

Review

Role of Natural Capital Economics for Sustainable Management of Earth Resources

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Abstract: Natural capital is the wealth of nations that determine their economic status. Worldwide, vulnerable people depend on natural capital for employment, salaries, wealth, and livelihoods and, in turn, this determines the developmental index of the nation to which they belong. In this short review, we have tried to sum up the ideas and discussions over natural capital's role in ascribing economic status to countries as well as the need for natural resource management and sustainability. This paper aimed to discuss how humanity's prosperity is intertwined with the services that ecosystems provide, and how poor natural resource management (NRM) has adversely affected human well-being. Our preselected criteria for the review paper led us to evaluate 96 peer-reviewed publications from the SCOPUS database, which is likely the most comprehensive archive of peer-reviewed scientific literature as well as WoS, PUBMED, and Google Scholar databases. Our review revealed that the availability of ecological services is crucial for clean water and air, food and fodder, and agricultural development. We further discussed important concepts regarding sustainability, natural capital and economics, and determinants of human well-being vis-à-vis the intergenerational security of natural wealth. To ensure current and future human well-being, we conclude that an in-depth understanding of the services that ecosystems provide is necessary for the holistic management of the Earth system.

Keywords: ecosystem services; natural resource management; natural capital; ecosystem service provisioning; the cost-benefit ratio



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1. Introduction

Natural capital is the wealth of countries that determines their economic status in the World. All the prosperous nations are wealthy based on their natural resources [1]. Hence, each country's income estimates are focused on the share of natural capital they possess [2]. This makes it efficient natural resources management crucial for each country. Disadvantaged populations the world over depend on natural resources for employment, wages, revenue, and livelihoods and, in turn, describe the developmental index of the country they belong to [3].

Based on the value of natural resources, policies on their sustainable use can be established, and each country has its economic growth priorities that correlate to the scale of its natural resources [4]. The strategies are also established in terms of their long-term sustainability goals and are among the core principles of sustainable development goals of the United Nations [5]. To strengthen the motives for continuous development and eradication of poverty, every resource-rich country has aligned its present and future development policies in this direction [6].

Revenues from natural resources are central to any nation's economy, and increase due to the increase in goods and services they provide [7]. Resource-rich countries will continue to grow more productive because of the rapidly increasing demand for their resources from economies [8]. With the ongoing decline in non-renewable energy, their availability would reduce, raising the competition that contributes to higher costs and higher wages for nations. Eventually, countries having already received their income will receive more from natural capital, resulting in greater inequity worldwide [9]. Worldwide, marginal and poor populations, particularly rural communities, depend directly on their natural livelihoods, and hence if managed efficiently and sustainably, natural resources can also play a leading role in alleviating poverty [10]. It is one of the critical concepts that local or national strategies intended to enhance natural resource conservation effectively would positively influence global poverty reduction [11]. Environmental policies have been framed worldwide along these lines. As such, nations ought to boost programs targeted at citizen engagement in NRM, formulating laws centered on providing access to infrastructure by awarding freedom of usage and supporting assessment tools to measure the effectiveness of funded programs to alleviate poverty and sustainable development [12].

Researchers have proposed an asset-based approach focusing on balance sheets and capital maintenance to monitor and enhance the sustainability indices and works by identifying the assets that enable consumers and enterprises to participate in economic activity. Many of these are infrastructure items and public goods, and natural capital plays a significant role in managing natural capital. Depleting natural capital has overestimated economic expansion and has left a legacy of capital maintenance and augmentation in the 20th century. These concepts have established the guidelines for a sustainable economic growth route [13].

This short systematic review is based on the Scopus engine's bibliographic search (<https://www.scopus.com/>, accessed on 5 June 2021) and other reputable repositories such as WoS, PUBMED, and Google Scholar (<http://www.scopus.com/>, accessed on 5 June 2021). Any original research article or review paper published between 1989 and the date 5 June 2021 containing the following terms in the title, keywords, or abstract was eligible ("natural capital" or "environmental economics" or "natural resource management" or "sustainability"). The output summed up more than 1450 papers, which amounted to more than 749 without duplicates. Highly cited Scopus, WoS, PUBMED, and Google Scholar indexed publications were used for this review, and others were left out. Finally, 96 publications were included that were meant for the specified criteria of this short review.

