




Article

Addressing Gaps in Environmental Water Policy Issues across Five Mediterranean Freshwater Protected Areas

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Abstract: The increasing pressure on water resources in Europe's broader area led member states to take measures and adopt a common legislative “umbrella” of directives to protect them. The aim of this research is to investigate practicing deficiencies, information lacks and distances from optimal status as set by the Water Framework Directive and supporting water uses. This contributes to the improvement of the efficiency and harmonization of all environmental goals especially when management of Protected Areas is addressed. Gap analysis, an approach that reveals the distance between current and desired level, was carried out, targeting five Mediterranean hydro-ecosystems, covering three major water policy pillars “Monitoring Practices”, “Management Practices” and “Water Quality and Pressures”. Data for such analyses was collected by literature research supported by a query matrix. The findings revealed a lack in compliance with the Water Framework Directive regarding the “Monitoring Practices” and several deficiencies in sites burdened by eutrophication and human pressures on “Water Quality and Pressures” field. As for “Management Practices”, extra effort should be applied in all hydro-ecosystems to reach the desirable state. We suggest that gap analysis, as a harmonization tool, can unify apparently different areas under the same goals to reveal the extra necessary “investment”.

Keywords: gap-analysis; water monitoring; management; protected areas

1. Introduction

Europe encloses water landscapes which are often dominated by various phenomena depending on regional characteristics and pressures. Such may be water scarcity, flood events, resource overexploitation for agriculture, forestry or aquaculture, pollution, seawater intrusion, severe hydromorphological changes and large-scale infrastructure. At the European Union (EU) level, freshwater policy derives mainly from two major Directives: the Water Framework Directive—WFD (2000/60/European Commission (EC)) that calls for “good ecological status” and the Habitats Directive (92/43/European Economic Community), targeting the network of the Natura 2000 protected areas (PAs) that calls for “favorable conservation status”. Directives bound the member states with results to be achieved, but each state can choose the methods for their implementation. Yet, water policy is also influenced by the Groundwater (2006/118/EC) and the Floods (2007/60/EC) Directives.

The water policy literature emphasizes the need for wide participation across institutions, at multiple levels (European, national, regional and local), in order to guarantee effective implementation and harmonization across EU countries [1–3]. The task becomes more difficult when it comes to managing water bodies in freshwater PAs, which are also designated as nature reserves (i.e., enlisted in the Natura 2000 network). That is because such areas have to respect the “umbrella” of EU directives,

national legislations for PAs management and statutory limits for each resource usage. Under these circumstances, knowledge on various aspects and concerted effort of the involved decision-makers that can determine the outcomes of a local management plan is very valuable. Protected freshwater areas, ecologically healthy and well managed, are essential ecosystems for securing the provision of freshwater services [4,5], while, very often they consist an important component of the whole river basin district [6], requiring wider management policies. Since the conservation goals of a Natura 2000 site and the environmental objectives of a water body, under the WFD, are often overlapping, the establishment of a tailor-designed, integrated monitoring programme, able to provide all the necessary information to build a body of knowledge, becomes of prime importance. Moreover, dealing with more than one legislative tool requires harmonization and constant re-evaluation to improve personnel, money and time efficiency. Evaluating the human pressures and implementing policy measures through the improvement of monitoring and management practices is a major challenge all over the world [7].

Focusing on the Mediterranean region, the acknowledgement of: (a) the additional stress due to water scarcity along with the high human pressure and (b) the structural and functional diversity of protected freshwater ecosystems, have been recently reflected in various research activities [8,9]. This may have profound practical consequences on water bodies' management and policy strategies, identifying the best management practices under multiple stressors' conditions, thus providing potentially useful information applicable to freshwater ecosystems.

Despite all the efforts and sound objectives in the European water policy legislation, progress in implementing the existing directives is slower than expected in many Mediterranean cases [10–14]. At the same time, the gaps between science and policy highlight the scarce development of efficient tools and models to be transferred towards policy implementation. This could be attributed to the lack of synthesis of a broad range of observations across water policy institutions or to the absence of common qualitative objectives which must be translated to quantitative targets. Socio-economic factors and political constraints also play a crucial role both at the Mediterranean and at a national level concerning the design and implementation of water policy. Stakeholder involvement is not only regarded as an essential element in environmental management and decision making [15], but it is also considered as critical in the context of ecosystem services [16–18]. Nowadays, it is a widely shared opinion that under conditions of complexity, uncertainty and difficulty of evaluation, common to many environmental problems, public participation has an important role in decision-making.

The overall objective of this research, included in the Interreg-MED 2014–2020 funded project entitled “Ecological sustainable Governance of Mediterranean protected areas via improved scientific, technical and managerial knowledge base” (EcoSUSTAIN), is to improve monitoring, management and networking, with the assistance of Information and Communication Technologies (ICT), of five freshwater ecosystems which are enlisted in the catalogue of the European PAs and National Parks (NP), thus the need for effective management and conservation is highly demanded. In order to achieve the main objective, the gap between current and desired level of several water governance factors were assessed. The paper presents the monitoring and the management strategy along with the mapping of pressures across these five areas.

