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Emerald Growth: A New Framework Concept for Managing Ecological Quality and Ecosystem Services of Transitional Waters

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Abstract: The aim of the present paper is to propose and elaborate on the concept of Emerald Growth as a new framework concept for managing ecological quality and ecosystem services of transitional waters. The research approach combines the longstanding experience of the authors of this article in the investigation of transitional waters of Europe with an analysis of relevant European Union directives and a comparative case study of two European coastal lagoons. The concept includes and reassesses traditional knowledge of the environment of lagoons and estuaries as an engine for sustainable development, but also proposes locally tailored approaches for the renewal of these unique areas. The investigation results show that the Emerald Growth concept enables to extricate better specific management aspects of ecosystem services of transitional waters that fill-in the continuum between the terrestrial (Green Growth) and the maritime areas (Blue Growth). It results from adjusting of both Green Growth and Blue Growth concepts, drivers, indicators and planning approaches regarding durable ways of revitalising coastal communities and their prospects for sustainable development. We conclude that the Emerald Growth concept offers a suitable framework for better dealing with complex and complicated issues pertinent to the sustainable management of transitional waters.

Keywords: Adriatic Sea; Baltic Sea; Curonian Lagoon; Emerald Growth; Lesina Lagoon; MSFD; MSPD; transitional waters; WFD

1. Introduction

The Water Framework Directive of the European Communities (WFD, 2000/60/EC) was the first official document introducing the term 'transitional waters' in 2000 to describe the aquatic continuum between freshwaters, coastal waters and marine waters. 'Transitional waters' are hence defined by the European Communities as "bodies of surface water in the vicinity of river mouths which are partially saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows".

Transitional waters are diverse, productive, ecologically important systems of a global scale that are valued for the services they delivered to human societies since the Paleolithic age. Transitional waters provided food, transportation routes, shelter (e.g., Venice). They also served as natural wastewater treatment systems. However, ecosystem goods and services delivered by transitional waters are insufficiently understood, in spite of being essential for a holistic consideration of sustainability conditions of the vast coastal and marine continuum. Therefore, any mismanagement of transitional waters might cost profoundly.

In the context of maritime spatial planning (MSP), the Land-Sea-Interaction (LSI) has been more addressed and studied, and the EU Maritime Spatial Planning Directive (MSPD, 2014/89/EU) refers to an interplay between the Integrated Coastal Zone Management (ICZM) and MSP. Albeit transitional waters play a pivotal role in LSI, and, as a consequence, in the MSP processes, the peculiarities of their management and planning are largely ignored by policymakers. In transitional ecosystems, the dynamic LSI patterns result in peculiar economical uses that need specific management and planning efforts very little discussed in the MSP context to date.

Transitional waters form coherent ecotones between terrestrial, freshwater and marine ecosystems categorized by high temporal variability and spatial heterogeneity [1]. The incidence of the human traces at lagoons and estuaries is recognized since prehistorical times, representing the core of early civilizations and posterior socio-economic formations [2]. Especially in the Mediterranean, we have plenty of documented evidence of multiple uses of coastal lagoons, from transportation to fisheries [3]. In the 1st century CE, Romans used the Tyrrhenian Sea coastal lagoon system as a connection route between Naples and Rome for military and commercial purposes [4].

The notion of 'transitional waters' defines a varied range of ecosystems types, including river estuary ecosystems, coastal lagoons, lakes, fjords and fjards, rias, brackish wetlands and hypersaline bahiras. Due to the hydrological balance between marine and freshwater forces, transitional waters, particularly the lagoons and the rias, are sediment and nutrient sinks, controlled by different variation scales according to the tidal cycles, seasonal and annual rhythms, precipitation cycles and climate variations [5].

Thus described, the "transitional waters" are included in a larger conceptual framework of the Coastal Transitional Ecosystems, which also includes the coastal basins of warm climates, often hyperhaline, not substantially influenced by fresh water but which share many fundamental features with the "transitional waters" [6]. A synthetic scheme of different coastal types denoted by the notion of "transitional waters" is provided in Table 1. The generalized view on the distribution of different coastal transitional ecosystems in Europe is given in Figure 1.

Table 1. Main physiographic forms included under the term transitional waters

Type	Characteristics
Classical estuary	Tidally dominated at the seaward part; salinity reduced by freshwater river inputs; riverine dominance inward
River mouth *	River outlet as a well-defined physiographic coastal feature
Delta *	Low energy, typically shaped, sediment dominated, river mouth area; estuary outflow
Fjord	Land freshwater seepage or seasonal riverine inputs; limited tidal influence; stratified; long narrow, glacially eroded sea inlet, step sided, sill at the mouth
Ria	Drowned river valley, some freshwater inputs; limited exchange
Non-tidal/microtidal lagoon *	Limited exchange with the marine area through a restricted mouth; separated from the sea by sand or shingle banks, bars, etc., shallow area, tidal range < 50 cm
Tidal lagoon	As above but with tidal range > 50 cm
Coastal plume *	Outflow of estuary, or lagoon, notably diluted salinity and hence different biota than in surrounding marine areas

* available in the Baltic Sea.

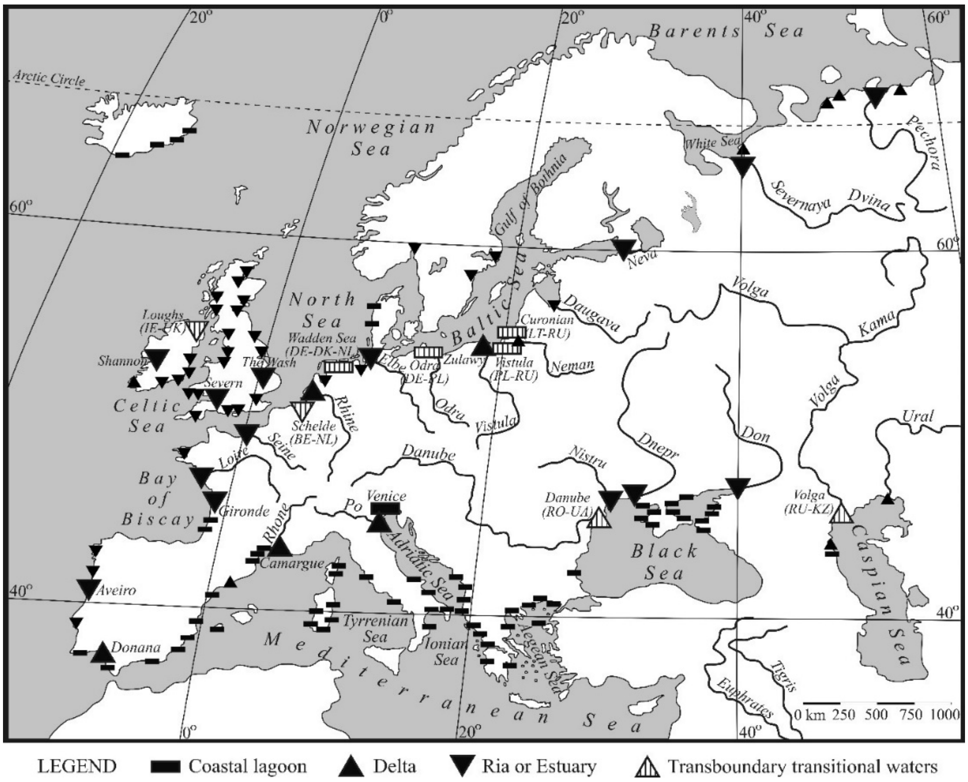

Figure 1. Generalization of major transitional water types in Europe

Transitional waters are under heavy human impact being the locations of major ports or cities. Therefore, these areas are degraded by dredging and contamination from industrial and agricultural activities, fishing, aquaculture as well as from urban sprawl and municipal pollution. These issues do have an enormous impact on human well-being in the regions adjacent to transitional waters since goods and services of these waters, being as diverse as the aquatic ecosystems supporting them, are also adversely affected [7]. Therefore, transitional waters have prompted the need to be categorised into operational types from both the academic and applied points of view [1,2,6].

