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HYDROGEOMORPHIC RISK ANALYSIS AFFECTING CHALCOLITHIC ARCHAEOLOGICAL SITES FROM *VALEA OII* (BAHLUI) WATERSHED. CASE STUDIES

Ph.D. thesis resume

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TABLE OF CONTENTS

CHAPTER I. GEOGRAPHIC FRAMEWORK

I.1. Regional setting

Valea Oii is located in the north-eastern part of Romania and occupies a central-western position in the Bahlui watershed (Fig. 1). After the digitization of the topographical plans (scale 1:5000, edition 1979) resulted a catchment area of 97 km^2. From spring until it flows into the Bahluieț river, in Sârca locality, to the main course is given different names depending on local place names, thus leaving the source to the village Băiceni is called Pârâul Rece (Cold Creek), then called Pârâul Oaia (Sheep Creek) to build Mădârjești. The build-out of Mădârjești until the entry into Lacul Sârca and the confluence with the brook called Bahluieț the name is Trestiana (homonymous valley).

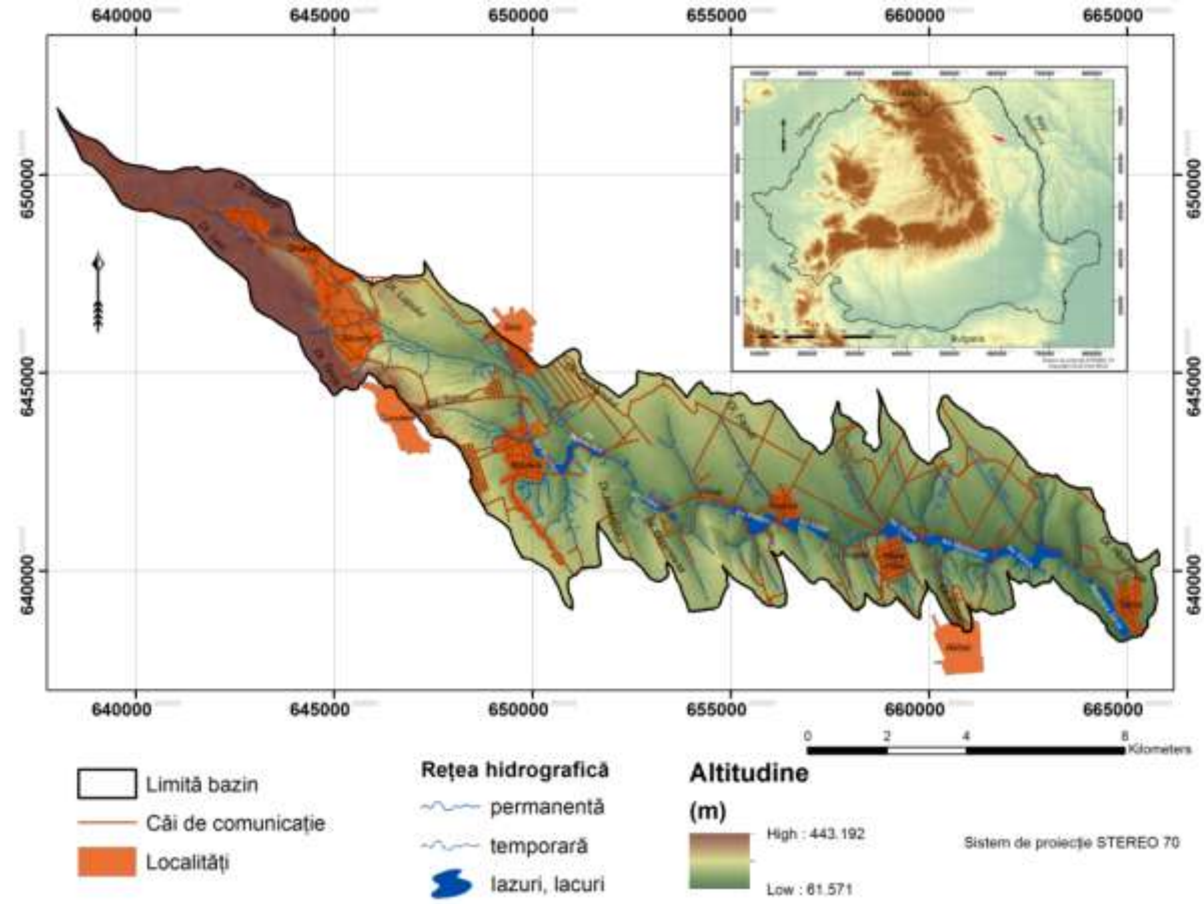

Fig. 1. Location of the Valea Oii watershed in Romania

From a mathematical perspective, the intersection of the parallel of 47°21'0.86" lat. N with the meridian 26°49'37.07" long. E marks the northernmost point in the basin, Stroiești Hill (444 m), and the intersection of the parallel of 47°13'23.32" lat. N cu with the meridian of 27°10'35.68" long. E marks the southernmost point of the basin, at the spill of Oii creek in the Bahluieț river, Sârca locality. The eastern boundary is the intersection of the parallel of 47°14'33.11" lat. N with the meridian of 27°11'25.26" long. E.

The study area is bordered on the north and north-east with Măgura catchment (74.21 km^2), Putina catchment (16.28 km^2), Bahlui catchment (2023 km^2), north-west with Bâdilița catchment (22 km^2), west with Hărmănești (41 km^2), south with Pășcănia catchment (11.32 km^2), Probota catchment (10 km^2), Cucuteni catchment (12.45 km^2)

and last but not the least Bahluieț catchment (110.56 km^2), which is it's right bank tributary.

I.2. Geographical regionalization and administrative division

Although it has a small area, the basin extends over two well individualized areas in the Moldavian Plateau: Moldavian Plain (occupying 90.5% of the total area of the basin) and Suceava Plateau (an area of only 9.5%); in the two grounds, there are also other subunits: hills Dealul Mare-Hârlău (Suceava Plateau).

From the administrative point of view, Sheep Valley basin lies exclusively in the county Iasi; it includes the following communes Todireşti (7126 ha total area), Cucuteni (2826 ha) Baltati(4508 ha), Belceşti (10390 ha), Cotnari (10335 ha) with the following villages: Stroesti, Băiceni, Cucuteni, Bals, Boureni, Filiaşi, Podişu, Gugea,Valea Oii, Baltati and Sarca. This administrative fragmentation of the basin is not beneficial, whereas in the 6 common basin has a peripheral location, this causes less attention from local authorities on land and less land improvement works taking place in the basin.

CHAPTER II. METHODOLOGY AND RESEARCH TECHNIQUES

II.1. Historical background of topographical measurements in Romania

The first maps designed by Romanians date back to the beginning of the 18th century for Valahia Mare through the instrumentality of the Cantacuzino steward (year 1700) and the map of Moldova through Dimitrie Cantemir (year 1737), the last map mentioned having the geographical parallels and meridians drawn on to it. The determination of the coordinates for the point *Dealul Piscului* took place from points of the EUREF network: Madrid (Spain), Onsala (Sweden), Wettzell (Germany), these three points being taken in consideration as being permanent, without errors. In the first instance there were chosen Matera (Italy), Graz (Austria) permanent point, and later on they were rejected due to their tectonic instability and also due to an error of altitude.

All the topographical works which took place on the country's territory, including topographical measurements performed until the present day but also the ones that fallow to be performed in the area of the basin are in the STEREO 70 projection, which was officially introduced in 1973 replacing the Gauss - Krüger projection which was representing the Romanian territory on 6 and 3 degrees time zones. The new projection holds elements of the *Krasovski - 1940* ellipsoid and the reference plan for altitudes *Black Sea - 1975*.

II.2. In situ identification of the GCP's (Ground Control Points) of different orders and their distribution in the catchment

Following the analysis of the map that contains the distribution of the GCP's in the basin we can observe a good coverage from this point of view, considering the proximity towards the GCP of 1st order (one of 6 in the country's territory) close to Sârca municipality. The presence of a total of 11 GCP's that cover a territory of 96 sq. km indicates the fact that the basin has an optimum coverage from this point of view and that the performing of topographical measurements in the area of the basin is an easy one (being that it is performed with a total station or the geodetic GPS). Thus there are 2 GCP's of 2nd order, 3 GCP's of 3rd order, 6 GCP's of 4th order and one point of 5th order (Bălțați Orthodox Church) that constitutes just a reference and orientation mark for the measurements done with the total station (fig. 2).

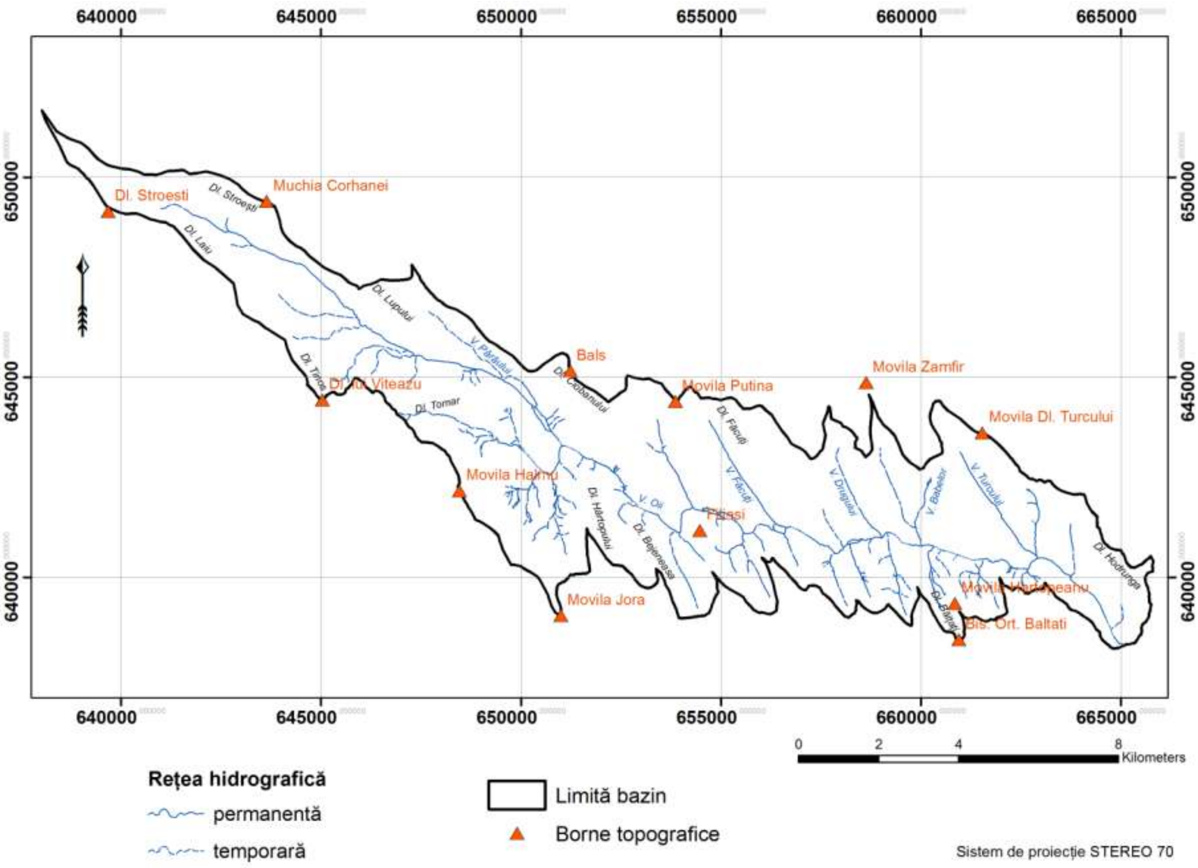

Fig. 2. Distribution of ground control points in the Valea Oii basin

II.3. Utilization of old and new topographic maps (Austrian maps, shooting plans, etc.)

In order to obtain a scientific approach, a varied cartographic background will be used, from a particular point of view, but also from a representation scale. Thus, under the representation scales point of view the following topographic maps will be used: scale 1:50000 (1895 edition), scale 1:25000(1984 edition), topographic plans scale 1:5000(1979 edition), orientation marks plans scale 1:20000 (1942-1945 edition), topographic plans scale 1:2000 (1973 edition) but also orthophotomaps (taken during the flights of 2005 and 2008), satellite images, etc.

II.3.1. Methodological staging

In the fulfillment of the geographical database, GIS software were used: TNTmips, AutoCAD 2008, Global Mapper, ArcGIS and as a software for graphical processing CorelDRAW was used.

In the execution of the DEM the topographical plans at a 1:5000 scale were used, with the fallowing stages: collection and selection of the cartographic support from the ANCPI (National Agency for Cadastre and Land Registration) Iasi, scanning, importing in the GIS, georeference raster cartographic objects.

Then, with the help of the *Raster to TIN* function (Triangular Irregular Network), a TIN was created for the 3D visualization with the help of ArcScene (fig.3). In the last years the modeling and 3D reconstruction is used more often in the capitalization and presentation of research results in geography, but also in archeology. From habitat reconstructions, the evolution of reliefs and reconstructions of objects, 3D modeling constitutes an indispensable tool in the interdisciplinary research.

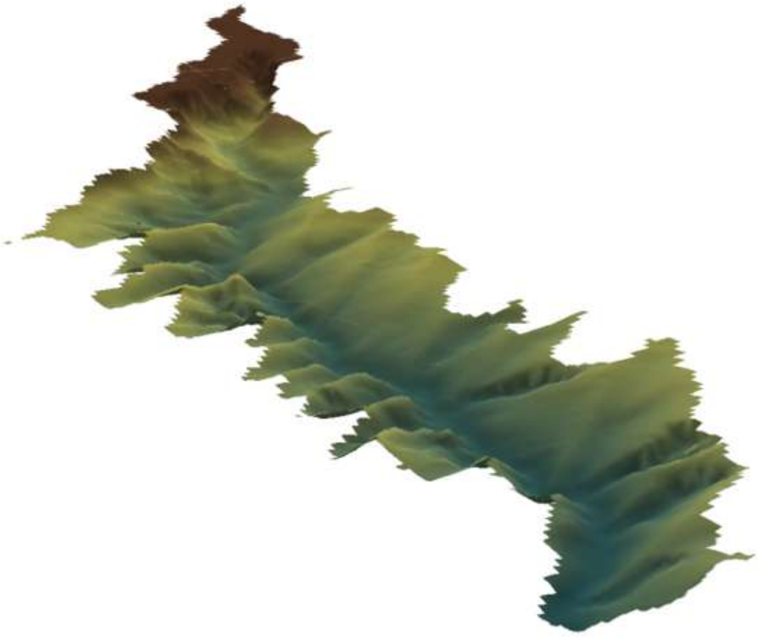

Fig. 3. 3D perspective (SSE view)

II.3.2. Databases integration in GIS

Ghilardi (2008 a, b) shows the importance of integrating geographical data base (connected to the mapping and conversion of the in situ data in digital format, realization of spatial analysis, 3D visualization, analysis through statistic methods of the distribution of settlements, paleogeographic reconstructions, all offering a better interpretation of the relationships of sites, their structure and their formation), but also archeological data (placement of sites) in a GIS (fig.4).