A prerequisite in addressing this issue is the estimation of the existing knowledge that the Management Bodies (MB) of each PA obtain on monitoring and water-quality status, in comparison to each ecosystem's needs. In undertaking a gap analysis, as used in business and management planning processes literature, clearly, the addressed question is “where we are and where we want to be”. Gap analysis is a powerful and efficient step towards setting management priorities especially concerning protected areas. It provides focus, direction and accountability for improving management efforts as a diagnostic tool. It is a tool of broad use adopted by several organizations (i.e., the World Health Organization (WHO), the United Nations International Children's Emergency Fund (Unicef), the International Union for Conservation of Nature (IUCN)) [19–21] for various reasons with biodiversity and natural resources protection among them. Biodiversity or qualitative elements identified as

“missing” through a gap analysis can then be examined more closely for their improvement and to support stakeholders’ work with biodiversity related data [22,23]. Gap analysis, as a method for identifying ‘gaps’ in land and water conservation practices has been applied in many studies [24–26]. The USA has applied a vast gap analysis project attempting to assess the status of the nation’s biodiversity [27]. Gap analysis has been performed during the environmental planning processes in Victoria-Australia [28], in Ohio nature reserve design [29] as well as in many other cases [22,30] dealing mostly with PA and PA networks management and used also as a mean to improve the overall level of water services [31].

In our research, gap analysis was selected for use since it is considered as an appropriate method to assess the conservation status (of protected areas, reserves, habitats, species) and to identify and evaluate priorities, thus providing information to decision makers. It is a novel, broadly accepted approach based on Burley’s [32] and Scott’s [33] concepts for the “identification of conservation gaps as a process to identify and classify the various elements of biodiversity and examine the existing system of protected areas”. Conservation and management prioritization methods usually perform gap analyses when a need to review or expand management plans exists.

Gap analysis is carried out as a comparison of actual performance with potential or desired performance [34–36] and not as a massive geographic information system (GIS)-based analysis for terrestrial areas like ecotopes [33]. In our case we adopt gap analysis as a “bottom-up” approach, described as one step procedure towards a comprehensive natural resource management planning effort. This approach transcends political boundaries [37–39] and allows creativity and collaboration at state and local level, where most land management decisions are made [40]. It is used, firstly, as a simple tool to assist the quantification of the gap between present and desired level of knowledge on fundamental aspects of WFD- and PA-related directives and, secondly, to periodically review and monitor the level of compliance [41].

Also, beside the deep insight on these three major water governance pillars in five PAs, a base is provided on which we can develop optimization scenarios for better PA operation accounting also for socioeconomic parameters. As a next step, the gap analysis could be integrated in a regional/national planning process beyond the boundaries of the protected areas. Working on gap analysis, freshwater ecologists, planners and environmentalists are cooperating towards effective conservation and management practices.

2. Materials and Methods

2.1. Description of the Study Areas

Five freshwater ecosystems (Figure 1) that are enlisted under the network of Natura 2000 and located in European NPs of the Mediterranean region are set as study sites:

1. Lake Albufera in L’ Albufera Natural Park—Valencia, Spain
2. Lake Visovac in Krka National Park—Šibenik, Croatia
3. Mantua Lakes in Mincio Regional Park—Mantova, Italy
4. River Una in Una National Park—Bihać, Bosnia and Herzegovina
5. Lake Karla in the Protected Area of Karla—Magnesia, Greece



Figure 1. The five study-area national parks' locations.

L' Albufera wetland, declared as Natural Park, Ramsar wetland, Important Bird and Biodiversity Area and site of Natura 2000 Network, occupies 211.2 km². The natural park is defined by a freshwater lagoon (23.2 km²), separated from the Mediterranean Sea by a sand barrier (33.2 km²). The climate is characterized as semiarid. Rice is the main crop and controls the water management. The lake is a very shallow polymictic one, hypertrophic since 1970 with potentially toxic cyanobacteria existence, high pH, co-occurrence of both freshwater and oligohaline waters [39,40] intense temperature variation due to its low depth, reaching a bad ecological status. Moreover, it is highly regulated, as the 70% of its inflows pass through a historic irrigation system.

Krka National Park lies within Šibenik-Knin County and covers a total area of 109 km² of the Krka River routine. It is a natural park and a Natura Network 2000 site. Visovac Lake is located at southwest of the Dinarid Mountains, formed by Krka River. It is a travertine barrage lake of 7.9 km² with a maximum depth of 30 m [41]. The climate is continental influenced by the mid-Mediterranean climate. Visovac Lake is monomictic system characterized by relatively high freshwater intake. Although it is located in a sparsely populated and almost intact environment, upstream some significant anthropogenic sources of pressure can be found, making it a sensitive ecosystem. Recent measurements of nutrient salts and organic pollution, on behalf of the PA management authority (unpublished), pose the matter of accumulation, endangering biota and water quality [42].

Mincio Park is a 19.47 km² PA. It is declared a Ramsar wetland and a natural reserve. Part of it is a Natura Network 2000 site. The climate is warm and temperate. This National Park hosts a heterogenous natural environment formed by several water bodies with different hydrological characters [43]. Mantua Lakes are a group of three eutrophic urban lakes situated in a valley-lacustrine system, with reduced hydrodynamism and many hydromorphological alterations. Based on previous monitoring results of the PA, the lakes, created by dammed meanders, are usually CO₂ supersaturated, with anoxia impacting on biological communities [44].