The notion of 'transitional waters' in the EU WFD interpreation means aquatic areas which are neither fully coastal nor enclosed or flowing freshwater areas [5] whereas, under the more comprehensive term 'coastal transitional ecosystems' could be simply defined as "coastal water bodies with limited seawater supply" [6]. Transitional waters are defined by physiographic features, discontinuities, salinity, or other hydrographic features. Even though the typology provided in the WFD is indispensable for defining environmental descriptors and ensuring environmental integrity, 'transitional waters' is still a complex and not exhaustive term.

The definition is even more challenging if applied to the three largest European transboundary lagoons located on the southern rim of the Baltic Sea [8]. This challenge is complicated because two of these transitional water bodies (Vistula Lagoon and Curonian Lagoon) are shared with the Russian Federation. This country is not an EU member and, therefore, the term 'transitional waters' has no legislative consequences in the Russian parts of both lagoons. Schernewski and Wielgat [9] highlighted that Baltic Sea countries have taken very diverse approaches towards the designation of coastal and transitional waters. Some countries have not designated any transitional waters at all, regardless of the WFD regulations.

In Sweden, there was an attempt to overcome problems with designating transitional waters by suggesting a further category of enclosed, brackish coastal types, whereas Denmark, Finland and Estonia do not have designated transitional waters at all [7]. In Germany, transitional waters were designated for its North Sea estuaries but for none of its Baltic Sea lagoons and estuaries. Lithuania considers the Curonian Lagoon to be a transitional water body [8]. Additionally, the discharge plume from the Klaipeda Strait into the Baltic Sea is also considered as transitional waters [7].

Poland has designated as transitional waters the Polish parts of the Vistula Lagoon and the Odra (Szczecin) Lagoon, a part of the Gulf of Gdansk (the inner Puck Bay) as well as the open parts of the Gulf of Gdansk and the Bay of Pomerania where riverine discharge plumes have an impact [10]. Poland has also designated the coastal areas affected by the riverine plumes discharging into the open Baltic Sea as transitional waters. Latvia treats the Daugava River estuary at Riga and the riverine discharge plume into the Gulf of Riga as a transitional water area [9].

Most of the properties of transitional waters derive from both hydrological balance and land-water interfaces [5]. Strong directional gradients of salinity, organic matter, nutrients and oxygen concentrations featured in these waters can on one hand act as filters for potential coloniser species but on the other host euryoecious invasive species [11]. From a trophic point of view, transitional waters are very productive [12]. The overall hydrological and ecological balance that maintains the ecological status of transitional waters covers scales ranging in time from minutes and hours to years for long-term hydrological balance and large species population dynamics. On the spatial scale, the effects of transitional waters are felt from local to global, regarding the migratory fish and bird species.

In recent decades, the EU has directed many efforts towards new concepts of sustainable growth, first the terrestrial one (Green Growth) and then the maritime one (Blue Growth). According to the Organisation for Economic Cooperation and Development (OECD): "green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies" [13]. The governance of marine resource uses ever more focuses on the recently introduced term and concept of Blue Growth [14]. The Blue Growth concept aims to facilitate sustainable economic growth based on the utilisation of marine resources, while at the same time mitigating their degradation, overuse and pollution [15].

The EU´s Blue Growth strategy emphasises the importance of marine areas for innovation and growth in five sectors in addition to increased emphasis on MSP and coastal protection [16]. The Blue Growth concept recognises that diverse maritime sectors, such as fisheries, shipping and tourism, and marine ecosystem services, such as food provisioning, coastal protection and carbon storage, are interconnected. Managing these sectors and services coherently can deliver additional value [16].

In coastal areas, especially in the lagoons and estuaries, the marine and terrestrial domains intertwine intimately, bringing out a unique habitat, with peculiar characteristics, in many aspects, hostile, while others are particularly favourable to human settlement. This environmental mosaic has generated particular socio-ecosystems of transitional waters with required special human skills, adaptive strategies and constant care of the environment. Therefore, in the case of transitional waters, it is challenging to discuss either Green Growth or Blue Growth purely.

In this interim zone, where terrestrial and marine ecosystems interact, the two aspects of sustainable growth go together and have always been intimately connected. In these environments set like emerald gems of the coast, we should instead discuss the Emerald Growth concept, that is the integration of the principles expressed by Green Growth and Blue Growth concepts. It treasures traditional knowledge of the elaborate lagoon and estuarine socio-ecosystems that have developed in these environments over the millennia but also implies new technological and economical solutions. It describes better the management aspects of ecosystem services of transitional waters lying between the terrestrial (Green Growth) and the marine areas (Blue Growth).

'Emerald Growth' is an overarching concept proposed by the authors of this article to address sustainable development and management issues of transitional waters within a broader river basin, coastal and marine interplay framework. The topic of Emerald Growth is especially important for the Baltic Sea due to its marine geography. Eight transboundary transitional waters are located around the Baltic Sea, particularly at its southern rim (Figure 2). They require cross-border cooperation in ecosystem-based MSP between the countries sharing them. Therefore, the task of delivering sustainable use of ecosystem goods and services in such complex environments becomes a real challenge.

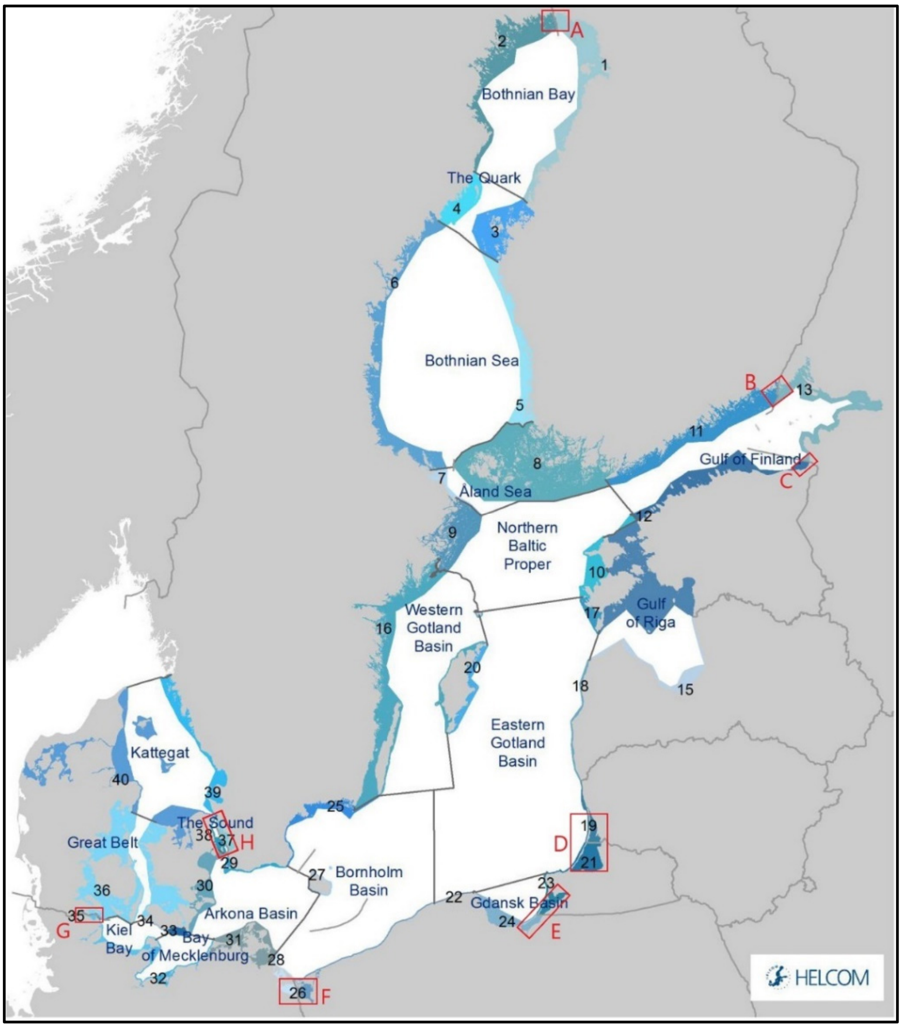

Figure 2. Distribution of coastal and transitional waters in the Baltic Sea Region (Source: Helsinki Commission). Transboundary transitional waters marked in red by the authors.

