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THE CITY-PORT OF HALMYRIS: AN INTEGRATED GEOARCHAEOLOGICAL AND ENVIRONMENTAL APPROACH TO THE LAST ROMAN BASTION ON THE EASTERN FLANK OF THE DANUBIAN LIMES

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Abstract. The last Roman City on the eastern side of the Danubian Limes is Halmyris. It is a City-port which plays a primordially military role, situated at the link between the fluvial and the marine environment. The fortress is famous for its location at the foot of the legendary Peuce Island. Halmyris benefits from important natural resources from two environments with distinct characteristics: marine (Halmyris Bay) and freshwater (Danube Delta). When the city was founded, the St. George arm was the most important navigation artery of Danube. Therefore, the penetration upstream was monitored strictly by the City-port of Halmyris (customs). This study emphasizes on the existence of natural favorable premises for the city of Halmyris and it attempts to revitalize thematic tourism. The assessment of paleoenvironment evolution and present conservation stage has been achieved to improve the risk management plan.

Introduction

The city of Halmyris is the last bastion situated on the Danubian Limes in the North-eastern extremity of Moesia Inferior and of Scythia Minor. Its location at the mouths of the St. George arm, led to the development of the

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military role first, and then, of the economic one. The Roman fortification, which represents the most important part of the site, covers 2.5 ha (210 x 180 m). It is an archaeological site with complex chronology: pre-Roman site (6^{th}-1^{st} centuries BC); civilian site (1^{st} century AD); earthen camp of the 1^{st} century AD (Vespasian); stone camp of the 2^{nd}-3^{rd} centuries AD; habitation level (between the end of the 3^{rd} century and the 7^{th} century AD). It was also contemporary with the Greek cities of Histria and Argamum, developed on the shore of the Halmyris Bay (which is today the Razim-Sinoe Lagoon System). Until the Roman-Byzantine period, the city functioned, and it has suffered multiple alterations throughout time. The extended civilian site was developed from the city westward, on the surrounding hills of the current village of Murighiol, and it is surrounded by a wall and a ditch. In the year 2002, the Episcopal basilica was discovered on the west from cardo maximus. It featured a martyr crypt comprising the remains of the Christian martyrs; Epictetus and Astion, martyred at Almyridensium civitas in situ (290 AD) (Suceveanu et al., 2003; Topoleanu, 2000).

The city of Halmyris is the first site on the Dobrudjan Danube for which the entire stratigraphy has been determined, from the base rock to the current vegetal layer on the roof. Fifteen habitation levels that have been perfectly identified archeologically and chronologically are documented as continual habitation from a modest indigenous site to the early Roman camp, and eventually to the Roman-Byzantine city (Topoleanu, 2000). The issue of the ancient name given to the city has stirred its fair share of polemics (Suceveanu & Zahariade, 1987). *The Antonine Itinerary* mentions the localities of Salsovia, which is, 17,000 steps (25,143 km) away from Aegyssus, and Salmorus which is also, 9,000 steps (13,311 km) away from Salsovia, that coincides with the city of Murighiol. Epigraphic evidence shows beyond doubt that the city of Aegyssus was located in modern-day Tulcea and Salsovia in modern-day Mahmudia, which leads to identifying the Murighiol ruins with the ancient city of Halmyris, whose Latin name was Salmorus, but also, Thalamonium in the subsidiary (Topoleanu, 2000). The same topographic sequence is also encountered in Notitia Dignitatum Orientis, a document that features the distribution of troops on the Danubian border of Scythia Minor. Subsequent sources use the Greek version of Halmyris (Philostorgios, an author who lived in the 5^{th} century AD; Hierocles and Procopius, 6^{th} century AD; part of news transmitted by Notitia Episcopatum in the 8^{th} century AD). Thalamonium was proven as a corrupt version of Halmyris. The placement of Gratiana at Murighiol and Halmyris at Dunavatu de Jos (the city of Zaporojeni) represents a methodological error. At Dunavatu de Jos, a 53 m x 40 m burgus was discovered, but it was far too small to have harboured the city of Halmyris. As

for Gratiana, named after Emperor Gratian (367-383), it must have been founded in that period or renamed in the 4th century AD, which excludes it as a viable option, because all the cities east from Aegyssus, preserved their ancient names. Admitting that Thalamonium represents a corrupted version of Salamorium (Salmorus, Halmyris), and that Halmyris cannot be pinpointed at Dunavatu de Jos neither Gratiana at Murighiol, its results show that Murighiol can only represent the ancient city of Halmyris. This is actually only a confirmation of an older theory, which can only be proven by discovering an explicit epigraphic document (Suceveanu & Zahariade, 1987; Topoleanu, 2000; Suceveanu et al., 2003).

