Chapter

Management and Sustainability of Greek Wetlands

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Abstract

Greece has today about 400 large and small wetlands. Some of them are international importance and some are considered as national importance. Several of them are composite and form wetland mosaics or complexes. The most common wetland types in Greece are: rivers, estuaries, deltas, lagoons, shallow lakes, shallow marine formations, marshes. Their total area is still quite large (210,000 ha) in spite of the heavy losses that occurred during the last two generations Threats of degradation are drainage, dam construction, irrigation networks, alteration in river morphology such as diversion flow, clearing of natural vegetation which alter hydrological regime and affect wetland function. Sustainable agriculture in the hydrological basins of important wetlands should be considered because these systems are threaten most.

Keywords: Wetlands Greece, agriculture, management, legislation

1. Introduction

Greece historic route, is depicted in wetland landscape. Since antiquity detailed description of the reedbeds of lake Copais is included in the botanical work 'Enquiry into plants' (IV:10–12) of Theophrastus from the 4th century BCE. Related flora and fauna are entailed in works on natural science of Theophrastus ('Enquiry into plants', 'On the causes of plants'), Aristotle ('History of animals', 'Parts of animals', "On the generation of animals"), Dioscorides ('On medical matters') [1]. First settlements were established along rivers and around lakes taking advantage of good grazing conditions and naturally irrigated land.

Contemporary history major social economic events, wars, economic crisis, have put a fingerprint in wetland landscape. For thousand year people ignored the diverse function that wetland perform and also put on them the label of malaria Farmers were interest in wetland trying to drain them for crops and to prevent flooding and to abstract irrigation water. Greece socioeconomic history is linked with wetland status After 1920, a rapid increase area loss was observed for example the Greek state implements a large scale land reclamation projects in the plain of Serres town. This coincides with the fact that period 1928 to 1936, was a great refugee problem that followed the Greco-Turkish War in 1922. Another example Lake Karla, Greece, was almost completely drained in 1962 both to protect surrounding farmlands from flooding and to increase agricultural area. The reclamation did not attribute the expected benefits [2]. Loss of wetland functions and values resulted in environmental, social, and economic problems [3]. An estimated loss 63% in original wetland area in Greece has been occurred over the twentieth century.

Large deltaic areas were shrinked with coastal erosion phenomena. These are attributed to hydrology modification due to dam construction [4].

A"first approximation" of National Wetlands Inventory was published in 1994, including a list of 400 wetlands, with inventory data on 271 of them by the Greek Biotope/Wetland Centre (E.K.V.Y) with the contribution of the former Greek Ministry for the Environment, Spatial Planning, and Public Works in 1994. Main focus of the original Inventory was the continental wetlands. Northern Greece (Anatoliki Makedonia, Thraki, Kentriki and Dytiki Makedonia and Thessalia) there are 118 wetlands, or 31% of the total number. The rest of the continental Greece (Ipeiros, Dytiki Ellada, Sterea Ellada, Peloponnisos and Attiki) contains 151 (40%), while 109 (29%) are in the islands and Crete (Ionia Nisia, Nisia Voreio Aigaio, Nisia Notio Aigaio and Kriti). As regards area or length, Northern Greece contains 48% (97479 ha) of the total wetland area and 56% (2389 km) of the total length of linear wetlands (e.g. rivers). The corresponding figures are, for the rest of continental Greece, 48% (97608 ha) and 37% (1588 km), and for the islands and Crete 4% (7530 ha) and 7% (294 km) [5].

However the morphology of Greece is unique with 6000 scattered islands and islets with a wealth of wetlands. Small wetlands which are spreading through the territory have received little attention and are not in the focus of conservation Nevertheless it is argued that play an important role in the maintenance of species biodiversity. Any loss reduces connectivity among species populations. Inadequate legal protection threatens its existence.