Considering this task, the main aim of the present paper is to propose and elaborate on the concept of Emerald Growth as a new framework concept for managing ecological quality and ecosystem services of transitional waters. The notion of 'Emerald Growth' is newly coined and presented in this article for the first time. A comprehensive study was undertaken by the authors to delimit all three concepts considering drivers, indicators and planning approaches. While concrete planning guidelines for transitional waters within the Emerald Growth framework pertinent to the EU WFD, MSFD, MSPD and other regulations are still in the conceptual phase, the drivers, indicators and planning approaches, which are proven relevant in spatial planning contexts, are summarised in Table 2.

Table 2. Drivers, indicators and planning approaches relevant in the spatial planning contexts.

Notions	Green Growth	Emerald Growth	Blue Growth
Key drivers	(1) Environmental and climate change and resulting economic policy changes; (2) Circular economy advancement	(1) Depletion of living resources; (2) Eutrophication; and water and sediment pollution; (3) Land reclamation; 4) Growing industrial and recreational use; (5) Sea level rise	(1) Growth of shipping; (2) Marine pollution; (3) Depletion of living resources; (4) Demand for energy and mineral resources; (5) Expanding networks of pipelines and cables
Main indicator groups [13]	(1) Economic growth, productivity and competitiveness; (2) Labor markets, education and income; (3) Carbon and energy productivity; (4) Resource productivity; (5) Multi-factor productivity; (6) Natural asset base; (7) Renewable stocks; (8) Non-renewable stocks		
Main planning approaches	(1) Hierarchy (2) Master-planning (3) Sectorial planning (4) Functional zoning (5) Detailed planning	(1) Hierarchy (2) Master-planning (3) Sectorial planning (4) Functional zoning (5) Trade-offs (6) Ecosystem approach (7) Cross-border links	(1) Master-planning (2) Sectorial planning (3) Functional zoning (4) Trade-offs (5) Ecosystem approach (6) Cross-border links

The Emerald Growth concept also includes and reassesses traditional knowledge of the coastal environment of lagoons and estuaries as an engine for sustainable development, but also proposes locally tailored approaches for the renewal of these unique areas. The Emerald Growth concept can be elicited by combining both Green Growth and Blue Growth concepts considering sustainable ways of enhancing the well-being of coastal communities and their prospects for a prosperous future. It also implies avoiding the adverse effects that may result from coastal population decline or monoculture prevalence (e.g., fisheries or coastal tourism).

On the conceptual level, the Emerald Growth concept is a framework for analysing socio-economic growth and human well-being relying on sustainable use of transitional waters, their resources and ecosystem services. The Emerald Growth concept applies where the complexity of estuarine and lagoon systems needs a goal- and solution-oriented, realistic and practical management approach. Therefore, it is very much coherent with the Blue Growth drivers, principles, indicators and planning approaches [14–16]. On the other hand, the Emerald Growth concept and principles are also quite coherent with the Green Growth concept and principles [13,17,18].

To showcase the usefulness of the Emerald Growth concept and to deliberate its implications, the methods, the results, the discussion and the conclusions are structured in the following way: First, we analyse relevant European Union (EU) directives and regulations regarding their potential to regulate environmental management and spatial planning of transitional waters and hence ensure a proper Emerald Growth framework. Next, ecosystem goods and services of transitional waters are typified and classified. Finally, to demonstrate the practicality of the Emerald Growth concept, in the results section, we apply it for the analysis of two case studies: the Curonian Lagoon (Baltic Sea) and Lesina Lagoon (Adriatic Sea).

The discussion focuses on the essential debatable issues of the perspectives and limitations of the Emerald Growth concept for facilitating sustainable management of various transitional waters. We argue that it is necessary to find a balance between different EU directives (WFD, MSFD, MSPD) and other supranational regulations pertinent to the protection of aquatic environments in each particular case in order to deliver a holistic approach for the transitional waters' management. In addition, the role of the EU Birds and Habitats directives should not be ignored. The conclusions of the paper highlight practical aspects of the Emerald Growth concept.

2. Materials and Methods

2.1. Methods

The in-depth analysis of relevant European Union (EU) directives and regulations concerning their potential to regulate environmental management of transitional waters and, therefore, to set the Emerald Growth framework, has been conducted during a series of six online workshops among the four authors of this article from 2018 to 2020. The discussed question was whether the transitional waters of the EU should be considered within the scope of the Marine Strategy Framework Directive (MSFD, 2008/56/EC) and the MSPD (2014/89/EU). If they do, then which regulatory areas have to be considered when integrating river basin management with the planning and management of transitional waters and marine territories. The answer to this question is pivotal for ecosystem-based planning and sustainable management of aquatic resources, and for delimiting the Green, Blue and Emerald Growth concepts.

The investigations leading to the case study analysis relied on longstanding first-hand experiences of the authors in the investigation of transitional waters in Europe, the Americas, Africa and Australia [3,8,19–26]. Data on ecology, history and economy of Lesina and Curonian Lagoons as the target areas of the comparative case study were obtained from different sources, namely old maps, earlier trade reports and investigations, other archive documents and literature. Data on traditional fisheries, aquaculture and exploitation of living resources in coastal lagoons of the Adriatic Sea and inherent effects on the recent evolution of lagoon ecosystems and landscapes were also derived from [27,28].

The vicissitudes of living resource uses in the Curonian Lagoon after post-Communist reforms and emergence of private fishery and husbandry were investigated first-hand. Since the mid-1990s, we have investigated social and economic transformations and environmental issues in the Baltic lagoon areas and compared them with the Italian lagoon management practice [3,8,22,24,29]. The issues of interest have been explored employing a wide spectrum of quantitative and qualitative methods—from the in situ and remote surveillance and simulation modelling of aquatic ecosystems to an assortment of social field surveys in the broader lagoon regions.

Perceptions and opinions about ecology, environment, ecosystem goods and services, as well as conservation and local development conflicts, were the key issues during the in-depth individual interviews and focus-groups with local interest groups—fishermen, farmers and environmentalists. During the investigation period spanning over two decades, there were over 20 qualitative longitudinal surveys carried out in Lithuanian and Italian lagoon areas as these were the main research target areas of the authors of the paper. These surveys were conducted within the framework of joint projects supported by EU regional (PHARE, TACIS, INTERREG) and academic research (FP6, FP7, Horizons 2020) cooperation programs.

