THE INFLUENCE OF FLUVIAL DYNAMICS ON GEOARCHAEOSITES FROM THE DANUBE BANK (THE MĂCIN BRANCH). CASE STUDY: TROESMIS FORTRESS (ROMANIA)

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ABSTRACT. – The influence of fluvial dynamics on geoarchaeosites from the Danube Bank (the Măcin Branch). Case study: Troesmis Fortress (Romania). Built since the first century AD, the fortresses along the right bank of the Danube river have suffered decay along the ages as a result of anthropic and geomorphological factors (weathering of construction rocks, fluvial and eolian erosion). Therefore, in order to study the evolution of the sites, analysis of the geological, geomorphological, hydrological and climatic conditions were made. Our study aims to analyze the Troesmis Geto-Dacian site (III - IV century AD) situated on the right bank of the Măcin Branch. Nowadays, the fortress stage of degradation is quite advanced, the main natural decay favouring factor being lateral erosion from the Danube. Fluvial erosion and associated geomorphological processes have determined the retreat of the right bank of the Danube, which led to the structural destruction of the archaeological sites. In order to determine the fluvial dynamics of the Măcin Branch sector**,** bibliographic materials (maps from different time periods etc) were analyzed and field observations were made. The result consisted mainly in the creation of maps that presents the dynamic of the Măcin Branch (Danube) and its influence on the Troesmis geoarchaeosite.

Keywords: fluvial dynamics, geoarchaeosite, Troesmis Fortress, Măcin Branch

1. INTRODUCTION

Our study area is situated in North-Weastern part of Dobrogea Plateau (South – East of Romania,), on the right bank of the Măcin Branch (Danube). In this sector of Danube is reported the presence of numerous archaeological sites representing ruins of geto - dacian fortresses: Noviodunum, Dinogeţia, Arrubium, Troesmis, Aegyssus, Proslăvita, Panagia, Beroe, Salsovia, Ibida, Argamum etc.(fig. 1). The fortresses from the Danube River (in Dobrogea Plateau) have suffered degradation over time, both because of anthropogenic and geomorphological factors.

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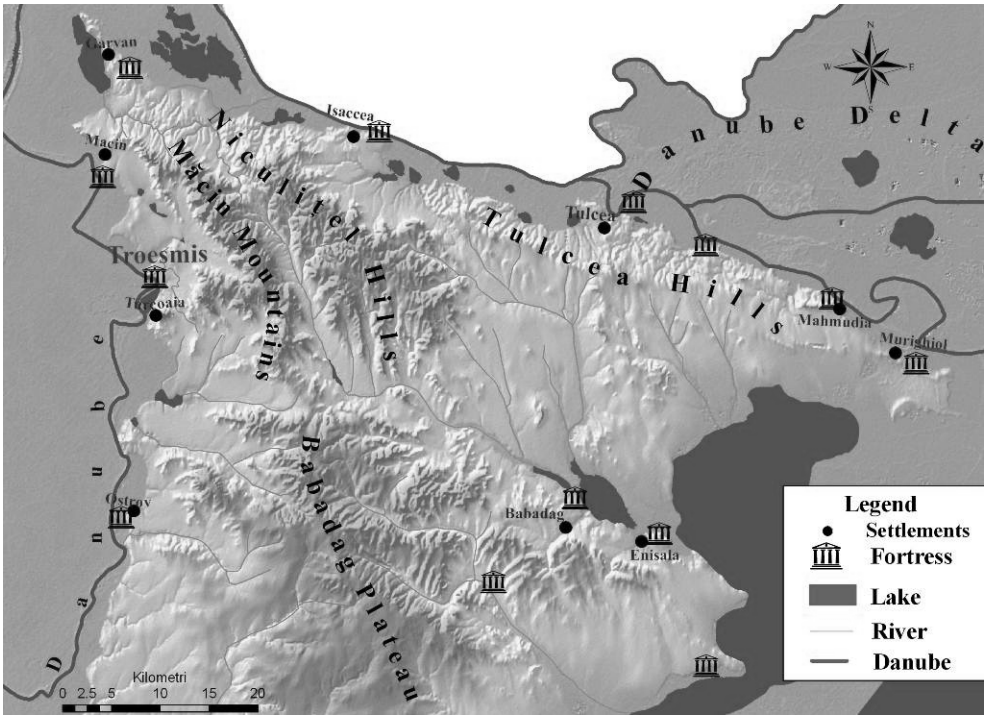

Fig. 1 ***The map of fortresses from Dobrogea Plateau***

Friable rocks, that forms the Măcin Branch banks, favoured the erosive action of the watercourse in Ostrov – Măcin sector. Being situated on the concave bank of Măcin Branch meander (formed next to Turcoaia settlement), Troesmis fortress has been exposed to the degrading action of Danube since the first century of its existence.