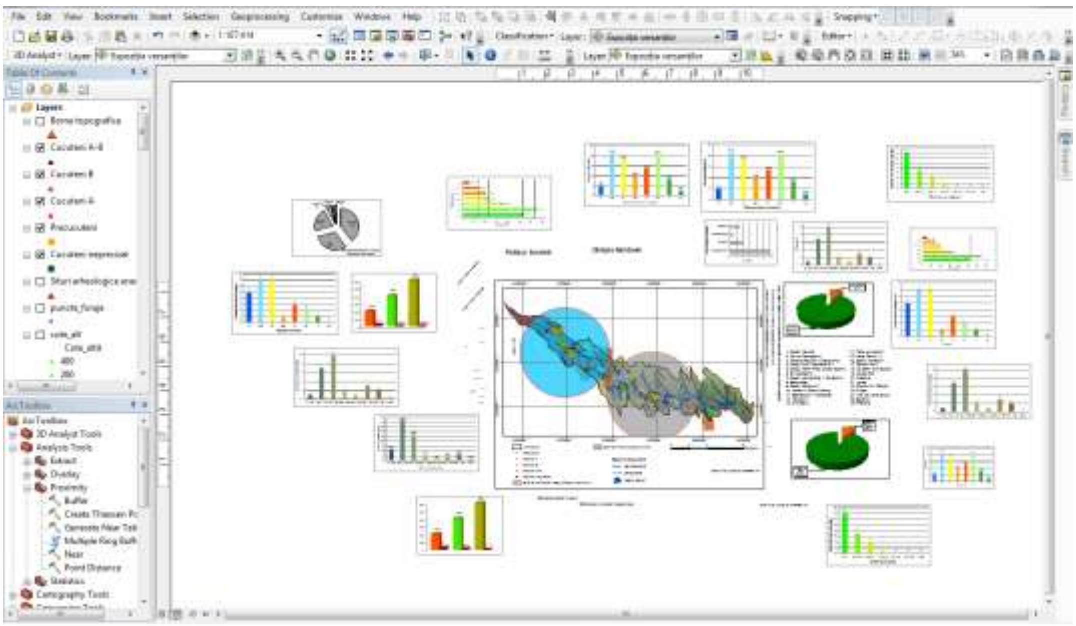

Fig. 4. Integration of spatial data in GIS (cartographic program ArcMap – print screen)

Within the ’90s, archeological studies were based only on a 2D perspective. With the development and implementation of new technologies of digital analyzing of terrain (satellite images, aerial photographs together with in situ observations, detailed topographical measurements), the passing towards a tridimensional analysis perspective took place. With the help of this tool, a plurality of analysis (visibility, proximity, etc) which can lead to the solving the proposed premises and to a better understanding of the archeological sites placements in certain locations, in accordance with certain factors derived from GIS analysis (altitude of relief, type of soil, sun orientation, proximity towards water resources).

CHAPTER III. GEOLOGICAL CHARACTERIZATION

III.1. Petrography and structural-tectonic aspects

From a geological point of view, the Valea Oii watershed overlaps entirely over the Moldavian Platform. Seeing that it is a basin with a reduced surface and the research that refer to the entire Moldavian Platform are vast and in detail approached in geological research and also geography studies, we shall stop over some researches done in the basin.

A paper of great importance in our endeavor is the one of Stefan P., from 1989,, *Geologia regiunii Dealului Mare-Hârlău și perspective în resursele minerale utile*, where the results of researches in situ are underlined between the years 1978-1988; with a major emphasis on the evolution of Sarmatian mollusk evolution, on the separation of Sarmatian stacks which outcrop in the region (fig.5) in many lithological units and last but not least, on the useful mineral resources (oolithic limestone, sandstones, sands, clays and mineral waters), with an economic importance at a local level. As for the stratigraphy, the limit between Volhinian and Basarabian was set based on the faunal criteria. The making of the geographical map of the Dealul Mare-Hârlau area at the 1:50000 scale, but also of some sections, are a main interest for understanding the placement of human settlements in this area.

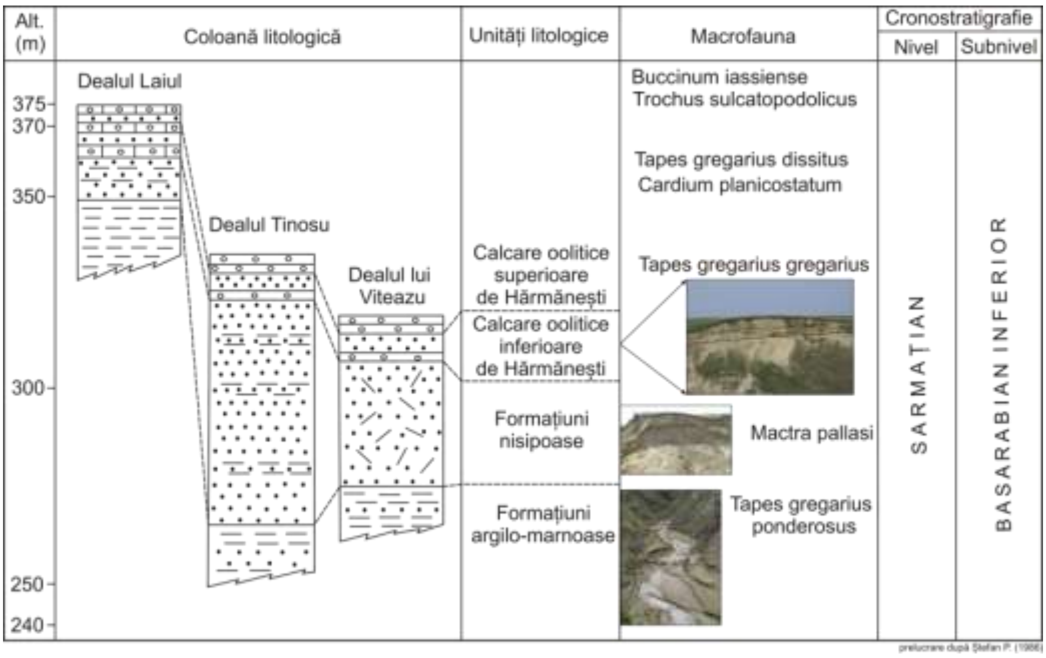

Fig. 5. Lithostratigraphic columns in the Băiceni area

CHAPTER IV. RELIEF

IV.1. Morphographical and morphometric characterization

Whereas the geomorphological processes that are taking place in this basin are only remembered or studied in a broader sense, some case studies are imposed. The Moldavian Plane is totally overlapped on the Moldavian Platform with a long paleogeomorphologic evolution (over 70 mil. years) which is also in a state of present evolution (Băcăuanu, 1967a).

The left side watershed of the basin coincides with the limit between the Bahluieț basin and the one of Bahlui and partially with the Măgura, outlining itself through: Dl. Stroiești (444 m), Muchia Corhanei/Dealul Osoi (365 m), Dl. La Rupturi (251 m), Dl. Măgurii (238 m), Dl. Țărna (187 m), Dl. Ciobanului (189 m), Dl. Lipoveanului (198 m), Movila Putinii (192 m), Dl. Făcuți (190 m), Dl. Polieni (160 m), Movila Zamfir (177 m), Dl. Basnea (150 m), Dl. Turcului (172 m), Coasta lui Donici (162 m).

The right slope outlines the Bahluietului basin limit through: Dl. Stroiești (420 m), Dl. Cepei (385 m), Dl. Laiu (375 m), Dl. Tinos (345 m), Dealul lui Viteazul (340 m), Dl. Halmu (256 m), Movila Jora (189 m), Dl. Hârtopului (183 m), Dealul Bejeneasa (183 m), Dl. Boghiului (169 m), Dl. Bălțați (152 m), Movila Hârtopeanu (176 m), Dl. Mândra (137 m), Dl. Sârca (126 m).

The network of the valleys existed almost entirely at the end of Pliocene and the beginning of Quaternary, the rivers were having the same general direction, with the exception of some small slides attributed to subsequent valleys. The subsequent character has been imprinted also in the Valea Oii basin; on the almost entire length of the valley the cross profile is asymmetric, the right slope being steep and the left one slightly slanting. Another aspect imprinted in the relief on the south limit of the basin, covered with a coluvial deposits which constitutes the terrace of the Bahluieț basin. The alluvial material carried along the valley has been submitted under the form of alluvial deposits, which due to external modeling factors have evolved in time under the form of local terraces, scattered on the left slope, uphill from Făcuți village or on the slopes of Bejeneasa Hill (Băcăuanu, 1966).

Taking in consideration the altitudinal difference of the basin, for accomplishing a hypsometric map (fig.6) the fallowing altitude classes were chosen: 61.5-100 m, 100.1-150 m, 150.1-200 m, 200.1-250 m, 250.1-300 m, 300.1-350 m, 350.1-400 m și >400.1 m. The areas wihich do not succeed 100m altitude represent 12.4% of the total surface being spread from the Bahluietului confluence until the half of the basin, where there are placed the main accumulations (Sârca, Mădârjești, Dobre, Ichim, Podișu) also the terraces of the two slopes are included, with a greater share for the left one. Altitues between 100.1-150m get the upper hand on the basin with a 41.9%, occupying the inferior third of the slopes on the left side, the majority of the right slope has the upper hand in the middle basin; the stage between 150.1-200m holds 26.6% of total, it met on the extrmities of both slopes from the effusion and util the borders of the Boureni and Bals villages, where the transition towards the plateau area takes place, that is accomplished throught the 200-300m stages (7.2%). The hypsommetric class of 300.1-350m with a 3.5% share, the one of 350.1-400m (6.3%) and the oneof over 400m

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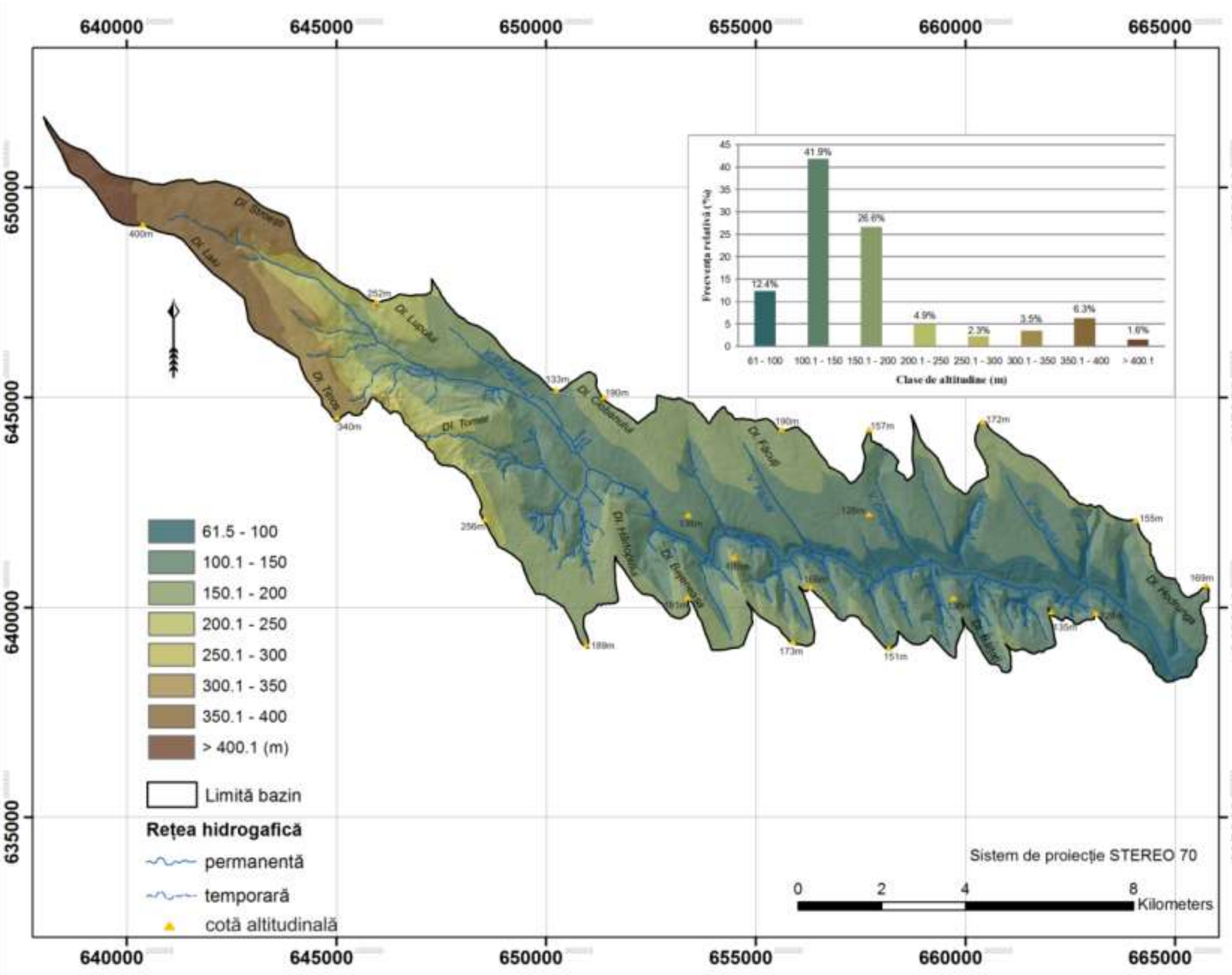

Fig. 6. Valea Oii catchment – hypsometric map

(1.6%) include the surfaces that are existing solely in the Dealul Mare-Hârlău in the NNW extremity also known as the Broscăria-Laiu plateau.

IV.2. Genetic types of relief (structural, sculptural, of accumulation)

Within the basin we find a denudational relief represented through sculptural and structural forms but also an accumulation relief.

IV.2.1. Structural relief – is characterised by the presence of cuestas , found on the tight side of the basin and throughout the structural plateau of the superior baisn Laiu. If in the Moldavian Plane two cuestas can be set apart, colluvial cuesta and valley flank cuesta, in our study basin only the delluvial cuestas are present, almost entirely formed out of the slope processes releases, developed mainly on deposits of loess, clay and loam.

IV.2.2. Sculptural relief – occupies the biggest surface of the basin on both of the slopes. During the formation of this type of relief, the main morphogenetic role is held by the external factors represesnted through the hidrographic network, the summ of the slope processes to which the climatic conditions are added and the presence of the soft rock sedimentation complex. Within this type of relief we find the following :

- *sculptural interstream areas* covered in eluvial clay with light washing processes which are met on the left side of the basin, with linear slopes with a tilt of no more than 3-5 degrees, the peaks evolution and stream plateau is due to some weak alteration processes, degradation and erosion, the descent of the general surface of the relief is slow, throught the means of some wide wavy formes, the possibility of natural conservation of the soil and even the formation of a 3-4cm slim counterpane of loessoidal clay. Through time these streams were analogized with erosion platformes. The sculptural streams undergo the form of hills and low plateaus (Dl. Lupului, Dl. Ciobanului, Dl. Făcuți).
- *colluvial slopes* with mixed degradations in multiple staged of evolution, spread on the right side of the basin, where the slopes exceed 3 degrees leaning. Here the majority of the surface erosion processes take place (gutters, trenches, gullies, torrents) favorised by the Sarmatian clay substrate; a special type of relief is the one developed on saline Sarmatian deposits or when, due to intense evapotranspiration and the low groundwater level, the salt reaches the surface soil through capillarity; to these fine texture saline deposits, washings are characteristic. Landslides with a wide diffusion are aquiring feature to this landscape, the majority being stabilized landslides.

IV.2.3. Accumulation relief - is represented by the Pleistocene and Pliocene terraces met in the inferior half of the basin, but also in plains, terraces, alluvial cones. The plains were formed in the postglaciar period through the succession of erosion and accumulation periods, with 3-20m thickness and are occupying the lowest portions of the relief. (Băcăuanu, 1967a). A very good example is from the upper basin, between Dl. Lupului and Dl. Mănăstirii, where both of the versants are affected by sliding processes, resulting a typical accumulation relief, where now is located Băiceni village.

IV.3. Location of archaeological sites based on the morphology and morphometry

The utilisation of a high quality and resolution cartographic stock, in the present case the numerical model of the terrain with 5x5pixel resolution, can help in obtaining more precise results. Internationally, for obtaining the numerical model of the terrain there are different methods and techniques used, with a direct aplicability over aercheological sites: satellite images from diferent years (CORONA – Goosens et al., 2006; Casana, 2008; ASTER, SPOT, LANDSAT, etc.), maps and topographic plans at different scales (Parmegiani, 2003),), aerial photography, direct measurements in the field with the GPS and total station, 3D scanner (Balzani et al., 2004), LiDAR (Harmon et al., 2006; Coluzzi et al., 2010), all these methods successfuly integrated in the GIS (Westcott, 2000; Harrower, 2010). The last one, LiDAR, is a very precise method, but also very expensive and it's usage is precise to just some high interest areas.

