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GIS applied to the urban archaeology of Enna (Sicily). Towards an archaeological potential predictive model

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Abstract

The development of a traditional urban Archaeological Map, an essential tool to provide a synoptic framework of the knowledge acquired so far, implies the idea of a final product and by now, for this very same reason, it can be considered outdated. It must give way to a far more complex analysis and to the elaboration of a tool useful not only to map the existing phenomena, but also for the study of the land transformation history. The goal is to analyze and then elaborate potential new knowledge based on the predictability of interred resources. Such an approach is in perfect harmony with Preventive Archaeology's latest rules and aims to overcome the concept of "Map of Risk" in favour of a "Map of Archaeological Potential". This will allow: the organization of the urban planning and building choices; the minimization of the archaeological site investigations carried out in an emergency; reduced damage to the public economy. At the same time, it will foster the planning of scientific research and help to conceive the buried archaeological heritage as a resource.

The present project proposes the elaboration of the first archaeological map of the city of Enna through GIS, an instrument which proved to be ideal, especially for the purpose of the difficult reconstruction of ancient urban topography and, therefore, of an assessment of potential buried archaeological sites.

Keywords: Archaeological Information System, Charter of the Archaeological Potential, Preventive Archaeology, Urban Archaeology

1. Introduction

The ancient Henna, called *Umbilicus Siciliae* by Diodorus Siculus[1] for its location in the centre of the island, was founded in the Classical age in a geographical context that was already rich in settlements dating back to prehistoric times. Indeed, this is an area that even if central, we could define as boundary because of its proximity to the Himera Meridionale River, considered a geographical frontier between the East and the West of the island. The city, developed on a 1000 m a.s.l. plateau, is cited as *Urbs Inexpugnabilis*[2] since, thanks to its

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[1] Diodorus Siculus, *Bibliotheca Historica*, book V, chapter III.

[2] Titus Livius, *Ab Urbe Condita,* Decade 2nd, Book 24, chapter 37.

geographical characteristics, it succeeded in resisting to many years of siege. Its origins are rather mythical and if we follow the literary source[3], we should date them to 665 B.C., when Syracuse would have founded it. This a posteriori hypothesis that does not find evidence in the archaeological findings that date back just from the 5th century B.C. when the first coins with legend *HENNAION* were minted (Jenkings, 1975; Caccamo Caltabiano, 2008). The same chronology can be given to the grave objects found in the only necropolis identified along the southern slopes of the mount, in the contrada Pisciotto. Despite the lack of findings dating back to the Greek age, the city is frequently cited by the sources of the time as a popular and venerated place as cradle of the *vetustissimam Cererem*[4], goddess of harvest and agriculture, mother of Proserpina, the girl kidnapped by the god Pluto. Several ancient writers localize the place of the rape around the Lake of Pergusa, a few kilometers from the city where a sanctuary dedicated to the goddesses with one or more temples and statues had been erected[5]. Local historians[6], from the 16th century, and the first archaeologists, from the end of the 19th century moved in search of these monuments. This research in fact turned out to be useless since the settlement on the plateau continued uninterruptedly and the historical phases overlapped.

2. From the Archaeological Map to GIS

To build an urban archaeological map means to draw this overlapping and account, on the one hand, for all the transformations the urban pattern has been subjected to, and, on the other, for all the lost data. This is the reason why GIS can be considered as a fundamental tool for archaeological research.

The use of IT tools to record and file archaeological data is not recent and it has been several years since software packages were developed able to manage the very large amount of data that can be produced during the research. The Database management systems, for instance, represented an important turning point in this sense, making it possible to manage the whole complex of documents all research should be equipped with and to connect historical, archaeological, excavation, topographic, photographic and graphic data.

Moreover, the use of artificial intelligence also made it possible to process data, connect them and calculate statistics in order to develop more complex analysis.

At the beginning this process concerned just the alphanumeric data, but we have been able to record an increasing use of tools for some years now that are able to manage and process the geographical data too. In this case too, a first phase, during which the IT tools were used just to go beyond the paper maps, is now followed by a second phase in which we ask the IT tools not only for the exact localization of data but also their analysis and processing.

This is why we believe that today we cannot conceive the idea of building an archaeological map without the GIS support, a system born for wider geographic scopes borrowed from archaeological research with more and more specific applications that range from large scale, in landscape archaeology[7], to the micro area of a stratigraphic excavation (Fronza et al., 2001), that can be managed in greater detail towards a truly surprising prospective of processing and analysis of data[8].

During the last 30 years (Allen et al., 1990) the adoption of GIS in archaeology has seen the

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[3] Stephanus Byzantinus, The Ethnica, under the heading "Enna".

[4] Cicero, *In Verrem,* book IV.

[5] We find references to the temples in Pomponio Mela, *De Chor*, II, 7; Strabo, *Geographica*, VI, 2, 6-7; Cicero, *In verrem*, IV, 48. The statues are cited and partially described by Cicero, *op. cit.*, book IV, chap. 49.

[6] Littara, 1587; Giovanni dei Cappuccini, 1752; Lo Menso, 1813; Vetri 1883.

[7] Some examples of GIS applications to the landscape archaeology are in Arnese, 2004; Eitel, Panagiotopoulos and Siart, 2008; Ayhan and Cubukcu, 2010.

