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Article

Effect of natural risk factors upon the evolution of Chalcolithic human settlements in Northeastern Romania (*Valea Oii* watershed). From ancient times dynamics to present days degradation

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With 7 figures

Summary: This study concerns the analysis of the Valea Oii watershed and the dynamics of human settlement depending on the occurrence of natural risk factors and their evolution. These include climatic change fluctuations, and appearance of new hydrological resources like springs, from consequent landslides, the disappearance of forests as a direct effect from overexploitation of the land. Archaeological sites and current villages have been investigated, as well as their emplacement depending on natural hazards (such as floods, landslides and gully erosion). At the same time, we have also indexed the water sources which include streams, springs and man-made lakes. The first archaeological records date back to the Chalcolithic period. The entire catchment includes a total of 26 Chalcolithic archaeological sites which are continuously threatened by numerous natural or anthropic risks. The morpho-hydrographic, geologic, and pedologic particularities have determined an early occupation of the area situated in the upper part of the watershed. In ancient times, the lower sector of the valley and the floodplain was used for agricultural purpose or for pasturing. Throughout time, human settlements shifted gradually towards the lower area. This phenomenon was triggered by significant deforestation, which led to an extension of the pastures and of the agricultural land. In the modern period, most settlements moved towards areas that were submitted to flooding. This process was determined by the escalation of landslides and by gully erosion which began after deforestation. In order to protect the floodplain settlements, dams were built to reduce the effects of high waters. One of the main advantages of studying small catchments is that the results can be extrapolated for larger catchments (> 100 km^2), the volume of analyzed data being smaller, but done with the same strictness. Therefore, the results of this study can surely provide important information and can save relevant archaeological and geographical data in a GIS which, in normal present conditions, would not be possible to be recovered in the future.

Keywords: Chalcolithic, natural hazards, natural resources, human settlements, GIS

1. Introduction and archaeological background

In locating, human settlements take into account the physical and geographical factors of the targeted area. Generally, dwellings are placed in the upper sectors of the small watersheds. A substantial amount of the environment is similar regarding the villages within the large watersheds. Based on the same principles, this has also been the general location for settlements throughout history. The economic development of certain entities or regions favoured the emergence of certain settlements in areas sensitive to natural hazards such as floods (Lanza 2003), landslides (Tarragüel et al. 2012), gully erosion (Romanescu & Nicu 2014) and exposure to the actions of seawaters (wind waves, tide), with negative effects on cultural heritage sites.

For the Romanian territory, the subject of the evolution of human settlements is a novelty, but with strong development potential. Romanian studies with tangential references

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to the subject are poor (Boghian 2004). As for international literature, it is worth mentioning research referring to the relationship of landscape–human settlement especially in relation to issues of natural resources and environmental factors (Brückner et al. 2006, Adderley et al. 2008).

The Valea Oii watershed is the place of discovery of the largest settlement belonging to the Cucuteni culture from Eastern Europe (Cucuteni–Tripyllia culture); Cucuteni culture ranges between 4525/4500–3500/3450 CAL BC (BEM 2000). Using an interdisciplinary approach, this study attempts to delimit, for the first time in Romania, the occupied areas for human settlements within a watershed, depending on the natural circumstances. Important data needs to be saved to local authorities in order to make the population aware of the cultural heritage potential and assessment in this area; urgent management measures are needed to be implemented in order to save what is left of the archaeological heritage sites.

2. Regional settings

The Valea Oii watershed is situated in the northeast of Romania and it covers, for the most part, the Moldavian Plain area, except for a small part of the upper basin situated in the Suceava Plateau. It is located in the Iasi County and it includes 11 localities: Stroesti, Baiceni, Cucuteni, Bals, Boureni, Filiasi, Podisu, Gugea, Valea Oilor, Baltati, and Sarca. From a mathematical perspective, the coordinates are as follows: 47°21′0.86″ lat. N (in the north) and 47°14′33.11″ lat. N (in the south); 27°11′25.26″ long. E. (in the east) and 26°49′37.07″ long. E. (in the west) (Fig. 1) (Nicu 2016). The geological, geomorphological, climatic, hydrologic characteristics are described and analyzed in a succinct manner by Romanescu & Nicu 2014. The maximum altitude is 443.19 m, and the minimum – 61.57 m, which means there is a 381.62 m difference in the level. This is why high waters or flood waters gain significant speeds, mostly in the

