

## The GIS of the territory of Poseidonia-Paestum

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**Abstract:** The paper concerns the implementation of GIS of the territory of Poseidonia-Paestum, developed within the urban planning of the municipality of Capaccio (Italy). Its construction involved the systematic collection, comprehensive and integrated of all available information and the construction of supports for the monitoring of archaeological remains.

The work involved the creation of an archaeological cartography useful for the purposes of the administration, protection and research.

The data collected were processed to produce thematic maps, spatial analysis and statistics, with the aim of evaluating the archaeological potential of the area. Through operations overlap, control and analysis of documents, a systematic process of rationalization of the management of Heritage has been implemented. From this point of view the archaeological map constitutes the basis for storage of geo-referenced spatial data and alphanumeric, developed as an open system, which can be used by other GIS systems.

The system allows to distribute the recoveries in the territory with different degrees of reliability, to know which areas have yielded ancient evidence and which others can potentially hide in the subsurface traces of ancient occupation. The system can assist the action of territorial protection and, at the same time, ensure its more effective planning. It offers the meaning of a dynamic area that does not remain stuck in the peremptory administrative acts, such as archaeological restrictions, but binds the land use and the real nature of the archaeological finds.

The system is built according to an open approach, considered as a possibility of the map sharing from the various Institutions: Local Authorities, Research Institutes and Archaeological Superintendence.

**Keywords:** Database; GIS; Spatio-Temporal Modeling

### Introduction

The archaeological GIS of Paestum area has been designed in the urban planning of Capaccio (for a general discussion about archaeology and urban planning VOLPE et al. 2009). The area includes a wide part of the Sele plan between the rivers Sele and Solofrone. The ends inside are fixed at the first relieves of the southern Appenine (Fig.1).

The area has a relevant archaeological value (Fig. 1). The city of Poseidonia-Paestum is in the center of the plain. The sanctuary of Argive Hera is north facing. The city was founded by Sybaritic people during the seventh century BC and continued until the Roman Imperial age (GRECO 1979; GRECO-STAZIO-VALLET 1987; GASPARRI 1989; GASPARRI 1990; AVAGLIANO 1992; GRECO 1992; LONGO 1999; CIPRIANI 2002; VOZA 2008).

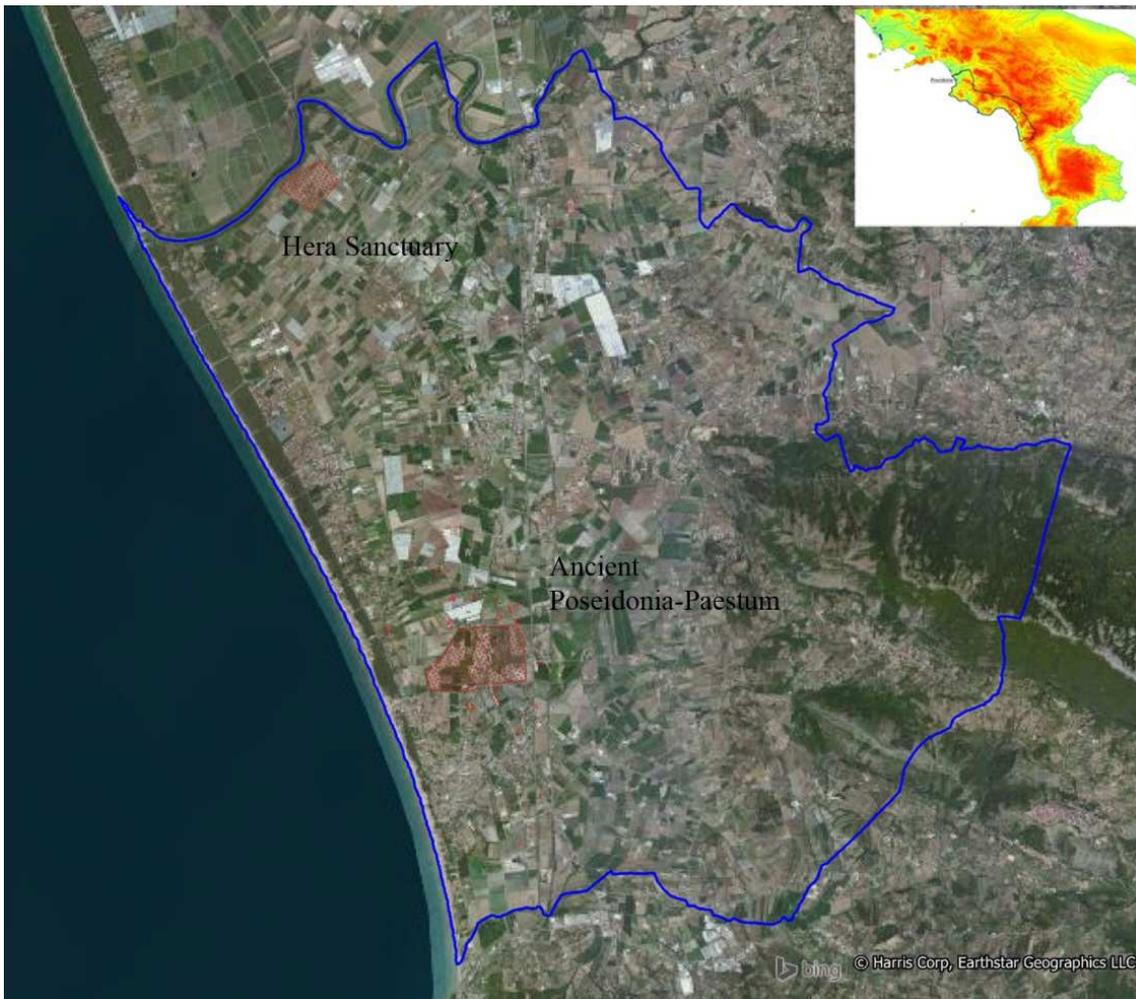


Fig. 1 – Capaccio municipality area

The work is the result of a deep research on the sources and methods to realize the instruments of the representation and management of the ancient material Heritage. It considered the census of the archaeological discoveries made during the years through each type of inquiry. Data collected has been inserted in an Informative Territorial System built in a GIS environment.

The collection of the bibliographic and unpublished documentation has been done in the archives of the Public Archaeological Service in Salerno, preserved in the head office and different offices of the National Archaeological Museum in Paestum. Furthermore, I analyzed the elaborations of archaeological cartographies made for the Regional Territory Map (CTR – Campania Region), the Territory Coordination Plan of Salerno Province (PTCP), and the map of Cultural Heritages of Cilento Park and Vallo di Diano. Later, thematic cartographies, spatial and statistical analysis were produced. This system gives the possibility to share the maps between the different institutions: Territorial Institutions, Research Institutions and Archaeological Soprintendenza.

