



THE IMPORTANCE OF RIPARIAN AND DELTAIC ECOSYSTEMS AND THE CONTRIBUTION OF ECOTOURISM FOR SUSTAINABLE ENVIRONMENTS: A LITERATURE REVIEW

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Abstract

Riparian and deltaic ecosystems are indispensably linked to human and wildlife well-being in multiple ways. Life is highly dependent on ecosystems and their benefits; yet, concerning impacts such as climate change, ecosystem degradation and over-exploitation, water scarcity and other environmental challenges, decrease the environmental sustainability. In order to protect the natural water courses and bodies against such threats, international actions and frameworks have been established both for public and private sectors. Nevertheless, while a promising progress in restoration has been made, the hazards continue to exist. Over the last years, the principles of environmental education and awareness tend to become global necessities, especially for the involved populations and the young generations. The increasing demand and implementation of ecotourism is a key product of such awareness that has resulted in the conservation of ecosystems, local culture and uniqueness. This study presents a review of scientific reports and articles related to riparian, deltaic, ecotourism and environmental conservation studies. The goal of this study is to provide sufficient information for riparian and deltaic ecosystems, by highlighting the unique region of Eastern Macedonia and Thrace in Greece. Furthermore, it describes effective ecotourism strategies, benefits and impacts, as well as possible needs and demands of local populations living in protected areas and their contribution to both environmental sustainability and ecotourism development.

Keywords: riparian and deltaic ecosystem, protected area, sustainable environment, ecotourism, Eastern Macedonia and Thrace



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Introduction

Riparian and deltaic (RaD) ecosystems are communities of living organisms that conjunct with nonliving components of their environment and interact as sufficient systems in sites of natural flowing watercourses [1-5]. Unlike RaD areas, the wetlands refer to land areas saturated with permanent or seasonal amounts of water, usually freshwater, and specific vegetation of aquatic plants adapted to their unique hydric soil [6-8]. While riparian areas differ from deltaic and the several types of wetlands, they all present similarities, especially in ecosystem services [9, 10]. Some of their common characteristics include water purification, flood control, carbon sink, shoreline stability groundwater recharge, as well as biological diversity due to their variety in wildlife and natural support for endangered species [8-11].

Such ecosystems often attract visitors, resulting in the promotion and development of ecotourism as an action of environmental responsibility and awareness through traveling in natural sites with cultural and other unique features [12, 13]. Nevertheless, the significance of ecosystems in environmental sustainability is not always highlighted; the human over exploitation has obviously left its perennial marks on earth, especially within RaD areas. Furthermore, sudden torrents, flash floods and other extreme weather events may also threaten the sustainability of such ecosystems [14].

Nowadays, owing to their essential role, many environmental sites are strictly protected in several possible levels, depending on their wildlife importance and rarity. Regulations and frameworks of international organizations have been established and followed by their member states aiming to protect and maintain their characteristics. This paper presents a broad review of studies and reports related to riparian, deltaic and ecotourism articles for the promotion of RaD ecosystems, by emphasizing the example case of the Eastern Macedonia and Thrace (EMT) that is a region of Greece. Additionally, it highlights the contribution of populations living in protected areas and the importance of a wide environmental education and awareness culture. The collected data of this review could possibly identify environmental, scientific, socioeconomic, political, management and other structural gaps for the conservation and promotion of RaD ecosystems, in combination with the robust growth of their inhabitants.



Definition and Features of RaD Ecosystems

Riparian studies involve a large spectrum of fields, such as forestry, ecology, geohydrology, biology, civil engineering and more; hence, there is no specific definition based on the characteristics of all these areas [15].

The term riparian has Latin origin and is derived from the word “riparius” which means “stream bank” [11, 16-18]. Although this definition is not widely accepted, due to the variabilities of the riparian areas, it is mainly used by scientists for the last 5 decades [19]. Riparian areas are adjacent to water courses or bodies, such as torrents, streams and lakes; their boundaries are linear in nature, although several hydrogeological conditions may change them within a duration of time [10]. In general, they could be described as the transitional zones between aquatic and terrestrial ecosystems that connect water bodies and their uplands.