Una National Park lies in the northwestern part of Bosnia and Herzegovina and has an area of 198 km². The park encompasses the Una river valley, the canyon and orographic slopes of neighboring massifs. The Una River is 212 km long and emerges as a karst spring, at the foot of the Pljesevica

and Strazbenica mountains. A moderately continental climate characterizes the area [45]. No visible effects of pollution or morphological alteration can be found in the area. The terrain assists to the self-purification ability of the system. It is neutral to alkaline pH and there are observations of relatively high calcium concentration and metal traces, while manganese is disturbing (Una PA MB unpublished data).

The Protected Area of Lake Karla, situated in the Eastern Thessaly has an area of 1.280 km² and is characterized by great land use heterogeneity. Parts of it are characterized as important bird and biodiversity areas and Natura Network 2000 sites. The newly recreated artificial Lake Karla, located at the lowest altitude, covers an area of 38 km². It is a very shallow, heavily modified water body and it is governed by a continental climate [46]. Lake Karla is exposed to point and diffuse pollution sources, which come from the intensive agricultural and livestock activities, leading already to a progressive eutrophication. It is characterized as eutrophic to hypereutrophic with frequent occurrence of algal blooms [47].

2.2. The Conceptual Framework

The gap analysis is undertaken with contributions from all EcoSUSTAIN partners and carried out on the sum of five Mediterranean PAs in three fields, covering: (a) “Management Practices”, (b) “Monitoring Practices”, (c) “Water Quality and Pressures”, to investigate sectoral or practicing deficiencies as well as information lack and distance from desirable status. More specifically, analyses take place inside the following three conceptual frames:

- Management Practices: the set of queries selected in this field is such that can produce a clear image regarding PA management structure and actions regarding to its effectiveness, the PA accessibility and relations with visitors along with other goods and comforts provided (Table A1).
- Monitoring Practices: Parameters indicative of biological, hydromorphological and physical-chemical quality elements are required to be monitored within certain frequencies. Similar to the WFD, other EU directives (bathing, nitrates, habitats), comprising Europe’s water policy legislation, set the frame of requirements for monitoring on which regional and national institutions are supposed to base their monitoring programmes. In this field, several quality elements, their monitoring frequencies and special assessments are included (Table A2).
- Water Quality and Pressures: This criterion is addressed mostly as the knowledge availability, for the ability of comparing biological, physicochemical, ecological and other abiotic parameters with the limits of guidances and directives, and synthesizing the information required by broadly accepted indexes. Along with the aforementioned parameters, descriptive assessment of probable amelioration/deterioration on certain ecosystem values and services is evaluated (Table A3).

2.3. Gap Analysis Methodology

The gap analysis applied methodology can be described by four steps, presented below:

1. First the identification of the objectives is set, meaning the desirable level (the 100% of the target value) which is different for each field. A final selection of 15 queries was considered as enough to reflect the preferable status in all three fields. An equal number of queries is selected for the comparability of the results.
2. Second comes the analysis of the current situation. The current situation is quantified based on: PA’s responsible MB on the three-set query matrix along with a dataset of recently (2016, 2017) monitored elements for the waterbodies provided by each PA Management Authority enriched with a database formed by raw data, gathered during an extended literature review.
3. The third step is gap assessment. The gap stems from the difference between current and desired level; namely the percentage of indices measured, along with their values of the ideal situation. These percentages come from the replies of the queries as follows: when the reply is yes or no, the percentage results in only two options, 0% or 100%, but when the reply has more options,

a classification of percentages is raised, according to the number of classes. When descriptive assessment is applicable in queries, replies stating amelioration are graded positively, those stating deterioration are graded negatively and those stating stability with half the full grade. More details on the grading of each query is presented in Appendix A.

4. In order to visualize the gap, simple mathematics are applied. The cumulative average statistics are used to assess the final results of every PA for the examined fields. A comprehensive presentation is performed regarding the derived percentage value for each query of the three thematic categories. Each one of these queries is equally important for the analysis, so, no weight coefficients are used. The same mathematic formula applies for the final value that characterizes each MB of PA and each category. This final value is the average of the gap of all three categories.

3. Results

For the needs of a comprehensive presentation of the results, three tables were created (Tables 1–3), showing the graded percentages of the queries' answers for the five PAs, regarding the fields of Management Practices, Monitoring Practices and Water Quality and Pressures.

Table 1. Percentages of gap analysis of the five protected areas (PAs) regarding the management practices. 1: L' Albufera, 2: Krka, 3: Mincio, 4: Una, 5: Karla.

