

USING GIS TO STUDY THE COASTAL GEOMORPHOLOGY OF THE ACHELOOS RIVER MOUTH IN WEST GREECE

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ABSTRACT: In this paper the counteractive dynamic marine and river environments responsible for a river mouth's and a delta's modulation is studied. The Acheloos River (West Greece) was chosen as the case study due to the recent changes taken place in its basin. The aim of this study is to analyze the present dominant environment and the impact of human activity on this balance. A GIS database was developed and updated in order to provide access for future use and computer analysis (both spatial and chronological). The study, includes an estimation of the delta forming processes, the impact of the anthropogenic parameters on these processes, and, finally, their representation.

KEYWORDS: COSTAL GEOMORPHOLOGY, ACHELOOS RIVER, GREECE, LATE QUATERNARY

INTRODUCTION

The study area is focusing on Acheloos' river delta in west Greece near Ionian coastal zone and west of Pindos mountain (Figure 1).

The geographical growth of Acheloos' basin is worth mentioning. Acheloos springs from Lakmos mountain (central Pindos), flows at the limits of prefectures Arta and Karditsa, in western Thessaly and at the limits with prefecture Evritania is linked with the rivers Tavropo and Agrafioti, separating Evritania from Etoloakarnania, and flows into Ionian Sea shaping an extensive deltaic field. In its wider basin of flow, four natural lakes exist (Trichonida, Lisimachia Amvrakia, Ozeros), where have been created four dams (Kremaston, Kastrakiou, Stratos I & Stratos II).

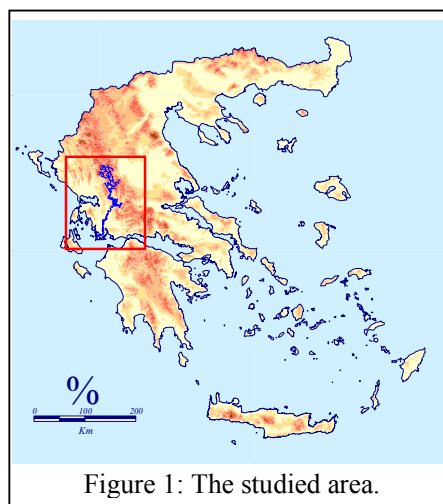


Figure 1: The studied area.

Acheloos is the main river of Western Central Greece, the first in water contribution and the second in length, found in the Greek territory, with a total length of 220 Km. It constitutes the main source of water both for the flat and the semi mountainous regions of Etoloakarnania. The shape of its basin is oblong with a maximum axis of 147 Km length and 63 Km width. The basin covers a total area of 6.226 Km² and is defined by the following geographic

coordinates: north 21.08°,38.29° and south 21.92°,39.73°. The maximum altitude of the area reaches 2.420 m.

Along of his valley many hydroelectric power stations of D.E.I. (public enterprise of electricity) have been constructed. Acheloos river's action, as well as Evinos river's (Piper & Panagos,1981), resulted in the development of lagoons such as Mesologi and Etoliko. Its extrusions compose a unique ecosystem (protected by the Ramsar treaty) of significant ecological value. Besides, the flora and the fauna of the region present particularity.

The climate in the Acheloos basin belongs to the mild Mediterranean (17,60°C –19,60°C) type and tends to Continental type (21,40°C) in territorial north and north-eastern regions (Liakouris, 1971). In particular, the warmer month of the year is July (average temperature: 27,40°C), while the coolest is January (average temperature: 8,30°C). The annual height of rain is aproximatelly 1.100-1.200mm.

The drainage basin of Acheloos may be divided into three individual subbasins: a) the upper part, which is defined by the administrative boundaries of Trilof community, b) the middle part, which is delimited in the south by Stratos village and includes Tavropos, Kremasta, Kastraki and Stratos artificial lakes, and c) the lower part, which includes the Trichonida, Lisimahia, Amvrakia and Ozeros natural lakes, the allouval plain and the Mesologi, Etoliko and Klisova lagoons (Liakouris, 1971).

The Acheloos drainage basin covers three isotopic geological zones; the Ionian one in the western region, the Gavrovo one in the central part and finally the Pindos zone in the eastern and northern -eastern part (Aubouin, 1959).

