LANDSCAPE AND ENVIRONMENTAL CHANGES SINCE THE NEOLITHIC IN EASTERN MACEDONIA (GREECE)

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ABSTRACT

The research conducted in the plain of Drama and its surrounding area shows a significant landscape evolution since the Late Neolithic and the settlement of the first farmers. Nevertheless, the regional land clearing is not directly associated with the beginning of the agricultural practices. From the Antiquity, a threshold in the landscape changes is overtaken. The land use intensified making the morphogenic system less resilient and the two historical alluvial aggradation stages are clearly linked to significant land use changes like upstream progression of cropping and grazing even if the role of the climatic fluctuation has not to be minimized.

KEYWORDS: Landscape changes; land use; soil erosion; alluvial records; Holocene, Greece

1. INTRODUCTION

In the past 30 years, numerous studies have highlighted landscape changes during the Holocene period in Greece and particularly in the Southern part of the country (e. g. Van Andel and Runnels, 1987; Rackham and Moody, 1996) but no systematic geoarchaeological studies have been conducted in Eastern Macedonia. The geoarchaeological investigations carried out in the basin of Drama and its surrounding area provide an opportunity to analyze landscapes responses to long-term land use changes at the junction of the Mediterranean area and the Balkans. The research had a dual purpose: (1) To determine the landscape changes in relation to long-term land use changes since the Late Neolithic (*c.* 7400-5300 cal. yr BP), and (2) to understand their environmental consequences and particularly the soil erosion and the stream aggradation or incision. The main results of the research conducted since 1995 are presented in the following lines.

1.1. STUDY AREA

The Drama depression is a Neogene fault basin (45-100 m high) in the Phanerozoic bedrock of the Rhodope (between 700-2100 m high), mainly composed of metamorphic rocks which are dominated by marbles (Psilovikos, 1986; Lyberis, 1994). The outlet of the plain is via the perennial Angithis River (6-29 m^3/s). The plain is fringed by a complex coalescing series of Middle and Upper Pleistocene aged alluvial fans (Broussoulis *et al.*, 1991; Lespez and Dalongeville, 1998; Lespez, 1999).

The current soil catena shows stony lithosol on the lower mountainous slopes covered with discontinuous Mediterranean shrubs. The gravelly reddish-brown soils on the apical and middle part of the Pleistocene fans and the calcimagnesic soils of the Neogene hills along the lower Angithis valley are cultivated in cereals like wheat and barley and in maize downstream. The distal parts of these fans are covered by vertic soils on which maize and mainly cotton are grown. Peaty and marshy Holocene deposits occupy the southern part of the plain. They correspond to the old Marsh of Philippi that was been drained in 1923 and today is mainly under maize cultivation.

The Holocene alluvial deposits are located along the main valleys, where they form alluvial terraces, particularly along the Angithis River. In the centre part of the plain, the Xeropotamos and the Drama River have constructed a large alluvial fan 12 km long and 16 km wide.

1.2. METHODS (FIG. 1)

To understand the landscape changes since the Neolithic, geoarchaeological studies have been undertaken. Local palynological investigations by Lespez *et*

