Height data from archaeological investigations for the reconstruction of the subsoil

3D data from archaeological investigations for the reconstruction of the subsoil

Valeria BOI / Federica LAMONACA / Milena STACCA

Soprintendenza Speciale per i Beni Archeologici di Roma

Abstract: The basis for our test is formed by the solid conceptual and technical foundation provided by the S.I.T.A.R. project, carried out by the Soprintendenza Speciale per i Beni Archeologici di Roma (Serlorenzi and De Tommasi are offering a paper on the project in this venue).

The investigations carried out by public offices as well as by private companies (including both non-destructive and destructive geophysical surveys, preventive excavations, planned investigations, etc.) that are archived in the S.I.T.A.R. databank produce huge amounts of elevation data with variable precision. These data consist of spot elevations derived from total station and GPS readings, and destructive geophysical investigations. Once verified, this elevation information leads to the gradual creation of an increasingly detailed reconstruction of the subsoil.

The integration of this data with those gathered from cartographic vector bases, as well as data from historical maps, multi-temporal satellite images, Digital Elevation/Terrain Models, and preexisting geological and geomorphological research makes the system a fundamental source for the detailed diachronic reconstruction of the morphology of the territory.

The multi-layered city of Rome is the perfect candidate for a historical and topographical analysis of settlement development in different time periods, both because of the density and complexity of its settlement layout, and because its expansion hastened the natural phenomena of erosion and filling.

The poster, hence analyses the Esquiline neighborhood which currently retains the urban layout that was in place after Rome was declared the capital of Italy. This layout significantly altered the original morphology of the hill, which was originally characterized by variations in elevation. Because of this, the Esquiline is an ideal case with which to test the potential of this type of analysis.

The above-mentioned analysis can be further refined and then applied not only to Rome, but also to other geo-archaeological contexts with multiple strata.

Keywords: GIS, height data, Urban Archaeology and town planning, DEM.

3D data from archaeological investigations for the reconstruction of the subsoil

A number of 3D data storage and processing systems are currently tested within the SITAR Project, under the direction of SSBAR (Soprintendenza Speciale per i Beni Archeologici di Roma).

The SITAR project aims to establish, maintain and develop a SDI, Spatial Data Infrastructure, in line with the guidelines provided by the E.C. in c.d. Directive INSPIRE issued by the European Parliament in 2007, that has been acknowledged in Italy through the work of two Ministerial Commissions set up in 2007 and 2010, the Commissione Paritetica nazionale per la realizzazione del Sistema Informativo Archeologico delle città italiane e dei loro territori (2007–08) and the Commissione paritetica nazionale per la realizzazione del Sistema Informativo Territoriale del patrimonio archeologico italiano (2010–11) (VALENTI and SERLORENZI 2010, SERLORENZI and DETOMMASI in this venue).

The aim of this first experimentation on the use of altimetric data is to reconstruct conceptual landscape patterns representing the depth where the principal determined chronological phases are attested, hence for example, the difference between the current surface, the higher level of the documented archaeological stratigraphies, the geological subsoil, enabling to yield spatial patterns describing the territory even in its diachronic variable.

Currently, altimetric data capture and systematization around a case study area, the Esquiline town district (1,960 km^2), are processed (Fig. 1). The urban planning metamorphosis that this very ancient neighbourhood went through, as soon as Rome was declared the new capital town of the Italian reign, thoroughly modified its morphological structure, making it the perfect ground for this kind of experiments.