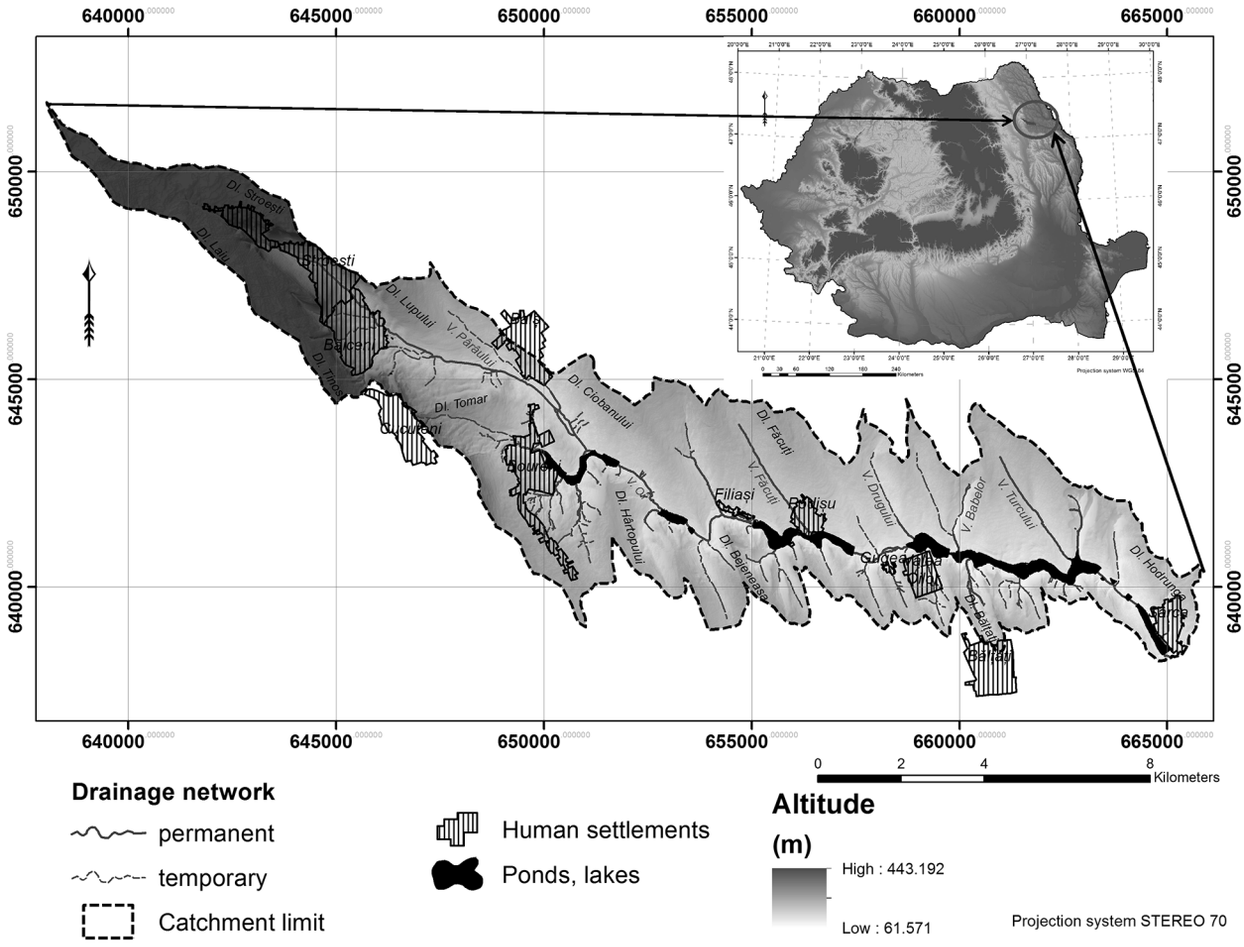

Fig. 1. Geographic location of Valea Oii catchment in Romania.

upper sector, with an acute negative influence on human settlements. This is why the construction of ponds with a protective role against floods was a necessity.

3. Materials and methods

The archaeological sites within the Valea Oii watershed were identified following the field surveys conducted within the past ten years and after consulting the Archaeological Directory of the Iasi County (1985). Archaeological sites and geomorphological processes were mapped with the GPS Leica 1200 System, so all the geographical data is updated to the fall of 2013. The surveys for Cucuteni gully continued every year since 2010. The final maps were obtained with the help of TNTMips and ArcMap software.

To distinguish the evolution of lake basins, human settlements and forests, topographical maps and plans have been used and the lake limits extracted. The following cartographic materials were used: topographical maps scale 1:50 000 edition 1894, shooting plans scale 1:20 000 edition 1957–1958, topographical plans scale 1:5000 edition 1982, and orthophotoplans scale 1:5000 edition 2005.

The data obtained was integrated in a GIS, processed and finalized by elaboration of the thematic maps. Ghilardi et al. 2008 shows the importance of integrating geographical data with archaeological data in a GIS.

4. Results and discussions

It is well-known that, in the past, most human settlements were located where there were natural resources and favourable natural defence conditions. From this perspective, the watersheds in the hills or mountains provide the best habitation conditions. Though the watershed is a well-defined geomorphologic entity, most old settlements were located in the upper side of the basin. This is also demonstrated by the Valea Oii watershed, within the Moldavian Plateau.