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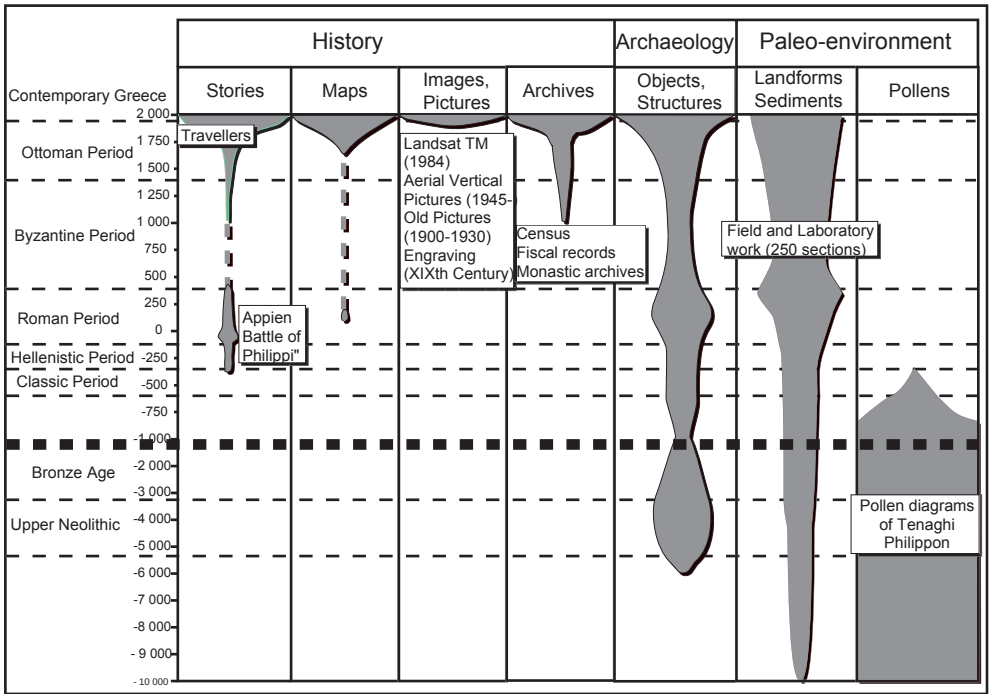
al. (2000) extended the research by Wijmstra (1969) and Greig and Turner (1974 and 1986). The archaeological map of the plain of Drama and its surrounding area (Koukouli-Chryssanthaki *et al.*, *in press*) has permitted assessment of the evolution of the settlement pattern. The extent and intensity of land use at different periods since the Late Neolithic had been determined by the available historical and archaeological data and particularly for the modern times by the study of travelers stories. For this last study, we extend to the plain of Drama and its surrounding area the research conducted by Bellier *et al.* (1996) in Chalcidiki. Assessment of soil erosion sensitivity is mainly based on the morpho-pedological investigations.

Fig. 1 : Informations used to reconstruct the landcapes changes during the Holocene in the Plain of Drama