In short, this system allows distributing the discoveries of the territory according to different levels of reliability and be aware of the areas that can potentially hide traces of ancient occupations in the subsoil.

## SIT Structure

The archaeological data has been organized as a system in order to build a unified SIT. The adoption of the system makes more easy and coherent the phases of inserting, updating, consultation and demand of information. It is composed of a well-organized structure, ideated according to a rational and logical scheme, in order to secure the different information, the distinction of thematic subjects (archaeological discoveries, bonds, cadastre and so on) and the analytical levels in which the information can be subdivided.

In the beginning a theoretical and ideal functioning was built. During this phase the issue was to define the relationship between the archaeological knowledge of the area and the urban and environmental context (Fig. 2).

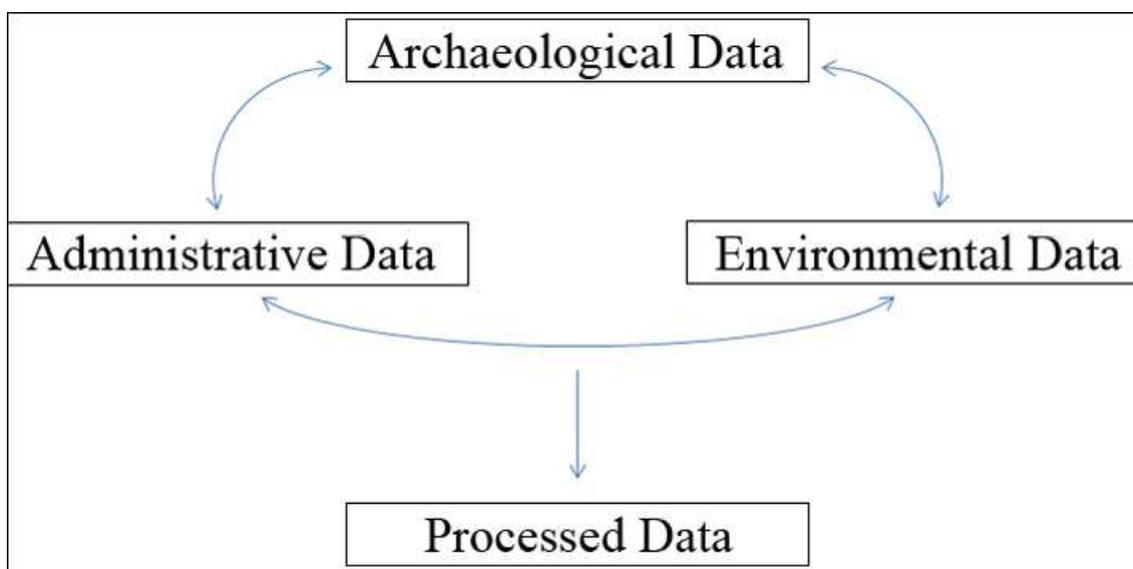


Fig. 2 – Data Model: conceptual scheme

For this reason a modular structure was designed to manage the single blocks of information in an independent way and, in the meantime, to grant relationships between the data. Later on, the three portions of the system were populated with entities, descriptors and attributions following the morals of completeness and interoperability. The last phase of formal realization previewed the scan of the physical relations between entities and their features.

The following scheme describes the structural articulation of the main informative sections of SIT:

- A) ARCHAEOLOGICAL DATA
  - 1) PUNCTUAL ARCHAEOLOGICAL DISCOVERIES
  - 2) AREA-ARCHAEOLOGICAL DISCOVERIES
  - 3) LINEAR ARCHAEOLOGICAL DISCOVERIES
  - 4) RESEARCHES
  - 5) NECROPOLIS
  - 6) MATERIAL DATA

- B) ADMINISTRATIVE DATA
  - 1) CADASTRE
  - 2) BONDS
  - 3) ADMINISTRATIVE INSTITUTIONS
  
- C) TERRITORY DATA
  - 1) LAND USE
  - 2) GEOLOGY
  - 3) GEOGRAPHICAL AREAS
  - 4) TERRITORY ELEMENTS
  
- D) ELABORATIONS
  - 1) THEMATIC CLASSIFICATIONS
  - 2) PREDICTIVE CLASSIFICATIONS
  - 3) POTENTIAL CLASSIFICATIONS

The archaeological information constitutes the main block of the system. It represents both a geographical structure, composed by a level of geo-referred elements, and a module to archive and classify data. These ones can be divided according to type and source quality, from which geometry and style of representation have been derived.

According to an operative point of view, the SIT model turns around an entity having the aim to connect and unify the different available sources: the context (Fig.3).

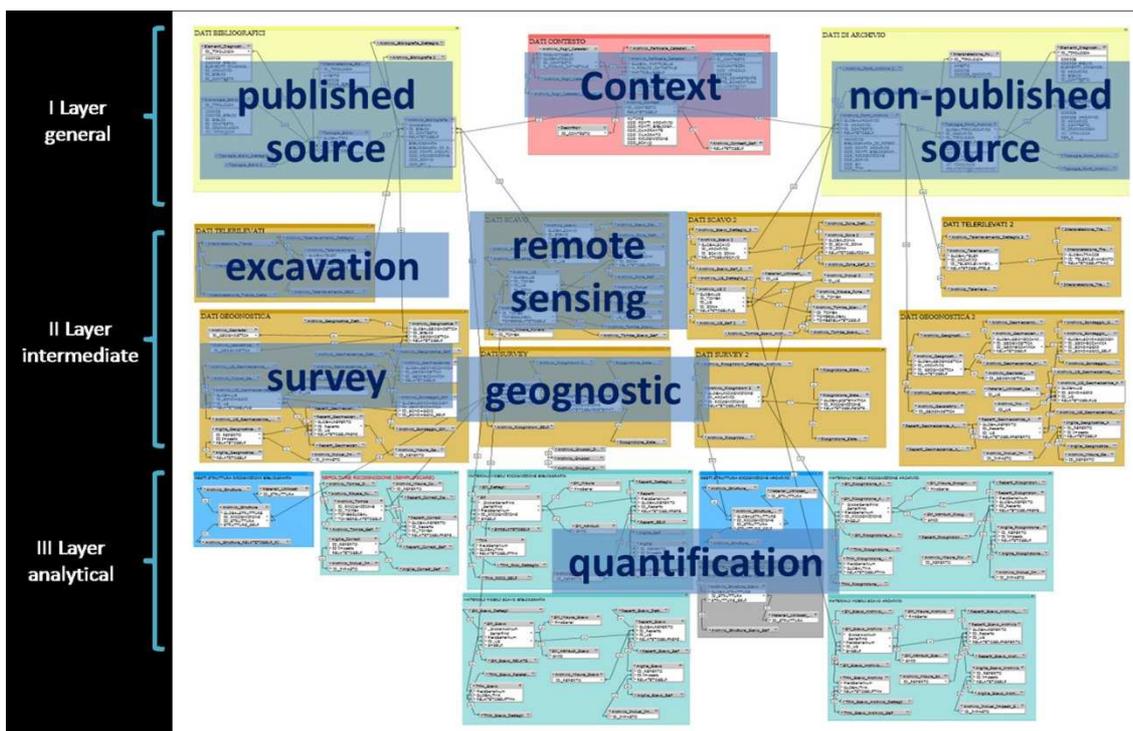


Fig. 3 – Archaeological Data Model: relational scheme

It corresponds to a discovery, a bibliographical voice, a new notice and so on. At the same time the context is a physical place, defined by three co-variables, time, space and function according to measurable entities. The different levels of characterization, approximation and accuracy of these three entities change the cognitive value of the datum and create an historical entity.

