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Cover image: embankments at the Danube waterfront of Regensburg "Donaumarkt" made of re-used Roman material, probably Carolingian (S. Codreanu-Windauer, BLfD 2014).

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research

Land, rivers and marshes: changing landscapes along the Adige River and the Euganean Hills (Padua, Italy)

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This paper analyzes the modification of settlement patterns, agrosystems and the management of land and water associated with the alluvial phenomena detected in the Padua plain from ancient to modern times.
Keywords: Padua plain, hydromorphological changes, LiDAR, historical landscapes, water uses

Questo articolo analizza la modifica dei modelli di insediamento, degli agrosistemi e della gestione di terreni e acque associati ai fenomeni alluvionali rilevati nella pianura padovana dall'antichità all'epoca moderna.
Parole chiave: *pianura di Padova, cambiamenti idromorfologici, LiDAR, paesaggi storici, uso dell'acqua*

1. Introduction

In the Veneto region, rivers were the connective pathways of the entire area and a key factor in the development of settlements. Their paths between the Alps and the sea ensured communication and commerce. The principal rivers were, and still are, the Po, Adige, Bacchiglione, Brenta, Piave, Sile, Livenza, Lemene and Tagliamento. The layout of these waterways has varied over time: from Antiquity to the Modern Age the historical hydrographic pattern has changed due to natural cli-

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mate evolution or man-made transformations. Paul the Deacon (*Historia Langobardorum*, III, 23) remembered the "flood" that in 589 would have diverted the course of the Adige River 20 km to the south. To explain this disaster, we can hypothesize two environmental and political contingencies: (1) the cold and rainy period of the late 6th century, and (2) the fragmentation of hydrogeological control between the inner plain, conquered by the Lombards, and the coastal territory, which remained under the political control of the Byzantine Empire (Brogiolo 2017a).

Traditional interpretations, confirmed and detailed by recent LiDAR analyses (Citter, Patacchini 2017), show: (a) a wide alluvial front, which moved southward from the ancient watercourse from Montagnana to Este to Monselice, with a conoid tendency; (b) marshes around the Euganean Hills, produced by the accumulation of river debris that had formed a kind of barrier; and (c) marshes and large lakes in some depressed areas of the Padua plain. However, we do not know the stages of formation. They do not seem to be limited to individual episodes, but rather to be distributed over a much wider timescale than just the end of the 6th century.

Before Venetian land reclamation in the 15th and 16th centuries, for which there are extensive records, we have little information about the phases of hydraulic systematization and agricultural (re)conquest that occurred since at least the Bronze and Iron Ages. These continued on a large scale in Roman times, when agricultural divisions with orthogonal plans appeared. Different patterns of centuriation have been hypothesized for these (Mateazzi 2012, 2013; Cattaneo 2013).

For the period between the Early Middle Ages and the Modern Age, we have taken into account certain written sources from the Carolingian period to the 11th century. There is a document from *c.* 830, which defines the boundaries between the *comitati* of Monselice and Verona, referring to some channels. For one of these channels, located between the village of Caselle and the Sanguinedo forest, the document specifies that *ipse fossatus factus fuit manibus hominum* (CDV I, n. 156, pp. 219-220). In 978, Gauslino (bishop of Padua) gave the collegiate of San Fidenzio di Megliadino the tithes of the newly cultivated lands (*novalia*), and those that would, in the future, be in the *curia* of Megliadino and Saletto. At the same time, he encouraged the beneficiaries to plant vineyards on the property of the church (Lanfranchi Strina 1973).