From fig. 7, refering to the classification of Chalcolithic aercheological sites on altitudinal classes, there can be observed the fact that a number of 17 sites (the majority belonging to the Precucuteni and Cucuteni phases) are placed on the 100-200m altitudinal difference (difference which occupies more than half of the basins surface), spread in the middle and superior basin until the contact with the plateau area, the preference for lower and relatively high formes is evident, where the slopes were permitting it, agriculture was practiced (Asăndulesei, 2012), but also the natural protection of the settlements.

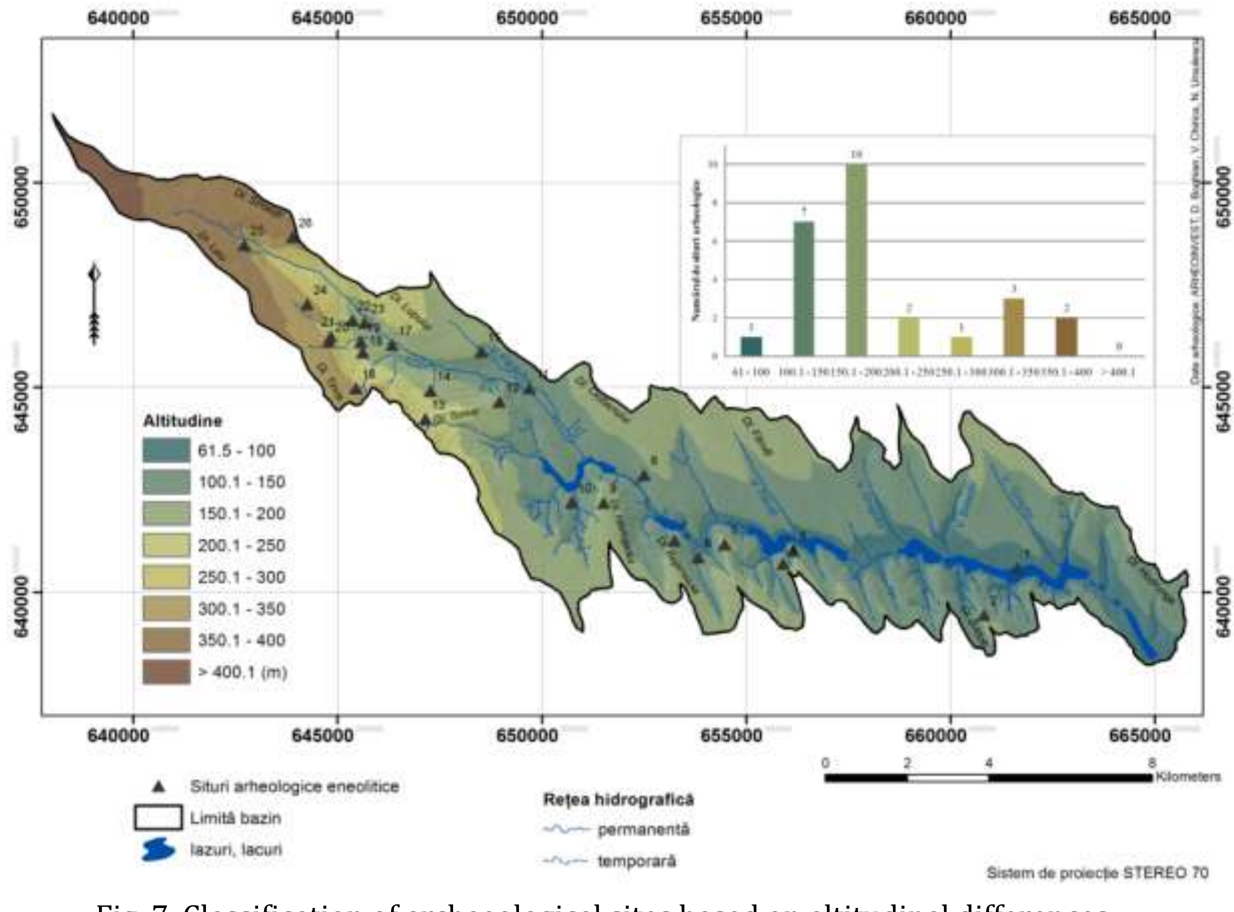

Fig. 7. Classification of archaeological sites based on altitudinal differences

It is not the case of the *Dealul Mandra* settlement, found at an altitude of 73m, in the proximity of the main course of the valley, the inhabitants could practice agriculture on the south slope. Proof of the fact that the settlement was located without taking in consideration other factors, such as natural defence, is that it exists only one archaeological layer – Cucuteni A, this settlement being abandoned at the end of this period.

The transition through the higher plateau area, with altitudes between 300-400 m, where there are met a number of 5 sites, is accomplished almost suddenly, in the 200-300 m class there are a number of 3 sites. In particular the settlements on higher altitudes were holding an essential role, the one of defence, inside these settlements fortification systems were found.

The mobilities of the Chalcolithic populations can not be completely understood, if the relief slope is not taken in consideration for the placement of settlements, their defence, but also terrestrial relationships, all of these with a minimum of physical effort (fig. 8).

The preference for putting up settlements in places with gentle slopes (3-5 degrees), with a number of 21 sites, all the other sites being met in the slope class between 5-7 degrees (4 sites), and also a site in the slope class 7-10 degrees. The last ones meet either at the contact between the plain and plateau, either on the right side of the basin, on the front of cuesta presently affected by the surface erosion processes.

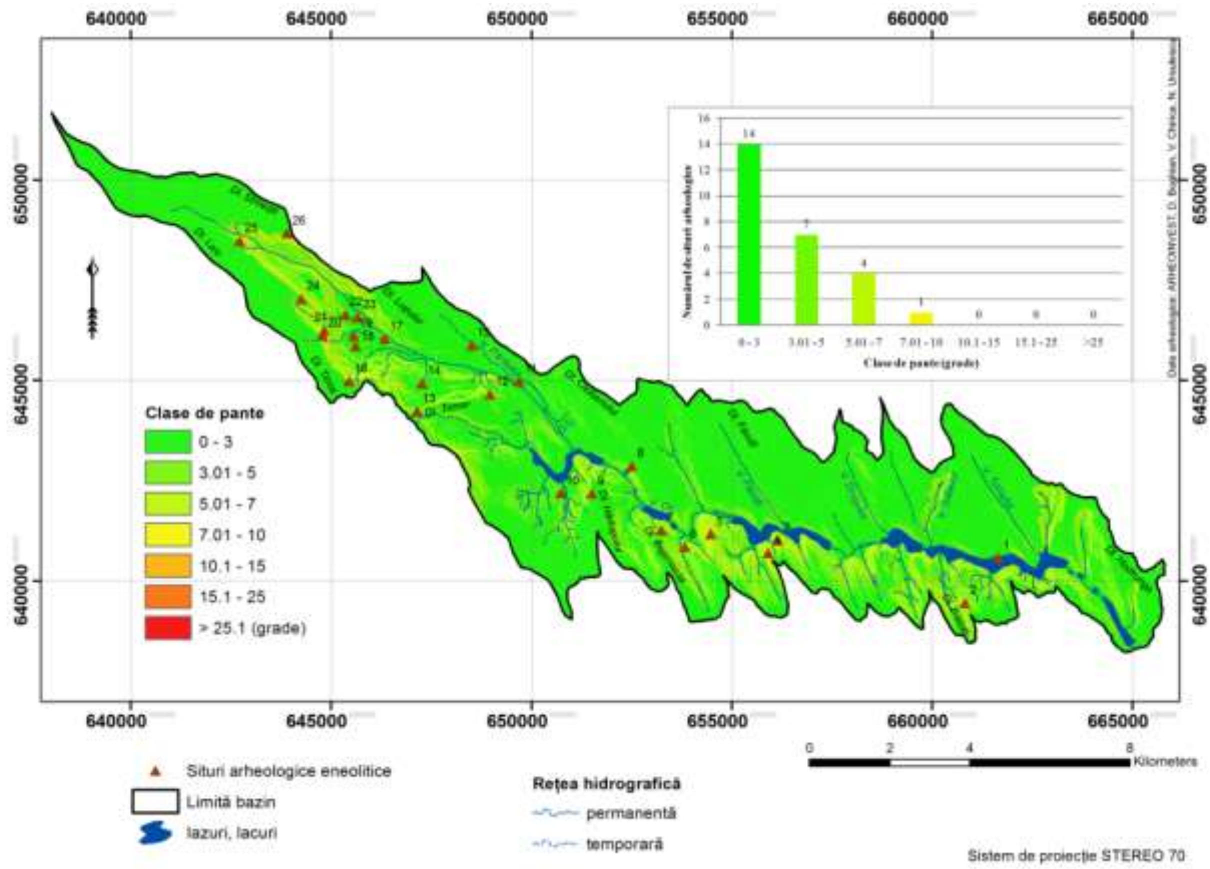

Fig. 8. Archaeological sites classification on slope classes

The predilection to setup the Cucuteni settlements on the north and north-east orientation slopes (Monah, 1985; Valeanu, 2003; Boghian, 2004; Asandulesei, 2012) is well known in the archaeological national literature. Following fig. 9, this aspect is once again underlined, 12 sites being setup on the norht and north-east slopes, from which they could profit from a grown termic comfort and solar light.

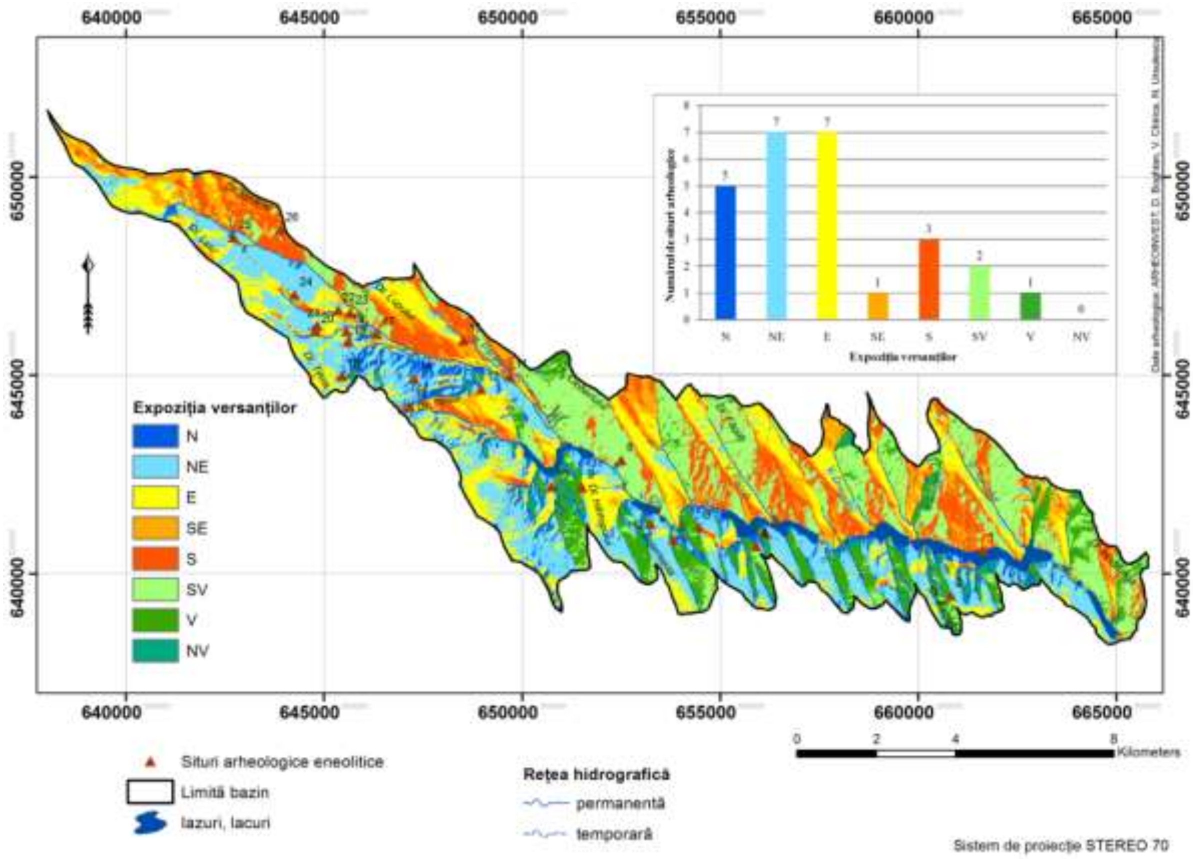

Fig. 9. Clasificarea siturilor arheologice pe clase de orientare a versanților

Within the basin, the east oriented slopes are also underlined, there are a number of 7 settlements, which were taking advantage of the sun light and the first rays of sun. Then follows a number of 3 sites setup on south orientation relief, assigned to phase Cucuteni A, assuming that during the hole time, the importance of this element was not realized, the settlements being abandoned towards the end of the period.

CHAPTER V. HYDROGRAPHY

The water resources on the Romanian territory are not of the vastest, occupying the 21st place in Europe from this point of view (Gâștescu, 2010). Valea Oii catchment (cadastral code XIII.1.15.32.12.7) enframes itself in the category of the 1st degree from the Prut basin, sub-basin of Bahlui river. Botoșani and Iași counties hold second and third places to the acquatic surfaces (after Tulcea county) from Romania (Gâștescu, 2010).

V.1. Stagnant waters (lakes, ponds, fish farms)

The existence and study of lacustrine accumulations within a given territory represents a high importance from an economic and landscape point of view. The necessity of the existence of these accumulations (lakes, ponds), especially in the Moldavian plain, first comes the presence of the continental termperate climate with excessive shades, with prolongued drought and running waters with a low flow (Băican, 1970). The permanent character of the water flows is due to the high factor of underground power of about 40-60% (Romanescu et al., 2008).

Within this basin the stagnant waters are established from the related lacustrine units, in number of 10, of an anthropogenic origin (Nicu et al., 2011). The level and evolution of these waters is variable, due to factors such as changing seasons, meteorological conditions (precipitations), from the usage category of the pool (simple – attenuation of the flash floods, complex – attenuation of the flash floods, pisciculture, recreation), but also from the geomorphological conditions (which sometimes has lead to the disappearance of some ponds due to landslides).

V.2. Location of archaeological sites based on water resources

Water represents the necessary elements of the existence of life on Earth. Human settlements, from ancient times, have taken in consideration the existence of water or its proximity when setup their homes. Although this factor was not a decisive one when huma choose a settlement, it can still be considered as being one of the most important, water constitutes a key element in choosing and developing human settlements (Boghian, 2004).

In the determination of the *distance to water* index there were taken in consideration the permanent water course, and also the intermittent course of drainage network (extracted from the topographic plans 1:5000 scale), because there is leakage when precipitations take place, prehistoric populations could take advantage from this fact, there were no major changes in the structure of the valley, the valley network being almost similar until the end of Pliocene to the beginning of the Quaternary periods (Băcăuanu, 1967a).

For the calculation of this index, the *Ring Buffer* function of the ArcGIS software was used. The distances used for the calculation of this index were of 200, 400, respectively 600 m; the maximum value was chosen of 600 m, because it represents the biggest distance from a site (*Pietrărie*) to the nearest water source. The ponds which are currently existing on the main cource of the valley were eliminated from the analysis.

This indicator, calculated at the level of the Bahlui catchment, for each of the three phases of the Cucuteni culture, it has underlined medium values of the distance between settlements and the one close to the water source; as follows, for phase A – 401 m, phase A-B – 408 m, phase B – 414 m (Asăndulesei, 2012). Following the completion of the proximity of archaeological sites map towards a source of water (fig. 10), from the total of 26 sites, it resulted a number of 19 sites which are placed at a 200 m distance from a water source, 5 sites at 400 m distance and a number of only 2 sites at a 600 m distance. Thus, the average distance from a prehistoric settlement to the nearest water source is of 269 m. Being a small basin in comparison with the Bahlui river catchment, the distancce of 200 m can be plausible in relation with our basins dimension. Following this analysis results the fact that the closeness towards the water resource constitutes one of the determinating factors in the layout of a settlement.