The disposition of settlements in the upper, small-sized sectors of the watersheds had the advantages of being an ideal place for defending against enemies, shelter from the whaling winds and the harsh winter blizzard. Also being extremely beneficial with densely forested areas with high abundance of food resources, wood for building and heating the houses. Most Chalcolithic settlements are located at the contact between the Suceava Plateau and the Moldavian Plain, in the upper sector of the watershed, which has an amphitheatre shape oriented

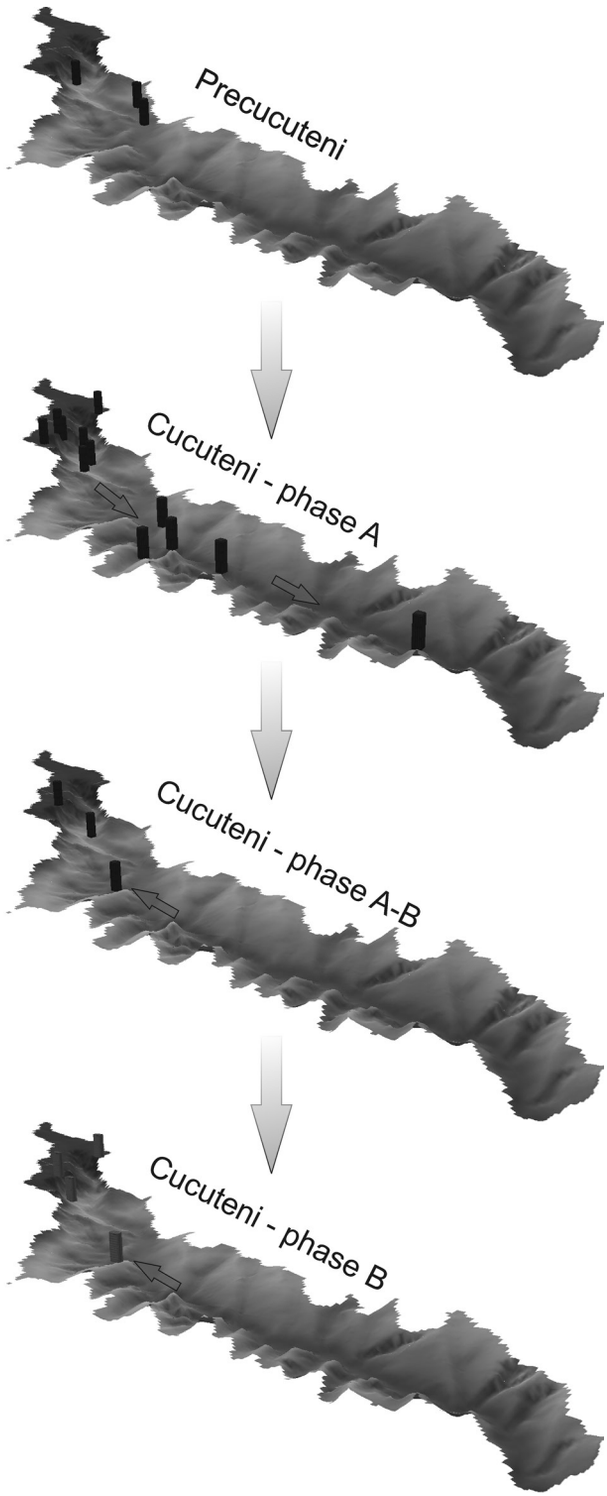

Fig. 2. Evolution of human settlements throughout the Chalcolithic period.

towards south-east. Around this area, it is worth mentioning the existence of 16 Chalcolithic settlements of the 26 inventoried from the entire basin. This location certainly took into account the fact that the settlements could be easily protected and that there were significant water resources, given the emergence of coastal springs or of springs at the foot of slopes (fresh water springs, sulphurous springs). The settlements in the upper part of the watershed are concentrated either on the hilltop, either on the big landslides diluvium from the right side of the valley.

The migration of settlements from upstream to downstream has the following causes: the degradation of natural conditions and the emergence of natural hazard processes; the exploitation of the new resources, with a focus on water and soil; the increase in the number of inhabitants and the search for vital space. It was easy to move towards and to exploit the lower area because the Chalcolithic population (Precucuteni – Cucuteni $A_{1,2,3,4}$ phases) had passed from the hunter stage to animal breeding (especially *Bos taurus* and *Sus scrofa domesticus* – remains were discovered and analyzed during archaeological excavations of *Dealul Mândra* site, no. 1) and plant cultivation. This stage coincides with the Atlantic climatic period, with the warmest and moistest period of the Holocene (Dinu & Marin 2003), optimal conditions for agricultural activities. The existence of Chalcolithic human settlements in the floodplain of the Valea Oii indicates that people had to change location. This "forced" movement was slow, and took from several years to several decades. The floodplain was an important source of producing clay, used for various purposes, such as loaming and pottery. Given that the settlements were affected by geomorphologic phenomena, humans felt the need to find a location where it was safer to look for food.

