local community in making forest management decisions, such as having guards, planting exotic or native species, or extracting timber or firewood by community members.

2. Materials and Methods

2.1. Study Site

Our study was conducted in afromontane forest in the South Gondar Administrative Zone in the Amhara region of Northern Ethiopia east of Lake Tana (11°41'34" N, 37°48'11" E, 1800–2600 m a.s.l, Figure 1). The Amhara region is mountainous (it contains Ras Dejen, the highest mountain in Ethiopia at 4550 m) and is quite wet. The average rainfall is 1216 mm (1103–1336 mm) and the average daily temperature is 19 °C (16.0–23.7 °C) [31]. The wet season is bimodal with most rain falling from June to September and a smaller amount in March and April [31]. Because of the topographical variation in the region, species composition varies across elevational zones. Montane forests (1800–2050 m a.s.l.) are dominated by *Vernonia* spp. (Asteraceae) *Millettia ferruginea* (Fabaceae), *Maytenus senegalensis* (Celastraceae), and *Teclea nobilis* (Rutaceae) and Upper Montane forests (2400–2800 a.s.l.) are dominated by *Juniperus procera* (Cupressaceae), *Euphorbia abyssinica* (Euphorbiaceae), *Carissa edulis* (Apocynaceae) and *Capparis tomentosa* (Capparidaceae). With permission from the office of Abune Aregawi, the Bishop of South Gondar, we established long-term research sites in 46 church forests. Twenty-two of these forests were located in the Montane zone and were within two Woredas: Dera (12 forests) and Fogera (10 forests). Twenty-four were located in the Upper Montane zone and were within three Woredas: Farta (12 forests), Esite (11 forests) and Dera (1 forest) (Figure 1).

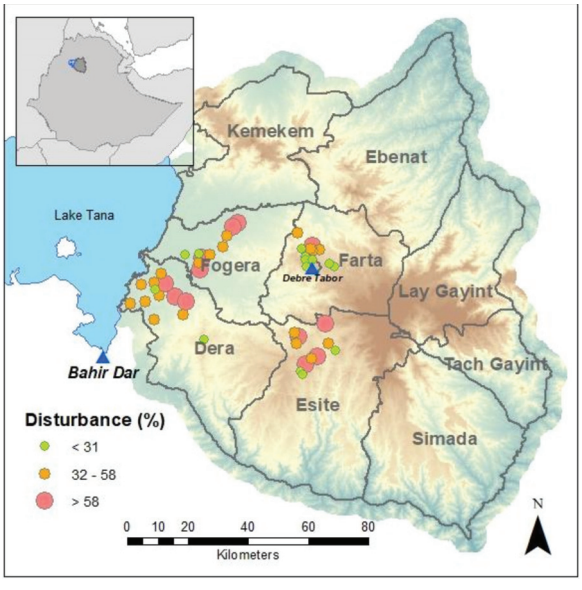

Figure 1. Map of the study area showing the distribution of the 46 church forests across four Woredas and two elevational zones. Forests in the Fogera (n = 10) and Dera (n = 12) Woredas were in the Montane elevational zone (1800–2050 a.s.l.). Forests in the Farta (n = 12), Dera (n = 1), and Esite (n = 11) Woredas were in the Upper Montane elevational zone (2400–2800 a.s.l.). The size and color of the dots represent the percent human disturbance (trails, clearings, buildings, and graves): <31% (small green dots), between 32%–58% (medium orange dots), and >58% (large pink dots). Basemap images obtained from ESRI.

2.2. Survey Methods

We surveyed all woody trees and shrubs with a diameter at breast height (dbh) > 1 cm along three modified Gentry transects that were established from the wall around the center of the church towards the edge of each forest at three cardinal directions that were 120° from each other (see Figure 3 in Cardelús et al. 2019). Each transect was 2 m × length of the forest, which varied quite a bit among forests (18–350 m). Species richness was measured as the total number of species encountered and abundance was measured as the total number of individuals counted along all three transects in each forest. For each species, we used online databases, such as Tropicos, JStor Global Plants, Kew Gardens, and the Flora of Zimbabwe to determine its fruit type and dispersal syndrome. We categorized dispersal syndrome into animal-dispersed and abiotic-dispersed plants, such as wind and ballistic.

2.3. Statistical Analysis

We used non-metric multidimensional scaling (NMDS) to test for differences in woody species composition between elevational zones (Montane and Upper Montane). Within each elevational zone (Montane and Upper Montane), we used NMDS to examine the effects of wall, forest size, degree of disturbance, and Woreda on tree species composition. The single forest in the Dera Woreda in the Upper Montane zone was removed as an outlier. We used the vegan package in R for our NMDS and the envfit function to test for significant effects of size and degree of disturbance [32]. For each NMDS, we used the Bray–Curtis index on abundance-based matrices. We tested for significant effects of wall and Woreda using the adonis function in the vegan package, which is a multivariate analysis of variance [32]. Degree of disturbance was calculated as the percent of each transect that was buildings, trails, graves, and clearings (for a description of disturbance types see Table 2 in Cardelús et al. 2019).

We did not include planted taxa and weedy taxa in our measure of disturbance because these species were part of the plant community that we were analyzing. We examined patterns in dispersal syndrome among forests visually within each NMDS.

We examined differences in elevation (m), forest size (ha), species richness, % animal-dispersed species, and % human disturbance between Woredas in each elevational range using 2 sample t-tests to test for the influence of local community on the plant community.

Within each elevational zone (Montane and Upper Montane), we examined the relationship between similarity in species composition with distance between forests (the distance decay relationship). Similarity in species composition was calculated using a Bray–Curtis index on an abundance metric with the vegan package in R [32]. The great circle distance between each forest in km was calculated from the haversine distance using the geosphere package in R [33]. Pairwise comparisons in compositional similarity and geographic distance across all 46 church forests were calculated. We examined the distance–decay relationship for all plant species using linear regression, and for abiotic-dispersed species (i.e., wind, gyration or ballistic dispersal) and animal-dispersed species together using an ANCOVA. We included wind-, gyration- and ballistic-dispersed species together as one category because the species with ballistic or gyration dispersal had either small dehiscent capsules or legumes. We examined how the distance–decay relationship varied with Woreda using an ANCOVA. We examined the relationship between similarity in species composition with the percent difference in size between forests. The percent difference in size was calculated for each pairwise comparison of all forests as the absolute value of the difference between two forests (denoted in Equation (1) below as F1 and F2) divided by the average of the two numbers multiplied by 100.

$$\frac{|F1 - F2|}{\left(\frac{F1+F2}{2}\right)} * 100 \quad (1)$$

We examined the relationship of compositional similarity and percent difference between forests for all plant species using linear regression, for abiotic-dispersed species (i.e., wind or ballistic dispersal) and animal-dispersed species together using an ANCOVA, and within Woredas using an ANCOVA.

We used ANCOVA to examine how the percent of animal-dispersed species were influenced by percent human disturbance and size of forest across elevational zones.

3. Results

We found a total of 9226 individuals in 46 church forests (Table S1). We found a total of 150 species from 106 genera and 75 families with 18 unidentified species (Table S1). This was fewer than found in a previous study of 28 church forests (168 woody species > 5 cm dbh, Wassie et al. 2010). The most species-rich families were Fabaceae (12 species, 9 genera), Euphorbiaceae (6 species, 4 genera), Rubiaceae (5 species, 5 genera), Oleaceae (5 species, 3 genera), and Asteraceae (5 species, 3 genera). Species richness in the 46 forests ranged from 7 to 35 with an average (± SE) of 18 ± 1 (Table S1) and abundance ranged from 16 to 558 with an average (± SE) of 202 ± 20 (Table S1).

Species composition was significantly different between the Montane and Upper Montane forests (adonis, $F_{1,45} = 11.75$, $R^2 = 0.21$, $p < 0.001$). Thus, we present the results for each elevational zone separately.

3.1. Montane Forests

Species composition varied across church forests in the Montane zone. Species composition was significantly affected by the degree of disturbance (envfit, $r^2 = 0.48$, $p = 0.003$) but not size ($r^2 = 0.17$, $p = 0.19$, Figure 2a). Wall had no significant effect on species composition (adonis, $F_{1,21} = 0.52$, $R^2 = 0.03$, $p = 0.91$), but species composition was significantly different between the two Woredas (adonis, $F_{1,21} = 2.93$, $R^2 = 0.13$, $p = 0.003$, Figure 2a). Church forests in the Fogera and Dera Woredas had similar levels of disturbance (Table 1). Average percent animal-dispersed species in forests in the Dera Woreda was significantly higher by 26% than in forests in the Fogera Woreda (*t*-test, $t = 2.78$, df = 19, $p = 0.01$,

Table 1). Species richness was also significantly higher in forests in the Dera Woreda than in the Fogera Woreda (*t*-test, $t = 2.70$, df = 20, $p = 0.01$, Table 1).

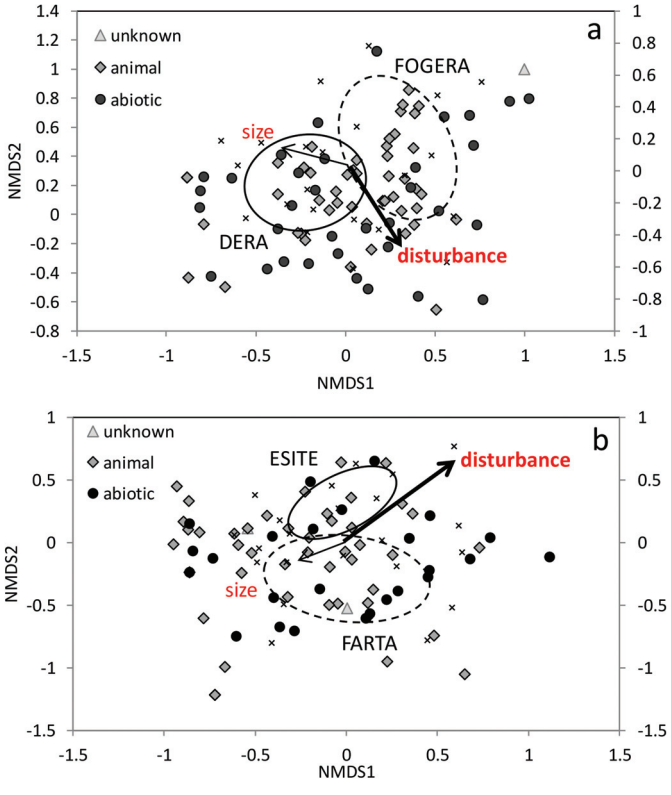

Figure 2. Non-metric multidimensional scaling ordination (NMDS) of species composition of plant species in 22 church forests in the Montane zone (**a**) and 23 church forests in the Upper Montane zone (**b**) in northern Ethiopia (the forest in the Dera Woreda in the Upper Montane zone was removed). A Bray–Curtis similarity index on abundance data was used. For **a**: two-dimensional stress = 0.22, Monte Carlo stress with 1000 iterations = 0.28. For **b**: two-dimensional stress = 0.24, Monte Carlo stress with 1000 iterations = 0.26. Ellipses denote the covariance matrix centered on the mean of each Woreda in each elevational range (Montane = Dera and Fogera; Upper Montane = Esite and Farta). Symbols represent dispersal syndromes: upward facing triangles = unknown; grey diamonds = animal dispersed species; black circles are abiotic dispersed species). Black x's represent church forests. The lines are the variables that correlated with the ordination with bold lines denoting significance.

Many of the plant species found in the most disturbed sites (those that fell negatively along NMDS axis 2 and positively along NMDS axis 1) were weedy, such as *Acanthus pubescens* (Acanthaceae), *A. sennii* (Acanthaceae) and *Vernonia myriantha* (Asteraceae), or exotic, such as *Grevillea robusta* (Proteaceae), *Opuntia ficus-indica* (Cactaceae), and *Eucalyptus camaldulensis* (Myrtaceae). Many of the plant species found in the least disturbed sites (those that fell positively along NMDS axis 2 and negatively along NMDS axis 1) were native with ranges restricted predominantly to east Africa, such as *Acokanthera schimperi* (Apocynaceae), *Pterolobium stellatum* (Fabaceae), and *Euclea racemose* (Ebenaceae). The three sites with the greatest disturbance that fell most negatively along NMDS axis 2 and positively along NMDS axis 1 were all in the Fogera Woreda, were less than 3.5 ha, and had >74% disturbance. The sites with the least disturbance that fell most positively along NMDS axis 2 and negatively along NMDS axis

1 were in the Dera Woreda, were greater than 3 ha, and had <45% disturbance. Thus, it appears that the differences in community management of the forests across Woredas may have a large influence on species composition through the degree of disturbance.

Distance between forests had a larger effect on similarity in species composition than differences in forest size. As predicted, similarity in species composition declined significantly with distance between forests for all species ($F_{1,228}$ = 49.18, p < 0.001, Figure 3a) and for both abiotic-dispersed and animal-dispersed species ($F_{1,456}$ = 57.6, p < 0.001, Figure 3b). The distance decay relationship did not differ across dispersal syndromes ($F_{1,456}$ = 2.2, p = 0.14) but the rate of decline in species composition for animal-dispersed species was 50% greater than for abiotic-dispersed species ($F_{1,456}$ = 73.1, p < 0.001, Figure 3b). Similarity in species composition declined with distance between forests significantly when considering forests only within Woredas ($F_{1,107}$ = 6.4, p = 0.01). The rate of decline in forests in the Fogera Woreda was steeper than in the Dera Woreda but this was not significantly different ($F_{1,107}$ = 0.7, p = 0.4, Figure 3c). Overall, similarity was significantly higher by 50% in the Dera Woreda than in the Fogera Woreda ($F_{1,107}$ = 20.7, p < 0.001, Figure 3c). Similarity in species composition declined significantly with percent difference in size between forests for all species ($F_{1,229}$ = 4.46, p = 0.04, Figure 3d) but not for abiotic-dispersed and animal-dispersed species ($F_{1,548}$ = 0.9, p = 0.35, Figure 3e). The way that differences in forest size influenced species similarity did not depend on dispersal syndrome ($F_{1,548}$ = 2.0, p = 0.16, Figure 3e), but similarity in species composition for abiotic-dispersed species was significantly larger than similarity in animal-dispersed species ($F_{1,548}$ = 82.7, p < 0.001, Figure 3e). Similarity in species composition was not significantly influenced by differences in forest size within Woredas ($F_{1,197}$ = 0.8, p = 0.4, Figure 3f).

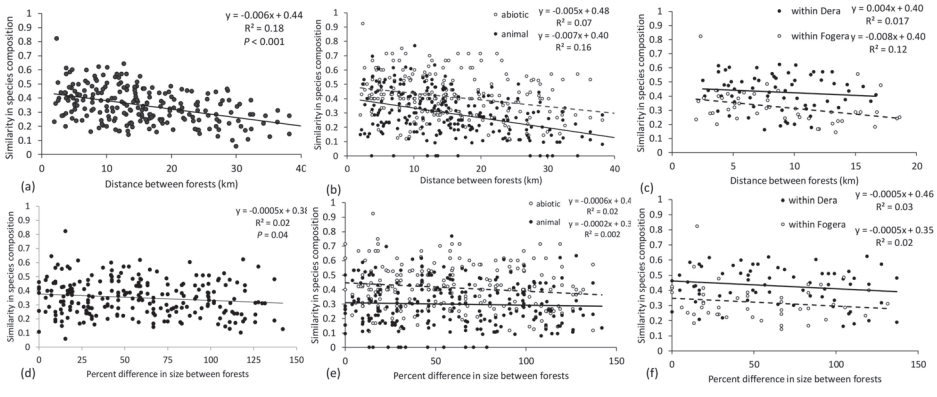

Figure 3. Similarity in woody plant species composition with distance between forests (**a**–**c**) and percent difference in size between forests (**d**–**f**) in Montane forests for all plant species (**a**,**d**), for abiotic-dispersed and animal-dispsered species (**b**,**e**), and for all species within Woredas (**c**,**f**). Similarity in species composition was calculated using a Bray–Curtis index on an abundance matrix. Distance between forests was calculated using the great circle distance from the haversine distance.

3.2. Upper Montane Forests

Species composition varied across sites. Wall had no significant effect on species composition (adonis, F = 1.16, R^2 = 0.05, p = 0.32). Species composition was significantly influenced by degree of disturbance (envfit, r^2 = 0.60, p = 0.002) but not size (r^2 = 0.08, p = 0.43, Figure 2b). Species composition was significantly different between the two Woredas (adonis, F = 2.73, R^2 = 0.12, p = 0.003, Figure 2b). Average size of church forests in each Woreda only differed by 1.2% while church forests in the Esite Woreda had 19.5% more human disturbance than church forests in the Farta Woreda (t-test, t = 2.55, df = 21, p = 0.02, Table 1), which may explain the significant differences in species composition between Woredas. Average percent animal-dispersed species in forests in the Esite Woreda was not significantly

different than in forests in the Farta Woreda (*t*-test, $t = 0.55$, df = 21, $p = 0.59$, Table 1). Average (± SE) species richness in the Esite Woreda was not significantly different than in the Farta Woreda (*t*-test, $t = -0.64$, df = 21, $p = 0.53$, Table 1).

Table 1. Characteristics of each Woreda within each elevational zone. Within each elevational zone, factors were compared across Woredas using *t*-tests. Values in brackets after the Woreda are the number of church forests within each Woreda. Values with different letters between Woredas within each elevational zone denote significant differences at $p < 0.05$.

Elevation	Woreda	Elevation (m)	Size (ha)	Species Richness	% Animal-Dispersed Species	% Human Disturbance
Montane	Dera (12)	1897.5 ± 18.6 [a]	5.4 ± 0.9	24.0 ± 1.8 [a]	59.1 ± 2.4 [a]	51.0 ± 5.0
	Fogera (10)	1842.7 ± 11.8 [b]	4.4 ± 0.8	15.9 ± 2.4 [b]	48.6 ± 3.0 [b]	50.0 ± 7.0
Upper Montane	Esite (11)	2511.8 ± 34.3	6.6 ± 2.2	17.0 ± 2.4	60.0 ± 3.2	44.0 ± 4.0 [a]
	Farta (12)	2518.3 ± 23.2	6.6 ± 1.3	19.0 ± 2.0	56.8 ± 4.8	27.0 ± 5.0 [b]

Many of the plant species found in the most disturbed sites (those that fell positively along NMDS axis 1 and NMDS axis 2) were weedy, such as *Maytenus gracilipes* (Celastraceae), *Acanthus sennii* (Acanthaceae), and *Justica schimperiana* (Acanthaceae), or exotic, such as *Arundo donax* (Poaceae) and *Chenopodium album* (Amaranthaceae), and most relied on abiotic means of dispersal. Many of the plant species found in the least disturbed sites were long-lived, animal-dispersed species, such as *Celtis africana* (Ulmaceae) and *Euclea racemosa* (Ebenaceae). The sites with the greatest disturbance that fell positively along NMDS axis 1 and NMDS axis 2 were both in the Esite Woreda, were <4.3 ha, and had >77% disturbance. The sites that had the least disturbance were both in the Farta Woreda, were >12.3 ha, and had <20% disturbance. These findings suggest that differences in species composition between Woredas might be due to differences in the degree of human disturbance.