Another aspect which can not be omitted is the one according to which the main occupation of the Chalcolithic populations was pottery, water being an indispensable element. Also, water was used for nourishment, household utility and sometimes probably for irrigation of crops on small surfaces. A hypothesis that circulated was one which stated that in case the prehistoric communities did not have easy access to a water resource, they would of dugg wells for capturing water (the Cucuteni sites from Habasesti and Trusesti), even if archaeological proof have never been found to confirm this fact (Văleanu, 2003a).

Two special cases are the ones of the archeological sites from la Iaz/Iazul 3/Dealul Mândra și Dealul Boghiu/Dealul Mare. In the first case, the archaeological site Dealul Mândra is placed at the 73m altitude, at less than 200m from the water course, and at the south-west border of the settlement there are three springs partialy clogged (one of them is captured), visible only when the Sarca accumulation level is lower (Nicu et al., 2012a). In this situation, the fact that the water was the decisive factor in placing the settlement can be stated.

In the second example, Dealul Boghiu/Dealul Mare settlement, in the eastern extremity appear to date a number of two coastal springs, at the median part of the corniceof the landslide detachment which affects the site on the vest, north and east part. Probably the existence of the two springs has favoured the appearence of the landslide. Currently, the springs are not captured and do not have a considerable flow, sometimes water formes small puddles in the back of the mounds of slip; these puddles often constitute the place of drinking for the numerous sheep present in the area. It can be presumed that the prehistoric populations could of used this spring as a source of water supply, being very accessible, on the east-facing slope, at a distance of approximately 250 m. We state this fact because for setting towards the main course of the valley, they were forced to travel a distance of approximately 700-800 m, to go down and up a slope of approximately 9-10 degrees (being a high altitude settlement 185 m), fact which in the same time would of made the inhabitants vulnerable in the face of possible enemies.

The adaptation of mankind to the surrounding conditions of the environment, and especially to the presence of water resources, is evidenced also by the evolution of human settlements which at the beginning were places at a higher area of the basin; then, with the evolution of the relief and the triggering of the hidrogeomorphologic processes, of the floods due to deforestation, began the occupancy of the lower plain areas, close by to the main water course, with fertile soils due to the supply from alluvial slopes.

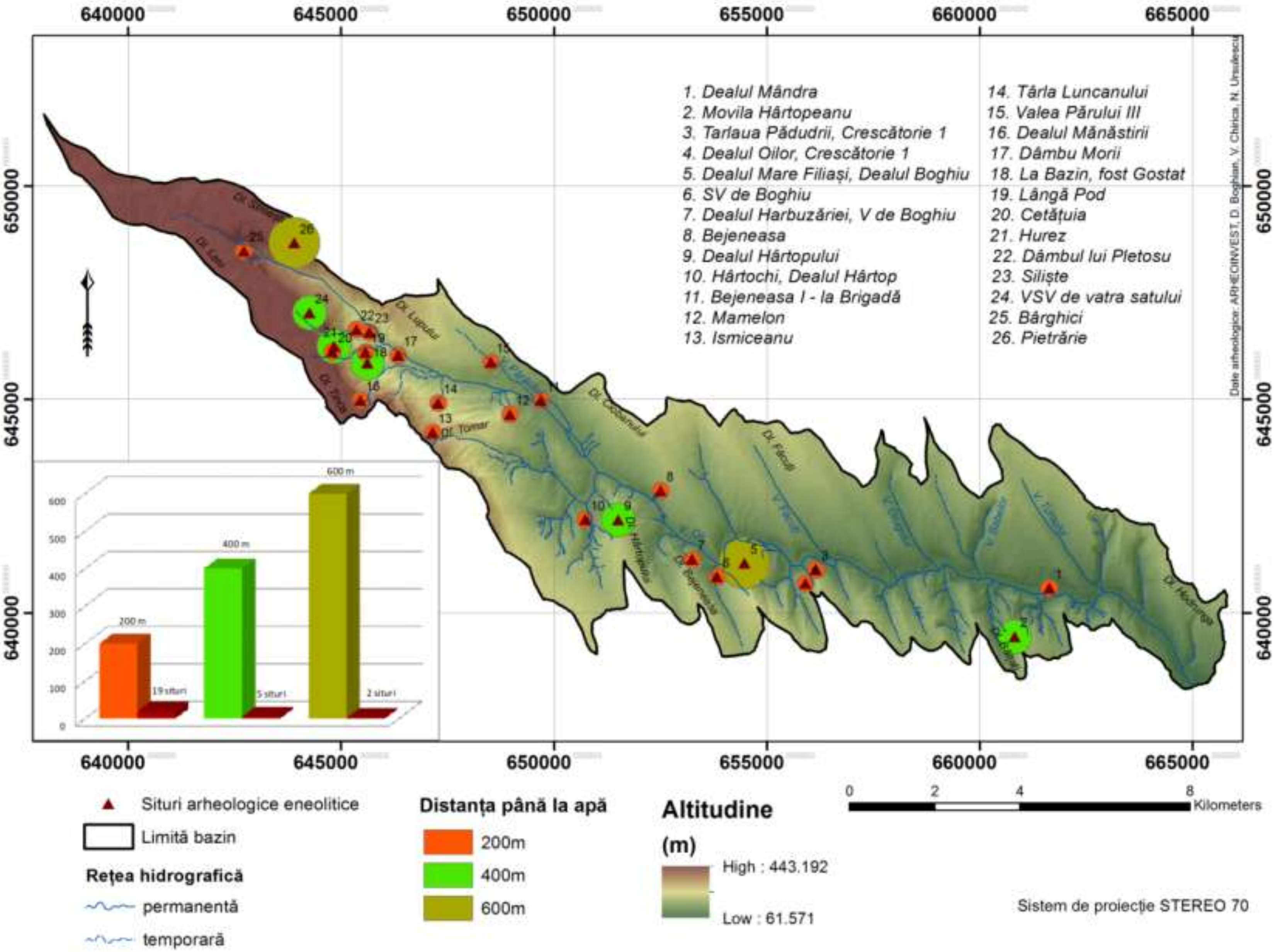

Fig. 10. Map of proximity of archaeological sites towards a water resource

CHAPTER VI. CLIMATE

VI.1. General view of the climate

In the Moldavian plain and also in the hydrographic basin Valea Oii, four main barometric centers act: Azores anticyclone, Siberian anticyclone, Icelandic cyclone and the mediteranian cyclones. Faint influences come on the behalf of the Scandinavian, Greenland anticyclones and from the north of Africa and the south-western depressions of Asia (Erhan, 2001; Mihăilă, 2006).

VI.2. Precipitations

The geographical placement of the Moldavian plain, east to the Carpathian chain which constitutes a real ''orographic barrier'' towards the dominant western cirrculation, determines an uneven distribution of the precipitations quantities. The main consequence of the interference of the Atlantic cirrculation with the Carpathian chain is the asymmetry of the precipitations quantities between the western wings and the eastern or south-eastern ones. A high importance is held by the relegating cyclones formed in the cold season in Baltic Sea region which then travel towards the north-west of the Black Sea, relegating towards east to west and thus affecting the Moldavian plain.

VI.3. The effects of topoclimatic and climate changes on the archaeological sites

Both climate oscillations and the tendency of temperature rise combined with the torrential rainfall charcateristics, have a damaging impact upon the degradation of the archaeological sites. The climatic changes and variations from the past have set their blueprint upon the dynamics of prehistoric populations. These were proven and described by Monah (1985), Boghian (2004). All the archaeological sites from the basin are under the direct action o the climate variations, three eloquent study cases have been analysed in detail in the final chapter. But, not only the climate variations are causing the in time degradation of the archaeological sites, actually an entire ensemble of factors are favourising and accentuating this process (land use, the degree of vegetation cover, slopes, bad management of land improvement works and especially the anthropogenic factor).

CHAPTER VII. VEGETATION AND FAUNA

VII.1. The spread of archaeological sites according to vegetation

The presence and automatisms of the forests have represented since ancient times places for human settlements. Besides the main exploitation role for it's wood resources in the scope of buiding and heating houses, the role of adjustment of the temperature in the specific area (higher thermal comfort in the warm season and the role of shelter in the way of the winds in the cold season), but also as shelter for wild animals hunted by the Neolithic populations. From the currently existing forest at the outskirts between the plain and plateau, the superior basin, specific species of the same family of trees have been preserved since the Chalcolithic: hornbeam (*Carpinus betulus*), elm (*Ulmus campestris*), ash (*Fraxinus excelsior*), wild cherry (*Cerasus avium*), within stands associations: corn (*Cornus mas*), hazelnut tree (*Corylus avellana*).

CHAPTER VIII. SOILS

Valea Oii catchment did not have, unfortunately real research of the soil cover, being most of the times integrated in higher relief units (Jijia Plain, Moldavian Plain); thus *Parichi M., Staicu Filuța* (1999), with the study *Contribuții la cunoașterea resurselor de sol ale Câmpiei Moldodvei*, where there are classified and divided the main soil classes and are measures for pedological optimisation are proposed.

VIII.1. Soil classes and types distribution

Table 1. The distribution of the main soil classes from Valea Oii catchment

Class	S (ha)	% (from total)
CHERNISOLS	6470.89	74.27
LUVISOLS	364.83	4.19
HYDRISOLS	124.71	1.43
PROTISOLS	539.82	6.20
ANTRISOLS	1052.72	12.08
VERTISOLS	159.81	1.83
TOTAL	**8712**	**100**

It can be observed (table 1) the clear domination of Chernisols which holds three quarters out of the basins surface 6470,89 ha (74,27%). Second to follow are the soils formed under the anthropogenic influence – antrisols, with a surface of 1052 ha (12,08%), protisols, which occupy about 539,82 ha (6,20%), and also luvisols with 364,83 ha (4,19%). In lower proportions vertisols appear (159,81 ha, 1,83%), with an azonal character, and hydrisols, which occupies the smallest surface of 124,71 ha (1,43%).

VIII.2. The role of soils in the placement of archaeological sites

Knowledge of soils in archaeology is an essential factor due to the fact that soil represents the base on which the prehistoric man has evolved since yearly ages until the present, but also the element in which the soil traces are preserved. The soil must not be considered a special element, but it must be placed in a physical-geographical context. If in the analysis of the archaeological material found buried, a study of its sedimentary rock side, spatial repartition, modifications due to pedogenetic processes, then it can be considered that only a part of the archaeological information is being studied (French, 2005), an insufficient factor for the realization of a complete analysis. Before beginning archaeological digging, holding information regarding classes and types of soil, obtained through pollen analysis (Tipping et al., 1999), can facilitate the understanding of the placement of certain settlements in different places, from different historical periods.

Another research domain in which the soils proprieties have a significant value is the one of the geophysical prospection (magnetometry, soil electrical resistivity, ground penetrating radar, etc.). In the case of GPR measurements (which functions on the principle of electromagnetic waves propagation in the soil), one of the most important proprieties is held by the electrical conductivity which depends directly on the high content of water, clay and soluble salts (McNeill, 1980). The soils with a high content of salts generate an increase of electrical conductivity and thus are not suitable for GPR measurements (Doolittle, 1995). In the case of these soils the penetrations depth is constrained to less than 25 cm, while in normal conditions, the penetration depth (which depends on the utilization frequency) can reach 25-30 cm (Doolittle, 2009). The same depth reduction marks were reported in the cases of soils with a high content of Calcium carbonate ($CaCO_3$) (Grant, 1994), or the ones with a high content of clay particles because they have the propriety of retaining a higher quantity of water (particles with a dimension of <0.002 mm) (Olhoeft, 1986).

Human communities have set thier settlements there where they had noticed a better development of agricultural production, in places where the soil proprieties were able to be used and the existent resources which enabled them to survive. After the execution of the distribution map of soil classes, a vectorial layer with the Chalcolithic archaeological sites was overlapped. Thus, the placement analysis of archaeological sites according to the existence of soil classes was possible, our main interest being found in the fertile soils used for agriculture (Chernozems) and the soils with a high content in salts (a possible resource used on a larger scale by the prehistoric populations).

The fact that in the past (6000 – 2000 BC) there were existing the same classes and types of soils which could of influenced the placement of archaeological sites can not be stated, however major modifications did not take place. Exceptions are the areas covered in the past with forests, especially the upper part of the basin, in the plateau area, where we mainly find hardwood species: oak (*Quercus robur*), elm (*Ulmus lamellosa*), hornbeam (*Carpinus betulus*).

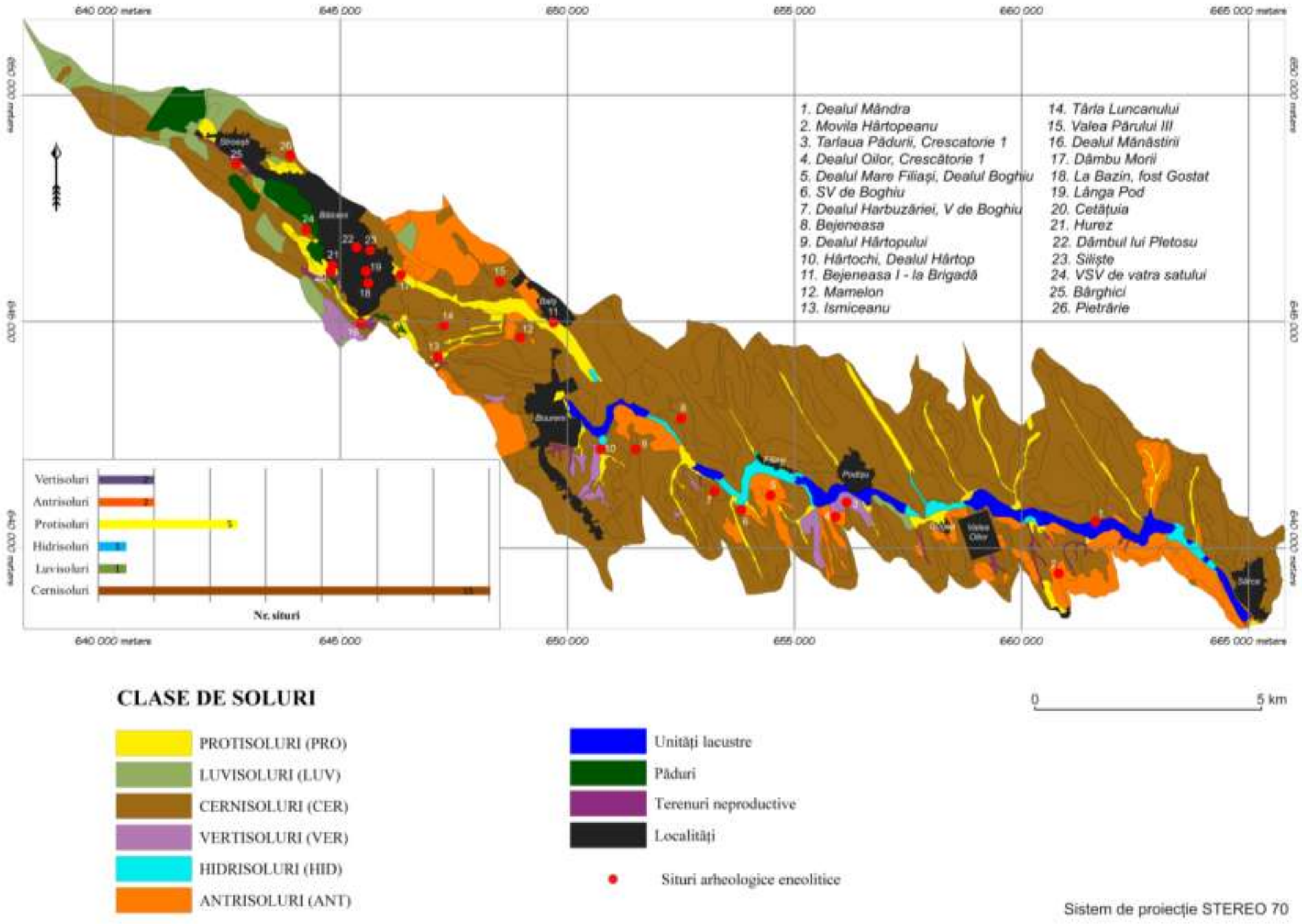

Fig. 11. Placement of archaeological sites on different soil classes

From fig. 11 it can be observed that a number of 15archaeological sites are presently placed on Chernisols (soils with a high fertility) which even if in the past were in the forming stage were construed for developing mixed vegetation associations, crops held a highly important role in the development of the Chalcolithic civilization, agriculture being one of the main activities (Boghian, 2004). The sites from this category are distributed almost uniformly on the entire surface of the basin, with a plus for the superior basin, where most of the settlements are concentrated. In the case of the Protisols, 4 sites are placed in this class, with soils still in an incipient stage of formation, mainly in meadows. The sites which are found on Antrisols (2 sites) are mainly affected by the slope processes, being under strong anthropic influence. Thus resulting the importance of internal soil proprieties, because the degree of vegetation coverage partly influences the erosion processes with negative effects among actual sites degradation. The effects are visible, when significant quantities of archaeological material is being washed and brought at the base of the slopes by the meteoric water.