[8] For the use of GIS in archaeological research, see Moscati, 1998; Moscati and Tagliamonte, 2002; Brogiolo and Delogu, 2006. Among the most significative experiences in the use of GIS for Urban archaeology, see Anichini and Gattiglia, 2012; Gelichi and Librenti, 2011; Brighi, 2011; Jessop, 2005; Tepstra and Rose, 2016.

development of a branch of research aimed at adapting the system to the archaeological field to such an extent that today we prefer to use the new acronym AIS, Archaeological Information System (Anichini and Gattiglia, 2012, p. 31).

3. The Archaeological Information System of the urban area of Enna

The work carried out for the development of the GIS for the urban archaeology of Enna followed a path marked by some steps that we briefly summarize here below.

3.1 First step: the census of what is known and its critical issues

The first phase consisted in the research and collection of existing data in order to achieve a preliminary census of what is known: this research included the analysis of ancient, historical, numismatic and epigraphic sources. This was followed by the examination of the archaeological research conducted in the urban area since the end of the 19th century, a phase mainly characterized by antiquarian collections followed by the real archaeology with Paolo Orsi from the beginning of the 20th century, then by a long silence that lasted more than fifty years until the end of the '70s, when a policy that was increasingly aware of the correct management and protection of the archaeological heritage got started[9]. The examination of the published documents has been followed by that of the unpublished ones through a survey of the archives of the Archaeological Section of the Soprintendenza BB.CC.AA. of Enna, that contain all the rough data, that is, the documents that are delivered after archaeological research. The archives also contain maps with the limits of the areas subject to protection constraints and the perimeters of the areas of archaeological interest.

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[9] Here the main bibliographical references regarding the archaeological urban research at Enna: Orsi, 1915, 1931; De Agostino, 1942-1943; Bernabò Brea, 1947; Fiorentini, 1980-1981; Cilia, 1985; Guzzardi, 1997-1998; Cilia and Fiorilla, 2006; Bonanno, 2013; Giannitrapani, Nicoletti and Valbruzzi, 2015: Valbruzzi and Giannitrapani, 2015.

This step was rather long and complicated and required many months of work, coming up against many critical points. The history of the archaeological research in the urban area of Enna, for a series of reasons ranging from discontinuity in leading the research, to the continuous and frequent succession of management figures in charge of the protection of the sites and, last but not least, the non-publication of the emerged data, shows long silent periods and a lack of homogeneity in the data production. To date, an overall interpretation, based on the actual archaeological data and not on interpretative hypotheses, has encountered big problems in being produced. Due to the lack of research, the weight of the ancient sources has been rather dominant up to now: to them alone, unfortunately, we can connect the image of a classical city that the archaeological research has not been able to resurface yet. The profusion and the prestige of some of these sources has, to some extent, diverted the gaze of eminent scholars who, trying to confidently confirm what has been handed down, have misrepresented the archaeological data and contributed to perpetuating wrong interpretations and distorted perspectives.

In this sense, the use of the GIS platform that was created has given rather meaningful results. In fact, the collection and filing of the archaeological documentation in a Database made up of related tables, required the elaboration of a specific vocabulary and a *thesaurus* of terms that was as objective as possible. This entailed the very difficult job of extracting the raw data from the interpreted ones with the result that we rebuilt a history of the archaeology of Enna that may be poorer and less fascinating, but is free of a series of superfluities not based on strictly scientific information.

The Database has been created through the Microsoft Access software and is built on a series of tables that have been connected to each other through the ID-code related to every single site. This is an index-linked numerical field that does not allow duplicates and so identifies the site unequivocally. It is a necessary condition to relate all the tables within the Relational

Database system and these tables to the records of the Geodatabase in our GIS platform.

By now the Relational Database (Figure 1) is made up of a limited number of tables:

1. the primary, called "Scheda Sito", containing all the main data referred to the site (name, localization, typology, chronology, state of conservation, juridical condition, bibliography, etc);
2. the "UT" (topographic unit) table;
3. the "SAS" (stratigraphic archaeological essay) table;
4. the "US" (stratigraphic unit) table;
5. the "Localization" table, where all the data

referred to the place of the finding are contained;
6. the "photographic documentation" table;
7. the "graphic documentation" table.

Following a hierarchical architecture, we also connected the "cases tables" (containing the catalogue of finds) to the US and UT tables and RA table (archaeological finds sheets) to the "cases" ones.