The procedure of archiving can be articulated into three levels of registration: the first and more general one is synthetic. It deals with the localization, description and discovery sources (bibliography, archive, researches and so on). The second one, or intermediate, records researches that created of the datum: excavation, recognition, tele-detection, surveys and so on. This level is useful to establish the degree of detail of types of exploration which created the archaeological document and allow the integration of the analysis followed in the time (including updates). In the third level the analytic one, the quantitative data, mobile or not, related to each context have been inserted, articulated in the different and probable researches. The union of the registration layers composes the archaeological context.

### **Archaeological Map**

The archaeological map is done by a series of maps describing the state of art of discoveries (Fig. 4).

Each object is related to single tables with all the information present in the system. The archaeological map is built according to the real consistency of the archaeological presences as has been individualized by past researches.

Firstly, sources were divided through codes of reliability expressing the degree of imprecision and partiality. From a graphic point of view this corresponded to a differentiation in the representation: the area in cases of a high level of precision, the point to indicate a generic position, linear forms for types of information coming from the photo-interpretation or linear structure as for examples roads or aqueducts.

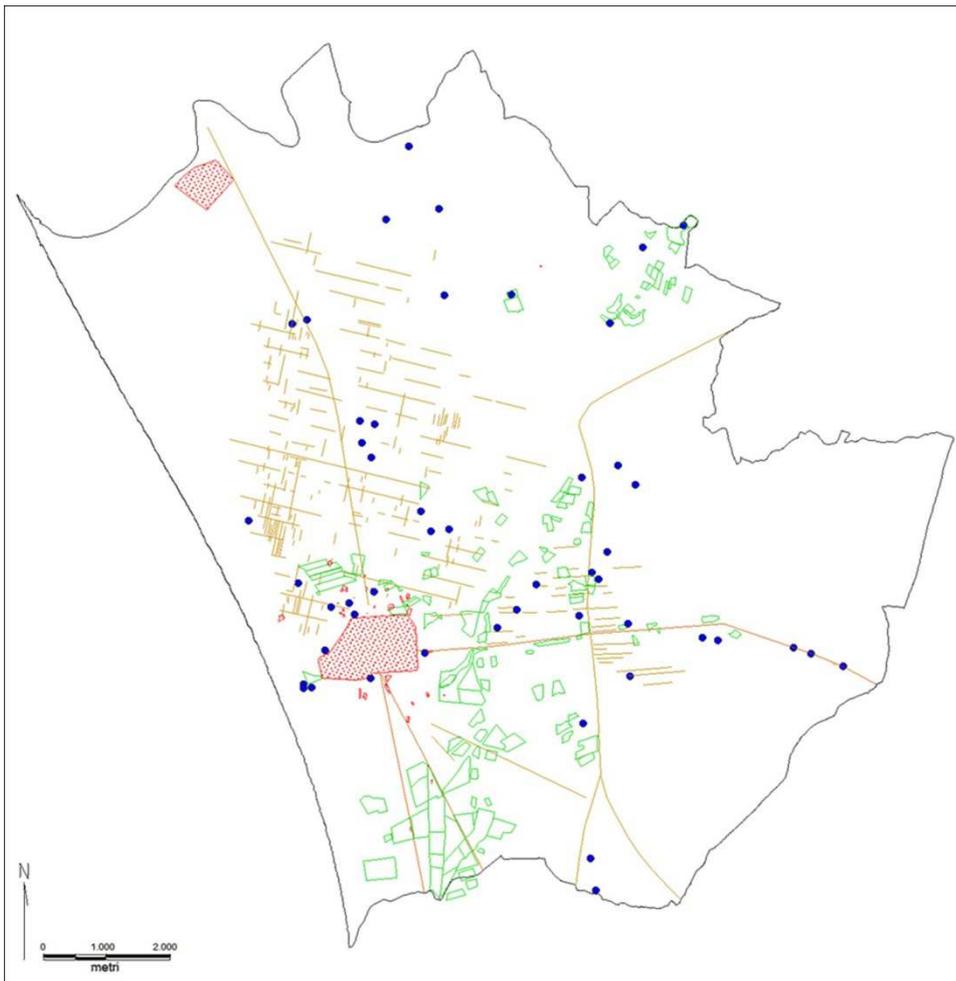


Fig. 4 – General archaeological map

Even the localization is expressed through different degrees of precision:

- Unknown
- Approximate
- Precise

In this way, one can calibrate the datum position against the discovery context and, if necessary, establish a further topographic analysis in the field.

The other information of the tables is organized in logical blocks. Among these the code called “state of preservation” is really important. It is a numeric value that expresses the nowadays condition of the good and the possibility it can constitute a part of a largest, already buried, archaeological context. This value is articulated into seven degrees. The lowest is assigned to goods where you know the exact extension which were completely removed from the field. The maximum one is given to the in situ and partially investigated testimonies (Fig. 5).

Conservation Status Index

- 0 = no archaeological data
- 1 = archaeological finding removed
- 2 = areas without archaeological indicators
- 3 = surrounding areas of an archaeological site, bond
- 4 = areas of surface archaeological materials
- 5 = areas that insist on a remote-sensing element
- 6 = archaeological remain still in situ

Fig. 5 – Conservation Status Index

The second level of the model is about investigations. In this case we have used areal zones to identify the searches. This level shows the actual extent of the investigations, some sort of research program, carried out over time.

In the third level of representation individual artifacts are distributed: structures and single objects and related information.

The archaeological module is dynamic. It allows displaying, distributing and analyzing archaeological contexts according to the articulated system scheme. It is possible to display only the most general level of contexts or to produce a map more detailed (Fig. 6).

Necropolis of Poseidonia-Paestum needs to be considered in a different context. You dispose of a detailed cartography is at one's disposal. In respect to this, a table dedicated to take data of each tomb with the indications of grave numbers has been formulated, ordered on the basis of the Paestum National Museum Catalogue and of some information useful to identify the type and chronology of all the burials (Fig. 7).

