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Soil Erosive Processes To Buried Archaeological Sites: Some Notes

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Abstract: *Europe has a rich and varied cultural heritage, characterized by the presence of exposed and buried archaeological remains. Pressures of various kinds, generate a series of direct and indirect threats to these complex cultural landscapes and to the archaeological data they contain. Understanding the extent of the risk and predicting its trend would allow us to limit the harmful impact while safeguarding the conservation of a large part of the historical heritage.*
***Key Word**: Archaeological heritage, erosive process, mapping, soil analysis*

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I. Introduction

Soil constitutes the most superficial layer of the earth's crust. This makes it an extremely complex and sensitive element which over time can be subject to a series of degradation processes and threats, including erosion. The erosive process is an irreversible phenomenon and can lead, over time, to the loss of useful information relating to the archaeological heritage [1]. Managing a phenomenon of this type represents a difficult task both in the case in which the archaeological traces are visible, i.e., those evidences whose position and topographic arrangement are well known, but above all in the case in which the evidences are hidden beneath the ground. In the second case, which is decidedly more significant, the position and state of conservation of the cultural asset cannot be defined precisely and therefore coordinating the erosive impact can be even more complicated.

II. Mapping of buried archaeological sites: two Italian projects

Quantifying the presence of archaeological assets and defining their exact position is not simple.

This survey, both for study and protection purposes, makes use of various tools; we cite, for example, historiography, satellite observation, ground penetrating radar, geophysical research through multi-beam echo sounders and magnetometers [2] (the latter particularly useful for evaluating the archaeological research potential of submerged sites) [3].

The interest has led to the formation, in recent years, of more sectoral works aimed at large-scale mapping capable of determining the archaeological potential and estimating the more or less intense presence of archaeological material in the subsoil.

Among the examples we propose the Italian MAPPA project [4]. This created a predictive map for the urban area of Pisa. In summary, the project, through algorithmic processing that takes into account a multiplicity of variables (type of finds, their information potential, functional and topographical relationships that each of them is able to provide, etc.), graphically renders the probability more or less high that in certain areas an archaeological stratification of lesser or greater importance is preserved. To make this possible, both data with a certain geolocation and those with an uncertain geolocation were taken into consideration (i.e., all the elements whose belonging to a specific area is known, but whose precise coordinates are not known). The result obtained by combining these variables is shown in the figure (fig. 1).

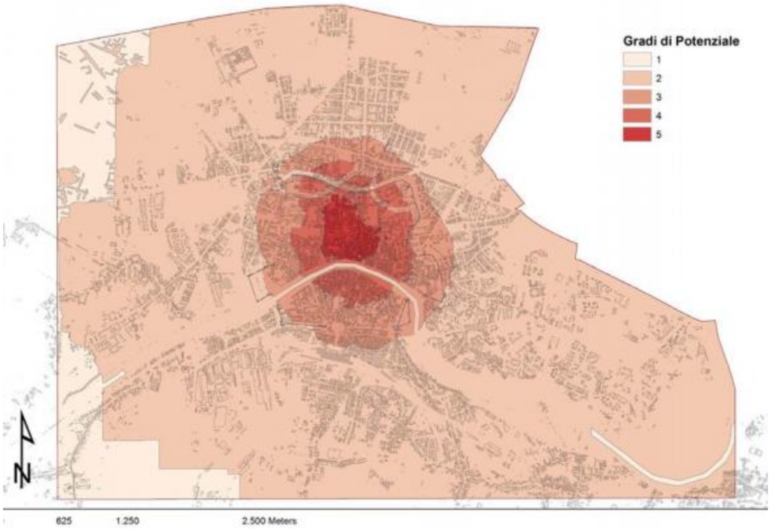

Figure 1: Map of the degrees of archaeological potential of the urban and suburban area of Pisa expressed from the minimum value (1) to the value (ANICHINI et al.2013, fig.7.3, p.117).

Still in the Italian context, the C.A.R.T. (Archaeological Map of Territorial Risk) is included in projects with similar purposes. C.A.R.T. [5] is a territorial information system created by the Institute for Artistic, Cultural and Natural Heritage in collaboration with the Archaeological Superintendency for Emilia Romagna and numerous regional public administrations and is used as a tool for knowledge and protection of the archaeological heritage, but above all as a support for planning of interventions in the territory. The final objective that the project pursues is to develop an interpretative and predictive map of the archaeological risk, a map therefore intended not only as a mirror of what exists, but as a real "preventive" protection tool. This database, interacting with a digitized cartography, allows the development of a series of thematic maps diversified according to the relevant objectives and the users involved, with particular regard to the urban centers of Bologna, Faenza and Forlì (fig. 2).

Figure 2: C.A.R.T

III. Soil analysis

As seen from the examples briefly described above, most of the elaborations derive from information obtained from more or less known data. Yet there are inverse approaches that attempt to hypothesize the presence of hidden archaeological remains, starting from soil analysis.

