Using GIS to Reconstruct the Roman Centuriated Landscape in the Low Padua Plain (Italy)

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Abstract:
This paper deals with the application of Geographical Information Systems to landscape archaeological studies and, in particular, with researches that follow an archaeomorphological approach. The study outlines the analytical potential especially for studying ancient land divisions. The case study presented here, drawn from a Phd project, is specifically dealing with the contribution that such Systems can bring to the archaeomorphological study of a wide stretch of the alluvial plain extended to the south of the city of Padua, with the Venice Lagoon to the east and the Euganei Hills to the west (Fig. 1): in this area, the analysis of landscape features highlights the traces of ancient territorial structures organized by orthogonal axes. We think they could be recognised as land divisions carried out during Roman times.

Keywords:
Landscape Archaeology, Archaeomorphology, GIS, Centuriation, Padua Plain

1. Introduction

When Romans took the control of the *Venetia* in the IInd century BC, the plain to the south of Padua was administratively divided among the ancient Venetic *oppida* of *Patavium* (Padua), *Ateste* (Este) and *Atria* (Adria) - see Fig. 2. In the Ist century BC these centres gradually increased their importance, first becoming *coloniae Latinae* (89 BC) and later, with Julius Caesar, being elevated to the rank of *municipia* (49 BC).

From this time and, in particular, from the subsequent Augustan age onwards, the archaeological data begin recording the existence of a population distributed over the greater part of the plain and which lasts until the entire IInd century AD. An evidence that would lead to think that in this moment a major programme of territorial reorganisation must have been implemented in order to exploit the land's agrarian potential to the full.

The real existence of this intervention, already variously hypothesized since the mid-XIXth century, was officially confirmed in the 1972 by the finding, near the village of San Pietro Viminario, of a gromatic stone bearing the cadastral indications of a land division carried out in the area during early imperial times (Lazzaro 1971-2). Despite this finding, however, all the attempts to reconstruct the morphology and extent of this land division in detail have given until now few and uncertain results (Lazzaro 1981; Pesavento Mattioli 1984; Rosada and Bressan 2008).

For trying to better understand the characteristics of the Roman intervention in the low Padua plain, it was therefore decided to implement a new study based on the principles expressed by Landscape Archaeology that, proceeding by way of an archaeomorphological approach[2], took advantage of using GIS and spatial technology (Matteazzi 2012; Fig. 3).

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2 Archaeomorphology is a discipline closely related to Landscape Archeology. It considers the present landscape as shaped by a series of structural components (such as roads, paths, channels, field boundaries), that are the traces of interventions carried out at different times and by different communities. These components came over time to overlap, change and erase each other, transforming the landscape in a complex palimpsest of traces that could be investigated by way of a "stratigraphic" reading, i.e. by establishing some relative chronological sequence among the traces themselves. See Palet 1997.

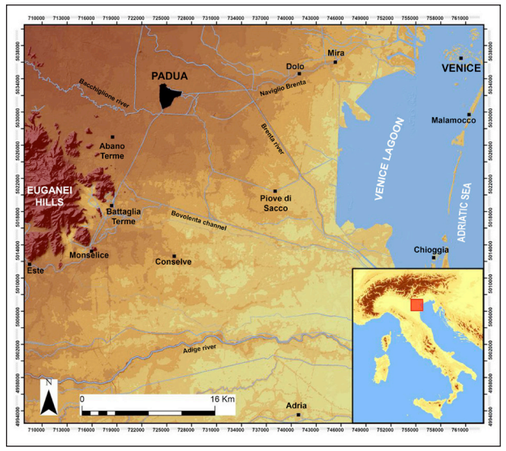

***Figure 1**. Location of the study area (drawing by M. Matteazzi).*

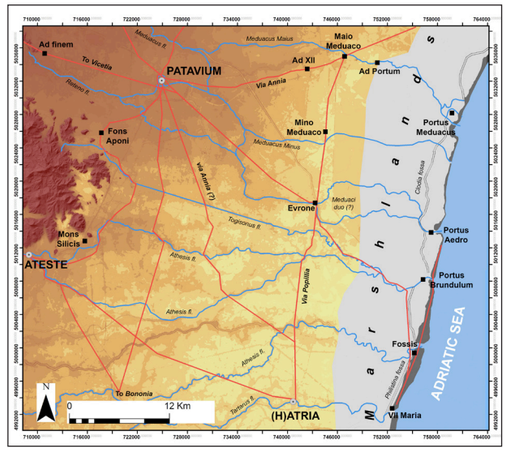

***Figure 2**. The low Padua plain during Roman times. Hypothesis of reconstruction based on paleoenvironmental, archaeological and historical data (drawing by M. Matteazzi).*