The soil is in continuous formation and evolution, being difficult for us to estimate, and estimations at a stage of assumptions, the extension and presence of a certain type of soil for the prehistoric periods. In the analysis of this element, the close study of internal factors (rock type), external (climate, hydrological regime) and anthropic factors, which condition the processes of deposition or erosion, can help us in estimating or redoing the soil layer from the past. We invoke the necessity to accomplish paleoenvironment analysis for a better understanding of the geographical and archaeological ensemble

Along time, stratigraphic studies held in different archaeological sites in which systematic diggings took place have brought a significant contribution to the chronology and evolution of a culture. A well preserved and conserved soil (where agricultural works did not take place in an intensive manner, a rare aspect though) can offer crucial information regarding the stored archaeological material. The stratigraphic analysis is one of the ground methods of archaeological research, which especially indicates succession and not duration.

CHAPTER IX. GEOARCHAHEOLOGY – BORDER SCIENCE

Geoarchaeology through the mediation of techniques and methods of research belonging to earth sciences has especially focused on in-situ studies of the deposition conditions of sediments and among the formation processes. Research has often been extended to a higher scale in the attempt of restoration in a regional context. The study of settlements / archaeological sites in a context in which the conditions of the environment are being studies and analyzed (Rossignol and Wandsnider, 1992), or the ones which include punctual archaeological research (Dunnell and Dancey, 1983),) requires a geoarchaeological analysis at a regional scale ever since the beginning of the research. Therefore, any old document or records related to the natural environment conditions (characteristics, analysis, and evolution), need to be studied and integrate among the archaeological researches for better emphasizing possible connections (if there are any) between the two fields of study.

The human – environment relation is the one closely tied and interdependent, because humans or communities of humans have always taken in consideration, with or without their will, the characteristics of the environment (*geological conditions* - basement resources of raw material for raising domestic settlements, production of hunting weapons, using flint as raw material, places of salt resources exploitation; *geomorphologic conditions* – the placement of settlements on structural plateaus in a defensive purpose or the defense towards natural hydrological phenomenon like floods, in contact areas for facilitating mobility between certain communities, exposition towards the Sun; *hydrological conditions* – proximity towards water supply resources - ponds, salty ponds, water streams; *pedological conditions* – soil fertility, mineral resources, the existence of consistent clay resources used in pottery; *vegetation and fauna conditions* – the existence of a rich forest fund which also constitutes a place of existence for wild animals, used as raw material for building houses, heating them in the cold season, food preparation, but also burning pottery) (Nicu et al., 2012).

The achievement of these connections has evolved during time and has become imperative in our line of study of archaeology (table 2), from the environment description, from the archaeological monographs until the studies related to the landscape archaeology (Aston, 1985), environmental archaeology, ethno-archaeology (David, 2001) and last but not least geoarchaeology (Wilson, 2011).

Table 2. Basic components of geoarchaeology (Brown, 2001, adaptation after Hassan, 1979 and Goudie, 1987)

Component	**Specific methods of research**
1. Locating archaeological sites	Topographic maps, remote sensing, GIS analysis
2. Geomorphologic analysis of relief	Mapping, stratification, dating
3. Stratigraphic studies	Combining of geomorphologic studies with remote sensing
4. Analysis of sedimentary deposits	Identification of the geological substrate (mineral studies, texture analysis, etc.)
5. Paleogeographic analysis	Analysis of geological substrate, paleoecology (snails, pollen, wood, insects, seeds)
6. The determination of the human - environment relations	Connections between environment and the cultural changes, cost surface analysis, catchments analysis
7. Natural hazards studies	The majority of the above mentioned
8. Dating	Luminescence dating, C^{14} dating paleomagnetic dating

On the other hand, the impact which the man holds over the environment has become an important problem, from an archaeological point of view abut also from a sustainable development perspective with which mankind is struggling at the moment (Goldberg, Macphail, 2006), making reference to the climate changes, deforestation, desertification, soil erosion etc. Here, geoarchaeology steps in, which studies the traces of human interaction with the surrounding environment since early times until present days. Geoarchaeological research on one side, supplies data concerning changes that took place in a certain region and on another side it permits the reconstruction of old landscapes and the understanding the paleoclimatic evolution. Man, since the beginning of its existence, through its actions, such as building shelters, finding food, has exploited the resources "served" by the geosphere, producing modifications, sometimes irreversible ones to the environment.

If new evidence is found over the existence of ancient communities, it must be taken in consideration mainly where they are placed, for making hypothesis (based on the geological attributes, geomorphological, pedological, archaeological) regarding the landscape evolution, its transformation, but also for being a real help for the ones who try to issue eventual sustainable politics for the future (Wilson, 2006). Humans shall be capable of surviving as long as he will have the ability to adapt, and as we well know, this is one of the basic abilities of man (may he be prehistoric or modern).

IX.1. Definitions

To the term it has been assigned different definitions both by the research school, but by the period, that is why some definitions have become more complex with the passing of time and the apparition of new research methods

Thus, in *Elsevier's Dictionary of Geography*, the term *geoarchaeology* is defined as a combination of cultural, economic, geological, pelaogeological analysis for having the ability to determine the relations between hman society from the pastand the urrounding environment. An incomplete definition we can state, because the analysis and involved sciences are of a greater number.

In the Brittish accepted view, *geoarchaeology* represents a new field of research which has met a fast develoopment in the passing of the last decade. Actually, geologists were applying methods and principles of archaeological research since 1863, then being recorded the first links between earth sciences and archaeology (Lyell, 1863).

Renfrew (1976) stopps over the origin of *geoarchaeology* and considers that this discipline uses the skills of a soil, sediments and relief preocupied geologist for summing up these procupations in the studies of archaeological sies, of placement, formation and their conservation, all this in case in which archaeological artefacts were found. In the way archaeology obtains its data through diggings, any problem of a archaeological nature has geoarchaeology as a starting point.

Shackley (1979) established one of the first markers and attempts of defining *geoarchaeology* as representing the application of earth sciences, including geophysical prospections and petrographical analysis, the majority of research from this field having tangences wth geology, geomorphology, pedology, sedimentology.

A concise definition is the one in which is stated that *geoarchaeology* represents a multiple relations approach, where methods and concepts from geography and geosciences find their applicability for studying Prehistory, Archaeology and History (Rapp, 1998).

French (2005) takes a real scientific trip in defining the term, thus dedicating an entire volume of methods, problems, scopes, more or less succeeding in offering a clear definition. In defining the term he refers firstly to geomorphology (which represents the science which studies relief, genesis, evolution, dymanics, reports with human society). *Geoarchaeolgy* represents the combined study between archaeology's characteristics and geomorphology and the „fingerprints" of the anthropic actions upon landscape evolution. The main scope of geoarchaeology is the one of reflecting in nature possible integrated models of the human-environment system and of reflecting upon the natural and anthropic impact upon landscape.

In defining the term, an important contribution is held by Brückner, with a well ellaborated definition, one of the most complete in the acceptance that ***geoarchaeology*** is an interdisciplinary science by excellence, which combines the geo-bio-archieves study in an archaeologic context with the help of geosciences for reconstructing the evolution and the utilization of landscapes and ecosystems, with special regard upon the interaction between people and the environment, with objectives, perspectives and methods of natural sciences: geosciences (geology, sedimentology, mineralogy, etc), physical geography (geomorphology, pedology, geoecology, biogeographhy, hydrology, meteorology and climate changes) and human sciences: archaeology, classic archaeology, historic sciences, prehistory, oriental studies, human geography (urban geography, rural geography, settlement geography, historic geography etc.) (Brückner, 2008).

IX.2. Evolution

Having as a starting point classic archaeology, there were researchers which made different connections between the existence and the placement of archaeological sites and the factors which determined thier placement. The link between archaeology and the environment (geological factor, climatic factor) took place since 1863 (Lyell), the precursors which lead to the development and implementation of new research methods were: Brakenridge and Schuster (1986), Bryson (1994), Hubert (2001), Kirkby and Kirkby (1976), McGHlade (1995).

A fulminant development took place in the paleomorphological reconstruction, both on the basis of numerical models of terrain and modern methods, of non-destructive archaeological prospections (Ground Penetrating Radar, magnethometer, soil resistivity), but also from carbon dating: Stafford (1995), Brückner (2003), Ghilardi (2008). Combinig and utilizing these methods from physics, chemistry, biology, geography are called *archaeometry* , term introduced in the speciality literature by prof. Christopher F.C.Hawkes from the Oxford University, England, in the year 1985.

In present days, geoarchaeology has reached to be a self standing study domain, results being exposed in books and expert magazines, which had their debute in the 1950s-1960s, such as: *Quaternary Research* (1963), *Journal of Archaeological Science* (1973), *Archaeomaterials* (1985), *Geoarchaeology an International Journal* (1986), *Archaeological Prospection* (1995), *S.A.P.I.EN.S*, but also in publications which have as main subjects archaeology, anthropology or geology: *Journal of Human Evolution, Journal of Sedimentary Research, American Antiquity, Antiquity*, etc. Specialized publications are dedicated to methdology, used in the study of geoarchaeology: *X-Ray Fluorescence Spectrometry (XRF) in Geoarchaeology*, *Journal of Archaeological Method and Theory*, *Archaeological Prospection*, *Remote Sensing in Archaeology*, *GIS and Archaeological Site Location Modelling*, etc. De asemenea, au devenit celebre simpozioanele și congresele internaționale dedicate geoarheologiei (atât metodelor de studiu cât și rezultatelor obținute în urma cercetărilor interdisciplinare): ISA

(*International Symposium of Archaeometry)*, *First, Second and Third Arheoinvest Congress – Interdisciplinary Research in Archaeology* etc.).

In the evolution and develpment, a semnificative contribution is held by the establishment in the IAG (International Association of Geomorphologists) of the WGG (Working Group on Geoarchaeology), in 1997; the groups activity consists in organizing conferences dedicated to this field: *Geoarchaeology of the Landscapes of Classical Antiquity* (1998, Belgium), *Geoarchaeology in Northwestern Europe* (1999, UK), *the International Colloquium on Geoarchaeology. Landscape Archaeology. Egypt and the Mediterranean World* (2010, Egipt), *Geomorphic processes and geoarchaeology. From Landscape Archaeology to Archaeotourism* (2012, Russia). As it can be observed, the groups preocupations are of the most diversed and have as a scope the development and implementation not only of research methods, but also publishing the results (source: http://www.geomorph.org/wg/wgga.html).

In contrast to the stage of foreign results and research , the one from Romania have met a less enthuziastic evolution summarizing to only some gradual research without an international echo. This is due to the lack of interdisciplinary funding, or either to the lack of qulified personnel etc. In 1996, during an initiative on the behalf of a researchers group frm the Romanian National History Museum, the Pluridisciplinary National Research Center is established (Popovici et al., 2002). Later on, within the "1 Decembrie 1918" University from Alba Iulia, after obtaining a research grant, the *Systematic Archaeology Institute* takes place (initially known as *Baza de Cercetari cu Utilizatori Multipli – B.C.U.M.*).

Of course, the city of Iasi was not indifferent to this filed, so well represented through some well known historians; thus, the interdisciplinary research have started since 1987, when at the initiative of prof. Mircea Petrescu-Dimbovita, the *Cercetări interdisciplinare în arheologie*section appeared in the *Moldavian Archaeology* periodical. Later on the *Centrul Interdisciplinar de Studii Arheoistorice* (CISA), in the „Al. I. Cuza", the center being established with the scope of „establishing contacts and collaborations with all that wish to contribute to the progres of the interdisciplinary archaeological research" (Ursulescu, 2006). All this culminated with the establishment, during the *Platformei de formare și cercetare în domeniul arheologiei, ARHEOINVEST* platform, of the Geoarchaeology laboratory, after winning a research grant; we can state , because I am a member in the Platform, that it holds the necesarry logistic support, including qualified personnel, necessary in optimal ongoing conditions and international standards of research.

Also, we can remember Pluridisciplinary National Research Center („Valahia" University from Târgoviște), *Computerized Archaeology Department* (National History of Transilvania Museum from Cluj-Napoca), *Institutul de Cercetări Eco-Muzeale* (Tulcea). The development of these centers, technologic progress, summer schoools in this field and auxiliary qualified personnel have build the premise of collaborations between Romanian and foreign researchers (Maillol et al., 2004; Micle et al., 2010; Asandulesei et al.,2012; Niculita et al., 2012a,b; Nicu et al., 2012a), but also individual research for some archaeological anf geographical interest areas, the attention being focused on the human-environment relations, of natural resources the terrain holds (Valeanu, 2003; Micle, 2011, Maruia, 2011, Asandulesei, 2012).

The peoples perception regrading the production and development of natural phenomenons has had a sinuous evolution along time. Usually, when man intervines in the path of nature, it has a tendency of comming back to the initial path, sometimes through some phenomenas perceived by man as dangerous. At the beginnings, these phenomenas were considered as ''acts made by God'' to punnish mankind for their sins, but this conception was overcomed with solid arguments by Immanuel Kant and Jean-Jacques Rousseau; their vision towards these events was a realistic one, and looking at disasters as natural events, mankind holding the blame because he was intervines with nature trying to change it (Huggett, 1997).

CHAPTER X. ARCHAEOLOGICAL REPERTORY

Eneolithic (lat. *aenus* = copper) or *Chalcolithic* (gr. *chalkos* = brass, *lithos* = stone), after the Neolithic era, between 6000-2000 BC, characterized by the development of brass and the assertion of new painted ceramics cultures (Ursulescu, 1999).

The cultural complex Cucuteni-Ariușd-Trypillia (name given after the eponymous resorts from Ariușd – close by Sf. Gheorghe, Cucuteni – close to Târgu Frumos and Trypillia – in Ukraine, not far away from Kiev) developed on a spread surface, of approximately 350 000 km^2 (on the Romanian, Moldavian and Ukrainian territories), from south-east of Transylvania (Brasov and Ciuc depression), Moldavian Sub-Carpathians floodplains, with entrances through the Oriental Carpathians, Curvature Sub-Carpathians and Moldavian Plateau valleys, until the plain areas between the inter-floodplains Pruth-Dniestr, Dniestr-Bug and South Bug and Dniestr (fig. 12). The common and determinant element of settlement placement was constituted by the relatively high relief (hills, foothills, platforms, snouts hill, terraces) (Monah, 1985; Petrescu-Dîmbovița, 2001).