The area of Acheloos delta is defined by the following geographic coordinates: north 21.08°, 38.29° and south 21.32°, 38.42° and it covers a total area of 175,2 Km². Acheloos delta belongs to the lobolate type, as it has the shape of a lobo with a solid head and a columella front. Its evolution depends on the predominance of the two environments: the continental and the marine one.

METHODOLOGY

The study of geomorphological and environmental changes involved a series of different stages: study of bibliographical references, field-work, observation and direct digitizing on the basis of two different aged (1960 and 1986) aerial-photos (H.A.G.S., scale: 1:33.000) and satellite images (Landsat, 2000), topographic (H.A.G.S. scale 1:50.000) and geological maps (I.G.M.E., scale: 1:50.000). All primary data were imported in a Geographical Information System in the MapInfo environment.

Thus a GIS database was developed and updated with data deriving from different sources. Data were analysed quantitative and qualitative, while different aged thematic maps were created. The geomorphological and anthropogenic alterations were studied through photo-interpretation of different date aerial photos and satellite image, as well as through field work. In order to increase the accuracy of photointerpretation, aerial photos were geo-referenced and finally transformed to ortho-aerial photos. These functions, along with the stereoscopic observation of the aerial photos were supported by photogrammetric softwares, enabling the

user to perform on screen stereoscopic observation and instant on screen digitization to the GIS database.

THE ACHELOOS DELTA COMPLEX

Man made interferences

The major anthropogenic intervention in Acheloos river is the construction of four hydroelectric dams (Figure 2). The biggest one is at Kremaston, which is situated three Km south-western of the junction of the rivers Tavropos, Agrafiotis and Acheloos. It is the first dam developed in Acheloos drainage basin (1966) and the most significant hydroelectric construction in Greece.

The Kastraki is the second dam developed in Acheloos drainage basin (1969) and it is placed thirty five Km southern of the Kremaston one. Stratos I and Stratos II dams developed in 1989 and are situated eight Km southern of Kastraki dam and sixty two km of Acheloos mouth.

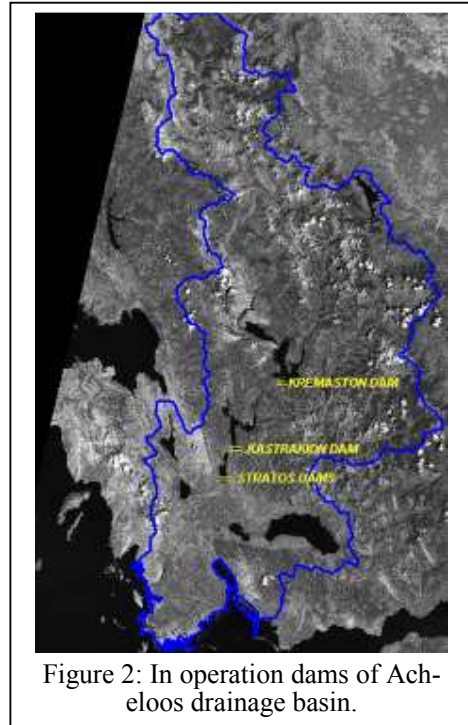


Figure 2: In operation dams of Acheloos drainage basin.

Geomorphological and land use alterations

Acheloos delta is a very dynamic system influenced primarily by fluvial and marine processes. Some of the delta plain features have been changed several times during the past decades (Sabot, et al, 2002).

In Acheloos delta area three main geomorphological units are distinguished: the delta plain (I), which is the dominant, the delta front (II) and the Prodelta (III) (Figure 3).

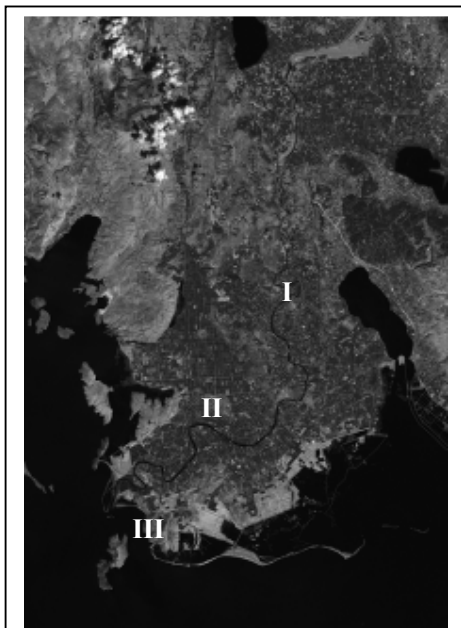


Figure 3: The three main geomorphological units of Acheloos delta.