Management Practices Queries	1	2	3	4	5
Operation under Legal and administrative frameworks (Environment, Biodiversity, Tourism, Research)	75%	100%	75%	100%	50%
Main actions (Surveillance, Environmental Awareness, Monitoring)	67%	100%	67%	33%	100%
Public involvement actions and stakeholder meetings	100%	100%	100%	100%	100%
Different Sources of income	50%	50%	25%	75%	50%
Volunteer Involvement	100%	100%	100%	100%	100%
No of employees per ha of PA's Management Body (MB) ¹	25%	100%	100%	75%	25%
Departments (Environment, Biodiversity, Surveillance, Tourism, Other)	60%	80%	100%	60%	80%
Employees training & education	100%	100%	100%	100%	100%
Application of best practices in Management plan	100%	100%	100%	100%	0%
Involvement of other Bodies/Stakeholders for management plan application	100%	100%	50%	50%	50%
PA open to visitors and existence of information points	100%	100%	100%	100%	100%
Organized fieldtrips or rides	100%	100%	100%	100%	100%
Ecological norms or ISO standards	0%	0%	0%	0%	0%
Posters stating basic behavioral standards for tourists	100%	100%	100%	100%	100%
Waste and recycling disposal places within PAs	0%	100%	100%	100%	0%

¹ The value 100% refers to the MB with the maximum number of staff of this fraction. It is not indicative of each MB performance.

Table 2. Percentages of gap analysis of the five PAs regarding the monitoring practices. 1: L' Albufera, 2: Krka, 3: Mincio, 4: Una, 5: Karla.

Monitoring Practices Queries	1	2	3	4	5
Water Monitoring	0%	100%	100%	100%	100%
Biodiversity Monitoring	100%	100%	100%	100%	100%
Water body identified according to Common Implementation Strategy Guidance (CIS) for Water Framework Directive (WFD)	0%	100%	100%	0%	100%
Water body subject to a monitoring protocol	100%	100%	100%	100%	100%
Monitoring involves chemical water quality	100%	100%	100%	100%	100%
Monitoring involves biological water quality	100%	100%	100%	100%	100%
Monitoring involves hydromorphological modification assessment	0%	100%	0%	0%	0%
Impact assessment	100%	100%	0%	100%	0%
Ecological services assessment	0%	100%	0%	100%	0%
Frequency for hydromorphological modification monitoring	100%	50%	0%	100%	0%
Frequency for hydrological parameters monitoring	100%	100%	100%	100%	100%
Frequency for nutrient parameters monitoring	100%	100%	100%	50%	100%
Frequency for chemical and abiotic parameters monitoring	100%	100%	50%	0%	100%
Frequency for indirect algal biomass monitoring	100%	100%	50%	50%	50%
Frequency for biological parameters	100%	50%	100%	0%	50%

Table 3. Percentages of gap analysis of the five PAs regarding the water quality and pressures. 1: L'Albufera, 2: Krka, 3: Mincio, 4: Una, 5: Karla.

Water Quality and Pressures Queries	1	2	3	4	5
Observed changes in water quality	100%	50%	50%	100%	0%
Observed changes in lake habitats	100%	50%	50%	-	0%
Observed changes in river habitats	-	50%	50%	100%	50%
Observed changes in conservation activities	100%	100%	0%	100%	50%
Observed changes in birds' presence	100%	50%	50%	100%	100%
Sewage treatment plants influence in area	0%	100%	50%	100%	100%
Agrochemicals influence in area	0%	100%	50%	100%	0%
Organic waste influence in area	0%	100%	50%	100%	0%
Discharges influence in area	0%	0%	50%	100%	0%
Uncontrolled residues accumulation influence in area	50%	50%	50%	100%	0%
Carlson Trophic State Index	100%	100%	100%	80%	100%
2008/105/EC—Priority Substances Directive	100%	75%	75%	50%	25%
2006/44/EC—Fish-Life Directive	100%	92.3%	84.4%	76.9%	100%
WHO Standards on recreational waters	100%	75%	100%	50%	25%
Other basic optional physicochemical parameters	100%	71.4%	85.7%	42.9%	57.1%

A mean value, for each PA, was calculated for the percentage values of all the queries. This application returned a percentage value per field for each PA, as shown by the graphs of Figures 2–4.

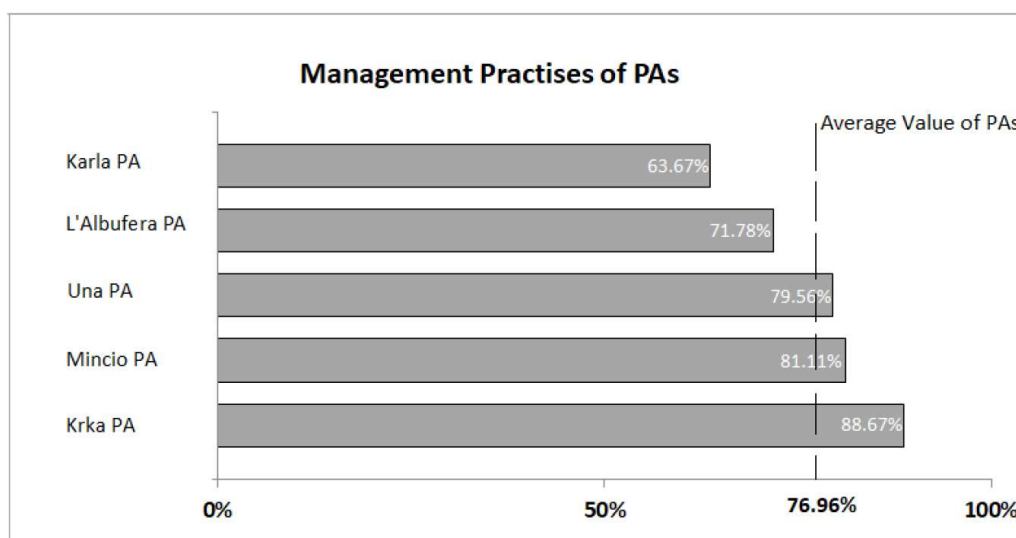


Figure 2. Gap rating on “Management Practices” for each of the five PAs.