2. Methodology

2.1 The Use of GIS

This choice was suggested by the increasing use of GIS in Landscape Archaeology studies, and particularly in those that consider an archaeomorphological approach (Palet and Orengo 2010), being their success mainly due to the high spatial and planimetric accuracy they ensure. Actually, this aspect results essential especially in those territorial studies in which the metrological basis plays a key role, as the research on the ancient land divisions where the distances among landscape components become the most important criterion for chronological definitions (Tolba and Romano 1996; Slapšak and Stančič 1998; Orengo and Palet 2009; Palet et al. 2011).

These tools also allow that a large number of geographically referenced sources, needed to conduct the archaeomorphological research, can be included and analysed in a single environment, permitting a high analytical potential: thanks to the multilayered and multiscale environment they provide, in fact the material can be combined in many ways and at different scales in order to achieve a more accurate data set.

It must however be outlined that these technical abilities do not bring a new methodology in the archaeomorphological study, being their advantage the fact that allow the realization of more rapid, more precise and more comprehensive analysis.

Another important aspect of GIS is its capability in presenting the results. The ability to export graphics in multiple and high quality formats allows one to obtain excellent results in presentations, illustrations and dissemination tasks in general.

2.2 The Geo-database

The analytical capability of GIS and, above all, their reliability is based on the quality of the starting data entered into the system. For this reason, at the beginning of the research it was necessary to proceed in constructing of a suitable geo-database - in this case developed with ArcGIS 10 - which included all the most important geo-referenced information about the morphology of the study area. The input data were both raster and vector data.

The initial cartography, which served as basis to georeference other cartographic

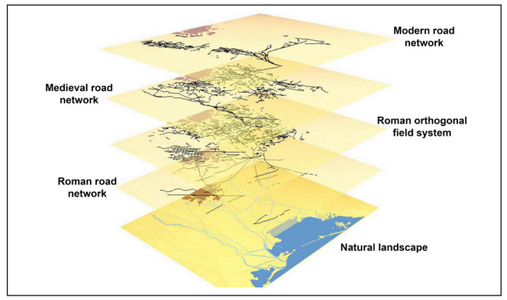

***Figure 3**. Diachronic archaeomorphological analysis of the study area (drawing by M. Matteazzi).*

and photographic raster sources, was the digitised version of Carta Tecnica Regionale (CTR) at 1:10.000 scale and the 2006-2007 orthophotographic series at the same scale, both provided by the Cartographic Office of Veneto Region (UCRV). Besides these, we have also used various tables of the Military Geographical Institute (IGM) cartographic series at 1:25.000 scale.

Concerning the cartographic sources, geomorphological and geological maps at 1:50.000 scale and planimetries of the excavated Roman settlements have also been incorporated. Numerous historical maps, created between XVIIth and XIXth century have therefore been included: these were all georeferenced and rectified, but because of their high degree of imperfection, have never been used in metrological analysis, although they were considered as relevant documents on landscape history.

In respect of the photographic material, very useful for the archaeomorphological study were the aerial photographs taken between 1954 and 1955 approximately at 1:33.000 scale, provided by CNR of Padua (Fig. 4): these were scanned with a resolution of less than 1m/pixel, which allowed them to be orthorectified and georeferenced, obtaining RMSE of less than 5m. The interest of these photographs mainly lies in their date of realization, cause they impress the image of the landscape before the heavy modifications it has experienced since the 1960s. All the aerial photographs available at