Information related to the existence of the archaeological site must be corroborated with the information available on the Danube Delta, the Black Sea, and the legendary Greek island of Peuce. The existence of this city must also be analysed in the context of landscape dynamics in the ancient times. Numerous specialists have studied the north-western sector of the Black Sea and the entire Mediterranean basin in the Greek and Roman period (Avram, 1990; Höckmann et al., 1997; Tsetskhladze, 1998; Demirbag et al., 1999; Cordova & Lehman, 2003; Bounegru, 2004; Haimovici, 2008; Hansson & Foley, 2008; Knappett et al., 2008; Retallack, 2008; Angelescu & Botez, 2009; Lungu, 2009; Luca, 2010; Turner & Crow, 2010; Keenleyside et al., 2011; Carozza et al., 2012; Allenbach et al., 2014; Farci, 2016). From a geologic and geographic perspective, numerous books and papers have been published regarding the evolution of the Danube Delta, of the Black Sea, and the repeated transgressions and regressions throughout various historical periods (Friedman, 1961, 1967; Feodorov, 1971; Stanley & Blanpied, 1980; Romanescu, 1996, 2013a, 2013b, 2014; Ryan et al., 1997, 2003; Ryan & Pitman, 1999; Ballard et al., 2000; Görür et al., 2001; Giosan et al., 2005, 2006; Dolukhanov & Arslanov, 2009; Dolukhanov et al., 2009; Giosan et al., 2009; Romanescu & Bounegru, 2009; Stanley & Toscano, 2009; Brückner et al., 2010; Soulet et al., 2011; Carozza et al., 2012; Mierla et al., 2015; Romanescu et al., 2015; Aragonés et al., 2016).

The main purpose of this study is to underscore aspects that relates to the natural environment, which also favoured the foundation of the Halmyris City at the mouths of the St. George arm (Danube Delta), in order to revitalize thematic and religious tourism management in the study area. These conditions are also highlighted by the political and economic climate of those times. Physical and geographic parameters are analysed in the light of the new investigating technologies: remote sensing (LiDAR technology) and geoarchaeological survey (topographic maps, orthophotos, geologic analyses, climatic and hydrologic data).

Study area – an overview of the geological and geographical setting

The city of Halmyris is situated at the boundary between the Danube Delta and the Dobrudjan mainland (fig. 1a), which is represented by the Tulcea Hills and the Bestepe Hills, which dates back to the Triassic and Jurassic and are dominated by limestone-rocks, modelled by external factors. These landforms were transformed into a residual type of landform, consisting of inselbergs and pediments, reduced to the pediplanation stage (Romanescu & Bounegru, 2009) (fig. 1b). The lower, eastern extremity of the Bestepe Hills is also known as the Dunavat Hills. At their feet, the city of Halmyris is situated. The Beibugeac corridor, that is, the former maritime and then, the lagoon bay, is positioned between the main alignment of the Bestepe Hills and the Dunavat Hills. It is connected to the localities of Murighiol (toward the St. George arm) in the north-eastern sector and of Sarinasuf (toward the Razim Lagoon) in the south-western sector (fig. 1c). It is 10 km long and 1-2 km wide on the average. In the central sector of the corridor, there are lakes with slightly salinized waters, which have been declared strictly protected areas from the landscape perspective. The asymmetrical pediments of the Dunavat Hills continue toward the Danube Delta, the Razim Lagoon, and the Beibugeac corridor areas. They are modelled by seawaters, thus, turning into a 1-3 m high terrace, highlighted in the Murighiol area (the city of Halmyris) and at Dunavatul de Jos (Romanescu et al., 2015).

The city of Halmyris is situated between the localities of Murighiol to the west and Dunavatul de Sus to the east, near the road connecting Dunavatul de Jos to the Tulcea town. In the northern sector, it actually opens toward the current drained floodplain of the St. George arm, where the shapes of Murighiol and Cruhlicul Mare lakes are outlined (Lake Cruhlicul Mic has been completely drained). In the southern sector, the dome-shaped Murighiol Hills (maximum 64 m high) are visible, while the 52 m high Dunavat Hills are situated in the east. The Dunavat Hills have a relatively prominent (compared to the flatness of the surrounding area) and rocky landform. Rendzinas and the somewhat colder climate during antiquity, favoured the emergence of pinewoods (*Pinus maritima*), which, led to the name Peuce given to the island (*Peuce* means *pine* in Greek) (fig. 1d). Their disappearance may be caused by the numerous steppe-like surfaces in Dobrudja, which do not benefit from significant wood reserves. Trees were cut down for multiple uses (combustible, shipbuilding, house construction, and so on); therefore, the current forestation degree is very low. The only remaining forests are shaped as galleries along the arms or the channels, and they comprise mainly poplars and willow trees.

