Diachronic environmental evolution of the Messolonghi lagoon in Western Greece and archaeological evidence

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Abstract
The area of Messolongion and Aitoliko lagoon is the greatest one in Greece, and among the greatest in Europe. Today, this region is an environmentally protected park, being located in the Southwestern edge of Sterea Ellada, where the Patraic gulf meets the Ionian Sea, and where the rivers Acheloos and Evinos flow into the sea. From the point of the biodiversity view, the above region is considered as one of the richest wetlands in number of species. In this area, lagoons, and terrestrial and river areas as well as the complex of Echinades islands of the Kefallinian Prefecture, are included, the region being distinguished for its biological, ecological, aesthetic, scientific, geomorphological and environmental significance.
The diachronic changes of the Acheloos river bed, from prehistoric times till today, were studied, due to the fact that this river has played an important role in the social, economic and cultural development of this area.
There is a close relationship between the environmental factors and the archaeological findings, especially in the sites that were selected in the past, for the establishment of new towns. This study made possible the recognition in depth, of the environmental problems of this region and allowed their facing with a responsible and effective way. At the same time, the importance of water in the development of economically robust and rigorous towns, was revealed

Keywords: Aitolia, Akarnania, Acheloos, Evinos, Antiquity, Environmental history

Introduction

Historical overview of the region

The main creators of the Messolonghi lagoons were the rivers Acheloos and Evinos. Both rivers were deified, as was the norm in ancient times, but Acheloos became the major symbol of water and fertility for the Greeks, as father of all running waters, and was worshiped throughout the ancient Greek world, from Sicily to Rhodes and beyond. In early iconography Achelous is depicted either as half human with a fish tail or as a bull with a human head. (Lambrinoudakis B.K. 2009).

In later bibliographic sources and especially engravings of 16th, 17th, 18th century, the Acheloos River is also depicted as a bull and the interpretation of its shape has to do

with the winding maneuvers, the folds, the curvatures currents. He symbolized the spirit of the water but also the spirit of nature, a force tamed by mankind (represented by Hercules) (Manikarou, M., 2009).

In ancient times, the whole area was the center of two great nations of Aitolia and Acarnania. The river was the border between the ancient Aitolia (east) and Akarnania (west). According to Hesiod, Acheloos was the eldest and the mightier son of Oceanus and Tethys. His daughters were the Sirens and Nymphs of springs, such as Castalia, Callirhoe, etc.

In ancient mythology and art is depicted the battle of God Achelous and the demigod Hercules, for the sake of Diianeira, the daughter of the king of Kalydona, Oeneas. Hercules defeated Achelous after he broke off one of his horns and threw him to the ground. Heracles agreed to give back the broken horn to Acheloos and in return he received the *cornucopia*, which was the source of abundance and fertility. The victory of Hercules as a metaphor is associated already in ancient times (Strabo, Geog. 10.2.19) with the construction of flood and drainage projects in the region and the cornucopia symbolizes the fertile earth that came from the construction of these works.

Another mythical incident associated with the alluvial work of Acheloos is the myth of Echinades Islands. According to the mythology Echinades were four nymphs who, during a sacrifice to the gods on the banks of the river, they had forgotten to sacrifice to the God Acheloos himself. The anger of the river was so great that its waters dragged away Nymphs into the sea and turned them into islands.

The power of Acheloos is evident in the large number of cities that were founded near its banks. Along the right bank are the towns: Stratos, Metropolis, Oiniades etc. while along the left bank are: Paleocastro, Spolaita, Arsinoe etc.

The first traces of human presence date in the Paleolithic Period, according to findings such as stone tools, and continue with finds from the Neolithic Period, with the earliest excavated settlement dating at the end of this era.

In the Bronze Age and especially in the Mycenaean period we already found well organized settlements. The easy access to water and soil tilth on both banks of the river helped the residents with the development of agriculture, stock raising and cultivation of trees as well as in commercial contacts with the cities of southern Greece.

The name of the Acheloos as Whiteriver (Aspropotamos) derives from its white sediment (clay) that carries from the flysch zone to its delta. He crosses a length of 200 Km, the basin covers an area of 5572 Km^2, the average annual runoff is estimated at 7800*106 m^3 of water and these irrigate around 370,000 acres of cropland (Stournaras, G., 2009).