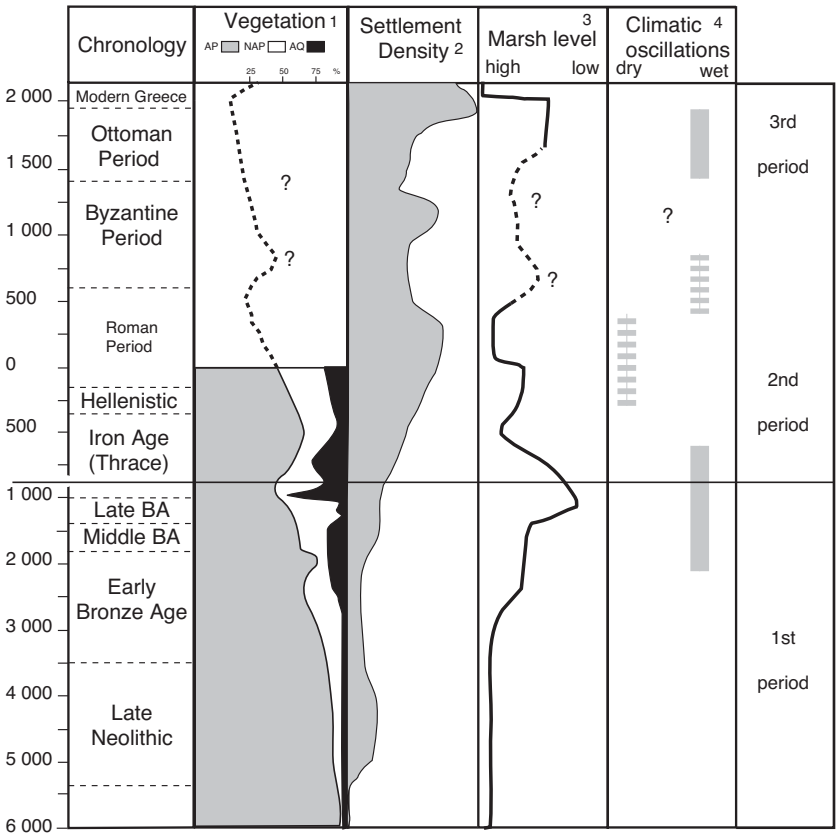


To understand the environmental consequences of the landscape changes, the evolution of the morphogenic system were studied. Davidson (1971) and Geyer (1986) were pioneers in the geomorphological research on the Holocene in Eastern Macedonia but no systematic studies of soil erosion and alluvial aggradation have been conducted in the plain of Drama and its surrounding area. After the first study of the Xeropotamos river basin (Lespez, 1998), a complete and systematic analysis of the morphology, stratigraphy, and chronology of the Holocene alluvial fills has been completed (Lespez, 1999 and Lespez, *in press*). Fieldwork has been conducted to establish the Holocene sediment distribution and stratigraphy. Dating control for alluvial units deposited since the eighteenth century has been obtained through analysis of historical documents. For older alluvial units, it has been provided through identification of archaeological artifacts and radiocarbon dating.

2. LANDSCAPE CHANGES

The landscape changes can be studied in connection with land clearing extent and settlement pattern. Based on the palaeoenvironmental and geoarchaeological knowledge, analysis has been focused on three periods.

Fig. 2 : Regional records of alluvial aggradation stages,land-use activity and climate change



(1) Pollen Analysis in the Marsh of Philippi, from the Neolithic to the Hellenistic period after Greig & Turner (1974, 1986) : AP=Arborean pollen, NAP=non arboreal pollen, AQ=aquatic plants and Cyperaceae and hypothesis for the later period after Lespez, 1999;. (2) Settlement pattern analysis for prehistoric periods (Blouet, 1976; Koukouli-Chryssanthaki, 1998; Koukouli-Chryssanthaki et al., in press) and historical studies (Collart, 1937; Lazaridis, 1973; Lefort, 1991; Stephanidou, 1991 and Petmezas (1996); (3) Pollen analysis of Greig & Turner (1974, 1986), Archaeological and Historical Informations (settlement pattern, old maps and historical diaries (Koukouli-Chryssanthaki et al., in press; Lespez, 1999) ; (4) Pollen Analysis (Greig and Turner, 1986), Bottema (1994) and Geomorphological and Historical Data (Lespez, 1999 and in press).

2.1. NEOLITHIC, BRONZE AGE AND EARLY IRON AGE (C. 7400-2800 CAL. YR BP)

In the studied area, 27 Neolithic (*c.* 7400-5300 cal. yr BP) and 19 Early Bronze Age (*c.* 5300-4000 cal. yr BP) archaeological sites have been identified (Blouet, 1986; Koukouli-Chryssanthaki *et al.*, *in press*). Despite the problems of sites preservation on the slope and site visibility under the more recent alluvial deposits, it confirms that Late Neolithic and Early Bronze Age correspond to a dense pattern of settlement.

Most archaeological sites are located in the centre of the plain or on the gentle slopes of the Pleistocene alluvial fans distal parts: c. 70% of the sites in the whole Angithis river basin and c. 90 % in the Drama basin. Moreover, in this lowland area, the number of archaeological site is probably underestimated because the visibility in this area is not as good as it is testified by discovering of prehistoric settlements under the historical alluvial deposits of the Xeropotamos alluvial fan (Neolithic and Bronze Age site of Kourovo, many more little settlements, Koukouli-Chryssanthaki *et al.*, *in press*). It appears that the farmers preferred to cultivate the soils rich in clay (> 50 % of clay). Furthermore, the glades opened onto the regional forest (Greig and Turner, 1986; Lespez *et al*, 2000) were too discontinuous and too scarce to really destabilize the vegetation as indicated by pollen diagrams from Philippi Marsh (Wijmstra, 1969; Greig and Turner, 1974; 1986) (Fig. 2). These observations are consistent with those in the Balkans (Willis, 1994) and explain the lack of significant landscape changes linked with the beginning of the land use unlike in many others Greek regions.