Since it is conceived as an open architecture, this Database, which is basic at the moment, can be implemented at every moment and at every step of the research.
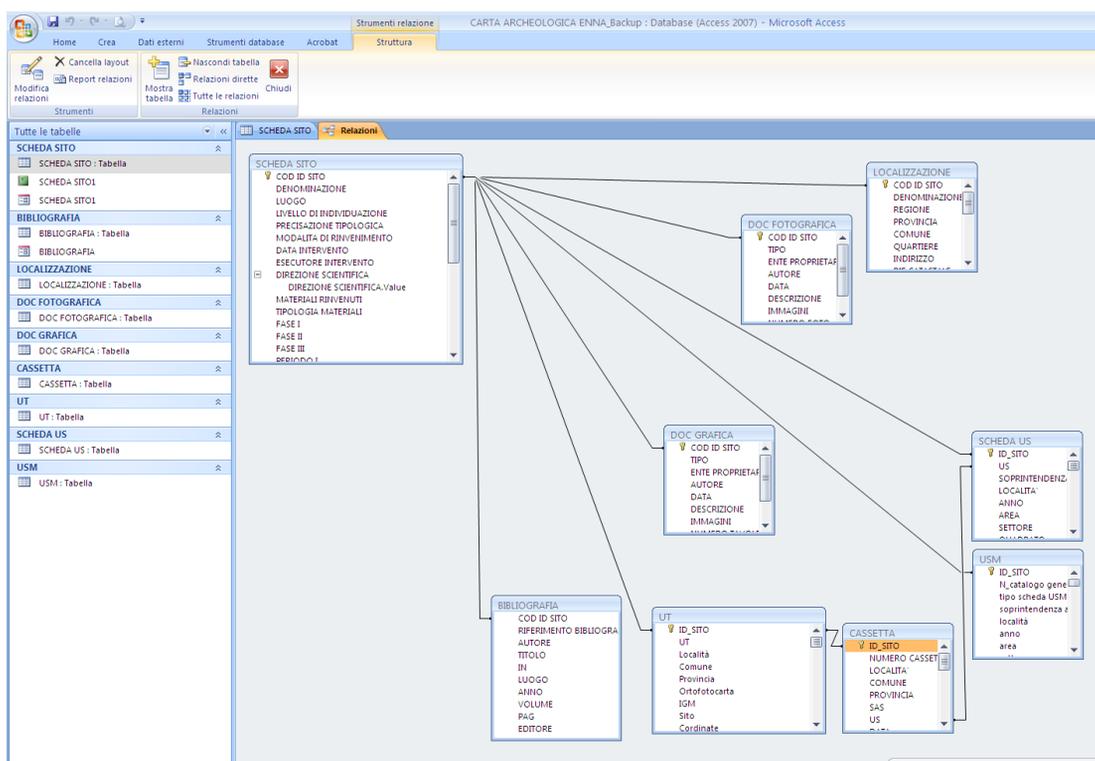

Figure 1. Structure of the External Relational Database linked to the features in Arcmap. Source: Author's elaboration.

Our Database has been conceived with two aims: to create a large box able to file as many data as possible coming from very different sources, and a platform able to communicate with the GIS tool.

3.2 Second step. Creation of the GIS platform

The second step consisted in the input of all the geographical data in *ArcMap*, that is the locationing of all the certain or supposed sites. The geographical data have been digitalized on

different layers and geo-referred on digital vectors or raster based cartographies.

The documentary base of the Project consists of a cartography which, grouped in a single set of data, brings forth the Group Layer of the Territorial Maps at different scales, from 1:25,000 to 1:2,000, to which the orthophoto graphic map, the DEM and some historical maps have been added.

On this basis, the geodatabase of all the archaeological interventions and the discoveries of the urban area of Enna has been created (Figure 2). We chose to distinguish, on different *layers*, the data obtained from "Literary and historical sources", based on rarely verified hypothetical locations; those deriving from "Archaeological research conducted at the end of the 19th / early 20th century", which, against any expectation, are rather precise and therefore are represented by punctual shapefiles; "Archaeological investigations from the second half of the '70s", when the Office of Soprintendenza BB.CC.AA. of Enna was established (however there is a rather fruitful phase of research not followed by an adequate edition of the results); and all the data resulting from "Inspections, alerts and urgent interventions". This Group layer, called *Archaeological Heritage*, also contains the polygonal shapefiles of the "Perimeter of the areas subject to protection constraints"[10], and the "Perimeter of the areas of archaeological interest for PTPR", developed on paper by the Soprintendenza BB.CC.AA. of Enna and digitalized, here, on polygonal shapefiles. Finally, other layers are constituted by the "Toponymy Testimonials", by the localization of the medieval "Well system"[11]; and by the linear path of the "Trazzere"[12].

Each of the layers listed above is connected to a related table reporting synthetic data. The item ID_SITO, containing a univocal code for every single site, allowed us to identify, without margin of error, each archaeological site and to connect it to the related external database that communicates with our GIS platform through the function *Join*. The exact correspondence of the code attributed to a single site on every table connected to it, guarantees the match between the systems and their interoperability.

4. Results and perspectives

4.1 Back to the objective datum

One of the aims of this research using the GIS platform was to strip the archaeological data from the interpretative apparatus that inevitably grew around it and to locate the naked data on a map with a predictive role. That is why the GIS functionality came to our aid. The mere possibility of linking each piece of geographical data to a table containing objective and precise information means that every single point marked on the map "speaks", not hiding its true nature, the accuracy of the positioning, the real data we have and those that are only interpretative hypotheses. Indeed, for each site a field called "Level of Localization" has been included in the table, which allows us to distinguish, even in the cartographic visualization using various kinds of symbols, which sites are supposed to exist only thanks to bibliographic sources and which, instead, can be located with certainty. So, while on a static map each point was equivalent to another and, for example, the hypothetical localization of the still to be found ancient theatre had the same value as the real location of a well, a grave and what has really been identified, our platform gives back to each element its real value and meaning, leaving no room for misunderstandings or recon-structions based on unproven data. This, in our opinion, is already an essential result.