The history of the water complex of the Messolonghi-Aitoliko lagoons begins several thousand years ago after opening the crevice ravine of Klisoura that reduced the waters of Lake Acarnania. Acheloos' infill part of it, and its waters found an outlet to the patraic Gulf, where along with Evinos River brought aggrade materials in the northern part of the Gulf of Patras. This has resulted in the creation a shallow marine area (0.80 cm depth) of the Messologgi Lagoon which in the northern part is connected via an outfall with the lagoon of Aitoliko.

The lagoon had an important historic role in the struggle of "free besieged" in 1826, during the siege of Mesologgi. The shallow waters prevented the Turkish ships to reach Missolonghi and thereby the islets (Vasiladi, Kleisova, Poros). Thus the provision of food supplies was facilitated through Aitoliko, while the rich sea-lagoon environment ensured food for the inhabitants (Kalavrouziotis, 2008). Only when they the islands of the lagoon fell, the warriors of Messolonghi, who meanwhile resorted in tamarisk and algae of the lagoon to feed, they decided the heroic exit at dawn on April 10, 1826 (Palm Sunday)

Professor Paliouras (Ypehode F.D.L.M.,2009) states that "the Messolonghi lagoon-Aitoliko associated with poetry and painting, the legend and allure of everyday life, with roe and pelades, with overnight fishing and daily struggle for survival in the *ivaria*[83], the lyrical speech and Byron's sacrifice. Within this setting the Byzantine churches, caves, monasteries, carry divine messages; everything seems to work in the still waters of the famous lagoon". In the area we find the cave of St. Nicholas of Varasova, St. Sosti in Vasiladi, St. Agathe, the church of Madonna in Phoenicia, the Holy Trinity of Kleisova, and the legendary monastery of St. Symios in eastern southern side of a hill of Mount Zygos.

The National Park Messolonghi-Aitoliko Lagoons

Since 2006 there is now institutionalized the national park of Messolonghi-Aitoliko Lagoons, the lower reaches and delta of Acheloos and Evinos Rivers and the islands Echinadaes (OG 477/31 May 2006). In fact, it is a cluster (6) individual lagoons, covering approximately 150,000 acres, while the wider area of the wetland system includes coastal ecosystems, marshes, saltpans, fields and drained areas given over to agricultural use. As shown in Figure 1, the entire wetland system covers 42% of the lagoons at a country level, is the largest lagoon in Greece and one of the largest in the Mediterranean.

Today based on geomorphology, as resulted from anthropogenic interference in the 1960-1985 periods, the Park consists of complex of (6) lagoons, relatively isolated from each other and each with different physicochemical characteristics:

Northern lagoon and channel Kleisova, Kleisova Lagoon, Central Lagoon, Lagoon of Aitoliko, Lagoon of Tholis and Lagoon of Paleopotamos.

The onshore section includes:

- Hills, distinguished scattered within the wetland, most of whom were part of Echinadae islands in the past and the alluvial action of Acheloos incorporated them into shore.
- The mountain Barasova (game reserve) and part of the mountain Arakythos (or Zygos)
- Sand dunes created by the debris of the rivers that delimit the lagoon from the open Ionian Sea
- The gorge of Kleisoura, integrated in the areas 'special beauty'.

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[83] *Ivaria* or *divaria*: wooden or reed fencing into a lagoon that serves as fish farm

- The forest of Fraxos, characterized as a 'heritage monument'
- Cultivated areas
- The island group of Echinadon inextricably linked to the estuarine system of Achelous.

Nowadays, throughout the national Park there are areas of absolute protection, nature protection and regional zones.