In an effort to fill this gap, in 2004 WWF Greece launched the "Conservation of Aegean Island Wetlands" project, striving to document the state of Greek island wetlands, highlight their importance and draw attention to whatever is needed for their preservation. The outcome of the project was the documentation and delineation of 824 natural and artificial wetlands (>0.1 ha) in 76 islands of Greece (100 on 8 Ionian Islands, 520 on 65 Aegean islands and 204 on Crete and 2 satellite Islands) have been documented and delineated. Of them, 602 are natural wetlands and 222 are artificial [6, 7]. Special issue needs to be mentioned is a priority freshwater habitat in Mediterranean the Mediterranean Temporary Pond (MTP) is a priority freshwater habitat type (3170*, NATURA 2000), that is mainly encountered in Mediterranean type arid and semi-arid climates. They are characterized by their ephemeral nature of their wet phase and the absence of any link with permanent aquatic body making them vulnerable to climate change. In Greece the MTP sites which are coincided in 18 Natura sites are concentrated in the southeastern part of the country [8].

Some of wetlands are international importance some are considered as European and national importance. Several of them are composite and form wetland mosaics or complexes. Ten Sites are designated as wetland of international importance as Ramsar sites with a surface area of 163,501 hectares varying size from 5,078 ha in lake Mikri Prespa to 33,687 ha in Messolonghi lagoons Greece the usual case is that the Natura 2000 site is much larger (average size 11,275 Ha) and engulfs the Ramsar site. A characteristic example of this relation between the two is the case of the lakes Kerkini and Mikri Prespa: the Ramsar boundaries are restricted to the water body whereas the relevant proposed Sites of Community Importance are large enough to include large part of the surrounding catchment area as well [6].

The most common wetland types in Greece are: rivers estuaries, deltas, lagoons, shallow lakes, shallow marine formations, marshes, springs, reservoirs. Their total area is still quite large (210,000 ha) in spite of the heavy losses that occurred during the last two generations [9]. Wetlands accordingly to their hydrology patterns are classified as precipitation dominated, groundwater fed and surface water dominated. With the exception of lake Mikri Prespa, which is not connected to a

Figure 1.
Ramsar sites in Greece [10].

major river basin, all the others have been proposed as representative examples of wetlands which play a substantial hydrological, biological or ecological role in the natural functioning of a major river basin or coastal system (**Figure 1**).

Nowadays threats of degradation are drainage, dam construction, irrigation networks, alteration in river morphology such as confinement of river beds, building embarkments, clearing of natural vegetation which alter hydrological regime and affect wetland function. Biodiversity governance is a continuous battle towards sustainable management in Greek wetlands despite the continuous threats.

2. Wetland protection legislation and administration

Environmental protection and legislation in Greece was very limited in the 1960s and 1970s. A basic national law for protected areas declaration is the Act on the Protection of the Environment of 1986 (No 1650) and its amendments by law 3937/2011 (ΦΕΚ 60/A/31-3-2011). This complements previous legislation and introduces the designation further more classes of protected areas in Greek territory. These are characterized as Absolute Nature Reserve Area, Nature Reserve Area, National Park, Protected Significant Natural Formation and Protected Landscape and Ecodevelopment Area [11].

Local Authorities are called to play an important role in the implementation of the 1986 Act. The power to designate protected areas and to determine the boundaries of such areas may be transferred to the Prefectures (i.e. the representatives of the central government at local level) under article 21.5 of the 1986 Act. In addition,

under article 27 of that same Act, any of the powers exercised by the Minister of the Environment under the Act may also be transferred to the Prefects.

Greece has moved one step forward, ratified international regulations for special commitment on the protection of the natural environment derived from international conventions. These conventions cover a) Wetlands of international importance according to the Ramsar Convention, b) World Heritage Sites (UNESCO), c) Biosphere Reserves (UNESCO, Man and Biosphere), d) Specially Protected Areas according to the Barcelona Convention, e) Biogenetic Reserves (Council of Europe) and f) Eurodiploma Sites (Council of Europe).