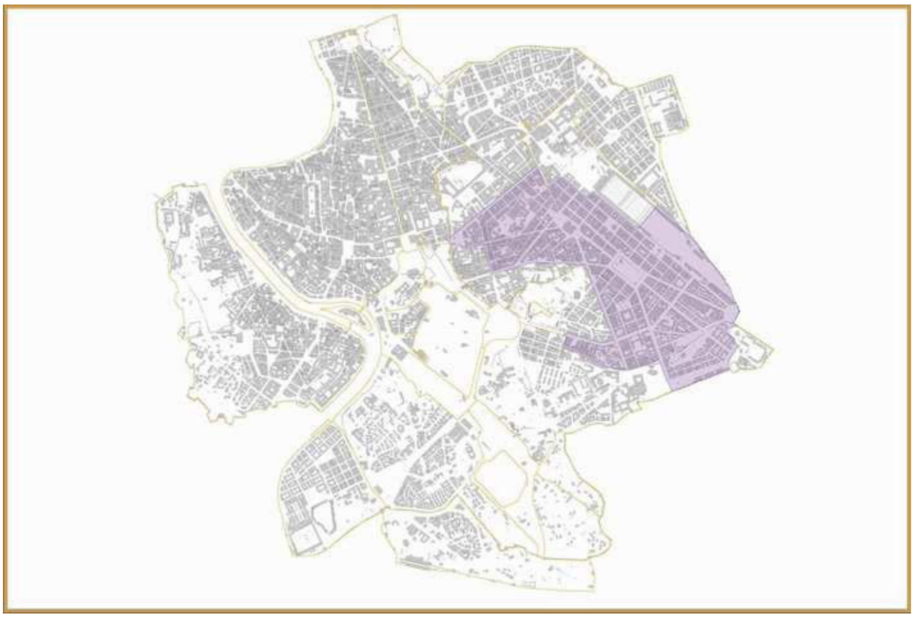

Fig. 1 – Case study area: The Esquiline town district in Rome (Copyright: MiBAC – Soprintendenza Speciale per i Beni Archeologici di Roma).

In order to pursue the aims of the case study here presented, we selected only those archaeological excavations that can be rightly positioned in the current topography and for which we own information about chronology, interpretation and height above sea level (Fig. 2).

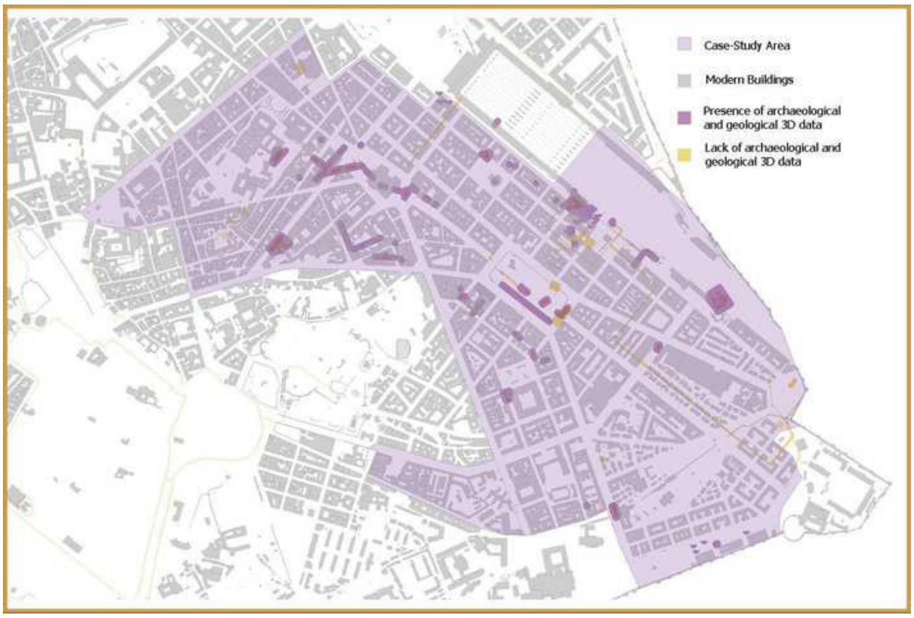

Fig. 2 – Chart of distribution and quality of 3D data in the Esquiline town district (Copyright: MiBAC – Soprintendenza Speciale per i beni Archeologici di Roma).

We also included archaeological excavations lacking height above sea level, but for which we can calculate it starting from the indication of the depth referred to the contemporary surface. As a matter of fact, a preliminary statistic calculated on the data from the archive’s documentation about the area of the Esquiline district shows that in most cases the altimetric informations are expressed in relative heights referred to the contemporary surface (Fig. 3).