In the Late Bronze Age and the Early Iron Age (*c.* 3600-2800 cal. yr BP), the number of the sites known do not change significantly (23 sites are occupied during this period) but settlement patterns show some modification. The sites

situated in lowland (*c.* 45%) and particularly on the vertic soil decreased while the defensive sites located on the lower slopes of the mountainous area and the upper part of the valleys increased (*c.* 11% in the former period to *c.* 36% in the Late Bronze Age). There is no geomorphological reason which could explain the best preservation of the Bronze Age archaeological sites more than this of the Neolithic sites on the slopes. So, shifting of the settlement to the foothills is noticed. Reddish-brown soils developed on marble slopes and on the conglomerate of the Pleistocene alluvial fans apical parts are now used probably mainly by cattle breeding. These soils are thinner and coarser. They have only 15 to 40 % of clay, more than 20 % of coarse fraction (> 200 µm) and are often pebbly or stony. They have a less stable texture and structure, and as the slope is steeper (2 to 20°) are more susceptible to erosion. The restoration of those soils is also difficult. This contributes to the difficulty of the forest restoration after the first noticeable land clearance (*c.* 4350-3650 cal. yr BP) shown by the pollen diagrams (Greig and Turner, 1974 and 1986).

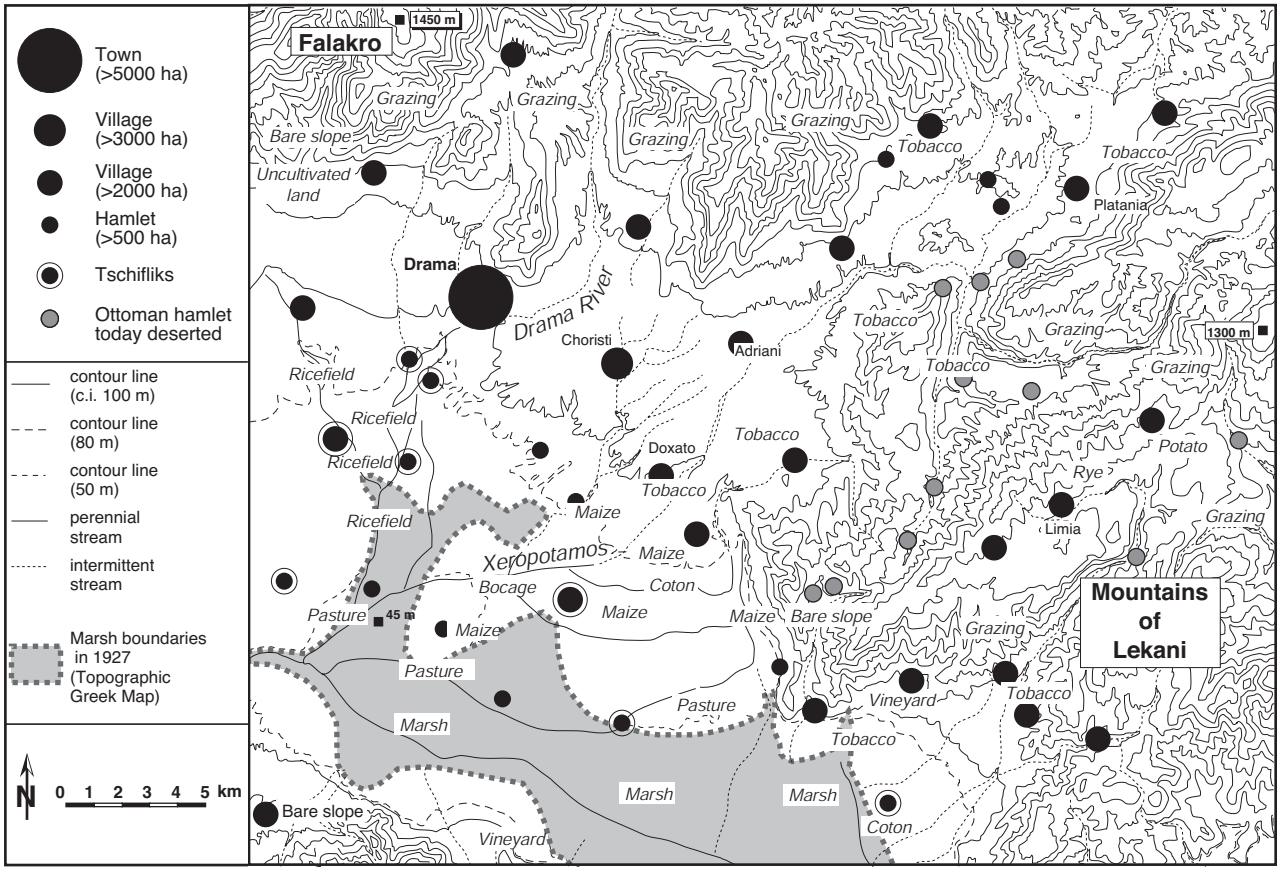
2.2. CLASSICAL, HELLENISTIC, ROMAN AND EARLY BYZANTINE PERIODS (6TH CENTURY BC – 6TH CENTURY AD)