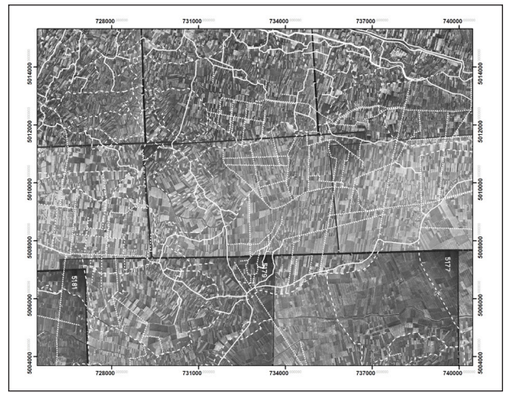

***Figure 4**. Archaemorphological analysis on the 1954-55 georeferenced and orthorectified aerial photographs. Legend: continuous lines: roads of likely Roman origin; dashed lines: roads of medieval origin; dotted lines: roads of modern origin.*

the UCRV have been used, in order to carry out a systematic reading of the territory searching for tracks that could be connected with ancient land use.

Vector data were extracted from 168 vector maps at 1:5.000 scale, from which it has been created a series of layers, including field boundaries, hydrology, paths, roads. Modern cadastral divisions, lithological soil and land use maps and the Venice Lagoon map, as well as elements of geomorphological (eg. alluvial ridges, ancient coastlines ...) and archaeological interest (an especially created Roman sites distribution map) were other vector layers included in the geo-database.

Finally, it was included a DTM with 5 m cells also provided by UCRV. The use of this DTM has proved crucial: thanks to a definition of this sort, the microrelief (e.g. alluvial ridges and depressions) and other morphogenetic characteristics that influence the morphology of the territory could particularly be highlighted, making it easy to connect the identified traces to the natural environment, for a better understanding of origin and evolution of the traces themselves, as well as the reasons that led them to be preserved within the present-day landscape or, on the contrary, to be erased.

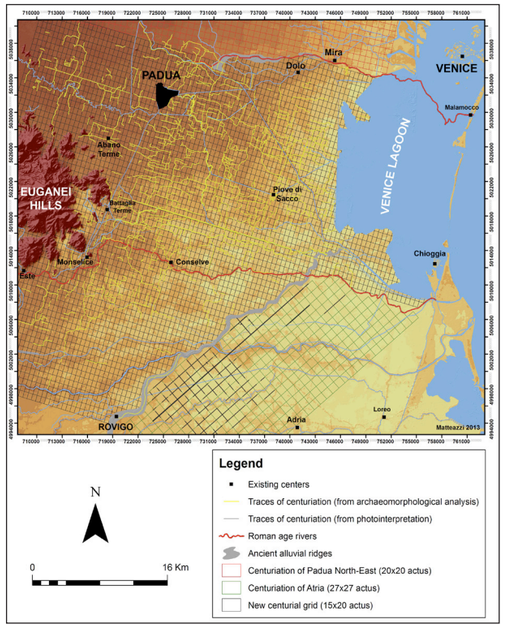

***Figure 5**. Archaeomorphological analysis of the study area showing locations of the centuriated grids detected in the low Padua Plain (drawing by M. Matteazzi).*

2.3 GIS Applications

For what more closely concerns the archaeomorphological study, the work has been based on digitised restitution of the main morphologies structuring the landscape, made from the carto-photographic base that has been created (Fig. 4). Specifically, this work has been realised through the creation of a vector polyline layer to which was joined a table reporting the type of the component (road, path, field boundary, municipal limit ...), the documentary source (cartographic or photographic) from which it was restituted, its orientation and morphologic features, eventual historical data associated and a hypothesis of chronology.

Another vector polyline layer merged all the information connected to traces and anomalies detectable from aerial photos (known or otherwise) and recognisable as human intervention in territory structuring (roads, paths, field boundaries...). Both layers were later correlated with the Roman sites layer, with the aim of defining the criteria for dating the identified traces, in particular by analysing the existing relationship among traces and distribution, chronology and (when available) orientation of the known roman sites.

Exploiting the high definition of the DTM at our disposal, we have also carried out certain types of topographic analysis, including Viewshed and Least Cost Route (LCR). The latter, in particular, was calculated from cost and friction surfaces: despite the numerous applicable cost models now available in the recent archaeological literature (De Silva and Pizziolo 2001; Van Leusen 2002; Fiz and Orengo 2008; Verhagen and Jeneson 2012), nevertheless it was necessary to create a specific model that took into account the particular geomorphological features of the study area, a low plain greatly influenced by fluvial and lagoon activity. This made it possible to reconstruct the ancient routes from *Patavium* to *Ateste* and from *Patavium* to *Atria*, lying on data provided by archaeomorphological analysis, archaeological and toponymy evidence, medieval written sources and, most important, the reconstructions of ancient environmental conditions (Fig. 2).