This was the reason for deforestation and for the extension of pastures, and for floodplain exploitation. After exploitation of agricultural lands in the middle and lower basin, at the beginning of the A-B transition period, Chalcolithic populations migrated back to the upper basin due to increased vulnerability of settlements

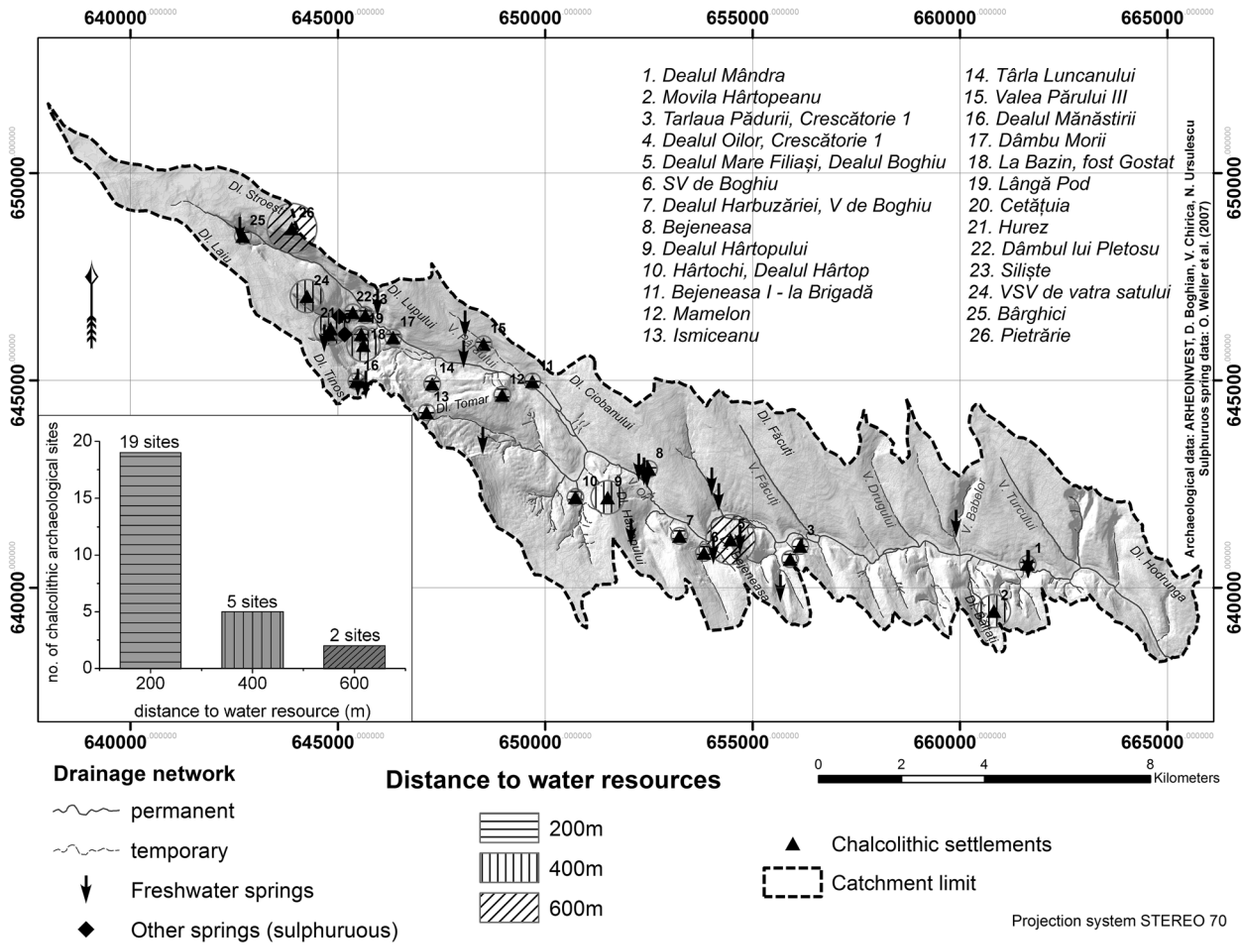

Fig. 3. Archaeological sites location depending on water resources.

located at lower altitudes. This also coincides with the climatic changes occurred between Atlantic climatic period with the Sub-Boreal one, which was characterized by temperature and dry climate; therefore, the water resources were reduced, agricultural production was dropping, Chernisols needed significant amounts of water to have a high productivity, thing which was no longer possible (Fig. 2).