As in Montane forests, distance between forests had a larger effect on similarity in species composition than differences in size of the forests. Similarity in species composition declined significantly with distance between all forests for all species ($F_{1,274} = 16.70$, $p < 0.001$, Figure 4a). The decline in similarity with increasing distance did not significantly vary with dispersal syndrome ($F_{1,548} = 2.9$, $p = 0.09$) but similarity in abiotic-dispersed species was 67% higher than in animal-dispersed species ($F_{1,548} = 84.6$, $p < 0.001$, Figure 4b). Similarity in species composition declined with distance between forests significantly when considering forests only within Woredas ($F_{1,117} = 3.9$, $p = 0.05$). The rate of decline in forests in the Esite Woreda was steeper than in the Fogera Woreda, but this was not significantly different ($F_{1,117} = 3.2$, $p = 0.07$, Figure 4c). Overall, similarity was significantly higher in the Esite Woreda than in the Farta Woreda ($F_{1,117} = 15.6$, $p < 0.001$, Figure 4c). Similarity in species composition was not significantly influenced by percent difference in size between forests for all species ($F_{1,274} = 0.31$, $p = 0.58$, Figure 4d) or for abiotic-dispersed species and animal-dispersed species either across all forests ($F_{1,548} = 0.9$, $p = 0.4$, Figure 4e) or when comparing forests within Woredas ($F_{1,117} = 1.0$, $p = 0.3$, Figure 4f). There was significantly higher similarity in abiotic-dispersed species than in animal-dispersed species across all forests ($F_{1,548} = 82.7$, $p < 0.001$, Figure 4e). Similarity in species composition was significantly higher within forests in the Esite Woreda than in the Farta Woreda ($F_{1,117} = 7.9$, $p = 0.006$, Figure 4f).

3.3. All Forests

The percent of animal-dispersed species in all church forests declined significantly with increasing human disturbance (ANCOVA, $F_{1,42} = 19.42$, $p < 0.001$, Figure 5) but it did not depend on elevational zone (ANCOVA, $F_{1,42} = 0.13$, $p = 0.72$). Elevational zone had no significant effect on the percent of animal-dispersed species (ANCOVA, $F_{1,42} = 0.58$, $p = 0.45$). The percent of animal-dispersed species in all church forests was not significantly influenced by forest size (ANCOVA, $F_{1,42} = 2.74$, $p = 0.11$) or the interaction of size and elevation (ANCOVA, $F_{1,42} = 1.42$, $p = 0.24$).

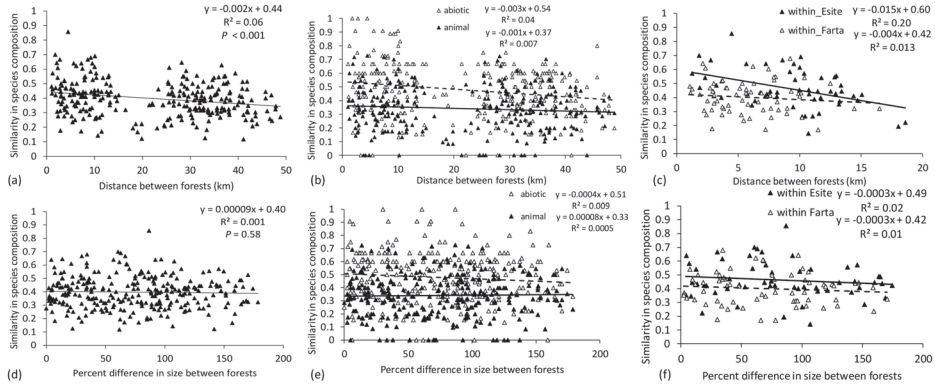

Figure 4. Similarity in woody plant species composition with distance between forests (**a**–**c**) and percent difference in size between forests (**d**–**f**) in Upper Montane forests for all plant species (**a**,**d**), for abiotic-dispersed and animal-dispersed species (**b**,**e**), and for all species within Woredas (**c**,**f**). Similarity in species composition was calculated using a Bray–Curtis index on an abundance matrix. Distance between forests was calculated using the great circle distance from the haversine distance.

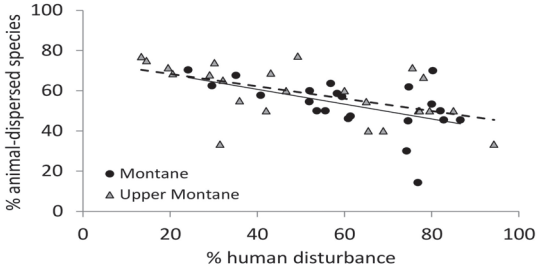

Figure 5. Linear regression of percent human disturbance on percentage of animal-dispersed species in each sacred church forest in the Montane zone (n = 22; y = −0.37x + 75.43, R^2 = 0.26; solid line, black circles) and Upper Montane zone (n = 24; y = −0.31x + 74.52, R^2 = 0.31; dashed line, grey diamonds) in the South Gondar Administrative Zone in northern Ethiopia.

4. Discussion

Species composition among 46 church forests at both elevational ranges was more influenced by degree of human disturbance than any other factor we examined. Interestingly, we found little support that forest size influenced species composition. Given that 93% of forests in the South Gondar region are <15 ha [28], the small variations we found in forest size might not be large enough to affect species composition. We found no significant effect of a wall, which was not surprising as previous research found only seedlings affected by the presence of a wall [29]. The differences we found between Woredas at each elevational range suggests that differences in the degree of human presence or the relationship of the local community to the forests between districts could be driving variations in species composition. Our data support our alternative hypothesis that the degree of human disturbance acts as an environmental filter affecting plant communities regardless of size.

We found a significant decline in species compositional similarity among forests with increasing distance between forests but not with varying forest size. This means that plant communities become more dissimilar to each other as distance between them increases but not as differences in forest sizes between them increase. Our findings are in alignment with a study of 28 church forests in the South Gondar Administrative Zone, that also found that similarity in species composition decreased with

increasing distance between forests [30]. In the Montane region, the decline in species compositional similarity was more rapid for animal-dispersed plants than for abiotic-dispersed plants, which suggests that plants that rely on animals for dispersal are more dispersal limited among these forests than wind- or ballistic-dispersed plants [17]. The steeper slope for animal-dispersed plants than abiotic-dispersed plants suggests that they are more aggregated, which might be due to their lower dispersal distances or a declining disperser community [17,34]. Surprisingly, in the Upper Montane zone, the decline in similarity for abiotic-dispersed plants was faster than for animal-dispersed plants. The Upper Montane zone is more mountainous than the Montane zone, which could disrupt wind currents between forests [35]. The lack of a significant decline in animal-dispersed species with increasing distance suggests that the animals that are present may be able to disperse to forests up to 50 km away. However, the decline in animal-dispersed plants with increasing human disturbance in the Upper Montane zone indicates that these dispersal agents avoid forests with a large human presence. In northeastern Tanzania, the most effective seed removal agents, which included three local bird species, removed 24%–85% fewer seeds from forest fragments (size range of 2–31 ha) than continuous forest (3500 ha) [36], which suggests that the dispersal agents that can facilitate dispersal of the core tree species might avoid forest fragments if they are mostly edge habitat. Furthermore, these fragments were not sacred forests or sites with a permanent human population; thus, dispersal of plants by animals in Ethiopian's church forests where there is a continuous human presence could be even further reduced if the dispersal agents avoid areas with a large human presence. Evidence is seen in the significant decline in animal-dispersed plants with increasing human disturbance regardless of elevational zone.

These church forests are the remaining arks for many indigenous species in the region and provide invaluable services to the church community. The reduced number of animal-dispersed species as human presence increases is alarming, particularly given the decline in forest area in the matrix around these church forests [37] and the high percentage of plant species that rely on animals for dispersal and pollination in tropical forests [38,39]. With reduced pollination due to habitat fragmentation in tropical forests, plants have shifted to increased selfing [20], which could compromise the continued persistence of fragmented forests on the landscape and reduce adaptation potential of these species to changes in their environment. The other possible source of forest regeneration is in the seed bank. However, few woody species have been recorded in Ethiopia's sacred church forests seed banks [25,40], which indicates that their presence in the forest is necessary to ensure future persistence of these woody species and that active restoration efforts are needed to conserve seeds and begin a native tree seedling planting program.

The two Woredas in the Montane zone that we surveyed were Dera and Fogera. Both of these Woredas border lake Tana, but Dera is closer to Bahir Dar, a medium sized city (243,330, [41]). The church forests in the Dera Woreda had higher species richness, a greater percentage of animal-dispersed species, and greater similarity in species composition among forests than the church forests in the Fogera Woreda. Given that distance from population center was not found to significantly affect these church forest plant communities [28], other factors between these Woredas must drive variations in plant communities. In the Upper Montane zone, church forest species composition also varied across Woredas. Forests in the Esite Woreda are closer to Debre Tabor, a small city (87,100, [28]), and had greater disturbance than forests in the Farta Woreda, which suggests that the influence of proximity to population centers differs across elevational zones. Given that forests within each zone experience similar microclimates and environmental conditions, socio-ecological factors likely differ across these Woredas and drive the variations in species composition, which could be informative to future forest conservation efforts. In a study examining community perspectives of church forest use in four church forests across four Woredas in 2002 and 2014 in the South Gondar Administrative Zone, respondents showed a lot of variation in their perceptions of the ecological and social values across Woredas, and there were shifts from social responsibility to official responsibility in protecting the forest and from valuing church laws to valuing state laws [42]. In ethnographic surveys of church forest communities in the South Gondar region, head priests varied in their understanding of why the church forest exists [27].

Good governance and strong leadership can allow for strong social capital, or effective community interactions, such as knowledge sharing among community members [43], which can strengthen effective community-based land management [44]. Thus, variation in governance and leadership as well as perceptions of the value of the church forest could explain the differences in species composition between Woredas within each elevational zone. Further understanding of perceptions of the value of forests and motivations to protect and manage the forest by local stakeholders across Woredas and elevational zones is needed.

Despite the largely negative impact of anthropogenic land-use change for many plants and large animals, a mosaic of forest with pastoral and agricultural land can provide habitat for small-mammals and a diverse array of plant species [45]. The ability of plant species to cross the matrix varies by species and the make-up of the matrix (e.g., agriculture, towns, roads), which indicates that distance alone cannot determine which species are most affected by fragmentation and that modification of the matrix can reduce the extinction risk of species in fragments [46]. In a large-scale analysis examining the importance of protected areas in tropical forests in conserving biodiversity globally, large frugivorous birds were deemed less vulnerable to the effects of fragmentation than other groups [47]. This analysis also found that reserves with increased on-the-ground protection efforts were improving in health due to the reduction in deforestation, logging, and hunting in the reserves [47]. Declining forest cover around the reserves was also contributing greatly to reduced forest health [47]. Given that the forest cover and scattered trees around church forests in Ethiopia have declined in the last century [37], building corridors and planting trees between forests would be a fruitful area to ensure connectivity between forests to conserve both species diversity and genetic diversity of the sacred church forests [48]. The global analysis by Laurance et al. (2012) found that changing climatic conditions, such as precipitation, temperature and wind, had weaker effects on forest reserve health than anthropogenic disturbances, such as logging and hunting [47]. This is a positive outcome, as it suggests that shifts in human values and behavioral norms within communities could help preserve forest integrity regardless of the changing climate.

We suggest several avenues to maintain and restore church forests. Building corridors using scattered native trees could improve animal movement and connectivity among forests for animal-dispersed plants [19] as well as improve forest health by modulating/buffering edge effects [47]. While forest size had little effect on species composition, larger forests will have fewer edge effects, and so we also recommend increasing core forest areas by planting native trees along the forest edge. We do not recommend planting *Eucalyptus*, which some forests have done, as it degrades soil nutrients and compromises native forest regeneration [49]. In a study examining the success of facilitated regeneration in Ethiopian church forests, seedlings of four native tree species grew well along the edge; these species can be used to increase core forest area [31]. To reduce the degree of human disturbance, we suggest on-the-ground protection efforts, such as continued building of stone walls and guards both of which encourage cattle and people to enter the forest using few main trails. The presence of guards may be less effective, as their main job is protecting the church and its valuables, which keeps them by the inner wall of the church and not on the periphery of the forest [22,27]. Thus, we propose guards whose sole role is to protect the forest. For any of these recommendations to take root, however, they need to be in line with community traditions [24] and include indigenous narratives of protection [27] as any recommendations or programs initiated outside of the culture of the church community will likely not succeed [50,51].

Supplementary Materials: The following are available online at http://www.mdpi.com/1999-4907/11/10/1082/s1, Table S1: List of woody species and their characteristics, Table S2: Sacred church forests and their characteristics.

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References

1. *Ecosystems and Human Well-Being-Synthesis: A Report of the Millenium Ecosystem Assessment*; Island Press: Washington, DC, USA, 2005.
2. *The IUCN Red List of Threatened Species*; IUCN: Gland, Switzerland, 2004.
3. Tilman, D.; May, R.M.; Lehman, C.L.; Nowak, M.A. Habitat destruction and the extinction debt. *Nature* **1994**, *371*, 65–66. [CrossRef]
4. Foley, J.A.; Defries, R.; Asner, G.P.; Barford, C.; Bonan, G.; Carpenter, S.R.; Chapin, F.S.; Coe, M.T.; Daily, G.C.; Gibbs, H.K.; et al. Global consequences of land use. *Science* **2005**, *309*, 570–574. [CrossRef]
5. Eriksson, O.; Ehrlén, J. Landscape fragmentation and the viability of plant populations. In *Integrating Ecology and Evolution in a Spatial Conect: 14th Special Symposium of the British Ecological Society*; Silvertown, K., Antonovics, J., Eds.; Cambridge University Press: Cambridge, UK, 2001; pp. 157–176.
6. Haddad, N.M.; Brudvig, L.A.; Clobert, J.; Davies, K.F.; Gonzalez, A.; Holt, R.D.; Lovejoy, T.E.; Sexton, J.O.; Austin, M.P.; Collins, C.D.; et al. Habitat fragmentation and its lasting impact on Earth's ecosystems. *Sci. Adv.* **2015**, *1*, e1500052. [CrossRef]
7. Jacquemyn, H.; Butaye, J.; Dumortier, M.; Hermy, M.; Lust, N. Effects of age and distance on the composition of mixed deciduous forest fragments in an agricultural landscape. *J. Veg. Sci.* **2001**, *12*, 635–642. [CrossRef]
8. Turner, I.M. Species Loss in Fragments of Tropical Rain Forest: A Review of the Evidence. *J. Appl. Ecol.* **1996**, *33*, 200. [CrossRef]
9. Woodroffe, R.; Ginsberg, J.R. Edge Effects and the Extinction of Populations Inside Protected Areas. *Science* **1998**, *280*, 2126–2128. [CrossRef]
10. Laurance, W.F.; Camargo, J.L.C.; Luizão, R.C.C.; Laurance, S.G.; Pimm, S.L.; Bruna, E.M.; Stouffer, P.C.; Bruce Williamson, G.; Benítez-Malvido, J.; Vasconcelos, H.L.; et al. The fate of Amazonian forest fragments: A 32-year investigation. *Biol. Conserv.* **2011**, *144*, 56–67. [CrossRef]
11. Lovejoy, T.E.; Bierragaard, R.O.; Rylands, A.B.; Malcolm, J.R.; Quintela, C.E.; Harper, L.H.; Brown, K., Jr. Edge and other effect of isolation on Amazon forest fragments. In *Conservation Biology: The Science of Scarcity and Diversity*; Powell, A.H., Powell, G.V.N., Shubart, H.O.R., Soule, M.E., Eds.; Sinauer: Sunderland, MA, USA, 1986; pp. 257–285.
12. Kapos, V. Effects of isolation on the water Island Press. In *Ecosystems and Human Well-Being-Synthesis: A Report of the Millenium Ecosystem Assessment*; Island Press: Washington, DC, USA, 2005.
13. Malcolm, J.R. Edge Effects in Central Amazonian Forest Fragments. *Ecology* **1994**, *75*, 2438–2445. [CrossRef]
14. Tabarelli, M.; Mantovani, W.; Peres, C.A. Effects of habitat fragmentation on plant guild structure in the montane Atlantic forest of southeastern Brazil. *Biol. Conserv.* **1999**, *91*, 119–127. [CrossRef]
15. Concepción, E.D.; Götzenberger, L.; Nobis, M.P.; de Bello, F.; Obrist, M.K.; Moretti, M. Contrasting trait assembly patterns in plant and bird communities along environmental and human-induced land-use gradients. *Ecography* **2017**, *40*, 753–763. [CrossRef]
16. Flynn, D.F.B.; Gogol-Prokurat, M.; Nogeire, T.; Molinari, N.; Richers, B.T.; Lin, B.B.; Simpson, N.; Mayfield, M.M.; DeClerck, F. Loss of functional diversity under land use intensification across multiple taxa. *Ecol. Lett.* **2009**, *12*, 22–33. [CrossRef] [PubMed]
17. Nekola, J.C.; White, P.S. The distance decay of similarity in biogeography and ecology. *J. Biogeogr.* **1999**, *26*, 867–878. [CrossRef]