The turning point to Biodiversity birds is the adoption of Ramsar Convention. This entered into force on 21 December 1975. According to Convention "wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tides does not exceed six meters". According to the same Convention, wetlands are also "riparian and coastal zones adjacent to the wetlands, and islands or bodies of water deeper than six meters at low tide lying within the wetlands". The Ramsar sites of Greece cover a total surface of 163,501 ha, and all of them also form part of Natura 2000 network.

Greece has currently 10 wetland complexes (consisting of 59 sites) as Wetlands of International Importance (Ramsar Convention Bureau, 1996) These are Kotychi lagoons, Amvrakikos, Mesolonghi laggons, Axios Loudias and Alakmonas delta, Lakes Volvi and Koronia, Artificail lake Kerkini, Lake Mikri Prespa, Nestos delta and adjoining lagoons, Lake Vistonis, Porto Lagos, Lake Ismaris and adjoining lagoons and Evros delta (Ramsar Sites Information Service). Moreover 100 sites were characterized as wetlands of national importance It However only ten wetlands of Greece are characterized as Ramsar sites International Importance and seven of them are included in Montreux Inventory with bad environmental status [9].

The trans-border Ramsar wetlands of Greece are the Evros delta and the lake Mikri Prespa (75% and 92% respectively belong to Greece). Three other sites, Axios delta, Nestos delta and lake Kerkini have trans-border watersheds. Eight out of the ten Greek Ramsar sites and their surrounding areas are a series of more than one wetlands. From the remaining two, lake Kerkini is a man-made wetland in an area that used to hold a series of marshes. Kotychi is an isolated wetland complex. Both of them are in strategic positions within migration routes for birds and thus are connected to other wetlands.

Designation of Special Protection Areas, according the Birds Directive 79/409/EC and pSCIs proposed Sites of Community Interest, according the Habitats Directive 92/43 are considered as keystones for Natura 2000 sites delineation in Greece. Sites Natura 2000 constitute environmental network of areas with high ecological, biodiversity or esthetic value. Greece includes at its National List 241 Sites of Community Importance (SCI) according to the EU Directive 92/43 and has declared 202 Special Protected Areas (SPA) according to EU Directive 79/409 [12, 13].

With the of Law 2742/99 there has been a shift, towards a more participatory approach in biodiversity governance. It was adopted mainly through the establishment of Management Agencies. Since 1999, 29 management agencies have been established in 94 of the 419 Greek Natura 2000 sites [14]. As a consequence, the majority of Greek Natura 2000 sites do not have a specific governance mechanism for their management. Management agencies should form the basis for periodic nationwide synthesis and reporting of information on the kinds, and outcomes of regulatory actions related to wetlands conservation. Stakeholders and local communities express their preference towards improving participation in decision making in conservation of Natura 2000 sites [15].

With the recently voted environmental law in Greece (Law 4685/2020) which is going to be the central Coordinator for all actions a new scientific, advisory and coordinating Organization, is established regarding protected areas in Greece. The new institution bears the name 'Organization for Natural Environment and Climate Change' and it is under the auspices of the Hellenic ministry of Environment and Energy Consolidation. In parallel this Organization is going to keep the 24 decentralized units, each one corresponding to a protected area [16]. It is argued consolidation of all management bodies to one central agency would improve administration of protected areas. In the other hand decentralized units must keep their dynamic and protect local wetlands with the active involvement of local communities.

People now want restore wetlands as in the case of Lake Karla, and take advantage of their benefits to the landscape [2, 17]. A National Strategy of Wetland Resources restoration, in 1990 was designed as a means for wetland conservation and restoration [18].

Wetlands cannot be understood hydrologically as a site in isolation but as an essential part of catchment system. Processes operating in the higher part of the basin or in the higher recharge zone to an aquifer controlled wetland feed the biotope. On the other coastal morphology and water quality is dependent of wetland function. Water Frame Directive as it has been harmonized in Greek legislation with the law 3199/2003 (ΦΕΚ280Α/09.12.2003) and the Presidential Decree 51/2007 (54/A/08.03.2007), puts the concept of integrated management at the geographic scale of River basins and helps understanding wetland function [19–23].