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[10] Available on the S.I.T.R. provincial Knot website (Soprintendenza BB.CC.AA. of Enna Data Processing). Direct link: http://www.regione.sicilia.it /bbccaa/Dirbenicult/soprintendenze/vincoli/Archeolo gici/archeoEn.html.
[11] For a recostruction of the well system, see Maggiore, 2010, pp. 229-240.
[12] *Trazzere* is the name given, in the local dialect, to the ancient roads. The "Regie Trazzere of Enna shapefile" can be downloaded at the following link:

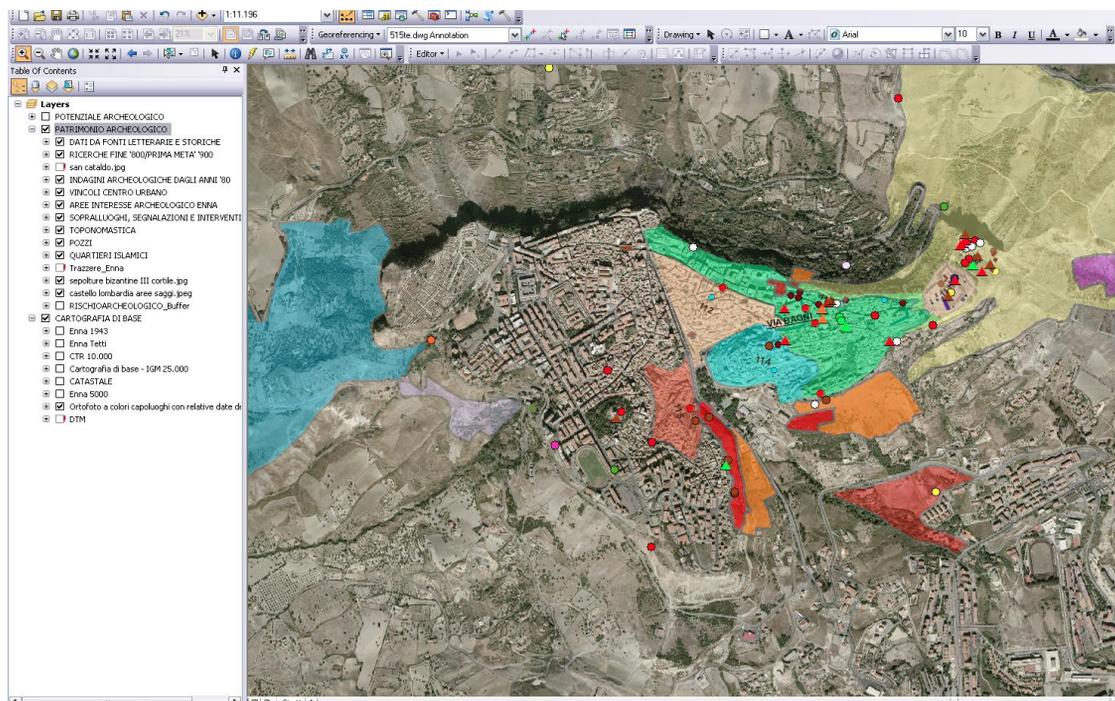http://www.opendataterritorioenna.it/dati-scaricabili/rete-trazzerale-della-provincia-di-enna/.

Figure 2. Screenshot of the Project "Urban Archaeology GIS of Enna". Source: Author's elaboration.

4.2 The Analysis

All the fields included in the Geodatabase, together with the more numerous and complex ones in the external relational database, linked through the *Join* function to our geographic data, allow a number of simple or combined queries that we can define as infinite, especially if we consider that, as this is an open platform it will be possible at any time to implement it by integrating missing and adding new data.

The archaeological GIS of the city of Enna, finding itself in a phase that we could define embryonic, is already very useful in the basic query forms of the system, because they make it possible to reflect on the ancient urban topography, which is vital for the development of any other observation.

The query selections carried out on the chronology of discoveries, combined with those connected to their typology and re-elaborated by spatial analysis tools, enable us to outline phase maps (Figure 3).

A more correct positioning of the finds, and the extrapolation of the merely supposed locations give us a more accurate picture of the different settlement phases and the dynamics of exploitation of the plateau. Therefore, now it is possible to get rid of the heavy conditioning imposed by ancient sources and the wrong location or dating of the findings.

Interesting observations have also been made in terms of the reconstruction of the history of the research and the methodologies that characterized it: for example, in the "method of discovery" field, within which the "planned excavation", "site identified as a result of reporting", "inspection result", "occasional recovery" items were made selectable, some statistical evaluations were made which should lead to a deeper reflection on how much this has influenced and continues to influence, the correct interpretation of the data.