The hardness of the rocks making up the city foundations, the smooth slopes of the surrounding hills, the relatively thin layer of loess, and the lack of

Figure 1. The geographical location of Halmyris Fortress in: (a) Romania; (b) on the territory of the Danube Delta and Razim-Sinoe Lagoon System; (c) on the current shore of the Black Sea equivalent to the ancient Halmyris Bay; (d) within the Peuce Island.

rain, failed to create proper premises for the site to be destroyed by gully erosion or landslides (the case for most sites in higher areas in Romania) (Romanescu, 2013a, 2013b). In exchange, deflation, which is favoured by strong NE-SW winter winds and by the "bold" areas (during most winters, the snow layer is absent) has played an important role in sediment-covering (Romanescu et al., 2015). The aggrading of the land surrounding the city was extremely fast because Danube floods and wetland vegetation contributed to a thick layer of both inorganic and organic materials. The development of hygrophilous vegetation around the city is also favoured by the presence of phreatic water near the surface (depending entirely on the Danube level) (Romanescu & Cojocaru 2010).

Methodology – geoarchaeological approach and remote sensing survey

For the landform within the city of Halmyris, field measurements were taken using LEICA GPS 1200 (made of a reference station and a rover), a hand-held droned flight machine and LiDAR technology (Mihu-Pintilie et al., 2016; Megarry et al., 2016; Wagstaff et al., 2016) (fig. 2a). GPS is more efficient because measurements are faster to take; therefore, it is possible to choose several points. The measurements were taken in 2012, 2015, and 2017. Ground control points were obtained from the National Agency for Cadastre and Land Registration Tulcea, because the area in question is included in the maximum deformation zone of STEREO-70 projection (42 cm/km). Three sets of coordinates were used for reducing errors to a minimum.

Measurements debuted with the ground control point of Murighiol Hilltop (fourth order) situated on the right side of the Murighiol - Dunavatu de Sus road (STEREO 70 coordinates: X - 829557.190, Y - 399931.392, Z - 63.620 m; geographic coordinates: 45°01'19.8226" N, 29°10'58.7113" E). The ground control point of Dunavatu de Sus (third order) is situated on the Dunavat Hilltop (STEREO 70 coordinates: X - 832509.150, Y - 399889.898, Z - 51.070 m; geographic coordinates: 45°01'13.4819" N, 29°13'13.1911" E), while the Movila Duna point (fourth order) is on the right side of the Tulcea – Murighiol road, before entering the Murighiol village (STEREO 70 coordinates: X - 825675.736, Y - 401931.418, Z - 45.510 m; geographic coordinates: 45°02'30.9998" N, 29°08'6.4451" E). In order to generating the LiDAR model, 3,765 points were measured with LEICA GPS 1200.

The series of thematic maps based on digital elevation model (DEM) were done in GIS by creating a geo-database using the ArcGIS v.10.2 software (Al-Ruzouq & Abu Dabous, 2017) (fig. 2b & 2c). The scanned maps were georeferenced in the cartographic projection system WGS 1984, UTM Zone