Comparing the aerial photos, dated in 1960, and the satellite images of 2000, many changes of the coastline, the river mouth and the land use have been observed. Prominent changes concerning the fluvial environment, such as abandonment of the old drainage system (ox-bow lakes, old delta mouth) have been mapped. These geomorphological alterations resulted to land use / land cover changes of the delta area. Most of the ox-bow lakes at the sites Aloupotripa and Lagades, and formed lunar lakes in 1960 have nowadays been dried up.

The two maps of figure 4 and 5 represent the drainage system and the land use in 1960 and nowadays correspondingly. Most of the old drainage system, which used to be organized with cultivations,

became inactive when a complex system of canals took its place, mostly for irrigation purposes.

As far as land use is concerned, most of the area of the deltaic field appears to be subjected to human intervention, focusing on the stabilization of the area and the growth of organized cultivations along with the road network. Furthermore, an expansion of the agricultural land and a decrease of the wet ground are observed.

The shape of the deposition tongue in Acheloos river mouth at the west part of the area has been eroded; consequently it appears to be more elongated nowadays. Moreover, the shape of the coastline has been altered during those years due to wave and the current action. The delta front has also been extensively modified in the past decades. This is apparent by comparing the figures 4 and 5, as well as the aerial photo and satellite image of the figure 6. These changes are mostly localized in the southern part (point x1, x2) and in the northern part (x3, x4).

The study of Acheloos delta evolution showed that the balance of this dynamic system changed due to dam constructions. Thus the fluvial supply has been decreased and nowadays the marine processes predominate over the delta.

Coastal zone alterations

In order to locate and estimate the coastal zone changes, a digital model of the submarine environment was developed (Figure 7). The old prodelta is nowadays submarine and may easily be shown. The area near the river's mouth has been altered; a bog used to be in the place of today's peatbog.