18. Aguilar, R.; Ashworth, L.; Galetto, L.; Aizen, M.A. Plant reproductive susceptibility to habitat fragmentation: Review and synthesis through a meta-analysis. *Ecol. Lett.* **2006**, *9*, 968–980. [CrossRef] [PubMed]
19. Kormann, U.; Scherber, C.; Tscharntke, T.; Klein, N.; Larbig, M.; Valente, J.J.; Hadley, A.S.; Betts, M.G. Corridors restore animal-mediated pollination in fragmented tropical forest landscapes. *Proc. R. Soc. B Biol. Sci.* **2016**, *283*, 20152347. [CrossRef] [PubMed]
20. Aguilar, R.; Quesada, M.; Ashworth, L.; Herrerias-Diego, Y.; Lobo, J. Genetic consequences of habitat fragmentation in plant populations: Susceptible signals in plant traits and methodological approaches. *Mol. Ecol.* **2008**, *17*, 5177–5188. [CrossRef]
21. Wassie, A. *Opportunities, Constraints, and Propects of the Ethiopian Orthodox Tewahido Churches in Conserving Forest Resources: The Case of Churches in South Gondar, Northern Ethiopia*; Swedish University of Agricultural Sciences: Uppsala, Sweden, 2002.
22. Klepeis, P.; Orlowska, I.A.; Kent, E.F.; Cardelús, C.L.; Scull, P.; Wassie Eshete, A.; Woods, C. Ethiopian Church Forests: A Hybrid Model of Protection. *Hum. Ecol.* **2016**, *44*. [CrossRef]
23. Cardelús, C.L.; Scull, P.; Wassie Eshete, A.; Woods, C.L.; Klepeis, P.; Kent, E.; Orlowska, I. Shadow conservation and the persistence of sacred church forests in northern Ethiopia. *Biotropica* **2017**, *49*, 726–733. [CrossRef]
24. Bongers, F.J.J.M.; Wassie, A.; Sterck, F.J.; Ayele, T.B.; Teketay, D. Ecological restoration and church forests in northern Ethiopia. *J. Drylands* **2006**, *1*, 35–44.
25. Teketay, D.; Granström, A. Soil seed banks in dry Afromontane forests of Ethiopia. *J. Veg. Sci.* **1995**, *6*, 777–786. [CrossRef]
26. McKean, M.A.; Ostrom, E. Common property regimes in the forest: Just a relic from the past. *Unasylva* **1995**, *180*, 3–15.
27. Orlowska, I.; Klepeis, P. Ethiopian church forests: A socio-religious conservation model under change. *J. East. Afr. Stud.* **2018**, *12*, 674–695. [CrossRef]
28. Cardelús, C.L.; Woods, C.L.; Bitew Mekonnen, A.; Dexter, S.; Scull, P.; Tsegay, B.A. Human disturbance impacts the integrity of sacred church forests, Ethiopia. *PLoS ONE* **2019**, *14*, e0212430. [CrossRef]
29. Woods, C.L.; Cardelús, C.L.; Scull, P.; Wassie, A.; Baez, M.; Klepeis, P. Stone walls and sacred forest conservation in Ethiopia. *Biodivers. Conserv.* **2017**, *26*, 209–221. [CrossRef]
30. Wassie, A.; Sterck, F.J.; Bongers, F. Species and structural diversity of church forests in a fragmented Ethiopian Highland landscape. *J. Veg. Sci.* **2010**, *21*, 938–948. [CrossRef]
31. Wassie, A.; Sterck, F.J.; Teketay, D.; Bongers, F. Tree Regeneration in Church Forests of Ethiopia: Effects of Microsites and Management. *Biotropica* **2009**, *41*, 110–119. [CrossRef]
32. Oksanen, J.; Guillaume Blanchert, F.; Kindt, R.; Legendre, P.; O'Hara, B.; Simpson, G.L.; Solymos, P.; Stevens, M.H.H.; Wagner, H.; Vegan: Community Ecology Package. R Packag, Version 1.17-9. 2010. Available online: http://CRAN.R-project.org/package=vegan. (accessed on 1 September 2009).
33. Hijmans, R.J.; Geosphere: Spherical Trigonometry. R Package Version 1.5-10. 2019. Available online: https://CRAN.R-project.org/package=geosphere. (accessed on 15 March 2020).
34. Morlon, H.; Chuyong, G.; Condit, R.; Hubbell, S.; Kenfack, D.; Thomas, D.; Valencia, R.; Green, J.L. A general framework for the distance-decay of similarity in ecological communities. *Ecol. Lett.* **2008**, *11*, 904–917. [CrossRef]
35. Banta, R.M.; Berri, G.; Blumen, W.; Carruthers, D.J.; Dalu, G.A.; Durran, D.R.; Egger, J.; Garratt, J.R.; Hanna, S.R.; Hunt, J.C.R.; et al. The Role of Mountain Flows in Making Clouds. In *Atmospheric Processes Over Complex Terrain*; American Meteorological Society: Boston, MA, USA, 1990; pp. 229–283.
36. Cordeiro, N.J.; Ndangalasi, H.J.; McEntee, J.P.; Howe, H.F. Disperser limitation and recruitment of an endemic African tree in a fragmented landscape. *Ecology* **2009**, *90*, 1030–1041. [CrossRef]
37. Scull, P.; Cardelús, C.L.; Klepeis, P.; Woods, C.L.; Frankl, A.; Nyssen, J. The Resilience of Ethiopian Church Forests: Interpreting Aerial Photographs, 1938–2015. *Land Degrad. Dev.* **2017**, *28*. [CrossRef]
38. Ollerton, J.; Winfree, R.; Tarrant, S. How many flowering plants are pollinated by animals? *Oikos* **2011**, *120*, 321–326. [CrossRef]
39. Howe, H.F.; Smallwood, J. Ecology of Seed Dispersal. *Annu. Rev. Ecol. Syst.* **1982**, *13*, 201–228. [CrossRef]
40. Wassie, A.; Teketay, D. Soil seed banks in church forests of northern Ethiopia: Implications for the conservation of woody plants. *Flora Morphol. Distrib. Funct. Ecol. Plants* **2006**, *201*, 32–43. [CrossRef]
41. Brinkhoff, T. City Population. Available online: http://www.citypopulation.de/Ethiopia.html (accessed on 10 October 2020).

42. Reynolds, T.W.; Stave, K.A.; Sisay, T.S.; Eshete, A.W. Changes in community perspectives on the roles and rules of church forests in northern Ethiopia: Evidence from a panel survey of four Ethiopian Orthodox Communities. *Int. J. Commons* **2017**, *11*, 355–387. [CrossRef]
43. Wilson, G.A. *Community Resilience and Environmental Transitions*; Taylor and Francis: Milton Park, UK, 2012; ISBN 9780203144916.
44. Bebbington, A.; Perreault, T. Social Capital, Development, and Access to Resources in Highland Ecuador. *Econ. Geogr.* **1999**, *75*, 418. [CrossRef]
45. Graham, S.I.; Kinnaird, M.F.; O'Brien, T.G.; Vågen, T.; Winowiecki, L.A.; Young, T.P.; Young, H.S. Effects of land-use change on community diversity and composition are highly variable among functional groups. *Ecol. Appl.* **2019**, *29*. [CrossRef]
46. Ricketts, T.H. The matrix matters: Effective isolation in fragmented landscapes. *Am. Nat.* **2001**, *158*, 87–99. [CrossRef] [PubMed]
47. Laurance, W.F.; Carolina Useche, D.; Rendeiro, J.; Kalka, M.; Bradshaw, C.J.A.; Sloan, S.P.; Laurance, S.G.; Campbell, M.; Abernethy, K.; Alvarez, P.; et al. Averting biodiversity collapse in tropical forest protected areas. *Nature* **2012**, *489*, 290–294. [CrossRef]
48. Couvet, D. Deleterious Effects of Restricted Gene Flow in Fragmented Populations. *Conserv. Biol.* **2002**, *16*, 369–376. [CrossRef]
49. Cardelús, C.L.; Mekonnen, A.B.; Jensen, K.H.; Woods, C.L.; Baez, M.C.; Montufar, M.; Bazany, K.; Tsegay, B.A.; Scull, P.R.; Peck, W.H. Edge effects and human disturbance influence soil physical and chemical properties in Sacred Church Forests in Ethiopia. *Plant Soil* **2020**, 1–14. [CrossRef]
50. Bhagwat, S.A.; Rutte, C. Sacred groves: Potential for biodiversity management. *Front. Ecol. Environ.* **2006**, *4*, 519–524. [CrossRef]
51. Hayes, T.M. Parks, People, and Forest Protection: An Institutional Assessment of the Effectiveness of Protected Areas. *World Dev.* **2006**, *34*, 2064–2075. [CrossRef]

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Conservation–Protection of Forests for Wildlife in the Mississippi Alluvial Valley

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Abstract: The nearly ubiquitous bottomland hardwood forests that historically dominated the Mississippi Alluvial Valley have been greatly reduced in area. In addition, changes in hydrology and forest management have altered the structure and composition of the remaining forests. To ameliorate the detrimental impact of these changes on silvicolous wildlife, conservation plans have emphasized restoration and reforestation to increase the area of interior (core) forest habitat, while presuming negligible loss of extant forest in this ecoregion. We assessed the conservation–protection status of land within the Mississippi Alluvial Valley because without protection, existing forests are subject to conversion to other uses. We found that only 10% of total land area was currently protected, although 28% of extant forest was in the current conservation estate. For forest patches, we prioritized their need for additional conservation–protection based on benefits to forest bird conservation afforded by forest patch area, geographic location, and hydrologic condition. Based on these criteria, we found that 4712 forest patches warranted conservation–protection, but only 109 of these forest patches met our desired conservation threshold of >2000 ha of core forest that was >250 m from an edge. Overall, 35% of the area of forest patches warranting conservation–protection was protected within the conservation estate. Even so, for those forest patches identified as most in need of conservation–protection, less than 10% of their area was currently protected. The conservation–protection priorities described fill an unmet need for land trusts and other conservation partners pursuing strategic forest protection in support of established bird conservation objectives.

Keywords: protected areas; conservation estate; conservation planning; bottomland hardwood forest

1. Introduction

Deforestation and conversion of land to agricultural production, abetted by levees and other flood mitigation projects, have markedly decreased the extent of bottomland hardwood forests in the Mississippi Alluvial Valley [1–3]. Because of this decreased forest area, many populations of forest-dependent wildlife have declined [4]. To increase the area of forest habitat for the conservation of migratory birds and other wildlife, conservation delivery professionals have relied on reforestation (also known as afforestation) to restore converted forest land. The Lower Mississippi Valley Joint Venture partnership (www.lmvjv.org) has promoted reforestation in this ecoregion for over two decades, as evidenced by avian conservation plans [5] and conservation decision support tools that prioritize restoration locations to enhance the conservation of breeding birds [6]. These avian conservation plans and restoration models were largely premised on the area and location of extant forest. Additional loss of extant forest not only has a direct negative impact on species using these habitats, but may

adversely affect the efficiency of ongoing forest restoration if areas of forest loss are adjacent to ongoing forest restoration.

Protected areas that are owned or managed by conservation-oriented entities and lands subjected to perpetual conservation-oriented easements or servitudes are effective methods of ensuring permanence of extant habitat, while concurrently conserving wildlife biodiversity and providing a range of other socio-economic benefits [7]. Indeed, the United Nations Aichi Biodiversity Target is that by 2020 "at least 17% of terrestrial and inland water, and 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures" [8]. Despite this mandate, the conservation–protection status of bottomland forests in the Mississippi Alluvial Valley has neither been quantified nor prioritized. Similarly, the degree to which existing protected areas are ecologically representative of historical bottomland forests is unknown. The Mississippi Alluvial Valley is of particular importance to North American biodiversity and ecosystem services as the largest floodplain in North America. It seasonally supports 40% of North America's waterfowl, 107 species of land birds breed in the ecoregion, and threatened and endangered species, such as pallid sturgeon, depend on floodplain dynamics of the Mississippi River. Thus, conservation–protection of forests in the Mississippi Alluvial Valley would greatly contribute to the United Nations Aichi Biodiversity Target.

To better understand current threats to bottomland forests and reduce the likelihood of future forest loss in the Mississippi Alluvial Valley, we sought to identify and characterize the conservation–protection status of existing forests and to prioritize additional need for forest protection within this ecoregion. We deemed forest areas to have protected conservation status when a reduced likelihood of being converted to non-forest habitat was conveyed via public (federal, state, or local government) or non-governmental conservation organization (NGO) ownership or from perpetual conservation-oriented easements or servitudes that were recorded in local land records.

Guided by the biological underpinning of a minimum area of core forest (i.e., interior forest buffered from deleterious forest edge effects), we sought to ascertain the current and future contribution of each forest patch for bird conservation based on existing levels of conservation–protection, landscape context, and hydrologic condition. Specifically, we evaluated the current level of conservation–protection for forest patches with sufficient area of core forest to be deemed important for forest-breeding birds. In addition, we presumed a greater need for conservation–protection for forest patches that were proximate to high priority reforestation zones, with the intention of increasing the efficacy of ongoing forest restoration efforts [6]. Finally, because forest patches less prone to frequent flooding have been disproportionately converted to agricultural use [1,2], we also presumed an increased need for conservation–protection of these forest patches.

2. Materials and Methods

2.1. Study Area

The Mississippi Alluvial Valley Bird Conservation Region (http://nabci-us.org/resources/bird-conservation-regions-map/#bcr26) is a relatively flat, weakly dissected alluvial plain of >10 million ha within 7 states: Illinois, Missouri, Arkansas, Kentucky, Tennessee, Mississippi, and Louisiana (Figure 1). Topographic and hydrologic differences subdivide this region into 14 physiographic provinces [9]. In this ecoregion, forest-dwelling birds are of great conservation concern because over two-thirds of the area that was formerly forested has been converted to other land uses.

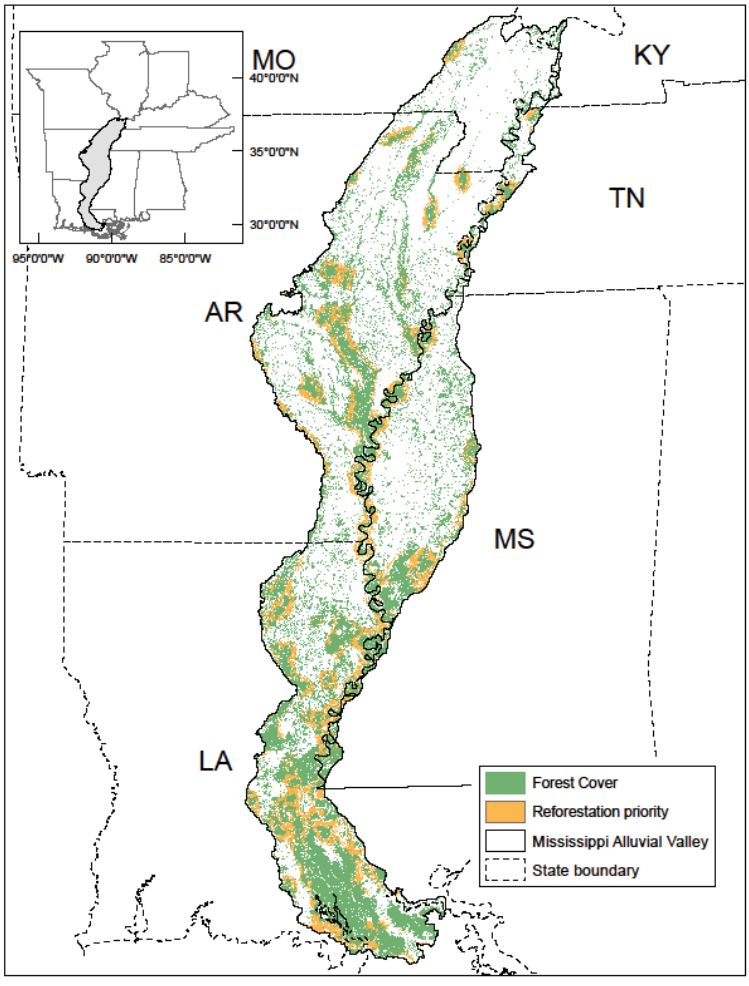

Figure 1. Forest habitat (green [3]) and high priority zones for forest restoration (brown [6]) within the Mississippi Alluvial Valley.

Average annual precipitation is 114–165 cm. Natural vegetation has been cleared from most of this ecoregion [1,2,10], being primarily converted to agriculture. Historically, extensive flooding dictated vegetative conditions, but levees, dikes, and dams have markedly altered the hydrology of the Mississippi Alluvial Valley [11]. These hydrological changes have influenced the composition and structure of the remaining forested wetlands [12–14].

Forest cover currently comprises approximately 30% of area within the Mississippi Alluvial Valley [3]. Remaining floodplain forests are dominated by oak-gum-cypress and elm-ash-cottonwood cover types. Co-dominant species within these forest types include oaks [overcup (*Quercus lyrata*), willow (*Quercus phellos*), Nuttall (*Quercus nuttallii*), water (*Quercus nigra*), and cherrybark (*Quercus pagodaefolia*)] as well as sweetgum (*Liquidambar styraciflua*), water hickory (*Carya aquatica*), sugarberry (*Celtis laevigata*), American elm (*Ulmus americana*), bald cypress (*Taxodium distichum*), green ash (*Fraxinus pennsylvanica*), and others [1]. Oak-hickory forests occur on isolated upland inclusions (e.g., Crowley's Ridge) within this floodplain. Co-dominant upland tree species include post (*Quercus stellate*), southern red (*Quercus falcata*), black (*Quercus velutina*), chinkapin

(*Quercus muehlenbergii*), and white (*Quercus alba*) oaks along with mockernut hickory (*Carya tomentosa*) and others [10].

2.2. Data Sources

Boundary: For our analyses, we used the Lower Mississippi Valley Joint Venture's conservation planning boundary for the Mississippi Alluvial Valley Bird Conservation Region because it well delineates the transition from alluvial floodplain and deltaic lands to upland habitat. We included all upland inclusions that were wholly contained within this boundary (Figure 1; http://www.arcgis.com/home/item.html?id=c72185797b564b5995f44e9bc367163e).

Forest: We used a binary forest classification derived from 2011 Landsat satellite imagery [3] to identify extant forest habitat within, and 1 km beyond, the Mississippi Alluvial Valley boundary (Figure 1; SROWEB.DBO.T2011_forest_w_reforestation; https://gisweb.ducks.org/arcgis/rest/services/SRO/Forest_2011/MapServer/0).

Reforestation priority: Reforestation (i.e., afforestation) priorities for bird conservation have been established for restorable lands within the Mississippi Alluvial Valley. These priorities are intended to effectively increase the number of forest patches that harbor >2000 ha of core forest, while concurrently targeting more than 60% forest cover within local (320 km^2) landscapes and restoration of higher elevation bottomland hardwood forests [6]. We extracted and used the highest (upper 10%) priority restoration zone from this reforestation decision support model (Figure 1; LMVJV/FBBDSM_2011; https://gisweb.ducks.org/arcgis/rest/services/LMVJV/FBBDSM_2011/MapServer).

Flood frequency: We used the inundation frequency of lands in the Gulf Coastal Plain and Ouachita Mountains (GCPO), including the Mississippi Alluvial Valley, that was developed from 50 Landsat scenes and 1334 total images depicting inundation extent under varying hydrologic conditions [15]. Inundation frequency ranged from 0% to 100% (in Supplementary Materials: GCPO Inundation Frequency Mosaic; https://www.sciencebase.gov/catalog/item/5617e3c3e4b0cdb063e3fc35).

Conservation estate: We identified lands owned or managed by conservation-oriented entities, either public or private, and lands subjected to perpetual conservation-oriented easements or servitudes from 7 geographic information system (GIS) source files:

1. Protected Areas Database of the United States 2.0, 2018: From the U.S. Geological Survey Gap Analysis Project, this database included public and non-profit lands and waters. Most were public lands owned in fee title, but the database also contained long-term easements, leases, agreements, and congressional (e.g., Wilderness Area), executive (e.g., National Monument), and administrative (e.g., Area of Critical Environmental Concern) designations as documented in agency management plans (https://doi.org/10.5066/P955KPLE).
2. National Conservation Easement Data, 2018: A public–private partnership database of locations for more than 150,000 conservation easements and land trusts throughout the United States (https://www.conservationeasement.us/).
3. Ducks Unlimited Conservation Easements, 2017: Locations for lands under conservation easement with Ducks Unlimited, Inc., a non-governmental conservation organization (https://gisweb.ducks.org/arcgis/rest/services/LMVJV_Parcel/Parcel_Private/MapServer/1).
4. Wetlands Reserve Program, 2016: Location information for lands under federal conservation easements with the U.S. Department of Agriculture. These conservation easements included the Wetland Reserve Program, Wetland Reserve Enhancement Program, and Wetland Reserve Enhancement Partnership. These data are not publicly accessible.
5. State Wildlife Management Areas, 2015: A Lower Mississippi Valley Joint Venture compiled database of locations for state-owned or managed wildlife conservation areas as provided by the conservation agencies of their state partners (https://gisweb.ducks.org/arcgis/rest/services/SRO/WildlifeManagementArea/MapServer/0)

6. National Wildlife Refuge System, 2015: Locations of existing U.S. Fish and Wildlife Service and National Wildlife Refuges as well as designated "areas of interest" for potential future acquisition by the National Wildlife Refuge system (https://gis.fws.gov/arcgis/rest/services/FWSCadastral_Internet/MapServer/2).
7. The Nature Conservancy, Louisiana Lands, 2018: Locations of lands owned or managed by the non-governmental conservation organization, The Nature Conservancy in Louisiana. These data are not publicly accessible.

All GIS raster data were obtained or converted to 30 m (900 m^2) pixel resolution for analyses. Unless otherwise stated, GIS manipulations were accomplished within ArcMap (Version 10.5.1; Environmental Systems Research Institute, Redlands, CA, USA). The above files were merged to create a unified depiction of the current conservation estate within the Mississippi Alluvial Valley (Figure 2; in Supplementary Materials: https://doi.org/10.5066/P90V76SY).