In the aerial photographs and the DTM-LiDAR analysis, we can see agrarian landscapes of centripetal morphology around some castles built on the top of the Euganean Hills, such as Arquà Petrarca, Baone, Monte Cero, Monte Cinto and many others. Most of these date from the second

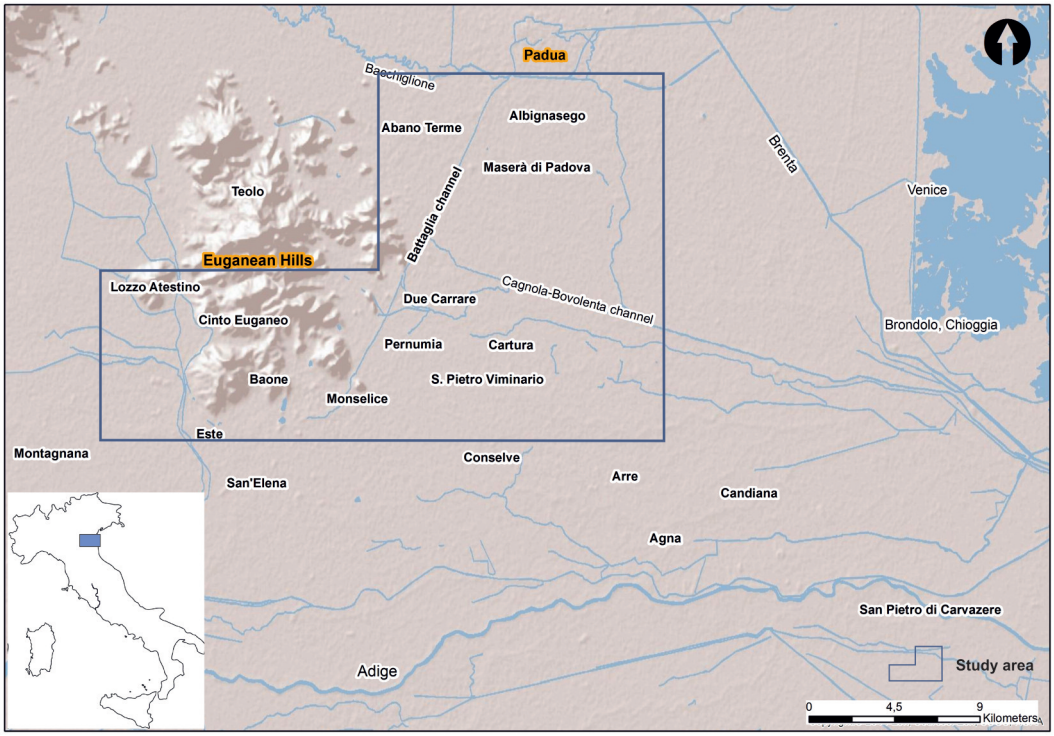

Fig. 1. Study area with the main sites mentioned in the text.

half of the 10th and the 11th centuries. However, without a systematic excavation, it is not possible to determine if there are any pre-existing settlements, as documented in the case of Montagnon, Baone or Cinto Euganeo (with Prehistoric and Early Medieval settlements), and therefore to which specific phase the surrounding landscape must be attributed.

Equally clear are the traces of radial morphology found in the plains, which converge towards the medieval castles, as in the cases of Pernumia, Tribano and Pozzonovo.

Better known are the works of hydraulic engineering for land reclamation dating from the 15th century onwards, which defined a landscape that was still readable in the early 1960s, before the process of industrialization.

With these premises, this paper focuses on the study of the environmental and historical landscapes of the southern plain of Padua in the district of Monselice, from the town of Montagnana to Pernumia, and from the Adige River to the eastern Euganean Hills (fig. 1).

2. Identifying traces of climate changes in the plain of Padua through rivers and marshes

Some geomorphological studies have confirmed the high mobility experienced by the main rivers in this area (especially the Adige), but have not clarified the causes and the consequences on the settlement and the agricultural organization (Piovan *et al.* 2010).

This study tries to delve into some of the following issues. Through which elements of the landscape can we identify, on the ground, the traces of the major climate changes that took place in this territory? How were the different settlements and roads organized in relation to the river networks, from Antiquity to the Modern Age? Is it possible to see traces of ancient agricultural landscapes and land divisions over time and, if so, are there different degrees of geomorphological instability in the studied area?