Wetlands occupy a dominant role in Environmental Education that is becoming increasingly important. They are considered particularly attractive areas for training in Environmental Education, because of their high scientific value and the fact that one can observe more and faster changes in images, sounds and events than in terrestrial ecosystems. It is a laboratory in the nature. Environmental Education Centers (EEC) is an institution with 30 year history in Greece consists of a network dispersed geographically in 53 distinct areas in country. Local wetlands ecosystems, biodiversity, protected areas conservation is on the core of provided environmental education. An outdoor component diversifies it from traditional education teachers, pupils and all the citizens. Despite difficulties arise from unsecure funding, unflexible school schedule, lack of specialized environmental knowledge centers seem to offer multiple benefits to the participants [23]. Operation of the Information Centre in ecosystem area, museum of natural and cultural history, points of observations in suitable locations, serve as environmental interpretation activities.

Contributors to the environmental education in the country are also NGOs (Non-Government Organizations), and Protected Area Management Agencies [24]. NGOs that are actively participate in the environmental protection are Hellenic Ornithological Society, the Greek branch of WWF, Medsos, Mom, Kallisto, Arktouros, Hellenic Society for the Protection of the Environment and the Cultural Heritage, EKBY, Archelon Medies (Mediterranean Education Initiative for Environment and Sustainability), and MIO-ECSDE (Mediterranean Information Office for Environment, Culture and Sustainable Development).

3. Aspects of Greek wetland management

Wetlands are normally not very easy to access so many people do not visit them. Photographers and film makers take snapshot of a beautiful scenery which thrives in watefowl, rare plants and reptiles. These powerful images attract the public but not educate them deeply in wetland science. In many case degradation could have been avoided if there was sufficient knowledge.

Although the high level of endemism, the biodiversity of Mediterranean wetlands is not well-known by the general public, with the possible exception of waterbirds, which gather in amazing numbers at some sites. The deltas of the Evros, Nestos, Acheloos, the double-delta area of the Arachthos and Louros, as well as the Lakes Kerkini, Shkodra and Prespa contain rich bird faunas often with more than 300 bird species per site. Delta Evros as a crossroad in waterfowl corridor is renowned as great value delta [25]. Illegal hunting is an activity related with wild bird fauna in delta regions as Amvrakikos gulf (Barelos, personal communication).

Wetlands constitute an ecological laboratory. A mosaic of phyto communities with varied chorological interest such as 'communities' saline and subsaline soils, freshwater soils periodically inundated and phytocommunities without particular habitat reference and riparian forests [26]. They possess one or more morphological or anatomic adaptions to enhance their ecological tolerance and adopt highly specialized life strategies in the wet dynamic environment. Aquatic bed plants, Nymphea alba, Potamogenon sp., Lemna sp., shrubs as Tamarix, Vitex agnus castus coastal dune such as Juniperus sp., Pancratium maritium, emergent plants as Phragmites austalis, Typha Latifoli, Salicornia and trees such as Populus Alba, Salix alba, Platanus orientalis Pinus pine asp. are the most conspicuous component of Greek wetland ecosystems (**Figure 2**). Some species are endemic and encountered in particular rare priority habitats with a great value for its conservation. As the base of the food chain and support a critical habitat for birds, fishes, macroinvertebrates of all the wetland communities [27, 28].

Wetland area have a great economic value in Greece. Wetland features and agriculture are intimately linked. Agriculture is by far the most important water consumer in Greece (89%).

The Evros, Pinios, Strymon plains as well as the lower Axios and Acheloos, including their main deltas, are fertile landscapes, intensively cultivated and densely populated. Water abstraction for irrigation purposes, construction of dams

Figure 2.
1. Thickets of Vitex agnus castus L.*in a natural habitat of community interest 2. Coastal dune with* Juniperus spp *(priority habitat). 3. Coastal dune Pancratium maritium 4.* Populus alba *5. Broadly distributed wetland grass, Phragmites australis 6. Salt tolerant* Tamarix alba*. (photos Mpeza).*

and ditches, fertile soils in the riparian valleys are the causes of an intense agriculture interest [29]. The Evros, Pinios drain the most intensively cultivated basins (53.4–40.6% of the basin). Plains of Serres (Strymon basin), Thessaloniki (lower parts of Axios and Aliakmon basins), Thessaly (Pinios basin) and Arta (lower Arachthos basin) have been designated as Nitrogen Vulnerable Zones [19].