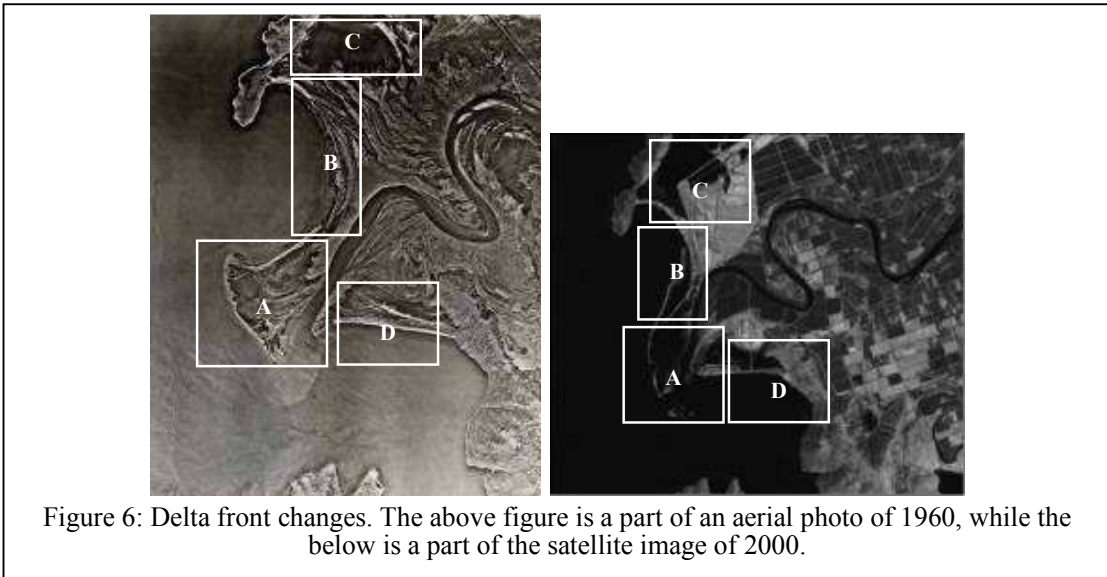
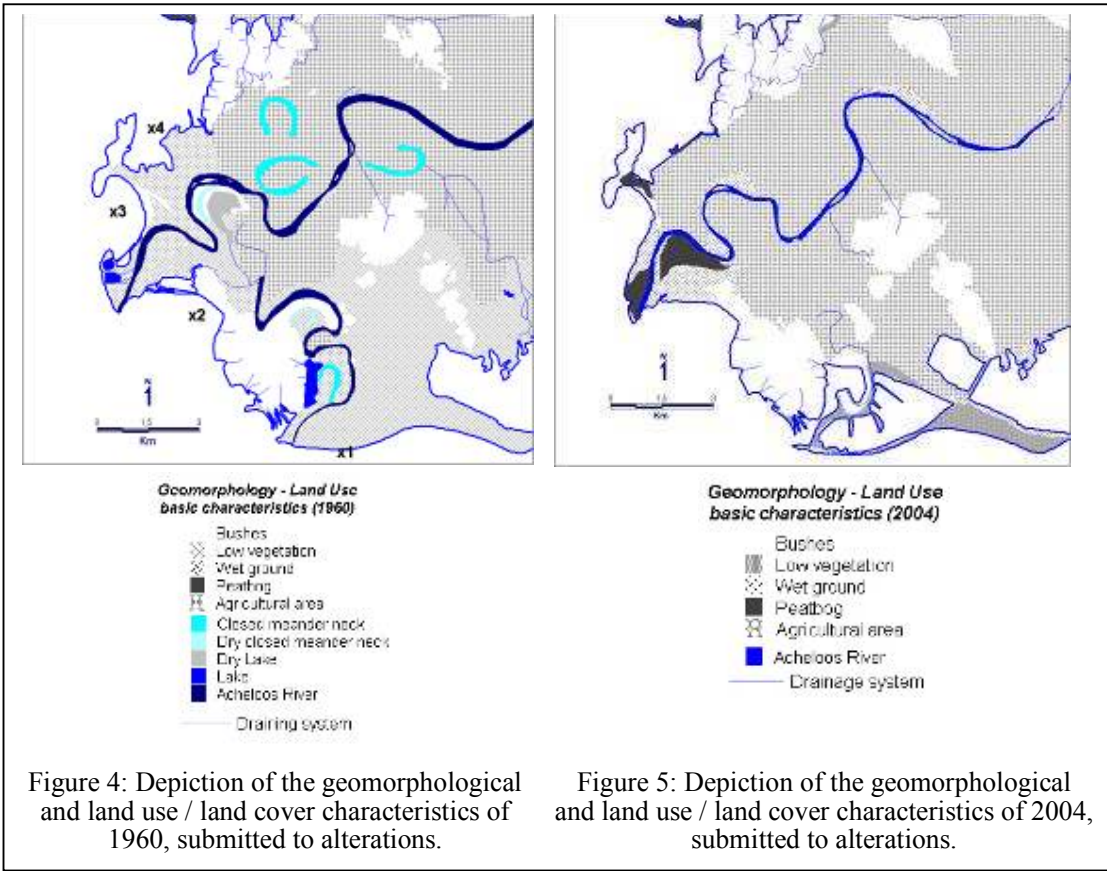
In addition, dunes fields are nowadays replaced by low vegetation or even wet grounds.

Finally, the morphological slope analysis in the coastal zone, concluded to the the maps of figure 8 & 9. It is obvious that morphological slopes differ in the two cases due to the changes of river flow (carring force and speed).

CONCLUSIONS

This paper can be considered as the beginning of a project handling the design and the implementation of a spatial database that stores the geomorphological and environmental data of Acheloos' delta. It is obvious that human interventions have modified the physical environment to a great extend. The dams construction has resulted in a progressive reduction of the fluvial sediments. Diverse geomorphologic and land use changes concerning the coastal plains and the coastal area are also detected (Figure 4 & 5). The degradation of this coastal area is accelerated by the salt water's intrusion, the over-exploration of the groundwater and the expansion of the touristic structures.

During this study was stimulated the necessity of approaching environmental coastal problems by constructing spatial and temporal databases and developing a long-term monitoring mechanism for local and regional planning.