The studied area is a portion of the Padua lowlands (fig. 1), distinguished by a complex fluvial system that, over time, has shaped the landscape, leaving traces of its activity in the many palaeo-riverbeds that can still be detected on the ground. In general, the soils are of alluvial formation, and the stratigraphic horizons are very uneven because of disturbances due to hydrographic changes caused by periods of climatic instability, or by human modification of the channels (Fontana, Mozzi, Bondesan 2008, pp. 85-86). The geomorphological map of the Padan plain (Castiglioni 1997) highlights this complex network of watercourses corresponding to the multiple lines of the rivers Brenta, Bacchiglione and Adige, with a geometry of riverbeds designed by diversions throughout history, especially in the case of the Adige River (Marchetti 2000, p. 83). One of the main causes of the transformation of the Adige, and of much of the hydromorphology of this territory, was the worsening climatic conditions suffered from the 5th to the 7th centuries (Cheyette 2008). It was a cold and rainy period, which, together with the low maintenance of rivers, caused the transformation and rupture of the waterways, the emergence of marshes in the lowlands and the increase in the sea level, which changed the coastline (Brogiolo 2015, p. 50).

2.1. Changes in the water courses

The geomorphological analysis carried out with DTM-LiDAR, through a visualization that enhances the micro-relief (*Color Ramp Constraint* with a height above sea level of 0-25 m), shows the old patterns of fluvial origin that in most cases follow the current road network (fig. 2).

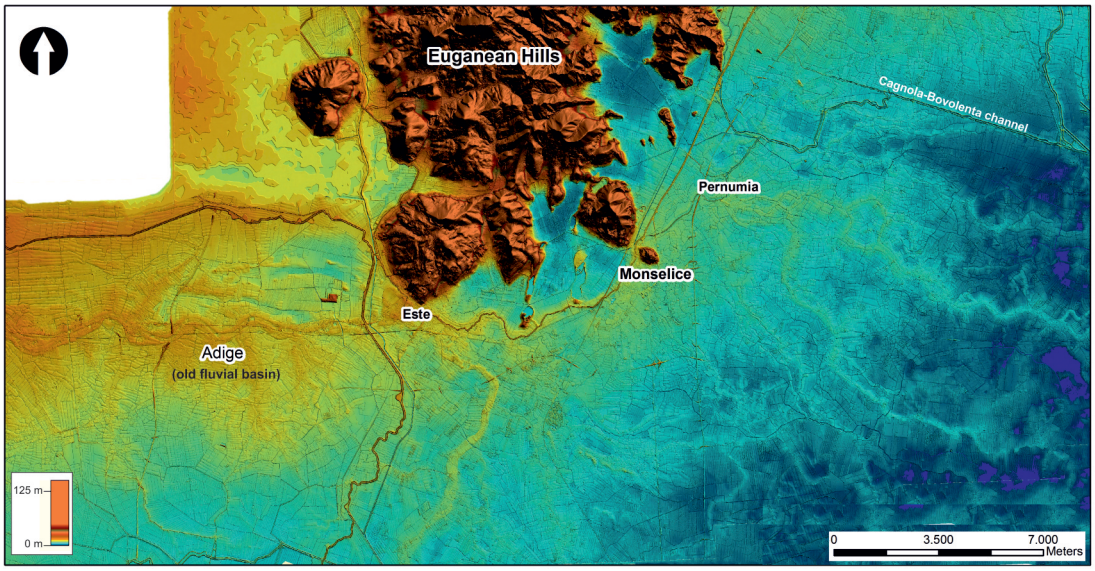

Fig. 2. Adige paleo-riverbeds detected through DTM-LiDAR analysis.

Unlike in the north of the study area (from the eastern plain of the Euganean Hills to the current course of the Bacchiglione, to the east), where only a few old riverbeds were identified, in the southern part, particularly to the south of the current Cagnola-Bovolenta channel, we can see a complex system of small waterways and branches related mainly to the old basin of the Adige River.