By analyzing the archaeological, historical and cartographic materials we noticed that the fortress surface has underwent to a continuous restriction as a result of erosive action of Măcin Branch. In time, the geoarchaeosite surface has been damaged both by the floods and alluvial sedimentation and by lateral erosion and subsidence that led to a continuous withdrawal of the right bank of Măcin Branch.

Our study aims to highlight the interaction between the evolution of the Măcin Branch and the preservation of Troesmis archaeological site. Thus, we aim to emphasize how the lateral erosion has lead to the degradation and even destruction of Troesmis geoarchaeosite.

In perspective, we aim to assess and achieve a preserve strategy for the archaeological sites (Dobrogea Plateau) that are under constant degradation caused by onset of the geomorphological processes.

2. TROESMIS GEOARCHAEOSITE

Troesmis Fortress is situated on the right steep bank (30 m height) of Măcin Branch (Danube river), at 3 km from Turcoaia and 15 km from Măcin settlements.

Over the entire ancient period the fortress was an important strategic point, being mentioned in the main historical and geographical sources. The earliest mention of it, dates from the end of first century BC and the beginning of the first century AD in Ovidius works, as *Trosmis.* The archaeological site is also mentioned as *Troesmen* in the Ptolemy works, in *Itinerarium Burdigalense* at Hierocles, in *"Cosmography"* and so on. (Florescu, 1980)

Built in thracian-getic period, Troesmis was destroyed and reconstructed several times. However, Troesmis crossed through a period of prosperity in Roman times due to the presence of the Fifth Macedonica Legion and also in the Byzantine period.

The fortress ruins (fig 2) have never been investigated systematically and exhaustively on their entire surface.

Fig. 2. ***Troesmis geoarchaeosite ruins***

The first excavations were made between 1864 - 1865 by A. Engelhardt and the research results (four inscriptions) were presented at the French Academy. Archaeological campaigns were then undertaken in 1967 (by E. Dejardins), between 1880 - 1900 (by Gr. Tocilescu), in 1939 (by Emil Coliu) and 1971 (by Al. Stefan). Archaeological research from 1977 had partially uncovered an extensive Roman settlement, composed of two fortifications. The site included the *Eastern Fortress* (V century AD) which follow the moeso-roman style with polygonal plan and *U* - shaped towers and the *Western Fortress* (IV-V AD) with rectangular form, symmetrical plan and towers on the corners. Between the two fortifications is situated the *civil settlement*, delined by three defense ditches, developed within the II-VII centuries AD. (Simion et al., 1980)

Currently, Troesmis archaeological site is in an advanced degradation stage. This stage is determined both by anthropogenic factors (livestock constructions during the communist period) and the fluvial dynamics of Măcin Branch. The latter, has been influenced by the overlapping of Troesmis geoarchaeosite on quaternary fluvial deposits represented by sands and silts of Holocene age (with thickness of 5 - 8 meters) and loess deposits of Pleistocene age (with thickness that can reach 15 to 30 meters).

3. METHODOLOGY

The main objective of our study is tracing the way in which lateral erosion has lead to the degradation of Troesmis geoarchaeological site. In order to achieve the proposed objective, historical and contemporary maps of the Danube River were acquired. Historical maps, which include the Troesmis geoarchaeosite, published in the 1743, 1760, 1794, 1826 and 1884 couldn't be used because of unknown cartographic projections and their small scales. Therefore, they couldn't be converted to stereo 70. The first cartographic materials that could be georeferencered were Austro – Hungarian maps from 1912. In our study, we also analyzed aerial photos and orthophotoplans from different time periods to determine the fluvial dynamics of the Măcin Branch sector.

The method consisted in georeferencing of topographical plans, maps from the begining of 1912 to 1996 with different scales, orthophotomaps (2002 - 2007), aerial photos and even satellite images (1989 - 2010). Data concerning the position of Măcin Branch from 2011 were obtained through field observations and GPS measurements.