It is confirmed and accepted that individual in-depth interviews deliver coherent, although not identical, ecosystem service information as do focus groups [30]. Therefore, the ratio between the number of those stakeholders with whom the individual in-depth interviews have been conducted, and those who participated in the focus groups was one to four in our surveys. Typically, a focus group comprised five to seven participants representing various local interest groups. In both cases, earnest efforts were taken to ensure the representativeness of the participants in terms of gender, age and trade. As a result, the perceptions and opinions of 180 locals have been sampled in the Curonian Lagoon area and ca. 100 locals in the Adriatic lagoon areas of Italy (mainly, Venice Lagoon and Lesina Lagoon).

2.2. Case Study Area

Lesina Lagoon in Italy (41°52′58" N, 15°26′21" E) is a nano-tidal lagoon (mean tidal range 0.3 m) extending parallel to the south coast of the Adriatic Sea for 22.4 km. It has an oblong shape with the width varying between 3.8 and 1.4 km (Figure 3). The mean water depth is 0.8 m with a maximum of about 1.5 m. Three artificially managed channels link the Adriatic Sea with the Lesina Lagoon [27].

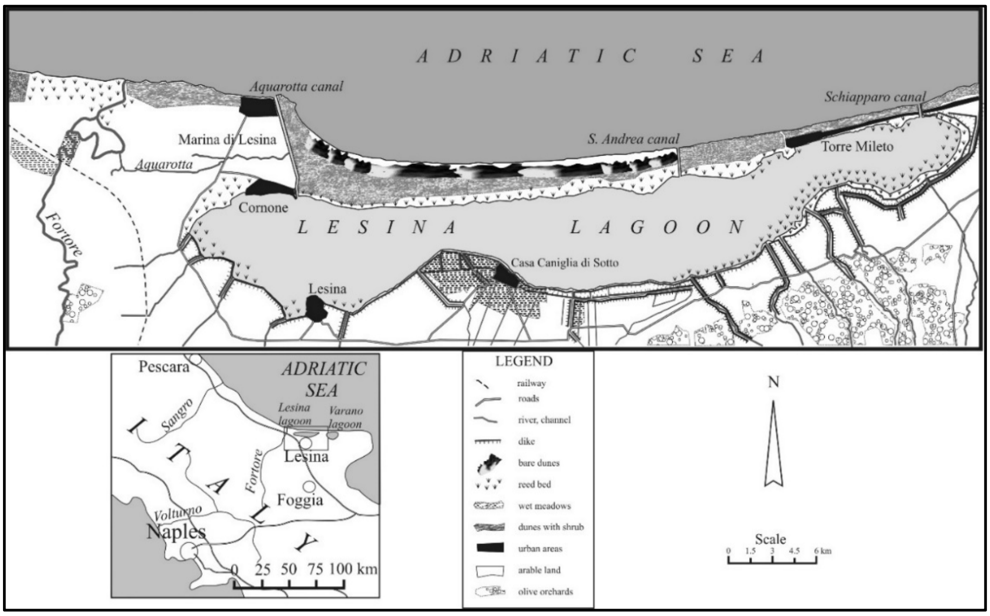

Figure 3. Lesina Lagoon. Source: authors' own plotting.

In the eastern part, fresh groundwater discharges into the lagoon, generating a saline gradient, salinity always remains lower than that of the sea ranging between 11 and 34 psu (average 23.7 psu) [31]. At the mean water level, the surface area of the lagoon is 51.5 km^2 and a volume is 0.04 km^3. The climate of the Lesina Lagoon region is typical Mediterranean one with dry, hot tropical summers and chilly, humid winters. The average annual precipitation level in this area is 427 mm [32].

The non-tidal Curonian Lagoon (55°11′55" N, 21°03′30" E) is an enclosed, shallow and almost fresh water body, located in the southeast angle of the Baltic Sea. The Curonian Lagoon is the largest lagoon in all Europe [33]. Its surface area is 1586 km^2, i.e., 30 times larger than that of Lesina Lagoon. The Nemunas River, whose catchment basin is 98,200 km^2, discharges into the Curonian Lagoon on its way to the Baltic Sea. The mean depth of the lagoon is 3.8 m, and the maximum depth is 5.8 m. Salinity varies from just 0.1 psu at the river mouths to 6 psu at the sea entrance [3].

Politically, the Curonian Lagoon is divided into two parts, the southern two-thirds belonging to Kaliningrad Oblast, which is the exclave territory of the Russian Federation, and the northern one-third to Lithuania. The area is in the transition zone from the temperate continental climate to the maritime one. Average annual precipitation level is ca. 750 mm [8]. The Curonian barrier spit separates the lagoon from the Baltic Sea. The east coast of the Curonian Lagoon is or has historically been part of the Nemunas Delta, which stretches about 70 km inland (Figure 4).

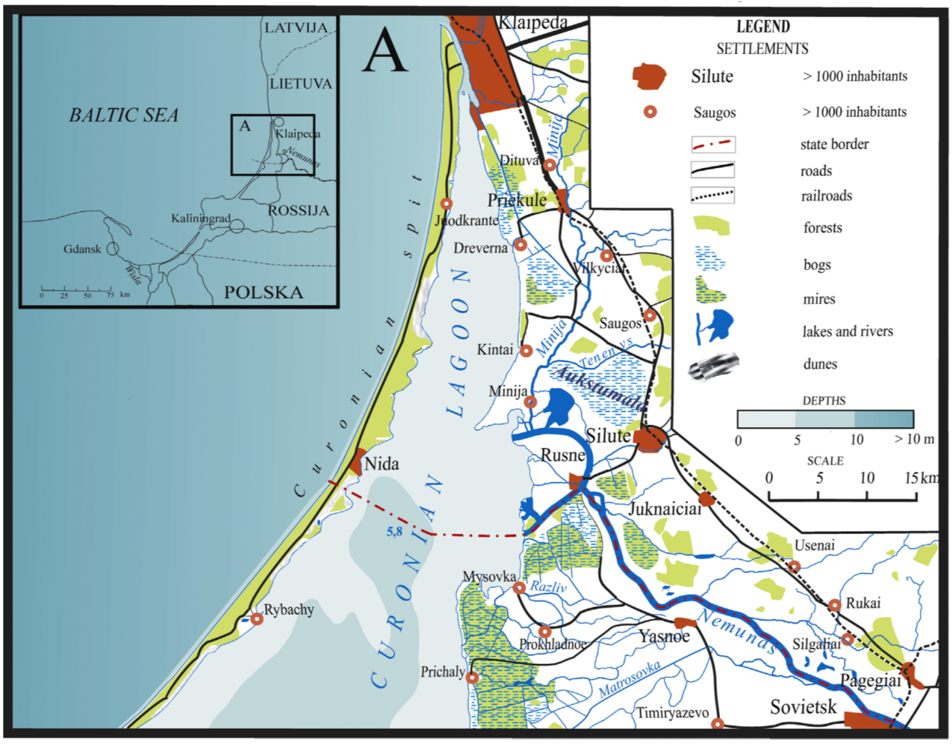

Figure 4. Curonian Lagoon (Lithuanian part). Source: authors' own plotting.

3. Results

3.1. WFD (2000/60/EC), MSFD (2008/56/EC) and MSPD (2014/89/EU): Delimiting Regulation Spheres in Open and Transitional Waters

Although the EU WFD provides an operational definition of transitional waters, still there is some fuzziness resulting from different approaches by the EU Member States in defining transitional waters [5,6,12]. The debates on transitional water definition became relevant within the EU, given the implementation of the WFD. There is also a need to define the limits of scope of the MSFD (2008/56/EC) and, particularly, those of MSPD (2014/89/EU). It states in its Preamble (paragraph 15) that MSP will contribute, among other things, to achieving the aims of the WFD.