The planimetric features and orientation of the main section of the Adige palaeo-riverbed is between 90°E and 26°NE. However, we can distinguish four other segments by showing different directions between 16°SE and 44°SE (fig. 3). The main course of the Adige seems to have followed the current channel at least until the area of Bonavigo (Verona), where it is divided into two distinct branches, which have already been identified by geomorphologists (Marcolongo, Zaffanella 1987, pp. 51-52).

The northernmost branch (A.1), reaches the city of Este (the Roman city of *Ateste*) and from there heads to the town of Monselice, probably following the course of the current Bisatto channel, which in the Medieval period was called *flumen Vigenzone* (Valandro 1997, p. 174). In Monselice, according to some scholars, the river passed through the south of the *Rocca* hill in the direction of Arzerdimezzo, as is suggested

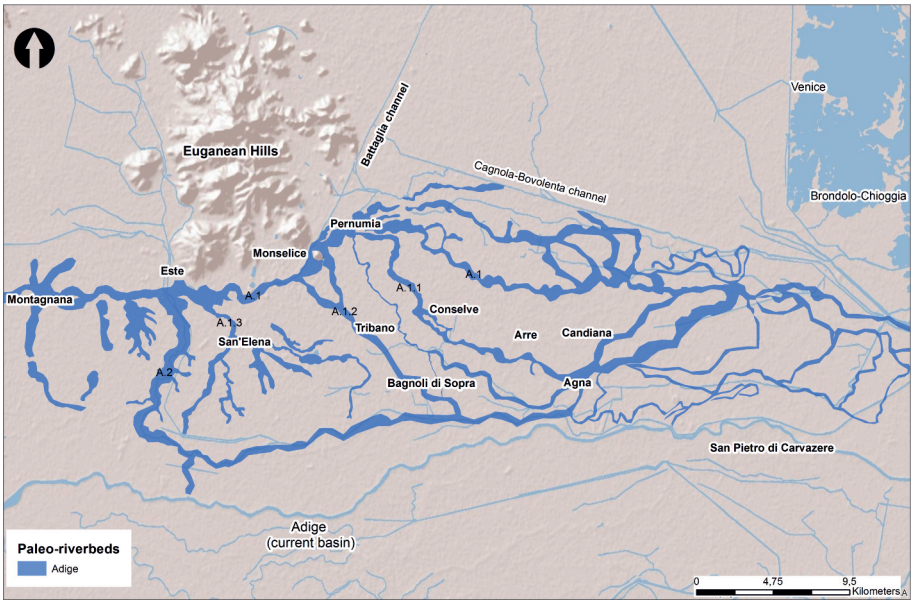

Fig. 3. Map of the different branches belonging to the former course of the Adige River.

by the former presence of a ford and a sales agreement dated to 1195 which refers to a bridge located at *Villa de Vallesella* (Corrain 1994, p. 70). However, according to the micro-relief shown by LiDAR, it seems that the much wider waterway detected in this section would pass not only south of the *Rocca* hill, but also north. This could indicate an isolation of the *Montericco* and *Rocca* hills, surrounded by the water of the Adige, probably giving the castle of Monselice a strategic role in Late Antiquity and the Early Middle Ages.

The northern part of this ancient riverbed is the branch that goes from Monselice to Pernumia, and from there proceeds to the south-east towards Conselve, Arre, Candiana and Concadalbero (A.1.1). Some radiocarbon dating confirms its activity from the Bronze Age to the Early Middle Ages (Mozzi *et al.* 2011, p. 86). Eventually, its water would flow to Brondolo (Chioggia, Venice) where traces of an ancient delta (Bondesan *et al.* 2008, p. 148) have been identified, probably due to a prolongation of the Brenta River through Civè and Ca' Bianca.

We should also highlight the palaeo-riverbed that descends from Pernumia to Tribano and Bagnoli, especially given the strong geomorphological evidence up to its confluence with an ancient riverbed of the Po near

the town of Agna (A.1.2). Even for this branch, the radiocarbon analysis suggests full activity during the Bronze Age (Primon, Furlanetto 2004, p. 311; Mozzi *et al.* 2011, p. 86).