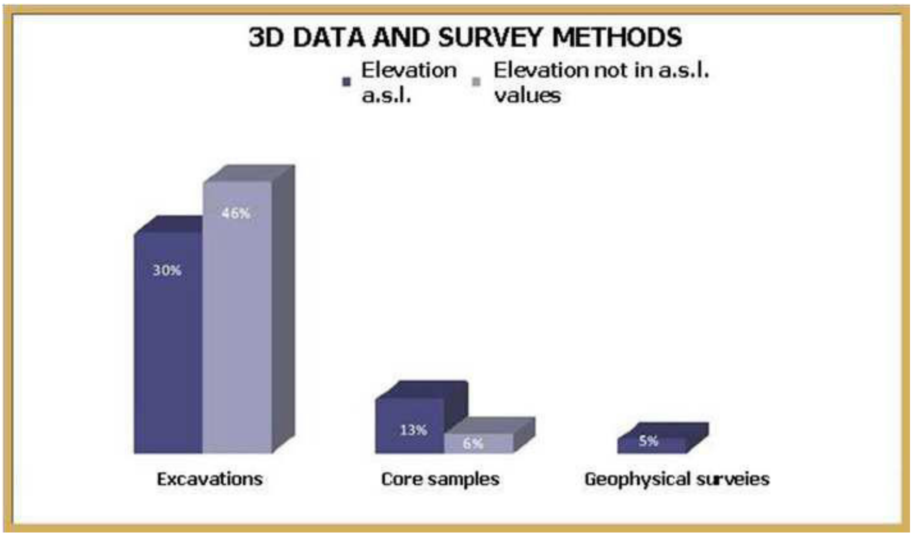

Fig. 3 – Chart of of the altimetric data for every type of archaeological survey (Copyright: MiBAC – Soprintendenza Speciale per i Beni Archeologici di Roma).

The SITAR GEO-Database stores altimetric data made of dimensioned points, calculated through surveys carried out with Total Station, GPS and geognostic analysis.

As far as archaeological excavation is concerned, the system acquires measured spots coming from topographic structure drawings and determined layers, with reference to the modern backfill, the archaeological evidence and the geological substratum (Fig. 4).

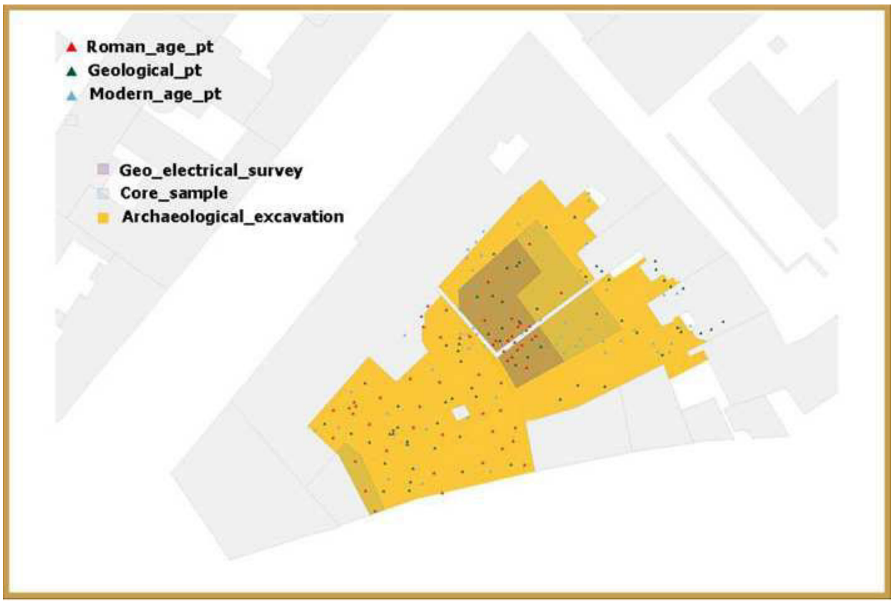

Fig. 4 – Selection of 3D data from archaeological excavations (Copyright: MiBAC – Soprintendenza Speciale per i Beni Archeologici di Roma).

The same information may be extracted from geognostic enquiries for which one starts with the synthetic reading of corings, in order to extract data on the height above the sea level of the present surface, on the archaeological deposit's higher level and on the geogical substratum's upper level (Fig. 5).