The Preamble of the MSPD further states (paragraph 16):"Marine and coastal activities are often closely interrelated. In order to promote the sustainable use of maritime space, maritime spatial planning should take into account land-sea interactions". Article 2 (Scope) of the MSPD explicitly defines the distinction between marine and coastal waters in its very first paragraph: "1. This Directive shall apply to marine waters of Member States, without prejudice to other Union legislation. It shall not apply to coastal waters or parts thereof falling under a Member State's town and country planning, provided that this is communicated in its maritime spatial plans".

Such a definition of the MSPD scope means that the EU Member States should define the boundary between the transitional and coastal waters, which fall within the sphere of regulation of the MSFD and the WFD. The marine waters which are the focus of both the MSFD and the MSPD also are subject to MSP. If the transitional waters or their parts happen to fall under town and country planning, this must be communicated in the descriptive part of the maritime spatial plans. To make matters even more confused, three Baltic Sea countries—Latvia, Lithuania and Poland consider nearshore plumes resulting from the most extensive river discharge as transitional waters. It implies that these nearshore areas fall under the regulation of all three directives—WFD, MSFD and MSPD.

In any case, the essential difference between the WFD, MSFD and the MSPD is that the former two tackle any issues pertinent to the quality management and improvement of the aquatic environment. Meanwhile, the MSPD addresses different issues and its aim is to integrate the ecosystem approach in spatial planning. Therefore, considering the issues of a good water quality status and its indicators, which is at the core of the WFD and the MSFD, the MSPD plays a complementary role. As mentioned above, MSP should contribute, among other things, to achieving the aims of the WFD, i.e., a good status of transitional, coastal and marine waters of the EU Member States.

The WFD process for identifying transitional water body types required the development of new approaches [2]. It further implied the necessity to adopt a standard set of typology factors (tidal range, salinity, vulnerability), and approaches for consistent and comparable typology categorisation across the European regional seas. Although the WFD separated coastal waters from marine ones on the basis of a 1-mile distance according to Article 2–7, it also implied that the estuarine, coastal and marine water body types are not distinct categories that can be identified by a set of factors, but rather a continuum. Therefore, the borderline between the three separate types is often difficult to define [34].

There are still doubts whether transitional waters ought to be excluded from the MSPD focus, if they have a sizeable marine influence, e.g., tidal lagoons and estuaries or where salinity incursion occurs as these are also part of marine systems [5]. According to Tagliapietra et al. [6], in a landscape ecology context, transitional waters as a specific class of habitats should be even approached as 'transitional seascapes' emphasising their marine character. Borja et al. [34] concur that there is a necessity for a seamless and harmonised transition from a watershed through transitional and coastal waters to a marine system.

Cases of transboundary water bodies best illustrate the fuzziness and difficulties with the precise delimitation of different water ecosystem types even within the 'borderless' EU. For example, in the Odra Lagoon, the German and Polish parts belong to different typologies: the German part is designated as coastal waters while the Polish part as transitional waters, which is confusing for both management and research purposes [8]. A similar situation is in Lithuania, where the nearshore freshwater plume discharged from the Curonian Lagoon to the Baltic Sea heading north stops being considered as transitional waters at the Latvian border [9].

3.2. Ecosystem Goods and Services of Transitional Waters

The functioning of transitional water ecosystems, if they are healthy, produces several essential goods and services for humans—biodiversity conservation, biological production, storm and flood protection, river flow purification, transformation and cycling of elements and nutrients, wastewater treatment. However, goods and services of transitional waters are not defined adequately yet [5] because ecological concepts and intangible ecosystem services such as resilience are still meagrely measured for marine and estuarine environments [23]. Yet, these services have to be quantified and related to the management framework to provide a holistic approach to managing these habitats.

Transitional waters provide biological resources commercially exploited since the very Stone Age [35,36]. Due to the geographical position between the firm terrestrial ground and deep sea, these shallow water bodies play an essential role as spawning areas for fish and invertebrates, support rich biodiversity and offer important migration corridors for fish and wetland birds [3]. Despite the high value of the goods and services provided by the transitional waters, the coverage of the provisioning potential of ecosystem goods and services by transitional and marine systems is less documented, if compared with the terrestrial systems [23]. This lack of information hinders the MSP process and the compliance with EU supranational legislation by the Member States [12].

According to the Millennium Ecosystem Assessment, ecosystem goods and services pertinent to transitional waters can be grouped into four broad categories [37]:

1. *Provisioning* of biological and non-biological products such as supplying of food and water. Transitional waters provide fish, shellfish, crustaceans and sea-weeds. They supply building materials such as sand and gravel, and medicinal products from marine plants, microbes and

animals. The definition can also include renewable energies (wind and wave power as well as tidal power systems for estuaries).

2. *Regulating* services are the benefits of regulating ecosystem processes such as climate and disease control. Transitional waters outperform all other ecosystems in terms of regulating services [20]. Transitional waters and their habitats like mangroves, salt marshes and intertidal flats regulate several material flows. They recycle various elements, retain excess nutrients that flow into the sea, protect the hinterland from floods caused by storms or hurricanes, and absorb and process waste materials.
3. *Cultural* services are intangible benefits that people draw from ecosystems, for example through relaxation and aesthetic experiences [38,39]. Cultural heritage is an important trait of cultural services provided by transitional water ecosystems, that is, the development of local cultures with peculiar ethnic connotations. From an inspirational point of view, without referring to the uniqueness of Venice, the Camargue of the Impressionist painters is worth-mentioning.
4. *Supporting* services are those that necessary for the production of all other ecosystem services, like soil formation and nutrient cycling. Primary production is another supporting service as it fuels and maintains the higher trophic levels of the ecosystem and its biodiversity in transitional waters, and in the adjacent sea. For example, coastal lagoons, estuaries and other transitional waters form the main nurseries for juveniles of many commercially harvestable fish species.

More specifically, the services and goods garnered from the transitional water ecosystems can be further categorised into seven groups:

- Harvesting of fish, cray fish, mussels, clams and shrimps [40];
- Growing domestic water fowl, halophytes for fodder and ethnic medicine, spices, fruits and producing traditional local wine;
- Protecting the marine environment from physical disturbances caused by flooding and from chemical disturbances caused by pollution from the watershed [41];
- Conserving aquatic biodiversity, especially the biodiversity of migratory fish and birds [42];
- Providing amenities for water- and nature- tourism and other types of outdoor recreation [19];
- Maintaining coastal cultural and historical heritage values like traditions of combining fisheries and farming, as well as sustainable small-scale aquaculture [3];
- Providing diverse and relatively readily available data for environmental research, education and public awareness illustrating the relationships between ecological, physical and human processes that shape the environment [8].

The increasing use of aquatic resources by all sectors of society and the mismanagement due to many conflicting stakeholder interests are responsible for the deterioration of these ecosystems and the decline of their economic value. The benefits of these ecosystems are threatened by the activities of humans [43]. Transitional waters are under constant pressure, including habitat loss and pollution from their surroundings and catchment areas [26,44]. Examples of this are the decreasing capacity of the transitional waters to supply fishery products or to ensure the circulation of elements [3,27,28].

In the last 60 years, humans have changed the ecosystems of transitional waters faster and more comprehensively than in any comparable period in the past [45]. Although changes in ecosystems have contributed to significant net gains for human well-being and economic development, these gains have had huge costs such as the deterioration of many ecosystem services and the increased risk of adverse changes [46]. The declining provision of ecosystem goods and services from transitional waters worldwide can increase significantly in the future, and adversely influence human well-being.