The existence of the other Chalcolithic settlements in the lower, plain area is also related to the water resources. The importance of water in the everyday life of a community was an essential part of living, which influenced the location of settlements near a water resource (permanent water course, temporary water course, and springs). Using the *Ring Buffer* tool of ArcMap, the proximity of Chalcolithic archaeological sites to a water source has been calculated. Therefore, the majority of settlements (19) were found to be located at a distance of less than 200 m from a water source, while, for distances of about 400 m and 600 m, the calculations outcome was of only 5 sites, and 2 sites, respectively (Fig. 3). The salty and sulphurous springs in the upper part of the basin had a very significant role in the local economy, as salt is one of the most important natural component the human body needs; after the chemical analysis of two sulphurous springs from the upper part of the basin, resulted in the water having curative qualities (Weller et al. 2007).

Presently, lakes and ponds represent 2.6% of the basin surface. The acute lack of water, mostly during the summer, determined the construction of dams and the intense use of ponds. These have been mentioned since Ştefan cel Mare prince hood (1457–1504), when, apparently, there were over 3000 small and large ponds (Baican 1996). As far as earlier periods are concerned, there is no available data to attest the existence of ponds on streams within the Valea Oii watershed. However, for the modern and contemporary periods, there is enough data to monitor their emergence and disappearance. After the digitization of the limits of lakes from the topographic maps, important alterations were registered in terms of number, shape, and area. In 1894 (Fig. 4a), there were many small-sized

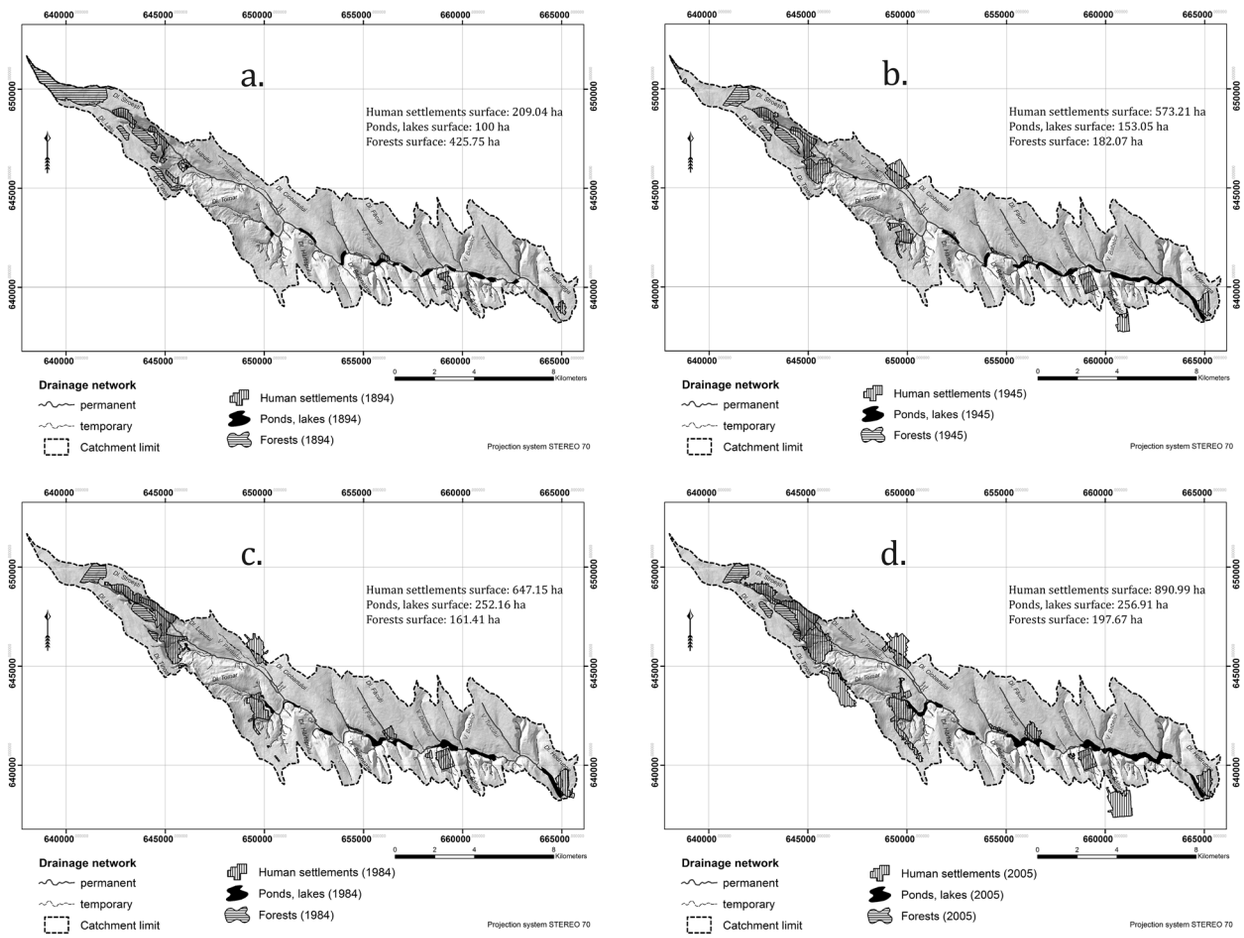

Fig. 4. Evolution of human settlements, forests and ponds since 19th century until present.