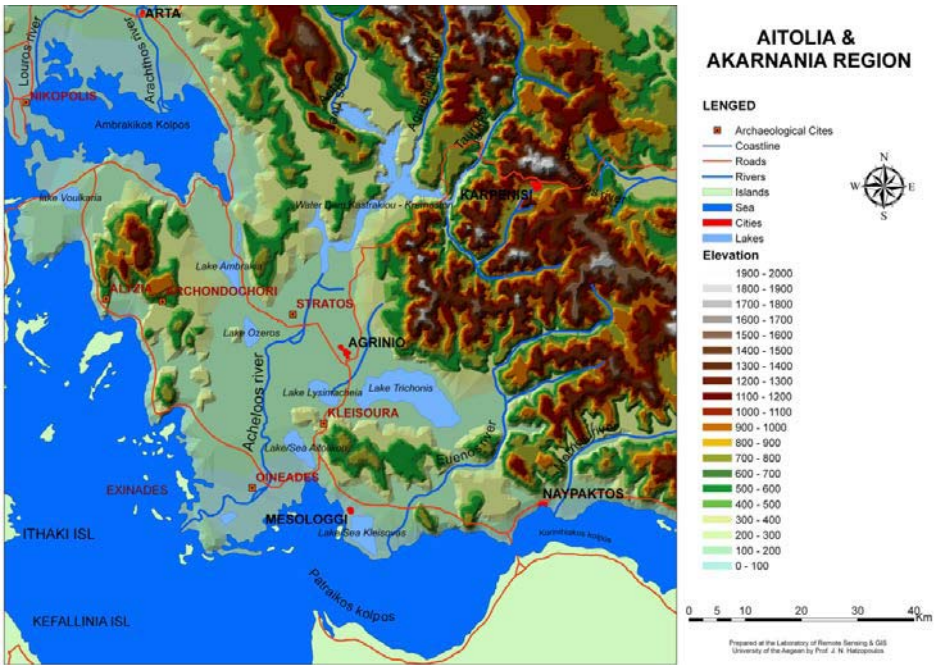

Figure 1 Geomorphologic structure in the study area

In the Zones of absolute protection is permitted:

- Scientific research and ecosystem monitoring
- The observation of nature
- The execution of works only in order to protect and improve the ecosystems
- The conservation and restoration of temples, monasteries and archaeological sites

In nature protection zones, except of the aforementioned is also permitted:

- The execution of projects of water resources management
- Mild recreational and Eco-touristic activity
- The installation of centers of ecological awareness
- Cleaning canals and ditches

Lastly in the regional zones are permitted activities beyond those mentioned, although always under control of any potential environmental implications.

Fishing is not characterized by a great variety of fish but for large populations. It is limited to the species *Sparus auratus, Dicentrarchus labrax, Mugil cephalus, Lisa aurata, Eucraulis encrasicolus.*

From the female *Mugil cephalus* is produced the infamous Roe of Messolonghi, a product with protected designation of origin.

In the lagoon there are natural fish farms known as Ivars. They consist of blocked areas of trapezoid shape on the locations where the lagoon communicates with the open sea. Fishing in the Ivars is allowed from June to January, while springtime is the period when fish are let in from the open sea. The depth of the lagoon prohibits the use of open sea fishing vessels and thus for the "harvesting" are used traditional methods, such as the wattle, 'Pezovolos', longline, 'Pyrofani', 'Stafnokari', trolling boats, 'Volkos', surrounding nets.

The aim of this work is to demonstrate the differences that existed diachronically in the region of the current Messolonghi lagoon and the deltas of Acheloos and Evinos Rivers and give useful information regarding the changes in this important aquatic ecosystem of Greece and the Mediterranean in general.

Diacronic evolution of protected area

The main tool is to identify the archaeological evidence in the said region, in order to determine the areas of human activities from the prehistoric to the Roman period. The location of settlements and other archaeological finds in combination with ancient literary sources as well as modern geological research give us an "horizon" in the use of the land and aqueous levels (of river-delta, lagoon or open sea) during antiquity.

The values in Table 1, were computed from Villas CA. 1983, as shown in Figure 2 maps, after they were overlaid over a current map using GIS tools and methods (Hatzopoulos, 2008). Villas's maps were considering certain land forms unchanged since 2000 B.C. and the areas of these land forms were subtracted from all maps to compute the Delta area which is created by alluvial deposits as shown in Table 1.

Table 1. The evolution of alluvial deposits in Acheloos River Delta, since 2000 B.C.

Period	Hectars [Ha]	Difference [Ha]	Change %	Total Change [Ha]	Total Change %
1900-2000 A.D.	32627.7	0	0.0	22170.3	212.0
1700-1800 A.D.	29355.5	3272.2	10.0	18898.1	180.7
1200-1500 A.D.	28880.5	475	1.6	18423.1	176.2
800-1100 A.D.	26148.7	2731.8	9.5	15691.3	150.0
100-400 A.D.	23027.2	3121.5	11.9	12569.8	120.2
700-400 B.C.	17388.1	5639.1	24.5	6930.7	66.3
2000-1600 B.C.	10457.4	6930.7	39.9	0	0.0

It is found that the present protected area includes 22627.7 Ha having increased by 212% in relation to the past. This increase is basically due to the river of Acheloos by which the soil

particles are brought and are accumulating in the Delta and secondarily to the numerous torrents existing in the surrounding area.