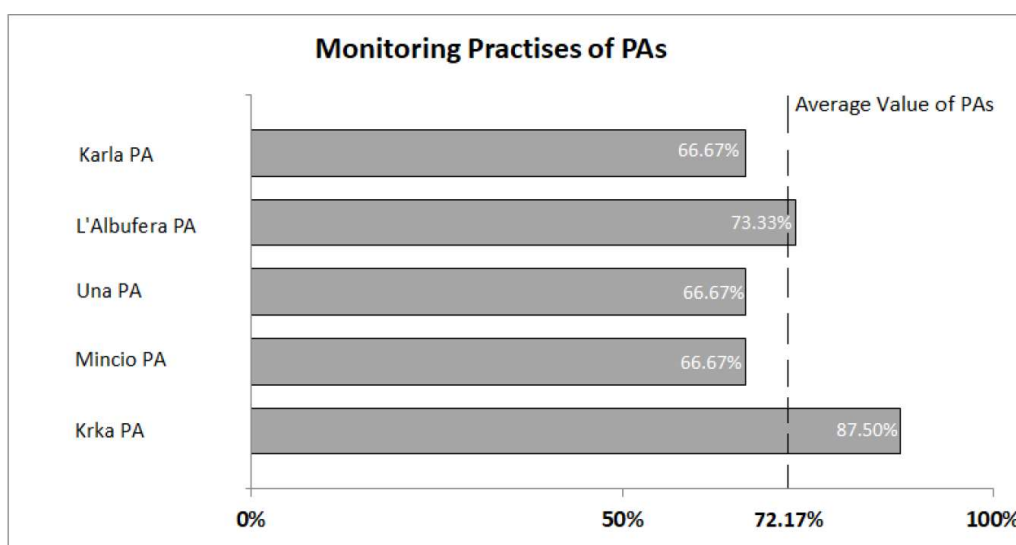


Figure 3. Gap rating on “Monitoring Practices” for each of the five PAs.

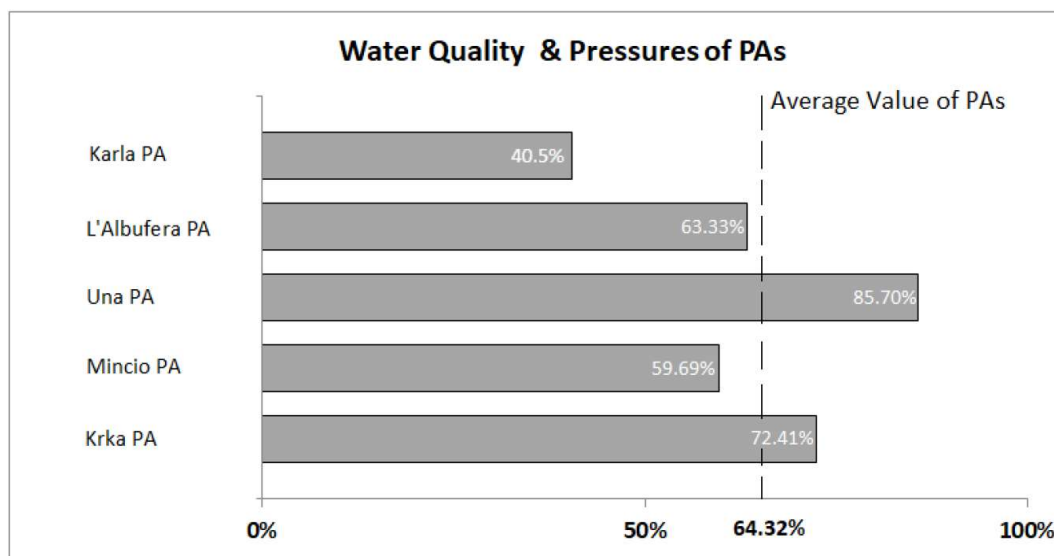


Figure 4. Gap rating on “Water Quality and Pressures” for each of the five PAs.

Regarding the “Management Practices”, the analysis highlighted that the “weakest” area of the framework in which Management Bodies function is represented by their actions and ability of exploiting different sources of income for their benefit, possibly affecting the number of employees in each management Body (Figure 2, Table 1). Most of the NPs’ gathered higher percentages on specific queries revealing an efficient organization scheme, fidelity to the management plan prerequisites, active management and proper infrastructure.