Starting from the geological characteristics of the soil (hydrology, acidity and alkalinity, types and concentrations of solutes, levels of organic substance dissolved in the soil, vulnerability of the soil to erosion, rigidity) we attempted to understand with what percentage the soil was able preserve the archaeological material still buried. The European map, ESDAC, is particularly useful [6], it is a resource published in the European Soil Data Center and open source.

This map defines various soil types (Albeluvisols, Andosols, Calcisols, Gypsisols, Technosols, Stagnosols, Solonchaks, Solonetz, Regosols, Podzols, Phaeozems, Planosols, Luvisols, Leptosols, Arenosols, Cambisols, Chernozems, Fluvisols, Cryosols, Gyosols Gleysols, Histosols, Kastanozemsdel) describing the characteristics in relation to their geographical position (fig. 3) [7].

Figure 3: The main types of soil in Europe.
https://esdac.jrc.ec.europa.eu/public_path/shared_folder/posters/JRC_europe_sheet_v5.pdf

Understanding which soils have the capacity to best preserve materials of various kinds is invaluable for the management of buried heritage and infrastructure and can also provide information on the long-term impact of waste on soil [8]. It is for this reason that, starting from this map, several studies have been developed that have tried to understand how these particular characteristics influence the conservation of archaeological material underground based on the type of buried evidence: bones, teeth and shells, organic finds materials, metals (Au, Ag, Cu, Fe, Pb and bronze), ceramics, glasses and stratigraphic evidence. (fig. 4).

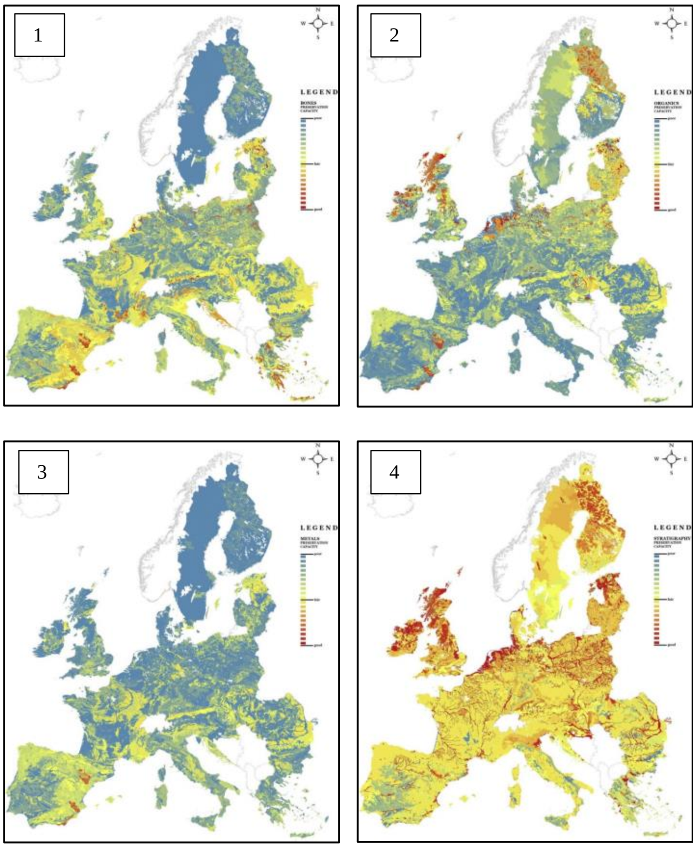

Figure 4: 1) Soil-based preservation capacity for buried bones, teeth and shells across the EU; 2) Soil-based preservation capacity for organic materials across the EU; 3) Soil-based preservation capacity for metals (Cu, bronze and Fe) across the EU; 4) Soil-based preservation capacity for stratigraphic evidence across the EU.258M. (Kibblewhite et al. / Science of the Total Environment 529 (2015) 249–263).

For example, bones, teeth and shells are better preserved in soils permanently impregnated with stagnant alkaline groundwater, as occurs in some lowland peat soils, because these, made up of CaCO3, are particularly sensitive to variations in soil pH. In contrast, ceramic remains better resist biological and chemical degradation; glass, on the other hand, having a very alkaline pH, seems to maintain itself better in those drier soils; organic materials buried in the soil such as plant material (e.g., wood, fibers, fruits, seeds and pollen), animal and human remains, tend to be completely destroyed in aerobic and humid soil conditions, while they tend to be preserved, even if not completely where soil conditions are preserved [9].

IV. Soil erosive processes

The theme of erosivity has occupied a secondary place in the scale of interest of archaeological studies. Yet it represents one of the eight threats listed in the European Commission's Thematic Strategy for Soil [10]; the degradation process is essentially due to the loss of soil (runoff, river erosion, marine erosion, mass movements, glacial erosion, wind erosion, karst erosion) [11] at a rate higher than its formation. This phenomenon contributes to the continuous modeling of today's physical landscape and can be a completely natural event dependent on factors such as climatic conditions, the geological, pedological, hydrological, morphological and vegetation characteristics of the territory, but it can often also be strongly influenced by activities human, in particular those linked to the agri-forestry-pastoral environment.
This phenomenon is constantly evolving and increasing.