2. Natural Resource Management (NRM)—Key to Sustainability

2.1. NRM and Natural Capital

Natural resource management (NRM) is central to every country's policymaking and involves mitigation programs for the vulnerable and underdeveloped during disasters and crises besides the far-sighted sustainability goals [14]. Therefore, every decision and policy concerning natural capital protection is crucial for environmental repayments to ensure long-term sustenance without becoming victims of catastrophe [15]. Hence, NRM focuses not only on merely living but also on nurturing and providing for intellectual development, and the returns from natural resources are eventually utilized for the overall good of human civilization [16]. The concept of sustainable development is shown in Figure 1.

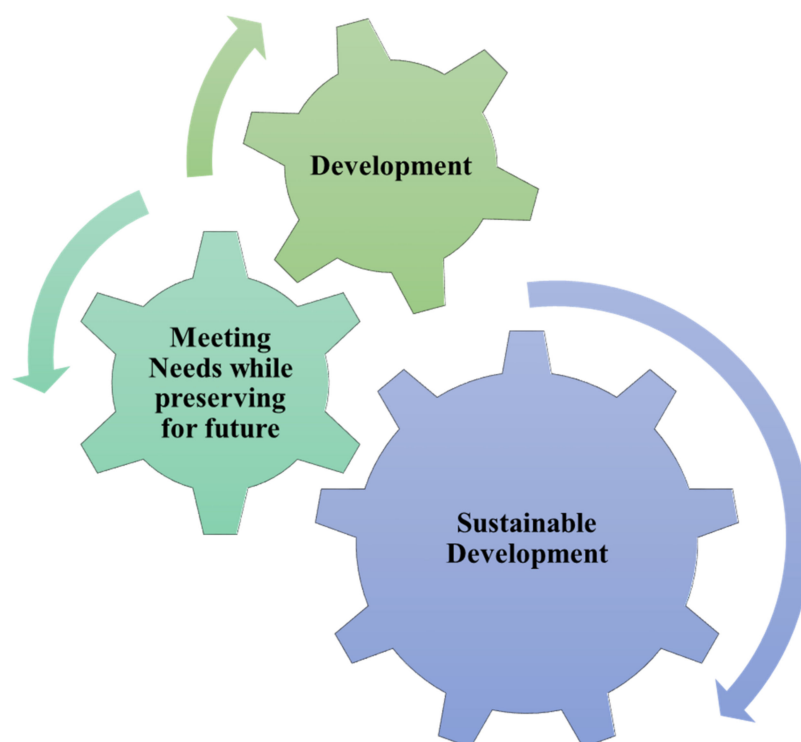


Figure 1. Concept of sustainable development [17].

For determining the precise value of the natural capital, individual-specific indices need to be generated. Economists have established various methods of measuring the value of natural capital so that people are made aware of their costs [18]. The two most used are existing income flows, and the potential income flows. Both of them operate due to manufacturing costs and demands that rely on the advantages and control of natural resources. However, there are often limitations to each method [19].

Researchers have developed some intriguing concepts to manage natural resources sustainably. Rick van der Ploeg (2017) proposes the permanent income theory, the hotelling rule, and the Hartwick rule as significant concepts to discuss how best to manage the many components of national wealth. These concepts propose an intergenerational sovereign wealth fund, a liquidity fund to act as a precautionary buffer to deal with commodity price volatility, and an investment fund to store some of that windfall until nations are ready to absorb the extra spending on domestic investment [20]. These planned economic set-ups are required to smooth up the natural resource consumption across human generations. Regarding the existing income flows, this approach is often misleading as it offers the value of natural capital as an inherently inaccurate overview of economic growth because of the inefficient indices that are represented as short-term progress. However, in the long term, when capital is no longer accessible, development inevitably ceases [21]. This very idea must be integrated into the nation's public policy system that invests in the production of human capital, different portions of the riches of natural resources [22]. Therefore, the basis for future investments is the sustainable management of all types of natural resources [23].

Estimation or valuations of natural resources is essential to help in decision making as already discussed in previous sections. In this context, a study carried out by Tolessa et al. (2017) in Chillimo Forest, Oromia National Regional State, Ethiopia showed that services provided by soil such as water regulation and supply, erosion control, soil formation, nutrient cycling, food production, and habitats had shown a drastic change in economic values due to change in the land use/land cover (LU/LC) patterns over four decades [24]. The authors argued that findings in terms of monetary values are indispensable to formulate environmental payments regulations and rural growth policies.