Near Este, we can see a sub-branch of the main course with a north-western/south-eastern orientation, marked by a channel seen through DTM-LiDAR that crosses the areas of Deserto d'Este, St Elena and Solesino (A.1.3). Geoarchaeological surveys conducted in Deserto d'Este and the discovery of a Roman *villa* in St Elena would suggest that the river course was active between the Roman period and the Early Middle Ages (Balista 2005, pp. 75-76). Therefore, this branch could be linked to the flood that occurred in the 6th century, since the survey in the *villa* of St Elena discovered a layer of alluvial detritus, the archaeological materials of which do not date later than the 6th century (Cipriano, Ruta Serfini, Cagnoni 2006). From Solesino, the course of the river seems to disappear. Its only visible continuation is in the direction of the town of Agna, over the traces of other courses and riverbeds highlighted by geomorphological studies, now incorporated in the tracks of some drainage ditches.

A southern branch, however, would have flowed from Bonavigo to Legnago, Badia Polesine, Lendinara and Rovigo, along the current route taken by the Adigetto River (A.2), at least in the Roman times, as evidenced by the presence of some findings throughout its path (CAV 1992, pp. 160, 163, 164; CAV 1994, p. 118). This branch would then lead directly into the Adriatic Sea in the area of Cavanella d'Adige.

These ancient branches of the Adige River are visible in current aerial photographs, as their margins are raised with respect to the level of the surrounding territory. We also must add that most ancient river channels are reused as roads, recognizable thanks to their tortuous paths in the historical maps and photographs taken before the industrialization of the countryside (GAI 1955). This has enabled easy identification by geomorphologists without having to use high-precision images (Castiglioni *et al.* 1998; Mozzi 2005). However, with the application of advanced visualization techniques applied to LiDAR images, we have identified many minor abandoned courses belonging to the drainage basin of the Adige River (fig. 3).

The hydrographic pattern detected in the study area is a fluvial network formed by a main channel with sinuous shapes and different branches with tortuous forms, some visible and others still missing after the river course mutated several times in the Middle Ages. It seems that around the 10th century the Adige River finally settled down over the ancient Chirola channel (Gualtieri di Brenna, Cantù 1861).