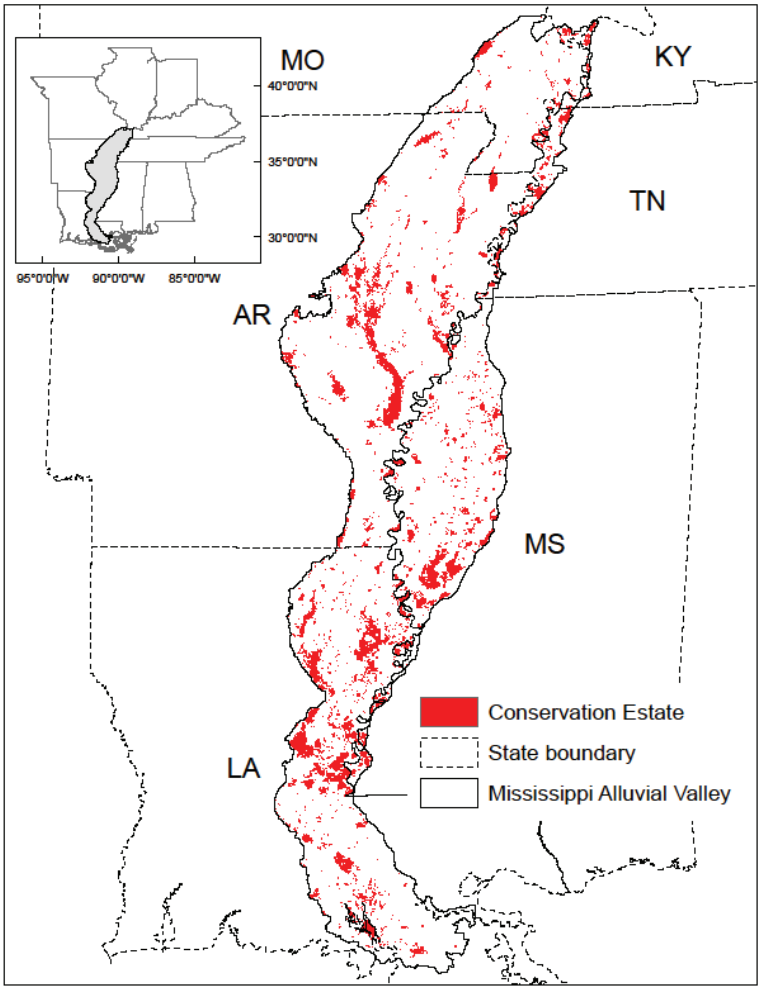

Figure 2. The existing conservation estate within the Mississippi Alluvial Valley wherein conservation–protection is legally mandated or culturally implied. Data sources are provided in text.

2.3. Forest Patches

Previous planning efforts for the conservation of forest-breeding birds in the Mississippi Alluvial Valley have made the biological assumption that birds occur at higher density, have increased probability of survival, and have greater reproductive success within forest interiors (i.e., core forest) [6,16,17]. To mitigate the presumed detrimental influences associated with forest edges [18], initial conservation planning in this region used a conservative 1000 m buffer from 'hostile' edges [19]. More recent conservation plans have assumed that a buffer distance of 250 m is enough to mitigate the detrimental effects of hostile edges [16].

We identified all extant forest patches (core forest plus the buffer), including reforested areas, within the Mississippi Alluvial Valley [3]. After identifying and including non-hostile habitats, we extracted core-forest areas that were >250 m from a hostile forest edge [16]. We considered cropland, pasture, grassland, aquaculture, urban, and suburban habitats to be hostile edges because these ecotones with forest tend to promote predator incursions [20] and greater abundance of the nest parasite, brown-headed cowbird (*Molothrus ater*) [21]. Conversely, we considered shrublands, emergent wetlands, and natural water bodies to be non-hostile habitats, such that forest core habitats extended to the boundary of these non-hostile edges.

Once core forest was identified, we used the ERDAS Imagine (Hexagon Geospatial, Madison, Alabama) raster processing software to clump (i.e., group) and uniquely identify all contiguous areas of core forest, hereafter referred to as 'core clumps'. Core clumps were separated from other clumps by at least one pixel (900 m^2) around the entirety of the clump, such that corner connections (i.e., diagonally connected pixels) retained continuity of the clump. The area (ha) of each forest core clump was then calculated.

In addition to reliance on forest interior habitat, previous conservation planners also assumed that a large area of core forest is needed to ensure occupancy by enough breeding individuals to diminish the likelihood of extirpation of a species from the forest patch and to provide habitat diversity consistent with the needs of priority bird species [5]. The minimum area of core forest previously recommended was 2000 ha [6]. Ongoing evaluation of habitat needs for breeding birds in this ecoregion suggests that a 2000 ha area of core forest would support populations with less than 1% likelihood of extirpation over 100 years for 46 out of 56 (82%) breeding species. Therefore, our goal was to emphasize core forest of >2000 ha. We recognized that additional forest restoration adjacent to core clumps <2000 ha could result in core clumps that exceed this threshold area. Therefore, we retained all core clumps ≥1600 ha (80% of 2000 ha). In addition, because reforestation efforts continue to focus restoration within higher priority forest restoration zones, we retained all core clumps (regardless of ha area) that were adjacent to the highest (upper 10%) reforestation priority zones (Figure 1).

We reestablished the entirety of forest patches for this set of core clumps that were ≥1600 ha or adjacent to high restoration priority zones (Figure 3), by returning the 250 m non-core forest buffer. Concurrently, we retained only forested habitat by removing water and herbaceous wetland habitat from these forest patches.

2.4. Conservation–Protection

For each forest patch meriting consideration for conservation–protection, as described above, we determined the percentage of the patch that was outside the conservation estate. Thus, forest patches with a value of 100 had no existing conservation–protection and were in greatest need of forest protection. Conversely, those patches with a value of 0 were fully protected and no additional forest protection was warranted. We adjusted the perceived need for conservation–protection of each forest patch, which was initially based solely on percent area not protected, to account for location and hydrology.

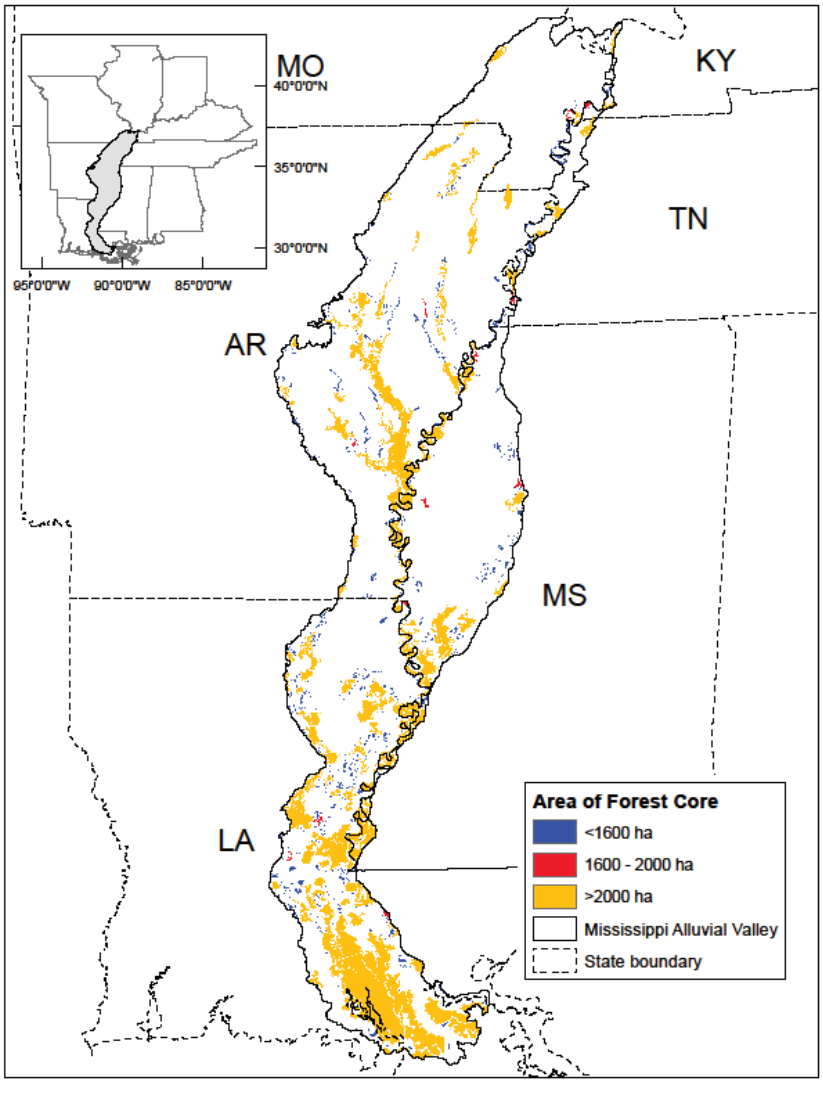

Figure 3. Extant forest patches within the Mississippi Alluvial Valley with merit for protection to support bird conservation by virtue of having interior core habitat (>250 from hostile edge) area >1600 ha or being located adjacent to high priority (upper 10%) restoration zones. Data source: this study.

2.5. Location

Because core forest patches with <2000 ha of core area were perceived to have less than optimal conservation value for forest-breeding birds, we reduced the perceived need for conservation–protection of core forest patches with 1600–2000 ha by 50% and core forest patches with <1600 ha by 100%. Conversely, we granted patches an increased need for protection when core forest patches were adjacent to the highest priority reforestation areas and therefore have greater potential for expansion of their core area. Within these high priority forest restoration areas, we increased the attributed need for protection by 40% of their initial perceived need for conservation–protection for patches with ≥2000 ha

of core forest and by 20% of their initial perceived need for conservation–protection for patches with <2000 ha of core forest (Table 1).

Table 1. Adjustments to attributed need for additional conservation–protection (% of patch unprotected) of forest patches within the Mississippi Alluvial Valley; reduced for small core area (% of original conservation–protection value), increased (20% or 40% of original conservation–protection value) when location was within a high priority reforestation zone, and further increased up to 20% relative to dryness of forest patch.

Area (ha)	Percent of Original Core Area Conservation–Protection Value	Reforestation Zone Addition	Hydrology Addition
≥2000	100%	40%	20% of dryness coefficient
1600–2000	50%	20%	20% of dryness coefficient
<1600	0%	20%	20% of dryness coefficient

2.6. Hydrology

To benefit priority forest-breeding birds, conservation plans previously placed increased emphasis on retention and restoration of bottomland forest sites that are less prone to prolonged flooding [6,16]. This emphasis on drier bottomland sites was because these forests had been disproportionately converted to agriculture [2] and continue to be more suitable for conversion to non-forest use than flood-prone forests. Moreover, bottomland forests with limited flooding tend to support more understory vegetation and are therefore important for ground-nesting silvicolous bird species [6]. The excessive loss of bottomland forests that are less prone to prolonged flooding may be exacerbated within the conservation estate by the bias of protected areas to be located on less-threatened land that is not easily converted to other uses [22].

For each of the forest patches deemed to have merit for bird conservation by virtue of having a core forest habitat area >1600 ha or being located adjacent to high priority restoration zones, we calculated their mean flood probability from inundation frequency data [15]. The resultant mean percent flood frequency was inverted and scaled (0–100) as a coefficient of dryness, such that 100 represented the least flood-prone forest patches and 0 represented the most flood-prone patches. Because we perceived drier forest patches to be of greater conservation value, we granted an increase in need for conservation–protection proportional to forest patch dryness (dryness coefficient x 0.2). As such, the least flood-prone forest patches received up to 20% increase in need for protection, whereas the most flood-prone patches received a negligible increase.

3. Results

Although we found only 10% of the area within the Mississippi Alluvial Valley was protected within the current conservation estate, most (84%) of this protected area was forested. Of the 3.1 million ha of extant forest [3], 882,000 ha (28%) was protected within the conservation estate. Forested land in the Mississippi Alluvial Valley had a greater frequency of flooding (17.5% ± 24.7%; mean ± SD) compared with lands not currently forested (13.3% ± 25.1%). We found an even greater propensity for flooding (23.7% ± 30.0%) for those lands protected within the current conservation estate.

For effective conservation of silvicolous birds, we determined 4712 core forest patches, harboring >2 million ha of forest, met our criteria for needing additional conservation–protection (Figure 3). Most of this area, approximately 1.5 million ha, was within 109 forest patches that exceeded our desired threshold area of ≥2000 ha of core forest. Over 1.3 million ha within these forest patches lack current conservation protection (Table 2).

Table 2. Proposed need for additional conservation–protection (2 = least in need; 100 = most in need) of 4710 forest patches within the Mississippi Alluvial Valley, their total area, and proportion of area protected within the current conservation estate.

Conservation–Protection Need	Total Area (ha)	Area (ha) in Conservation Estate	Proportion of Area in Conservation Estate	Cumulative Area (ha) to Provide Complete Conservation–Protection (From Most in Need)
2	371	311	0.84	1,323,272
3	160	136	0.85	1,323,212
4	15,465	14,072	0.91	1,323,188
6	10,106	9404	0.93	1,321,795
7	5838	5596	0.96	1,321,093
8	1011	953	0.94	1,320,851
9	14,693	12,529	0.85	1,320,793
10	7962	6769	0.85	1,318,629
11	3094	2057	0.66	1,317,436
12	8628	5585	0.65	1,316,399
13	535	454	0.85	1,313,356
14	12,758	8750	0.69	1,313,275
15	12,480	6789	0.54	1,309,267
16	8820	6071	0.69	1,303,576
18	22,296	14,965	0.67	1,300,827
19	87,473	8542	0.10	1,293,496
20	13,482	9525	0.71	1,214,565
21	3693	2316	0.63	1,210,608
22	11,732	8201	0.70	1,209,231
24	47,806	39,724	0.83	1,205,700
25	5302	4448	0.84	1,197,618
26	17,206	10,723	0.62	1,196,764
27	13,019	9855	0.76	1,190,281
30	4013	3083	0.77	1,187,117
31	18,136	12,754	0.70	1,186,187
32	8274	5511	0.67	1,180,805
33	10,425	6993	0.67	1,178,042
34	1682	833	0.50	1,174,610
35	31,466	19,432	0.62	1,173,761
36	58,741	41,255	0.70	1,161,727
37	96,216	66,954	0.70	1,144,241
39	8771	5819	0.66	1,114,979
41	5200	2379	0.46	1,112,027
43	82,826	49,515	0.60	1,109,206
44	22,468	12,558	0.56	1,075,895
45	5391	2455	0.46	1,065,985
46	14,053	8578	0.61	1,063,049
48	1447	117	0.08	1,057,574
49	5471	1	0.00	1,056,244
50	34,401	17,404	0.51	1,050,774
51	191,264	97,227	0.51	1,033,777
52	4484	1333	0.30	939,740
53	6467	2815	0.44	936,589
54	1824	5	0.00	932,937
56	41,907	17,458	0.42	931,118
58	6333	2330	0.37	906,669
60	9265	2859	0.31	902,666
61	12,571	4879	0.39	896,260
62	9355	428	0.05	888,568
63	34,378	13,383	0.39	879,641
64	19,885	6786	0.34	858,646
65	5251	1995	0.38	845,547
66	3038	887	0.29	842,291
68	54,873	16,071	0.29	840,140
69	1859	574	0.31	801,338
70	2308	665	0.29	800,053
71	2341	692	0.30	798,410
74	50,496	11,598	0.23	796,761
75	15,667	3548	0.23	757,863
77	15,841	3106	0.20	745,744
80	456,125	69,700	0.15	733,009
82	5031	868	0.17	346,584
84	8256	793	0.10	342,421
85	15,084	1822	0.12	334,958
86	90,798	693	0.01	321,696
87	1559	73	0.05	231,591
88	25,155	1852	0.07	230,105
89	18,785	384	0.02	206,802
90	41,379	5281	0.13	188,401

Table 2. *Cont.*

Conservation–Protection Need	Total Area (ha)	Area (ha) in Conservation Estate	Proportion of Area in Conservation Estate	Cumulative Area (ha) to Provide Complete Conservation–Protection (From Most in Need)
91	22,839	804	0.04	152,303
92	9867	134	0.01	130,268
93	34,567	906	0.03	120,535
94	61,553	0	0.00	86,874
95	4170	164	0.04	25,321
97	13,472	445	0.03	21,315
100	8297	9	0.00	8288
Total	2,039,255	715,983		

When we accounted for the forest area of a patch, its location within high priority reforestation zones, propensity for flooding, and the proportion of the patch within the existing conservation estate, the attributed need for conservation–protection ranged from 2 (least in need) to 100 (most in need). We masked areas within these forest patches that were in the current conservation estate, as these areas are already protected, and displayed the attributed need for conservation–protection of the remaining forest patches (Figure 4; https://doi.org/10.5066/P90V76SY).

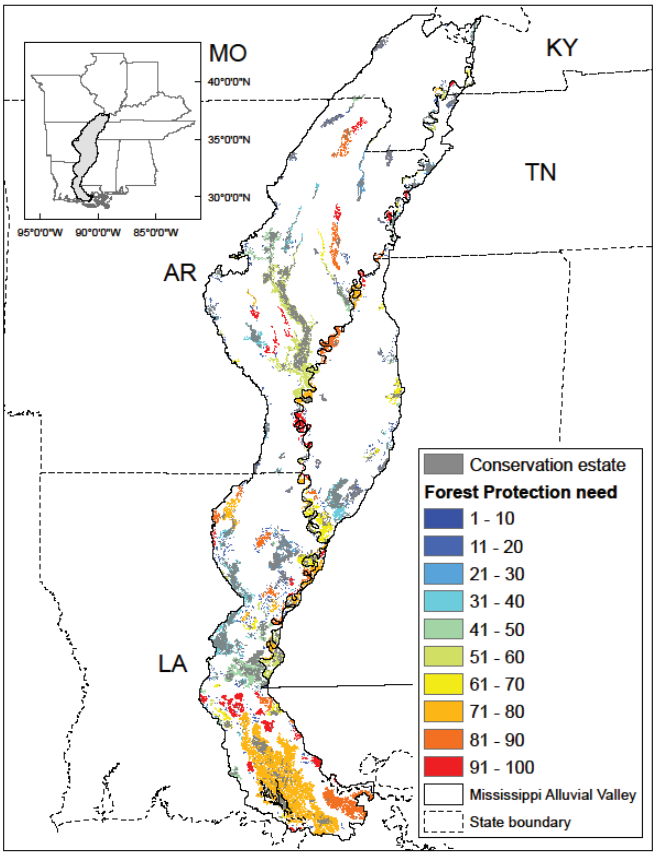

Figure 4. Modeled priority (1 = low, 100 = high) of forest patches for additional conservation–protection to conserve silvicolous birds within the Mississippi Alluvial Valley. Areas with existing conservation–protection within targeted forest patches are depicted as conservation estate.

Of the 109 patches with core forest area that exceeded our target of ≥2000 ha, 36% of their area was in the current conservation estate. For all forest patches deemed in greatest need of additional protection (i.e., conservation–protection need >90), ≤4% of their area was protected within the conservation estate (Table 2).

4. Discussion

Our primary motivation for this assessment was to assess the current vulnerability of extant forest in the Mississippi Alluvial Valley to potential future conversion to a non-forest habitat. Although the Convention on Biological Diversity's Aichi Biodiversity Target (i.e., that at least 17% of terrestrial and inland water habitat be in the conservation estate) was intended as a national benchmark, the 10% protection within the Mississippi Alluvial Valley ecoregion falls well shy of this objective. Attainment of the 17% target within this ecoregion would entail increasing the area of the current conservation estate by >700,000 ha—nearly doubling the area of forest currently under conservation–protection.

Our finding that the Mississippi Alluvial Valley extant forest, and even more so the existing conservation estate, has a greater flood frequency than non-forest land supports prior conclusions that protected areas are biased towards locations that are unlikely to face land conversion pressures even in the absence of protection [22]. Worldwide, this bias in conservation–protection leads to more protected areas being at higher elevations with steeper slopes. Conversely, within the topographically limited Mississippi River floodplain this bias is toward lower, more flood-prone locations. Even though our conservation–protection model granted increased emphasis to less flood-prone bottomland forest, the existing bias of increased flood frequency associated with extant forest may overwhelm our intention of increasing the ecological representativeness of protected forests.