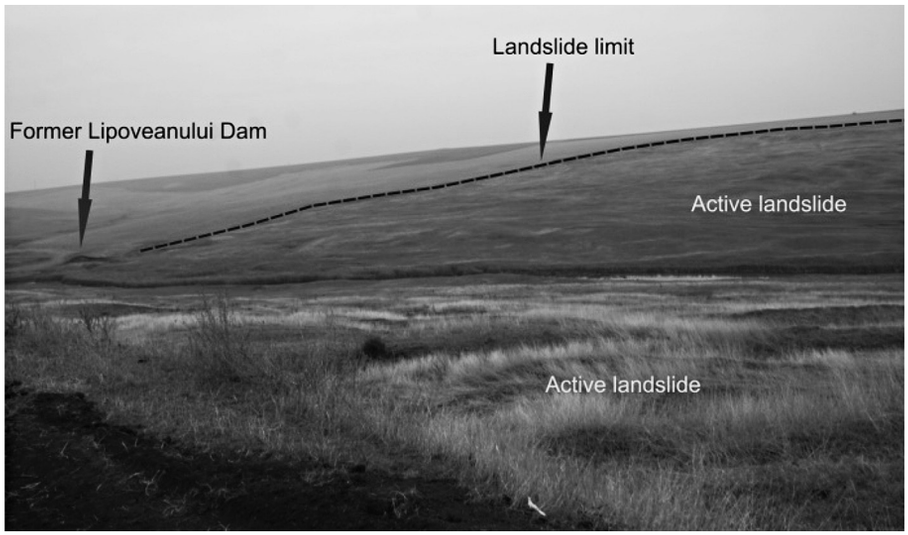

Fig. 5. The landslide leading to the disappearance of Lipoveanul Lake.

ponds (14) used mainly for livestock and rarely for irrigation. Throughout time, there has been a tendency to reduce their number and increase their surfaces, in order to mitigate the negative effects of floods. In 1945 (Fig. 4b), there were 8 lakes registered, in 1984 (Fig. 4c) there were 9, while in 2005 (Fig. 4d) there were 15 identified. The lakes within the lower sector were fragmented into smaller surfaces to improve their management. The geomorphologic processes within the watershed contributed to the disappearance of certain lakes. Rapid sedimentation is due to the accelerated soil erosion in the upper sector. Besides alluvia depositing, a very important role in the disappearance of lakes has been played by the manifestation of landslides. From this perspective, the disappearance of Lipoveanul Pond is worth mentioning (Fig. 5). The lack of water imposed the construction of another reservoir at Bejeneasa, in 1962 (the raise of the dam to 4 m and a total volume of 0.090 mln.m^3). In 1964, the total water volume of the lakes was 4.28 mln.m^3, with a mean captured flow of 115l/s. Currently, the total water volume stored by all the dams within the basin comprises 25.75 mln.m^3. This volume satisfies the needs of agricultural and household consumption.

The new settlements within the upstream sector of the watershed have inherited the sites of the old archaeological sites: Stroeşti, Băiceni, Balş and Cucuteni villages. The settlements within the lower sector are much more recent and they occupy the zones around the ponds, on floodplain terraces, or on the primary fluvial terrace (non-floodable): Boureni, Filiaşi, Podişu, Valea Oilor, Bălţaţi and Sârca villages. The Chalcolithic settlements in the lower sector of the watershed had habitation continuously until the Middle Age, proving that the land is highly suitable for the placement and development of human settlements due to abundant natural resources present in the area: fertile soils – some of the most fertile soils in the north-eastern Romania, water resources. The following examples are worth mentioning within the evolution process of the Chalcolithic settlements: archaeological excavations in the upper basin, near the settlement *Dealul Manastirii*, revealed evidence of Geto-Dacian habitation (1st century BC – 1st century AD); archaeological site of *Dealul Mandra* – contains traces datable to the Stone Age, late Bronze Age (Noua culture) (Chirica & Tanasachi 1984).

Most of the new villages were founded in the fifteenth-seventeenth centuries: the village of Stroesti, from the upper basin, was mentioned in documents of 19 November 1611; the village of Cucuteni was mentioned in documents of 5 October 1448; the village of Baiceni (Baiceni de Baia – old name) was mentioned in documents of 25 August 1454, during the reign of Petru Voda; the village of Baltati, with the historical name of Gugea, was mentioned in documents of 1473, during the reign of Ştefan cel Mare (Chirica & Tanasachi 1984). Not all settlements occupied the old sites; some of them are placed deep within the valley.