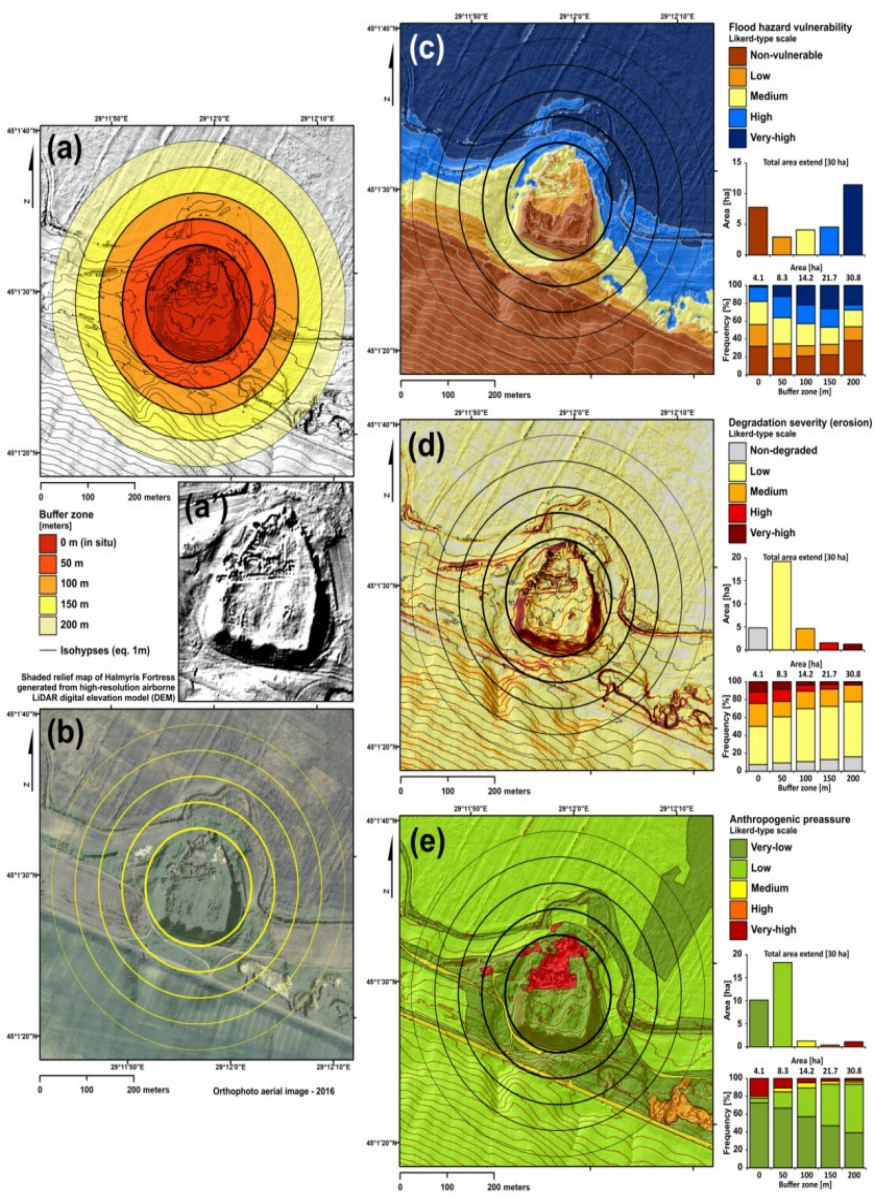

Figure 2. Present morphology of the archaeological site: (a) DEM made using LiDAR technology; (b) slope map; (c) curvature map; (d) 3D model.

35N. The following geographic elements were vectored: the city site, the area within city limits, the limits of lakes, the hydrographical network, the isohypse, the reedbed area, the vector projection of the topographic profiles made using the GPS, and so on. Attribute tables were elaborated for each vector thematic layer for the classification and elaboration of the DTM and 3D model (fig. 2d). The final layouts led to exporting images in *.tif*. The analogue cartographic materials used for the geo-database are as follows: the topographic maps at 1:5,000 scale (ed. 1984) and orthophotos (ed. 2015).

Besides the extremely rich geologic, geographic, archaeological and cartographic bibliographic materials, maps were also studied. These maps were elaborated by certain travellers who determined a position – based on their own research or on collected information – for the city of Halmyris and the surrounding area. A special attention was given to researching the deltaic area, which also stimulated the highest number of studies in the field and which favoured the emergence and development of the Halmyris City. The grain size analyses conducted for superficial deposits also helped to decipher the origin and effluence of the deposited material (Freire, 2014; Leshikar, 2010; Westley & Dix 2006).

Results and discussions

Conservation stage in context of paleoenvironment evolution

The emergence of the city is related to the importance of the place, it is therefore entailed by several aspects, as follows: the contact between the continental mainland and the deltaic environment, the mouth of the most important hydrographical artery in eastern Europe (the Danube through the St. George arm), the legendary Peuce Island, the vicinity with the limestone quarry of Mahmudia, the existence of pine forests, the existence of a deep gulf (Beibugeac corridor) that facilitated the contact between the Halmyris Bay (of the Black Sea), and the deltaic space. The Dunavat Peninsula, which is connected to the continental mainland through an extremely narrow isthmus was previously considered an island because of erroneous information caused by local topography, mostly marine (comprising gulfs and salt marshes). Ancient Greeks founded settlements only near shores. The continental mainland always remained a terra incognito, thus, they rarely reflected within maps (except for regions bearing a strategic importance). The upstream sector of the Danube is remembered only for the existence of the boat bridge built by Darius in the narrowest sector, at the level of the Noviodunum City (modern-day) (Romanescu et al., 2015).

The city had a military and strategic role for dominating the Danube and the sea commerce implicitly. The economic role was a secondary one, because the continental natural resources were scarce. The mouth of the St. George arm, the Beibugeac corridor (connecting the delta to the Halmyris Bay), and the dome-shaped hills in the Peuce Island (Dunavat Peninsula) represented strong points throughout the existence of the Halmyris City (fig. 3a). The military control was perfect on the land (isthmus), the river (total control of the arm), and the sea (control of the Halmyris Bay and of the Black Sea coast, implicitly).

The St. George arm, the most southern and the most important of the ancient period was known as the Peuce Mouth, the Holy Mouth (Stoma Peuke – Peuce), the Sacrum Ostium, or the Hieronstoma. The mouth reached the extreme eastern point of the Dunavat Peninsula (Peuce Island) around 1,000 years ago. The hypothesis is based on the existence of toponyms such as Ad Stoma (At the Mouth) or Stoma Peuce (The Peuce Mouth) mentioned by Strabo and Ptolemy, and which designate the former locality of Dunavatul de Jos (Romanescu et al., 2015). The Beibugeac corridor, developed between Murighiol and Sarinasuf, was a smaller gulf part of the great Halmyris Bay (*myris* – water; *hal* - salt), positioned deep toward the deltaic sector (Suceveanu et al., 2003; Romanescu, 2013a, 2013b). During the Climatic Optimum, this corridor reached its peak extension, comprising the most apparent separation of the Dunavat Peninsula, which became a large island. The corridor clogged due to continental alluvia deposit that was transported by streaming, sheet and wind erosion (Romanescu et al., 2015).