Both anthropogenic and natural, the LULC shift's effect is one of the most significant drivers of change in ecosystems and their services and poses substantial threats, particularly to soil ecosystem processes and functions [25]. After the industrial revolution, the critical drivers of LULC change worldwide have been population growth and economic expansion, especially in developing countries that prioritize economic prosperity [26]. Seventy percent of the world's largest cities can now be found in the developing world [27]. In fast-growing developing countries such as India, China, Pakistan, and Turkey, the rapid urbanization and widespread LULC shift have drawn stakeholders' challenges to devise policies that could ascertain the ecosystem's welfare and efficiently perform natural resource management practices. Throughout the unprecedented transformation from a predominantly agricultural society to a modernized and industrialized society, vast areas of arable land, forests, grasslands, and numerous bodies of water have inevitably been used in new ways to meet the high demands of urbanization and industrial growth, ultimately affecting the services provided by the fundamental component of the biosphere, the soil [28,29]. NRM is the solution that needs to be incorporated at all levels of policymaking, from local to global. Figure 2 shows ways of successful implementation of the concept of sustainability.

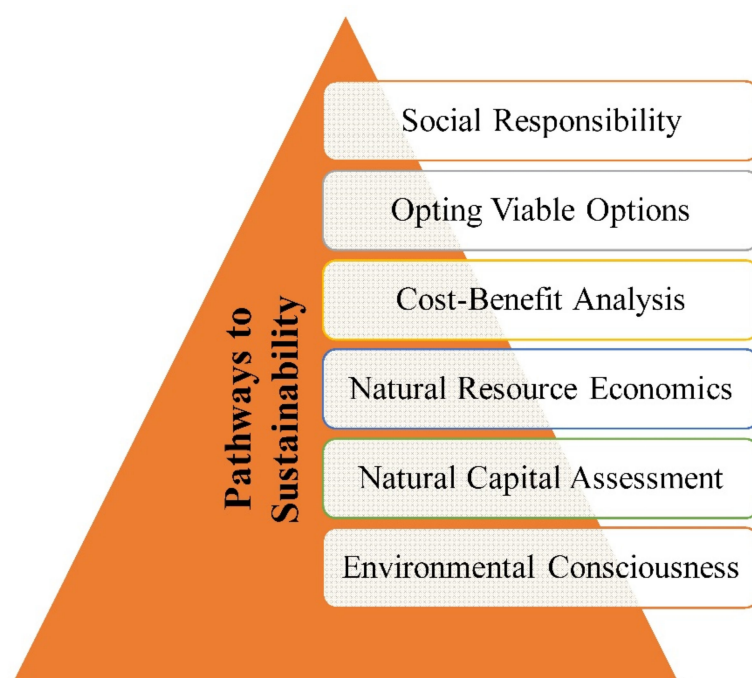


Figure 2. Pillars of successful implementation of the concept of sustainability.

2.2. Humans and Eco-Service Values

Since early times, the foundation of every human civilization's economy has been the services provided by the ecosystems [30]. However, it has been considered and limited to the functioning of natural systems. Almost all the life-supporting functioning of the biosphere is sustained by the ecosystem, including waste storage, water, and nutrient storage, seed distribution and pollination, control of crop pests, and food and habitat supply for the organisms, in addition to the essential requirements of life such as air and water [31–34].

The provision of ecological resources is thus needed for forest, fish and wildlife, safe water and air, and agricultural development, and hence necessitates the development and conservation of environmental goods, which otherwise are regarded merely as natural resources (Figure 3) [35]. Unless humans notice the decline in habitats, biodiversity degradation, and deserts, environmental resources are not valued, and their understanding the economic effect of depleted environments must be assessed [36]. Ecosystem facilities also

deliver leisure and cultural events, including aesthetic enjoyment, teaching, and science study [37].