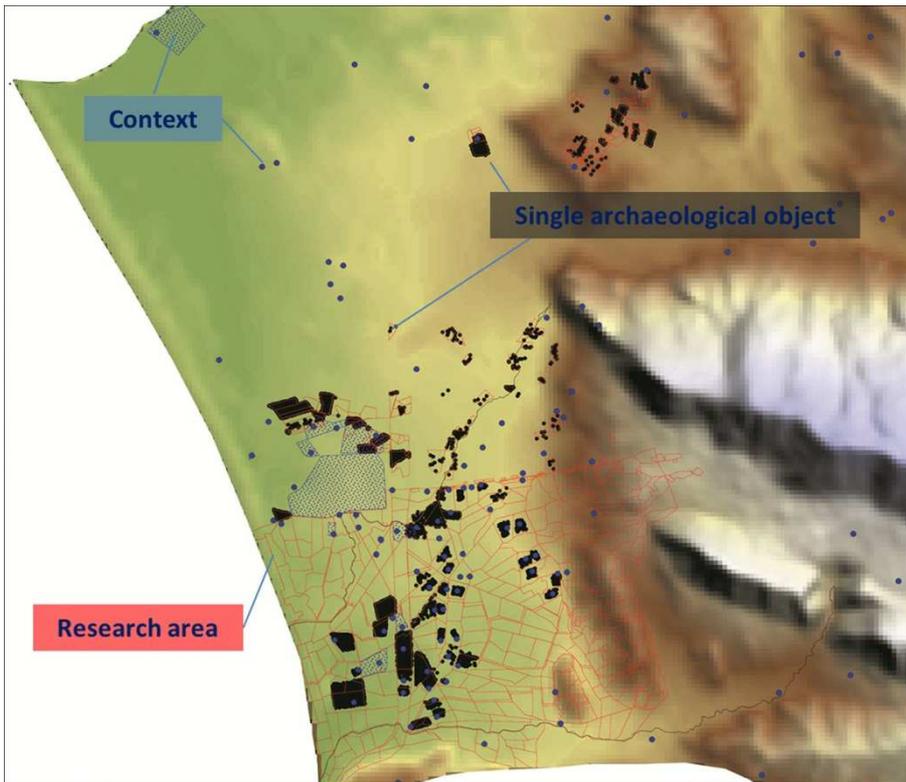


Fig. 6 – General archaeological map: different entry levels

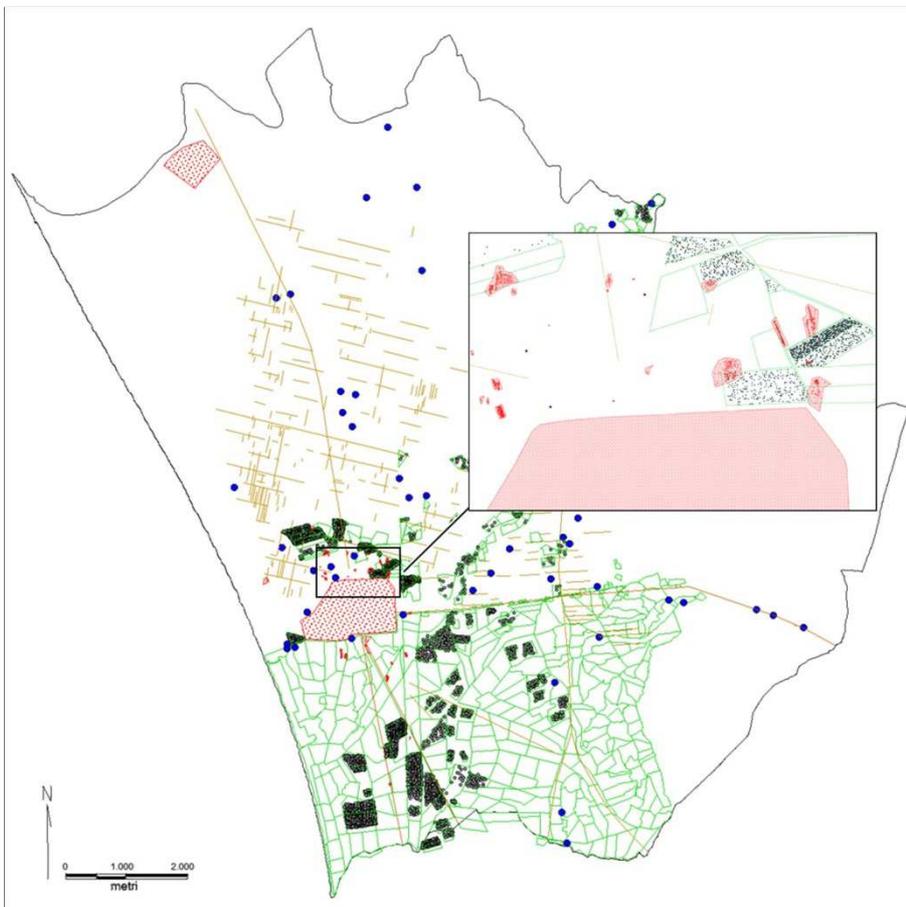


Fig. 7 – General archaeological map: funerary areas

## Administrative Data

Section dedicated to administrative documents is composed of different tables and maps created to manage and update the parts of the territory under restriction. The module can be articulated into Cadastral Units, Bonds, and Public Institutions. The cadastral units map represents the general plan of reference. In this map, the archaeological discoveries and areas of interests are integrated with legislative bonds. (Fig. 8).

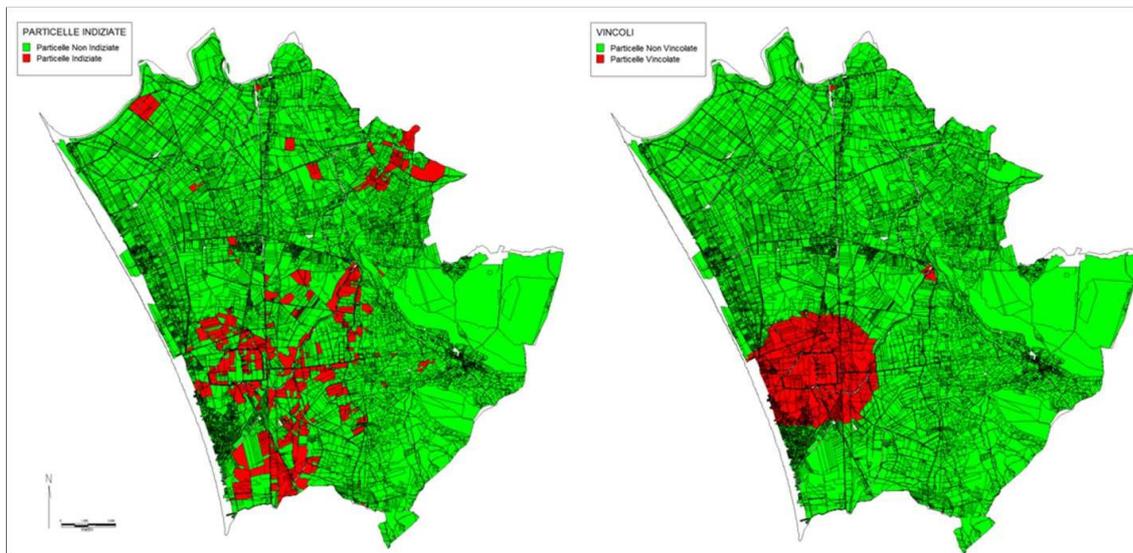


Fig. 8 – Cadastral map: parcels with archaeological remains (right); administrative bonds (left)