The existence of the Beibugeac corridor connected to two water bodies

with different characteristics together (Halmyris Bay with salt waters, St. George arm, deltaic area with freshwaters), which eventually prompted the construction of the city in its immediate vicinity. The morphology of the Beibugeac corridor is identical to the one of a fluvial or maritime arm, which subsequently clogged together by the alluvia deposit that was transported by sheet erosion on the slopes or accumulated by wind. The altitudes in the centre of the corridor are higher than the current level of the Black Sea or of the topographic surface within the Danube Delta. Geologic data have proven the lack of fossils. Therefore, river bed aggradation is exclusively due to the continental contribution. The existence of 5-6 m altitudes in the north-eastern sector, near Murighiol, is due to the action of the wind, which repositioned the material, reshaping it as dunes. Hence, the isthmus was buried underneath the deposits, measuring a couple of metres in thickness.

The position of the Halmyris City on the right bank of the St. George arm, downstream from the north-eastern entrance of the Beibugeac corridor indicate the importance of this area from a geo-strategic and commercial perspective

(fig. 3b). The military garrison of Halmyris, organized as a port, ensured entrance to and exits from the Danubian space toward the Black Sea and vice versa. The city is placed on the extreme northern and eastern limes. Actually, it was the last bastion at the eastern frontier (fig. 3c). At the same time, trade was also done on the Beibugeac corridor, because it was possible to transport merchandises over the isthmus, in both directions (fig. 3d). The region on the side of the Halmyris Bay was monitored by the military fort located at Dunavatul de Jos (fig. 3e).

The existence of the mouth of the St. George arm near the Beibugeac corridor determined the placement of the city on the marine terrace dug into the rock of the Murighiol pediment. Arguments favouring the existence of the mouths near the Dunavat Peninsula include the absolute ages determined for the deposits within the Danube Delta, the zone between the initial coastal barrier (Caraorman) and the Dunavat foreland (Ad Stoma) is 2,100 years old at the most (Giosan et al., 2005, 2006). Therefore, the Peuce Mouth (Stoma Peuce) was located at the level of Dunavatul de Sus. The St. George arm (or Peuce) was also the most important one for navigation, because it was the first deltaic arm encountered by the Greeks or Romans who came from the Mediterranean Sea. Furthermore, the St. George arm was extremely important because all the Greek and later the Roman cities were built on the northern branch of the Dobrudjan Plateau, which is adjacent to the Danube Delta and to the Hamlyris Bay (fig. 3f). The location of the Halmyris City corresponds perfectly to the distances chosen by ancient Greeks for observation and signalling (Romanescu, 2014). Therefore, the Roman camp of Dunavatul de Jos represents an important point for observation and signalling in the marine environment (fig. 3g & 3j).

The city of Halmyris is situated between two large meanders that required the boats to slow down in order to follow the proper navigable channel. In this case, control was significantly facilitated because boats came up or went down at low speed, after crossing the old, meandered path of the St. George arm (Romanescu, 1996). The strong meandering of this arm is due to its age and, therefore, to its very reduced slope. Until the finalization of partial channelling (1985-1990), the St. George arm had the highest meandering degree. After the channelling, the navigable stream dropped from 108 km to 70 km. The result was that 38 km of channels cut through the great meanders in order to facilitate navigation (Romanescu, 1996, 2014). In this case, distance was extended, slope increased, water speed augmented, riverbed deepened, and water volume increased to the detriment of upstream sectors, the Chilia and Sulina arms (Giosan et al., 2005, 2006).

A very important role in the placement and development of the city was represented by the Beibugeac corridor, which had a waterway in the Razim

Lagoon, toward Histria and Argamum, and another toward the St. George arm (an important communication path toward the continental inland). The continental connection between the Peuce Island and the continental mainland

