JOURNAL OF ANCIENT HISTORY AND ARCHAEOLOGY

Institute of Archeology and Art History of
Romanian Academy Cluj-Napoca
Technical University Of Cluj-Napoca

# Journal
## of Ancient History and Archaeology

DOI: http://dx.doi.org/10.14795/j.v8i3

ISSN 2360 266x

ISSN–L 2360 266x

No. 8.3 /2021

# CONTENTS

## STUDIES




Design & layout:
Petru Ureche

# Studies

## ARCHAEOLOGICAL TOPOGRAPHY

# THE INTERACTIVE DIGITAL MAP - A MODERN APPROACH FOR ARCHAEOLOGICAL HERITAGE MANAGEMENT

**Constantin Viorel MARIAN**
"Politehnica" University, Bucharest
constantinvmarian@gmail.com

**Mihaela IACOB**
"Dunărea de Jos" University, Galați, /
ISACCL, Bucharest
iacobm9@yahoo.com

**Nicolae GOGA**
"Politehnica" University, Bucharest /
University of Groningen
n.goga@rug.nl

DOI: 10.14795/j.v8i3.655
ISSN 2360 – 266X
ISSN–L 2360 – 266X

**Abstract:** The paper presents one of the main products of the ArchTerr project "Integrated management of archaeological heritage: archaeological map and administrative procedures for heritage research and protection". The project is funded by UEFISCDI following the collaboration of two scientific research centers, "Dunărea de Jos" University of Galați and "Politehnica" University of Bucharest.
The aim of this scientific paper is to present the main product of the above mentioned project, the interactive digital map of the historical archaeological heritage with geospatial information (Geographic Information Systems GIS).
The paper presents the national context that generated the need to develop such a computer application, some European archaeological heritage records models that could be used as examples to follow and the achievements in this field in Romania. The new functionalities introduced by the interactive digital map developed within the *ArchTerr* project are: polygonal representation of any archeological site surface, representation of its protection area (when the site is also a historical monument), representation of researched areas using preventive archaeological methods, the representation of the archaeological discharged areas inside a site (following the preventive archaeological research). Regarding the efforts to protect the archaeological heritage, we mention the daily activity usefulness of this map for a wide range of users: county directorates for culture; urban planning services (within city halls and county councils); cadastral offices; real estate agencies; any person who intend to ask for a building permit inside an archaeological heritage protected area.
At *www.archterr.ro* it could be found the fully functional interactive digital map.
**Keywords:** *archaeological historical heritage, GIS, archaeological site, interactive map, geospatial representation, archeological heritage records keeping, accounting and monitoring.*

### INTRODUCTION

The interactive digital map of the archaeological heritage is one of the products of an experimental-demonstrative project: "Managementul integrat al patrimoniului arheologic: harta patrimoniului arheologic și procedurile administrative de protejare a patrimoniului archeologic" acronym ArchTerr, project funded by UEFISCDI under the "Planul Național de Cercetare, Dezvoltare și Inovare 2015 2020, PN III, Program P2, Creșterea competivității economiei românești prin cercetare, dezvoltare și inovare, Subprogramul 2.1. Competitivitate prin cercetare, dezvoltare și inovare - Proiect experimental-demonstrativ".

The project, carried out by the University "Dunărea de Jos" University of Galați in partnership with the "Politehnica" University of Bucharest between November 2020 and October 2022, aims to make a permanent working tool available to those who manage information and potential issues related to archaeological heritage in territory, mainly the county directorates for culture. The proposed tool is a digital application with a web interface that will allow the storage of all archaeological heritage information available at territorial administrative unit level (county, city, commune) in a database interconnected to an interactive digital map. As new data is gathered, the information will be constantly updated and can be searched using complex queries, based on different criteria. Finally, a set of unitary procedures, applicable to the decentralized public services of the Ministry of Culture, as a tool for implementing the normative acts in force for archaeological heritage protection, will be added.

The first two deliverables are useful to local public authorities, cadastral offices, real estate advertising agencies, police (especially heritage police), public and private beneficiaries interested in carrying out investments in archaeological heritage protected areas, archaeologists and all those interested in the study of archaeological sites (given the fact that specialized information will be constantly updated).

Our approach involves a model that propose an integrated view of evidence and archaeological heritage protection, adapted to the way in which the management of cultural archaeological heritage is understood at European[1] level in countries such as: France[2] (the archaeological map), Italy[3] (the archaeological risk map), Greece[4] (the archaeological cadaster), England[5] (the map of historical heritage), etc.

During the design and implementation of the experimental-demonstrative model of archeological heritage evidence and management, we took into account the technology transfer from (the fields of) computer science, communications, topography, photogrammetry to (the field of) archaeological heritage. The situation of the patrimony evidence at national level was also taken into account, the discrepancies that exist from one county to another (thus the reason to select three pilot counties to experiment the digital product: Constanța, Covasna, Galați). Only after verifying the reliability, adequacy and efficiency of the product in these counties, it will be possible to move to the next stage, a finished product, ready to be installed and used by any institution with responsibilities to protect and monitoring the archaeological heritage.

In following chapters, we will describe one of the projects' deliverables, namely the archaeological heritage interactive digital map, which will be presented from the perspective of the information contained and the technical ways to implement it.

## STATE OF THE ART

The ArchTerr project starts by identifying a strong need for local and central public institutions (with a role in the management and protection of the archaeological heritage) obliged to cope with investment development trends and awareness, at international and national level, of the fact that the archaeological heritage, as part of the cultural heritage, is a non-renewable resource of national identity, vulnerable to these trends. This situation has imposed, at international level, the need for legislative regulation and for instruments to meet the two trends: on the one hand the protection of the archaeological heritage and on the other hand, the natural development of contemporary society. This could be achieved by imposing rules and steps to follow, so that a certain balance, a modus vivendi, is created between the two tendencies.

At European level, the first regulatory attempts concerning the national cultural heritage protection (including the archaeological heritage) date from the 18th century, but only starting from the 19th century we can talk about creation of dedicated institutions effectively involved in archaeological heritage evidence and protection.

Romania has also joined this trend, the first regulation related to the protection of the built heritage appears as a result of the establishment, by Decree no. 1649/1864, of the Archaeological Committee of Romania, „Comitetul Arheologic din România[6]", and the first record / primary inventory of the archaeological heritage was made through the archaeological questionnaire „chestionarul arheologic" written by Al. Odobescu and sent to the teachers with the invitation to provide data about the existence of historical vestiges in the villages where they worked. Based on the 1600 responses received, Al. Odobescu wrote the archaeological repertoires of Dorohoi și Romanați[7] counties. Odobescu's efforts were continued by Gr. Tocilescu, who, through the work "Fouilles et recherches archéologiques en Roumanie" (București, 1900), mapped over 60 Dacian and Roman settlements and monuments; at the same time, through the activity carried out by Pamfil Polonic, an impressive number of camps and fortresses from Oltenia and Dobrogea[8] were registered topographically. At the same time, in the Romanian provinces of Bucovina and Transilvania we are witnessing attempts to map and create an inventory of historical sites and monuments, so that the efforts in the Romanian and extra-Carpathian provinces are chronologically presented as follows:

- the first archaeological repertoires in Transilvania written by de Karl Goos (1879), Iulian Marțian (*Archäologisch-prähistorisches Repertorium für Sieberbürger*, Viena, 1909; *Repertoriul arheologic pentru Ardeal*, Bistrița, 1920)[9];

- the first archaeological map of Bucovina (in 1894, *Charta arheologică a Bucovinei*, published in the Romanian Geographical Society Bulletin "Buletinul Societății Geografice Române", XV, trim. I-II, 1894, 64-94), due to D. Olinescu[10];

[1] BORȘ 2014, 92-94.
[2] CARTE 2019.
[3] CART 1996.
[4] CADASTRE 2021.
[5] HISTORICENGLAND 2019.
[6] PĂUNESCU 2003, 35-36; BORȘ 2014, 44.
[7] BORȘ 2014, 46-47.
[8] PĂUNESCU 2001-2003; BORȘ 2014, 48-49.
[9] BORȘ 2014, 50.
[10] NICULICĂ 2009, *passim*; BORȘ 2014, 50;