Deltas refer to deposit areas that are landforms and were built by a stream flow into or against permanent water sources. They exist since the early times and can be found in all the continents. It was the Greeks that first used the word "Delta" for the shape description of deposits above the sea level at the Nile River mouth and it has been used ever since [20, 21]. During the formation of a delta, the river flow from higher elevations deposits mud, silt, gravel and other particles at its mouth and because the flow slows the river expands to a larger body of water. The evolution of a delta is highly determined by watershed characteristics such as the location, size, slope and chronic land-uses[22].

The RaD ecosystems are characterized by several features such as cleansing, renewal, recycling and goods production in seafood, forage and timber; hence, they are not only essential but also beneficial to humans and wildlife [23, 24]. Besides the economic benefits, the RaD areas act as autonomous “societies” (e.g. ecosystems) since they are able to support safe animal habitats and conserve biodiversity, stabilize stream banks, filter sediments and nutrients, retain water quantities, reduce chemical inputs (immobilization), behave as natural storages and rechargers for subsurface aquifers, reduce the flood and torrent flows in cases of extreme weather events, as well as provide environmental health and uniqueness [11, 24-28].



The uniqueness of each RaD ecosystem and its wildlife is dependent on the differentiations due to the major influence of water, soil and vegetation over time. [9, 29-32]. Additional factors such as the human influence or extreme weather events may also cause alternations that lead to temporary or permanent variations [31, 33, 34]. It should be highlighted that the human influence and more specifically, agricultural activities and over-urbanization, are considered as major threats for every ecosystem [35-37].



International and Regional Conventions for RaD Ecosystem

Although the over-utilization of ecosystems has obviously been decreased since 2000, it still exists; therefore, the conversation and protection of the biosphere is imperative [38-40]. Thus far, there are over 100,000 sites recognized as protected areas and cover more than 10% of the Earth's terrestrial surface [41, 42].

The Convention on Wetlands, for instance, also known as the Ramsar Convention, that is an intergovernmental treaty for the environment, was established in 1971 by United Nations Educational, Scientific and Cultural Organization (UNESCO), and came into force in 1975. The Ramsar identifies wetland systems of global importance, especially those providing wildlife habitats. Based on 2016 Ramsar data, there are 2,265 Ramsar Sites, that involve the protection of 218,562,565 hectares in 169 countries [8].

Another example is the Natura 2000, that is an ecological network established by the European Union (EU) for the conservation and the protection of biodiversity, while promoting the agricultural, energy and transportation sustainability [43, 44]. This network covers approximately 20% of land- and 6% of sea- territories within EU, in which more than 6000 species are under conservation status [44].

Another wide network that involves the participation of international academia in educational, environmental, social, cultural and communicative sciences is the UNITWIN (University Twining Program)/UNESCO Chairs Program, released by the UNESCO in 1992 [45]. Regarding the conservation and ecotourism of RaD ecosystems, the UNESCO awarded in 2016 the Department of Forestry and Natural Environment Management of the Eastern Macedonia and Thrace Institute of Technology, the UNESCO Chair on "Conservation and Ecotourism in riparian and deltaic ecosystems (Con-E-Ect) [46].

Last, the UNESCO's Man and the Biosphere Programme (MAB) that is an intergovernmental scientific programme aims to connect people and their environments under a scientific basis. It was first launched in 1971; nevertheless the biosphere reserve concept was developed in 1974 in order to further encourage the establishment of protected areas worldwide [47].

All the aforementioned strategies clearly indicate that a serious effort for the protection of ecosystems is underway and in combination with "green-thinking" (ecotourism, climate change reduction, etc.)



and the participation of local populations, the economic development and environmental protection can be adequately co-exist.



Protected RaD Ecosystems in EMT and other regions of Greece

Several RaD ecosystems in Greece, same as with other similar areas around the coastal areas of the Mediterranean Sea, were inhabited thousands of years ago because of the many ecosystem services they offer. Unavoidably, these RaD ecosystems experienced intensive and continuous land use or other human disturbances, resulting in their degradation and their present difficulties in environmental and biodiversity maintenance and re-establishment [48-53]. There is evidence that vegetation and wildlife of RaD lowland areas have been degraded or even eliminated, mostly due to the agriculture, unlike riparian-mountainous regions in which agricultural activities are not as commonly occurred [9, 52, 54, 55].