Just to provide an example of the erosive extent, just think of the sea that hits the Italian peninsula. According to what was reported by Legambiente, from 1970 to 2020 the stretches of coast subject to erosion have tripled and today 46% of sandy coasts suffer from it, with very different trends between regions and peaks of 60% and more in Abruzzo, Sicily and Calabria [12] (fig.5).

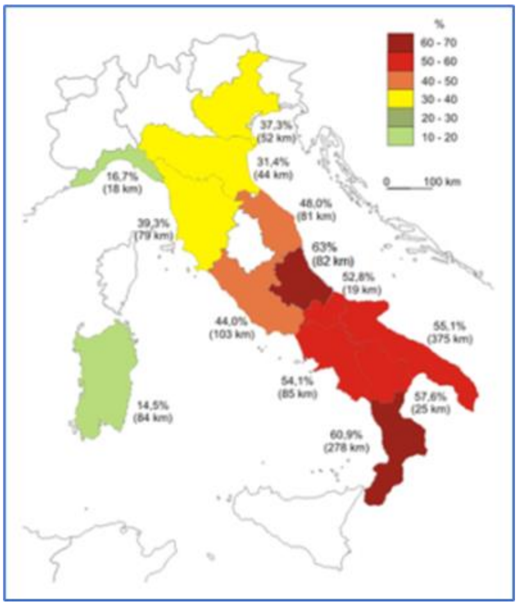

Figure 5: Italy, erosive process http://www.erosionecostiera.isprambiente.it/

In any case, understanding the evolution of erosion in relation to the spatial distribution of the finds can bring considerable benefits. To date, there are several tools, including low-altitude aerial photography, computer vision, soil science, ethnoarchaeology and GIS that offer their support in monitoring cultural heritage (in Italy particular support is provided by VIDEOR [13], ITACA - Innovation Technologies and Applications for Coastal Archaeological Site [14].

Regarding soil loss in Europe, especially that caused by water, a good starting point is provided by the European Soil Data Center (ESDAC) [15], which publishes detailed and updated maps on the progress of erosion processes (fig. 6).

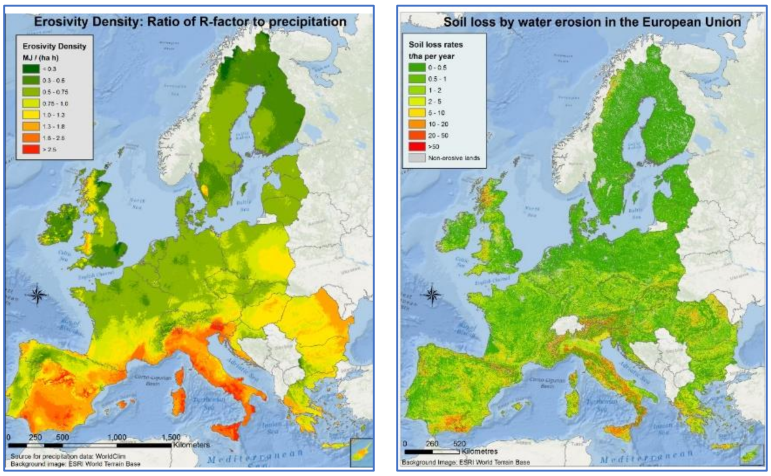

Figure 6: Erosive processes in Europe (ESDAC).

As can be clearly seen from the figure, the European countries belonging to the Mediterranean basin (Italy, Spain and southern France) are those more exposed to threats linked to soil loss compared to the northern ones.

Starting from these premises, some studies have attempted to combine the information obtained from the analysis of erosion processes with that of the conservation of buried archaeological goods.

In particular, the research conducted by AGAPIOU et al. 2020 [16] showed first of all how the majority of areas, for all four types of archaeological material (metals, organics, bones, stratigraphy), are considered low threat areas regardless of the conservation capacity of their soils [17] ; Secondly, it was understood that the Northern countries (e.g. Scandinavians) can be considered almost exclusively low threat areas, unlike the Mediterranean areas which, on the contrary, are characterized by a moderate and high risk: in particular, the Italy seems to be the area most at risk of losing archaeological remains (especially those of organic origin) precisely because the annual loss of soil is quite high (fig. 5). Another area that, similarly to Italy, would appear to have a high rate of soil loss due to erosion and poor preservation of organic material is the southern coast of Spain.

V. Conclusion

Managing a phenomenon like erosion is not easy. This is intended to be a brief intervention aimed at underlining the importance of monitoring this change on which the preservation of archaeological evidence not yet identified depends. It seems appropriate, as a first step, to intervene on the identification of the remains using all the tools available with the consequent drafting of overall archaeological maps that are able to provide a clear and precise idea of the potential. Constant monitoring will ensure that we have a clearer picture of the situation in the future and will allow the definition of targeted safeguard interventions.

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