The vagile and often migratory habits of birds, which were our conservation emphasis during this study, suggest that connectivity of protected areas is not of paramount importance. Therefore, despite the Aichi Biodiversity Target of establishing well-connected protected areas [23], our conservation–protection model does not accentuate connectedness of lands within the conservation estate. Nevertheless, conservation planners may choose to place greater emphasis on areas that provide linkage between existing protected areas or that provide linkages between isolated populations of less vagile, resident species of conservation concern (e.g., Louisiana black bear, *Ursus americanus luteolus*; [24]). Alternatively, landscapes currently depauperate in habitat within the conservation estate may benefit through the provision of foundational conservation–protection of extant forest areas.

Our final model of perceived need for conservation–protection of bottomland forests included numerous, small, core forest patches, many of which were markedly below our core forest target of 2000 ha. We included these small, core forest patches because of their location within reforestation priority zones, and our hope that future forest restoration will increase their forest core area. Even though we included these small patches as in need of additional protection, their need for protection was markedly reduced relative to larger core forest patches.

We have assigned priority for conservation–protection to core forest patches in this ecoregion but these priorities should not be viewed as a directive or desire for increased public ownership of these forests. Indeed, private conservation easements, such as those executed with Ducks Unlimited or The Nature Conservancy, may be equally effective at long-term conservation of these bottomland forests [25,26].

5. Conclusions

We established the relative priority of more than 4000 forest patches in the Mississippi Alluvial Valley for increased conservation–protection for wildlife, based on their area, location, and hydrology. Only 109 of these forest patches exceeded our targeted threshold area of >2000 ha of core forest. Attainment of the international standard of 17% of area within the conservation estate will require nearly doubling the >700,000 ha of forest that is currently protected within the Mississippi Alluvial

Valley. Adding this additional forest within areas targeted for forest restoration will improve the likelihood of increasing the area of existing forest patches to >2000 ha.

Extant forest within the Mississippi Alluvial Valley was skewed toward lands that are frequently flooded. Those forests that are currently afforded conservation–protection by virtue of being within the existing conservation estate also had a greater likelihood of frequent flooding. This bias in flood condition suggests that granting increased priority for conservation protection to less flood-prone forests was justified.

As conservation partners in the Mississippi Alluvial Valley invest their limited resources for conservation of forest landscapes capable of sustaining breeding bird populations, guidance with respect to more focused forest protection facilitates greater efficiency in conservation actions. As such, the conservation–protection priorities we identified fill an unmet need for land trusts and other conservation partners pursuing strategic protection in support of Joint Venture objectives. This positive impact is two-fold: (1) protecting forest tracts in 'high need' of protection will directly benefit species using these habitats and (2) retaining the efficacy of past and ongoing reforestation efforts predicated on the presence of adjacent core forest. Conservation delivery networks of the Joint Venture (https://www.lmvjv.org/conservation-delivery-networks), in particular, are uniquely poised to utilize this information for efficiently and effectively protecting forest lands in this region.

Supplementary Materials: Data layers depicting the Bird Conservation Region boundary, forest cover, and reforestation priority are available as digital map layers at http://gisweb.ducks.org/conservationplanning/). Digital data for flood frequency within the Gulf Coastal Plain and Ozark region are available at https://www.sciencebase.gov/catalog/item/5617e3c3e4b0cdb063e3fc35 [27]. Digital representation of existing conservation estate and conservation–protection priority of forest patches in the Mississippi Alluvial Valley are available at https://doi.org/10.5066/P90V76SY [28].

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Disclaimer: The information and views set out in this article are those of the authors. The use of trade names in this publication does not imply endorsement by the U.S. Government.

References

1. Rudis, V.A.; Birdsey, R.A. *Forest Resource Trends and Current Conditions in the Lower Mississippi Valley*; U.S. Department of Agriculture Forest Service, Southern Forest Experiment: New Orleans, LA, USA, 1986.
2. Twedt, D.J.; Loesch, C.R. Forest Area and Distribution in the Mississippi Alluvial Valley: Implications for Breeding Bird Conservation. *J. Biogeogr.* **1999**, *26*, 1215–1224. [CrossRef]
3. Mitchell, M.; Wilson, R.R.; Twedt, D.J.; Mini, A.; James, J.D. Object-based forest classification to facilitate landscape-scale conservation in the Mississippi Alluvial Valley. *Remote Sens. Appl. Soc. Environ.* **2016**, *4*, 55–60. [CrossRef]
4. Pashley, D.N.; Barrow, W.C. Effects of land use practices on neotropical migratory birds in bottomland hardwood forests. In *Status and Management of Neotropical Migratory Birds*; Finch, D.M., Stangel, P.W., Eds.; U.S. Department of Agriculture Forest Service, Rocky Mountain Forest and Range Experiment Station: Fort Collins, CO, USA, 1993; pp. 315–320.

5. Twedt, D.J.; Pashley, D.; Hunter, W.C.; Mueller, A.J.; Brown, C.; Ford, R.P. Partners in Flight Bird Conservation Plan for the Mississippi Alluvial Valley (Physiographic Area # 05). 1999. Available online: https://www.lmvjv.org/landbird-plans (accessed on 26 December 2019).
6. Twedt, D.J.; Uihlein, W.B., III; Elliott, A.B. A spatially explicit decision support model for restoration of forest bird habitat. *Conserv. Biol.* **2006**, *20*, 100–110. [CrossRef]
7. Watson, J.E.M.; Darling, E.S.; Venter, O.; Maron, M.; Walston, J.; Possingham, H.P.; Dudley, N.; Hockings, M.; Barnes, M.; Brooks, T.M. Bolder science needed now for Protected Areas. *Conserv. Biol.* **2016**, *30*, 243–248. [CrossRef]
8. Convention on Biological Diversity. *COP 10 Decision X/2: Strategic Plan for Biodiversity 2011–2020*; Secretariat of the Convention on Biological Diversity: Nagoya, Japan, 2010; Available online: http://www.cbd.int/decision/cop/?id=12268 (accessed on 26 December 2019).
9. Chapman, S.S.; Kleiss, B.A.; Omernik, J.M.; Foti, T.L.; Murray, E.O. *Ecoregions of the Mississippi Alluvial Plain*; Map Scale 1:1,150,000; U.S. Geological Survey: Reston, VA, USA, 2004. Available online: http://ecologicalregions.info/htm/map_eco.htm (accessed on 26 December 2019).
10. Oswalt, S.N. *Forest Resources of the Lower Mississippi Alluvial Valley*; U.S. Department of Agriculture Forest Service, Southern Research Station: Asheville, NC, USA, 2013; p. 29.
11. Remo, J.W.F.; Ickes, B.S.; Ryherd, J.K.; Guida, R.J.; Therrell, M.D. Assessing the impacts of dams and levees on the hydrologic record of the Middle and Lower Mississippi River, USA. *Geomorphology* **2018**, *313*, 88–100. [CrossRef]
12. Keim, R.F.; Chambers, J.L.; Hughes, M.S.; Nyman, J.A.; Miller, C.A.; Amos, J.B.; Conner, W.H.; Day, J.W., Jr.; Faulkner, S.P.; Gardiner, E.S.; et al. Ecological consequences of changing hydrological conditions in wetland forests of coastal Louisiana. In *Coastal Environment and Water Quality*; Xu, Y.J., Singh, V.P., Eds.; Challenges in Coastal Hydrology and Water Quality, Water Resource Publications: Highlands Ranch, CO, USA, 2006; pp. 383–395.
13. Gee, H.K.W. The Effect of Hydrologic Modifications on Floodplain Forest Tree Recruitment and Growth. Ph.D. Thesis, Louisiana State University, Baton Rouge, LA, USA, 2012; p. 140.
14. King, S.L.; Keim, R.F. Hydrologic modifications challenge bottomland hardwood forest management. *J. For.* **2019**, *117*, 504–514. [CrossRef]
15. Allen, Y. Landscape scale assessment of floodplain inundation frequency using Landsat imagery. *River Res. Appl.* **2016**, *32*, 1609–1620. [CrossRef]
16. Mitchell, M.; Twedt, D.J.; Wilson, R.R.; Elliott, A.B.; James, J.D. *MAV Forest Breeding Bird Decision Support Model–Update 2015*; Lower Mississippi Valley Joint Venture: Jackson, MS, USA, 2015; p. 7. Available online: https://www.lmvjv.org/s/LMVJV_FBBDSM_2015_Summary.pdf (accessed on 26 December 2019).
17. Chalfoun, A.D.; Thompson, F.R.; Ratnaswamy, M.J. Nest predators and fragmentation: A review and meta-analysis. *Conserv. Biol.* **2002**, *16*, 306–318. [CrossRef]
18. Fletcher, R.J. Multiple edge effects and their implications in fragmented landscapes. *J. Anim. Ecol.* **2005**, *74*, 342–352. [CrossRef]
19. Mueller, A.J.; Twedt, D.J.; Loesch, C.R. Development of management objectives for breeding birds in the Mississippi Alluvial Valley. In *Strategies for Bird Conservation: The Partners in Flight Planning Process*; David, R.B., Pashley, N., Cooper, R., Niles, L., Eds.; Cornell Lab of Ornithology: Ithaca, NY, USA, 1999; Available online: http://birds.cornell.edu/pifcapemay/mueller.htm (accessed on 26 December 2019).
20. Saracco, J.F.; Collazo, J.A. Predation on artificial nests along three edge types in a North Carolina bottomland hardwood forest. *Wilson Bull.* **1999**, *111*, 541–549.
21. Thompson, F.R.; Robinson, S.K.; Donovan, T.M.; Whitehead, D.R.; Faaborg, J. Biogeographic, landscape, and local factors affecting cowbird abundance and host parasitism levels. In *Ecology and Management of Cowbirds and Their Hosts: Studies in the Conservation of North American Passerine Birds*; Smith, J.N.M., Cook, T.L., Rothstein, S.I., Robinson, S.K., Sealy, S.G., Eds.; University of Texas Press: Austin, TX, USA, 2000; pp. 186–219.
22. Joppa, L.; Pfaff, A. Reassessing the forest impacts of protection. *Ann. N. Y. Acad. Sci.* **2010**, *1185*, 135–149. [CrossRef] [PubMed]
23. Saura, S.; Bastin, L.; Battistella, L.; Mandrici, A.; Dubois, G. Protected areas in the world's ecoregions: How well connected are they? *Ecol. Indic.* **2017**, *76*, 144–158. [CrossRef] [PubMed]

24. Davidson, M.; Murphy, S.M.; Ribbeck, K.; Kimmel, F.; Duguay, J. *Louisiana Black Bear Management Plan*; Louisiana Department of Wildlife and Fisheries: Baton Rouge, LA, USA, 2015; p. 74. Available online: http://www.wlf.louisiana.gov/louisiana-black-bear-management-plan (accessed on 26 December 2019).
25. Bingham, H.; Fitzsimons, J.A.; Redford, K.H.; Mitchell, B.A.; Bezuary-Creel, J.; Cumming, T.L. Privately protected areas: Advances and challenges in guidance, policy and documentation. *Parks* **2017**, *23*, 13–28. [CrossRef]
26. Mitchell, B.A.; Stolton, S.; Bezaury-Creel, J.; Bingham, H.C.; Cumming, T.L.; Dudley, N.; Fitzsimons, J.A.; Malleret-King, D.; Redford, K.H.; Solano, P. Guidelines for privately protected areas. In *Best Practice Protected Area Guidelines Series No. 29*; International Union for Conservation of Nature and Natural Resources: Gland, Switzerland, 2018. [CrossRef]
27. Allen, Y.C. *Landscape Scale Assessment of Floodplain Inundation Frequency in the GCPO*; U.S. Geological Survey Data Release; U.S. Geological Survey: Reston, WV, USA, 2015. Available online: https://www.sciencebase.gov/catalog/item/5614315be4b0ba4884c610ae (accessed on 26 December 2019).
28. Elliott, A.B.; Mini, A.E.; McKnight, S.K.; Twedt, D.J. *Forests in the Mississippi Alluvial Valley Lacking Sufficient Conservation Protection*; U.S. Geological Survey Data Release; U.S. Geological Survey: Reston, WV, USA, 2019. [CrossRef]

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Preserving Biodiversity and Ecosystem Services in West African Forest, Watersheds, and Wetlands: A Review of Incentives

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Abstract: While biodiversity and ecosystem services derived from the natural environment are the backbones of West African rural livelihood, unsustainable exploitation of natural resources, conflicts, and climate change threaten the continued provision of ecosystem services. This threat creates an urgent need to safeguard the integrity of the environment. Evaluating the effectiveness of environmental conservation projects is central towards designing and scaling-up successful conservation projects. Using secondary literature and project reports, we reviewed ongoing and completed conservation projects in the West African sub-region. Scientific work on incentives for ecosystem services in sub-Saharan Africa typically focuses on Southern and Eastern Africa, leaving Western Africa underserved. This study fills this literature gap by compiling lessons from conservation projects in West Africa to offer region-specific incentives that should inform the design of conservation projects in the region. The study shows that the way forward is a holistic, sustainable development approach that mirrors and meets strategies outlined in Sustainable Development Goals 1, 2, 5, 8, 13, and 17: No Poverty, End Hunger and Promote Sustainable Agriculture, Gender Equality, Decent Work and Economic Growth, Climate Action, and Partnerships for the Goals, respectively.

Keywords: biodiversity; ecosystem services; West Africa; incentives; Sustainable Development Goals

1. Introduction

Biodiversity is described as a stock of living resources determined by nature as well as, to some extent, human activity [1,2]. Ecosystem services (ESs), on the other hand, are biodiversity flows beneficial to man. Ecosystem services include provisioning services (food, drinking water, medicine, and hydroelectric power), regulating services (carbon sequestration, climate regulation, and clean air and water), cultural services (tourism and religious and cultural benefits), supporting services (agriculture, soil formation, and flood and erosion control) [3]. In West Africa, watersheds, wetlands, forest, and vegetation are biodiversity hubs and primary providers of ESs. These hubs characterize the environmental landscape in West Africa and are crucial to the livelihood of its citizens.

However, the integrity of these biodiversity hubs is at serious risk. Agricultural expansion, overexploitation of biological resources, population explosion, urbanization, and climate change is destroying biodiversity ecosystems [4]. The occurrence of invasive species as well as industrial and pesticide discharge are threatening the quality and volume of native flora and fauna species residing in watersheds and wetlands across sub-Saharan Africa [4,5]. Consequently, these have degraded and reduced the size of biodiversity hubs in parts of West Africa [3]. Close to 90% of West Africa's original forest has disappeared with small fragments of this natural forest existing in Cote d'Ivoire, Nigeria, and Cameroon [6]. Over-exploitation of forest resources, mining, agricultural expansion,

hunting and population growth is fragmenting tropical forests and driving biodiversity losses [7]. These losses threaten both wildlife as well as the current and future livelihoods of those individuals and communities that depend on ESs in West Africa.

In response to these threats, governments, and private sector organizations in developing countries are implementing environmental conservation policies and programs to regulate and preserve biodiversity resources and raise awareness of threats facing biodiversity hubs. For instance, conservation programs such as Reducing Emissions from Deforestation and Forest Degradation (REDD), REDD+, Payments for Ecosystem Services (PES), and Forests and National Park protections laws are increasingly being implemented to protect biodiversity spots and curtail the over-exploitation of forest resources. The + sign adds conservation and sustainable management of forest carbon stocks in developing countries to the existing REDD mandate [8–10]. Reviews of the implemented policies and programs are becoming common because programs and policies must adapt to the changing environmental, institutional, and economic conditions surrounding these programs. Findings from the reviews uncover up-to-date, comprehensive information and steers discussions absent in individual case study research [11]. The results of reviews, therefore, guide policymakers in the design and implementation of new programs as well as in adjusting and scaling-up pilot programs.

In Africa, the few reviews of ecosystem services and conservation programs in Africa concentrate mainly on Eastern and Southern Africa while it should be noted that there are fewer conservation programs in Africa compared to other developing regions of the world [5,11–14]. Sub-Saharan Africa lags behind other developing parts of the world in the implementation of conservation programs [11]. Furthermore, poverty alleviation and equity are dominant themes in conservation (watershed) programs in Africa [5]. Both studies demonstrated that strict regulatory requirements and poor technical knowledge limit opportunities for trading ecosystem services and implementing trading schemes in Africa. Sustainability in Africa depends on the assessment of ecosystem services, especially provisioning ecosystem services, and these assessments are dominant in conservation programs in Eastern and Southern Africa [14].

These studies also lamented the dearth of conservation programs and information on those programs in other parts of Africa. Indeed, an extensive literature search revealed that no study has reviewed conservation programs in West Africa. Given the growing interest in conservation policies and programs in West Africa, it is important that this gap is filled. Assessing the effectiveness of these programs underscores their contribution towards protecting biodiversity, combating poverty, and promoting sustainable agriculture and gender equality, in addition to achieving the Sustainable Development Goals (SDGs).

This study fills that gap by reviewing ongoing (and defunct) policies and programs that protect watersheds, wetlands, and forests in West Africa. We draw attention to the activities of these programs, highlighting their outcomes and challenges to offer region-specific incentives that inform the design of conservation projects in West Africa. Incentives, in this study, refer to mechanisms and tangible benefits that motivate environmental conservation. In a review of conservation programs in Asia, Latin America, and Africa, it was discovered that incentives are more effective environmental conservation measures compared to other instruments [12]. The authors, however, caution that, for incentives to achieve their goals, specific economic, cultural, and institutional conditions must be considered before introducing incentive initiatives. In evaluating conservation programs in West Africa, we tease out those critical cultural, economic, and institutional conditions crucial to successful environmental conservation programs in the region. In different parts of Africa, dependence on ESs differs as socioeconomic conditions, geography, and vegetation changes, creating slight differences in priorities for each region [15]. Our findings should inform the implementation of conservation initiatives in Africa and target potential project sponsors and managers seeking to design and finance projects in West Africa.

The rest of the study is organized as follows. Section 2 introduces the materials and methods used in this study. Section 3 presents an overview of the current state of biodiversity spots in West

Africa. Section 4 summarizes ongoing (and completed) conservation projects in West Africa in Section 4. This section focuses on the objectives of these programs, the ecosystem services they provide, the institutional actors involved in the projects, their outcomes and the challenges they faced. Section 5 discusses various incentives for increasing investments in environmental conservation and projects in West Africa, while Section 6 concludes the paper.

2. Materials and Methods

In putting together this study, a desk review of reports on active and defunct conservation programs in West Africa was conducted. According to [16], qualitative reviews attempts to understand the meaning of and contextualize events and processes. We find this approach suited to the aims and scope of this study. This process unfolded in two stages.

In the first stage, we searched for information on environmental conservation programs implemented in West Africa between September 2017 and January 2018 using the following online social science database: Google Scholar, PubMed, ISI Web of Science, ResearchGate, and ScienceDirect. The search focused on conservation projects that transformed vegetation and forest cover, i.e., deforestation, afforestation, and watershed protection projects. Project implementation and evaluation reports published by the implementing agency in English were consulted to obtain information on these projects. Some of the official reports released by National Governments on some programs in Fracophone West Africa were written in French. The reports were supported by information collected from peer-reviewed articles investigating these projects. The Watershed Markets Database, The Economics of Ecosystem and Biodiversity (TEEB), Forest Trends, Global Environmental Facility (GEF), and the United Nations Framework Convention on Climate Change (UNFCCC) websites were consulted for additional information.

Multi-criteria analysis was employed to evaluate these programs and collect the necessary information [17]. Information on the location of each project, motivation behind its formation, program design, program objectives, ESs, costs, and the actors involved—both implementers and beneficiaries—were gathered. Information on the environmental, economic, and social outcomes of each program as well as the challenges each program faced was also collected.