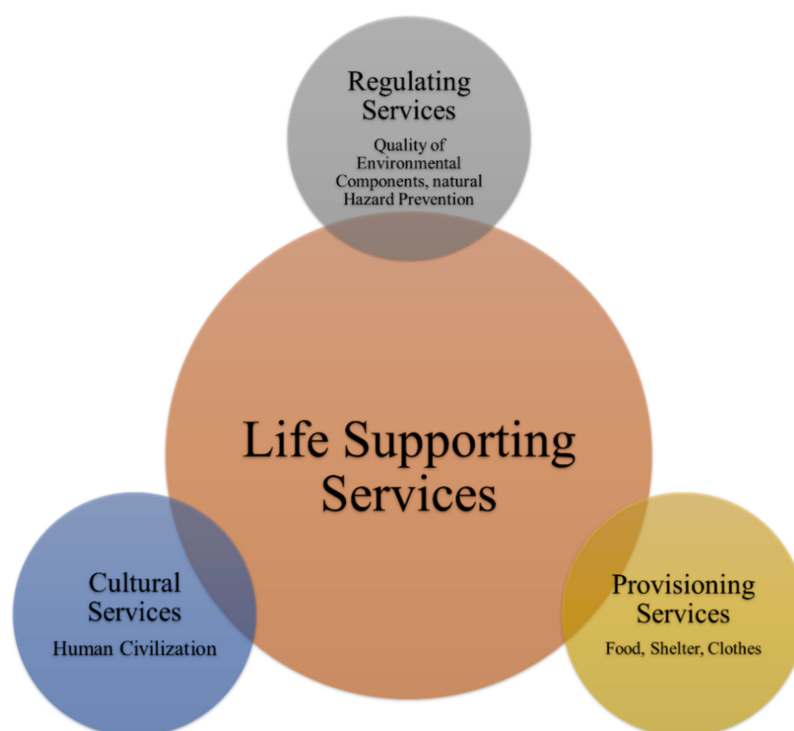


Figure 3. Services ecosystems provide for sustaining life on Earth [35].

De Groot et al. (2012) gave an overview of 10 principal biomes' values based on accounting units for ecological systems [38]. In total, 320 publications were screened, covering over 300 case study locations. About 1350 estimates of the value were coded and stored in a searchable Ecosystem Service Value Database (ESVD). For the analysis, a selection of 665 qualitative descriptions was used. The study showed that the total value of ecosystem services is considerable and ranges up to trillions of dollars per year for the pack of ecosystem services that could potentially be provided by an 'average' hectare of open oceans [38].

Furthermore, in another report, Costanza and colleagues measured the annual value of ecological services worldwide at around twenty billion dollars. UNEP reports that carbon conservation by trees is worth 4 billion US dollars. Pollination by insects adds about 200 billion US dollars per year to cultivation [39]. Furthermore, Balthazar et al. (2015) [40], using five decades of land cover maps, tried to analyze the impact of forest cover change on the services ecosystems provide. The study had devised a new method called a multi-source convergence approach to reduce the uncertainties arising due to differences in resolutions of aerial photographs and satellite imagery. The study was carried out in Pangor catchment, Ecuadorian Andes. They demonstrated that studies carried out at a shorter time interval might show contrasting results as their results showed net reforestation for the 1990s. However, over the 50 years, the results showed that ecosystem services provided by the soil particularly biodiversity, soil structure, and composition, protection against water erosion, above-ground carbon storage (biomass), soil carbon storage, and aesthetic quality of the landscape, gradually fell by 16%. Moreover, globally, the conversion of grasslands into plantations has mostly had an adverse and potentially lasting effect on the distribution of ecological services provided by the soil. Furthermore, in many areas, the transformation of degraded agricultural land into pine plantations as a means of reforestation, for example, has resulted in a shift in ecological conditions destroying the biodiversity and functioning of the natural landscape.

2.3. Natural Resources-Based Capital and Employment

Natural resources are typically the backbone of local livelihoods in low- and middle-income countries and can be used to encourage investment that enhances the most underprivileged sections of the community by continually monitoring proactive policies and regulations (Figure 4) [41]. In poorer countries, natural capital is the primary source of employment, and leaders also prefer to encourage their optimism as incentives [42].

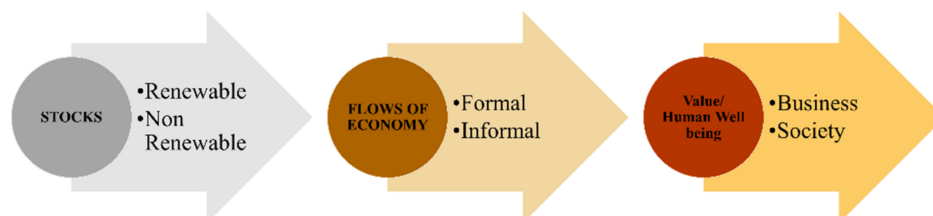


Figure 4. Human well-being is a determinant of the stocks of natural resources.