About 60% of the total rice production and 2/3 of the total mussel production (>30 000 tons/year) of Greece occurs in the Axios Delta and estuary. The most important lakes for fisheries are production: 950 tons/year), Trichonis (500 tons/year), declining in recent years, Kerkini (150 tons/year) and Prespa (100 tons/year) [30]. It is worth noting that the former Karla Lake which was fed from Pinios river had an average annual production of 1000 tons. Even if the total quantity of fish caught in the most important lagoon system Amvrakikos has undergone a reduction because of a dramatic decrease in eel production, local fishermen catch great quantities of mullets (40.4%), sea bass (28.4%), eels (38.2%) sea bream catches have increased by 178.6% [31].

Spiritual and cultural values are arisen in wetland area. From antiquity people concentrate around water and stories of water civilization were written. Wetlands hosts archeological sites of major cultural, historic and scientific interests are, ancient theaters, mills, lighthouse (faros) monuments, geological formations, churches depicting history in the centuries from the Neolithic period to post-Byzantine period [32].

Small farmers, fishermen, aquaculturists are living around wetlands. Local communities develop traditional water management practices, use traditional tools and boats, fairy houses, old customs as the bird dance where children mimic the movements of birds was in the Lake Mikri Prespa, reminiscent of the past Greece [33].

A traditional shilt house (called "pelada" in Greek) is unique in the lagoon of Kotychi, Etoliko in Messsolonghi Central Greece, is made from lake plants Small boats with lack of keel, so that they are easily navigates and easily drawn in the land are all connected with civilization in the perimeter of the lagoons. These traditional boats called priaria in Western Greece and "plava" in Northern Greece [34].

Intangible values as seasonal changing color palette. Salicornia's reddish marsh fall color, outstanding Flamingos color in the winter landscape sounds of rustling leaves, bird song, water flow, are emerged from the unique landscape (**Figure 3**).

Wetland functions are seriously impeded from human activities in Greece. Hydrology regime is wetland signature. Are dependent on rainfall, runoff, and seasonal flooding for their water supplies. All Mediterranean wetlands suffer more often in prolonged periods of extreme, high temperatures which lead to diminution of water or total drought. Human induced climate change make signs to wetland function. Lowering of water table and extended shortage rainwater cause stress to vulnerable aquatic ecosystems. Signs of climate change make their appearance in local communities.

Kalodiki calcareous fen is an inland belonging to the western chain of Greek wetlands. It possesses a great ecological value that as it protects 8 species of the Nature Directives and 4 habitat types of the Habitats Directive and one priority habitat 7210* Calcareous fens with Cladium mariscus and species of the Caricion davallianae [35]. Soil moisture, water depth and to a lesser extent dissolved nitrogen determine their 18 vegetation types relative composition [35]. The wetland struggles for its survival as it might be dry much of the year, but that are maintained by repeated seasonal saturation or inundation, require protection even at times when they are completely dry if they are to retain their functions (**Figures 4** and **5**).

Ecological state of the whole ecosystem is strongly dependent on a small dam. Farmers often damage the dam in order to irrigate their fields. The dam is badly maintained and leaks. Phytocommunities respond impressive in water level

Figure 3.
Salicornia sp *colonized mud as sand in National Park of Amvrakikos gulf, NW. Greece. Habitat code 1310 (photo Mpeza).*