Adverse changes in ecosystems directly feedback to the socio-economic system that relies on the ecosystem goods and services of transitional waters. An example is the loss of estuarine wetlands as fish nursery areas whereby these juvenile fish develop to become the commercial stocks [46]. For the sustainable management of environmental resources, identifying and quantifying ecosystem goods and services are increasingly required [47]. The decline of the carrying capacity of the transitional waters will have long-term effects. The degradation of the transitional coastal ecosystems also acts as a bottleneck in the movement of wildlife. This bottleneck will hinder the migration of birds from the southern wetlands to the Arctic breeding grounds and the migration of fish from the sea to rivers.

3.3. Case Study: Comparative Analysis of the Curonian Lagoon (Baltic Sea) and Lesina Lagoon (Adriatic Sea)

3.3.1. Emerald Growth Drivers

In this comparative case study, we illustrate the concept and analytical framework of Emerald Growth through the analysis and interpretation of the critical drivers of European transitional waters, using Lesina Lagoon (Italy) and the Curonian Lagoon (Lithuania/Russia) as an example. These areas are nutrient and contaminant traps and valuable fish habitats, and therefore vitally important for the integrity both of terrestrial and marine environment. Due to shallow water conditions and variation in water salinity, coastal lagoons are among the richest biotopes on the Earth with high productivity and rich biodiversity [20].

In our opinion, the usefulness of the Emerald Growth concept for analysing trends and capabilities for sustainable development and management of transitional waters can be best illustrated through the analysis of the Emerald Growth drivers. As in [48], we interpreted drivers as external forces on which the individual actors cannot possibly have an impact with their own means. It is notable, that Emerald Growth drivers and the alternative development scenarios for transitional waters, like the Blue Growth drivers and the alternative development scenarios for marine waters, are closely interrelated.

Different alternative scenarios are not only resulting from the sequence of political reforms or societal developments shaping the potential of the transitional water areas, but are also dependent on the external drivers and forces which have an impact on the future and should be considered seriously in policy formulation, planning and decision-making [48]. The descriptions of drivers and scenarios can be done for each Emerald Growth sector, fisheries, agriculture and outdoor recreation in the case of the Curonian and Lesina Lagoons. For these lagoons, we have identified the main five specific drivers (Table 2): the depletion of living resources, eutrophication, sea level rise, land reclamation, as well as growing industrial and recreational use.

Yet, a comparative analysis of the Curonian and Lesina Lagoon development in the modernity shows that the main driver of Emerald Growth throughout ages was active human interference into natural processes. An untenable interference had caused the depletion of fish resources, reclamation of aquatic-terrestrial ecotones, and shift towards reliance on the subsidised intensive agriculture in the reclaimed areas (Table 3) and the resulting structural decline of the lagoon economy (Figure 5). Similar negative processes had adversely affected many other European lagoons in the modernity as well [3]. Such a nature mismanagement policy had resulted in the declining diversity of migratory fish and bird species and recurring sharp production crises in the lagoon areas.

The societies and environment of the Curonian and Lesina lagoon areas have undergone immense changes during the modernity from the Napoleonic reforms till nowadays. These changes had resulted in economic ups and downs within the course of modern history. There always existed differences between the Emerald Growth drivers in two lagoons, but the similarities prevailed. It is evident from the scheme (Figure 5) what the resulting relative economic share of the yielded local commodities from the lagoons (fish) and their fringes (agricultural products) on the regional scale in various phases of the lagoon ecosystem evolution was. We see that radical changes in the tenure of land and water inevitably led to imminent economic and ecological precarities.

Table 3. Emerald Growth in the European lagoons in the modernity.

Period	Feudal Tenure	Privatisation	Cooperation	Current Stage
Main yield	Fish, cattle forage	Dairy products, vegetables, fish	Dairy products, vegetables, fish	Dairy products, vegetables
Fish stock use	Sustainable	Unsustainable	Quasi-sustainable	Quasi-sustainable
Causes of precarity	Diseases (plague, malaria), wars	Fish stock depletion, wars	Diking, land reclamation	Eutrophication, over-reliance on subsidies
Environmental concerns	Low	Increasing (eutrophication, persistent pollution)	Increasing (eutrophication, persistent pollution)	Stable
Provisional ecosystem services	High	Intermediate	High	Decreasing *
Cultural ecosystem services	Low	Increasing	Increasing	High
Economic role	High	Low	High	Low

* In case of nature protection focus scenario.

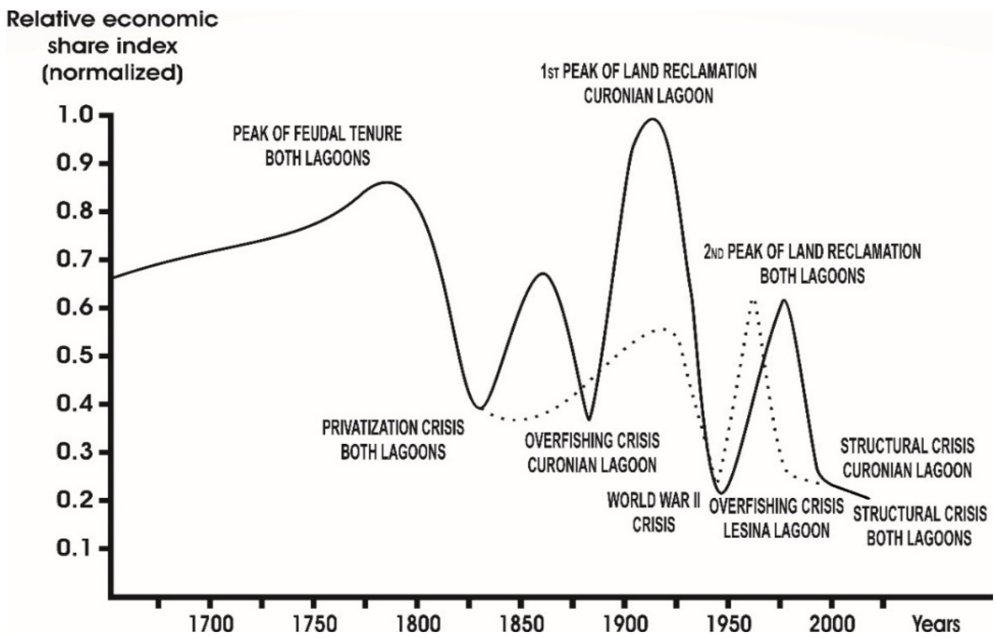

Figure 5. Resulting relative economic share of yielded products from lagoon areas on a regional scale (taking the first peak of land reclamation for 1.0; the dashed line shows the relative share of the products from Lesina Lagoon if it differs from the Curonian Lagoon) (Compiled and plotted by Ramūnas Povilanskas)

Depletion of Living Resources

Availability and eventual depletion of fish resources are the main specific drivers of Emerald Growth. The traditional fishing strategies differ significantly in the Mediterranean, Baltic and Atlantic lagoons, due to different physical processes, which control the water level, water exchange between the sea and the lagoon and water salinity in different seasons. In the Mediterranean lagoons, the fish species, which are the most important for lagoon fisheries, enter the lagoons at the end of winter as newborn fry, while for the sexually mature fish the impulse to migrate back to the sea comes in autumn at the onset of the breeding season. The years between the stage of fry and that of sexual maturity fish spend in the lagoon [27,28].

In the Baltic Sea lagoons, which are controlled by surplus precipitation and an influx of vast volumes of freshwater from large tributaries, the migration pattern of the important commercial fish species—other than eels—is opposite to that of the Mediterranean lagoons. Since the commercial fish like salmon, sea trout or twaite shad prevailed in the catches, the main fishing areas traditionally had been either in the lagoon or in the mouths of the river tributaries and branches or regularly flooded shallow deltaic lakes as well.