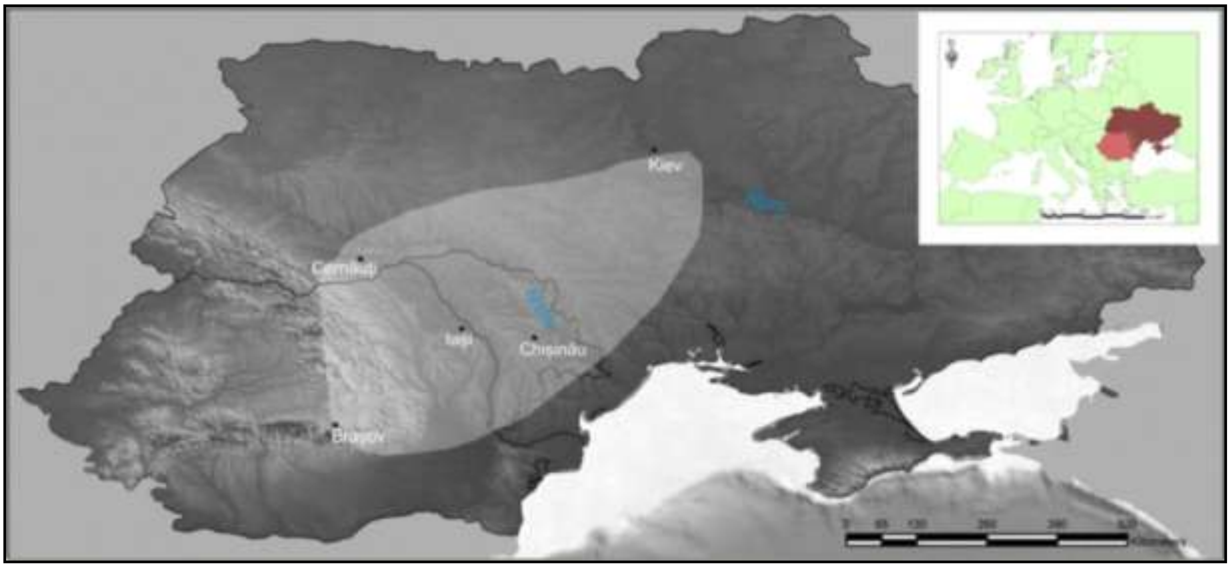

Fig. 12. Spread area of the cultural complex Cucuteni-Ariușd- Trypillia (processing after Asăndulesei A., 2012)

At the international level, the Neolitical era research through the interdisciplinary means and methods knows a real ascending trend every year (Morales et al., 2013; Li et al., 2013; Berger et al., 2013; Windler et al., 2013). On the base of multilayer research in the settlement from Cucuteni, were performed the first periodic scales by Schmidt (Petrescu-Dîmbovița, 1966).

The most recent absolute chronology data were obtained through palynology analysis and carbon dating throughout some representative settlements for the Chalcolithic period (Cucuteni – *Cetățuie*, Iași county, Poduri – *Dealul Ghindaru*, Bacău county, Hăbășești – *Holm*, Iași county); the chronologic dating was and still is a real challenge for the archaeologists. The Cucuteni culture phases are (Mantu, 1995, 1998, quoted by Ursulescu, 2013):

- Precucuteni I: ~ 5050 – 4950 BC
- Precucuteni II: ~ 4950 – 4750 BC
- Precucuteni III: ~ 4750 – 4600/4550 BC
- Cucuteni A: ~ 4600/4550-4050 BC
    - Cucuteni A_1: ~ 4600 – 4550 BC
    - Cucuteni A_2: ~ 4550 – 4300 BC
    - Cucuteni A_3: ~ 4300 – 4150 BC
    - Cucuteni A_4: ~ 4150 – 4050 BC
- Cucuteni A-B: ~ 4050 – 3775 BC
- Cucuteni B: ~ 3775 – 3500 BC

C_{14} dating indicated the below chronology, a bit different from the one above:

- Cucuteni A: ~ 4525/4500 – 3950 CAL BC
    - Cucuteni A_1: ~ 4525/4500 – 4450 CAL BC
    - Cucuteni A_2: ~ 4450 – 4150 CAL BC
    - Cucuteni A_3: ~ 4450 – 3800 CAL BC
    - Cucuteni A_4: ~ 4250 – 3950 CAL BC
- Cucuteni A-B: ~ 4050 – 3700 CAL BC
- Cucuteni B: ~ 3800/3750 – 3500/3450 CAL BC (Bem, 2000).

Within the basin, in some archaeological sites, systematic excavations took place and different analysis from interdisciplinary domains have been made: Cucuteni – *Cetățuie* (nr. 20), Băiceni – *Dâmbul lui Pletosu* (nr. 22), Băiceni – *Dâmbu Morii* (nr. 17), Băiceni – *Dealul Mănăstirii* (*La Dobrin/Dealul Gosanul*, nr. 16), Băiceni – *Hurez* (nr. 21), Băiceni – *Siliște* (nr. 23), Bălțați – *Dealul Mândra* (*La Iaz/Iazul 3*, nr. 1), Filiași – *Dealul Boghiu* (*Dealul Mare Filiași*, nr. 5).

Because we are studying a relatively small basin (97 km^2) the undergone research in this area were focused mainly on the entire Bahlui basin (2032km^2) (Boghian, 2004) or Bahlueț basin (558 km^2) (Asăndulesei, 2012). If at the beginning of the research only 23 sites were known, presently with the help of interdisciplinary research and repeated field trips during the interdisciplinary research platform Arheoinvest, and of a good collaboration between georaphers and archaeologists from the country and abroad, a number of 26 sites resulted which were integrated in a data base with the help of GIS (Asăndulesei, 2012; Brigand et al., 2012).

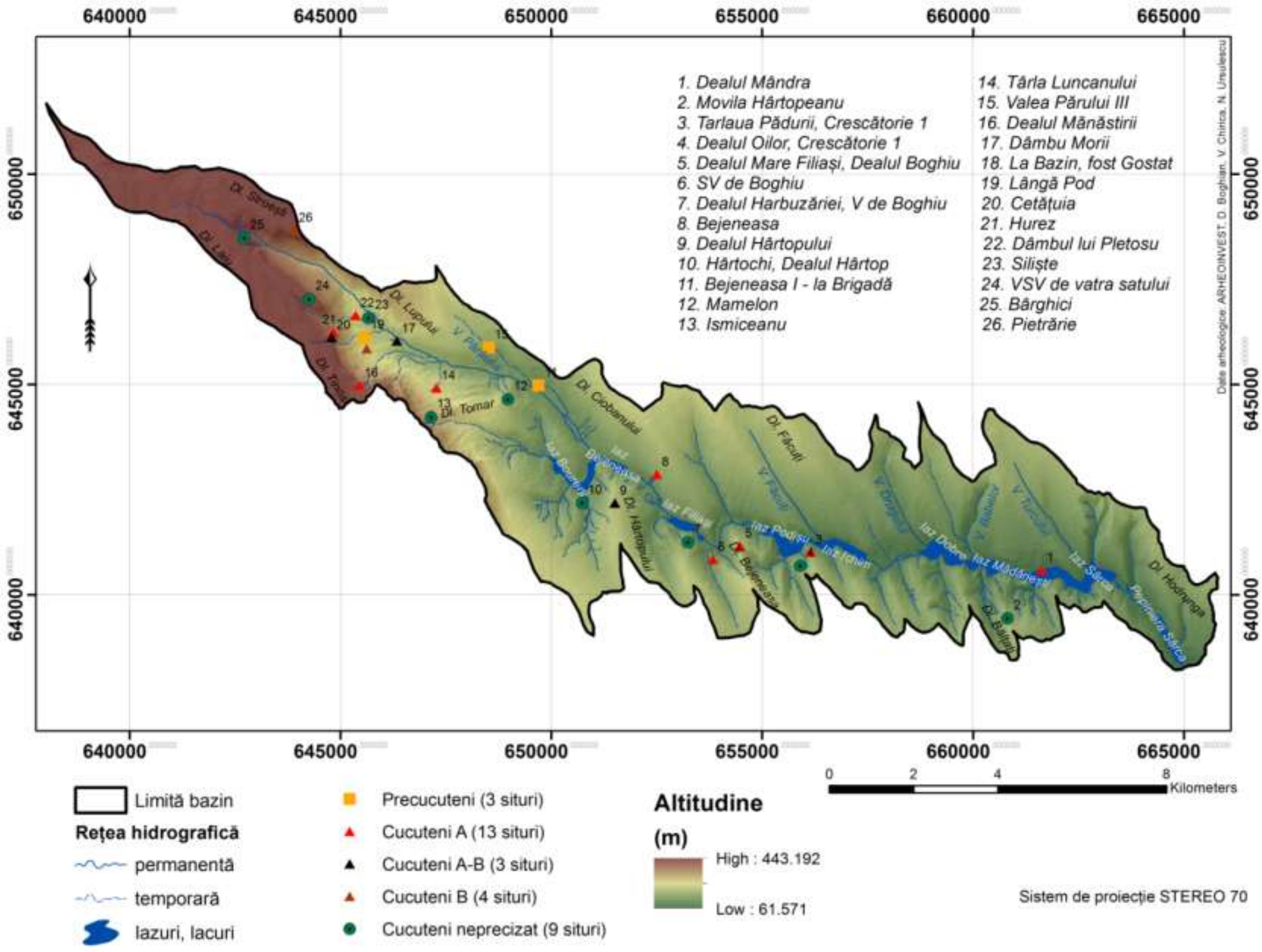

Fig. 13. Chalcolithic archaeological sites from Valea Oii catchment

Concerning their periodization, from the total 26 sites, a number of 3belong to the pre-Cucuteni period, 13 sites to the Cucuteni A period, 3 sites to the trasition Cucuteni A-B period, 4 sites to the Cucuteni B period and 9 sites have an unspecified period (fig.13). The ones with unspecified phase were researched only at a surface level being almost impossible to predict a phase in the absence of archaeological diggings. We invoke here the necessity of archaeological research for setting an evolution phase, so the analysis undergone with the help of the GIS to be plausible.

CHAPTER XI. ARCHAEOLOGICAL SITES AFFECTED BY CURRENT HYDROGEOMORPHOLOGICAL PROCESSES

The basin is not characterized by a large develpment of the slope processes. After analysing the affected surfaces from erosion extracted from the pedological maps at 1:10000 scale, it resulted the fact that more than half of the basins surface, either it is not eroded (40%), either it is poorly eroded (31%) or moderately eroded (21%); these areas are mainly developed on the left side of the basin and the structural plateaus (in the upper basin, in the plateau area). The processes are especially concentrated in the upper basin, at the contact between the plain and plateau, where the relief energy is high. At the entire level of the country, the area of the Moldavian plateau is known as being a very favorable one to the develpment of landslides (Surdeanu, 1998).

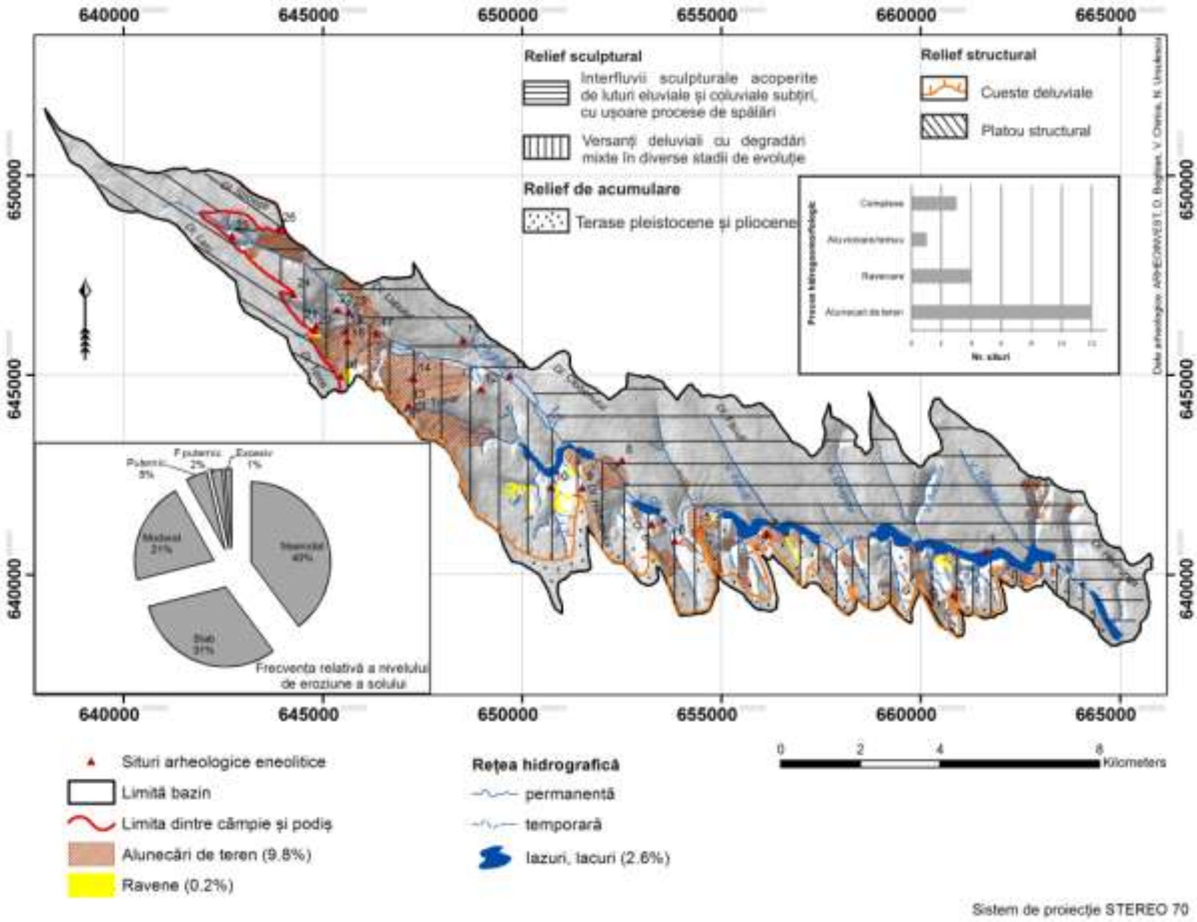

Fig. 14. Geomorphological map of the hydrogeomorphological processes which affect the archaeological sites

At an international level, the studies and researches regarding the affectation of the archaeological sites by the landsliding processes are numerous and spread throughout the entire surface of the planet, because considerable efforts are being made for salvaging and conserving the international cultural heritage (Canuti et al., 2000; Christaras et al., 2002; Grossi et al., 2007; Sdao, 2007; Alexakis, 2010; Eeckhaut et al., 2010; Nikolova et al., 2012; Tarragüel, 2012). From this point of view the national level literature is very poor, almost inexistent (Bâca, 2011).

From the most frequent geomorphological processes, the most frequent are the landslides, the studied area thus framing itself in the category with a high potential, high probability and medium susceptibility to landslides (Bălteanu et al., 2010). These occupy an approximative surface of 110 ha (9,8% from the total surface of the basin; the landslides were extracted out of the ortophotoplans at a 1:5000 scale – 2005 edition, combined with direct on site observations and measurements with a total station and a GPS, fig.14), spread mainly on the right side of the basin.

XI.1. Archaeological sites affected by gullying (case study)

XI.1.1. Dealul Mănăstirii (la Dobrin/Dealul Gosanul), site localised in the upper part of the basin (geographical coordinates WGS 84: 47°17'20" lat. N, 26°55'20" long. E; STEREO 70: X = 645383.084, Y = 645024.074) in the area of the transition coast between the Moldavian Plain and the Suceava Plateau, on the Cucuteni commune territory , area known in the geomorphological literature as Coasta Dealul Mare-Harlau, on the south-east border of the Laiu plateau. The geomorphological processes have a pronounced charcacter " *this coast is highly fragmented due to water erosion, which dugg deep the Baicenilor valley plateau*...". The gullying process is recorded in literature „*torrential gullying is characteristic on Dealul lui Voda and is enough frequent in the Deleni-Harlau region, in the Cucuteni-Baiceni region, and due to the regressive submission of the torrent network in the contact area towards the coastal lowland*..." (Bucur, 1954).

This gully was chosen because through its evolution it affects the archaeologic sites of Neolithic age Dealul Mănăstirii (la Dobrin/Dealul Gosanul), but also the geto-dacian settlement Mlada. The Neolithic settlement belonging to the Cucuteni A_3 period is in a fast process of degradation; after the archaeological research undergone by Chirica V., Popovici R., Iconomu C. in 1979 and by Petrescu-Dâmbovița M. in 1981 settlement remains, ceramics, a fragment of an antropomorphic idol, but also some scheletons were discovered (Chirica, 1984). Regarding the geto-dacian site Mlada, this was researched by Laszlo A., through diggings between the years 1964-1966, 5 sections being mapped revealing two levels of living, holes, and also a lot of archaeological pottery remains.