On a programmatic basis, it would then be appropriate to develop recovery and restoration programs and policies by questioning the system on the "degree of conservation" that each site presents or to plan a more careful protection by analysing the fields related to the "legal status" of goods and, above all, by developing analyses on the fields called "archaeological risk", "archaeological building risk" and "protection proposals" in order to develop a specific urban policy and more targeted research and protection programs.
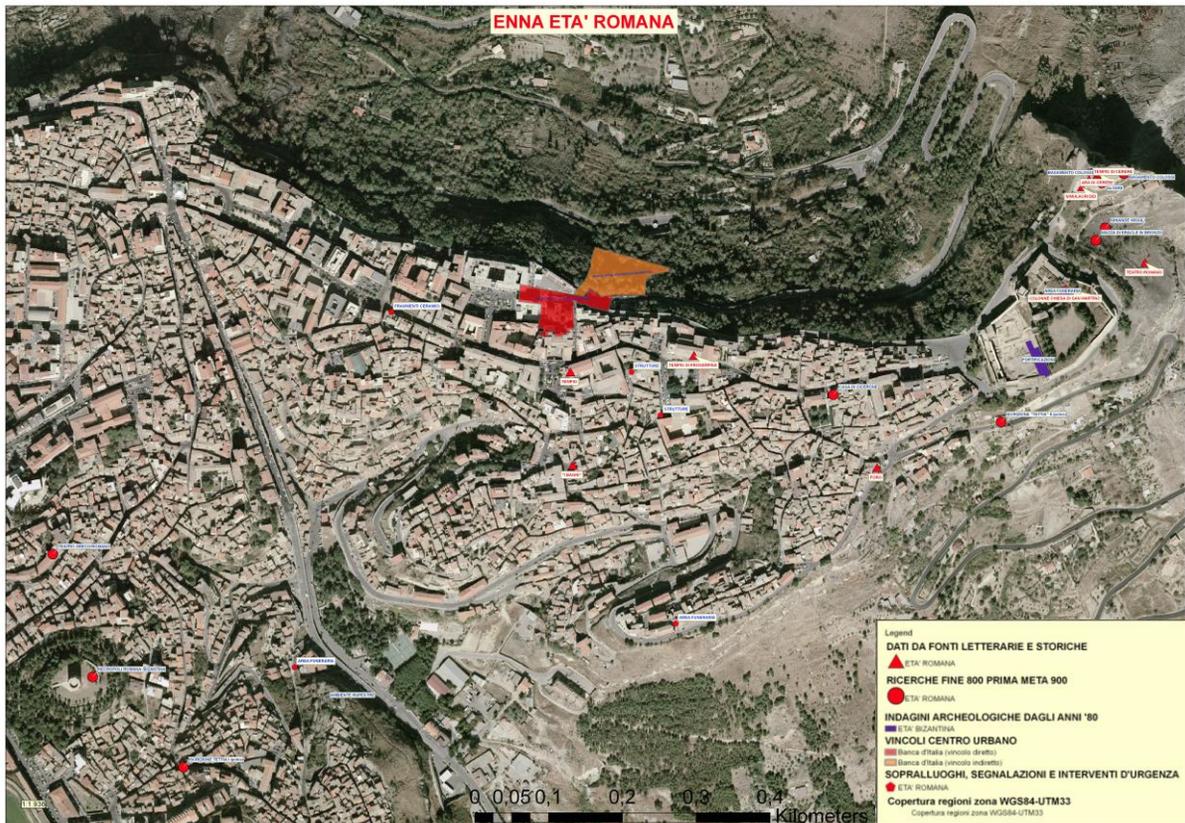
Figure 3. Phase map based on findings dating back to the Roman period. Source: Author's elaboration.

4.3 The Map of the Archaeological Potential

The collection of data deriving from archaeological research was accompanied by an analysis of the city's most recent urban history: some ancient cartographic documents were uploaded on the platform, reproducing the state of expansion of the city in relatively recent years.

The following map (Figure 4) is a 1943 topographic city plan realized by the US army[13], overlaid on a 2010 orthophoto[14].

This overlapping of two different moments of the history of the city, together with the "switching-on" of the findings of some areas, led us to reflect on a particular moment of the history of archaeology: the beginning of the '30s, when the first research was conducted on

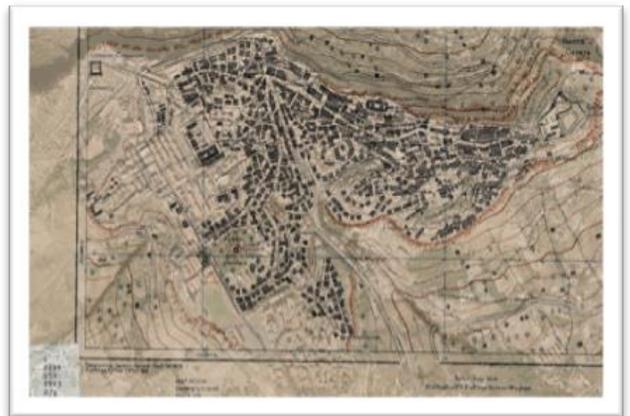the western side of the Enna plateau.

Figure 4. Map of Enna of 1943 on an orthophoto of 2010.

At that time, this large non-built-up area was considered barren even from an archaeological point of view. According to some sketchy information related by Paolo Orsi, we know that

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[13] The chart has been downloaded from http://www.lib.utexas.edu/maps/ams/italy_city_plans/
[14] Downloadable from: http://wms.pcn.minambiente.it/ogc?map=/ms_ogc/WMS_v1.3/raster/ortofoto_colore_capoluoghi.map&.

when explored, some of these areas were not exactly virgin but already deeply transformed by the presence of quarries. Although the area was already ruined by mining activities, rare fragments of prehistoric sherds and Greek tiles were found (Orsi, 1931, p. 380). Thanks to the recent publication of part of Paolo Orsi's notebooks (Valbruzzi, 2015), today the news is that "in the esplanade near the Tower of Frederick II" late Roman or Byzantine burials had been found. This data, combined with the discovery of a headstone in the same area with the Latin inscription on *tabula ansata*, seem sufficient to exclude the hypothesis that the area was not frequented.