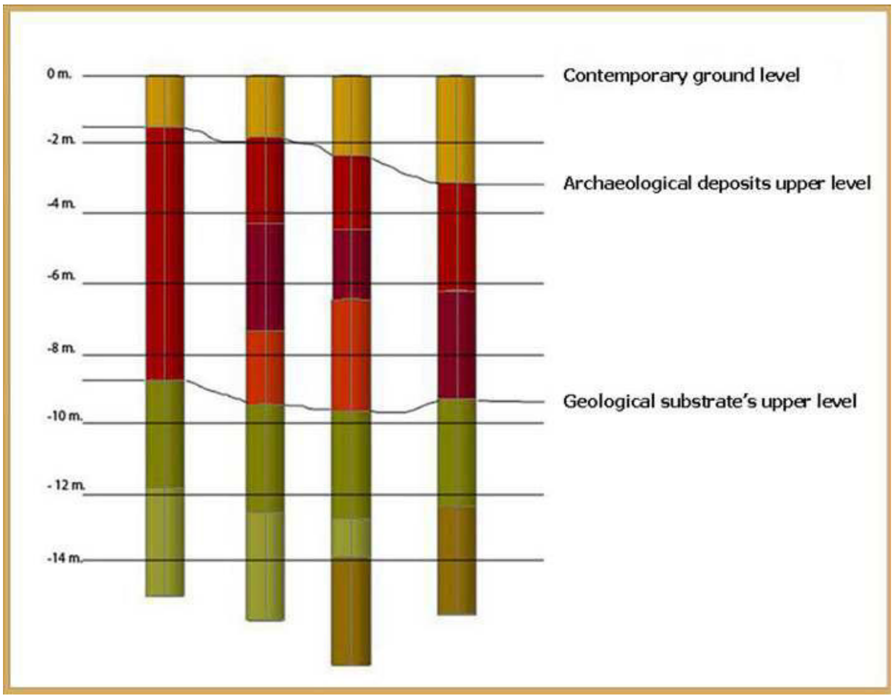

Fig. 5 – Analysis and 3d data extraction from corings (Copyright: MiBAC – Soprintendenza Speciale per i Beni Archeologici di Roma).

In this topographic geo-database, each 3D point is steadily linked to its geological or archeological evidence, thus acquiring all of the descriptive attributes. Therefore each altimetric point can be sorted through its descriptive, chronologic or type information.

These records, integrated with up-to-date topographic bases, historical cartography and geological / geo-morphological analysis, can be used to render spatial models describing the territory also under its diachronic variable.

In the case study here presented, we visualize the result of the interpolation of measured spots, resulting from a preliminary archaeological investigation of the Esquiline district area. The trial restoration of surfaces has been realized through the use of different methodologies: we have produced vectorial TIN samples and DEM (digital elevation models) raster, experimenting different interpolation algorithms, to reconstruct a conceptual landscape pattern representing the chronological macro-phase of Roman time (Fig. 6). For the project Autocad Map© 3d 2010 and Arc Gis© 9.2 are used. Some similar experimentations have already been conducted for the territory of Bologna (PESCARIN 2007) and for a town district in the centre of Rome (DEMETRESCU and FONTANA 2009).