It also constitutes the object of interdisciplinary research set in the fall of 2008 undergone with last generation equipment (Mihu-Pintilie, 2011; Nicu, 2011; Romanescu et al., 2012; Nicu, 2012; Romanescu, Nicu, 2013), being researched under geomorphologic aspect in 2010 (Chiriac, 2010). As it can be observed, to this gully a high level of importance was set through the interdisciplinary researches made, continuing to be under our close observation, being a tipical case study in the cultural heritage protection and especially in the land degradation with effects on archaeological sites. In the following of the gully monitoring process beginning with the year 2008, besides the measurements with the total Leica TCR 1201 station and GPS Leica System 1200 and drawing up maps with the in time evolution of the gully (fig. 15).

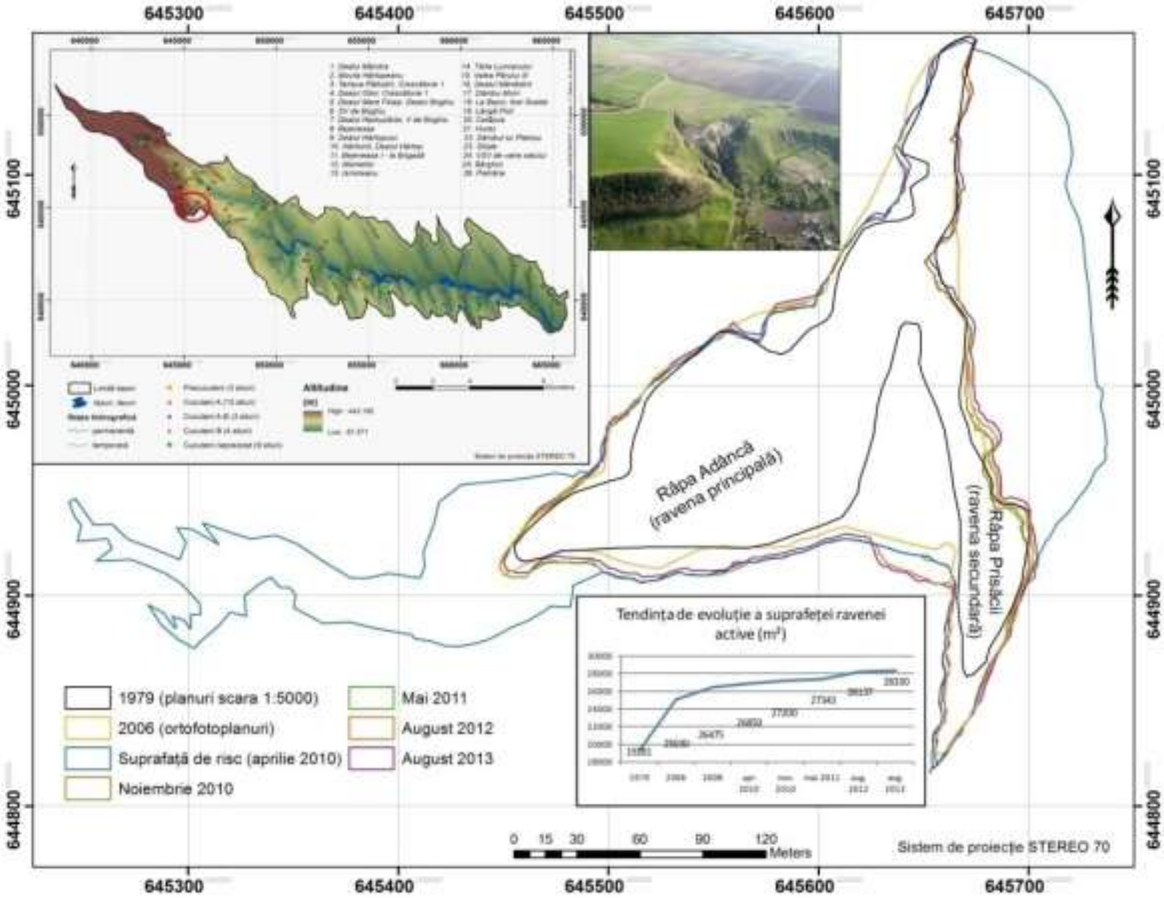

Fig. 15. The Băiceni – Muzeu Cucuteni gully evolution

The regression rate of the gully can varry from year to year, according to the meteorological conditions and the anthropic interventions; inside it many other processes are being developed such as geomorphological processes (landslides, crashings) noted fact by the achaeologists in literature „*the ESE part of the resort is destroying due to landslides* ” (Chirica, 1984). The Baiceni-Muzeu Cucuteni gully is characterized through a low hydrological activity almost all year, but even if it holds a small drainage area, when torrential rainfall occures it presents a potential hydrological risk of maximum flow (Nicu, 2012).

XI.2. Archaeological sites affected by landslides (case study)

X.2.1. Dealul Boghiu (Dealul Mare), approximately placed in the middle part of the basin (geographical coordinates WGS 84: 47°15'7.2" lat. N, 27°02'27" long. E; STEREO 70: X = 654471.048, Y = 641163.201); the site, of Cucuteni A_3 period is situated of about 600 m South of the Filiași village and approximately 2 km West of the Podișu village (both belonging from an administrative point of view to the Bălțați commune, Iași county), on a front of cuesta with an altitude of 185 m oriented towards North.

The settlement with a 1.5 ha surface was discovered and researched for the first time by Orest Tafrali in the fall of the year 1935, whom, along with Emil Condurachi and Victor Manoliu have undergone a series of archaeological surveys with unexpected results. Other researches followed of Berlescu N. in 1955, Boghian D. And Mihai C. between 1984-1986.

The topographic survey was done along two days in the month of June of 2011, for which there were measured approximately 2000 points with the help of the total station, in STEREO 70 coordinates system, completed with approximately other 1000 points measured with the GPS in the month of May 2013 (fig. 16).

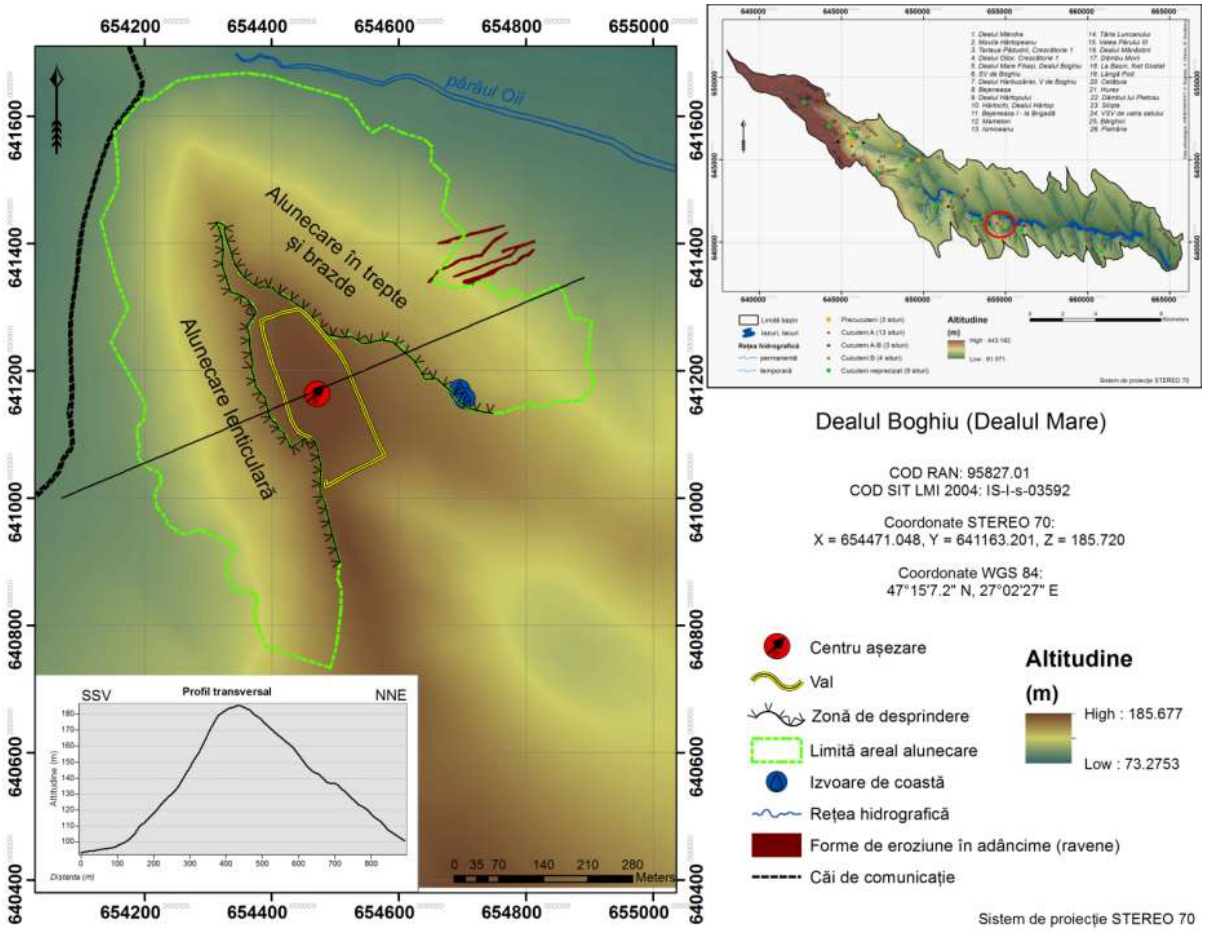

Fig. 16. Detailed DEM of *Dealul Boghiu (Dealul Mare / Filiași)* archaeological site

Regarding the toponymy of the hill where the archaeological site is placed, on the 1984 maps with the 1: 50000 scale it is found under the Dealul Boghiu name, on the shooting plans from 1942, Dealul Boghiu, then on the topograhical maps with the 1:25000 scale, 1985 edition its names is changed into Filiasi, probably due to the placement of the homonymous ground control point 3rd order.

This site was intensively affected (including the anthropogenic fortification system) by a landslide in an active stage, with a surface of 320000 m^2 (32 ha), of gullying processes in the east side of the slope, but also by anthropic activities (overgrazing, diggings undergone by local authorities without the archaeologists agreement, a big hole for clay exploitation, with a surface of 800 m^2 and depth of approximately 8 m, with a flagrant violation of Statute no.43 / 30 January 2000 regarding the protection of archaeological cultural heritage). The 32 ha surface frames the landslide as size in the very big landslides (Cornforth, 2005). Analyzed from a typological point of view, the left side of the landslide is lenticular type, and the right side is disposed in steps and furrows

Therewith, by using the GIS instruments, a tridimensional modelling of the settlement was possible with all the chartographic elements included (fig. 17).

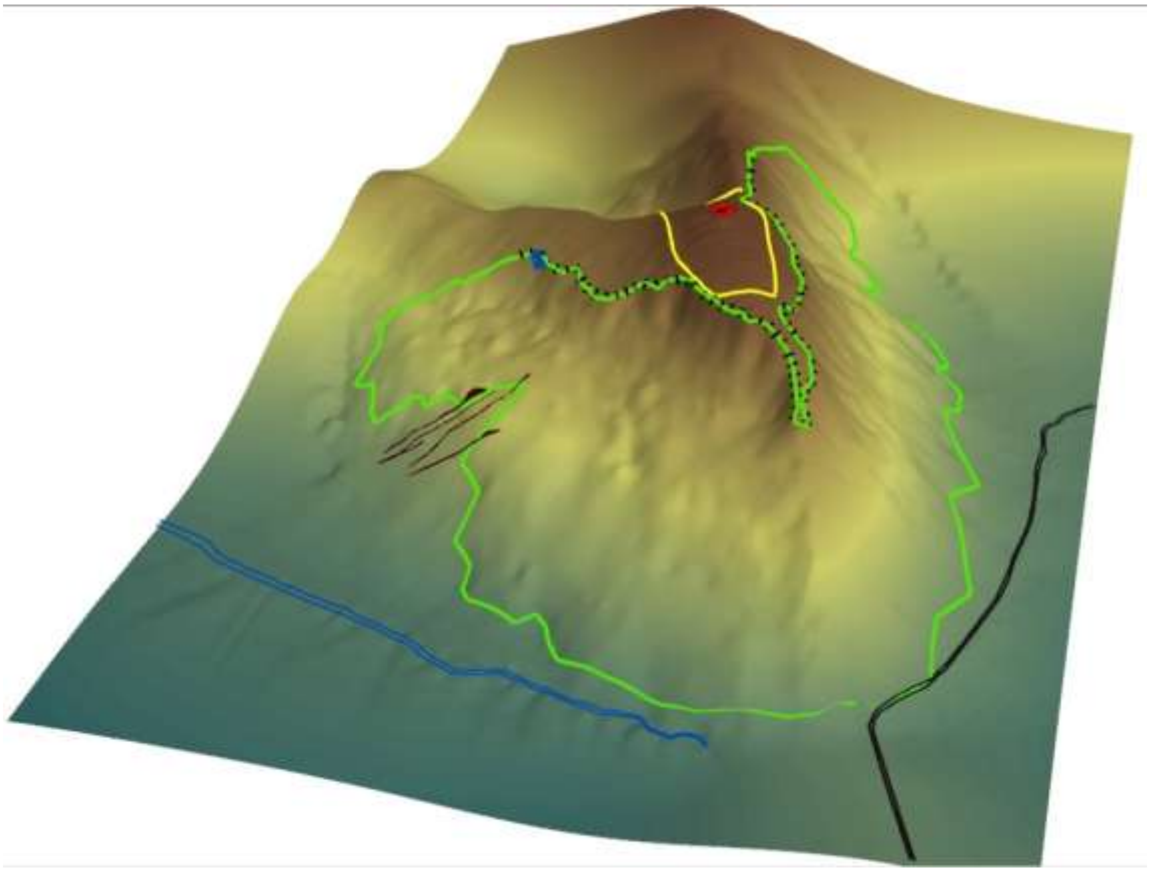

Fig. 17. 3D perspective of *Dealul Boghiu (Dealul Mare / Filiași)* archaeological site (NNE view)

XI.3. Archaeological sites affected by alluvial/warping and back water (case study)

Sedimentation and ersoion represent active processes in time which have contributed to the modelling of relief. From a geographical point of view, they provoke imbalances in basins systems. Human activities accelerate the sedimentation and erosion processes. The thickness of the sediments is proportional with the mechanic characteristics of the soil, properties of the geological substrate, capacity of water transportation, morphometric characteristics of the basin (slope, altitude), the degree of vegetation coverage of the soil, landuse, the intensity of human activities within the basin. In a general way, besides the in-situ negative effects of translocation of soil particles, erosion affects the agricultural lands by reducing soil fertility and by transporting sediments, thus water quality is affected. Concerning the present case study the sedimentation was present before dam building and after dam building and filling with water, the place of sedimentation was taken by erosion through waves action. Thus, sedimentation has contributed in the covering of potential traces of living and indestructable archaeological proof. All in all, the sedimentation process can have a possitive effect, the one of conservation of settlements (if they existed) in the sediment mass.

Dam building affects the natural evolution of the valley in two ways: stopping natural fluxes of sediments and sediment load upstream. Another result of dam building is the overload of the dam with water and cause floods. Sometimes, even though the dams are built with the scope of stopping negative effects associated with maximum flow, they can constitute triggering factors in producing such phenomena.

Water streams have an erosion action, transport and deposition of the sediments. Erosion produced by water streams is set towards streams and has the natural tendency of reducing the angle of inclination and achieving profile equilibrium. The action is influenced by the transport capacity and is proportional with the stream velocity - erosion and transport on the superior course, transport and deposit on the middle course and deposition on the inferior course. Earthworks on the water streams have a local influence on water flow channel; earthwork on main course leads to steep slope and also to the increase of water flow (Julien, 2010).

X.3.1. La Iaz (Iazul 3/Dealul Mândra) placed on the interstream area with soft slopes between Valea Turcului to the East and Valea Babelor to the West (geographical coordinates WGS 84: 47°14'43" lat. N, 27°08'80" long. E; STEREO 70: X = 661630.029, Y = 640579.428), in the point called "La Gorciu", at approximately 2.5 km NNE from the Baltati village, on the left side of the valley, in the area of Madarjesti pond dam.