Today we believe that the archaeological research that was still in an embryonic state in the '30s did not manage to properly document the area: in fact, as visible on the maps dating back to the '50s and '60s, in the following years this part of the plateau underwent the most profound transformation subjected to a trend of urbanization to be considered among the most impressive in the history of the city. A photographic documentation of the years preceding the building boom came to our rescue in this sense too.

Therefore, if scholars have been inclined to state for several decades that the ancient settlement was located only on the eastern part of the plateau, in the light of what has been ascertained thanks to the analysis resulting from the present study, we believe that we must also focus on the western sector of the town.

This has a significant influence on our assessment of the archaeological Potential.

The Map of the Archaeological Potential obtained by this analysis (Figure 5) outlines the different levels in the following way: in red, HIGH level of potential, areas with the most significant results during the archaeological research and areas focused on because of historical data and tradition, despite the poor findings. In yellow: areas where we believe it is still possible to identify ancient traces, despite the fact that the archaeological research has not

recorded significant findings (MEDIUM). The remaining part of the western sector of the plateau is outlined in green (LOW): this is the widest area affected by the invasive building activity from the '50s to the '80s. A fourth level of risk, MEDIUM HIGH, was created through the GIS Buffer function and affects the slopes. Therefore, a 200 meter width band has been traced all around the areas marked on the plateau: a summary and only indicative delimitation, apt to include the slopes of the urban centre certainly affected by a secondary distribution of finds, by necropolis or fortification sections.

The resulting map highlights a differentiation of areas according to their potential to show traces of the past. Consequently, it could be transformed not so much into an instrument whereby we could impose bans for public or private works, but into an opportunity for all the parties involved to develop projects, so to reconcile protection and scientific research in a smart, history respectful urban development.

5. Conclusions

The need to geo-refer uncertain or only supposed data has forced us to reflect on previous research and to ascertain the numerous "information gaps" gathered over time. These holes, almost physiological in multi-layered sites and in continuity of life such as urban centres, are on the one hand mainly due to the loss of information following demolitions and destruction and, on the other hand, to the difficulty in interpreting complex stratigraphies.

Nevertheless, the biggest voids are mostly owing to the lack of continuity in the research and classification. Today, as a result, there is not only little conformity in what has been published so far, but also among the archival data of the Soprintendenza we face a fragmentary and incomplete documentary production.
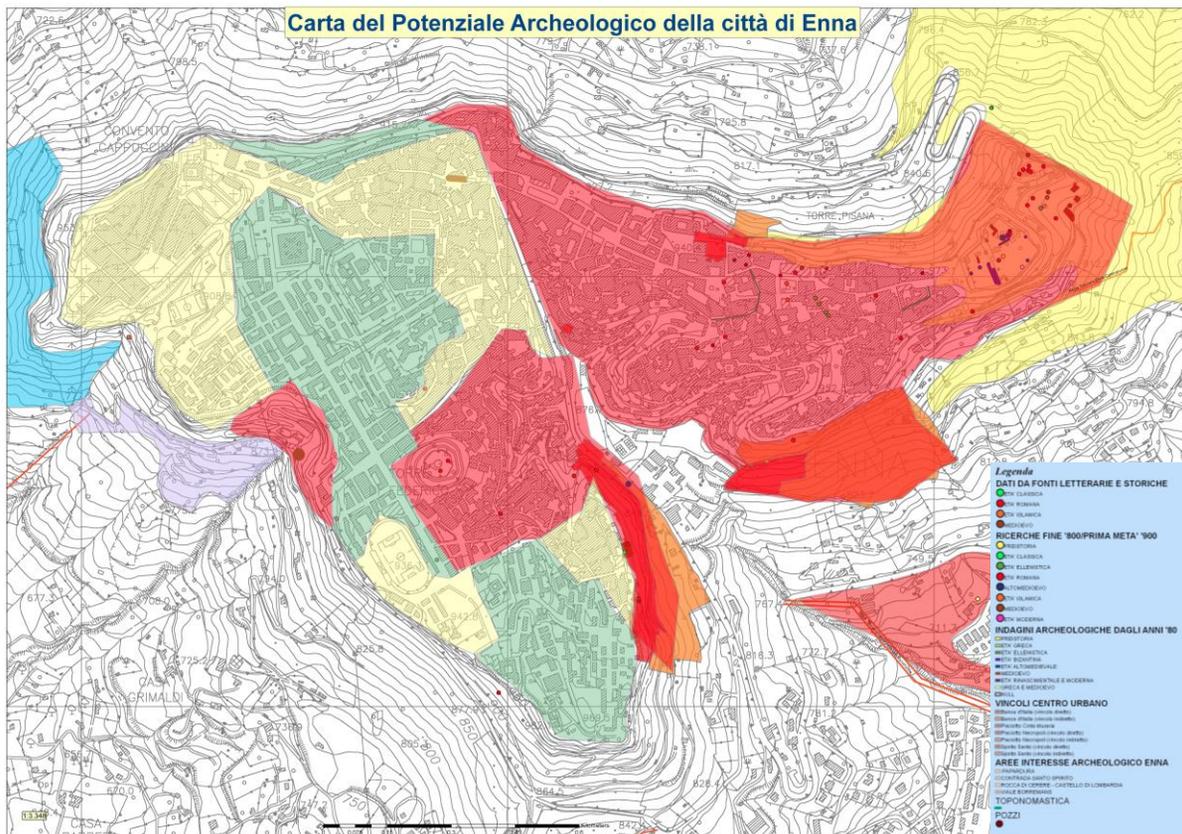
Figure 5. Map of the Archaeological Potential of the Urban area of Enna. Source: Author's elaboration.