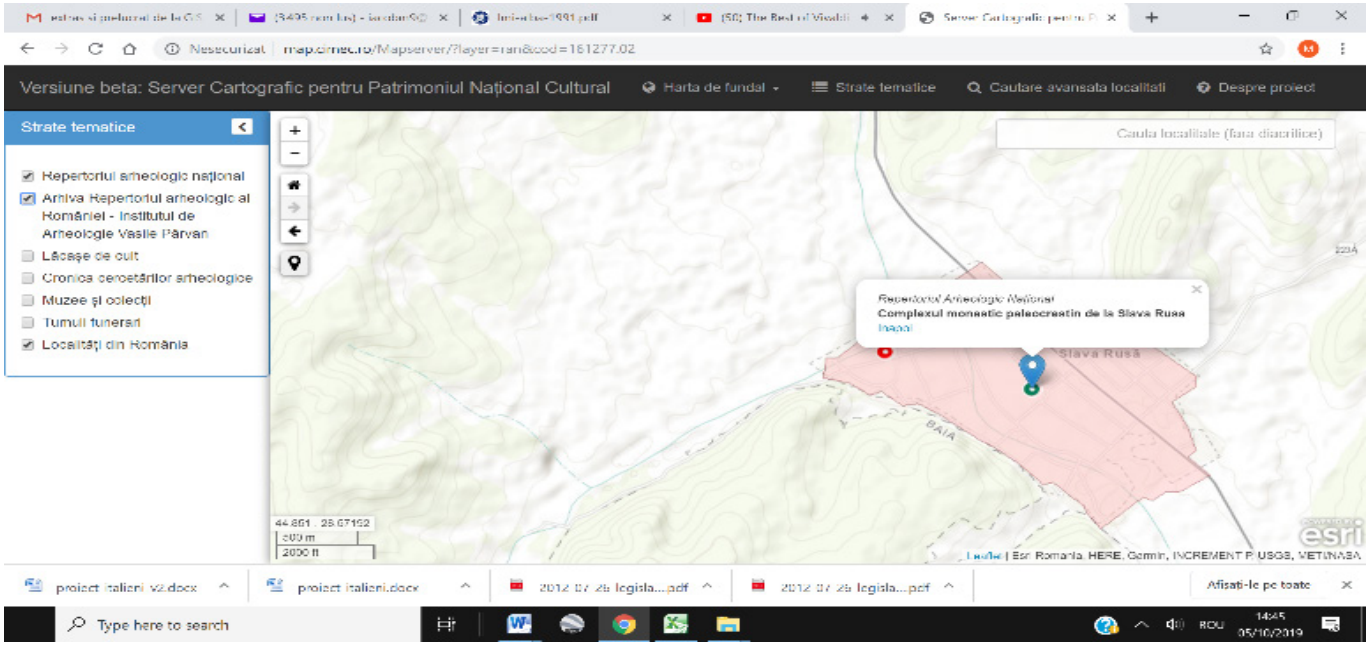


**Fig. 1.** Erroneous representation of the Paleo-Christian monastic complex from Slava Rusă, Slava Cercheză commune, Tulcea county (located 2.5 km west of the village) on the cartographic server of the national archaeological repertory RAN (https://map.cimec.ro/Mapserver, accessed 10 October 2019).

- the inventory of public and historical monuments in Romania "*Inventarul Monumentelor Publice* și *Istorice din România*" (1904)[11] – including the category of monuments and archaeological sites;

- the list of cultural monuments on the territory "*Lista monumentelor de cultură de pe teritoriul R.P.R.*" *(1955)*[12] of 115 archeological monuments out of a total of 4345 registered monuments;

- the archaeological map of Romania "*Harta arheologică a României*" (1972)[13]; it was presented as a graphical only representation on paper, with a global analysis by epochs and historical periods, without a list of represented sites;

- the national cultural heritage list of assets "*Lista bunurilor din Patrimoniul Cultural Național al Republicii Socialiste România (monumente istorice)*" - *propunere* 1978[14]: 1237 archaeological sites were registered out of a total of 8536 monuments;

- the list of historical monuments "*Lista monumentelor istorice 1991-1992*[15]": unpublished, indicative until the publication of an official list. It formed the basis for the list of historical monuments "*Lista monumentelor istorice - modificări* și *completări*" and the list of disappeared historical monuments "*Lista monumentelor istorice dispărute - modificări* și *completări*", approved by the Minister of Culture "*Ordinul Ministrului Culturii* și *Cultelor nr. 2314/2004*[16]", the latter list gathering 9662 archeological sites and monuments. The 2004 list underwent successive updates in 2010[17] and 2015[18].

- the list of protected areas "*Lista zonelor protejate 2000*, *Legea 5/2000 privind aprobarea Planului de amenajare a teritoriului național - Secțiunea a III-a - zone protejate*[19]", which records 145 archaeological sites as protected areas.

The protective measures do not achieve the desired effectiveness, despite the protection status granted by law, due to the fact the above mentioned List is presented toward the users only in paper format. This List doesn't have the possibility of consulting an online version of the LMI, with complete and updated data necessary for the identification / geo-spatial delimitation of monuments that are archaeological sites (they are presented in the List by approximate geographical positioning in relation to a village, water stream, landform or even private owner).

The national archaeological repertory *"Repertoriul Arheologic Național - RAN*[20]" is administratively managed by the Ministry of Culture and the National Institute of Heritage. It is established by a government ordinance on the protection of archaeological heritage and the declaration of archaeological sites as areas of national interest "*Ordonanța Guvernului nr. 43 din 30 ianuarie 2000 privind protecția patrimoniului arheologic* și *declararea unor situri arheologice ca zone de interes național*[21], and the ministry order "*Ordinul MCIN nr. 2458/2004 de aprobare a Regulamentului privind administrarea Repertoriului arheologic național*[22]". RAN is defined as "a way of scientific management that allows a general inventory and visualisation (geographical and cartographic) of information collected for the purpose of management, protection and enhancement of archaeological heritage" (art. 2) in order to "locate and assess as accurately as possible the known archaeological heritage, to assess the

[11] INVENTARUL 1904.
[12] LISTA 1955.
[13] CONDURACHI/DUMITRESCU/MATEI 1972.
[14] LISTA 1978.
[15] LISTA 1991-1992.
[16] LISTA 2004.
[17] LISTA 2010.
[18] LISTA 2015.
[19] LISTA 2000.
[20] RAN 2000.
[21] ORDONANȚA 2000.
[22] OMCC 2004; OBERLÄNDER-TÂRNOVEANU 2014, 20-32; BORȘ 2014, 127-128; OBERLÄNDER-TÂRNOVEANU 2016.

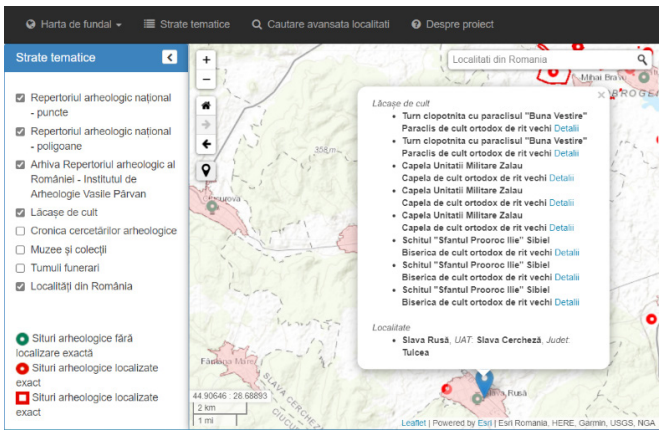


**Fig. 2.** Erroneous representation of worship places in Slava Rusă (com. Slava Cercheză, jud. Tulcea) on the cartographic server of the national archaeological repertory RAN (https://map.cimec.ro/Mapserver, accessed 23 July 2021).

areas where the heritage is threatened by risk factors and to identify new archaeological sites" (art. 3).

The regulation does not stipulate who has the obligation to transmit, respectively, to enter and to verify the data in the system, it does not present an interface that allows uploading / modifying data by Ministry of Culture officials or its decentralized services which are closer physically and as data source of the monitored archaeological sites. This makes the centrally managed RAN directory to contain some errors and confusion. Efforts to introduce as many sites as possible are to be appreciated, at the time of writing and submitting our project the RAN directory registered 17940 sites (accessed October 5, 2019) and at the time of writing this paper the RAN directory should contain 21563 sites (accessed July 21, 2021). But unfortunately most of the sites are lacking the Stereo70 coordinates and without geospatial location. Efforts are being made in this