The findings of gap analysis on “Monitoring Practices”, revealed as main problematic areas the compliance with the Water Framework Directive in the matter of sampling frequencies and the designation of the water-body limits/type. It can be seen that almost all the quality elements set by the WFD are monitored according to plan, but without the proper frequency trend (Figure 3, Table 2). Another issue is that three of the national parks have not quantified the ecosystem services their areas are capable of providing, and four out of five have not evaluated hydromorphological modifications. Overall, the analysis showed a relatively good state in monitoring practices, providing adequate knowledge on water quality and the pressures upon it.

In the field of “Water Quality and Pressures”, gap analysis revealed several deficiencies, mostly dealing with the series of pressures each PA faces and the lack of improvement of quality criteria relevant to biodiversity and habitats (Figure 4, Table 3). Discharges and residues accumulation pull the average down in a negative manner and this could possibly be connected to the lack of awareness of hydromorphological modifications. Major distance found in “Water Quality and Pressures” field (Figure 4) is attributed mostly to Karla, Mincio and L’ Albufera Parks, which host the more eutrophicated water-bodies, suffering from various and multiple human-induced pressures.

The average gap was calculated in order to visualize the results (Figure 5). In general, the part of “Management Practices” received better rating, followed by knowledge availability in order to produce indices related to “Water Quality and Pressures”. Furthermore, the results showed a possible vulnerability of surface water bodies of the PAs in connection with the human activities-pressures found in these areas.

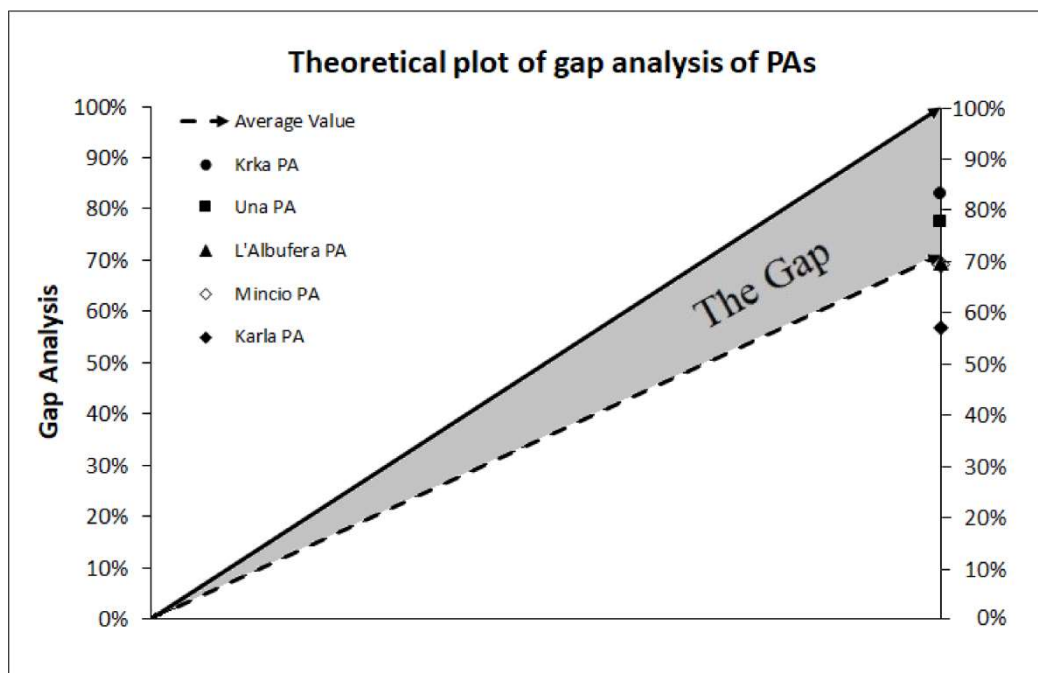


Figure 5. Theoretical plot of average gap for the three fields, for five PAs and their individual grading.

4. Discussion

Given that environmental sustainability and ensuring human well-being in the Mediterranean area strongly depend on sustainable water resources management and valuable NPs preservation [48], the elaboration of coherent cost-effective measures across all Mediterranean water bodies is required. This should be based on comprehensive monitoring analysis, on the assessment of the anthropogenic pressures, and on the ability to make reliable prognosis. In this context, effective management actions can derive from proper monitoring practices and pressure assessment methods. One example could be gap analysis, used as a tool to assist the quantification between present and desired level in important PAs' governance major topics.

In our research, the most problematic issues for the viability of the PA MBs seem to be funding, the low level of communication level and the cooperation between institutions, along with lack of clear management goals. Water bodies are supposed to be governed by institutional structures at river basin level following the WFD and Habitat Directives, while the participatory management process is also required shifting to a multi-level governance approach [1,14,49]. Countries with pre-existing participatory mechanisms and established regional institutions are more familiar with water management tools [10,50] and are expected to implement the European water governance agenda easier than member states with more centralized and hierarchical administrative structures [51,52]. For example, Greece faces significant difficulties in implementing the EU environmental legislation [10,53,54] since there are complicated administrative procedures between public authorities.