3. Reconstructing the Centuriated Landscape

Using this methodology, it was possible to identify the traces of a wide orthogonal field system which extends over the greater part of the study area (Fig. 5). This structure respects the same orientation followed by most of the components forming the territory main hydrological network and, in particular, by the Bovolenta channel, which seems having acted as an important axis of the field system itself.

The alignment of the majority of the known Roman sites along or near the traces belonging to this orthogonal system, the fact that the wall structures of the (few) excavated

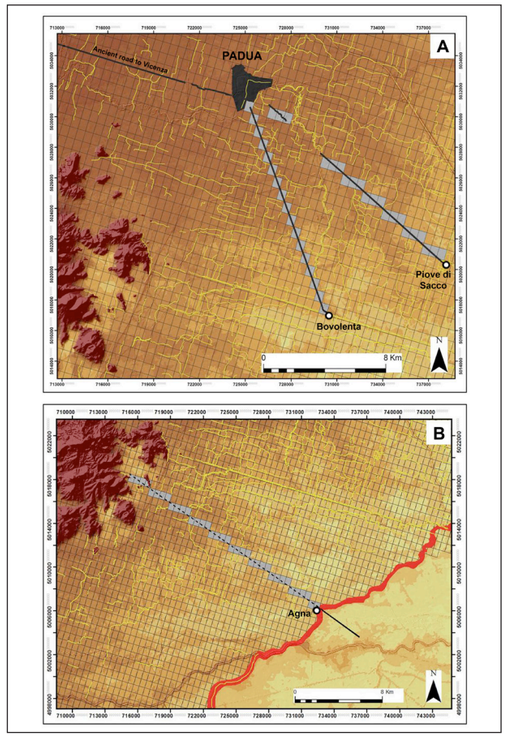

***Figure 6**. Two details of the study area, showing the relationship between the centuriated grid detected in the low Padua plain and some roads acting as diagonal lines (drawing by M. Matteazzi).*

Roman settlements are perfectly oriented with it, beside the clear deformations and erasures caused by the setting of medieval road network and field systems, are good clues that could testify for its ancient origin.

Metrological analysis show that almost all the identified traces respect modular distances among them, based on multiples of a common divisor corresponding to 5 Roman *actus* (about 177.5 m): this would allow to recognise in this orthogonal field system an example of the most popular typology of Roman land divisions known as centuriation, in this case modulated on base units (*centuriae*) corresponding to rectangles of 15x20 *actus* (532x710m). According with the information provided by the gromatic stone of San Pietro Viminario, we can also try to recognise the main E-W axis of this centuriation (the *decumanus maximus*) in a road currently passing through the village of Cartura.

The grid we could reconstruct includes the entire Roman urban area of *Patavium*, suggesting a direct connection between this intervention of centuriation and the ancient town (Fig. 5). Such a relationship is also suggested by a straight stretch of road, recently identified as a part of the route from *Patavium* to *Vicetia* (Vicenza) mentioned in ancient itineraries (Matteazzi 2008): this road would then be exit from the Roman town acting as a *decumanus* (Fig. 6a).

Two other roads, one leading to the medieval *castrum* of Bovolenta (and recognised as a part of the Roman route to *Atria*) and another leading to the medieval fortified village of Piove di Sacco, seem to have played a different role, since they diagonally cross the centurial grid (Fig. 6a): the first one cutting each grid unit, the other one going through groups of three grid units. This fact is noteworthy because it has been argued that centuriations could be constructed from straight stretches of road, which would act as hypotenuses, or diagonal lines, of the grid, following the gromatic process known as *varatio* (Roth Congès 1996; Palet and Orengo 2011). These diagonal lines could cross one or more grid units, depending on the angular relationship between the road and the land division and the grid module.

In our study area we can find out another example of road acting as diagonal line of the land division. It is a long straight track highlighted by aerial photographs southeast of the village of Agna and identified as a part of the route *Patavium-Atria* (Fig. 6b): hypothetically, if we extend the track line to the northwest, we can see how it crosses diagonally our grid, passing through groups of four *centuriae*.