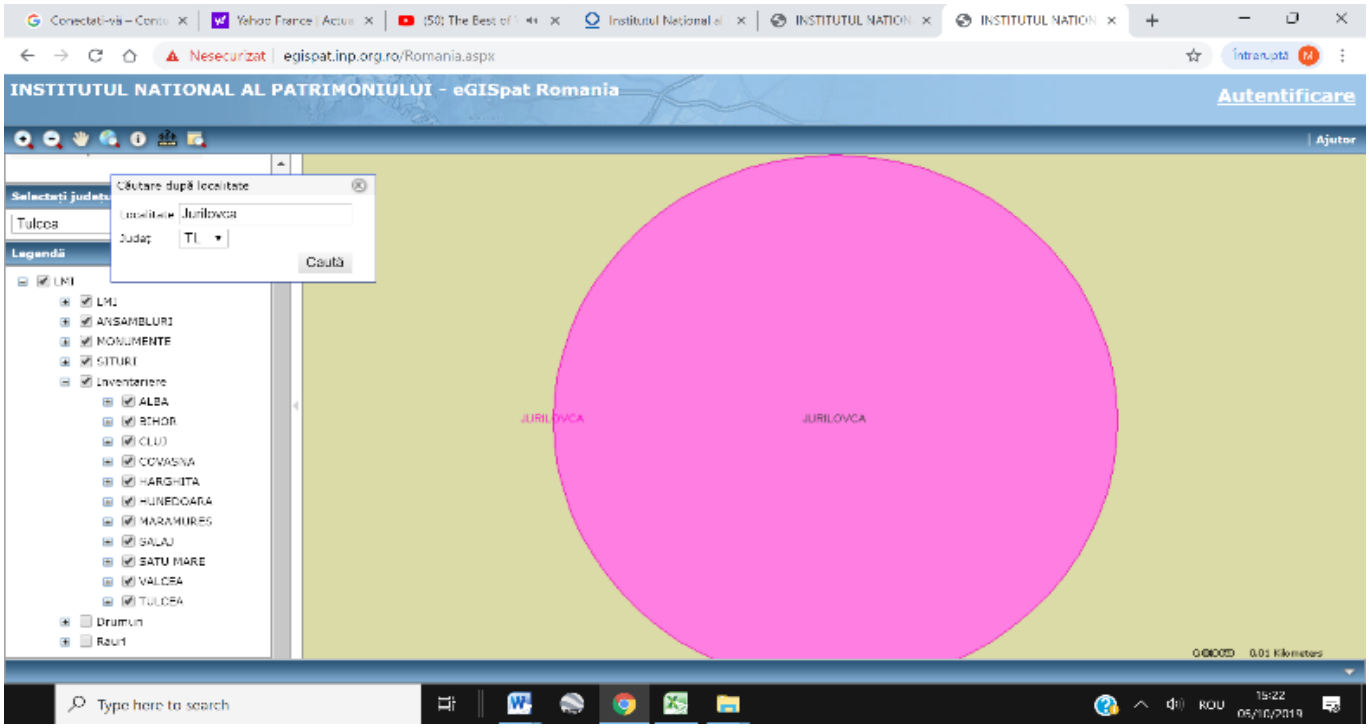


**Fig. 3.** Erroneous (hilarious) representation of archeological sites on the territory of Jurilovca village, Tulcea county (https://patrimoniu.ro/monumente-istorice/egispat, accessed 11 October 2019).

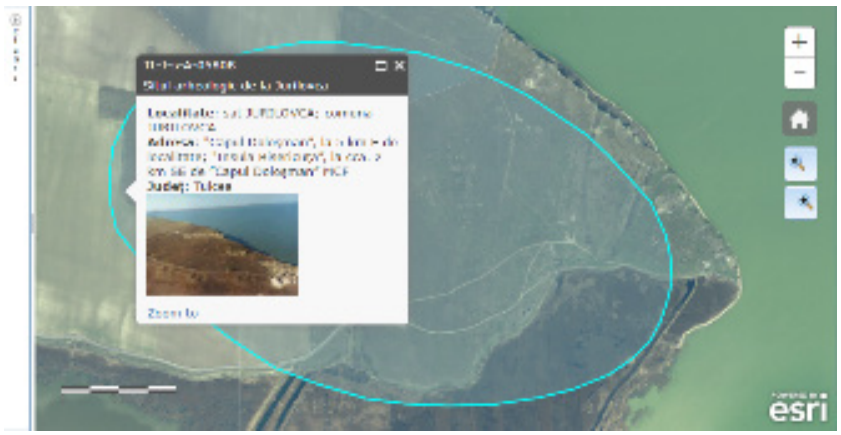


**Fig. 4.** Erroneous representation of the archeological site-historical monument TL-I-s-A-05808 on the territory of Jurilovca commune, Tulcea county (http://gislmi.inp.org.ro, accessed 23 July 2021).

sense, with a relatively recent cartographic server interface[23] being attached to RAN directory, without the information accuracy always being ensured. In the image below, the Paleo-Christian Monastic Complex (a site located 2.5 km west of Slava Rusă village) is positioned on the map in the center of Slava Rusă village (interrogation October 10, 2019), so that at a later interrogation (July 2021) it was no longer found on the map, being replaced with information that has nothing to do with Slava Rusă village.

The program *„Programul Național de Implementare a unui Sistem Informațional*

[23] RAN 2000.

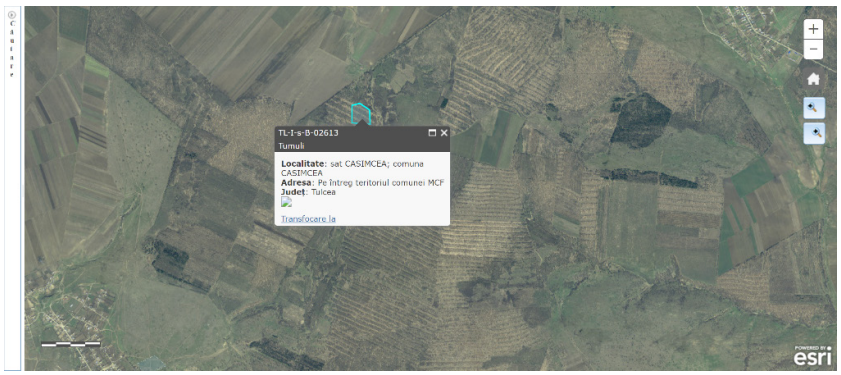


**Fig. 5.** Erroneous representation of the archeological site-historical monument TL-I-s-B-02613 on the territory of Casimcea commune, Tulcea county (http://gislmi.inp.org.ro. accessed 23 Julv 2021).

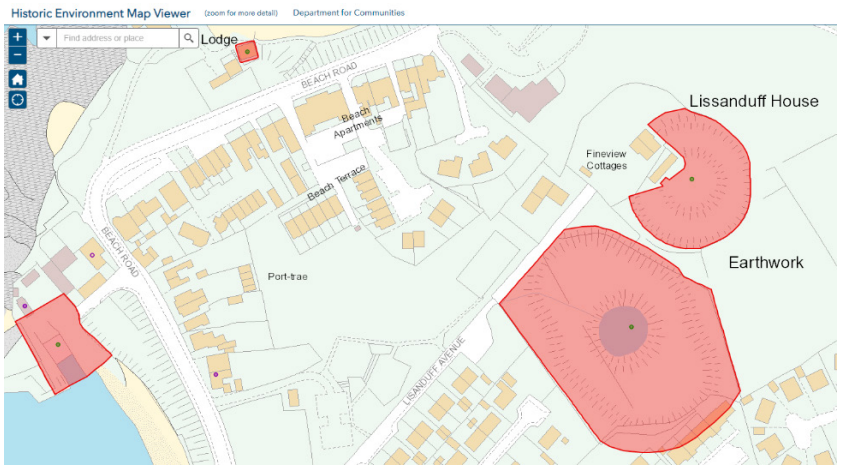


**Fig. 6.** Representation of archeological sites from the Earthwor area in Historic Environment Map Viewer application (https://dfcgis.maps.arcgis.com/apps/webappviewer/index.html?id=6887ca0873b446e39d2f82c80c8a9337, accessed 23 July 2021).

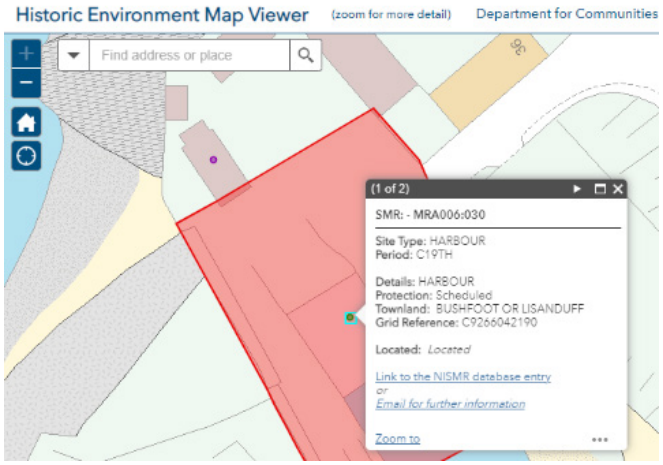


**Fig. 7.** Representation of archeological sites in the Earthwor area in the Historic Environment Map Viewer application, detail of one site SMR: MRA006:030 , (https://dfcgis.maps.arcgis.com/apps/webappviewer/index.html?id=6887ca0873b446e39d2f82c80c8a9337, accessed 23 July 2021).

*Geografic (GIS) pentru protecția patrimoniului cultural imobil (arheologie și monumente istorice) eGISPAT"* was established by the *„Ordinul Ministrului Culturii nr. 2408/2005"* for a 7 year time period (2006-2013) and aimed at creating a geographical information system (GIS) for immovable national cultural heritage protection (archeology and historical monuments), based on a partnership between MCIN, INP and ESRI Romania, the role of INP being to coordinate the activity of data collection, processing, verification and centralization; In the activity of uploading information in the platform were involved private companies, but also the county directorates for culture that received the software, the necessary licenses and logistics (GPS, computer). It was offered a short training program, without the licenses required to run the application to be updated.

Checking the publicly accessible interface shows us that information has only been entered for a few counties, and the information entered is not always up to date. Moreover, the placement of the monument sites on the map and the delimitation is somewhat random, as can be seen from the representation of "Argamum Fortress" monument: in October 2019 the perimeter of the fortress was represented by a circle and in July 2021 the representation has an oval shape but part of the remains of the fortress (those on the lake shore) being left outside the delimited perimeter.