This work was born with the belief that a GIS dedicated to urban archaeology is not only a useful tool to take a census of all the data produced by discontinuous and confused research in order to reorganize and reconsider them, but also a necessary instrument for the protection and management of the urban area.

If the research and protection bodies of the archaeological heritage adopted such a system consciously and commonly, it would acquire the role of an open source bank where all data could merge. This would reduce the dispersion of information to a minimum, oblige all professionals or operators to use standard criteria of general documentation and guarantee a minimum level of cataloguing of the data.

On the other hand, used by the territorial management bodies, it would become an invaluable tool for urban planning and the preliminary planning phase of public procurements, as it would speed up the survey procedures of the *Archaeological Interest Preventive Evaluations* regulated by the Code of Public Procurement and aim to avoid the unlucky event of bumping into unexpected finds of archaeological artefacts during the excavation work.

To produce a map based on the *predictivity* of the buried resources, recording the hidden archaeological deposit but also highlighting all the areas where it has been irreparably compromised, means to approach a model of *preventive* urban archaeology. This is the reason why we prefer to use the definition "Map of the Archaeological Potential" to "Map of the Risk": it is not just a matter of semantics. It is a deeper difference that has to exercise influence on the mentality of those who live in and those who govern a city; a change in perspective to go beyond the idea of an archaeology of emergency, towards archaeological research and urban development planning that provides for the protection and enhancement of an archaeological heritage that has to be interpreted as a real resource.

References

1. Allen K.M.S., Green S.W. and Zubrow E.B.W. (Eds), *Interpreting Space: GIS and Archaeology*, London, 1990.

2. Anichini F., Dubbini N., Fabiani F., Gattiglia G. and Gualandi M.L. (Eds.), *MAPPA. Metodologie Applicate alla Predittività del Potenziale Archeologico*, I, Rome, Nuova Cultura, 2013.

3. Anichini F., Fabiani F., Gattiglia G. and Gualandi M.L. (Eds.), *MAPPA. Metodologie Applicate alla Predittività del Potenziale Archeologico*, I, Rome, Nuova Cultura, 2012.

4. Anichini F. and Gattiglia G., "Urban Archaeological Information System. Riflessioni e criticità", in Anichini F., Fabiani F., Gattiglia G. and Gualandi M.L. (Eds.), *MAPPA, Metodologie applicate alla predittività del Potenziale archeologico*, vol. I, Rome, Nuova Cultura, 2012, pp. 31-39.

5. Arnese A., "GIS for archaeological survey in Kaulonia", *Proceedings of the 31st CAA Conference* (Wien 2003), BAR International Series 1227, 2004.

6. Ayhan I. and Cubukcu M.K., "Explaining Historical Urban Development Using the Locations of Mosques: A GIS/Spatial Statistics-Based Approach", *Applied Geography*, 30, 2, 2010, pp. 229-238.

7. Bernabò Brea L., "Enna (Iscrizione ricordante una sacerdotessa di Cerere. ENNA – Chiesetta rupestre bizantina dello Spirito Santo. Enna – Villaggio preistorico del IV periodo siculo al Cozzo Matrice)", *Notizie degli scavi*, I, VIII, 1947, pp. 241-246.

8. Bonanno C., "Il castello di Lombardia alla luce delle recenti indagini archeologiche", in Bonanno C. and Valbruzzi F. (Eds.), *Mito e Archeologia degli Erei – Museo Diffuso Ennese. Itinerari archeologici*, Soprintendenza per i Beni Culturali e Ambientali di Enna, Palermo, 2013, pp. 25-26.

9. Brighi O., "Urbanistica ed archeologia preventiva a Cesena", in Gelichi S. and Negrelli C. (Eds.), *A piccoli passi. Archeologia predittiva e preventiva nell'esperienza cesenate*, Florence, 2001, pp. 51-55.

10. Brogiolo G.P. and Delogu P., "La città italiana alla luce del convegno di Ravenna", in Augenti A. (Ed.), *Le città italiane tra la tarda Antichità e l'alto Medioevo*, *Proceedings of the Conference* (Ravenna, 26-28 February 2004), Florence, 2006, pp. 615-628.

11. Caccamo Caltabiano M., "Il ruolo di Demetra nel documento monetale greco", in Di Stefano C.A. (Ed.), *Demetra, La divinità, I santuari, il culto, la leggenda*, *Proceedings of the I International Conference* (Enna, 1-4 July 2004), Pisa-Rome, 2008, pp. 123-134.

12. Carafa P., "Teaching and Researching with the GIS: an archaeological story", *Journal of Research and Didactics in Geography (J-READING)*, 1, 2, 2013, pp. 73-83.

13. Cilia E., "Enna archeologica", in AA.VV., *Henna tra storia ed arte*, Palermo, 1985, pp. 133-169.

14. Cilia E., "Attività della Sezione Archeologica della Soprintendenza di Enna", *Kokalos*, XXXIX-XL, II, 1, 1993-1994, pp. 917, 921-922.