In order to determine the fluvial dynamics in the studied sector we identified the position of the Măcin Branch course and mapped the cartographic materials from the beginning of twentieth century. Likewise, in order to determine the migration rate of the meanders we used the TCTM method (Topologically Constrained Transect Method). Thus we measured the distances between watercourses from successive time periods. Initially, the lines that follow the middle of the draining canal were digitized for each year we had cartographic material. Thus, the migration of the line that marks the middle of the draining canal from a certain time period could be correlated with the position from a different time period. The data obtained were interpreted to highlighting the influence of the Măcin Branch migration on Troesmis geoarchaeosites.

4. RESULTS AND DISCUTIONS

Being exposed to geomorphological processes, Troesmis geoarchaeosite is currently in an advanced stage of degradation. The most important natural factor that led to the degradation of archaeological site is represented by lateral erosion of Măcin Branch (Danube river).

Troesmis fortress is situated on the concave bank of Măcin Branch (fig. 3), on friable deposits of fluvial origin, which makes the promontory on which it was built to be constantly exposed to fluvial erosion and associated processes (crumbling, rolling, splash, complex and linear erosion on the bank side etc.).

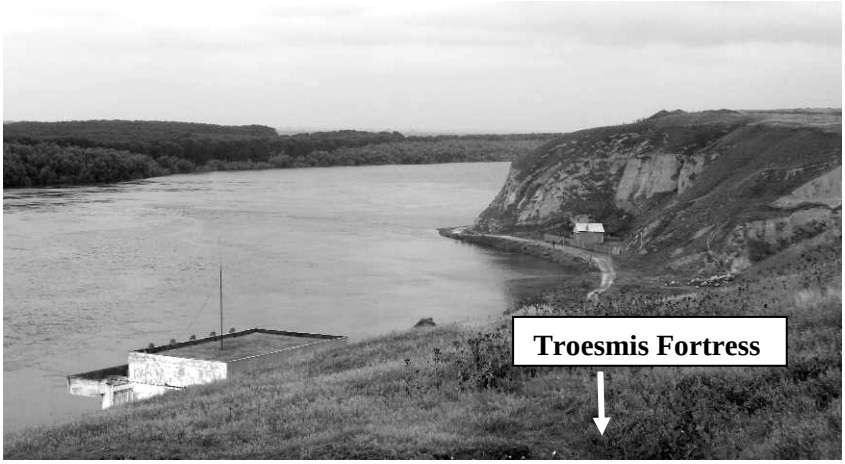

Fig. 3 ***The concave bank of Măcin Branch***

In the present study we followed the meander dynamics next to Troesmis fortress between 1912 and 2011. In this period, we noticed a predominantly migration of Măcin Branch meander to the East and North-East (Tabel 1).

Tabel. 1 ***The movement direction of Măcin Branch next to Troesmis Fortress***

Measurement period	Movemenet direction	Distance (m)
1912-1924	NE	43.88
1924-1942	E	11.73
1942- 1962	NE	24.23
1962-1971	NE	14.65
1971-1980	V	16.56
1980-1986	SV	23.78
1986-1989	NE	30.75
1989-1996	NE	61.78
1996-2000	SV	24.82
2000-2003	V	23.66
2003-2007	V	21.90
2007-2011	E	14.42
1912-2011	E, NE	90.72
1912-1996	E, NE	146.68

Between 1912 (information taken from the Austro-Hungarian maps) and 1971 (present situation from the Russian maps) the Măcin Branch migrated to the North-East, flooding Troesmis ruins (fig. 4).

In this period, an area of 4000 square meters of the existing geoarchaeosite was flooded. The most eastern point was reached by Danube in 1996, when the course migrated with 146,68 meters from its position in 1912 (Fig. 5).