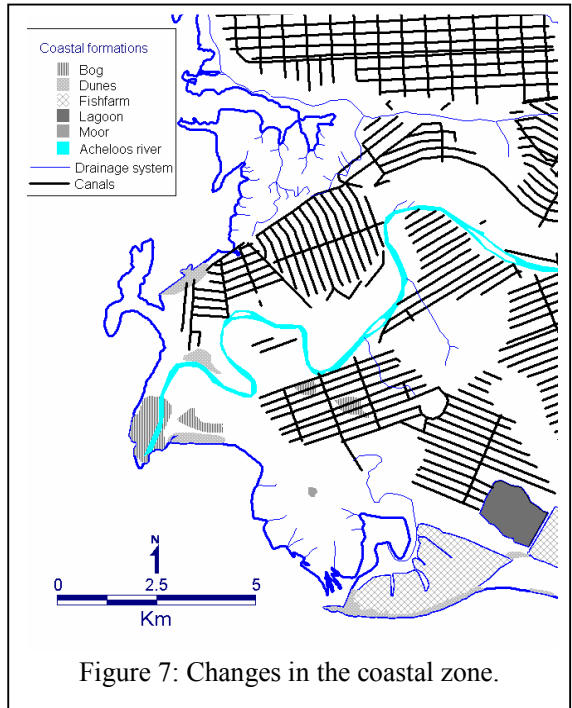


Figure 7: Changes in the coastal zone.

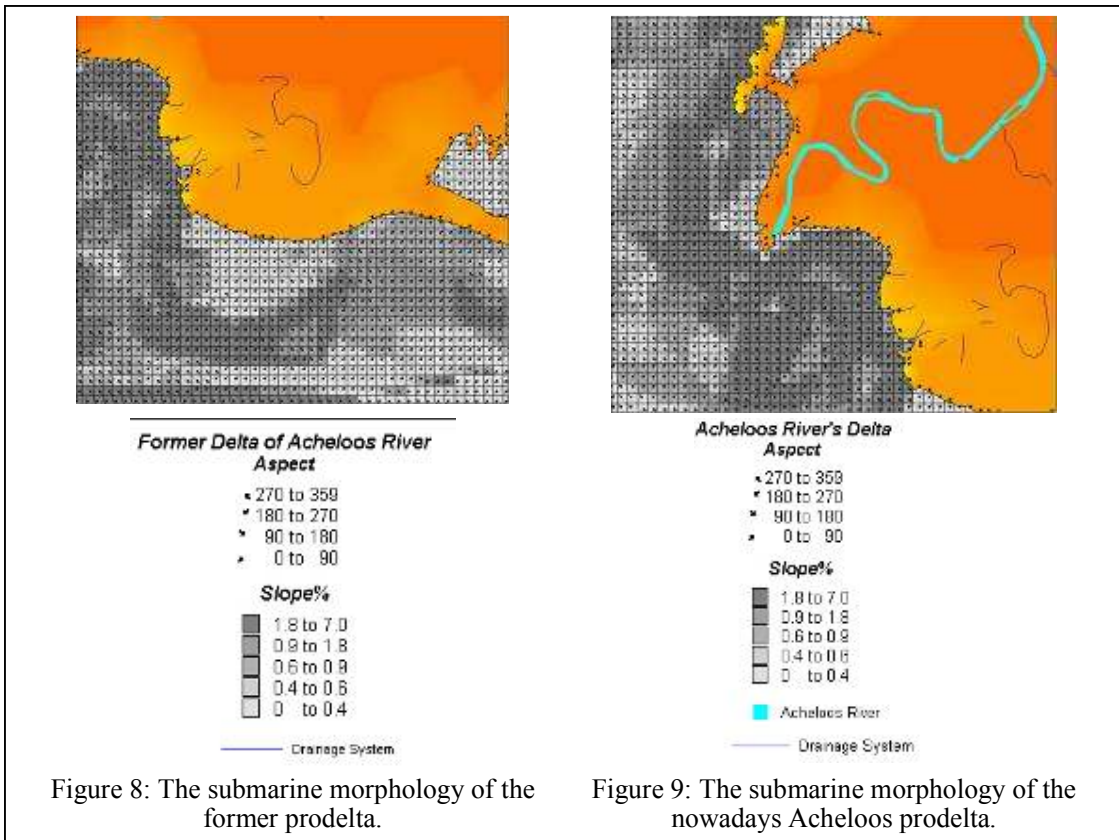


Figure 8: The submarine morphology of the former prodelta.

Figure 9: The submarine morphology of the nowadays Acheloos prodelta.

In conclusion, the study reaches a definition of the dominant environment and refers to the consequences of Acheloos River's diversion via the Thessaly Plain, for the environment and the surrounding areas; the diversion is a major project still subject to approval, but due for completion in the next few years.

ACKNOWLEDGEMENTS

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