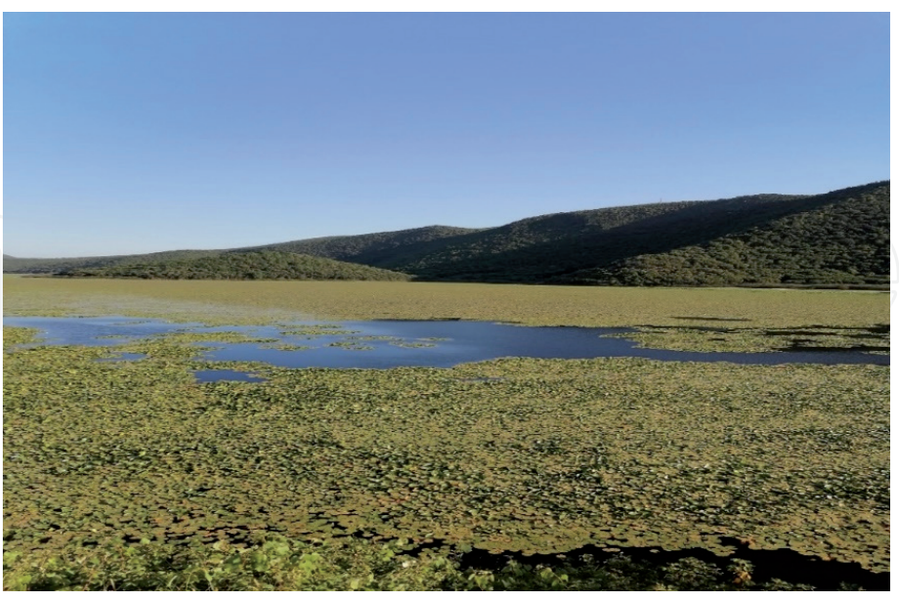

Figure 4.
Submerged plant Nymphea alba situated inland wetland of Kalodiki Natura 2000, code GR2120002 (Mpeza).

Height. When water levels exceed 4 m, the Phragmito Magnocaricetea communities disappear, while Potametea communities disappear when the level drops below the soil surface. However, disappearance of emergent plants and their communities due to excessively high water levels would influence bird species by the

Figure 5.
Dry Kalodiki fen at October 2019 (Mpeza).

absence of breeding places [36, 37]. Fen acts as carbon storage and take attention in mitigating climate change.

Coastal wetlands receive the burden of human activities like the flux of massive visitors or suffer from erosion phenomena, climate change, eutrophication and construction of small enterprises and roads or establishment of settlement area. Coastal systems land valuable habitats and contribute to biodiversity. Priority habitats such as type 2250" Salt dunes with *Juniperus spp*." it is encountered in Greek Natura sites such as Elafonisi, Falasairna, Gavdos, Acheronta Starits contributing to landscape integrity. The habitat increases coastal resilience retaining sand and halt erosion phenomena in parallel creating biodiversity areas. The habitat suffers from fragmentation with road construction, car parks and small business as result of intense touristic activity in the coast eradicate crucial habitas [38, 39].

Intense agriculture activity in the perimeter of wetland area is a non –point source for agrochemicals and pesticides inputs to receiving waters [40]. In the period 1995–1996, water samples from Louros estuary revealed a continuous presence of triazines, alachlor and metolachlor and sporadic peaks in May and June for other herbicides as, atrazine, simazine and degradation product desethyl-atrazine (DEA) The inputs of the five major herbicides, atrazine, simazine, alachlor, metolachlor and desethyl-atrazine (DEA) to the Louros River are mainly from tributaries and the agricultural area draining to the river estuary. Atrazine and its degradation product DEA are the most abundant herbicides discharged into Amvrakikos Gulf, followed by metolachlor, simazine and alachlor [41, 42].

Mussels were used in another study to assess possible pesticide pollution impacts in the Amvrakikos Gulf in the period 1992–1996. Around Louros and Arachthos rivers in the flood plain of Arta there is an intensive agriculture activity. Riverine flows are discharged for in the swallow lagoons of the deltaic formation. Scientists used mussels to detect general oxidative stress effects on the health status of mussels. They used special biomarkers of oxidative stress as decreased acetylcholinesterase activities that indicated exposure to organophosphate and carbamate pesticides. Responses of the antioxidant enzyme glutathione peroxidase suggested the presence of contaminants capable of reactive oxygen species generation that could be related to organochlorine pesticide contamination in the area [43, 44].