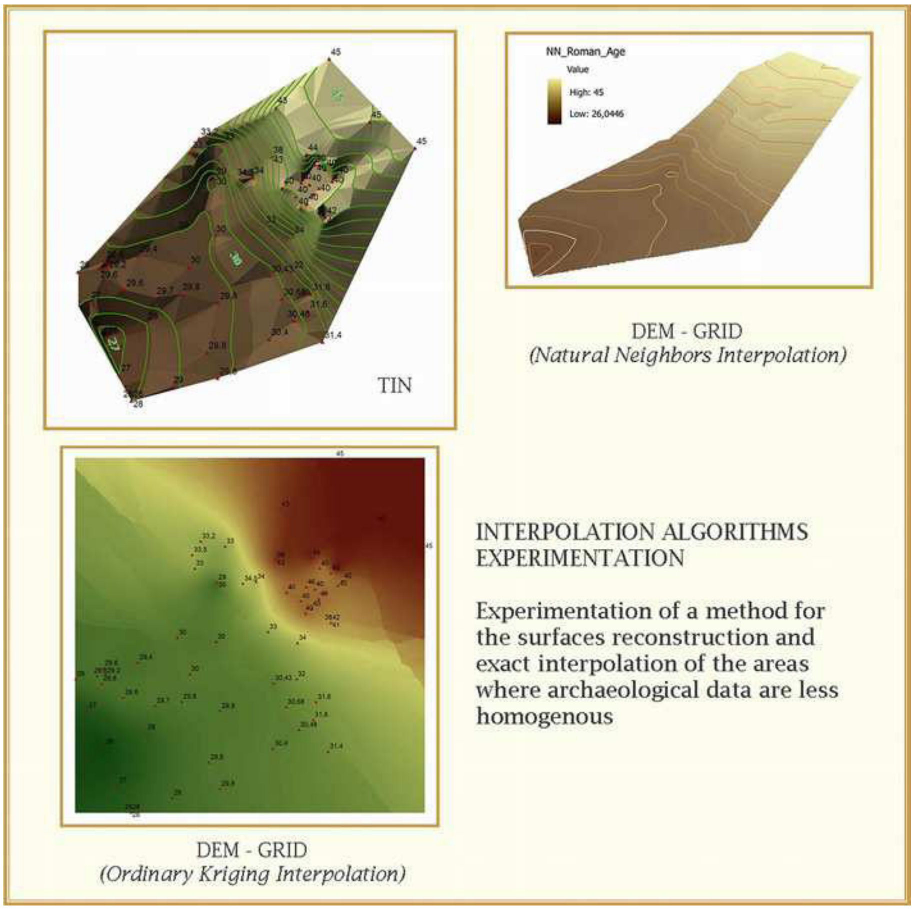

Fig. 6 – Experimentation of different interpolation algorithms, to reconstruct a conceptual landscape pattern representing the chronological macro-phase of Roman time (Copyright: MiBAC – Soprintendenza Speciale per i Beni Archeologici di Roma).

Experimental 3D models creation is carried out distinctly for each area of survey, representing the starting ground to piece together, through interpolation, the surface of any unsurveyed areas. Within the surface reconstruction process for areas where archaeological data are less homogenous, a relevant role is played by geological *continuous* surface 3D data, based on previous specific analysis, through which data interpolation can be directed and sorted.

During the reconstruction of *experimental* 3D samples, the extensive gathering and elaboration of 3D data referring to the current geological substratum's surface is of basic importance, serving as guide and filter for the interpolation of the archaeological level's data, especially for areas in which the measured spots used for the restoration of the archaeological level are less dense and not homogeneously distributed: in such instances current surface and geological substratum represent the lower and upper space limits circumscribing the experimental sample of the surface that one has to restore.

Surfaces restored in this way do obviously not represent a *realistic surface*, but a *conceptual* model of the landscape morphology in a given chronological phase; one of the first applications of such a restoration of the *3D experimental sample* of surface and structures of Roman time is for example their contextualization in the current topography or the generation of 2D sections that enable the visualization of the surface's pattern on an axis which has been determined by the user (Fig. 7).

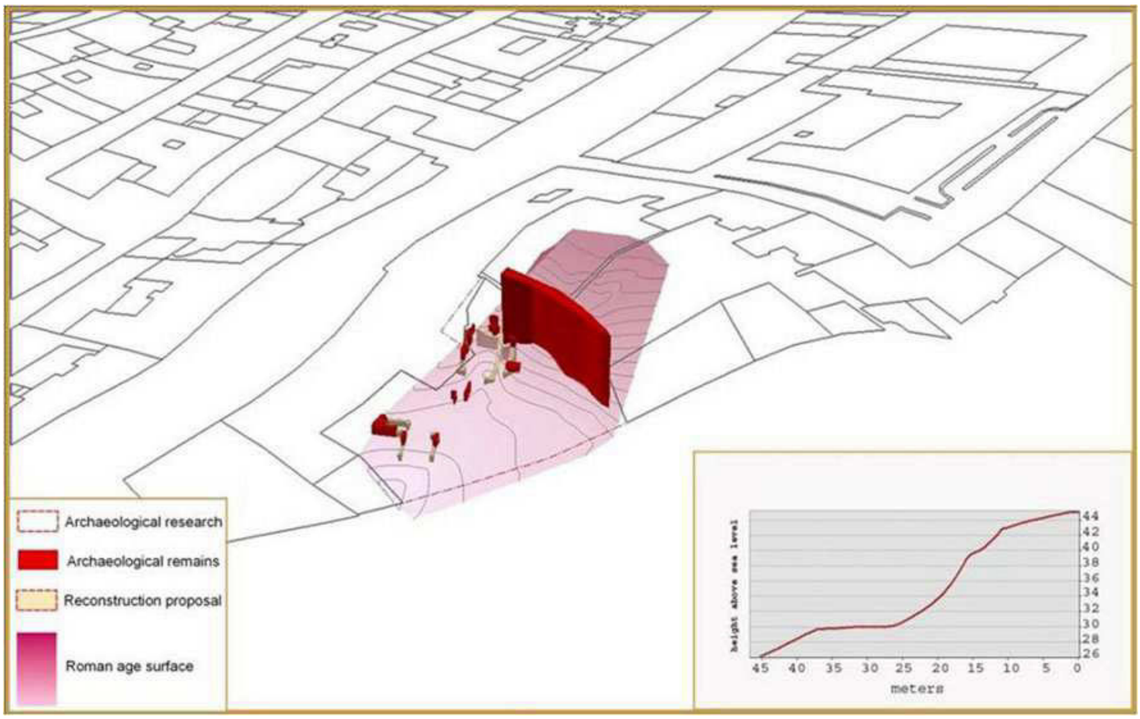

Fig. 7 – Contextualization of surface and structures of the Roman time in the current topography (Copyright: MiBAC – Soprintendenza Speciale per i Beni Archeologici di Roma).