In another worth mentioning case, the mounds that have as address "the entire territory of Casimcea commune", are represented as a single point, in the center of the village[24].

Unfortunately, only a small number of county directorates for culture (the Ministry of Culture decentralized services, which monitors the protection of cultural heritage in the territory) still use this records system. Those who still use this application complain that the ArcGis license installed at the time 2006 is no longer compatible with the operating programs on commonly used PCs and that they no longer benefit from specialized support from the initiators of the digital application (Ministry of Culture, Institute National Heritage Site).

The program "Inventarierea siturilor arheologice ca modalitate primordială de protecție juridică a patrimoniului arheologic" was carried out between 2005-2008 in a small number of counties - Alba, Cluj, Constanța, Hunedoara, Iași, Maramureș, Sălaj, Tulcea, Vâlcea[25] - without producing the expected effects, the results of such a program not being made public[26].

County archaeological repertoires. Archaeological repertoires were made in classical format for the following

[24] EGISPAT 2021.
[25] BORȘ 2014, 129.
[26] Reținem totuși lista celor 102 tumuli din jud. Tulcea menționați la TOPOLEANU/JUGĂNARU/MICU/AILINCĂI/MIHAIL/STĂNICĂ/COSTEA 2008.

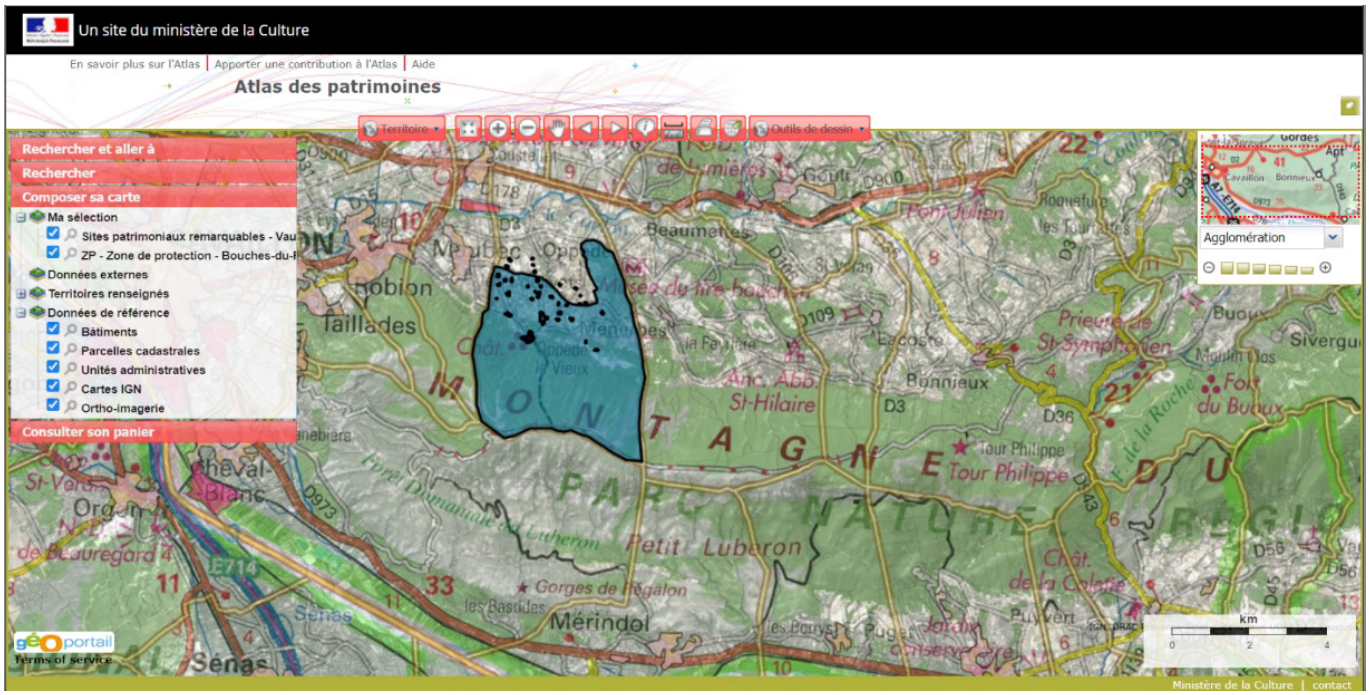


**Fig. 8.** Representation of archeological sites in "Atlas des patrimoines" application, France (https://dfcgis.maps.arcgis.com/apps/webappviewer/index.html?id=6887ca0873b446e39d2f82c80c8a9337, accessed 23 July 2021).

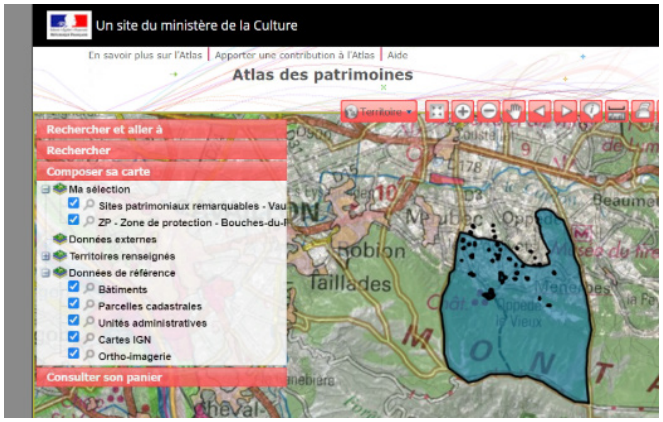


**Fig. 9.** Representation of detailed archeological site in "Atlas des patrimoines" application, France (https://dfcgis.maps.arcgis.com/apps/webappviewer/index.html?id=6887ca0873b446e39d2f82c80c8a9337, accessed 23 July 2021).

counties: Bihor[27], Botoșani[28], Iași[29]; Cluj[30], Mureș[31], Alba[32], Brașov[33], Covasna[34], Arad[35] (1999), Harghita[36], Dâmbovița[37]; Caraș Severin[38], Sibiu[39], Hunedoara[40], Sălaj[41], Maramureș[42], Galați[43]; the only county that has an online repertoire being Botoșani[44].

[27] DUMITRAȘCU 1974.
[28] PĂUNESCU/ȘADURSCHI/CHIRICA 1976; ȘOVAN 2013; ȘOVAN 2016.
[29] CHIRICA/ TANASACHI 1984-1985.
[30] CRIȘAN/BĂRBULESCU/CHIRILĂ/VASILIEV/WINKLER 1992.
[31] LAZĂR 1996.
[32] MOGA/GIUGUDEAN 1995.
[33] COSTEA 1995.
[34] CAVRUC 1998.
[35] CRIȘAN 1999.
[36] CAVRUC 2000.
[37] OLTEANU 2002, 2006.
[38] LUCA 2004.
[39] LUCA/PINTER/GEORGESCU 2003.
[40] LUCA/ROMAN/DIACONSCU/SUCIU 2005; LUCA 2008.
[41] LUCA/GUDEA 2010.
[42] KACSÓ 2011.
[43] CROITORU 2013.
[44] ȘOVAN 2016.

Based on the above analysis, we can only share the conclusion of Corina Borș: "it is obvious that the general situation is at least dysfunctional and there is currently no integrated system of evidence of real archaeological heritage (archaeological sites and monuments) and much less a digital map of its distribution and characteristics, essential tools for the elaboration and implementation of concrete, efficient actions in the field of archaeological heritage protection in România"[45], the same specialist insisting on the „need for a modern, integrated inventory system of archeological sites and monuments in România"[46].

## CULTURAL HERITAGE MANAGEMENT - EUROPEAN MODELS

In England, the role of registering, evaluating and monitoring monuments classified in the register of monuments at local level (Sites and Monuments Records) and classified in the register of national monuments, belongs to a central government agency: the English Heritage, established in 1983 as a legally independent body. For the monuments registered in the two Registers there is a complex, computerized documentation, including for each monument: documents related to the property, interventions history in the site or on the monument, images, topographic plans, maps. Depending on certain criteria of significance, authenticity, rarity, these monuments have different degrees of protection: the registers are constantly updated. Based on these national records systems (Sites and Monuments Records and local archives), the curators, archaeologists working in territorial structures involved in the management and protection of archaeological sites make recommendations to entrepreneurs / builders / investors on the potential of a particular area, propose the works to be done for the protection of the archaeological heritage and

[45] BORȘ 2014, 129.
[46] BORȘ 2014, 146.