It has been considerable research on the ability of wetlands in agricultural settings to serve as sinks for fertilizers such as phosphate and nitrate and a

limited number of studies show the potential for wetlands to adsorb agricultural pesticides [45].

Research confirms the continuous presence of pesticides in river waters in catchment with intense agriculture activity. As regarding pesticides, the most polluted rivers are the Axios and Aliakmon. S-triazines, amide herbicides and organophosphorous insecticides are the most frequently detected, while organochlorine pesticides as legacy pesticides (banned in Greece in 1972) occur at very low concentrations [30, 45].

Wetlands as a land between terrestrial and open water ecosystems have proven to play a key role in trapping plastic liter, including large items Rivers are an important pathway for plastic litter transport. High flow takes away large items towards the coast while during low flow, plastic waste is stranded on riverbanks During high flow, thinner plastic bags are many times trapped from the overhanging vegetation at the bank of the rivers (**Figure 6**). Furthermore, plastic items on the river route are obstructed at dams [17, 46].

Rural communities, farmers, cattlemen, fishermen throw their wastes into rivers and coastal lagoons. Illegal hunting takes place in areas rich in waterfowl species and an example is Amvrakikos [33]. Agriculture nets, plastic films, pesticide empty bottles, ropes are abandoned in the field from farmers. These items are degraded under sun break into smaller pieces and are carried away from wind and surface run

Figure 6.
Illegal dumping site in river banks in an intensively cultivated area in Natura 2000 site B. "Christmas tree" transport solid waste with river flow C. Old Delta of Kalamas river, NW. Greece D. dumping site in lagoon n delta Kalamas (Ieronimaki).

off into wetland Causes are arisen from inadequate solid waste management scheme and lack of environmental awareness. While a lot of research is conducted in coastal litter, little is known about the accumulation of the plastic litter in the transition zone of wetland. Moreover, little is known about the mechanisms that control the transport of microplastics and their accumulation in on wild life [47].

Many rivers receive untreated effluents from rural communities that are not connected with WWTPs (Water Waste Treatment Plants) and this causes stress to all receiving water bodies. For example, the Aoos basin, most of the catchment remains in a wild, almost untouched state with restricted agriculture, forestry, cattle breeding and some aquaculture. The river receives untreated effluents from five urban settlements (Konitsa, Permet, Argirokastro, Tepelen, Mamalje, Selenica), small-scale industrial areas and by-products of petroleum extraction in the lower section [30].

Nevertheless, wetland function can be beneficial for agriculture also. Wetland ecosystems are characterized with outstanding biodiversity, longer and more complex food chains which may reveal biotic interactions useful for designing pest management strategies. Birds that live in these ecosystems, nearby cultivations eat insects which cause harm to crops. Special mention is made for soil borne pests as they are serious pests eating seeds and seedlings grown in winter. This also diminishes toxic insecticides usage in field and adverse impacts to the ecosystems.

Pollinating insects find water in humid wetland soils especially in arid regions. Crops such cotton, sunflower is adapted to insect pollination, although insects are nuisance for farmers in the area. A unique crop which occurs exclusively around lake Prespa "Phaseolus multifolio" takes advantage of the pollinator's abundance in the neighborhood wetland [48].

Plants of wetland such as riparian woodland (*Platanus orientalis*, *Alnus glutinosa, Populus sp., Ulmus minor, Fraxinus sp., Salix sp*). Reedbeds (*Phragmites sp*). halophytic, semihalophytic and shrub–scrub vegetation (Ar*throcnemum glaucum, Juncus sp., Salicornia sp., Tamarix sp)*. Marshes and wet meadows (L*olium perenne, Menta pulegium, Plantago major, Carex sp.*) are used for nutrient removal and organic contaminants degradation [2].