The current human settlements occupy 8% of the entire surface of the valley. Archaeological sites located in the upper basin and around the steep hills are strongly

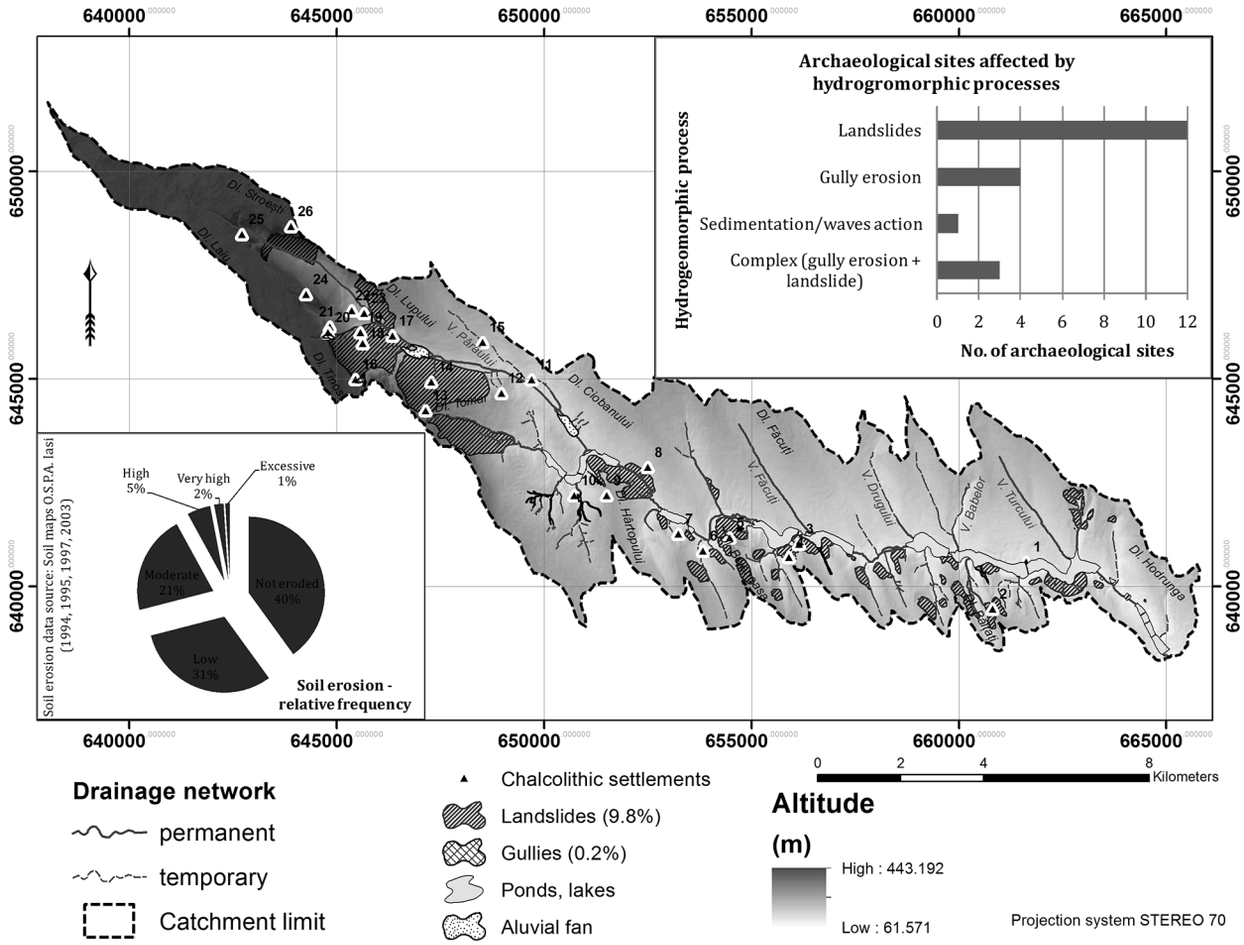

Fig. 6. Map of Chalcolithic archaeological sites affected by natural risk phenomena.

affected by current geomorphologic processes (Fig. 6), while those located in the lower basin are permanently threatened by floods caused by heavy rain, backwater, or dam-break events. From a total number of 26 Chalcolithic archaeological sites, 3 are affected by gully erosion (0.2% of the total surface, Fig. 7), 12 by landslides (9.8% of the total surface), one by sedimentation/backwater processes, and 2 by complex processes (landslides and gully erosion).