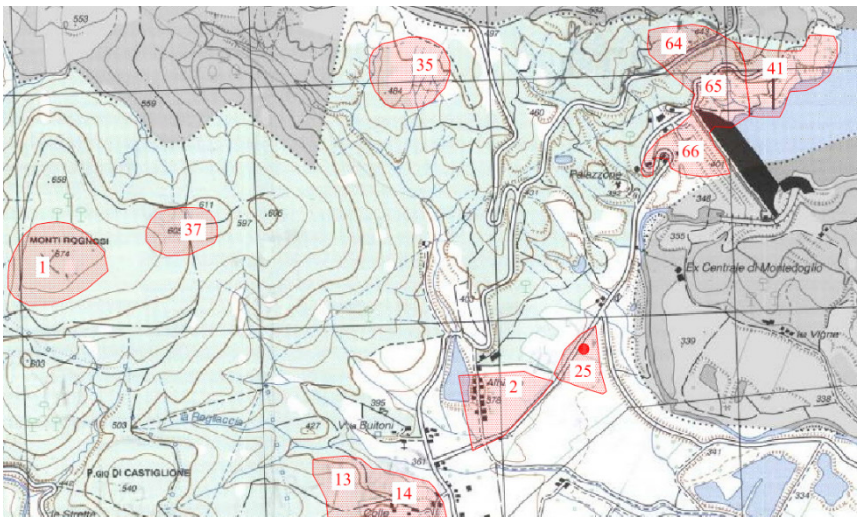


**Fig. 10.** Excerpt from "Carta del rischio archeologico" for Comune di Anghiari (https://bussola.s3.eu-west-1.amazonaws.com/285451/Carta%20del%20rischio%20archeologico.pdf – accessed 23 July 2021).

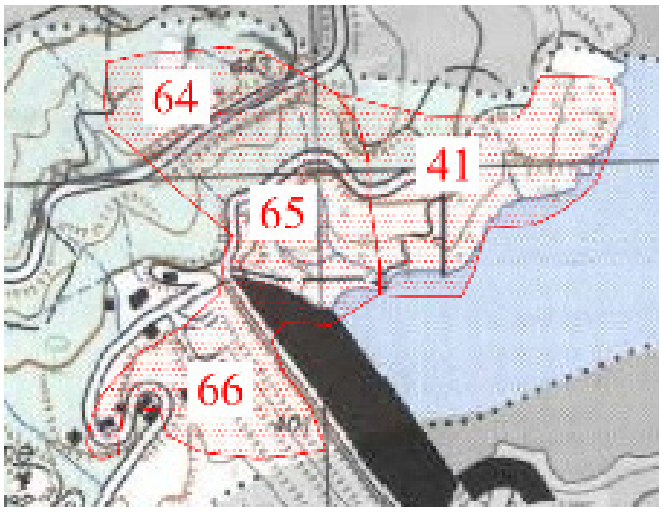


**Fig. 11.** Detail from "Carta del rischio archeologico" for Comune di Anghiari (https://bussola.s3.eu-west-1.amazonaws.com/285451/Carta%20del%20rischio%20archeologico.pdf – accessed 23 July 2021).

monitor the compliance to the research and protection standards.

In France, the record of archaeological heritage is organized by the Ministry of Culture through the "Carte archéologique nationale" which is a tool for knowledge and research for archaeologists, an archaeological heritage decision and management tool for national and local public authorities (especially to the regional archeology services, which correspond in Romania to the county directorates for culture), a general information repository for the public. The map is a cartographic inventory of information on archeology throughout the country, from its origins to the present day and is presented in both paper and digital format[47]. In 2007, 400000 sites were registered in the system, and 500000 in 2013, out of an estimated total of 5000000 to 10000000 sites. The computerized version is a national application consisting of a database associated with a geographical information system, to which is added a search / query tool within the database.

In Italy we find a well-developed system of evidence and protection of the archaeological heritage: "C.A.R.T. - Carta archeologica del rischio territoriale", an archaeological map of territorial risk. CART consists of a GIS to which all the archaeological information present or signaled on a territory is attached and which is suitable for interrogations and analyzes. It was initiated by the "Istituto per i Beni Artistici Culturali e Naturali" in collaboration with the "Soprintendenza Archeologica per l'Emilia Romagna" and numerous local public authorities and public institutions (museums) in 1995. It was designed as an instrument of scientific knowledge and archaeological heritage protection, and above all, as a support platform for scheduling any intervention in the territory. Over time, the system has spread throughout the country, many territorial identities benefiting from such systems of evidence and management of archaeological heritage[48].

## DESIGNING THE INTERACTIVE MAP AND TECHNICAL DETAILS

The overview of the archeological heritage protection at national and European level made the project's initiating team aware of some limitations of existing records evidence systems of the archaeological heritage at national level. and determined us to capitalize on the French and Italian models, given that these countries have a close to us structure in terms of managing in the territory the heritage protection issues through decentralized services of the relevant ministries in the territory.

For this project we focused on three counties (ATU - Administrative-Territorial Units, U.A.T. – Unități Administrativ-Teritoriale) Constanța, Covasna and Galați which present specific situations, different from one to another. This selection was a challenge to integrate solutions adapted to very different situations, so that, even at experimental stage to respond a diverse and complex set of needs using IT solutions. The data we currently have for the three counties are as follows:

Constanța: 476 registered sites in the List of Historical Monuments (LMI) 2015, 636 registered sites in the National Archaeological Repertory (RAN), 21 UATs (out of 70) with updated General Urban Plans (PUG) containing information about archaeological sites delimited by Stereo70 coordinates; at the county level there is no archaeological repertoire on paper format and no digital records of the sites at the level of the County Directorate for Culture Constanța;

Covasna: 141 registered sites in LMI 2015, 467 registered sites in RAN, 10 UATs (out of 45) with updated PUG containing information about archeological sites

[47] CARTE 2019; CHAILLOU/THOMAS 2007; FROMENTIN/LAUZANNE/ROPARS 2006. LORHO 2014.

[48] CART 1996; IBC 2021; SISTEMA 2021; RISCHIO 2021; CALAON/PIZZINATO 2011; CAPPONI/CACACE 2021; CERVIA 2013; GUERMANDI 1998; GUERMANDI 2001; PIZZINATO 2009-2010.

delimited by Stereo70 coordinates; at the county level there are archeological repertoires on paper format and a digital record of the sites at the level of the Covasna County Directorate for Culture;

Galați: 96 registered sites in LMI 2015, 160 registered sites in RAN, 12 UAT (out of 65) with updated PUG containing information about archaeological sites delimited by Stereo70 coordinates; at the county level there is an archeological repertoire on paper format made in a traditional way (without locating Stereo70 systems and discoveries) that capitalizes the documentation gathered from the specialized bibliography and archives of the History Museum "Paul Paltânea" in Galați.

The project capitalizes on all available resources presented above (including LMI and RAN information) adding information about sites with Stereo70 delimitations from archaeological diagnoses imposed by investment projects, archaeological sites researched or identified by preventive archaeological research, included or not in the Chronicle of Archaeological Research *„Cronica Cercetărilor Arheologice"*[49], but stored in the three county directorates for culture archives. Last but not least, the archaeological sites identified by specialists (archaeologists) as a result of research projects will be added. As an example we mention a project for Constanța county, intended to new mapping techniques and non-invasive investigation of archaeological sites in central Dobrogea (case study: Casimcea river basin) "*ArchaeoMap – Tehnici noi de cartare* și *investigație noninvazivă a siturilor arheologice* în *Dobrogea centrală (studiu de caz: bazinul râului Casimcea)* - finanțat de UEFISCDI în cadrul programului *Parteneriate*, subprogramul *Proiecte Colaborative de Cercetare Aplicativă,* 2014-2016)". In this project the Museum of National History and Archeology Constanța had the status of partner institution and some of the current team members were involved at that time in the project. For any accidental archeological discoveries, the specialized publications and the archeological repertoires of Galați and Covasna counties will be capitalized.

To design the interactive map model, we started with the inventory of all documentation types (descriptive, photographic, graphic) available for each archaeological site. It was considered to identify accessible digital storage formats, which would allow them to be easily found, to identify programs to be used in building the computer system so that, over time, its updating would not be burdened by obtaining expensive licenses. After designing the system we moved on to the experimentation and testing phase.

During the building phase of the system, the focus was how to provide in the easiest manner the archeological information towards one single database. There are two way to provide the same information to the database: directly form the graphical interface of the interactive digital map or using a by completing the web-based form. The interactive digital map and the database are completely interconnected, any change on one subsystem will be instantaneously seen on the other.

A user (currently a project team member, later a county directorate for culture employee) will provide the

[49] CRONICA 1983.

**Fig. 12.** ArchTerr digital interactive map - representation of archaeological sites in Nicolae Bălcescu commune, Constanța county.

essential information related to an archaeological site: file code, site name, author of site file initiation, county, GIS coordinates (without these mandatory information a site listing cannot be generated). Starting from this essential information, one can then complete the documentation of an archeological site.

The fully functional interactive digital map could be found at *www.archterr.ro* under the map section.

The interactive digital map has multiple, some important ones will be described in detail:

**1.** Simultaneous representation on the same map of different coordinate systems information.

The system allows the coordinates data entry in either WGS84 or Stereo70 system and internally reconvert the data before representing them on the map. This approach is avoiding the use of intermediate transformation programs from one system to another and is reducing the risk of human error.

**2.** Position real-time verification (the coordinate's correctness and site position)

System data entry using the interactive digital map allows an immediate visualization, on the map, of the polygon generated by the coordinates (WGS84 or Stereo70) and offer the possibility to correct the position if necessary.