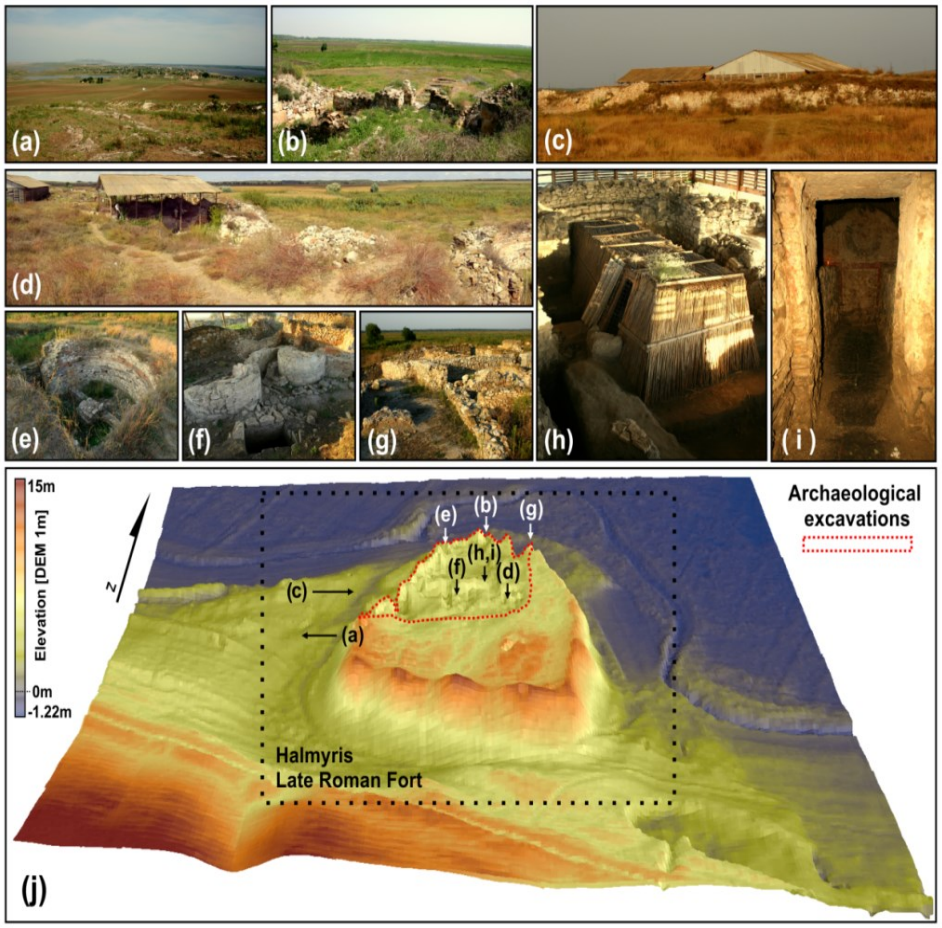

Figure 3. Inside the excavated area: (a) view to the Beibugeac corridor; (b) north gate; (c) byzantine structures – view from outside of fortress; (d) internal limestone structures; (e) tower gate; (f) roman thermae (lavacrum); (g) defense wall; (h) inside of the Christian basilica; (i) the painted crypt of St's. Epictetus and Astion; (j) 3D model with location of photos and excavated area.

was insured by an extremely narrow isthmus, with low altitudes (between the Murighiol locality and the Murighiol Hill), which was subsequently covered by

materials transported from slopes by sheet erosion or brought along by the wind (with a dominant NE-SW direction) and deposited as dunes (Romanescu et al., 2015). In the ancient period, the Peuce Island represented a reference point for the penetration of the Greek civilization in the Black Sea. It was connected to an extremely narrow isthmus. The colonization of such an island and its fame represent development premises for any human settlement in its vicinity. In any case, the Greeks would have chosen such a placement only if it brought important military or economic benefits. The model taken over by the Romans only consolidates this supposition.

The emergence of a city at the limit between two environments with distinct characteristics was favoured by two types of resources: of the saline environment (the Black Sea, the Razim Lagoon) and of the freshwater environment (the St. George arm and the Danube Delta per se). The saline environment contributes to fish production (the amount is not spectacular, but the quality is high). The freshwater environment comprises a specific and abundant fish fauna, as well as wetland-specific vegetation (reed, bulrush, osier, and so on).

The current path of the St. George arm is more northern than that of the Roman period. The foundation of the Danube Delta has a slight and continuous inclination toward the north, which also determined, actually, the three arms to deviate slightly in the same direction. For this reason, the Chilia arm - the most northern one is the youngest and the largest of the Danubian arms. This deviation set the city-port of Halmyris away from the arm per se.

The continental resources in the immediate vicinity of the Halmyris City are extremely scarce, due to the geologic substrate and to the tough climate (Finné et al., 2011). Precipitation level is very low (450-500 mm), considering that pouring rains are frequent. Soils are productive only if irrigation is applied.

Therefore, because there were no irrigations in the ancient period, these fields were not valued very much from an agricultural perspective. The most important resources were provided by the aquatic environment and by the deltaic space situated in the immediate vicinity. Underground resources have always been exploited only in the southern sector of the Razim-Sinoe Lagoon System, near other Greek and Roman cities. The value of construction rocks is noteworthy (especially limestone) and clay for pottery. The only limestone quarry in the area that is still exploitable nowadays is the one in Mahmudia (10 km away from the city of Halmyris).

The current exploitation of the Halmyris City consists of the transited tourist flow, mainly during the summer, and during the season for The Danube Delta Biosphere Reserve. Dobrudja is the region that records the highest number of summer tourists in Romania. Even the tourists that come to the Black

Sea coast choose to have one or two-day trips in the north of Dobrudja, for visiting the Danube Delta and the cities on the Danubian Limes or the Razim-Sinoe Lagoon System. In this case, tourists can visit the area by land or by water (Finné et al., 2011; Romanescu et al., 2012).