Alternative new ideas about purification potential of wetlands have been recognizing. Halophytes in conjunction with associated entophytic and rhizosphere bacteria are involved in organic contaminants biodegradation in contaminated water and soil. Species of genus Tamarix and its associated bacteria have been shown to contribute to degradation of bisphenol-A a widespread xenobiotic and endocrine disruptor [49, 50].

Depositional features of deltas such as Lagoons, sand bars, thin land forms towards the sea, barrier islands, are well formed in the geological past. Physical or human interventions alter river's geomorphology, destroy these geoforms. Construction of two high dams inland in river Nestos and diversion of the flow to the east resulted to drying river channels and erosion of coastal landforms. This affects crop's yield in the vicinity of the river and fish catch in lagoons [51].

A positive example of human activities in the conservation of wetlands are found in the wet meadow issue a fringe wetland biotope in the lake Mikri Prespa in the core of the National Park of Prespa. Wet meadow has been a valuable biotope in the ecosystem. Since the mids 1970's a dramatic reduction of wet meadow area and a concomitant expansion of reed beds was observed in the littoral zone. Tall helophytes such as P. australis, T. angustifolia, Schoenoplectus lacustris and related taxa tend to expand on drier substrates excluding less competitive species.

The drivers for this ecological change was water level fluctuations and dynamics of vegetation management. Habitants abandoned their traditional occupations such as livestock grazing, stop use of reeds as an animal feed and as construction material

for ceilings, fishing moved to deeper waters from littoral zone and they diverted farming exclusively in beans.

An innovated restoration programme the LIFE Nature project titled "Conservation of Priority Bird Species at Lake Mikri Prespa, Greece was planned and implemented with encouraging results. A combination of adjustment water level and vegetation management with cutting and grazing by water buffalo herds gave rehabilitation to wet meadow biotope. Wet meadows are key habitats for spawning fish, amphibians, and feeding ground for endangered water birds, while they also hold socio-economic importance related to fish populations (carp) and grazing [52].

Wetland restoration and conservation is complicate ecological-socioeconomic projects in Greece. Restoring wetland value for the society goes together with wetland functions which are physical, chemical, and biological processes that are performed in the area and the interconnections in the whole catchment processes [2, 53].

4. Conclusions

Wetlands are ultimately linked from the ancient time with history culture and local economy. Despite the wetlands value there is a long road to the sustainable management and their harmonized relations with human activities. Although they suffer from degradation in the past, they still support endemic and threatened species and encompass priority habitats with a great value of conservation. Main economic activities as agriculture, aquaculture, fishing, livestock are taking place in estuaries in lakes and ponds in deltaic formations, which constitute wetland areas.

A wealth of small wetlands is scattered in the numerous remote islands in the Greek landscape which provide ecosystem services which cannot be ignored. With the law Law 4685/2020 a new institution 'Organization for Natural Environment and Climate Change' which is under the auspices of the Hellenic ministry of Environment and Energy Consolidation is going to be the central Coordinator for all actions in protected areas in Greece.

COVID-pandemic may influence the attitudes and the ideas about development and nature conservation in all over the world. In the new era Mediterranean Wetlands face ecological challenges with diminution and pollution which are intensified in the view of climate crisis. Physical issues as increasing average and maximum temperatures declining total precipitation increasing frequency and intensity of storms and sea level rise under the umbrella of climate crisis and the risks they pose for the survival of Greek wetlands must be foreseen.

New priorities and reevaluation of the National Strategy for the conservation of wetlands must be put a barrier in the Interface between science and policy science and local communities need to be strengthen.

In this direction implementation of agro-environmental (sustainable) management measures in rural areas neighboring wetlands as wise use of agrochemicals, choice of crops requiring fewer inputs. Assimilation of new knowledge about wetlands with systematic monitoring of water quality data, census of bird population trends mapping every plant role in wetland phytocommunity, harmonization with the use artificial intelligence for data processing and drone technology for large scale monitoring of monitoring of trends in bird population, characterize genetic material from biological populations. Novel education wetland projects need to be delineated which embedding wetland curriculum in school education and engage citizen science projects with activities and conservation action in the field.

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