Concerning the true extent of this centuriated field system, we can find its northern limit in an area north of Padua, where

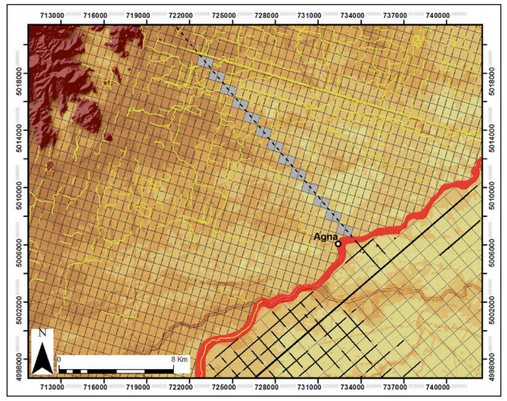

***Figure** 7. The relationship between the "centuriation of Adria" (in black) and the centurial grid detected in the Padua plain (in yellow): the kardines of the first one hypothetically pass through the second one, acting as diagonal lines. The two grids are clearly separated by an ancient alluvial ridge (in red) constructed by the Po river during the Bronze age (drawing by M. Matteazzi).*

the traces belonging to our structure meet those belonging to the so called "centuriation of Padua North East" (Fig. 5), a still perfectly preserved example of classical centuriation with a grid moduled on base units of 20x20 *actus* (Brigand 2011). In this area the archaeomorphological analysis suggests that the boundary between the two centurial systems could have corresponded to an ancient alluvial ridge of Brenta river, likely during Roman times followed by the northern branch of this water course known in classical sources as *Meduacus Maius* (Fig. 2).

To the south, the traces disappear within an area where the reading of some aerial photographs had revealed, since the 1980's, the evidence of a land division thought to be a centuriation connected to the Roman town of *Atria* (Fig. 5) and known in the literature as "centuriation of Adria North West" (Masiero 1999).

In this study, all the available aerial photograms (taken from the 1950's to the present time) have been scanned, georeferenced, orthorectified and re-analysed, in order to achieve a better definition of the known tracks and try to identify any new track.

The new analysis carried out, beside the confirmation of the existence of such a centuriation, for which an unusual grid modules of 27x27 *actus* (958.5 x988, 5 m) have been proven, also has led to define the limits between the "centuriation of Adria" and the one we have identified in the Padua plain. These limits can be recognised, to the east, in an ancient alluvial ridge of the Po river surely active between the Bronze Age and Early Iron Age (Piovan, Mozzi and Stefani 2010); to the north, in the final stretch of what has been identified as the palaeo-bed followed in Roman times by the northernmost branch of Adige river (Mozzi et al. 2011).

Even more interesting is to note the close connection existing between these two centurial grids. As we can see in Fig. 7, the *kardines* of the southern "centuriation of Adria", if extended to the northwest, diagonally intersect the northern grid, going through groups of two *centuriae*. This evidence seem to suggest that the centuriation we detected in the Padua plain is newer and that it was built by using the "centuriation of Adria" as an important reference point.

4. Final Remarks

In respect to the attribution of this intervention of land division it is difficult to think about a single connection with *Patavium*, since the territory on which the traces can be detected includes areas that in Roman times certainly belonged to the *ager* of *Ateste* (Bosio 1992). For this reason it is considered that the centuriation identified to the south of Padua could correspond to a larger pattern of structuring of the territory, in some ways comparable to examples of very large land divisions that include, in a single cadastre, territories belonging to different communities (e.g. *civitates*, *praefecturae*... - Ceraudo and Ferrari 2009). This intervention would have therefore involved, at first, the whole Padua plain, and only later would be administratively

divided among the various communities which were distributed over it.

The use of a particular metrology of 15 *actus*, quite common during Caesar and Augustus times both in Italy and Spain (Palet, Fiz and Orengo 2009), and the evidence provided by archaeological data testifying a population spreading from the second half of the Ist century BC, could suggest the study area has been subjected to this intense territorial structuring phase during the principate of Augustus. A centuriation carried out at this time would be consistent, to the other hand, with some other interventions promoted in the area by Augustus himself, including the re-founding of *Ateste* as *colonia* and the subsequent settlement within its countryside of many veterans of the battle of *Actium*, and the almost total urban restructuring of *Patavium*.

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