Currently in Greece there are 21 natural lakes, 14 artificial, 22 major rivers and 33 deltas [56]. *Tables 1 and 2* show the major rivers and deltas of Greece, respectively. Furthermore, Greece has a noteworthy biodiversity of 6000 plant species, 116 mammal species, 58 reptile species and more than 400 recorded bird species, many of which are endangered [57]. This variety of water courses and bodies and their wildlife are essential for the environmental prosperity of the country.

On 21 December 1975, Greece joined the Ramsar Convention and 10 sites of 163,501 hectares total surface area were recognized as Wetlands of International Importance (Ramsar Sites) [8]. *Table 3* shows these 10 sites. Moreover, there are 241 Sites of Community Importance (SCI) that belong to the Natura 2000 Network, according to the EU Directive 92/43 along with 202 Special Protected Areas (SPA), EU Directive 79/409 [58]. It should be mentioned that the most of the Ramsar Sites are located in EMT region. Several areas of water courses and bodies of Nestos and Evros rivers that are included in the Ramsar Sites, are considered as RaD ecosystems of major importance for the whole territory of southeast Europe.

The Natura 2000 protects 5 sites in Greece, 3 of which are in the National Park of the EMT region[59]. Moreover, the MAB Programme currently involves two regions in Greece the Samaria National Park (Gorge of Samaria) and the National Park of Olympus [60].



Table 1. Major Deltas in Greece

1	Axios Delta National Park - Axios, Aliakmon and Gallikos Delta Complex
2	Delta Louros and Arachthos
3	National Park of Eastern Macedonia and Thrace – Nestos Delta
4	Evros Delta
5	Pineios Delta
6	Alfios Delta
7	Sperchios Delta
8	Acheloo Delta

Table 2. Major Rivers in Greece [61]

No.	River	Total Length
1	Maritsa	299 miles (Greece, Bulgaria, Turkey)
2	Struma	258 miles (Greece, Bulgaria)
3	Vardar	241 miles (Greece, Former Yugoslavic Republic of Macedonia)
4	Haliacmon	185 miles
5	Arda	180 miles (Greece, Bulgaria, Turkey)
6	Aoös	169 miles (Greece, Albania)
7	Nestos	140 miles (Greece, Bulgaria)



Table 3. List of Greek Wetland Systems of International Importance [62]

No.	Site	Date of designation	Region, province, state	Area	Coordinates
1	Amvrakikos gulf	21/08/1975	Epirus	23,649 ha	39°06'N 020°55'E
2	Artificial Lake Kerkini	21/08/1975	Central Macedonia	10,996 ha	41°13'N 023°08'E
3	Axios, Loudias, Aliakmon Delta	21/08/1975	Central Macedonia	11,808 ha	40°30'N 022°43'E
4	Evros Delta	21/08/1975	Thrace	9,267 ha	40°50'N 026°04'E
5	Kotychi lagoons	21/08/1975	West Greece	6,302 ha	38°01'N 021°17'E
6	Lake Mikri Prespa	21/08/1975	West Macedonia	5,078 ha	40°46'N 021°05'E
7	Lake Vistonis, Porto Lagos, Lake Ismaris & adjoining lagoons	21/08/1975	Thrace	24,396 ha	41°03'N 025°11'E
8	Lakes Volvi & Koronia	21/08/1975	Central Macedonia	16,388 ha	40°41'N 023°20'E
9	Messolonghi lagoons	21/08/1975	Aitolioakarnania	33,687 ha	38°20'N 021°15'E
10	Nestos delta & adjoining lagoons	21/08/1975	Eastern Macedonia, Thrace	21,930 ha	40°54'N 024°47'E



Description and Aspects of Ecotourism

Tourism in general has managed to become a priority strategy for the economic development of several countries [63-65]. Among the different types of tourism, ecotourism or nature-based tourism has become one of the most popular concepts of today [66-68]. It promotes the environmental sustainability and ensures the smooth process of conversation, through the effective use of resources [69, 70].

Ecotourism can be described as a heterogeneous phenomenon of global socio-economic and tourism principles that surrounds the core ideas of exploring, respecting, studying, protecting and enjoying ecosystems, water courses and bodies, wildlife, as well as natural, archeological and cultural resources and sites [42, 71-78]. This statement is perhaps the most accurate definition that refers to ecotourism, since due to the numerous aspects and variations of ecotourism, each given term is either incomplete or dependent to ecosystems with specific characteristics [79-82]. Nevertheless, each description is a mix of information that refers to the unique characteristics of an area, its desired attractions, the purpose of visiting and its behavioral effects on both visitors and inhabitants.