While the Curonian Lagoon and its tributaries had always remained a state domain, Lesina Lagoon was a private property till the very 1934. Both lagoons had been famous for centuries for their eels, which were caught during their migration to the sea and sent to the major cities of Italy and Germany where they constituted the traditional Christmas dish. Hence, fishing of eels and other commercially valuable fish made the lagoon resource owners and users wealthier than the farmers in adjacent areas. In both lagoons, however, the mismanagement of fish stock and lack of proper fishery control had led to the depletion of fish resources and the decline of fisheries.

Throughout the modernity, both lagoons experienced disputes among the local communities over the control and use of fishing areas. These disputes have resulted in protracted a period of decadence in the fishery management. In the 1970s, in Lesina Lagoon the annual yield in fish had dropped to less than 40 kg/ha, and the fishermen had dwindled to 40 units, mostly pensioners rounding off their income [27]. The 1970s–1980s also witnessed a dramatic global decline of the eel stock [49], which had a detrimental effect on eel fisheries, and on the welfare of the fishermen in both lagoons.

While entering the 2020s, a slow yet sure decline of commercial and artisanal fishing continues in both lagoons. The economic reforms of the 1990s have radically changed the fishing organisation in the Curonian Lagoon. Many small private fishing enterprises have got the license to fish. It has proved harder to monitor the size of the catches landed, and poaching, which gives a substantial nontaxed profit, has increased drastically [3]. Lack of proper collaboration with Russia on the protection of fish resources also played a negative role. Although fish monitoring in both parts of the lagoon is conducted in a coordinated way [8], yet it does not prevent the decline of the lagoon fishery.

Similarly, Lesina Lagoon experiences a further decline of the artisanal lagoon fishery. The weirs are opened and closed with regard to the fish migrations, and fishing rules are enforced [3]. However, the lagoon is still exploited by small vessels of 40 artisanal fishermen using traditional fishing gears and targeting a broad spectrum of species [50]. The local fishery is still mainly based on the use of "paranza" (Figure 6), a traditional fishing system made up of net walls fixed on stakes and retaining devices (fyke-nets), but also on the use of gillnets and trammel nets. It features low selectivity and produces a considerable amount of by-catch, including juveniles of commercial species [50].

Figure 6. Artisanal stake-nets in Lesina Lagoon (Image: Ramūnas Povilanskas).

Other Specific Drivers of Emerald Growth

With the advent of industrial agriculture, wetland fringes of both lagoons had been reclaimed and turned into agricultural landscapes, whereas the ecotones, which integrated aquatic and terrestrial ecosystems, had been extensively eliminated. Such a situation significantly impaired the capacity of the lagoon areas to fulfil their fundamental ecological functions, whereas, the reclaimed land at the Curonian Lagoon became ever more dependent on the external subsidies in the Soviet period. Central USSR ministries of agriculture and fisheries provided production plans and techniques, financed land reclamation, maintenance of dikes and polders and restocking of fish [29].

After the collapse of the Soviet Union, the main local agro-industrial activities, namely dairy cattle breeding, and milk production have dwindled mostly to the low-productivity farming at smallscale individual farms. Since the maintenance of dikes and water pumping stations needs substantial financial resources, only part of the polder system was maintained properly, due to the lack of proper financial and energy resources, while the rest was left unattended and rapidly declined. Currently, agriculture on the Lithuanian side of the Nemunas Delta depends heavily on the EU agricultural sub-sidies, likewise on the reclaimed fringes of Lesina Lagoon.

In the Lesina Lagoon area, state authorities have drained 1500 ha of freshwater wetlands in the 1950s. These efforts were part of a comprehensive land reclamation program aimed to increase the acreage of land suitable for agricultural purposes, and for maintaining the permanent high-water level within the open lagoon perimeter as well. These areas used to be a prime habitat and feeding ground for the eel. The engineering works had the effect of lowering the salinity at the eastern end of the basin. This intervention has caused the 500 ha, once occupied by eelgrass, to be invaded by reed growth. Thus, the engineering works took away a third of the prime habitat for eel production [3].

The prospect of lucrative recreational fishing services makes the Curonian lagoon communities waver: whether to continue relying on the commercial exploitation of the declining fish stocks or to shift to the provision of the recreational fishing services. The Curonian Lagoon region has been always famous as a major destination for recreational fishermen [3]. Considering the number of tourists visiting the Curonian Lagoon and, particularly, the Nemunas Delta, the fishermen constitute a significant part (ca. 50%). A phenomenon of particular interest is the upstream migration of smelt in winter and early spring. It attracts thousands of recreational fishermen. This ‘secondary’ wave of tourists gives the major low-season share of income to the local hospitality sector in the region.

Eutrophication is also a pivotal driver of Emerald Growth. Eutrophication itself is usually considered as a result of a vast array of internal and external forcing drivers [31]. Yet, eutrophication related drivers are among the most important factors causing pressure and impacts on the transitional water bodies [26]. Due to their large variety in the turnover rate and, hence, due to considerable exposure to rapid nutrient enrichment, the transitional water ecosystems, in general, and the Curonian and Lesina Lagoons in particular, are vulnerable to eutrophication [31]. Therefore, different Emerald Growth scenarios, from the maintenance of traditional artisanal fisheries to the development of new sectors, e.g., tourism, are directly reliant on the current eutrophication levels and their future trends in both lagoons.

Considering different Emerald Growth scenarios, eutrophication of transitional waters, despite recent positive trends, including re-oligotrophication [51], can be seen as a constraint for sustainable development in transitional waters. The simultaneous increases in nutrient loads and in the rate of sea-level rise may result in adverse synergistic effects. The drowning of coastal marshlands due to sea-level rise and loss of creek-edge marsh [52] due to eutrophication impose unwelcome limits on human activities and may result in coastal areas with a dramatically reduced capacity to provide important ecological and economic services.

Last but not least, the sea level rise can be also considered as a critical driver of Emerald Growth, especially regarding the loss of coastal marshlands, and an ever-accelerating erosion of barrier spits separating coastal lagoons from the ocean or the sea. Lagoons and estuaries are highly adaptable ecosystems. In natural conditions, these systems would have moved along the coast following its development under sea level rise. However, the lack of plasticity of the modern human landscape and the rapidity of climate-related changes put their very existence at risk.

The Emerald Growth concept, envisaging local-scale integrated economy, reuse of materials and innovative widening the use of local materials and provisional services, for instance, the use of salttolerant plants and saltmarsh gardening, may be included in the accommodation measures. State-of-the-art agriculture models must be adopted in the transitional islands with complete water recycling and zero emissions. An opportunity, on the other hand, can be provided by 'depolderization', that is, the planned reconversion of lagoons and wetlands reclaimed during the last two centuries often lying below the main sea level, whose productivity is currently possible only using hydraulic pumping.

3.3.2. Preconditions for Sustainable Emerald Growth Scenarios

Surrounding Lesina Lagoon with an embankment has eliminated the once wide ecotone of shallow water, which was the habitat of wetland birds [3]. With the undersigning of the Ramsar Convention (1971), the Italian government has finally renounced its policy of draining wetlands. Now the surviving wetlands are to be conserved to benefit bird species broadly termed as wetland birds [53]. Therefore, in 1981, the eastern portion of Lesina Lagoon (Sacca Orientale, IT9110031, 927 ha, Figure 7) has been designated as a bird sanctuary. In 1991 it was included within the newly instituted Gargano National Park.