In the second stage, we consulted reports and documents on ongoing conservation projects in other parts of Africa and developing regions of the world. The information obtained from these projects were combined with information from our case studies in West Africa to structure the discussion on incentives for conservation projects in West Africa and make policy recommendations.

3. West African Wetlands, Watersheds, and Forests

In West Africa, temperature and rainfall operate in the extremes engendering droughts and flooding. The region is characterized by the Sahara Desert to the north and lush green tropical rainforest to the south, which gives way to mangrove swamps connecting the coasts to the mainland. In the middle is the savanna vegetation characterized by grassland and short-to-medium height trees. The diverse vegetation in West Africa supports a vibrant ecosystem and biodiversity hub.

Four of the 17 primary watersheds in Africa (see Figure 1) are located in the Western part of the sub-continent, namely the Senegal River basin, the Volta River basin, the Niger River basin, and the Lake Chad basin [18].

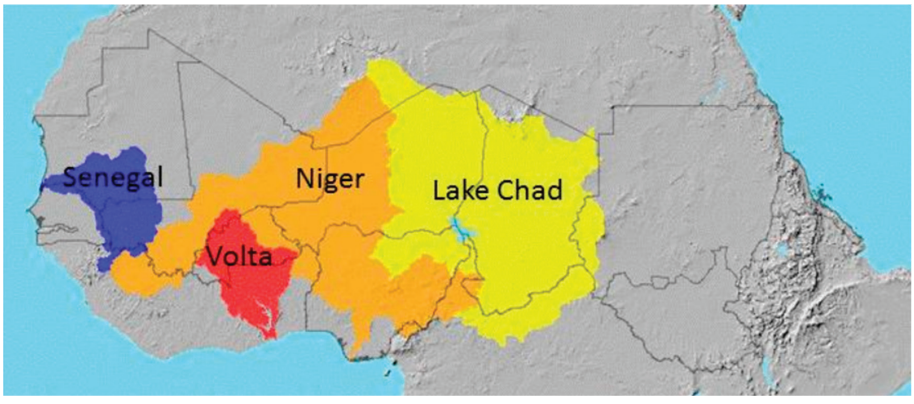

Figure 1. Niger, Lake Chad, Volta, and Senegal basins. Source: [19] Van Der Wijngaart et al., 2019.

The Senegal River basin cuts across four countries: Guinea, Mali, Mauritania, and Senegal. The Volta River basin is shared by six West African countries, namely Mali, Burkina Faso, Benin, Togo, Cote d´Ivoire, and Ghana. The Lake Chad basin spreads to over seven countries, two of which are in the West: Nigeria, Niger, Algeria, Sudan, Central Africa Republic, Chad, and Cameroon. The Niger River Basin spreads through seven West African countries, namely, Guinea, Cote d´Ivoire, Mali, Burkina Faso, Benin, Niger, and Nigeria, as well as Algeria, Chad and Cameroon. Each of the watersheds plays significant roles vital to local economies across West Africa. They are essential sources of water for agriculture, public health, food, clean water, and hydroelectric power. The watershed and wetlands in West Africa are home to 3 million endemic and migratory birds spanning 400 species and support over 2000 known species of indigenous African freshwater fishes [7]. The estimated value of ecosystem services that can be attributed to inland watershed and wetlands ranges between US$5000 and US$100,000 per hectare, while coastal watershed and wetlands were between US$500 and US$1,000,000 per hectare in 2007 [20]. The economic value of Hadejia-Nguru wetlands, which forms part of the Komadougou-Yobe river basin of the Lake Chad basin in Nigeria, was estimated at over US$16 million per year [21].

The Guinean forest, with an estimated area of 553,427 km^2, is also a biodiversity hub. It is a tropical forest in West Africa, "Upper and Lower," that cuts across several Africa countries from Guinea to Sierra Leone as well as beyond the borders of Nigeria (see Table 1) comprising fragmented forest separated by agricultural land, cities, and villages [7].

Table 1. Total area and proportion of hotspots in West African countries.

Country	Total Area (km^2)	Area of Overlap with Guinean Forest Hotspots (km^2)	Percentage of Hotspots in Each Country	Percentage of Countries in Hotspots
Benin	117,650	1462	0.3%	1.2%
Côte d'Ivoire	325,990	150,300	27.2%	46.1%
Equatorial Guinea	28,051	1965	0.4%	7.0%
Ghana	242,178	79,902	14.4%	33.0%
Guinea	249,691	48,488	8.8%	19.4%
Liberia	96,861	95,376	17.2%	98.5%
Nigeria	926,744	127,583	23.1%	13.8%
São Tomé and Príncipe	1001	1001	0.2%	100.0%
Sierra Leone	73,316	47,350	8.6%	64.6%

Source: Adapted from. Carr. et al. (2015) [7].

The forests comprise numerous species of trees providing ecosystem services and various forest products that support human livelihood, e.g., timber, fruits, carbon storage, disease control, tourism, pollination, and water regulation, among other ecosystem services. It also houses over 9000 species of vascular plants, 700 species of birds, 300 species of mammals, 100 reptiles, and 500 freshwater fish [7,22]. Of these species, 1800 plants, 48 birds, 65 mammals, 20 reptiles, and 118 amphibians are native to West Africa [7]. There are approximately 483 plant species, 48 bird species, 65 mammal species, 11 reptile species, 77 amphibian species, and 172 bony fishes under threat of extinction [7]. Among the most threatened mammalian species are indigenous chimpanzees and gorillas, African elephants, pygmy hippopotamus, and primates such as rodents and bats [7].

To the best of our knowledge, few literature has specified a value for forest ecosystem and biodiversity in West Africa; we assume that, for carbon storage, biodiversity conservation, hydrological benefits, and forest products including tourism should be well above US$2,000 per hectare given the combination of primary and secondary forest cover [23,24].

The provisioning services of ES, which improves agricultural productivity, can be achieved through sustainable and environmentally friendly agricultural and pastoral practices, while regulating services are embodied in reforestation and afforestation activities that sequester and reduce carbon emissions. These services reflect the relevance of ESs to agrarian households in West Africa [14,15]. For instance, agriculture accounts for 60% of the labor force but only 35% of the Gross Domestic Product (GDP) in West Africa [25]. The disparity between the GDP and employment figures implies that the majority of West Africans are poor [25]. Indeed, farmers cultivate on poor soils, with limited agricultural technology uptake and adoption, which impedes agricultural development [26]. Climate change affects the poor primarily via agriculture, thus making West African farmers especially vulnerable to climate change [27]. West Africa's population is projected to grow faster than any other region in the world by 2030 [28], putting more pressure on already dwindling natural resource stocks in a region where the majority live in poverty and is vulnerable to climate change. The economic importance of ESs has made forest and watershed (wetland) conservation an absolute priority.

4. Conservation Projects in West Africa

Compared to Latin America and Asia, there are few conservation programs in Africa. Only 3% of Agriculture, Forest, and Land Use projects under the Clean Development Mechanisms (CDMs) are in Africa, while the majority of the Voluntary Carbon projects are in Asia and Latin America [11,29]. Furthermore, about 13% of global watershed protection programs are situated in Africa [13]. West Africa's share of those programs is small because most projects are established in Eastern and Southern Africa.

From the literature search, we identified 14 ongoing and defunct land-use conservation programs in West Africa (see Table 2). We should note that 33 of the 234 CDM projects in Africa are in West Africa, with about 582,000 Certified Emissions Reductions Certificate (CERs) issued, i.e., 5% of total CERs in Africa [29]. Most of these projects, however, are not land-use conservation projects, but thermal, hydro, and renewable energy projects.

Table 2. Conservation Projects in West Africa.

Project	Location	Source (s)
A Sustainable Management Program (SANREM)	Mali	[11,30]
Acacia Community Carbon Plantation	Niger	[31]
Carbon Sequestration and Sustainable Agriculture	Senegal	[32]
Carbon Sequestration Pilot Projects in West African Savannah Optimum	Mali, Benin, and the border between Ghana and Burkina Faso	[32]
Guinean Forest Hotspots	Guinea, Sierra-Leone, Liberia, Ghana, Cote "d" Ivoire, Togo, Benin, Nigeria, Sao Tome and Principe	[7]
Participatory Rehabilitation of Degraded Lands Project	Senegal and Mauritania	[11,33]
Rehabilitation of Degraded Pasture Land Project	Burkina Faso	[34]
Senegal Plantation Project	Mali	[11,31]
Sequestration of Carbon in Soil Organic Matter Program (SOCSOM)	Senegal	[11,25]
Sourou Valley Wetlands Valuation Project	Burkina Faso	[35]
Sustainable Energy Management Project	Burkina Faso	[11]
The Ghana Cocoa Carbon Initiative (GCCI)	Ghana	[36,37]
The Gola REDD Project	Sierra-Leone	[38]
Village-based Management of Woody Savannah and the Establishment of Woodlots for Carbon Sequestration Project	Benin	[11,31,32]
Restoration of Degraded Forest Land Projects	Ghana	[39,40]

4.1. Types of Project

Based on their activities, the conservation programs in West Africa were different and fell under various project types. The sustainable management program, sequestration of carbon in soil organic matter program, Sourou Valley Wetlands project, Carbon Sequestration and Sustainable Agriculture program, and Carbon Sequestration projects in Mali, Senegal, Burkina-Faso, Senegal, and Benin, respectively, were experimental or research projects (see Table 2 for full names). Their goal was to assess the economic and ecological potential of various agro-ecological zones to sequestrate carbon. The Gola REDD+ project in Sierra Leone was conceived as a REDD+ project, while the Ghana cocoa carbon initiative is attempting to modify its activities to fit into the REDD+ framework. The regional program to manage the Guinean forest hotspots program combines social, economic development and environmental conservation objectives and bears a strong resemblance to Integrated Conservation Development Projects (ICDPs). The Acacia carbon projects in Niger and Senegal and the plantation project in Mali are funded by the Biocarbon fund managed by the World Bank. Achats Services International sold the carbon credits from the Nigerian project, while the credits from the Malian project remained with the World Bank. The sustainable energy management project in Burkina Faso was implemented under the Activities Implemented Jointly (now Joint Implementation) framework of the Kyoto Protocol, meaning they are Kyoto-compliant. Similarly, the Plan-Vivo project in Burkina Faso was implemented under the Plan Vivo Voluntary Carbon Market requirements, with Plan Vivo managing the carbon credits. The remaining projects, the Participatory Rehabilitation of Degraded Lands in Mauritania and Senegal, and the Village-Based Management of Woody Savannah in Benin

have features synonymous with programs that remunerate ES providers for adopting sustainable land-use activities (or PES). However, in this instance, socioeconomic development was a primary objective along with environmental conservation.

The size of land enrolled in these projects varies between 10,000 and 126,000 ha (see supplementary file; Table S1, Column 5). Operating costs range from US$143,000 for the Sustainable Management Project in Mali to US$4–8 million for the Participatory Rehabilitation of Degraded lands project implemented in Senegal and Mauritania. The Guinea Forest Hotspots program initially costs US$ 8.3 million dollars over 10 years, but the program was recently extended to 2021 with an additional US$ 9 million dollars bringing the total cost to US$15.2 million dollars.

4.2. Institutional Actors

A consortium of both public and private organizations sponsored and coordinated these programs (see supplementary file; Table S1, Column 7). Similar to findings from [5], the conservation programs in Africa were mainly financed by external bodies. These funds ranged from climate funds, e.g., the Biocarbon climate fund managed by the World Bank, to funding from United Nations agencies and foundations such as McArthur. Funds from foreign government agencies such as the United States Agency for International Development (USAID), governments of Norway, Japan, and Luxembourg and the European Union were used to develop and implement other projects. International research institutes, e.g., National Aeronautics and Space Administration (NASA) and various university departments financed most of these research projects. Programs were also sponsored with funds from international agencies and Non-Governmental Organizations (NGOs) such as Global Environment Facility and Conservation International. In addition to funding, these NGOs also act as intermediaries, playing support roles. They initiate, implement, and monitor programs, as well as sensitize, train, and acquaint participating communities with sustainable land-use practices. These activities helped to reduce the environmental conservation know-how deficit among ES providers and induced the rise of local NGOs and civil society organizations. NGOs were sometimes joined in this supporting role by host governments in each program locale, from the national to the local level.

4.3. Objectives

Even though all the programs employed various strategies to achieve their objectives, all those objectives revolved around environmental conservation (see supplementary file; Table S2, Column 4). Most telling, however, is the effort to link economic development and environmental conservation objectives. This reflects the reality in developing regions where conservation programs fundamentally disrupt the livelihood activities of ES providers and where conservation programs without poverty alleviation/socioeconomic development objectives are often deemed unattractive [41].

4.4. Outcomes

Information on the outcomes of these programs was only available for five programs (see supplementary file; Table S2, Column 5). The available information showed these programs had some positive effects on the environment, local economies, and institutional units within the participating communities.

The programs mainly promoted reforestation, afforestation, and avoided deforestation. About 842,000 tonnes of CO_2 was sequestered in the Woodlot program in Benin and 3.3 tonnes/ha was sequestered in the Participatory Rehabilitation Program in Senegal and Mauritania [31,33]. The tree planting activities contributed to increased vegetation and forest cover and decline in bush burning. The programs also succeeded in raising awareness of environmental degradation and climate change within the participating communities. The research projects identified deficiencies in local land use practices to ensure that participating communities utilize sustainable agricultural practices that reduce their vulnerability to climate change. For instance, the sustainable management program in Mali introduced a novel system of shifting pastoral activities based on the regenerative abilities of pastures.

The Guinean Hotspots program created a database to store and track the number of flora and fauna species present in the Guinean forest.

The programs also had positive socioeconomic effects. In addition to creating a credit scheme for micro-projects, half of the households participating in the participatory rehabilitation program in Senegal and Mauritania improved their income by 12% [33]. The program, along with the Guinean hotspots program and the Woodlot management program in Benin, introduced activities such as beekeeping that provided alternative sources of income and reduced intensive agricultural production activities.

Within the participating communities, the programs empowered local institutions on conservation activities. For instance, the Woody Lot program in Benin and the sustainable management program in Mali pursued a decentralized decision-making process that actively integrated locals in the program agency. The decentralized process brought together several communities under a single institutional framework that ensured the continued adoption and use of the program activities even after payments had stopped. Furthermore, the programs induced the rise of civil society organizations in West Africa dedicated towards environmental conservation. In Sierra-Leone, the Guinea hotspots program gave rise to other smaller conservation initiatives and multiple NGOs [7]. Overall, the inclusive approach helped to reduce the knowledge gap related to environmental issues that characterize institutions and communities in sub-Saharan Africa. This raised awareness of environmental degradation and the threats posed by climate change.

4.5. Challenges

Unsurprisingly, the leading challenge program developers faced was the poor, technical know-how among local partners (see supplementary file; Table S2, Column 6). The poor, technical know-how manifested in terms of little knowledge of sustainable land-use practices and monitoring, reporting and verifying greenhouse gases. This supports the findings of [10] that, while the basic knowledge of forest management activities is not particularly new in sub-Saharan Africa, locals are unfamiliar with activities such as green accounting, establishing baselines for additionality, monitoring, and verifying carbon offsets. The poor technical know-how often slows down technology uptake by program participants [42]. Organizing training seminars to close this knowledge gap translates to higher costs of operating the programs.

In addition, the legal and institutional framework in West Africa constituted another challenge. Both frameworks in West Africa tend to subordinate environmental conservation, and instead promote economic development [43]. This made introducing conservation activities (e.g., avoided deforestation and reforestation) very difficult in areas that previously favored logging and timber companies. For instance, this was noticeable in Ghana where legal and cultural frameworks supported the exploitation of trees (to promote economic growth) which threatened to undermine the Ghana Cocoa Carbon Initiative program. Managing the conflicts over land rights among communities was another institutional challenge. This situation exacerbates when conflicts among multiple stakeholders with divergent interests arise over access to the resources present on those lands.

Finally, the inability of conservation payments to adequately compensate ES providers and cover opportunity costs was another limiting factor. This highlighted the delicate balance between pursuing environmental conservation goals and meeting the socioeconomic interests of the communities.

5. Discussion

So far, we have provided a synopsis of the conservation programs in West Africa, their activities, outcomes and challenges. In addition to lessons from the programs, we highlight lessons from environmental policies enacted by West African governments, as well as policies and programs in other parts of the developing world to discuss incentives that could encourage the conservation of West African ecosystems. We frame these lessons based on identifying and utilizing incentives that are needed for conservation programs to make headway in West Africa.

We consider incentives from three dimensions: incentive mechanisms, demand-side incentives, and supply-side incentives. Incentive mechanisms are policies, programs, and markets that encourage and promote conservation, e.g., PES, carbon emissions trading markets and REDD+ programs. Demand-side incentives identify potential sources of funding for these programs and conditions that motivate investors to finance biodiversity conservation projects in West Africa. Economic, social, and psychological benefits that induce ES providers in West Africa to adopt environmental conservation activities and mindsets are considered as supply-side incentives.

5.1. Incentive Mechanisms

The development and promulgation of the Kyoto protocol engendered various frameworks that support programs developed solely for environmental conservation. These frameworks, such as Clean Development Mechanisms (CDMs) and Voluntary Carbon Standards (VCS), established markets for ecosystem services and biodiversity protection. Markets operating under CDM and VCS frameworks allow developed countries to channel funds to developing countries to financially support carbon sequestration projects that protect forests and watersheds. Carbon stored in these projects is then sold on market exchanges by developed countries to meet their emission obligations. Carbon credits sold in CDM markets allow developed countries to meet their emission reductions pledges under the Kyoto protocol. On the other hand, credits sold in VCS markets involve entities, both private and public, interested in voluntary emissions reductions. Markets for carbon sequestration are well developed and better funded compared to other ecosystem services, especially since sequestered carbon is a public good whose benefits are widespread [44]. While the benefits of carbon sequestration, focusing on tree planting activities, constitutes a medium to attract funding, the ability of soils to store carbon and adapt to climate change is also gaining attention.

The UNFCCC developed the REDD and, later, the REDD+ frameworks to reduce emissions from forest degradation and promote sustainable forest management. Like CDMs and VCMs, REDD+ facilitates the sale of carbon credits in carbon exchanges or markets. The difference is that the requirements for monitoring, reporting, and verifying carbon credits under these frameworks decrease in rigor from CDMs to VCMs and REDD+. Under these frameworks, PES, Payment for Watershed Services (PWS), and carbon forestry programs, among other programs, have been introduced in developing countries.

Several challenges impeding the implementation of conservation programs in Africa have been highlighted by a number of studies [5,10,45]. These challenges are conflicting legal frameworks defining property rights, limited technical and market information, a lack of institutional experience and adequate business models, and a mistrust of markets for public goods. Clearly defined property rights and access to resource use are crucial to establishing conservation programs, and conflicts between state and customary property rights laws in West Africa undermine this concept [46]. In both the private sector and government agencies, knowledge gaps exist on how to execute and administer processes linked to, and policies that promote, conservation: establishing ES baselines, monitoring, reporting, and verifying ESs, and awareness of sustainable land-use activities [10]. The latter challenge becomes noticeable when the rigorous process of complying with CDMs, VCMs, REDD+, and other markets for public goods requirements becomes necessary. Tradeoffs between environmental goals and developmental goals promulgated by governments to combat food insecurity and reduce poverty hinder conservation. In our case study, the GCCI in Ghana exemplifies this tradeoff. Working around this tradeoff is difficult because three-quarters of poor West Africans live in rural areas and depend on ESs provided by the environment to sustain their livelihood [47]. Finally, corruption that disrupts equitable transfer and distribution of payments from programs to participating communities constitutes another challenge [10]. All these challenges significantly raise the costs of implementing conservation programs in West Africa. Hence, potential project investors are reluctant to invest in conservation projects in West Africa.