The concepts of ecotourism as a mean of development and sustainability should be considered only after a thorough evaluation analysis of the benefits and impacts. A successful scheme of ecotourism management involves the augmentation of socioeconomic and environmental benefits for the involved populations, the visitors, as well as the wider region while it presents minimal negative effects in every aspect [42, 83, 84]. To further promote the efficiency of sustainable ecotourism management and reach the maximum profit with the least possible damages, the principles of prevention, planning, monitoring, evaluation, restoration and education should be fully adopted [42].



Facts and the role of Local Populations in RaD Ecotourism

Regarding traveling destinations, the RaD and other water-related ecotourism genres have rapidly managed to become not only popular attractions but also important income sources [85-87]. Swimming, scuba diving, water-rafting and other water sports are few of the available activities when visiting water-based areas [85, 88]. Yet, the risks of contamination by pollution are high due to the massive number of visitors and the establishment of businesses that provide all kinds of services [42].

The management planning of ecotourism strategies is often a complicated issue, especially when it involves the conservation of protected areas, water resources and the livelihood of local populations [13, 42, 84, 89]. The limited involvement of citizens and the de-facto decisions for their surroundings due to environmental policies may cause problems to all the involved parties and the environment itself [84, 90-93]. Inefficient planning, limited funds and complicated bureaucratic procedures result in high costs and low benefits when establishing protected zones in ecosystems; phenomena such as loss of income, reduction of regional socioeconomic growth, environmental apathy of local populations, as well as protests are usual in such cases [42, 94-96]. On the contrary, when local communities and their business ideas are taken into consideration, the benefits for environmental protection and ecotourism multiply since the needs for life quality improvement and the conservation of resources are included [13].

All the decisions for the protection and conservation of environmentally valuable areas eventually lead to positive, negative or a mix of both outcomes; therefore, prior to any decision, all the empowerment/disempowerment scenarios that are related to economic, psychological, social, political must be evaluated mainly by the perspective of local residents and young generations [13, 97-100].



RaD and other Ecotourism areas in EMT, Greece

The EMT region of Greece is a unique RaD ecosystem within an approximately 200 kilometers perimeter and it is widely known for its rare wildlife and unique biogeoclimatic conditions [93]. It also presents an impressive cultural heritage due to its early inhabitation [101]. Its mountainous riparian areas are almost intact, same as with its flora and fauna; however, its lower parts have been overwhelmingly damaged or changed [47].

Nowadays, the conversation of the plethora protected zones and the environmental awareness of its populations and visitors are major factors for the increasing development of ecotourism and the effective preparedness against threats, such as human exploitation and natural hazards [35]. It should be mentioned that there are several protected areas in EMT; those of major importance and high environmental value are the National Parks of EMT and Rhodope Mountains, the wetlands that include the lakes Kerkini, Vistonida, Ismarida and the lakes lagoon around these areas, the Deltas of Nestos and Evros rivers and the forest areas of the Rhodope Mountains in the prefectures, including the Dadia Forest Reserve [102-104].

Over the last years, notable efforts have been made towards the promotion of “smart” land-use, RaD conservation and ecotourism and the wide participation, education and training of the local populations by the EMT authorities [42, 105, 106]. Nevertheless, a lot more need to be done in order to reach an ultimate balance between the environmental sustainability and the maximum economic development of the EMT.



Conclusion and Suggestions

The unique contribution of RaD ecosystems and their biodiversity to human prosperity is chronically proven. Yet, RaD protected areas are still vulnerable to the increasing challenges of urbanization and extreme disasters. Although globally established frameworks and actions aim to protect their sustainability, the threats are multiple. Ecotourism is a key factor that maintains the biodiversity of protected areas, while it provides additional income opportunities for the involved populations.

By enhancing the conservation of RaD ecosystems, wildlife and local communities benefit equally and learn to exist in the same environment. Ensuring policies for minimal environmental and socioeconomic impacts by promoting wide and active participation of all the stakeholders can secure the required demands for sustainable and developing environments.

The example of the EMT is a success story of harmonically connected RaD protected areas, ecotourism activities and socioeconomic development that could be used as a paradigm shift towards a sustainable approach for human and wildlife cohabitation.



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