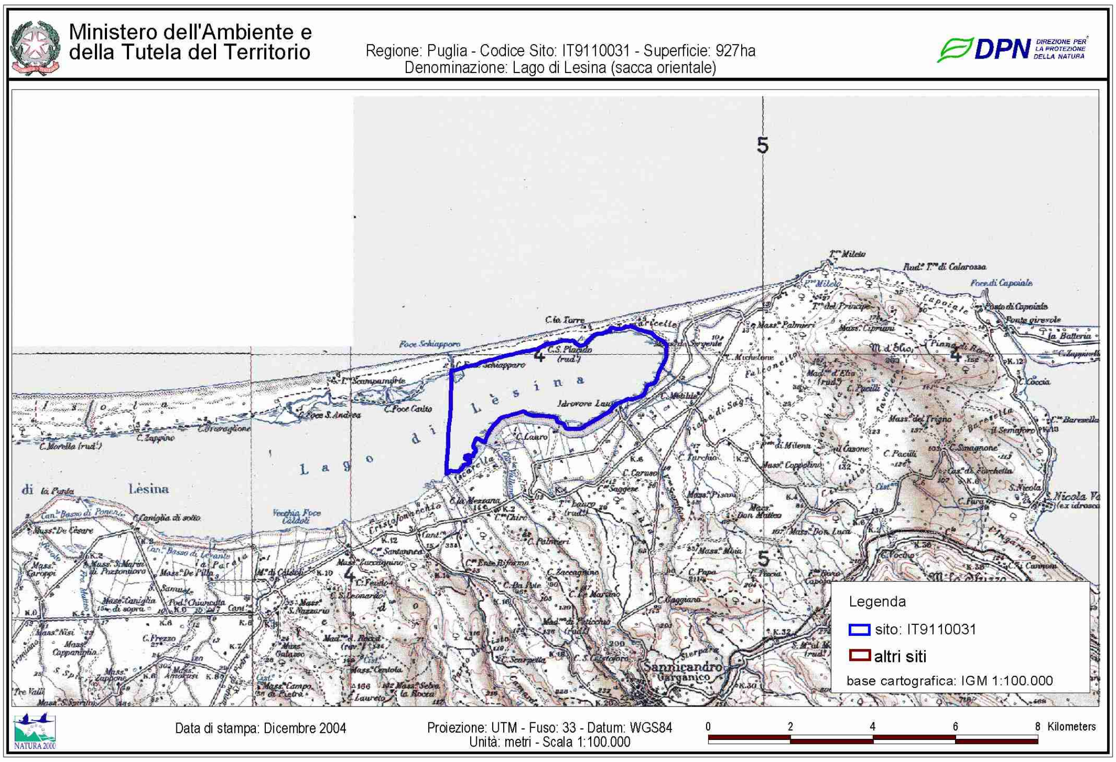

Figure 7. Part of Lesina Lagoon which is a bird sanctuary included into the Gargano National Park (Courtesy: Directorate for Nature Protection).

High concentrations of wetland birds in the Nemunas Delta also classify the area as being of international importance for nature conservation. Nemunas Delta Regional Park established in 1992 was included in the list of wetlands of international importance by the Ramsar Convention [3]. Later, in 2004–2005, the system of protected areas was supplemented with Natura 2000 sites in compliance with the requirements of the EU Birds and Habitats Directives. The whole Curonian Lagoon itself was designated as a biosphere polygon in 2009. Legislative measures create a number of constraints mostly towards the intensive use of natural resources while providing additional incentives for the culural uses of the lagoon area.

This development could be considered typical for the transitional waters featuring important cultural and nature values (e.g., UNESCO heritage sites) and goes well in line with proposed Emerald Growth trends in the European lagoons in the modernity (Table 3). This scenario (nature protection priority) implies an increase in the importance of cultural ecosystem services (including recreational fishery) with a decrease in the value of provisioning ones. However, this does not imply a drop in income or economic value [54]. Indeed, if managed correctly, the nature protection priority could even increase it.

Another Emerald Growth scenario (sustainable development priority) could be proposed for the territories lacking much of natural and cultural values where enviromentally friendly production solutions (e.g., sustainable aquaculture beside sustainable fishery) along with other innovations (alternative energy production, extraction of biologically active chemical compunds from natural sources) could be a future development trend.

4. Discussion

From the presented case study, we see that Emerald Growth can evolve in different directions at different periods in history—from intensive development to extensive development, from sustainable development to decline. We also see that fisheries in transitional waters are ever less important for sustainable Emerald Growth. For the use of transitional waters' ecosystem goods and services to be truly sustainable, the riparian communities using transitional waters need to search for alternative under-utilised ecosystem services to integrate a sustainablefisheries. In the case of transboundary transitional waters, the Emerald Growth deliberations must also take into account the situation and plans of the neighbouring country sharing the transitional waters. These plans may diverge significantly and adversely affect your plans because the aquatic ecosystems do not recognise borders.

The findings of our study support the notion that the WFD process for identifying coastal and transitional water body types requires the development of new typological principles. We need to elicit a standard set of factors and their categories for comparable and consistent categorisation of various transitional waters across the coastal areas of different regional seas. We should also reconsider if estuaries and other transitional waters have to be excluded from MSP as currently, it is the case in the EU. On the contrary, it is necessary to find a balance between different EU directives (WFD, MSFD and MSPD) and other supranational regulations pertinent to the environmental protection of aquatic environments in each particular case in order to deliver a holistic approach for the transitional waters' management [55,56].

The EU nature conservation directives—the Birds Directive (2009/147/EC) and the Habitats Directive (92/43/EEC)—are also highly relevant documents for the Emerald Growth framework since there is a high emphasis on priority coastal habitat types (such as coastal lagoons) in these applications within the EU Natura 2000 scheme (the world's largest network of protected areas). Emerald Growth provides a suitable framework in the need to promote holistic cultural, natural and sustainability management approaches in the Natura 2000 sites [57–59]. It is obvious that protected territories established in both lagoons create new possibilities for sustainable Emerald Growth including eco-oriented tourism (especially birdwatching), recreational fishery and sustainable uses of specific local products.

Interaction between the watersheds of the rivers discharging into the transitional waters and their ecosystems, particularly regarding their productivity and resilience [60,61], is also among the essential issues of the perspectives and limitations of the Emerald Growth concept. This issue is especially pertinent for facilitating sustainable management of the two largest south Baltic coastal lagoons—the Curonian Lagoon and Odra Lagoon being recipient water bodies of large rivers—Nemunas and Odra, respectively. As many environmental problems affecting the transitional waters are generated upstream in the watersheds, like in the case of Blue Growth drivers, the 'sustainability dilemma' strongly relies upon environmental leadership, innovation and a common focus on the circular economy [48].

5. Conclusions

The main practical implication of the study is that on the policy aspect, contrary to a commonly accepted view among policymakers throughout the EU, stronger links should be established between the Emerald Growth and MSP principles. The Emerald Growth concept offers a suitable conceptual framework for an adequate understanding and dealing with complex issues pertinent to environmental protection and sustainable development of the economies of transitional waters, particularly the transboundary ones. The differences in formal designation and planning approaches between the countries sharing the transboundary transitional waters should not be considered as an obstacle to the cross-border co-operation efforts to manage the transitional waters, environmental protection, nurturing of ecosystem goods and services and sharing a joint vision of Emerald Growth.

The investigation results show that the Emerald Growth concept and management framework enables to extricate better specific management aspects of ecosystem services of transitional waters that fill-in the continuum between the terrestrial (Green Growth) and the maritime areas (Blue Growth). The Emerald Growth concept offers a suitable framework for better dealing with complex and complicated issues pertinent to sustainable management of transitional waters. Although each transitional water body is unique in many ways, yet the drivers shaping their future development scenarios are similar and some standard integrated planning and sustainable management procedures are attainable.

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