Table associated to cadastre is organized into two sections. In the first one, the bond parameters are listed; presence/absence bond, bond code; responsible institution, decree year, abbreviation of bonds present in the maps of other Institutions, spatial reliability. This block of points allows to know the archaeological value of the units. Information in the table clarifies the types of researches done to retrieve the archaeological relics and the degree of coverage. In this case, a code that defines topographical precision and layer of collimation between investigation and cadastral units has been elaborated. In this way it's possible to understand if a unit has been completely or partially investigated. (Fig. 9).

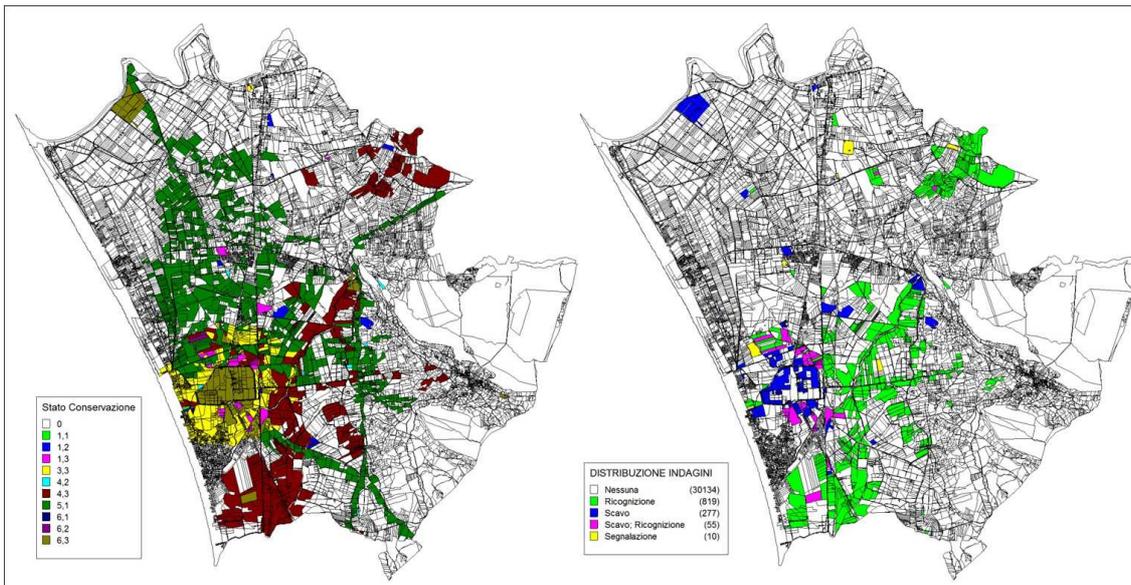


Fig. 9 – Cadastral map: parcels and conservation status (right); parcel archaeological value (left)

The main issue is related to the mutability of the unit dimensions, above all for the map of bonds done years ago. For these reasons, two more types of maps have been elaborated. The first one re-builds the more ancient bonds according to the cadastre of the 40's, while the second one refers to the same administrative decrees referring to the state of nowadays.

### Spatial data

Physical features of environment have acquired through a work of digitalization of maps edited in and updated studies of geology, geomorphology and paleography (Amato et al. 2012; Cinque et al. 2012). Archaeological data with the introduction of environmental issues are not more dispersed on an abstract plan, without any territorial components as form, resources and movement.

The module of environmental data is composed of different levels corresponding to further aspects of the territory: geology, geomorphology, hydrography, landcovers.

The work of composition of the natural context of Capaccio has also included the acquisition of the data related to the land use. In particular, several maps have been inserted derived by the Corine Land Cover project, Campania Region and Capaccio Municipality.

The information of these different maps has been used to build zones of surface visibility. In this case the classes of land use has been unified on the base of two parameters: exposition and accessibility in order to create three macro categories that show up zones of surfaces that are exposed and passable, zones partially visible and passable, zones completely covered and not practicable.

The utility of these new instruments is related to the activity of archaeological prospection, above all in the frame of the c.d. prevented archaeology. On the base of this map, in fact, one can discriminate the municipals areas, which are susceptible of direct recognition investigation (Fig. 10).

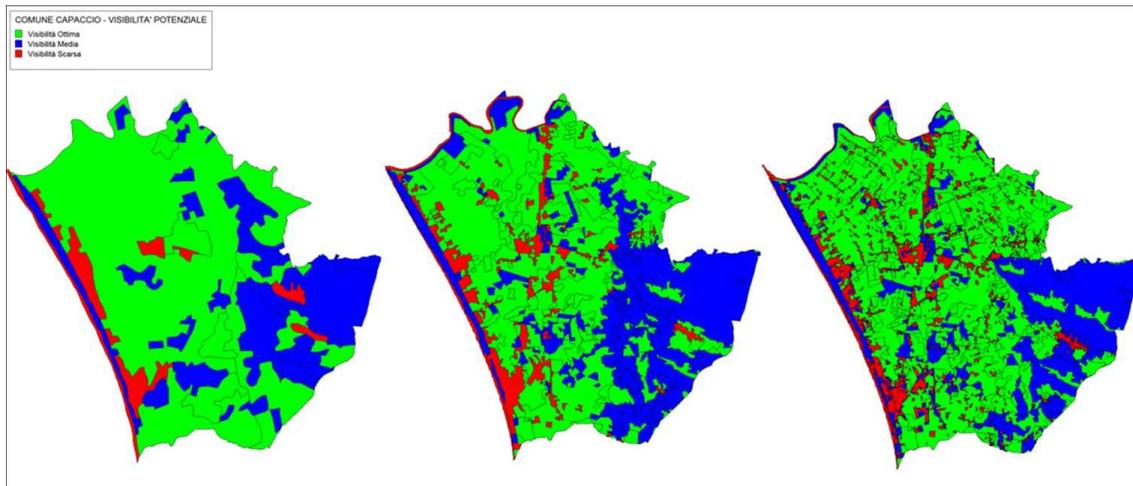


Fig. 10 – Visibility maps: Corinne Land Cover (right); Campania Region (center) Capaccio Municipality (left)