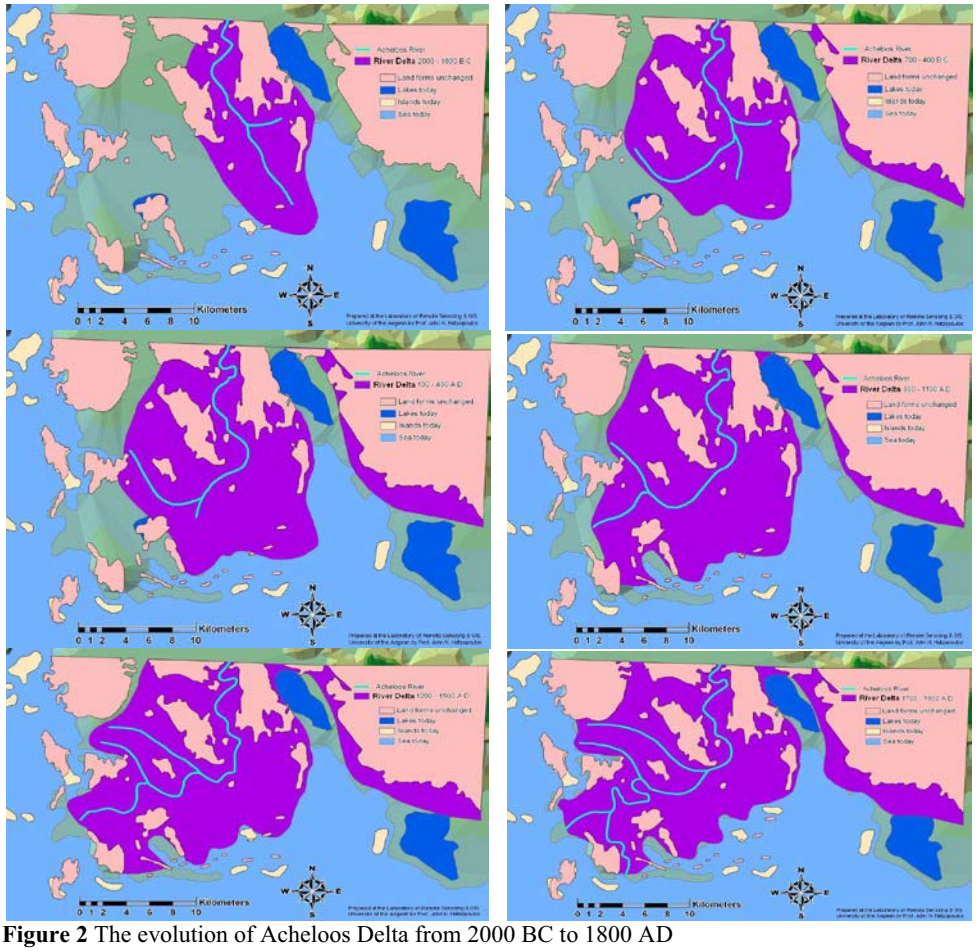

Figure 2 The evolution of Acheloos Delta from 2000 BC to 1800 AD
Adaptation in geological map from the original Villas 1983

Archaeological Finds in the Area

The earlier archaeological finds in the area, although sporadic, are found in locations closely connected to the two rivers. Stone tools of middle and early Paleolithic were located upstream near Acheloos, close to the Evinos delta and south of the modern city of Agrinio, in the old banks of the lakes that at the time occupied a much larger area (Papakonstantinou, 1991) These finds bear witness that the earliest human presence in the area revolved around the major water sources, which is logical, considering that the main activity was hunting. The early nomadic population depended on the presence of fresh water and on the movement of pray along the river valley.

The earliest located settlement in the region is also connected to the Acheloos River. The "Lagada" Settlement is found on the west banks of "Ryakas", a confluent of Acheloos, a few kilometers north of Stratos. The settlement, which dates from the late Neolithic to the

Late Helladic period was situated in a privileged geographical position, monitoring the passages to and from the Acheloos valley to the North and West (Basilogambrou 2004).

Figure 3 Ancient cities and fortified locations along the Acheloos River and the South coast of Aitolia

In the Helladic - Mycenean period, the archaeological evidence is more numerous. Homer, in the Iliad (List of Ships) mentions that king Thoas led the Aitolians with 40 ships in the war of Troy. Five Aitolian cities participated in the campaign: Kalydon, Plevron, Halkis, Pyleene and Olenos. All five of them lay in the south coast of Aitolia, all in the area defined by the Acheloos and Evinos Deltas[84]. Although the exact location of the last two cities, Pyleene and Olenos, has not been verified, it is believed that they are located in the area of interest, on the south – southwest slopes of Mountain Arakynthos (Portelanos, 1998).