Tourism may be developed if the area is prepared to accommodate religious travellers. Within the city of Halmyris, the oldest records of Christianity on the Romanian territory were discovered (fig. 3h). The crypt within the city comprises the in situ remains of the Christian martyrs Epictetus and Astion that were martyred at Almyridensium civitas in AD 290 (Suceveanu et al., 2003; Topoleanu, 2000) (fig. 3i). Unfortunately, the remains were later transferred to the Constanta Metropolis.

Assessment of present conservation stage and risk management

The aim in archaeological perimeters should be consistent with international standards for the management of archaeological sites and the conduct of archaeological research. These objective must be adequate to the additional demand of preservation of archaeological sites and materials in situ, and intended for public scrutiny. From this perspective, the Halmyris Fortress is recorded in the National Archaeological Record of Romania (RAN Code 160920.02), and in the List of Historic Monuments of Romania (LMI Code TL-I-s-A-05844). The main features of the Halmyris Fortress and the ancient harbor are described in table 1. The detailed list of archaeological discoveries in the excavated perimeter is given in table 2.

However, the conservation of the archaeological sites is a complex scientific approach and must involve more advanced risk assessment methods. From this point of view, the quantification of anthropogenic impact and the hydro-geomorphological processes which degrades the topographic surface inside the archaeological perimeters and causes irreversible damage must be a priority for the management plan. In this context, for evaluations of the present conservation stage inside of Halmyris Fortress and surrounding area a GIS method developed by Mihu-Pintilie et al., (2016) was applied.

The analysis of natural and anthropogenic hazards was carried out within several buffer zones with 50m equidistance, having as a central element the roman fortress because the degradation severity decreases from the inside to the outside of site (fig. 4a & 4b). Three risk maps were generated: flood hazard vulnerability map (fig. 4c), degradation severity (erosion) map (fig. 4d), and anthropogenic pressure map (fig. 4e). The descriptive statistics of affected areas corresponds to the inside perimeter of the site and buffer zones of 50m, 100m, 150m, and 200m.

The flood hazard map based on LiDAR 3D model (1 m resolution) and on the interpretation of current hydro-morphological processes, highlights sectors below Black Sea level (Very-high vulnerability class) and the areas between 0 – 2 m altitudes (High vulnerability class). In these perimeters a strong flood of the Sf. Gheorghe Arm can destroy or cover with sediments the harbour area, part of the defence trench, and the northwest wall. However, most of the site area is protected from floods, which also indicates the harbour function of the Halmyris Fortress in the ancient times (fig. 4c).

Table 1. The main features of Halmyris Fortress and the surrounding area in the present time according to RAN* and LMI**

Site information	**Description**
RAN Code*	160920.02
LMI Code**	TL-I-s-A-05844
Name (in Romanian)	The Fortress of Murighiol [Halmyris] - At the fortress (Cetatea de la Murighiol [Halmyris] - la Cetate)
County / Commune / Village	Tulcea – Murighiol – Murighiol
Landmark	At 2 km SE from the village (Murighiol) and 200 m N from the Murighiol – Dunavatul de Sus highway; 1.5 km S by St. George's Arm.
Land use	Agricultural land
Ownership	Public
Owner	Tulcea County Council
Site class	Civic dwelling (Ancient and Byzantine)
Site type	Fortress
Site surface	3 ha
State of preservation	Good (last record update – 21.02.2017)
Natural hazards	Earthquake, floods, natural fire, excess of water in soil, erosion, deflation, biogenic activity of wild animals.
Anthropogenic preassure	Demolition and rock extraction, treasure hunters, vandalism, fires caused, pasture and related agro-technical activity.

*RAN – National Archaeological Record of Romania
**LMI –List of Historic Monuments of Romania.

The degradation severity map has been achieved by mapping the present geomorphological processes – surface erosion, linear erosion, and slope gravitational processes, and anthropogenic interventions – archaeological excavations and traces of intensive grazing. For the digitization of the thematic layers were used as cartographic support the DEM LiDAR model, orthophotos

(ed. 2015), and aerial photographs – vertical and oblique. For each erosional process the vector layers were rasterized – ArcGIS – Raster Interpolation function, and classified using the ranking method – ArcGIS – Map Algebra Function, with scores between 0-5 (0 – null; 1 – non-degraded; 2 – low; 3 – medium; 4 – high; 5 – very high) (Mihu-Pintilie et al., 2016).

Table 2. Description and state of preservation of archaeological finds in the Halmyris Fortress and the surrounding area according to RAN* and LMI**

Class / Type	**Period (Date)**	**Culture**	**Description / Notes**	**Code****
Stronghold	The Roman-Byzantine period (2nd – 7th Chr.)	Unspecified	The Roman-Byzantine fortress of Hamlyris has 16 towers, a paleochristian basilica with crypt, the Roman thermae and the fortress port located on the eastern side (between T1–T6).	TL-I-m-A-05844.01
Fortification	The Greek period (4th BC – 1st Chr.)	Hellenistic	-	TL-I-m-A-05844.01
Civic dwelling	Roman period	Unspecified	-	TL-I-m-A-05844.02
Necropolis	The Greek-Roman period (4th – 7th BC)	Unspecified	-	TL-I-m-A-05844.03
Paleochristian basilica	The Roman-Byzantine period (4th – 7th Chr.)	Roman-Byzantine	Paleochristian basilica with the painted crypt (where the relics of Christian martyrs Epictet and Astion were discovered). Restoration works are required.	-
Thermae (lavacrum)	The Roman-Byzantine period (4th – 7th Chr.)	Roman-Byzantine	Thermae in good state of preservation. Restoration works are required.	-

*RAN – National Archaeological Record of Romania
**LMI –List of Historic Monuments of Romania.

