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 II\textsuperscript{nd} 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 I\textsuperscript{st} 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 II\textsuperscript{nd} 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-XIX\textsuperscript{th} 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\textsuperscript{2}, took advantage of using GIS and spatial technology (Matteazzi 2012; Fig. 3).

\textsuperscript{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.
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 1960; Slapšak and Stančič 1998; Orengo and Matteazzi 2010), 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 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, because they impress the image of the landscape before the heavy modifications it has experienced since the 1960s. All the aerial photographs available at 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 1:50.000 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 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).

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

Figure 4. Archaeomorphological 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.
centuriae. Archaeomorphological analysis of the study area. Two details of the study area, showing the known or otherwise and recognisable as anomalies detectable from aerial photos all the information connected to traces and historical data associated and a hypothesis of photographic) from which it was restituted, its...), the documentary source (cartographic or road, path, field boundary, municipal limit a table reporting the type of the component...), 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 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 Pizzolo 2003; 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 Pataurium to Atria and from Pataurium to Vicetia, 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).

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

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

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).

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

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 Pataurium, 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 Pataurium 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. 6b): the first one cutting three grid units, 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 hypoteneuses, or diagonal lines, of the grid, following the gromatic process known as ortostasi (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 Pataurium-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...
The new analysis carried out, beside the confirmation of the existence of such a centuriation, for which an unusual grid modules of 27x27 actus (938.5 x 988, 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 centuriar 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 kardines. This evidence seems 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 cadastral, territories belonging to different communities (e.g. civitates, praefecturae… - Ceraudo and Ferrari 2005). 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 2000), and the evidence provided by archaeological data testifying a population spreading from the second half of the 1st 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.

References


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