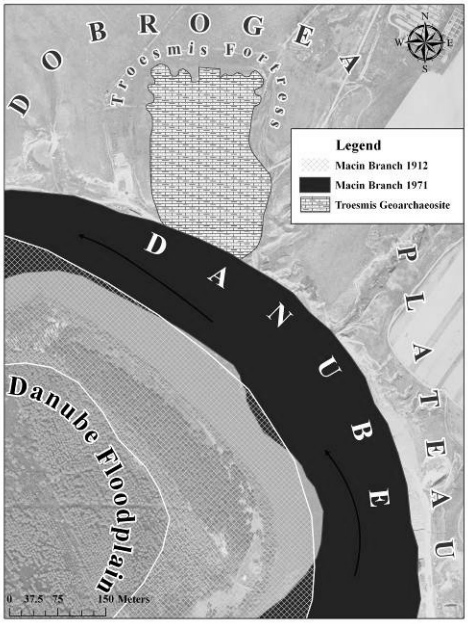

Fig. 4 ***Watercourse position in 1912 and 1971***

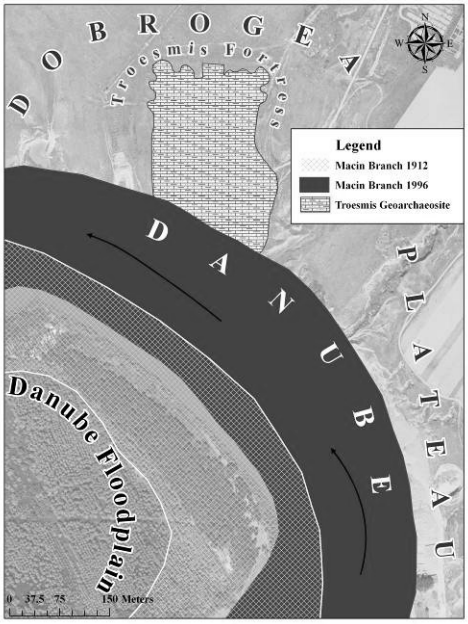

Fig. 5 ***Watercourse position in 1912 and 1996***

In the eighth decade of the last century the Măcin Branch withdrew to the West. This direction has been maintained until 1986. In the next 10 years Măcin Branch advanced around 90 meters to North-East. The fortress was flooded again on a surface of approximately 6000 square meters. After which, in the next 11 years (1996-2007) Măcin Branch has recovered 70 meters to the West.

Starting from 2007 until 2011 when we made the last GPS measurements, Măcin Branch migrated to the East with almost 12 meters. Thus, in about 100 years Măcin Branch has migrated about 90 meters to the Troesmis fortress (Fig. 6)**,** the easternmost course being reached in 1996.

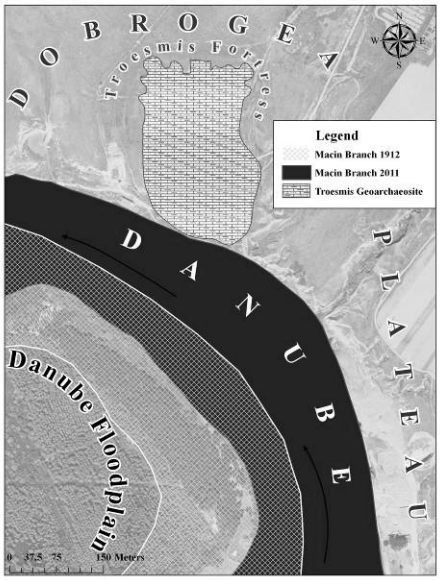

Fig. 6 ***Watercourse position in 1912 and 2011***

On average, in the 100 years, the rate migration of Măcin Branch to the East or North-East is 9 meters in 10 years.

The greatest average rate of watercourse migration to the East – North-East was about 15 meters in 10 years, between 1912 and 1996. Although it can be noticed that after 1996 Măcin Branch is moving to the West – South-West, the general migration tendence is towards East - North-East.

5. CONCLUSIONS

Following the meander evolution next Troesmis fortress in the last 100 years we have observed its migration to East – North-East, threatening the geoarchaeosite. According to the cartographic data obtained in the studied period (1912 - 2011), the current surface of Troesmis geoarchaeosite has been flooded two times.

In 1971, Măcin Branch flooded Troesmis fortress on a surface of 4000 square meters, while in 1996 of 6000 square meters. These regular flooding determine a sharp degradation of Troesmis ruins, so the site walls are destroyed and the space between them is open to sedimentation. In this case, the situation may become similar to Arrubium Fortress which was mainly destroyed due to the lateral erosion of Măcin Branch.

As a result of friable rocks which form the Danube floodplain, Măcin Branch migrated to the West and South-West between 1971 – 1986 and 1996 - 2007. Nevertheless, the overall trend of Măcin Branch migration in Ostrov - Măcin sector is to the East – North-East. In this case, the Troesmis geoarchaeosite is being susceptible to flooding which can led to its destruction. Thus, fluvial erosion and associated hydro-geomorphological processes can cause a sharp degradation of Troesmis geoarchaeosite. In the future is required a preserve strategy of Troesmis fortress.

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