Apart of the above mentioned there are also a number of cites that flourished during the Classical and Hellenistic period. Two of the most important guarded the upper and the lower course of Acheloos. Stratos, the capital of Akarnania is situated on a very strategic point of the river's flow, where Acheloos enters the great Aitoloakarnanian plain. There the river widens and it is believed that from this point down, it was navigable[85].

On the river's delta there are a number of cities and fortifications founded on what used to be the Echinades Islands. The most prominent of them is Oiniadaes, the "guardian" of delta. Oiniades, a major port during the ancient times, now lays a few kilometers inland due to the alluvial deposits. To the south, on the hill "Skopas" another fortified settlement is

[84] Halkis, although it is situated at the east of River Evinos and Mount Varassova, may be considered in direct influence of the river, since it benefited from the passages that Evinos created to the inner, mountainous mainland.
[85] Thucydides (Historiae, C,7) writes that the Athenian fleet went upstream the Acheloos river (428-427BC)

found, probably the ancient city “Nasos”, meaning “island” (Murrey, 1985). Indeed the place used to be an island during the classical and Hellenistic period and had a supportive role to the port of Oiniadae. To the north-east, near the village Mastrou is located another city known from the literary sources. The location is identified with Paianion, the city that Fillip V destroyed to the ground (Polybius 4.64 – 4.65). Another important city controlling the river passages is Metropolis, near the village Palaiomanina. The city is at about the same distance from Stratos and Oiniadae, in mid-road.

In addition to the cities mentioned (fig. 3) there is a new location unknown to bibliography, which was pointed out to us by local hunter. The site is located in the hill of *Astrovitsa,* about 4 km north-west of Aitoliko. The only known monument there is the post-byzantine church of Agia Paraskevi on the foothills (Paliouras, 1985). The rocky hill has a trapezoid shape and it is very steep on its south and west face, following a downward slope to the east (fig. 4). According to our guide, the remnants of a city’s constructions were visible a few years back, due to a summer fire that burnt down all the – wild - vegetation.

Figure 4 The hill of Astrovitsa as seen from the east.

During our visit the vegetation had grown back and it was close to impossible to detect any ancient ruins, apart from the east and north-east side of the hill, were the foundation of ancient fortification walls were barely visible (fig 5). It appears that the fortification had different construction methods, which is common in the area, if not different dating.

Despite the scarce visible archaeological evidence, Astrovitsa is ideal as a location for an ancient city. The hill itself is a venture point, giving a strategic advantage and a habitation area of about 1.000 m^2. It lies in between the Acheloos River and the Aitoliko lagoon and it benefits from both. As shown in figure 3, up to the classical period the city was surrounded by water, since a branch of the Acheloos flowed just to the south.

Since the identification of the Aitolian city-names is somewhat inconclusive, this unknown city seems as a good candidate for one of the two unidentified cities mentioned in Homer’s Catalogue of Ships. Could this be Olenos, the city nearest to Plevrona, that was destroyed to the ground by the Aitolians, according to Strabo? Whatever might be its name,

there is a probability that the city in the time of Homer's description had a port and thus was able to support a fleet.

Figure 5 Fortifications on the east and north-east side of the hill

Conclusions

There is a close relationship between the environmental factors and the archaeological evidence in the area, mainly in the places of choice for the construction of a city. Water is the key factor: access to fresh water, but also access to water-ways that enabled transportation, communication and commerce.

At the same time, the ancient cities are always situated on high ground, either on the slopes of the surrounding mountains or on free – standing hills (and former islands). From these locations the inhabitants were protected from the devastating power of the rivers, and also had a strategic advantage, controlling all the passages to and from the mainland. A secondary benefit of building cities in rocky ground is that all the fertile alluvial plain stayed unoccupied, free for cultivation.

The paleo-morphology of the environment should always be under consideration when in search of archaeological evidence and researchers not be fooled by the appearance in the present time. The evolution of the Acheloos delta and the Mesologgi lagoon system proves that what we see now is not what it was.

Furthermore, we should have in mind that archaeological evidence of the prehistoric and early classical periods are nowadays buried deep in the alluvial silt. This fact may account in some cases for the absence of archaeological finds dating to these periods.

The use of GIS tools and methods provide a substantial help to combine all kinds of geospatial prehistoric and historic temporal information to describe the landform change through the centuries.

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