Administrators emphasize their actions on the conditions for unemployment and the need to boost the GDP in all situations [43]. Jobs are created as governments agree that vast numbers of small farmers should be given production privileges. The obligation to achieve sustainable returns from reducing big firms are optional when GDP is rising [38]. Many researchers have shown that economic stability enhances individual well-being in a country by providing a safety net of protection against negative income shocks, permitting current and future spending flows [44]. The fisheries industry is a persuasive example of this practice, where the more significant yet limited number of ships is more equipped to gather fish for export, while an immense flotilla of small fishing ferries would produce a more considerable amount [45].

Nonetheless, studies indicate that non-farm revenue from natural resources plays a significant role in maintaining rural livelihoods [46]. Policy policies aimed at promoting small and medium-sized businesses, focused on utilizing local natural capital in many instances, will encourage the development of rural economies [47]. A convergence of priorities development, employment, and long-term economic prosperity can be seen in the implementation of policies that position countries on the road to green growth [48].

Natural resources may provide significant employment [49]. While this number of employees engaged in industrialized, environmentally destructive companies has decreased substantially due to the enormous potential of mechanization and increased efficiency, job opportunities in the renewable energy sources have risen and have the potential to continue to expand over the long term [50]. For instance, clean energy workers in Europe alone have risen from over 60,000 in the late 1990s to more than 300,000 in 2006. Sustainable energy industries created more than a million employees in the late 2000 decade. Over a decade, Sweden has had a substantial and growing conservation sector, which, according to an estimate, hired around 1.5% of the national population in 1998 [51]. According to figures, Germany employs approximately 2 million employees in sustainable sectors of employment [52].

Green jobs are also on the rise in agriculture, with research finding that organic farms have more jobs per output and selling units than traditional farms do. Sustainable, organic farming requires smaller-scale farms and less computer reliance, thereby providing more employment [53]. Although the opportunities for job development in forestry are more nuanced, it provides steady jobs for around 2% of the world's population [54]. Over the coming decades, foresting programs relevant to growing demands for wood fiber and carbon sequestration would generate new employment [55].

2.4. Poor Natural Resource Management and Costs to Human Well Being

The worldwide cost of inadequate natural resource protection is considerable, impacting least-developed, and developing countries alike [56]. Weak management of resources

includes failure to sustainably maintain sustainable resources—such as loss of surplus grains in stores of India—as well as failure to adequately spend the profits from non-renewable resource purchases and failure to obtain sufficient rent from energy contracts causing the bulk of capital to go to private companies at the expense of this, a case that is being witnessed in India right now [57]. Table 1 summarizes some of the few natural resources and their approximate economic costs (in dollars) calculated using various econometric methods. It is evident from these approximate estimates that it is virtually incomprehensible to fully assign total costs to the complete biosphere that supplies ecosystem services for humans to live. These estimates have also been plotted in Figure 5.

Table 1. Few of the natural resources and their approximate economic valuations.

S No	Natural Resources	Approx. Value in Dollars	Source
1.	Freshwater	73.48 trillion	[58]
2.	Trees	16.2 trillion	[59]
3.	Coral reefs	9.9 trillion	[59]
4.	Wild sea fish	274 billion	[60]
5.	Plankton	222 billion	[61]
6.	Bees and other pollinators	170 billion	[62]
7.	Coastal wetlands in US	23.2 billion	[63]
8.	Polar bears in Canada	6.320 billion	[64]
9.	Sharks	944 million	[65]
10.	The Grand Canyon	711 million	[66]
11.	Yellowstone National Park	543.7 million	[66]
12.	Dung beetles	380 million	[67]
13.	Corbett Tiger Reserve India	235.2 million	[68]
14.	Manta rays	140 million	[69]
15.	Birds in Seattle	120 million	[70]
16.	Wild river eels	72 million	[71]
17.	Wild sturgeon	5 million	[71]
18.	Beaver	120,000	[72]
19.	Acre of oyster reef	6800	[73]
20.	Sea otter	6250	[74]
21.	Wild salmon	81	[75]
22.	Indian vulture	65	[76]

Maximizing short-term profit is liquidating natural capital; for example, the green revolution in India generated surplus grains but affected the long term sustainability of the land to maintain natural fertility and hence such unreliable information and forecasts of the pace of production at which the resource is produced ultimately negatively affect the resource itself [77,78]. The returns do not prove sustainable in these cases, and the resource has been depleted. Poor results also arise if the possible competing uses of resources are not considered and strategically integrated [79].