Beyond this one may also process the archaeological deposit's experimental altimetric mapping, derived from a subtraction between the current surface and the archaeological deposit's upper level: this map visualizes to which extent the modern deposit has obliterated the antique structures and quantifies the degree of variations in the territorial morphology during time.

The presented one is an example of this experimentation carried out on the data of a preliminary investigation on the Esquiline district. Different shades of green register areas where archaeological evidence has been attested at a lower level, between 9 and 7 metres ca. Red areas are those in which archaeological evidence is at the minimum depth, between 200 and 80 centimetres ca. from the current surface (Fig. 8). When accomplished, such a highly accurate 3D database on territorial scale is the ground on which new previsional devices for the Archaeological Potential definition can be tested. A map of the archaeological deposit's depth compared with current ground level, that shows the morphological diachronic variation, sets up a new helpful tool for urban planning and historical evidences protection.

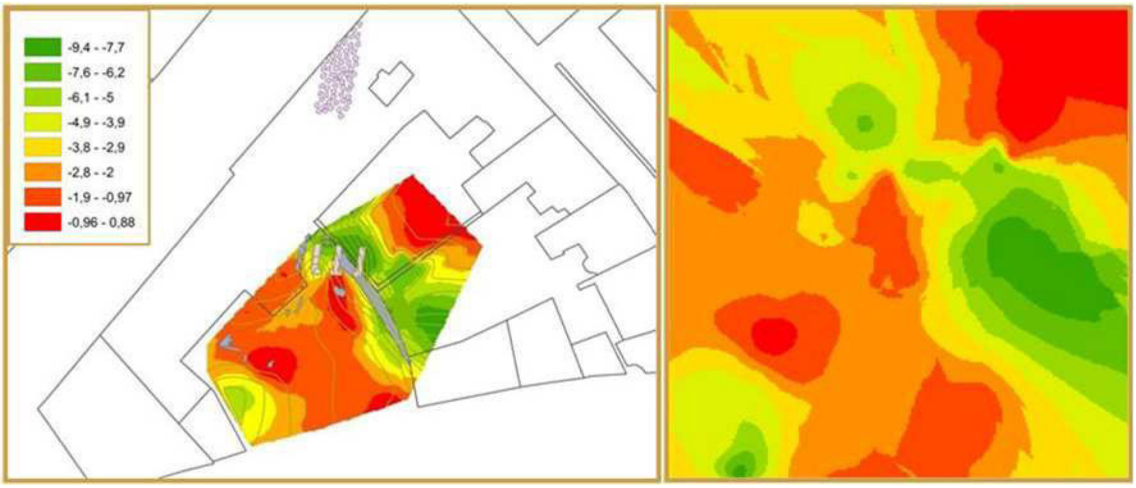

Fig. 8 – Map of archaeological deposit's depth compared with current ground level. Morphological diachronic variations are shown by different shades of colour (Copyright: MiBAC – Soprintendenza Speciale per i Beni Archeologici di Roma).

To this end, the operating standards setup of the scientific and graphic documentation for the new geognostical as well as archaeological investigation becomes essential, in order to assure uniformity and quality of new data that come toghether in the system: as a matter of fact it is desireable that research carried out on the territory will yield the output of altimetry data full and comprehensive of any relevant morphological variation, made up by a regular grid of 3D points above sea-level and by an overall census of geognostic surveys data.

References

DEMETRESCU, E., FONTANA, S. (2009). Archeo-restituzioni territoriali e urbane, valutazione del rischio archeologico e software open-source, In: *Archeologia e Calcolatori,* Supplemento 2. Firenze, edizioni All'Insegna del Giglio, 95–106.

PESCARIN, S. (2007). Bologna in età Romana dal GIS alla realtà virtuale, In: *Ut Natura Ars – Virtual Reality e Archeologia. Atti della giornata di studi.* Imola, University Press Bologna, 115–122.

VALENTI, M., SERLORENZI, M. (2010). La sistematizzazione dei dati conoscitivi, In: *Roma Archaeologia – Interventi per la Tutela e la Fruizione del Patrimonio Archeologico - Secondo Rapporto.* Roma, Electa, 63–74.

http://www.inspire-geoportal.eu/

http://www.londoncharter.org/