Special attention should also be paid to the broader thematic of hydromorphological modifications and ecological services and impact assessments. These elements are not monitored according to the directives' suggestions, thus augmenting the gap values. It used to be an area of less concern along the management and scientific communities, as depicted also by the gap analysis, since the majority of the studied areas have not yet included these in a standardized protocol. Hydromorphological modifications can exert a strong, if not a dominant, influence on the water chemistry and ecology. In order for the studied ecosystems to maintain their functionality, implementation actions must focus on the protection and conservation of the natural water regimes and catchment topography according to the ecohydrological principles [55,56]. One other basic outcome is that it would be favorable if

Management Bodies of all PAs could focus on the “Water Quality and Pressures” field. This field is interconnected with monitoring practices for generating the proper amount of information, tailored thresholds and forewarning systems. This data generation is extremely valuable for the design of measures towards pressure alleviation and water quality improvement. As for the more degraded areas, namely, L’ Albufera, Mantua Lakes and Karla lake, their overall image in this field is mediated by the almost complete knowledge on the water quality-related parameters and the extended research [44, 47, 57, 58]. Another important issue raised by the gap analysis is the stakeholders’ engagement as an essential element for the environmental management and decision making. This issue has also been highlighted by [50] strongly suggesting the actual involvement of stakeholders in the decision-making process. The latter require goals clarity, capacity, adaptiveness and effectiveness of stakeholder engagement [59, 60]. More steps should be done towards citizen engagement in Mincio, Krka and Karla PAs.

Having applied a gap analysis, targeting WFD monitoring and pressure mapping in so many different PAs appears to be adequate to group fundamental goals and incorporate harmonization with other directives, indexes and Guidances. Such harmonization is valuable for the better understanding of monitoring needs and of water quality issues, as for knowledge base building. At the same time, gap analysis reveals the need to apply an extra (monitoring and management) effort for waterbodies to reach the desirable status, to reinforce the existing monitoring systems in the region, and to make the existing datasets accessible by policy makers, so as to meet the requirements of the relevant initiatives. This contradicts the traditional monitoring programmes undertaken by individual agencies that relate to specific objectives (i.e., meeting water quality criteria) in cases where other factors as habitats, protected species and services should also be considered. Yet, our analysis on monitoring and water quality could be seen as a second level information for the operational managers (people responsible for policy implementation), capitalizing data developed through research projects, thus a common understanding might be achieved.

The limitations of the study have to do with the data which are used in the gap analysis. Time series of spatial data regarding water quality and species/habitat records would give a more precise assessment of MB actual performance. Without explicit data and extended databases on water quality monitoring-related parameters and on species/habitats conservation actions it is unlikely that such a gap analysis could provide an effective tool for management practices, for new infrastructure development as well as for ecosystem services mapping. Gap analysis, as performed in this research, is a multipurpose analysis rather than a strict conservation or protection program. It is a tool for effort estimation and pinpointing the areas where further investment/actions to be taken are needed. When used also as a harmonization tool then the variety of the selected parameters in the analysis are limited by the common transnational (EU and national) legislation. Another limitation could be the timing since it takes a “snapshot” of the situation. This could be overcome by doing regular follow-ups and assessing progress, given that more measures are taken, and results are collected. Gap analysis has been applied widely in terrestrial ecosystems as a GIS-based tool and the financial management as an operational tool. More scientific knowledge should be achieved for its successful application in aquatic ecosystems.

Although it is difficult to make a comparison between countries, since the organization of public institutes dedicated to environmental issues varies greatly from one national model to another, the Management Bodies of these PAs could act as intermediate or meso-institutions [61] since they represent the level where the general rules and ministerial decisions should be “translated” into practices, implemented, monitored and managed. To what extent they could facilitate the Protected Area Management Effectiveness (PAME) as described by IUCN [62, 63], depends on their capacity building and their funding. After all, PAs and river basin districts MB owe to meet the needs for conservation, touristic attraction and water quality policies. Many times, gaps in the knowledge on the policy instruments within the governing institutions hinder their effectiveness [64]. It is thought that if

these gaps can be identified, steps can be taken to fill them, achieving more effective management, thus leading to an increase in sustainable water use, water quality and economic output [65].

5. Conclusions

Summarizing, the goal of this paper is to account the gaps in the applied environmental policy in five NPs aiming at the improvement of their management planning process. This research revealed that all national parks have been altered by human pressures. Hereby we enumerate our major findings: (A). In the Management Practices field (average gap 20.04% of the target goal) most problems are associated with the staff use (6th query, 35% gap) which is entirely connected with the ability to exploit different sources of income (4th query, 50% gap), meaning submitting proposals, running projects and “lobbying”. A budget augmentation can lead to employing more people and distributing them in different departments (7th query, 24% gap) and thus expand their main actions (2nd query, 26.6% gap). More staff can even undergo the difficult procedure of obeying ecological norms, and adopting and following ISO standards (13th query, 100% gap). In the Monitoring Practices field (average gap 27.83% of the target goal), some actions should be taken towards performing simple, but basic, analyses in order for most NPs to assess hydromorphological modifications (7th query, 80% gap), impacts (8th query, 40% gap) and ecological services (9th query, 60% gap) once and then to monitor the equivalent changes (11th query, 50% gap) in a frequency proposed by the WFD. For the Water Quality and Pressures field (average gap 35.68% of the target goal), things are not easy to change rapidly. If measures are taken in the Management and Monitoring Practices fields, a general amelioration can be achieved long-term. In the time being all NPs are involved in scientific projects focusing the best preservation of their natural resources, so, in a perpetuation of a gap analysis in a reasonable timestep (i.e., 2 years), the values in all fields would be higher. (B) The protected areas that have to put more effort in reaching the favorable status are Karla, Mincio and L' Albufera, and this can possibly be explained by the water body types and the human induced pressures during the last centuries. (C) We suggest that harmonization among EU directives is valuable for the better understanding of biodiversity and of water quality issues. (D) The Management Bodies of the examined PAs could upgrade their role acting as “facilitators” of the EU and national environmental policies. (E) We recommend the close cooperation between the institutions, along with the clear management goals for the PAs. (F) The lessons learned from this EcoSUSTAIN action will help to design future monitoring plans leading to proper management actions by highlighting the gaps in each field and revealing shading effects of improper measures taken so far.