## Elaborations

The final step relates to a realization of a map of the potential. With this term, one is able to research discoveries and archaeological sites in zones without direct indicators. According to this definition, the map of the potential is a predictive one. It is the result of an interpolation because it comes from points and known archaeological places. A map created by discrete variables (ANICHINI et al. 2012; ANICHINI et al. 2013). So, the main issue is reference model to be used for its realization. At present there are two types of consolidated processing procedure: inductive and deductive (VERAGHEN 2012; VERAGHEN-WHITLEY 2012). The first is analytical and starts from available data. It poses significant questions. Firstly the choice of numeric parameters to achieve spatial interpolation calculations: variable encoding; archaeological weighting, environmental and cultural variables. Secondly the archaeological data are heterogeneous and sometimes hardly interpretable and it's always high the risk to close the data in a deterministic grid in which the potential is a direct result of specific values: the ancient anthropic landscape is hardly reducible to schematic parameters, safe and stable. Otherwise we have always to be aware that a general algorithm able to predict forms and modes of any human system does not still exist. On the other hand the inductive method is quite easily executable. Moreover, such method is always verifiable since the procedure is explicit and reproducible. The second method proceeds from a general functioning model of the territory built on communities. theoretical assumptions then combined with the data. The result is a general diachronic view of ancient

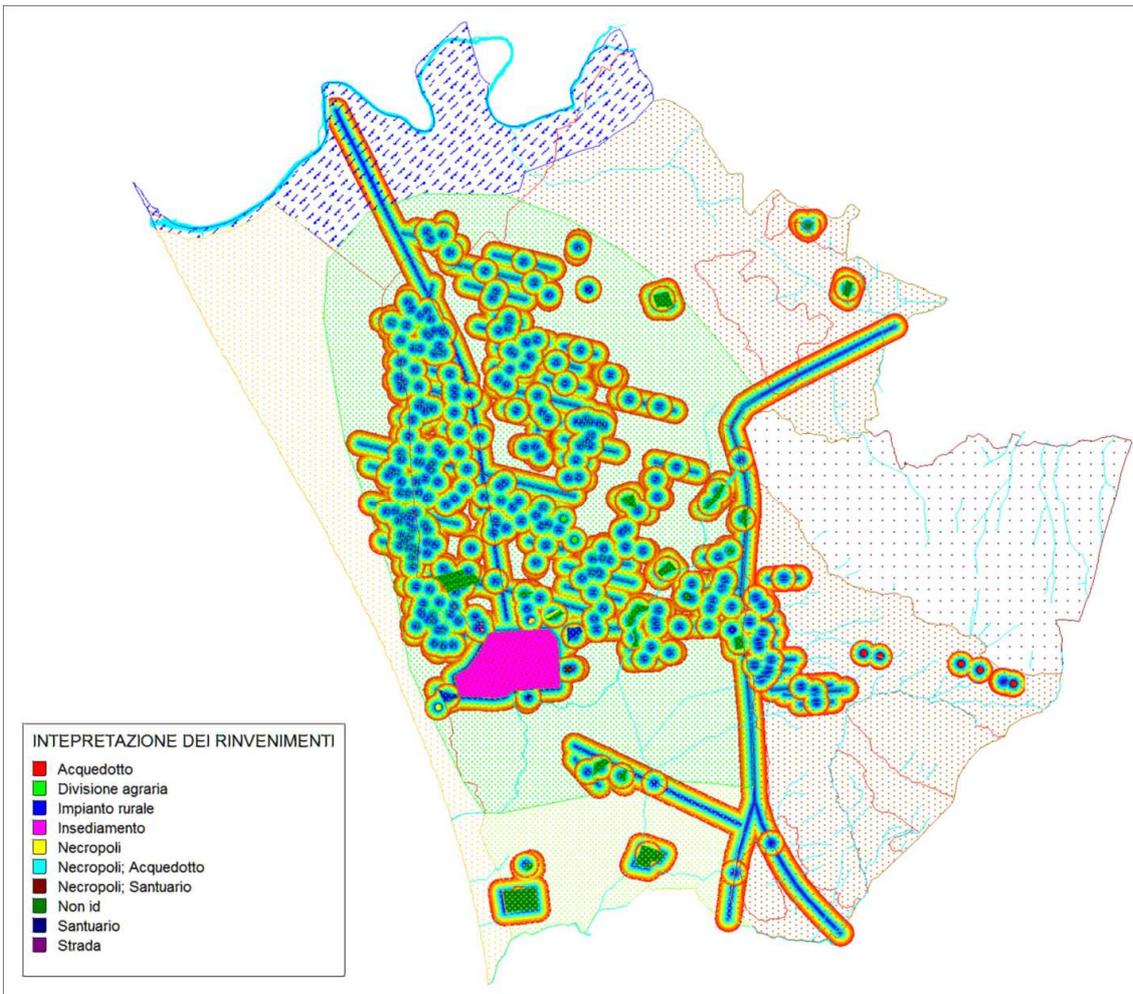


Fig. 11 – Distance analysis

The risk is to compress data in an abstract scheme; the advantage on the contrary is to valorize non-quantifiable data and relevant such as economic, social and ideological.

In the present work a mixed procedure was used involving at same time an inductive and a deductive approach. In a first step the archaeological potential has been formulated starting from individual data classified on numerical parameters. Then this value has been distributed through the entire territory. In this way the archaeological data are significant points used to build an interpolated plan.

The result is a general design of the territory of Capaccio where zones of homogeneous potential, zones where the presence is predicted, the frequency and consistency of such types of archaeological rests are visualized.