15. Cilia E. and Fiorilla S., "Archeologia urbana ad Enna. La Chiesa di San Cataldo, primi dati sull'abitato medievale", *Proceedings of the 4th National Conference of Medieval Archaeology*, (Abbazia di San Galgano, Chiusdino, 26-30 September 2006), Florence, 2006, pp. 186-190.

16. De Agostino A., "Studi sulla topografia di Henna", *Bollettino Storico Catanese*, VI-VII, 1942-1943, pp. 117-129.

17. Eitel B., Panagiotopoulos D. and Siart C., "Investigation of Past Archaeological Landscapes Using Remote Sensing and GIS: A Multi-Method Case Study from Mount Ida, Crete", *Journal of Archaeological Science*, 35, 11, 2008, pp. 2918-2925.

18. Fiorentini G., "Ricerche archeologiche nella Sicilia centro-meridionale", *Kokalos*, XXVI-XXVII, II, 1, 1980-1981, pp. 581-600.

19. Fronza V., Nardini A., Salzotti F. and Valenti M., "The GIS solution for an excavation. Some considerations about the experience of

the Medieval Archaeology Chair at the University of Siena", *Proceedings of the 28th CAA Conference* (Ljubljana, 2000), BAR International Series 931, 2001, pp. 173-177.

20. Gelichi S. and Librenti M., "La Carta di rischio archeologico urbano di Cesena: dieci anni dopo", in Gelichi S. and Negrelli C. (Eds.), *A piccoli passi. Archeologia predittiva e preventiva nell'esperienza cesenate*, Florence, All'Insegna del Giglio, 2011, pp. 29-36.

21. Giannitrapani E., Nicoletti R. and Valbruzzi F., "La campagna di scavi archeologici 2008 presso la Rocca di Cerere a Enna – i dati (Dataset)", 2015, http://mappaproject.arch.unipi.it/mod/Documents.php?pk=55896ccdcae9c5.45170015.

22. Giovanni dei Cappuccini, *Istoria Veridica dell'Inespugnabile città di Castrogiovanni e della sua antichità*, Enna, 1752.

23. Gottarelli A. (Ed.), *Sistemi informativi e reti geografiche in archeologia: GIS-Internet. 7° Ciclo di lezioni sulla ricerca applicata in archeologia*, Florence, All'Insegna del Giglio, 1997.

24. Guzzardi L., "L'attività della Soprintendenza ai Beni Culturali e Ambientali di Enna nel settore archeologico: 1996-1997", *Kokalos* XLIII-XLIV, 1997-1998, 1, pp. 291-310.

25. Jenkins J.K., "The coinage of Henna, Galaria, Piakos, Imachara, Kephaloidion, Longane", *Proceedings of the 4th Conference of the Numismatic Centre* (Naples, 9-14 April 1973), Rome, Istituto Italiano di Numismatica, 1975, pp. 78-83.

26. Jessop M., "The Application of a Geographical Information System to the Creation of a Cultural Heritage Digital Resource", *Literary and Linguistic Computing*, 20, 1, 2005, pp. 71-90.

27. Littara V., *Historia Haennensis*, Caltanissetta, 2002.

28. Lo Menso V., *Descrizione storico topografica della regia città di Castrogiovanni*, 1813.

29. Maggiore G., "Enna, l'impianto urbanistico islamico (IX-XI secolo): dati preliminari", in

Pensabene P. (Ed.), *Piazza Armerina, Villa del Casale e la Sicilia tra tardo antico e Medioevo*, Rome, L'Erma di Bretschneider, 2010, pp. 229-240.

30. Moscati P., "GIS Applications in Italian Archaeology", in Moscati P. (Ed.), *Methodological Trends and Future Perspectives in the Application of GIS in Archaeology*, *Archeologia e Calcolatori*, 1998, pp. 191-236.

31. Moscati P. and Tagliamonte G., "GIS Applications in Italian Archaeology. The Results of a Survey and the Development of the "Caere Project", in García Sanjuán L. and Weathley D.W. (Eds.), *Proceedings of the European Workshop on ARM & GIS*, (Sevilla, 1999), Sevilla, Pedro Cid, 2002, pp. 75-83.

32. Orsi P., "Castrogiovanni. Esplorazioni nel Castello di Lombardia", *Notizie degli scavi*, VI, 1915, pp. 232-233.

33. Orsi P., "Studi preliminari sulla topografia dell'antica Enna", *Notizie degli scavi*, VII, 1931, pp. 373-394.

34. Tepstra N. and Rose C. (Eds.), *Mapping Space, Sense, and Movement in Florence. Historical GIS and the Early Modern City*, London, 2016.

35. Valbruzzi F., "Sulle orme di Paolo Orsi: la ricerca archeologica nell'antica Enna dall'unità d'Italia al nuovo millennio", in Guida M.K. and Russo P. (Eds.), *Arti al centro. Ricerche sul patrimonio culturale della Sicilia centrale 1861-2011*, Florence, Polistampa, 2015, pp. 251-267.

36. Valbruzzi F. and Giannitrapani E., "L'immagine ritrovata di una città antica: l'archeologia urbana ad Enna", in Anichini F., Gattiglia G. and Gualandi M.L. (Eds.), *MAPPA Data book 1, I dati dell'archeologia urbana italiana*, Rome, Edizioni Nuova Cultura, 2015, pp. 39-55.

37. Vetri P., *Storia di Enna. Dai primordi all'invasione araba*, 1883.