5. Conclusions

Valea Oii watershed represents an old habitation area, dating back to the Chalcolithic, which is still inhabited today. Within this basin, traces of the Cucuteni–Trypillia culture were discovered and also the name of the culture is the same; this culture goes back through the mists of time to around 5 000 years ago. It is worth underlining the high density of archaeological sites, mostly in the upstream sector of the basin, at the contact between the higher area (plateau) and the lower area (plain). Most Chalcolithic settlements in the upper sector of the basin represented the distribution basis for the population in the lower basin. The migration process was caused by climatic changes, deforestations, exploitation of the new resources, with a focus on water and soils, and the emergence of natural risks phenomena (landslides, rill, interrill and gully erosion). The wish to extend the inhabited area and the agricultural fields caused powerful soil erosion, which consequently created non-productive lands (anthrosols, protosols). At this point, humans shifted their attention towards the lower area, exposed to floods, but with more water resources and agricultural fields with higher productivity. The distribution of human

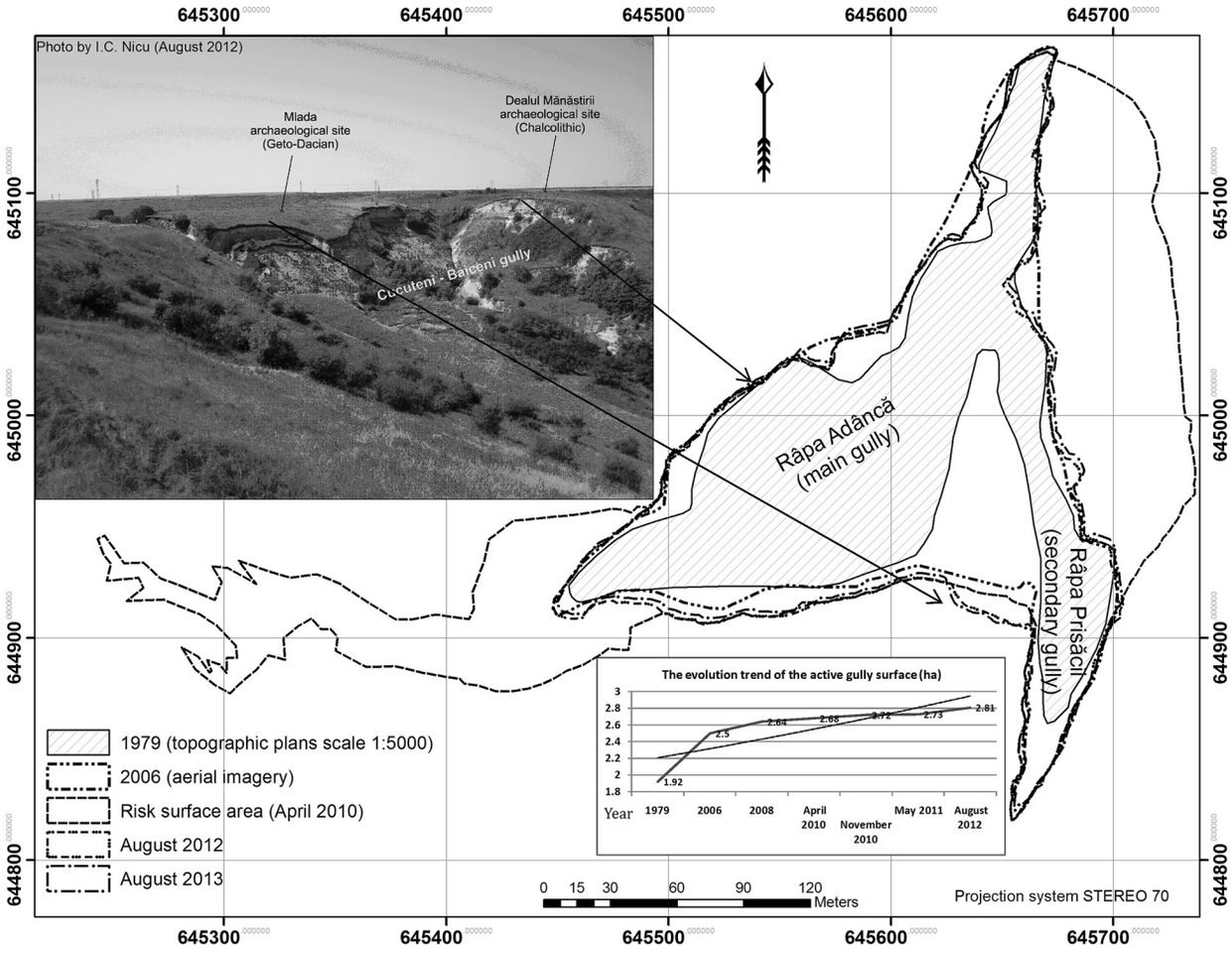

Fig. 7. Cucuteni-Baiceni gully evolution over the last 34 years and the two archaeological sites affected (detail).

settlements is conditioned by the existence of water. The limited existence of water resources forced the construction of ponds. This is why the old and new human settlements within the lower basin are located along the valley.

Immediate anti-erosion measures have to be taken by the Romanian authorities in order to stop the erosion processes and to save the cultural heritage not only of Romania, but for the entire world.

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