During the Antiquity, the region experienced two main stages of settlement. In the middle of the fourth century BC, the Macedonians conquered the region inhabited by the Thracians and Philippe II founded the city of Philippi. The extent of the land clearing is testified by a pollen diagram (Greig and Turner, 1974) and by a convincing account of Theophrastus: "…at Philippi there was formerly more freezing of trees; but at present now [3rd century BC] that the water has for the most part disappeared underground and been dried out, and the whole country has come under cultivation, there is much less". Then, in the first century AD, the Roman conquest lead to the foundation of an important Roman Colony which took advantage of the arrival of Roman settlers after the battles of Philippi and Actium. The inhabitants of Thracian, Greek and Roman origins lived in small villages (the *vici*) and in the main city of Philippi. Despite the lack of pollen data for the Roman period but according to numerous historical data (Collart, 1937; Lazaridis, 1973; Koukouli-Chryssanthaki, 1998), it clearly seems that this period corresponds to the first phase of important land clearing. The plain and the lower slopes of the mountainous area were probably totally cleared (fig. 2). This settlement pattern can be observed with little change as far as the beginning of the Early Byzantine period (6th century AD) before a significant demographic decrease (Koukouli-Chryssanthaki, 1998). The inhabitants and the land under cultivation were mainly located (75% of the sites) on the apical and middle part of the Pleistocene fans and the main crops in this area were cereals like wheat and barley and vineyards (Lespez, 1999). So, the growth of the settlement, the extension of the land clearing and the land use pattern on the apical and middle part of the Pleistocene fans and the Neogene foothills probably explain that a threshold in the extension of the land use is overtaken.

2.3. THE OTTOMAN PERIOD (15TH – BEGINNING OF THE 20TH CENTURY)

During the Byzantine times, the available information are scarce for the plain of Drama but the study of Lefort (1991) shows that the foothill were probably totally under cultivation and the lowland and mountainous areas have probably experienced an extensive cattle breeding. This is also confirmed by the ottoman fiscal data available for the 15th century on the same area (Lespez, 1999). Since this period, all the observations show that the land use of the plain of Drama and its surrounding area have a total coverage (fig. 3). The Pleistocene alluvial fans of the piedmont are completely farmed. The development of the agricultural exchanges (Stephanidou, 1991; Petmezas, 1996) and the increase of the population due to historical reasons and particularly to the withdrawal of the Ottoman Empire towards the southeast of the Balkan area (Panzac, 1992) are favorable to important changes of the land use. Old maps and travelers stories made possible the reconstruction of the landscapes between the eighteenth and the beginning of the twentieth century. Downstream around the Marsh of Philippi, the increase of commercial crops such as rice, cotton and maize is noticed while in the valleys of the mountainous area the development of extensive grazing and tobacco cultivation is emphasized (fig. 3). The Mediterranean forest vegetation has totally disappeared from the basin and almost all the mountainous areas.