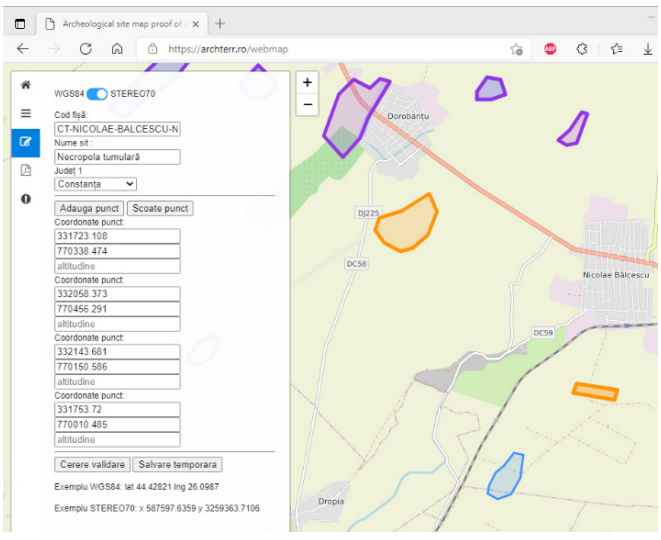


**Fig. 13.** ArchTerr digital interactive map - data entry menu with the representation of sites in various management stages: newly entered (blue color), sent for validation (orange color), validated (purple color).

**3.** Surface limits inside a site (based on archeological criteria)

The map allows the generation of four types of polygons, marked differently: the archaeological site limits polygon (marked with a different color if the site is registered in the LMI inventory); the archeological site protection area limits polygon; the researched area by preventive archeological excavation limits polygon; the polygon with the delimitation of the areas for which the archaeological discharge was issued. All these representations are indispensable to the county directorates for culture employees in the activity of legislation efficient implementation of the archeological patrimony protection.

**4.** Different visual representations of geospatial (GIS) information based on user's access rights

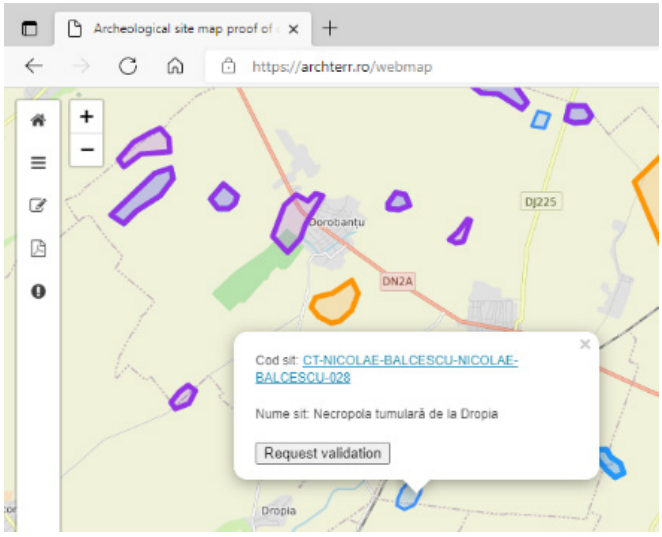


**Fig. 14.** ArchTerr digital interactive map - representation of sites in various data validation stages, illustration of a site during data validation process.

From a data entry permissions point of view, there are two user level (archeologist): the authors who provide descriptive information and data entry; the manager who verify the archeological data correctness and validate it.

A piece of information can be entered any time after the first form generation (following the completion of the five mandatory elements previously stated). At the end of the data entry process, the information are transmitted to the next level, respectively to the users who validate the information. During the intermediate data processing until validation the information is not displayed to the general public, but only to the users involved in the project. On the interactive map the polygons are marked with different colors. Once the information is validated, it becomes publicly available, accessible to anyone interested in the archaeological heritage of a particular area.

**5.** Visual comparison of a terrain overlapping with a protected area

The system is designed so that by entering the coordinates of a terrain a polygon will be generated, allowing immediate verification if this terrain is positioned inside an archaeological site, in its protection area or partially overlapping any of them.

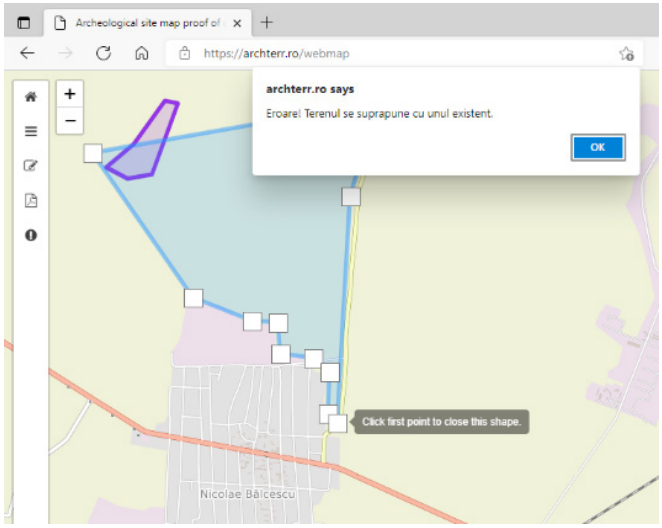


**Fig. 15.** ArchTerr digital interactive map - checking the positioning of a terrain in relation to an archaeological site.

**6.** User's easy access to archeological site information

Information on areas with archaeological heritage can be accessed immediately, shortening search times for the county directorate for culture employee directly involved in the application of legislation on the protection of archaeological heritage who must make an informed decision on the procedure to be followed (e.g. request to carry out archaeological diagnosis, preventive archaeological research, archaeological supervision for constructive intervention, exercise of pre-emption, issuing a permit or a negation in case of sale of land outside the built-up area, respectively issuing various types of permits, as appropriate).

An efficiency increased activity of protection of the archeological patrimony will be possible to obtain also for the city planning services (these being able to be informed directly and correctly on the protection regime of a certain territory). The urbanism certificate certify the necessary approvals in this area.

An investor could benefit of a shortening of waiting times, and especially the possibility to predict the financial resources necessary for preventive archaeological research activities (diagnosis, excavation, archaeological surveillance), even a redesign of the investment in an area that is not encumbered by any archeological obligations (arising from the presence on the field of an archaeological heritage protected area). Any user or investor is able to access the interactive digital map directly by entering the coordinates of the investment field and checking beforehand its situation related to an archaeological heritage site.

In the case of historical monument sites that have not officially marked (through PUG) the protection area, according to the current legislation the protection zone is established at 50/100/200/500 meters outside the outer limits of the archaeological site surface. Using the interactive digital map it is possible to generate this zone using the ruler and the cursor directly on the map.

**7.** Overlapping descriptive site-related information with geospatial information

The interactive digital map allows the overlapping of descriptive site-related information with geospatial information, accessing a site from the map interface opens a connection to the database and offers the possibility to consult additional data about this specific site. Moreover, the map allows thematic queries, displaying geospatial information according to the established criteria. The two functionalities allow the interactive digital map usage as a valuable tool for scientific research.

**8.** Documents generation with the user's map view

To better support the external users, we added the option to generate documents in pdf format containing the map view and information displayed to the end user.

**9.** The interactive digital map is a daily working tool adapted to different users' needs

**Fig. 16.** ArchTerr digital interactive map - distance measuring tool between two sites.

The interactive map created within the ArchTerr project stores and represents geospatial information on lands with archaeological heritage on which different degrees of protection are established and marked separately. The stored data in a quasi-exhaustive database describing an archaeological site is easily accessible by several categories of users: officials from the decentralized public services of the Ministry of Culture, town halls, cadastral offices and real estate advertising agencies, individuals or legal entities interested in documenting or initiating different types of interventions in areas categorized as archaeological heritage.

## COORDINATES INTEGRATION ON THE INTERACTIVE DIGITAL MAP

One of the best known reference systems for geospatial information is the World Geodetic System (WGS) with the variant WGS84 due to the fact that it works with the Global Positioning System (GPS) reference. The WGS system is a de-facto standard and its usage encompass cartography, satellite navigation and geodesy.

The current version of World Geodetic System is the one defined in 1984 (known as WGS84). This World Geodetic System is defined and standardized since 1984 by the United States National Geospatial-Intelligence Agency at www.earth-info.nga.mil. The GPS Division released the latest revision in 2014.

The system used in Europe is The European Terrestrial Reference System 1989 (ETRS89) described in detail at etrs89.ensg.ign.fr (for more information please consult itrf.ign.fr and www.euref.eu). The main point about this system is the fact that the Eurasian Plate is considered static and not subject to continental drift. That means the coordinates and maps are not subject to change. The Global Navigation Satellite Systems (GNSS) and the EUREF Permanent GNSS Network is described at www.epncb.oma.be.

Since G730, 1994, the WGS84 implementation are coincident with ITRF at approximately 10-centimeter error. That means the ITRF coordinates are equal to WGS84 with a maximum 10 cm error.

In Romania, it is mandatory that the topographic and geodetic works be executed in Stereo70 projection system (Stereographic 1970). These topographic and geodetic works include maps, cadastral plans, topographic maps, etc.