In a transboundary context, this can be incredibly difficult. For example, water-related problems pose significant obstacles to controlling natural resources and international collaboration in Central Asia, as was witnessed in the case of the Amu Darya and Syr Darya basins [80]. Water demand is increasing, but frameworks for collaboration between upstream and downstream countries are still inadequate, as is witnessed in the case of the Jhelum basin, Kashmir, and many other similar areas of the world [81–83]. Deserts expand due to lousy farming methods, fisheries decrease because of the Syr Darya and the Amu Darya, and climate change renders water availability uncertain [84]. Also affected is energy production in dams. Increasing food and fuel prices also present significant challenges to human security, especially in the poorer Tajikistani and Kyrgyz countries [85].

Furthermore, Assennato et al. (2020) [86] assessed the value of controlling erosion (a key product of human negligence) if decisions regarding land-use planning are made, keeping sustainable management goals (SDGs) into consideration. This study carried out in the whole of Italy revealed that the increase of Italy's soil use between 2012 and 2018,

equivalent to approximately 30 hectares, is significantly correlated with the economic loss of about 2.5 billion euros per year. Moreover, it also showed a significant correlation with erosion management needed to overcome the negative impacts of unsustainable soil use, costing about 35 million euros per year.

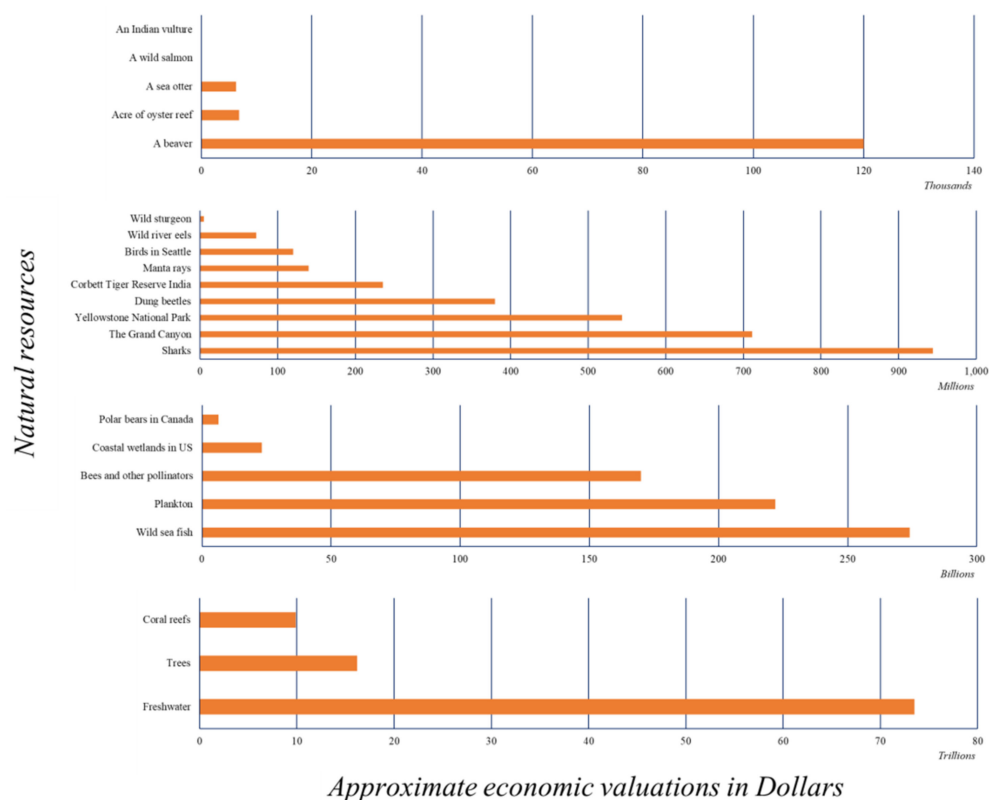


Figure 5. Graph depicting some natural resources and their approximate economic valuations using various econometric models [58–76].