However, governments in West Africa are making several policy moves to tackle these problems. These policy moves point to several targets outlined in SDG 13 to alleviate the negative impact of climate change. Specifically, governments at different levels are incorporating conservation measures into development plans and strategies. All the countries in West Africa, except Mauritania, have joined the Forestry Partnership Carbon Facility (FPCF) and UN-REDD REDD+ readiness platforms [48]. A third REDD+ platform, the Forest Investment Program (FIP), is investing in forest management projects in Burkina Faso, Ghana, and Ivory Coast. In addition to the Gola REDD+ project from our case studies, about 10 REDD+ demonstration pilot projects are underway in Liberia, Ghana, and Nigeria [5,8].

The increasing number of REDD+ programs is closing the local knowledge gap regarding conservation practices, green accounting, and raising awareness on climate change. Countries are required to articulate, in concrete terms, strategies and plans for tackling forest degradation, protect watersheds, and reduce carbon emissions to qualify for REDD+ programs. These plans and strategies are changing the institutional landscape in West African countries towards conservation. For instance, the evaluation of the REDD+ strategic framework in Nigeria and Ghana found that previous forest laws that favor logging companies were restructured to push forward responsible forest stewardship [48]. The evaluation also found that various institutions nest together to lay the groundwork for REDD+ and that actors at the local or regional level are actively involved or even drive the process. This decentralized decision-making trend is also consistent with observations from our case studies in Mali and Senegal [30,32]. Burkina Faso and Liberia recently reformed their land tenure laws in 2009 to promote the responsible use of natural resources by recognizing and empowering customary laws above state laws [34,49].

Therefore, what incentive mechanisms are better positioned to take advantage of the evolving environmental conservation landscape in West Africa? There are three general incentives that underpin conservation initiatives: direct payments, compensation-based welfare measures and biodiversity protection [50]. Protecting biodiversity hubs and their ESs entails strict regulations that restrict the ability of ES providers to access ESs supporting their livelihood. This issue becomes more pronounced since governments own most lands and forests that support poor ES providers [49]. Hence, regulations guiding natural resource use are difficult to enforce because they are subject to political pressure [51]. In instances where regulations are enforced, ESs providers often exploit open lands, thereby creating leakages. This implies previous destructive production activities being carried out on lands not enrolled in the program.

On the other hand, direct payments and welfare measures, in the West African socioeconomic context, are more attractive avenues to pursue conservation. This is because they compensate ES providers for forgone alternatives and for switching to new production practices. Examples include compensatory programs such as PES, PWS, and Community-Based Forest Management (CBFM) programs. PES, according to [52], transfers payments from ES users to providers with payments conditional on an agreed process for managing natural resources. The institutional arrangement underpinning PES and PWS is flexible enough to leverage funding from CDMs as well as VCMs and REDD+ frameworks. If implemented under the right circumstances, direct payments and welfare-based programs could be beneficial to both the environment and participating communities [53,54]. In the case of PWS, apart from the Sourou wetland valuation project in Burkina Faso financed by Environment and Agriculture Research Centre (EARC) and Economic and Social Policy Centre (ESPC), no other projects have explicitly focused on watershed and wetland protection in West Africa. There are 15 watershed projects that are currently active or in the works in Africa, with one of the projects currently being developed in West Africa [55]. This raises the question of how to fund these programs.

5.2. Demand-Side Incentives

External funding sources sustained all the programs in our case studies. This is consistent with the view that local markets for ecosystem services in Africa are less developed than their counterparts in Latin America or Asia [56]. However, the increasing development of environmental conservation

frameworks by West African governments is providing opportunities for countries to exploit several funding channels.

For countries involved in REDD+, three funding channels currently exist. The first channel allocates funds from the Green Climate Fund, the Forest Investment Program, and the Forest Carbon Partnership Facility to governments participating in REDD+ readiness and demonstration projects [57]. Currently, the Acacia carbon projects in Mali and Niger and sustainable energy management program in Burkina Faso benefit from these carbon funds. The REDD+ pilot projects in Senegal, Malawi, and KawiSafu in East Africa started with funds from the green climate fund [58]. In the second channel, developed countries sign bilateral agreements with developing countries to finance and provide technical support to national governments at different levels of readiness for REDD+. In this model, notable NGOs such as the World Wide Fund for Nature and Global Environmental Facility also provide technical support. From our case study, the Gola REDD+ project in Sierra Leone falls under this category. Another example is the bilateral agreement to support the REDD+ strategic framework between the German Federal Ministry for Economic Cooperation and Development and the Togolese Ministry of Environment and Forest Resources, the governments of Norway and Burkina Faso [11,59]. The third channel establishes VCMs that sell carbon credits generated from REDD+ projects. The projects, however, must fulfill carbon offset requirements set by VCS or by certifiers such as Plan Vivo [60]. To illustrate, Plan Vivo currently sponsors 17 operational projects worldwide: six projects were implemented in East and South Africa and two in Burkina Faso (see Table 2 for the projects).

These funding channels were set up by developed countries to cater mostly to carbon sequestration projects in developing countries. This underscores the first target outlined in SDG 17 to promote global partnerships for sustainable development by encouraging developed countries to assist developing countries financially in achieving sustainable development objectives. Still, developing local markets for ESs is imperative, especially true for watershed and biodiversity protection programs, where location matters both in providing ESs and funding the programs [44,50]. In general, funds for watershed protection come from five sources: hydroelectric power suppliers, large industrial users, municipal water suppliers, irrigation water users, and general tax revenues [61]. Thus, the sound financial health of institutions is an essential prerequisite for PWS schemes, a quality lacking in many public and private African institutions [61].

Still, we can learn from narratives in other parts of the world. Most notable is the Quito Water Trust fund model in Latin America. A consortium of water users in Quito, Ecuador, established a water trust fund in the late 1990s [62]. The fund is managed by a local bank, and returns from investments are used to finance watershed protection projects whose activities are managed by an external environmental NGO. This funding model has since inspired similar models in different parts of the world [63]. The Payments for Watershed Services programs in the Uluguru Mountains in Tanzania and in Lake Naivasha Basin Kenya are similar models that already exist in Africa. In the former program, the local Coca-Cola Company and a public water provider created a trust fund and subsequently entered into contractual agreements with upstream farmers to adopt sustainable land use practices that protected the Ruvu river basin in the Uluguru Mountains [64]. In the latter program, a consortium of water companies, horticultural growers, and tourism industry organizations established a fund from which they compensated farmers cultivating land near the Lake Naivasha to adopt ES generating activities [65].

The trust fund arrangement can be replicated in West Africa, with urban dwellers, public and private utility companies, mining companies, and breweries operating in West Africa as primary funding sources. What incentives can induce these companies to sponsor conservation programs? For instance, declining water quality and quantity that threatened their water source motivated the Quito Trust Fund and subsequent models. Therefore, the first incentive can be tied to service provision. If, for instance, water scarcity threatens water supply for utility companies and breweries, a clear incentive exists to invest in watershed protection and biodiversity conservation programs. Tourist

companies and NGOs, both internal and external, are potential funding sources for biodiversity conservation projects. Declining flora and fauna species that attract tourists is a potential incentive for financing conservation programs. We also acknowledge that other viable alternatives such as water treatment and filtration plants that efficiently utilize water exists. Watershed protection programs in cities in North and South America were observed to be more cost-effective, and support a larger population compared to building a treatment plant [66,67].

In instances where the services provided by target companies are not threatened, corporate social responsibility (CSR) could be used to incentivize companies to sponsor conservation programs [68,69]. CSR projects promote the image of the implementing companies and generate public goodwill. In this regard, some multinationals are already active. In Nigeria, oil drilling companies SHELL and Chevron sponsor community development programs in the oil-rich Niger-Delta region and are listed in the Nigerian REDD+ framework as partners and potential buyers of carbon offsets [48]. Furthermore, a local brewery built by Heineken in Sierra Leone and SABMiller in Ghana sponsor projects ranging from water recycling to health care and community development initiatives [70]. See [71] for a review of various CSR projects in Nigeria, and [72] for that of CSR projects in Ghana, Liberia, and Guinea.

A common thread among all these companies is their preference for socioeconomic development programs. Preferences for socioeconomic initiatives align with the priorities in West Africa where environmental conservation is secondary to livelihood improvements. This means that investments in environmental conservation only rise when environmental degradation poses a direct threat to the supply of ecosystem services. Therefore, changing attitudes towards conservation is essential, starting with governments emphasizing environmental conservation alongside the socioeconomic development in their development plans. While we are not advocating prioritizing conservation projects over economic development projects, it would be prudent to link conservation efforts to socioeconomic development. Failure to tackle current environmental degradation decreases the stock of ecosystem services available to future West African ES providers.

5.3. Supply-Side Incentives

Incentives on the supply side revolve around inducing behavioral changes conducive to environmental conservation. Successful conservation programs require proper organization, resource tenure, consultation with local stakeholders, and the provision of consistent incentives [52]. The two latter points are pertinent in West Africa because the success of all incentives mechanisms is contingent on how it builds up the socioeconomic interests of the people [73].

However, will poor ES providers in West Africa show any interest in conservation programs? Narratives from studies suggest that adequate payment incentives might stimulate conservation behavior among ES providers. For instance, despite differences in Willingness to Accept (WTA) estimates, it was shown in [74] that opportunity costs largely dictated farmers WTA payments for a watershed program near Lake Naivasha in Kenya. Given sufficient incentives, 74% of ES providers in Liberia demonstrated a willingness to adopt responsible land management practices [75]. Furthermore, among those who expressed opposition to conservation, distrust of government authorities was cited as the main reason. Adequate payments has been highlighted as a critical factor that motivates the uptake of conservation programs [76]. These results imply that, even though conservation programs might intrude on their livelihoods, farmers might be willing to participate in conservation programs provided they are sufficiently compensated.

Thus, the design and magnitude of incentive payments are significant. Payments or incentives must cover opportunity and transaction costs of switching to new livelihood activities or participating in conservation programs [77,78]. Inadequate payments undermine environmental conservation goals by discouraging participation in conservation programs or engendering leakages. What incentives should be considered when designing payment incentives that adequately cover the costs of those participating in conservation programs in West Africa?

One incentive is encouraging diversified livelihood strategies. The UN acknowledged diversification as an SDG 8 target to drive economic growth and provide decent employment. Diversification provides alternative income sources, bolsters income flows, and helps to reduce leakages and pressure on the environment [79,80]. However, diversification activities should be designed to align with the needs of its target group [81]. This should come in various forms, for instance, via business start-ups or upgrading activities. In our case studies, beekeeping was the main diversification activity, but others exist. Alternative environmental activities, such as agroforestry, ecotourism, and poultry-keeping, and informal activities, such as woodcarving and tailoring, are viable diversification activities.

While human capital deficiencies can limit diversification [82], skill and knowledge acquisition training and seminars can reduce these deficiencies and build human capital. Apart from encouraging diversification, skill and knowledge acquisition also helps to reduce knowledge on conservation activities in West African institutions. The reduced knowledge gap becomes significant because future conservation initiatives can reduce initial start-up costs of organizing training seminars to build local capacity. The dissemination of knowledge and training underscores the importance of NGOs (or intermediaries) to the environmental conservation process and activities in West Africa and Africa. This further highlights SDG 17 targets: enhance the flow of information and technology on conservation from developed to developing countries to facilitate capacity building.

Another incentive is introducing conservation activities that build on already existing production systems. This is because ES providers might not be receptive to new production systems, especially if they disrupt everyday livelihood activities. In West Africa, the majority of ES providers engage in agricultural production, with agroforestry often promoted as a viable conservation production system [83,84]. Benefits from agroforestry run from payments for carbon sequestered from afforested trees to water conservation, improved soil fertility, and future returns from the sale of trees, among other benefits. Empirical evidence from TIST and ECOTRUST agroforestry schemes in East Africa reveals that farmers earn payments for carbon sequestration as well as indirect benefits such as access to credit, improved farm productivity, and knowledge of sustainable and efficient farming techniques [31,85,86]. Inherent in agroforestry is the synergy between food security and climate change mitigation (also known as 'Climate Smart Agriculture') [87]. This is why SDG 2 strategies to promote sustainable food production and resilient agricultural practices commonly hinge on agroforestry as its cornerstone, and why opportunities to scale up agroforestry activities should be explored.

Building on existing production systems raises the need to work with local communities or regions. An inclusive decision-making process builds trust and identifies the interests of all stakeholders. The inclusion of all stakeholders in a program's decision-making is central to achieving sustainable forest management [6]. In our case studies, project activities were internalized by ES providers when they were involved in the program decision-making process. Sustainable grazing and land use practices introduced by the Guinea Hotspots and Sequestration of carbon in soil organic matter programs in Senegal continued to be used by the communities after both projects were canceled [30]. Both programs were not only built on pre-existing land management practices but also pursued an inclusive decision-making process that recognized the peculiarity of different participating stakeholders and attempted to reconcile these peculiarities under a single framework [30]. In Ghana, local stakeholders were involved at every stage of the decision-making process of the restoration projects. This approach was singled out as the main driver of success of the projects [40]. Conversely, the impacts of the sustainable management program in Mali was slightly diminished when influential groups hijacked decision marking, which created conflicts over resource use and property rights [30]. Although the REDD+ readiness design are initially inclusionary, an exclusionary approach often emerges when programs are implemented [48].

Therefore, in engaging with participating communities, notions of equity and justice should be strongly considered. Studies that examined the dimensions of justice in REDD+ in West Africa advocated for the inclusion of transparency, equity, and legitimacy as specific elements of justice

in conservation instruments [9]. Similarly, equity is crucial to planning and implementing effective policies, and assessing social effects engendered by changes in the value of ESs [88]. In concrete terms, the notion of equity starts with an inclusive decision-making process. A transparent and accountable system that ensures equitable distribution of benefits, costs, and risks is equally urgent. Understanding the cultural, historical, and social background of regions in West Africa is key to achieving this objective. For instance, the immense contribution women make to agriculture in West Africa fails to translate to increased decision-making or ownership of production resources; an area dominated by men. Corrective institutional interventions to correct this imbalance such as equal access to resources and skill acquisition for men and women constitutes a credible pathway to climate smart agriculture [89,90]. Pursuing inclusive decision-making and corrective institutional interventions ensure targets outlined in SDG 5 such as the full participation of women in the leadership process and embarking on reforms aimed at facilitating access to economic resources are met.

The notions of equity also extend to the international community. Western impressions of sustainable development and its manifestation in international conservation frameworks such as REDD+ are, in some instances, incompatible with the prevailing social, economic, and institutional settings in Africa [46]. Expectations regarding environmental conservation must align with realities in West Africa. For instance, understanding that environmental projects can disrupt livelihood activities of rural West Africans and further drive them into poverty. How this plays out would depend on country, regional, and local specifics in West African communities [46].

Efforts at conservation in West Africa holds promises and pitfalls. Current trends suggest that environmental conservation is seeping into the national, regional, and local consciousness in West Africa. Most relevant to environmental conservation are incentives that enhance the environmental, socioeconomic, institutional, and cultural interests of West Africans. From advancing measures that alleviate poverty, improve technical know-how, connect partners from diverse backgrounds, build local institutions, tackle climate change, and promote equity, this incentive approach entails empowering West African ES providers, an approach reminiscent of the ideals of the SDGs and that meets several targets articulated in SDGs 1, 3, 5, 8, 13, and 17 to end poverty, end hunger, promote sustainable agriculture, reduce gender inequalities, push for climate action, and build partnerships for sustainable development.

6. Conclusions

This study reviewed on-going and completed forest and watershed (wetlands) projects in West Africa and their corresponding financing mechanism. From the lessons gleaned from the projects, we outline several incentive measures tailored to address region-specific challenges and inform prospective conservation projects in West Africa. We considered incentive from three dimensions: incentive mechanisms representing conservation programs, demand-side incentives representing the interests of ES users and buyers, and supply-side incentives that induce ES providers to internalize conservation attitudes.

We argue that both environmental conservation and economic objectives should proceed together before meaningful environmental conservation can occur. The current movement towards restructuring existing laws and institutions in West Africa to accommodate conservation programs needs to continue. The ability to finance these mechanisms depends on this movement and signals to potential investors the embrace of sustainable land use activities. Still, poverty alleviation objectives must not be completely ignored. This is because many West Africans rely on resources from forest and watershed (wetlands) to support their livelihoods.

Regarding specific incentives, it is crucial to design and implement incentive mechanisms that build on already existing location systems and platforms. This engenders trust and facilitates uptake of program activities and conservation principles. Intermediaries are also needed to reduce knowledge gaps among potential ES providers in the communities and link them to potential buyers/users of ES

who will sponsor and fund programs. Articulating equity goals, fair distribution of costs and benefits, and participatory decision-making should feature prominently in these mechanisms.

Put simply, an ideal conservation incentive mechanism in West Africa should adopt a bottom-up, inclusive, fair, and transparent decision-making process, must combine socioeconomic and conservation objectives, and adequately compensate ES providers.

Supplementary Materials: The following are available online at http://www.mdpi.com/1999-4907/10/6/479/s1. Table S1. Conservation programs in West Africa; Table S2. Conservation programs in West Africa (continued).