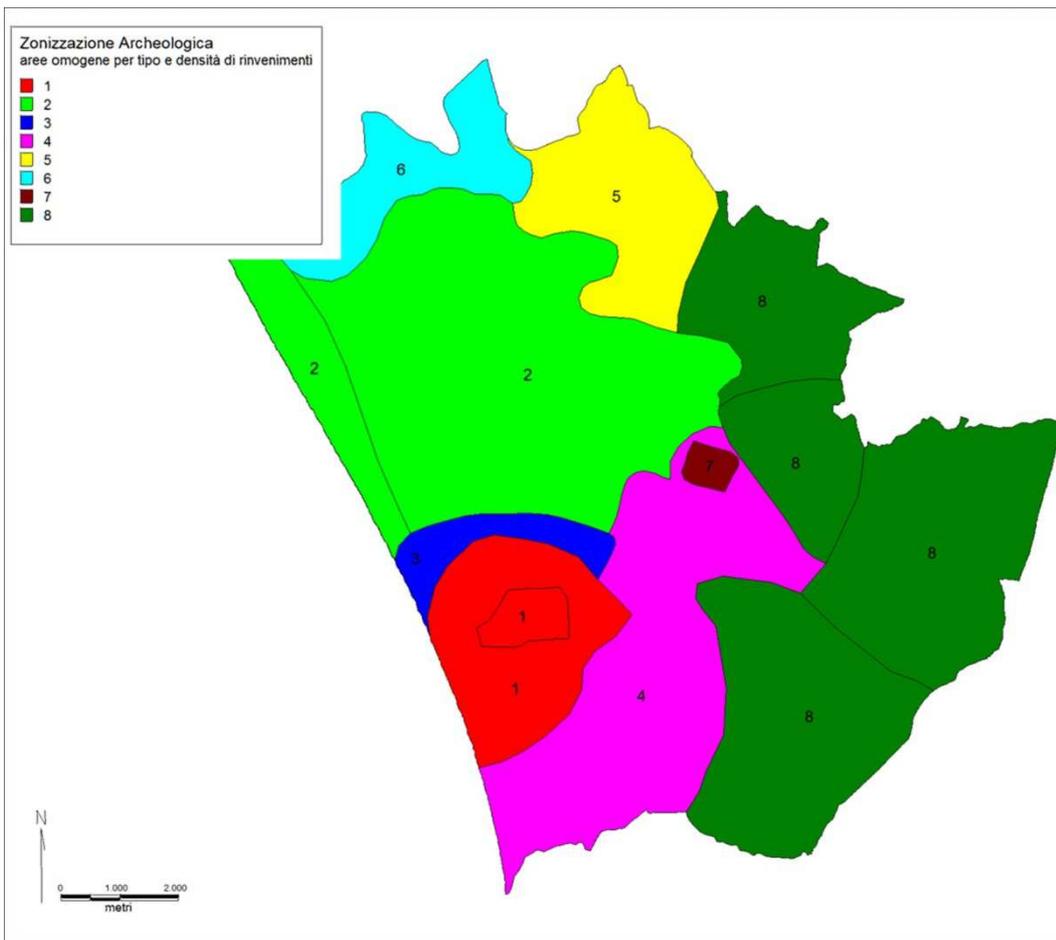


Fig. 12 – Archaeological zones: 1 area of the city center, urban necropolis and periurban sanctuaries; 2 rural area with limited and missed types of settlement; 3 periurban area without archaeological consistent indicators; 4 area with nucleated settlements and types of missed rural settlements; 5 area of nucleated settlements disposed in the valleys transverse to the river at a great distance from the city center; 6 area of pertinence of the river Sele and sanctuary of Hera argiva; 7 area of pertinence of sources of Capodifiume and related sanctuary; 8 hilly areas with service and temporary structures

Starting from the table “state of preservation” a first map has been produced. The code “state of preservation” has in fact an implicit value of potential, because a certain datum of presence, corresponds a high level, while at the bottom of the scale one locates the absence of documents. In the middle, 5 degrees describing in a sequent way the possibility that the archaeological trace can reveal a basin of hidden presences.

The value “state of preservation” has been distributed with interpolators *IDW* and *Kriging* and overlying at trend analysis. Both interpolators do not give particular differences. On the other side, the trend analysis shows how the value is in the territory, which is the directions of increasing and decreasing of this measure. In this way, the *trend* can also represent a sort of reference or validation map of the distributions expressed through the space interpolators. The integrated analysis of the three documents elaborated a general map divided into fields corresponding to the values of the state of preservation.

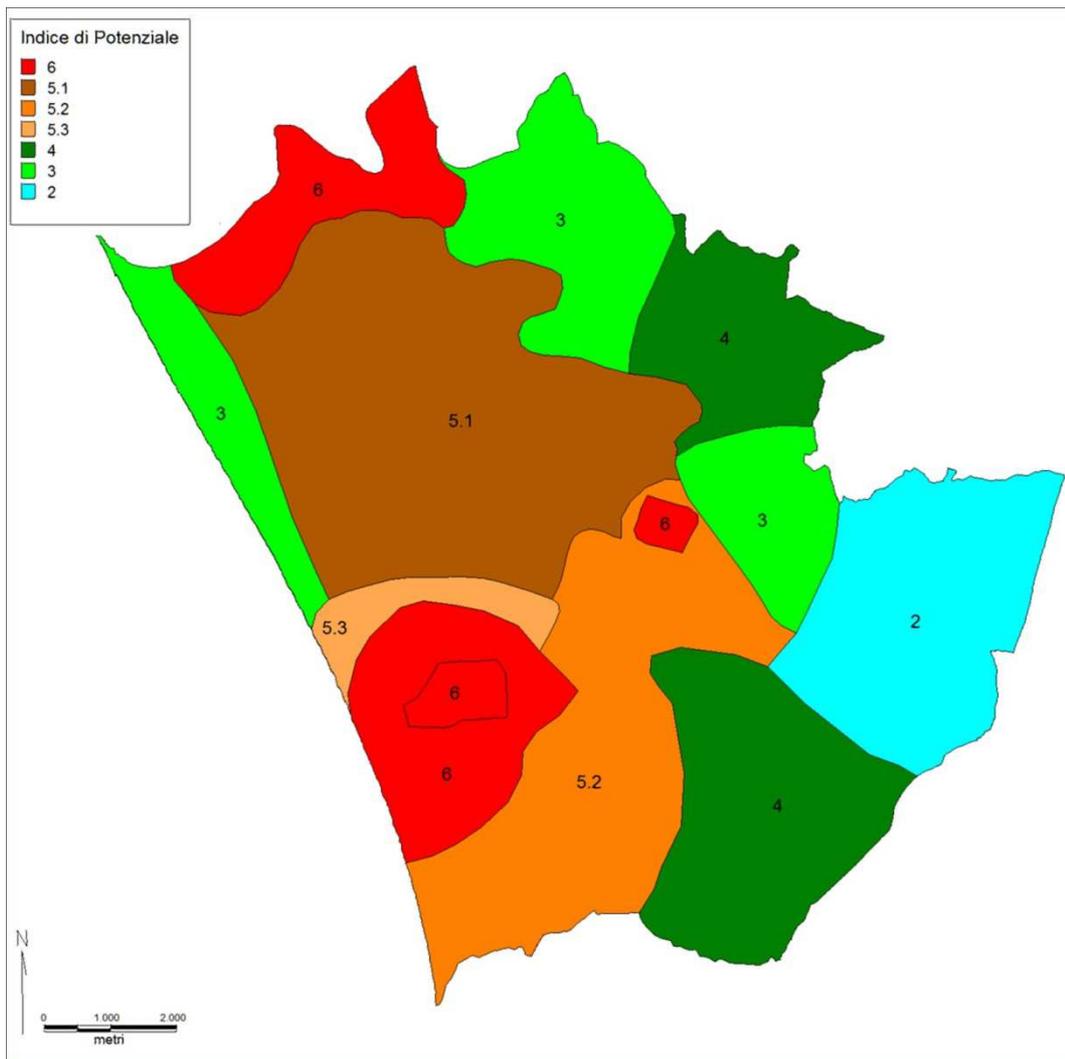


Fig. 13 – Archaeological potentiality index

From other points of view the degrees of the potential have been considered as fields of the territory where the level of presences depends on its destination of use. In this case, the problem shifts to what is hypothetically possible and to what the consistency. In other terms, the problem is not only to discriminate vacuum and full zones, but also to predict types of testimonies and their configuration.