This Stereo70 system is legislated by Decree no. 305 of 15 September 1971 on the geodetic, topo-photogrammetric and cartographic activity, as well as on the procurement, determination and use of data and documents resulting from this activity (published in the Official Gazette no. 111 of 26 September 1971). "Decretul nr. 305 din 15 septembrie 1971 privind activitatea geodezică, topo-fotogrammetrică și cartografică, precum și la procurarea, determinarea și folosirea datelor și documentelor rezultate din această activitate (publicat în Monitorul Oficial nr. 111 din 26 septembrie 1971)".

The 1989 European Terrestrial Reference System (ETRS89) which is used in Europe as a geodetic reference system, is managed in Romania by the National Cartography Center (ROMPOS at www.rompos.ro) which also defines the two coordinate systems used in Romania.

In order to ensure the determination of the precise position in the European reference and coordinate system ETRS89, ROMPOS uses its own national network of permanent GNSS stations (RNSGP), satellite navigation systems (GNSS - Global Navigation Satellite Systems such as GPS, Glonass, Galileo).

In Romania, the computer application TransDatRo can be used for the conversion and precise determination of the position in the European reference and coordinate system ETRS89. The official version of the TransDatRo application is made available to users by the National Cartography Center at www.rompos.ro (ROMPOS).

According to the above theoretical presentation, a first challenge was the simultaneous representation on the same map of information from different systems (WGS84 and Stereo70). Due to the fact that the information available to archaeologists or regular users is either in WGS84 format or in Stereo70 format, a mathematical translation between the two representation systems had to be implemented. These transformations are usually available in expensive commercial applications. The integration of this automatic translation into the project means that it is no longer necessary to use other software applications, nor is human intervention necessary.

A second important implementation of the project was the possibility to correct the geospatial GIS information initially entered through a form. The modification of this information is done interactively on the map, all these modifications being automatically saved in a database

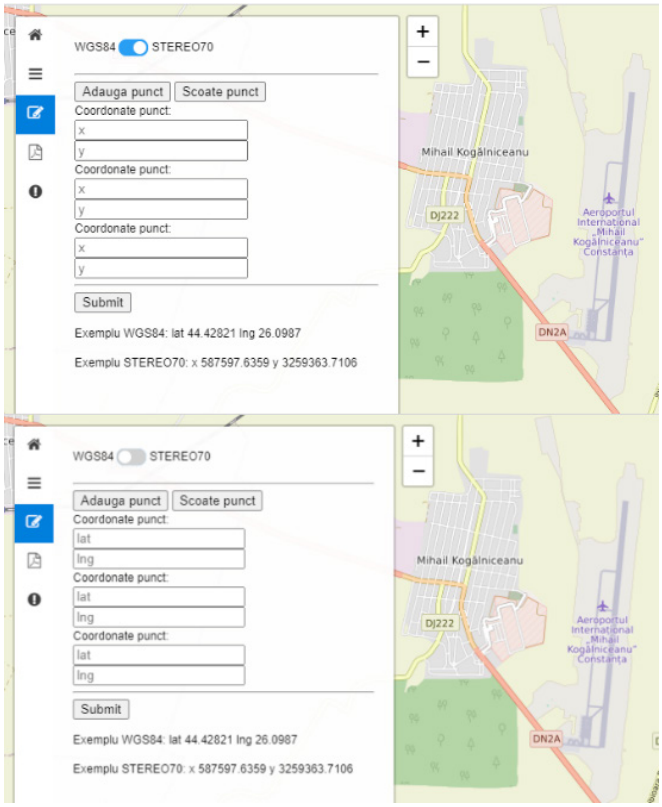


**Fig. 17.** ArchTerr digital interactive map - representation of both WGS84 and Stereo70.

without the need to provide the same information in text mode.

Given that the computer application must be available to archaeologists not only from fixed sites with good quality Internet connectivity, from an IT&C point of view decisions have been made and technologies have been implemented to minimize the amount of data needed to be exchanged between the central servers (on which the application is installed and running) and the terminal equipment used in the field by archaeologists or regular users.

Another problem that was solved from an IT&C point


**Fig. 18.** ArchTerr digital interactive map - optimised graphical web interface.


**Fig. 19.** ArchTerr digital interactive map – responsive optimised graphical web interface.

of view was the accommodation of the devices diversity that access the application's website and particularly the graphical interface of the interactive map. We refer here not only to the access devices screen sizes and resolutions but also to the different applications which are used to access the GIS geospatial information and the interactive graphical map.

## CONCLUSIONS

In this paper it was presented one of the main products of the project "Integrated management of archaeological heritage: archaeological map and administrative procedures for research and protection of heritage" funded by UEFISCDI, respectively the interactive digital map of archaeological historical heritage. The project resulted from the collaboration of "Dunărea de Jos" University of Galați and "Politehnica" University of Bucharest. As an example, we mention two other products of this project, namely the database containing the relevant information for each

archeological site and the procedures that will help the unitary application of heritage protection legislation.

The map provides a users' friendly work environment and has almost zero implementation costs for any concerned institution. The map users are official agencies in the territory, county directorates for culture employees or any person interested by information in the field. The implementation costs have been optimized because the application is built using free open source software resources, it does not require the purchase of additional licenses.

A strength of ArchTerr interactive digital map is the computer application possibility to display geospatial information allowing on the same map simultaneous representation of locations in two different positioning systems and coordinates (WGS84 and Stereo70). It also allows immediate integrity verification of users' information and the possibility of visually comparing any area overlapping with an existing archeological site or protection zones.

The application data can be easily accessed by all potential users because historical and archaeological descriptive information is superimposed over the geospatial GIS information.

Several categories of polygonal surfaces can be delimited for each archeological site, these being marked separately with different visual representations depending on the user access rights and data validation level during the validation process.

Even if the interactive map is not a substitute for other archaeological heritage management instruments (e.g. the National Archaeological Repertory / Repertoriul arheologic național), it serves both the evidence inventory (record keeping activities) and to monitor the interventions in archaeological heritage areas.

As a conclusion, the ArchTerr interactive digital map is a modern valuable working tool, mandatory for the archaeological heritage protection during the day by day activities at county directorates for culture and is also accessible to real estate investors, land owners, general public.

**ACKNOWLEDGEMENTS**

The research was enabled thanks to an Excellence Cluster build around the "Dunărea de Jos" University Galați (Department of History) and "POLITEHNICA" University Bucharest (Computer Science Department, Faculty of Engineering in Foreign Languages).

This work was supported by a grant of the Romanian Ministry of Research and Innovation, CCCDI-UEFISCDI, project number PED 571/2020 within PNCDI III.

**REFERENCES**

BORȘ 2014

Borș, C., *Protejarea patrimoniului arheologic din România. Despre situri și monumente arheologice din perspectiva evoluției cadrului legislativ în context European* (Cluj-Napoca: Mega).

CADASTRE 2021

https://www.arxaiologikoktimatologio.gov.gr/en (accessed 2 July 2021)

CALAON/PIZZINATO 2011

Calaon, D./Pizzinato, C., L'analisi archaeologica nei processi di valutazione ambientale. Proposta metodologica in ambiente GIS, *Archeologia e Calculatori* 22, 413-439.

CAPPONI/ CACACE 2021

Capponi, G./Cacace, C., Il Sistema Informativo Territoriale della Carta del Rischio, (https://www.ingenio-web.it/2834-il-sistema-informativo-territoriale-della-carta-del-rischio (accessed 19 July 2021).

CART 1996

https://patrimonioculturale.regione.emilia-romagna.it/aree-tematiche/patrimoni/musei/focus/patrimonio-archeologico/valorizzazione-dei-siti-e-dei-musei-archeologici-1/archivio-delle-iniziative-di-valorizzazione-1/c-a-r-t-carta-archeologica-del-rischio-territoriale (accessed 8 October 2019).

CARTE 2019

https://www.culture.gouv.fr/Sites-thematiques/Archeologie/Etude-recherche/La-carte-archeologique-nationale (accessed 6 October 2019).

CAVRUC 1998

Cavruc, V. (coord.), *Repertoriul arheologic al județului Covasna*, Seria Monografii Arheologice I (Sfântu Gheorghe).

CAVRUC 2000

Cavruc, V. (coord.), *Repertoriul arheologic al județului Covasna*, Seria Monografii Arheologice II (Sfântu Gheorghe).

CERVIA 2013

https://www.comunecervia.it/aree-tematiche/urbanistica/pug-approvazione/pug/quadro-conoscitivo-2013.html (accessed 15 January 2021).

CHIRICA/TANASACHI 1984-1985

Chirica, V./Tanasachi, M., Repertoriul arheologic al județului Iași, I-II (Iași: Academia de Științe Sociale și Politice a R.S. România: Universitatea "Al. I. Cuza, Iași).

CONDURACHI/DUMITRESCU/MATEI 1972

Condurachi, E./Dumitrescu, V./Matei, M.D., *Harta arheologică a României* (București: Meridiane).

COSTEA 1995

Costea, F., *Repertoriul arheologic al județului Brașov* (= *Cumidava* 15-19) (Brașov: C2 DESIGN).

CRIȘAN 1999

Crișan, G. H., *Repertoriul arheologic al Mureșului inferior: Județul Arad* [Bibliotheca Historica et Archaeologica Banatica 24] (Timișoara: Editura Orizonturi Universitare).