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References

1. Bolt, K.; Cranston, G.; Maddox, T.; McCarthy, D.; Vause, J.; Vira, B.; Pearce-Higgins, J. *Biodiversity at the Heart of Accounting for Natural Capital: The Key to Credibility*; Cambridge Conservation International: Cambridge, UK, 2016.
2. Tisdell, C. *Economics, Ecology and the Environment*; Working Paper No. 41, Sustainability: The Economic Bottom Line; The University of Queensland: Brisbane, Australia, 2000.
3. Aglanu, L. Watersheds and Rehabilitations Measures—A Review. *Resour. Environ.* **2014**, *4*, 104–114.
4. Kabii, T. An overview of African wetlands. In *Wetlands, Biodiversity and the Ramsar Convention: the Role of the Convention on Wetlands in the Conservation and Wise Use of Biodiversity*; Hails, A., Ed.; Ramsar Convention Bureau: Gland, Switzerland, 1997. Available online: https://www.oceandocs.org/bitstream/handle/1834/457/Africa_Wetlands_1.pdf?sequence=1&isAllowed=y (accessed on 6 May 2018).
5. Forest Carbon Partnership Facility (FCPF). REDD+ Countries. 2017. Available online: https://www.forestcarbonpartnership.org/redd-countries-1 (accessed on 21 February 2018).
6. Hillstrom, K.; Hillstrom, L.C. *Africa and the Middle East: A Continental Overview of Environmental Issues*; ABC-CLIO: Denver, CO, USA; Oxford, UK, 2003.
7. Carr, J.; Adeleke, A.; Angu Angu, K.; Belle, E.; Burgess, N.; Carrizo, S.; Choimes, A.; Coulthard, N.; Darwall, W.; Foden, W.; et al. *Ecosystem Profile Guinean Forests of West Africa Biodiversity Hotspot*; Critical Ecosystem Partnership Fund: Arlington, VA, USA, 2015.
8. Cerbu, G.; Swallow, B.; Thompson, D. Locating REDD: A global survey and analysis of REDD readiness and demonstration activities. *Environ. Sci. Policy* **2011**, *14*, 168–180. [CrossRef]
9. Isyaku, U.; Arhin, A.; Asiyanbi, A. Framing justice in REDD+ governance: Centring transparency, equity and legitimacy in readiness implementation in West Africa. *Environ. Conserv.* **2017**, 1–9. [CrossRef]
10. Mbow, M.; Skole, D.; Dieng, M.; Justice, C.; Kwesha, D.; Mane, L.; El Gamri, M.; Von Vordzogbe, V.; Virji, H. *Challenges and Prospects for REDD+ in Africa: Desk Review of REDD+ Implementation in Africa*; GLP Report No. 5. GLP-IPO; GLP International Project Office: Copenhagen, Denmark, 2012.
11. Jindal, R.; Swallow, B.; Kerr, J. Forestry-based carbon sequestration projects in Africa: Potential benefits and challenges. *Nat. Resour. Forum* **2008**, *32*, 116–130. [CrossRef]
12. Bond, I.; Grieg-Gran, M.; Wertz-Kanounikoff Hazlewood, P.; Wunder, S.; Angelsen, A. *Incentives to Sustain Forest Ecosystem Services A Review and Lessons for REDD*; Natural Resouce Issues No. 16; International Institute for Environment and Development: London, UK; CIFOR: Bogor, Indonesia; World Resources Institute: Washington, DC, USA, 2009.
13. IIED. Watershed Markets. 2017. Available online: http://www.watershedmarkets.org/casestudies.html (accessed on 22 July 2017).
14. Wangai, P.; Burkhard, B.; Mueller, F. A review of studies on ecosystem services in Africa. *Int. J. Sustain. Built Environ.* **2016**, *5*, 225–245. [CrossRef]
15. Egoh, B.N.; O'Farrell, P.J.; Charef, A.; Gurney, L.J.; Koellner, T.; Abi, H.N.; Egoh, M.; Willemen, L. An African account of ecosystem service provision: Use, threats and policy options for sustainable livelihoods. *Ecosyst. Serv.* **2012**, *2*, 71–81. [CrossRef]

16. Bryman, A.; Bell, E. *Business Research Methods*; Oxford University Press: Oxford, UK, 2007.
17. Booth, A.; Anthea, S.; Diana, P. *Systematic Approaches to a Successful Literature Review*, 2nd ed.; Sage: London, UK, 2016.
18. UMICH. *Africa, Primary Watersheds*; University of Michigan: Ann Arbor, MI, USA, 2017. Available online: http://www-personal.umich.edu/~{}sarhaus/courses/DirectedStudy/astrid/undpseed/afsheds.html (accessed on 2 December 2017).
19. Van Der Wijngaart, R.; Helming, J.; Jacobs, C.; Garzon Delvaux, P.A.; Hoek, S.; Gomez y Paloma, S. *Irrigation and Irrigated Agriculture Potential in the Sahel: The Case of the Niger River Basin: Prospective Review of the Potential and Constraints in a Changing Climate*; EUR 28828 EN; Publications Office of the European Union: Luxembourg, 2019; ISBN 978-92-79-74275-0. [CrossRef]
20. TEEB. The Economics of Ecosystems and Biodiversity for Water and Wetlands. 2013. Available online: http://www.ieep.eu/assets/1107/TEEB_Water_Wetlands_Executive_Summary.pdf (accessed on 6 May 2017).
21. Schuyt, K. Economic consequences of wetland degradation for local populations in Africa. *Ecol. Econ.* **2005**, *53*, 177–190. [CrossRef]
22. UNESCO. Tiwai Island Wildlife Sanctuary. 2017. Available online: http://whc.unesco.org/en/tentativelists/5742/ (accessed on 8 April 2018).
23. Pearce, D.W. The economic value of forest ecosystems. *Ecosyst. Health* **2001**, *7*, 284–296. [CrossRef]
24. Pimentel, D.; McNair, M.; Buck, L.; Pimentel, M.; Kamil, J. The value of forests to world food security. *Hum. Ecol.* **1997**, *25*, 91–120. [CrossRef]
25. Jalloh, A.; Nelson, G.C.; Thomas, T.S.; Zougmoré, R.; Roy-Macauley, H. *West African Agriculture and Climate Change: A Comprehensive Analysis*; IFPRI Research Monograph; International Food Policy Research Institute: Washington, DC, USA, 2013. [CrossRef]
26. Roudier, P.; Sultan, S.; Quirion, P.; Berg, A. The impact of future climate change on West African crop yields: What does the recent literature say? *Glob. Environ. Chang.* **2011**, *21*, 1073–1083. [CrossRef]
27. Hertel, T.W.; Rosch, S.D. Climate Change, Agriculture, and Poverty. *Appl. Econ. Perspect. Policy* **2010**, *32*, 355–385. [CrossRef]
28. Robison, R.; Findlay Brooks, R. *West Africa: The Climate of Change Climate Change Impacts, Awareness and Preparedness across West Africa*; University of Cambridge Programme for Sustainability Leadership: Cambridge, UK, 2010.
29. ACAD. *Carbon Markets and Africa: A Quick Fact Sheet for Journalists*; United Nations Environmental Programme and RISO Centre: Roskilde, Denmark, 2017. Available online: https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Carbon%20Market%20Quick%20Facts%20%20ACF%202012.pdf (accessed on 17 August 2018).
30. Roncoli, C.; Jost, C.; Perez, C.; Moore, K.; Ballo, A.; Cisse, S.; Ouattara, K. Carbon sequestration from common property resources: Lessons from community-based sustainable pasture management in north-central Mali. *Agric. Syst.* **2007**, *94*, 97–109. [CrossRef]
31. Masiga, M. Payments for Environmental Services in Sub-Saharan Africa: Taking stock and generating evidence for increased investment and development of PES. In *Payment for Environmental Services Laying the Ground Work*; Mogaka, H., Okeyo-Owuor, J., Kipkoech, A., Eds.; ASARECA: Entebbe, Uganda, 2011; pp. 83–105.
32. FAO. *A Review of Carbon Sequestration Projects*; Food and Agriculture Organisation: Rome, Italy, 2004.
33. Kane, N.; Toure, O.; Quiroga, E. *Conservation of Biodiversity through Participatory Rehabilitation of Degraded Land in Arid and Semi-Arid Cross-Border Zones of Mauritania and Senegal Final Project Evaluation*; United Nations Development Programme and Global Environmental Facility: New York, NY, USA, 2010.
34. Plan Vivo. Rehabilitation and Sustainable Management by AGED of Degraded Pastures in the Sahel region of Burkina Faso. 2017. Available online: http://www.planvivo.org/docs/PDD-Rehabilitation-of-Degraded-Pastures-AGED.pdf (accessed on 19 March 2018).
35. Somda, J.; Nianogo, A.J. TEEB Case: Wetland Valuation Changes Policy Perspectives, Burkina Faso. 2010. Available online: TEEBweb.org (accessed on 13 July 2017).
36. Katoomba. *Sweetening the Deal for Shade-Grown Cocoa: A Preliminary Review of Constraints and Feasibility of 'Cocoa Carbon' in Ghana*; The Katoomba Group: Accra, Ghana, 2009.

37. Asante, W.; Anim, E.; Asare, R. *Institutional Innovations In Africa Smallholder Carbon Projects: Case Study Cocoa Carbon Initiative*; CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS): Copenhagen, Denmark, 2012.
38. RSBP. The Gola REDD Project. 2013. Available online: https://www.golarainforest.org/Microsoft%20Word%20-%20VCS%20PD_For%20audit%20Dec%202013.pdf (accessed on 25 November 2018).
39. Appiah, M.; Fagg, M.; Pappinen, A. A review of reforestation approaches in Ghana: Sustainability and genuine local participation lessons for implementing REDD+ Activities. *Eur. J. Sci. Res.* **2015**, *131*, 70–99.
40. International Tropical Timber Organisation (ITTO). Assessing the ITTO Guidelines for the Restoration, Management and Rehabilitation of Degraded and Secondary Tropical Forests: Case studies of Ghana, Indonesia and Mexico. 2015. Available online: https://www.itto.int/direct/topics/topics_pdf_download/topics_id=4632&no=1&file_ext=.pdf (accessed on 5 May 2019).
41. Alix-Garcia, J.; Sims, K.; Yanez-Pagans, P. Only one tree from each seed? Environmental Effectiveness and Poverty Alleviation in Programs for Payment for Ecosystem Services. *AEJ Econ. Policy* **2015**, *7*, 1–40. [CrossRef]
42. Sokona, Y.; Denton, F. Climate change impacts: Can Africa cope with the challenges? *Clim. Policy* **2001**, *1*, 117–123. [CrossRef]
43. UNEP. *Environmental Accounting of National Economic Systems: An Analysis of West African Dryland Countries within a Global Context*; United Nations Environment Programme: Nairobi, Kenya, 2012.
44. Alston, L.; Andersson, K.; Smith, S. Payment for Environmental Services: Hypothesis and Evidence. *Annu. Rev. Resour. Econ.* **2013**, *5*, 139–159. [CrossRef] [PubMed]
45. Unruh, J. Carbon sequestration in Africa: The land tenure problem. *Glob. Environ. Chang.* **2008**, *18*, 700–707. [CrossRef]
46. Mantlana, B. *Readying Africa for REDD+*; COP 17; Heinrich Böll Foundation: Cape Town, South Africa, 2011.
47. GEF. GEF's Programmatic Approach to Biodiversity Conservation in West and Central Africa. 2010. Available online: http://www.thegef.org/gef/sites/thegef.org/files/publication/westafrica-BIO.pdf (accessed on 10 February 2017).
48. Asiyanbi, A.; Arhin, A.; Isyaku, U. REDD+ in West Africa: Politics of Design and Implementation in Ghana and Nigeria. *Forests* **2017**, *8*, 78. [CrossRef]
49. RRI. *Who Owns the Land in Africa? Formal Recognition of Community-Based Land Rights in Sub-Saharan Africa*; Rights and Resources Group: Washington, DC, USA, 2015.
50. Kroeger, T.; Casey, F. An assessment of market-based approaches to providing ecosystem services on agricultural lands. *Ecol. Econ.* **2007**, *64*, 321–332. [CrossRef]
51. Wunder, S.; Engel, S.; Pagiola, S. Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries. *Ecol. Econ.* **2008**, *65*, 834–852. [CrossRef]
52. Wunder, S. When payments for environmental services will work for conservation. *Conserv. Lett.* **2013**, *6*, 230–237. [CrossRef]
53. Hejnowicz, A.; Raffaelli, D.; Rudd, M.; White, P. Evaluating the outcomes of payments for ecosystem services programmes using a capital asset framework. *Ecosyst. Serv.* **2014**, *9*, 83–97. [CrossRef]
54. Pagiola, S.; Arcenas, A.; Platais, G. Can Payments for Environmental Services Help Reduce Poverty? An Exploration of the Issues and the Evidence to Date from Latin America. *World Dev.* **2005**, *33*, 237–253. [CrossRef]
55. Bennett, G.; Carroll, N. Gaining Depth: State of Watershed Investment 2014. 2014. Available online: www.ecosystemmarketplace.com/reports/sowi2014 (accessed on 10 May 2017).
56. Cisneros, J.A. *Forest Carbon Projects in Africa: A Mapping Study*; Background Report for the 'Political Ecologies of Forest Carbon in Africa' Research Project; STEPS Centre: Sussex, UK, 2012.
57. World Bank Group. World Bank Group Climate Finance: 2017. Available online: http://www.worldbank.org/en/topic/climatefinance (accessed on 10 April 2018).
58. FAO. REDD+ Initiatives, Experience and Challenges in Africa. 2016. Available online: http://www.fao.org/3/a-mp513e.pdf (accessed on 25 June 2018).
59. GIZ. *Support for REDD+ Readiness and Rehabilitation of Forests in Togo (ProREDD)*; German Federal Ministry for Economic Cooperation and Development (BMZ): Eschborn, Germany, 2017. Available online: https://www.giz.de/en/worldwide/31415.html (accessed on 8 June 2017).

60. Joseph, S.; Herold, M.; Sunderlin, W.; Verchot, L. REDDC readiness: Early insights on monitoring, reporting and verification systems of project developers. *Environ. Res. Lett.* **2013**, *8*, 1–15. [CrossRef]
61. Ferraro, P.J. Regional review of payments for watershed services: Sub-Saharan Africa. *J. Sustain. For.* **2009**, *28*, 525–550. [CrossRef]
62. Arias, V.; Benitez, S.; Goldman, R. *Water Fund for Catchment Management in Quito, Ecuador*; The Economics of Ecosystems and Biodiversity (TEEB): Geneva, Switzerland, 2010. Available online: TEEBweb.org (accessed on 13 April 2017).
63. Goldman, R.; Benitez, S.; Calvache, A.; Ramos, A. *Water Funds: Protecting Watersheds for Nature and People*; The Nature Conservancy: Arlington, VA, USA, 2010.
64. Lopa, D.; Mwanyoka, I.; Jambiya, G.; Massoud, T.; Harrison, P.A.; Ellis-Jones, M.; Blomley, T.; Leimona, B.; van Noordwijk, M.; Burgess, N.D. Towards operational payments for water ecosystem services in Tanzania: A case study from the Uluguru Mountains. *Oryx* **2012**, *46*, 34–44. [CrossRef]
65. Chiramba, T.; Mugoi, S.; Martinez, I.; Jones, T. Payment for Environmental Services pilot project in Lake Naivasha Basin—A viable mechanism for watershed services that delivers sustainable natural resource management and improved livelihoods. In Proceedings of the UN-Water International Conference on Water in the Green Economy in Practice: Towards Rio, Zaragoza, Spain, 3–5 October 2011; UNEP: Nairobi, Kenya, 2011; Volume 20.
66. Appleton, A. How New York City Used an Ecosystem Services Strategy Carried out Through an Urban-Rural Partnership to Preserve the Pristine Quality of Its Drinking Water and Save Billions of Dollars and What Lessons It Teaches about Using Ecosystem Services. In Proceedings of the Katoomba V International Conference, Tokyo, Japan, 5–6 November 2002.
67. Hanlan, J. Watershed protection to secure ecosystem services. *Case Stud. Environ.* **2017**, 1–7. [CrossRef]
68. Benjamin, O.; Maduekwe, E.; Punt, M.; Buchenrieder, G. Corporate sustainability and social responsibility of smallholder farmers: Implications for agriculture financing. In *Handbook of Research on Small Business Social Responsibility: Global Perspectives*; Spence, L., Frynas, J., Muthuri, J., Navare, J., Eds.; Edward Elgar: Cheltenham, UK, 2017.
69. Visser, W. Corporate social responsibility in developing countries. In *Oxford Handbook of Corporate Social Responsibility*; Crane, A., Matten, D., McWilliams, A., Moon, J., Siegel, D.S., Eds.; Oxford University Press: Oxford, UK, 2008.
70. Agterhof, G. *Corporate Social Responsibility in Developing Countries: Comparative Analysis of Breweries in Sierra-Leone and Ghana*; University of Groningen: Groningen, The Netherlands, 2014.
71. Amaeshi, K.M.; Adi, A.B.; Ogbechie, C.; Amao, O.O. *Corporate Social Responsibility in Nigeria: Western Mimicry or Indigenous Influences?* ICCSR Research Paper Series No. 39; ICCSR: Coventry, UK, 2006; SSRN 896500.
72. Forstater, M.; Zadek, S.; Guang, Y.; Yu, K.; Xiao Hang, C.; George, M. *Corporate Responsibility in African Development: Insights from an Emerging Dialogue*; The Joan Shorenstein Center: Boston, MA, USA, 2010.
73. Wollenberg, E.; Springate-Baginski, O. *Incentives + How can REDD Improve Well-Being in Forest Communities?* Center for International Forestry Research (CIFOR): Bogor, Indonesia, 2009.
74. Nyongesa, J.; Bett, H.K.; Lagat, J.K.; Ayuya, O.I. Estimating farmers' stated willingness to accept pay for ecosystem services: Case of Lake Naivasha watershed Payment for Ecosystem Services scheme-Kenya. *Ecol. Process.* **2016**, *5*, 1–15. [CrossRef]
75. Innis, P. *Watershed-Based Payment for Ecosystem Services in Liberia: Examining Prospects and Challenges for Implementation in the St. Paul River Basin*; The International Institute for Industrial Environmental Economics: Lund, Sweden, 2015.
76. Kabii, T.; Horwitz, P. A review of landholder motivations and determinants for participation in conservation covenanting programmes. *Environ. Conserv.* **2006**, *33*, 11–20. [CrossRef]
77. Benjamin, O.; Blum, M. Participation of smallholders in agroforestry agri-environmental scheme: A lesson from the rural mount Kenyan region. *J. Dev. Areas.* **2015**, *49*, 127–143. [CrossRef]
78. Kerr, S.; Pfaff, A.; Lipper, L.; Cavatassi, R.; Davis, B.; Sanchez, A.; Hendy, J. Will Buying Tropical Forest Carbon Benefit The Poor? Evidence from Costa Rica. *Land Use Policy* **2004**, *24*, 600–610.
79. Grieg-Gran, M.; Porras, I.; Wunder, S. How Can Market Mechanisms for Forest Environmental Services Help the Poor? Preliminary Lessons from Latin America. *World Dev.* **2005**, *33*, 1511–1527. [CrossRef]

80. Knoke, T.; Calvas, B.; Aguirre, N.; Román-Cuesta, R.M.; Günter, S.; Stimm, B.; Weber, M.; Mosandl, R. Can tropical farmers reconcile subsistence needs with forest conservation. *Front. Ecol. Environ.* **2009**, *7*, 548–554. [CrossRef]
81. Ngugi, R.K.; Nyariki, D.M. Rural livelihoods in the arid and semi-arid environments of Kenya: Sustainable alternatives and challenges. *Agric. Hum. Values* **2005**, *22*, 65–71. [CrossRef]
82. Jouni, M. Livelihoods, vulnerability and adaptation to climate change in Morogoro, Tanzania. *Environ. Sci. Policy* **2008**, *11*, 642–654.
83. Kiptot, E.; Franzel, S.; Degrande, A. Gender, agroforestry and food security in Africa. *Curr. Opin. Environ. Sustain.* **2014**, *6*, 104–109. [CrossRef]
84. Minang, P.; Duguma, L.; Bernard, F.; Mertz, O.; van Noordwijk, M. Prospects for agroforestry in REDD+ landscapes in Africa. *Curr. Opin. Environ. Sustain.* **2014**, *6*, 78–82. [CrossRef]
85. Benjamin, O. Improving credit allocation to sustainable agriculture in Sub-Saharan Africa: Review of bio-based economy benefits. *Oida Int. J. Sustain. Dev.* **2012**, *4*, 16–24.
86. Benjamin, O.; Punt, M.; Blum, M. The impact of extension and ecosystem services on smallholder's credit constraint. *J. Dev. Areas* **2016**, *50*, 333–350. [CrossRef]
87. Mbow, C.; Van Noordwijk, M.; Luedeling, E.; Neufeldt, H.; Minang, P.; Kowero, G. Agroforestry solutions to address food security and climate change challenges in Africa. *Curr. Opin. Environ. Sustain.* **2014**, *6*, 61–67. [CrossRef]
88. McDermott, M.; Mahanty, S.; Schreckenberg, K. Examining Equity: A multidimensional framework for assessing equity in payment for ecosystem services. *Environ. Sci. Policy* **2013**, *33*, 416–427. [CrossRef]
89. Farnworth, C.; Fones Sundell, M.; Nzioki, A.; Shivutse, V.; Davis, M.; Kristjanson, P.; Rijke, E. *Transforming Gender Relations in Agriculture in Sub-Saharan Africa*; Swedish International Agricultural Network Initiative (SIANI): Stockholm, Swedish, 2013.
90. Nielsen, J.Ø.; Reenberg, A. Cultural barriers to climate change adaptation: A case study from Northern Burkina Faso. *Glob. Environ. Chang.* **2010**, *20*, 142–152. [CrossRef]

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