Fig. 3: Settlement and land use from 1850 to 1930 (travellers stories, old maps and census of 1920) in the Xeropotamos and the Drama River basins.

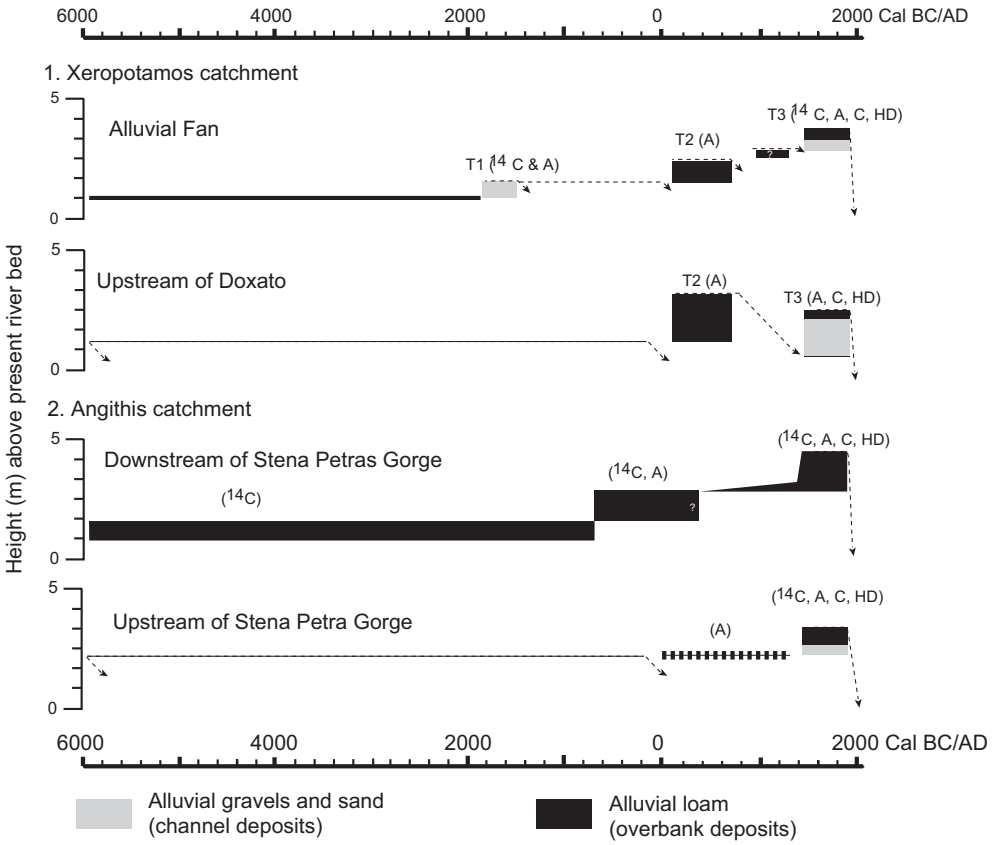


3. SOIL EROSION AND ALLUVIAL AGGRADATION (FIG. 4)

The environmental consequences of these landscapes changes are mainly take account from a geomorphological point of view. The research conducted shows that the rivers of the plain of Drama experienced a very close chronostratigraphy despite the difference of flow (perennial, seasonal or ephemeral) (Lespez, 1999; Lespez *in press*).