CRIȘAN/BĂRBULESCU/CHIRILĂ/VASILIEV/WINKLER 1992

Crișan, I.H./ Bărbulescu, M./Chirilă, E./Vasiliev, V./ Winkler, I., 1992, *Repertoriul arheologic al județului Cluj* (Cluj-Napoca).

CROITORU 2013

Croitoru, C., *Galați: Repertoriul descoperirilor arheologice și numismatice* (Galați: Editura Muzeului de Istorie Galați).

CRONICA 1983

*Cronica cercetărilor arheologice din România, 1983 - 2019. Rapoarte preliminare de cercetare arheologică,* http://cronica.cimec.ro/ (accessed 23 July 2021).

DUMITRAȘCU 1974

Dumitrașcu, S., *Repertoriul monumentelor naturii, arheologice, istorice, etnografice, de arhitectură și artă din județul Bihor* (Oradea).

EGISPAT 2006

https://patrimoniu.ro/monumente-istorice/egispat (accessed October 2019).

EGISPAT 2021

http://gislmi.inp.org.ro (accessed 23 July 2021).

FERRONI/CACACE

Ferroni, A.M./Cacace, C., *Carta del Rischio: la vulnerabilità archeologica*, accesibilă la: http://www.icr.beniculturali.it/documenti/allegati/Vulnerabilita_archeologica.pdf (accessed July 2021).

FROMENTIN/LAUZANNE/ROPARS 2006

Fromentin, F./Lauzanne, S./Ropars, A., *L'inventaire archéologique national*, In: Dabas *et al*. (ed.), *La prospection*, Paris: Errance (nouvelle édition revue et augmentée).

GUERMANDI 1998

Guermandi M.P. (ed.) Cart. *Carta archeologica del rischio territoriale,* "IBC. Informa- zioni, commenti, inchieste sui Beni culturali" 6, 3, 41-72.

GUERMANDI 2001

Guermandi M.P. (ed.), *Rischio archeologico: se lo conosci lo eviti. Atti del Convegno di studi su cartografia archeologica e tutela del patrimonio (Ferrara 2000)* (Firenze, All'Insegna del Giglio).

HISTORICENGLAND 2019

https://historicengland.org.uk/listing/the-list/map-search?clearresults=true, (accessed October 2019, July 2021).

INVENTARUL 1904

https://patrimoniu.ro/monumente-istorice/lista-monumentelor-istorice (accessed 10 October 2019).

KACSÓ 2011

Kacsó, C, *Repertoriul arheologic al județului Maramureș*, I, II [Bibliotheca Marmatia 3] (Baia Mare: Eurotip).

LAZĂR 1996

Lazăr, V., *Repertoriul arheologic al județului Mureș* (Târgu Mureș).

LISTA 1955

https://patrimoniu.ro/monumente-istorice/lista-monumentelor-istorice (accessed 10 October 2019).

LISTA 1978

https://patrimoniu.ro/monumente-istorice/lista-monumentelor-istorice (accessed 10 October 2019).

LISTA 1991-1992

https://patrimoniu.ro/monumente-istorice/lista-monumentelor-istorice (accessed 10 October 2019).

LISTA 2000

https://lege5.ro/Gratuit/gi3donbu/legea-nr-5-2000-privind-aprobarea-planului-de-amenajare-a-teritoriului-national-sectiunea-a-iii-a-zone-protejate (accessed July 2021).

LISTA 2004

https://patrimoniu.ro/monumente-istorice/lista-monumentelor-istorice (accessed 10 October 2019).

LISTA 2010

https://patrimoniu.ro/monumente-istorice/lista-monumentelor-istorice (accessed 10 October 2019).

LISTA 2015

https://patrimoniu.ro/monumente-istorice/lista-monumentelor-istorice (accessed 10 October 2019).

LORHO 2014

Lorho, T., *Patrimoine archéologique et système d'information géographique,* CFC (No 22-Juin 2014) http://www.lecfc.fr/new/articles/220-article-51.pdf (accessed 15 January 2021).

LUCA 2004

Luca, S.A. (coord.), *Repertoriul arheologic al județului Caraș Severin* (Alba Iulia: Altip).

LUCA 2005, 2008,

Luca, S.A. (coord.), *Repertoriul arheologic al județului Hunedoara* (ediția I, ediția a II-a 2008) (Alba Iulia: Altip).

LUCA 2008,

Luca, S. A., *Repertoriul arheologic al județului Hunedoara* (ediția a II-a) [Bibliotheca Brukenthal 26] (Sibiu).

LUCA/GUDEA 2010

Luca, S. A./Gudea, N., *Repertoriul arheologic al județului Sălaj* [Bibliotheca Brvkenthal 45] (Sibiu, Alba-Iulia: Altip).

LUCA/PINTER/GEORGESCU 2003.

Luca, S.A./Pinter, Z.K./Georgescu, A. 2003, *Repertoriul arheologic al județului Sibiu (situri, monumente arheologice* și *istorice)* [Bibliotheca Septemcastrensis 3] (Sibiu).

LUCA/ROMAN/DIACONSCU/SUCIU 2005

Luca, S. A./ Roman, C./Diaconscu, D. /Suciu, C., *Repertoriul arheologic al județului Hunedoara* [Bibliotheca Septemcastresis 14] (Alba Iulia: Altip).

MIHAI/ANGELESCU 2009

Mihai, D./ Angelescu, M.V., A centrally managed GIS System for the Protection of the Archaeological Sites and Historic Monuments, In: *Listing Archaeological Sites, protection for Historical Landscape*, EAC Occasional Paper nr. 3, Brussels 2009, 109-114;

MOGA/GIUGUDEAN 1995

Moga, V./Giugudean, H. (eds.), *Repertoriul arheologic al județului Alba* [Bibliotheca Mvsei Apvlensis 2] (Alba Iulia).

NICULICĂ 2009

Niculică, B. P., *Din istoricul preocupărilor arheologice* în *Bucovina: Societatea Arheologică Română* (Suceava: Editura Universității din Suceava).

OBERLÄNDER-TÂRNOVEANU 2014

Oberländer-Târnoveanu, I., Patrimoniul arheologic național: politici, documentare, acces, In: Musteață, S. (ed.), *Arheologia* și *politicile de protejare a patrimoniului cultural* în *România (culegere de studii)* (Chișinău - Iași, Arc), 13-43.

OBERLÄNDER-TÂRNOVEANU 2016

Oberländer-Târnoveanu, I. Arhivele arheologice, In: Musteață, S. (ed.), *Tendințe curente* în *protecția patrimoniului arheologic* în *România* și *Republica Moldova* (Chișinău - Iași: Arc), 69-82.

OLTEANU 2002, 2006

Olteanu, G., *Repertoriul arheologic al județului* Dâmbovița, I (2002), II (2006) (Târgoviște: Cetatea de Scaun)

OMCC 2004

http://cimec.ro/legislatie/OMCC-2458-2004-RegulamentRAN.pdf.

ORDONANTA 2000

https://patrimoniu.gov.ro/images/pdf/OG-43-2000-Arheologie-2006.pdf.

PĂUNESCU 2001-2003

http://www.cimec.ro/Arheologie/Arhiva-Digitala/4Pamfil%20Polonic/PamfilPolonic.htm (accessed October 2019).

PĂUNESCU 2003

Păunescu, A., *Din istoria arheologiei românești pe baza unor documente de arhivă* (București: AGIR).

PĂUNESCU/ŞADURSCHI/CHIRICA 1976

Păunescu, A./Şadurschi, P./Chirica, V., *Repertoriul arheologic al județului Botoșani* I (București).

PIZZINATO 2009-2010

Pizzinato C., *L'analisi archeologica nei processi di valutazione ambientale. Proposta metodologica in ambiente GIS,* Archeologia e Calcolatori 22 (2011), 413-439.

POCOBELLI 2009

Pocobelli, G.F., *Anghiari. La Carta del Rischio Archeologico. Stato della ricerca, problemi e prospettive* In: Salvini, M./Lelli, P. (eds.), *Le memorie celate: il paesaggio archeologico nella terra di Anghiari*, Anghiari, 16-21

RAN 2000/2004

http://ran.cimec.ro/, (accessed 5 October 2019).

ȘOVAN 2013

Șovan, O. I., *Repertoriul arheologic al județului Botoșani* (Botoșani: Pim).

ȘOVAN 2016

Șovan, O.I., *Repertoriul arheologic al județuui Botoșani*, ediția a II-a. Bibiotheca Archaeologica "Hierasus" Monographica 4 (Botoșani).

SERVER 2015

https://map.cimec.ro/Mapserver, (accessed 5 October 2019, 21 July 2021).

TOPOLEANU/JUGĂNARU/MICU/AILINCĂI/MIHAIL/STĂNICĂ/COSTEA 2008

Topoleanu, F./Jugănaru, G./Micu, C./Ailincăi, S./Mihail, F./Stănică, A./Costea, I, *Inventarierea siturilor arheologice din județul Tulcea, Studiu de caz: Mormintele tumulare* (I) [Biblioteca Istro-Pontica 3] (Tulcea).