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Appendix A

Gap analysis was performed with the answers on the following query matrixes by the MBs of the five PAs, dataset of recently (2016, 2017) monitored elements for the waterbodies provided by each PA and the sum of the available scientific literature focused on these areas. There were three topics under examination, regarding management practices, water quality monitoring and pressures on water resources. In this section all questions were posed to the PAs' MBs

Table A1. Gap analysis queries on Management Practices are presented in the same sequence as presented in Table 1 along with the grading of each query in percentage (%) depending on possible answers. The final grading is the sum of the grades of all available answer options.

Query No	Possible Responses and Grading (in%) of the Target Value				
1	Environment (25%)	Biodiversity (25%)	Tourism (25%)	Research (25%)	
2	Surveillance (33.3%)	Environmental Awareness (33.3%)	Monitoring (33.3%)		
3	Yes (100%)	No (0%)			
4	National/Municipal (25%)	Own/Private (25%)	LIFE (25%)	Interreg 2014–2020/European Regional Development Fund (ERDF) /Horizon 2020 (25%)	
5	Yes (100%)	No (0%)			
6	The value 100% refers to the MB with the maximum number of staff of this fraction per area. 25% for the MB with less staff				
7	Environment (20%)	Biodiversity (20%)	Surveillance (20%)	Tourism (20%)	Others (20%)
8	Yes (100%)	No (0%)			
9	Yes (100%)	No (0%)			
10	Yes (50%)	Yes with Contract (100%)	No (0%)		
11	Yes open (50%)	Yes with Kiosks (100%)	No (0%)		
12	Yes (100%)	No (0%)			
13	Yes (100%)	No (0%)			
14	Yes (100%)	No (0%)			
15	Yes (100%)	No (0%)			

Table A2. Gap analysis queries on Monitoring Practices are presented in the same sequence as presented in Table 2 along with the grading of each query in percentage (%) depending on possible answers. The final grading is the sum of the grades of all available answer options.

Query No	Possible Responses and Grading (in%) of the Target Value					
1	Yes (100%)	No (0%)				
2	Yes (100%)	No (0%)				
3	Yes (100%)	No (0%)				
4	Yes (100%)	No (0%)				
5	Yes (100%)	No (0%)				
6	Yes (100%)	No (0%)				
7	Yes (100%)	No (0%)				
8	Yes (100%)	No (0%)				
9	Yes (100%)	No (0%)				
	Every month	Every 3 months	Every 6 months	Every year	More than 1 year	Never
10	100	100	100	100	50	0
11	100	100	100	100	50	0
12	100	100	50	0	0	0
13	100	50	0	0	0	0
14	100	50	0	0	0	0
15	100	100	50	0	0	0

Table A3. Gap analysis queries on Water Quality and Pressures are presented in the same sequence as presented in Table 2 along with the grading of each query in percentages (%) depending on possible answers. The final grading is the sum of the grades of all available answer options.

Query No	Possible Responses and Grading (in %) of the Target Value			
	Don't know	Negative	Positive	None
1	0	0	100	50
2	0	0	100	50
3	0	0	100	50
4	0	0	100	50
5	0	0	100	50
	Affect little	Affect	Main source of contamination	Don't know
6	75	25	0	0
7	75	25	0	0
8	75	25	0	0
9	75	25	0	0
10	75	25	0	0
11	Total N (20%)	Total P (20%)	Chl-a (20%)	Turbidity (20%)
12	Metals (25%)	Agrochemicals (25%)	Pesticides (25%)	Priority Substances (25%)
13	Zn and Cu, CaCO ₃ (hardness), Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), pH, NH ₄ , NH ₃ , NO ₂ , Temperature, Dissolved Oxygen (DO), Phenols, HOC1 and Total P all take 8% if there are any recent recorded values			
14	Mycrocystin (MCYST) (25%)	Cyanoacterial biovolume (25%)	Chl-a (25%)	Leptospira/Amoeba/Feacal coliforms (25%)
15	Conductivity, Alkalinity, Salinity, Total Dissolved Solids (TDS), Dissolved Organic Material (DOM), Oxidation/Reduction Potential or redox Potential (ORP), Phycocyanin and others photosynthetic pigments all take 13% if there are recent recorded values			

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