The first noticeable traces of soil erosion and alluvial aggradation appear towards the Late Bronze Age (3600 to 3000 cal. yr BP) in the plain of Drama. Some other observations made near the archaeological sites elsewhere in the plain of Drama confirm the age of this first trace (Lespez et al., 2000 and Lespez, *in press*). Nevertheless, these observations are too discontinuous and too scarce to indicate a period of important acceleration of alluvial aggradation and soil erosion. The low level of the alluviation during the Neolithic and the Bronze Age probably points to the low level of soil erosion despite the early settlements. So, the destabilization of the soils happened later in Eastern Macedonia than in many regions of Greece (Van Andel *et al.*, 1990). This is mainly explained by the settlement pattern during the Neolithic and the Early Bronze Age. It appears that the farmers preferred to cultivate the soils with a good textural stability located on the gentle slopes of the centre of the basin while the glades opened onto the regional forest were too discontinuous and too scarce to really destabilize the vegetation. During the Late Bronze Age, the land use pattern change. The soils under cultivation, located on the foothills, have a less stable texture and structure and as the slope is steeper are more susceptible to erosion. This contributes also to the difficulty of the forest restoration after the first noticeable land clearance and probably explains the appearance of the first traces of soil erosion and alluvial aggradation.

Fig. 4. Age-depth diagram for Holocene alluvial units and incision in the Xeropotamos and Angitis River Basins



Dating control : ^{14}C, radiocarbone; A, Archaeological; C, Cartographic HD, historical diaries

During the historical periods, the increase of the alluvial aggradation is undoubted. Along the lower course of the Xeropotamos, the rate of aggradation has doubled since the Late Bronze Age (0.5 to 0.6 mm/yr.) compared to the whole Holocene (0.25 mm/yr.). The alluvial aggradations are then observed in particular during the Antiquity and Early Byzantine period and the Ottoman times. Along the lower course of the Angithis, increased rates of alluviation are also noticeable: alluvial filling has been at least three times greater during the Antiquity period (1.1 mm/yr.) as compared to the whole Holocene (0.3 mm/yr). During the Ottoman period, the rate of accumulation has been three to five times that during the Late Holocene on the Xeropotamos alluvial fan and in the Angithis valley (Lespez *in press)*. The two phases of accelerated alluviation in historical times are clearly linked to land use changes, particularly with the upstream progression of cropping and grazing. The high sensitivity of the new land under cultivation and/or grazing in foothills and in the mountainous area, which were favorable to increase runoff and sediment supply, was crucial for accelerating the alluvial aggradation downstream. Moreover, the increase of the land use in the centre part of the plain was never accompanied by a control on the flows and permitted numerous channel changes.

4. CONCLUSION

The research conducted in the plain of Drama shows a significant landscape evolution since the Late Neolithic and the settlement of the first farmers. Nevertheless, the regional land clearing is not directly associated with the beginning of the agricultural practices. This evolution shows an interesting parallel with the Balkan area (Willis, 1994) more than with the southern Greek regions (Van Andel *et al.*, 1990). This is probably in connection with the submediterranean climate of continental eastern Macedonia but it is also locally explained by the settlement pattern during the Neolithic and the Early Bronze

Age. From the Antiquity, the landscape changes cross a threshold. The land use intensified making the morphogenic system less resilient and the two historical alluvial aggradation stages are clearly linked to land use changes. These alluvial sequences testify the role of long-term wavelength of cultural and land use expansion cycle in the Late Holocene morphogenic system.

Nevertheless, the role of the climatic fluctuation in the triggering of soil erosion and alluvial aggradation has not to be minimized even if it is more complex to identify. The shortage of accurate data is restricting the possibility of reliable reconstruction of the regional pattern of climatic changes, particularly for the Late Holocene (Lespez, *in press*). Nevertheless, the climatic change seems to have been important in the acceleration of the alluvial filling. In fact, the major period of aggradation is the Ottoman period clearly associated with the conjunction of climatic (Little Ice Age) and anthropogenic factors (Lespez, *in press*). It appears probably that the early historic deforestation and agricultural activities have rendered river system more sensitive to relatively modest changes in climate as often observed in Europe.

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