Before building the dams along the basin between 1961-1962, the settlement was affected by sedimentation processes, but with the building of dams, the process was stopped. The anthropic activities which affect the settlement are met on the entire surface of the settlement, agriculture having the highest amplitude. A significant part of the site was destroyed between 1961-1962 works when all the dams within the basin were built.

Once the GPR measurements were done for setting the depth of the pond and identifying possible archaeological abnormalities, the determination of the ice thickness was possible (which osscilates between 40-50 cm), but also the initial conformation of the valley before the building of the dams and the sedimentation of the valley bottom. All the accomplished profiles show the actual conformation of the ponds bottom and sediments; after the data processing with the help of the RadExplorer 1.41 (Malå Geoscience, Sweden), the profiles no. 876 and no. 878 are the ones which especially caught our attention.

For depth calibration during the data processing, we used the standard value for relative dielectric permittivity (after Conyers, 2004) for water 0.04 m / ns (the values coincide for water in liquid form but also in solid – ice form, like in the present case). Therefore, with the help of the 250 MHz antenna, after data calibration, a maximum penetration depth of 3.8 m was reached.

The 876 profile (fig.18) has a length of 80 m, on the SW-NE direction, parallel with the bank of the Sârca pond. On approximately the entire length of the profile there can be identified a number of four anomalies , starting from meter 12 until meter 60, which can be associated with possible traces of archaeological settlements.

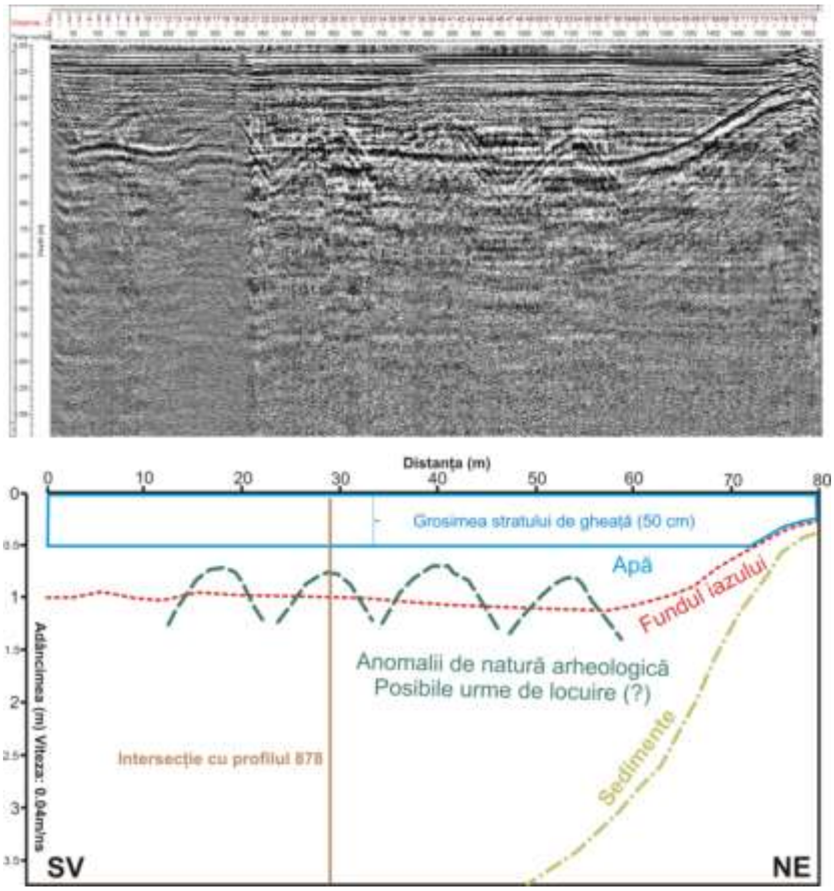

Fig. 18. GPR profile no. 876 (80 m length)

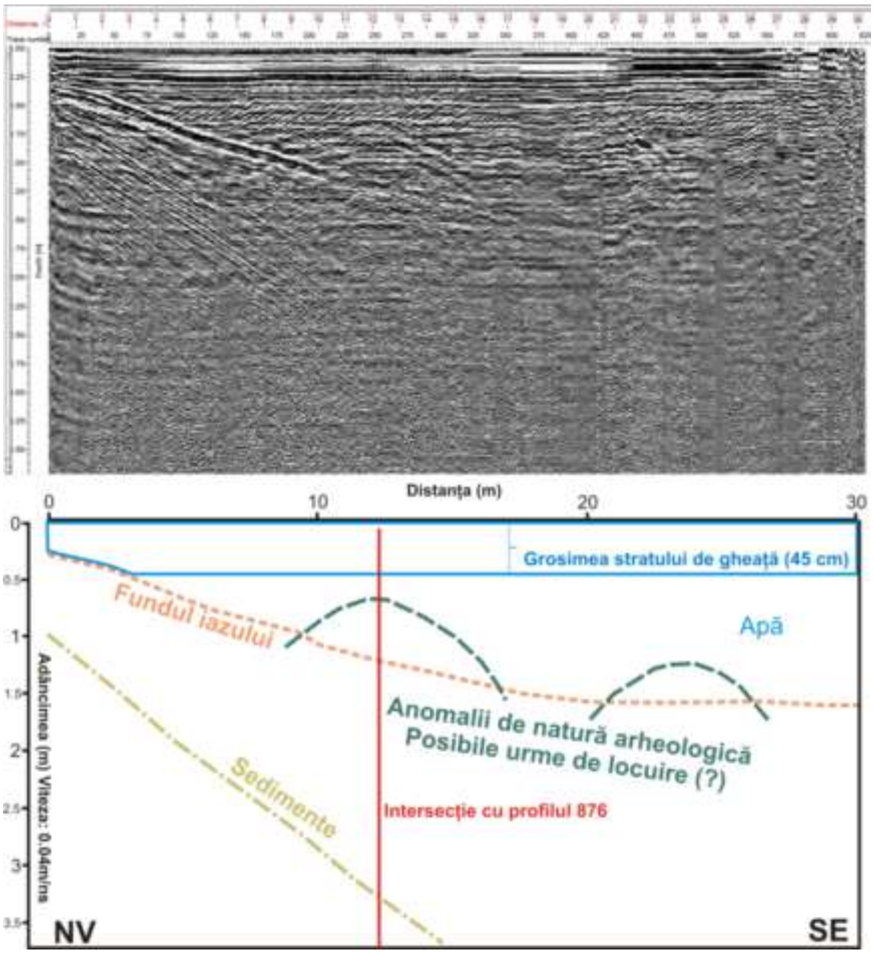

Fig. 19. GPR profile no. 878 (30 m length)

After the correction of the altitudinal points marked with the GPS resulted a flat surface of about 0.13 ha (1325.12 m[2]), favorable surface for building a number of 4-5 settlements, we state this fact because the 5 submerssed settlements wold be found in continuation of the other 4 settlements visible on the shore. Regarding the sediment thickness, it starts from 0.5 m close to the shore, until 3 m at a distance of about 30 m from shore. Further, the limitations of the 250 MHz antenna are obvious, making it unsuitable for larger depths; in this case the usage of the 100 MHz is required (this will be accomplished in the future for deepening the research related with the warping of all the ponds within the basin) which, in ideal conditions can reach depths of 20-25 m. What is found under the sediments bed is, most likely the valley conformation befor warping. In this case, the GPR represents the best non-destructive method for determing the sediment thickness, but also high resolution images (Bristow, 2003).

To make the switch to the next observations related to the following profile – 878 and 876 they intersect each other at meter 28. Profile 878 (fig.19) has a 30 m length and was configured on the NW-SE direction, approximately perpendicular with the ponds shore, and also on profile 876. Also in this case some anomalies can be observed which can be linked with traces of settlements. The scans were done in the inferior course of the valley, there where they are deposited, at least at a theoretical level, the highest quantities of sediments; unfortunately were not scanned, thus it cannot be safely stated that this area holds higher amounts of sediments than upstream (fact which we hope will be accomplished in the future). Ideally would be that these scans would be accompanied by dating in order to have a better overview of the valley evolution. Being a plain basin, the transport capacities of water are not as important as they would be in the case of a basin in a piedmont or mountain area, but also they are not to be neglected.

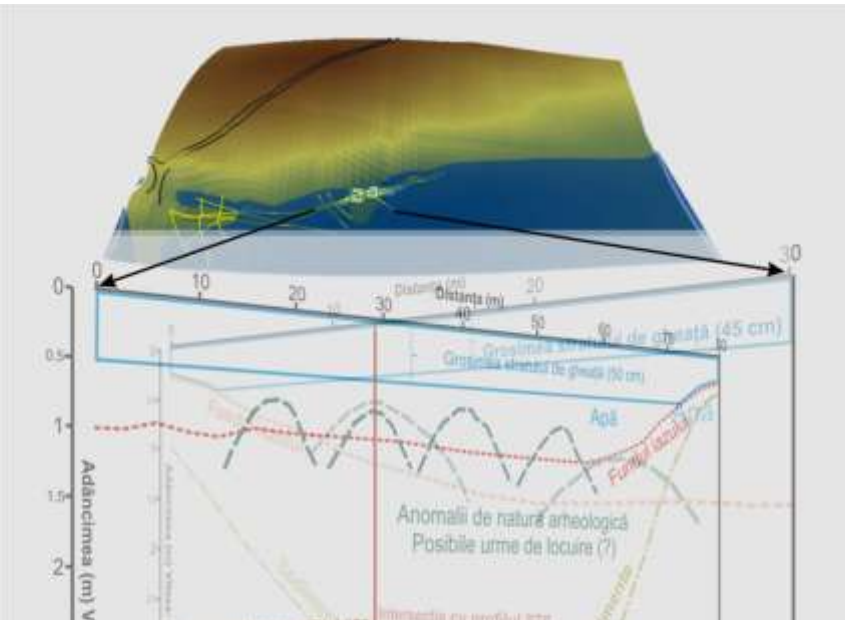

Fig. 20. Interpretation/overlay of 3D GPR profiles no. 876 and 878

Besides these natural processes, the site is also affected by the agricultural workings in an intensive manner in the NNW part of the settlement, where the Chernisols are present with a high productivity and fertility.

In the case of both profiles, the results are not absolute, they can be confirmed or not only in the possibility of significant decrease of Sârca pond water level, can sufficiently enough for a settlement to be observed and eventually archaeological excavations be undergone. Another method which could confirm the findings is drilling, where stratification can be observed in detail.

Finally, overlapping the GPR profiles (fig.20) offers a clearer perspective over what is going on under water level from the Sârca pond.

XII. FINAL CONSIDERATIONS

The present study, with a pronounced interdisciplinary character, based on a small territory (which can rightfully be considered the cradle of Neolithic civilization of Eastern Europe), has reached sensitive points in the research of main environmental factors, in a tight correlation with the placement and distribution of archaeological sites. 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. During the 3 years of doctoral studies, a great part of the observations were made in-situ, the basin practically being „made by foot" many times. The in-situ stage thus represented one of the most important stages of the process.

All the obtained informations through the GIS analysis were stored in digital format. The settlements were individually mapped, with high precision due with the help of the GPS: during the in-situ research done along with archaeologists within the country and from abroad, some imprecise or insuficient desciptions were corrected and/or completed. If, at the beginning of the researches a number of 23 Chalcolithic sites were known, presently their number is of 26, being discovered, mapped and partially dated: *SV de Boghiu* – Cucuteni A (Filiași, Bălțați commune), *Dealul Harbuzăriei/vest de Boghiu* – Cucuteni unprecised (Filiași, Bălțați commune) and *Dealul Hârtopului* – Cucuteni A-B (Boureni, Târgu Frumos).

In every chapter which describes the natural framework, the archaeological factor is also analyzed and completed with conclusions regarding the placement and evolution of sites in different natural conditions. This is where the GIS instrument stepped in and obtained the morphological parameters and afferent statistics (hypsommetry/site placemet on hypsommetrical classes, slopes/placement on slope classes, slope orientation/placement of sites on orientation classes).

The predillection for setting the settements close to a permanent water course was highlighted, but also on structural terraces and plateaus for a better visibility, and in falt terrain for agricultural reasons, on the North oriented slopes were the profitability of the Sun's light was higher, close to forested areas.

The measurements done with the latest high precision technology (total station, GPS, geodetic) represent a novelty and originality point in speciality literature in Romania. The lack of the nine topographical levels from the basin area lead to the utilization of the total GPS station for accomplishing the numerical model of the terrain to this area.

The measurements were continuous for the duration of a week with the help of the "Platformei de Cercetare Interdisciplinară Arheoinvest" colleagues. The obtained data were integrated and processed with the help of GIS. Thus a numerical model of the terrain was acheieved for the superior basin area, which did not existed at this scale and which could of been useful in out scientific strives (the SRTM and the numerical model of the terrain resulted after digitizing topographical mapps at a 1:25 000 scale insufficiently detailed).

Analyzing all the natural hazards (floods, landslides, gullying, etc.) with a direct effect on the population met an ascensional trend in the speciality literature both national and international level in the last decades, on the ground of climatic global changes and of anthropic interventions; this approach applyied on the archaeological sites in the means of protecting the patrymony, also comes as a novelty on a national level.

In-situ mapping of all the hydrogeomorphological processes combined with the utilization of high resolution satelite images dellivered extremely detailed thematical maps of the entire basin, all the archaeological sites bing affected by actual hydrogeomorphological processes in different stages of evolution. Also, there where the possibility occured all the anthropic effects were taken into consideration. The importance of protecting and conserving the cultural heritage must be underlined here and the essentiallity in preserving the national identity and integrating the cultural heritage for future generations. Thus, the results of this study lead to obtaining and salvaging some important informations of archaeological manner, which through the nature of the suffered transformations almost continously, their future recovery would not be possible.

The three case studies analyzed (*Dealul Mănăstirii/la Dobrin/dealul Gosanul*, *Dealul Boghiu/dealul Mare/Filiași*, *la Iaz/Iazul 3/Dealul Mândra)* are tipical examples of archaeological sites which are under the direct effect of soil erosion processes, under actual regulations for heritage protection, under anthropic interventions and under a defective management. Studies show a series of irregularities and actions undergone by local authorities or ceretain private businesses whcih are directely in charge of territory arrangement and which most of the times do not care about the real in-situ necessities. The lack of collaboration between the geographers and people in charge of territory arrangement is obvious, because it leads to degradation. The reduction measurements of soil erosion proposed by us are made at an empirical level and could constitute a real basis of sollutions and approaches which would serve local authorities when starting land improvement works.

Another aspect is the one of touristical valorification of the existent sites. At Cucuteni there is a museum of the civilization but year after year the number of visitors is lower, due to defective promotion from the local authorities. The results of our studies might be of value in increasing the material and informational basis of this museum but of other institutions of the same profile, thus forcing through an adequate promotion the rise of public interest in the Chalcolithicl civilization which existed on the groud of our country.

Being placed on ,hot spots of the basin with a good visibility between them, we can conclude that probably the neolotical opulations had a pretty good control of was happening inside the basin. This fact is not decisive in the placement of settlements, cosidering the numberous factors with a complementary character (close to water sources, terrains adequate for agriculture etc.)

Intuition and revealing existent links between man and environment among these civilizations on the premises on acctual traces left as an anthropic intervention, constitute the backbone of this thesis. Some models of migration and abandonment were intuited at the level of the entire basin, realized on the pure arhaeological facts but also on new tendencies in the international literature which were not applyed at a national level – the island biogeography, which indicated the same migration tendency from the middle basin to the superior one beginning with the second age of living (Cucuteni A-B), mainly placed on the Holocene climatic variations.

Another novelty point among our research is represented by the saturated areas (of soils with high concentration of salts, not of salted streams), closely connected with the placement of archaeological sites, but also their economic importance for the current population, but for the past one as well.

Even if the great civilizations of the world were developed and placed on low alluvional valleys (Nile) or in coastal areas with high productivity (Peru), the Chalcolithic population has preffered the high areas with adequate relief for a better defense.

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