In this case the discoveries have been classified for the nature of discovery (for example are of relics; grave; rests of structure and so on) and typology (for example: necropolis, sanctuary, aqueduct, road and so on). An analysis of the distances on the base of these distributions has been created, drawing zones of 500 m and 200m with step of 50 m and 20 m for each discovery. (Fig. 11)

The result is a map that suggests possible aggregations and space relationships. In this way a description of the space of the Achaean colony distinguishing urban, sanctuary, grave, productive, rural zones and so on have been deduced.

The integration of maps, derived from space interpolation and schemes of distribution, took to the design of homogeneous zones (Fig. 12).

The procedure has been done on documents divided into single periods. This was done to safe guard the differences between organized and distinct systems of the space and to evaluate the character of the vertical

over position of discoveries in the territory. Finally, each zone was inserted in a general map of potential. In this case the value expressed the general type of behavior which has to define prescriptions and typologies of intervention.

Norms vary in relation to the class of potential. From the obligation of stratigraphic investigations to the need of preventive researches; from activities of excavation assistance to the simple inspections and so on (Figs. 13-14).

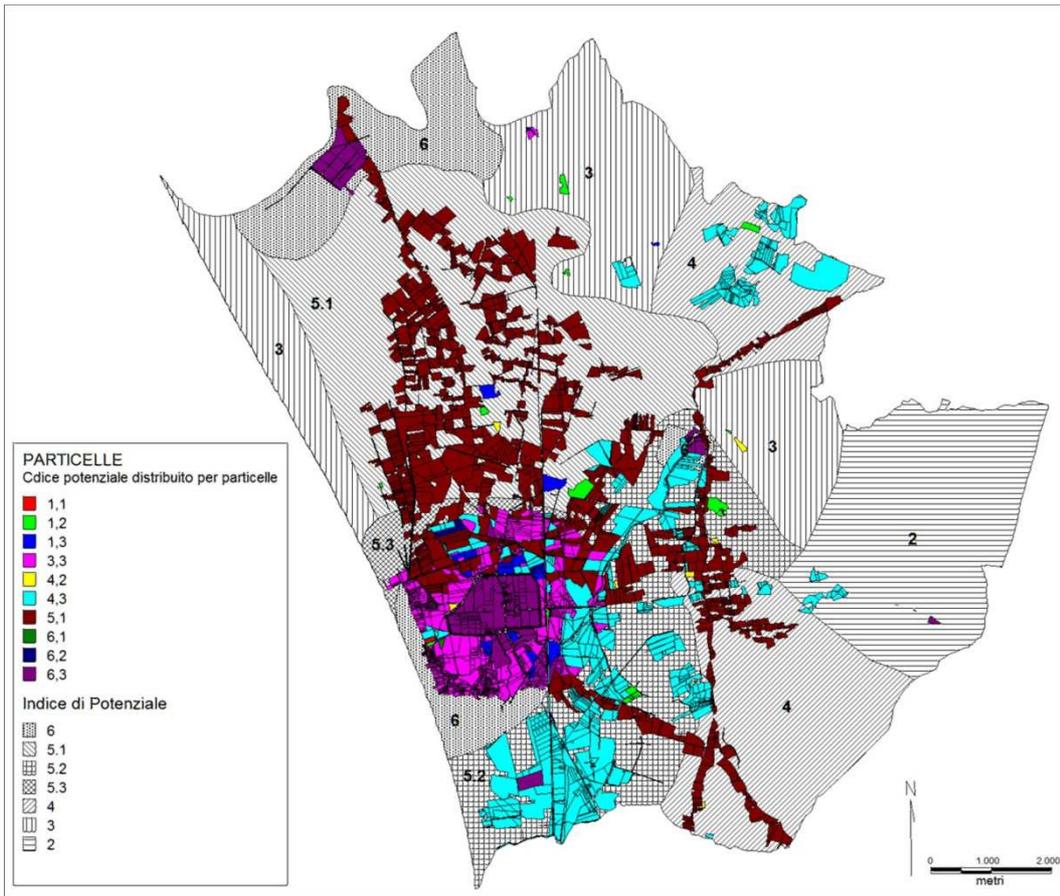


Fig. 14 – Archaeological potentiality index and cadastral parcels

### **Zones 1, 6 and 7 constitute the class 6.**

It includes areas with the highest concentration of archaeological finds: the artifacts are visible and are irremovable.

These areas require close cooperation between the authorities before embarking on any type of urban intervention.

### **Zones 2, 3 and 4 are included in class 5**

It offers a high probability of discovery even if at different depths. It has been divided into three sub-classes 5.1, 5.2, 5.3

The subclass 5.1 includes the northern portion of the Sele plain with areas of paleo-dunes, and those indicated by the nuclei of graves identified by previous archaeological research.

5.2 The subclass extends from the headwaters of Riverhead to the southern side of the plain. Numerous and extensive areas of fragments fall into it and the complex Tempa del Prete and Linora.

The subclass 5.3 corresponds to a limited strip of land that extends just beyond the urban necropolis. For these areas, a preliminary evaluation is required.

**Zone 5 falls within the class of potential 3.**

It includes fragmented and punctual remains (graves, farms, etc.).

**Zone 8 (hills and mountains) is distributed in to classes 2, 3 and 4.**

In particular, the class 2 is characterized by the Roman aqueduct that runs between the town of Capaccio, the band area of foothills and the eastern side of the plain. In class 3 and 4 are specific structures linked to different types of land use.

Preliminary inspections are necessary in areas with indices from 2 to 4 in order to define the presence or the absence of any archaeological stratigraphy.

## Conclusions

In conclusion, the structure that is provided by Capaccio Administration has been conceived in order that:

- It allows the retrieve and catalogue of the territory archaeological documentation, as for example the source of information, the nature of the Good and the type of discovery;
- Offer a support to the action of Archaeological Protection of the Supervision coordinating it with the administrative one of Capaccio and open it through research and information;
- Discriminate between the different degrees of risk and give back the map of the archaeological potential;
- Introduce an instrument to execute researches in the subsoil and surface;
- It adapts the interventions in the territory to the prerogatives of preservation and evaluation of the Patrimony according to the norms of Laws on the protection
- Establish the realization of management instruments used for the management of archaeological discoveries and information, even if in prospective of hypothesis of valorization, diffusion and material organization of the Patrimony of nowadays and the future one.

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