According to degradation severity model > 10% of the analysed area (> 30 ha) is affected by soil erosion and gravitational processes (Very-high vulnerability class) (fig. 4d). The most affected perimeters are inside of the archaeological excavations and on the surface of the outer wall due to the large slope. Also, the anthropogenic pressure increases erosion processes due to intensive grazing or through the extraction of building materials within the site area (fig. 4e).

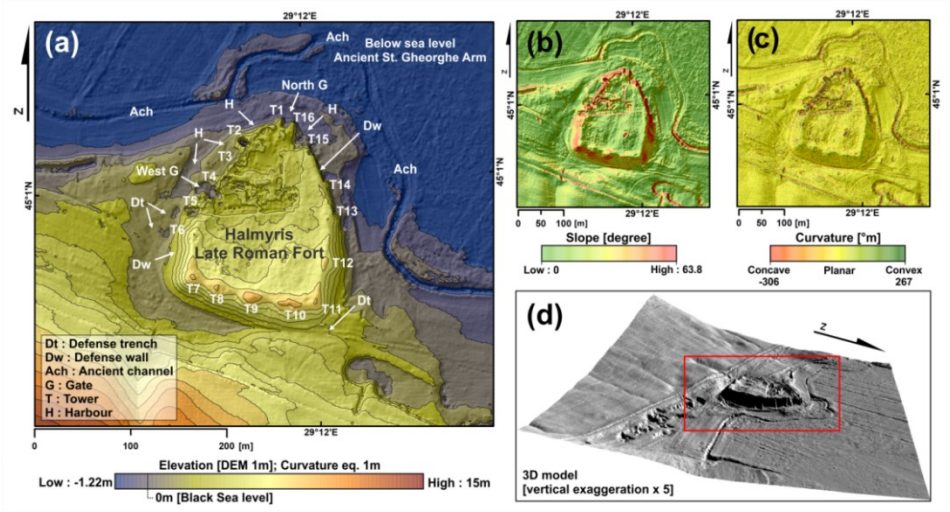

Figure 4. GIS methods applied for assessment of natural hazards and anthropogenic impact (Mihu-Pintilie et al., 2016) which affect the Halmyris Fortress in present-day: (a) Buffer zone (50 m) used for assessment of complex risk inside of archaeological site and surrounding area - (a') in the lower square the DEM resolution and the scale of work are highlighted; (b) Orthophoto aerial image (ed. 2016) used for identification and digitization of anthropogenic preassure; (c) Flood hazard vulnerability map; (d) Degradation severity (erosion) map; (e) Anthropogenic pressure map and descriptive statistics for (c), (d) and (e).

Conclusions

All the Roman cities of Dobrudja are situated on the right shore of the Danube. The last city in the eastern Empire is situated at the mouth of the St. George arm in the Danube Delta, at the foot of the legendary Peuce Island (in the north). The main role of the city-port is military. The continental natural conditions are not favourable, mostly from a climatic perspective (lack of precipitations due to the influence of continental climate with excessive nuances).

The city of Halmyris benefitted from a special strategic position: the mouth of the important Danube arm (St. George), the placement at the contact between two environment with distinct characteristics (marine - Halmyris Bay; freshwater - Danube Delta and St. George arm), the placement at the northern contact of the Beibugeac corridor, as a connection between the Halmyris Bay and the Danube Delta, the placement on the northern facade of one of the most

important island of the ancient Greek world (Peuce Island), easy connections to the old urban settlements in the immediate vicinity of the Black Sea coast, construction materials (limestone) nearby (Mahmudia), morphography suitable for long-distance observations (the Dunavat Hills), and the policy of dominating a navigable stream of European importance. The city of Halmyris is known in the European history as place of the earliest Christian martyrs on the Romanian territory: Epictetus and Astion, martyred at Almyridensium civitas in 290 AD. From this perspective, a very important branch of religious tourism (local or general) can be developed. Unfortunately, the remains of the two martyrs were taken to Constanta, the most important city in Dobrudja. For this reason, a pilgrimage to the crypt of the two martyrs is practically pointless. From the perspective of sustainable conservation of Halmyris Fortress, we believe that a risk management plan needs to be developed. The flood hazard, degradation severity and anthropogenic pressure maps can be used to quantify the vulnerability and may underlie the actions of rescue and / or preserving of the tangible cultural heritage.

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