It is observed that quantifying the implications of land-cover change on ecosystem services to address the knowledge gap requires significant issues surrounding the development of urban areas and human activities on ecosystems [87]. However, solutions to problems ensuring that new information is manifested as sustainable decisions can only materialize if all the stakeholders agree to sustainable terms and conditions. Furthermore, while much research deals with the rate of degradation in various land usage situations, few studies have discussed how resource use impacts the services they provide. Studies need to be carried out globally to educate people regarding the effects of resource use and the policies that can be implemented to help overcome ecosystems' destruction to ascertain human well-being (Figure 6).

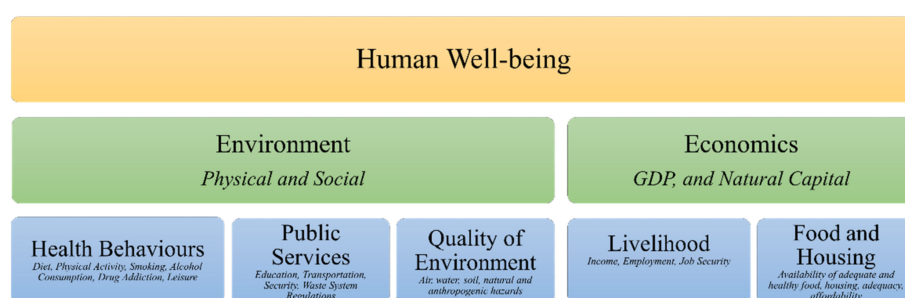


Figure 6. Major determinants of human well being.

3. The Way Forward

Throughout the recent global financial and economic crises, the possible synergies between policies for encouraging a transition to green development have become apparent [88]. Several policymakers have emphasized the significant effect of some of their green initiatives on jobs [89]. In the US alone, the Economic Advisers Council estimated that by the end of the 2010s decade, the Recovery Act's nearly 100 billion USD jump would maintain or produce over 1 million productive years. The current research further shows that around 30 million jobs will now be created by 2050, despite mounting energy alternatives such as wind power generation, photovoltaics, and bioenergy-related agriculture and industry [90].

Alternatively, poor management of natural resources represents lost opportunities and cost to human beings and the environment for sustainability [91]. The harm to individuals and the ecosystem through ineffective capital management activities and strategies is evident from various global studies, although the net costs in lost resources are impossible to measure [92]. The mismanagement of resources has a strong and catastrophic effect on the whole economic set-up humans have developed since the industrial development era [93].

These adverse effects will only be averted if policymakers implement resource allocation strategies that consider long-term sustainable horizons which employ a full resource exploitation process, i.e., shutting/down to avoid hazardous pollution and the equilibrium between existing revenue generation and potential development of energy [94]. In other terms, this is called sustainable development, which precludes new opportunities to the employees, employers, and future of the Earth [95,96].

However, the green economy is both an advantage or disadvantage for the labor market and skills, which are the significant factors that govern the green growth market. Hence policies must be developed that cater to the challenges and opportunities to transition to a resource-efficient, low-carbon, green economy. The entire global economy across various sectors will bring profound transformations, whereby more jobs will be created, and many jobs will be eliminated or reframed. Hence a far-sighted approach is required to target the labor market and establish the necessary conditions for supporting green jobs, bridging the gaps in the required skills and shifting the need for human capital requirements to greener alternatives.

4. Conclusions

The cost of the resources of the planet is too high what humans have known so far. Using unsustainable means of development, developed and developing countries have adversely affected Earth's natural resource base. The human species cannot thrive without the natural resources and services that ecosystems provide. The review discussed various studies regarding the capital values of ecosystem services. Moreover, it has also been discussed how the green economy will eventually become the new governing concept if the planet's resources are managed sustainably. Until now, the mismanagement of natural resources has only led to the devastation of ecosystems. The solution can only be to understand the importance of the ecosystems by assessing the capital value they possess. Throughout the world, policymakers need to step up to think about the welfare of current and future generations by seeking scientists and ecosystem economists' help. The green economy has to pave the way for the Earth's sustainability in every aspect, be it environmental or human employment.

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