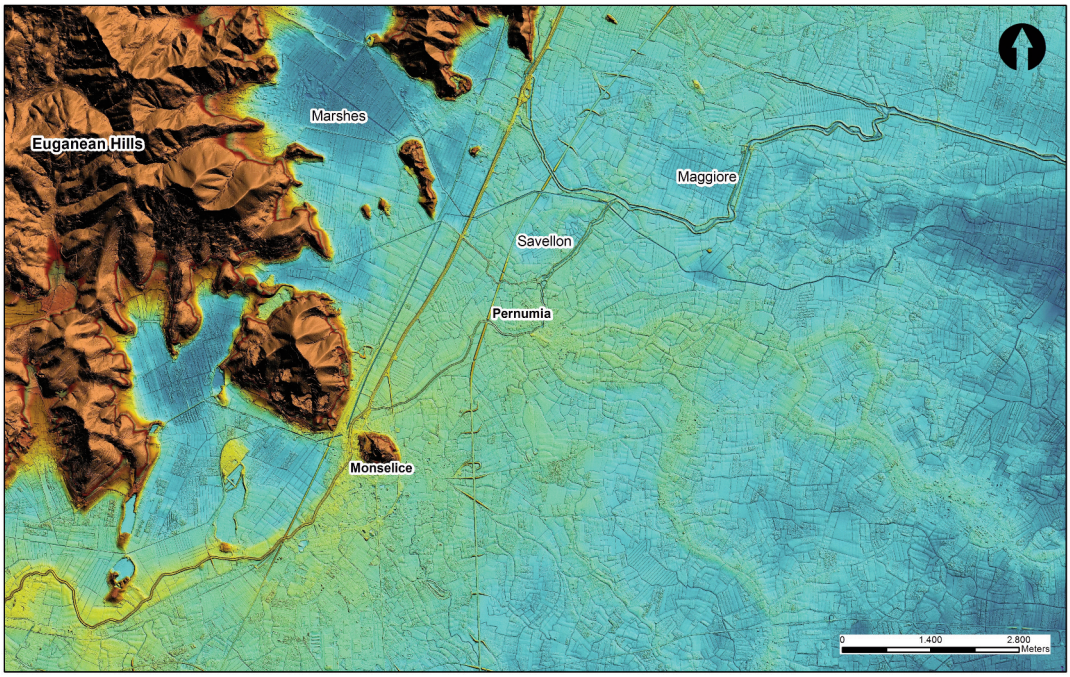

Fig. 4. Marshy areas in the territory between Monselice and Pernumia.

2.2. Traces of dried marshes

In addition to rivers, marshes dictated the development of the territory from Late Antiquity onwards. Wet periods from the late 5th to the early 7th centuries, and between the 8th and the 12th centuries, favoured an increase in woodlands, while the depressed areas returned to being marshy, as DTM-LiDAR images show (fig. 4). Some traces of former wetlands are found in the area between Este, Monselice and Pernumia. In the Austrian cartography (1845) we can already see how the property boundaries follow the basin layout of these dried marshes after the land reclamation process in the 16th century. Also, reclaimed land are still identified with place-names reminiscent of those marshes, such as the toponym "Palù", which is located on the old marsh of Savellon[1]. On the DTM-LiDAR, these flooding areas coincide with the lowest points of the territory – one of the most evident is the marsh Maggiore.

[1] Toponym that means "sandy bottom", attested between the 12th the and 13th centuries like "marsh between the mount Vignalesco" (1175), "marsh in Savellone" (1168) (Grandis 2003, p. 6; Zanini 1925, p. 13).

The few surviving written sources that refer to this territory clearly indicate that, during the Middle Ages, a large area of wet woods appeared between the main town of Monselice – where the parish, the castle and the royal court were located –, Pernumia and Conselve (Bortolami 1978). Even after a period of prolonged and persistent agricultural recovery, promoted between the 11th and the 13th centuries by the church of Padua and some Benedictine monasteries (St Ilario, St Giorgio di Fossone, St Michele di Brondolo), large forests (Reoso, Visignolo) and vast wetlands survived in the area. Therefore, in the mid-13th century, a new impetus was given to land reclamation, coinciding with a new warmer climate period that had as a consequence the increase of the population and the need to cultivate new lands through reclamation and deforestation. This was a common phenomenon in Europe, especially during the 13th and the 14th centuries. It shows that the layout of the road paths or the agricultural landscape of the Roman period had been lost for centuries, at least in this southern area of the Padan Plain, where many wetlands are attested. In the Padua area, the real protagonist of the land reclamation process during the Middle Ages was the Monastery of Santa Giustina, which received many donations from the Paduan bishops and important noble families.

3. Organization of settlements and roads: indicators of human life along waterways

The recognition of changes in ancient fluvial courses over time is the key to understand the different settlement patterns in this territory throughout history. At the same time, georeferencing the various archaeological evidence helps us to date the emergence, alteration or disappearance of different river systems identified through remote sensing and other techniques and sources. In the heart of the Padan Plain, distribution maps show how many settlements are located on the banks of active rivers (Brogiolo 2015, p. 55). One example is the area between Este, Monselice and Pernumia, adjacent to the Euganean Hills, where, as noted earlier, the main hydrographic system of the Adige developed, before its southward shift around the 10th century. As shown in the images (fig. 5), the settlement pattern that we observe through the GIS positioning of archaeological data from the Roman period shows a relatively scattered distribution marked by numerous settlements of villas and villages that belonged to the *territorium* of the *Colonia Ateste* (fig. 5.1). Some of these sites are positioned along the old course of the Adige River, while others are not directly related to the waterways. However, looking at the distribution of settlements in Late Antiquity and

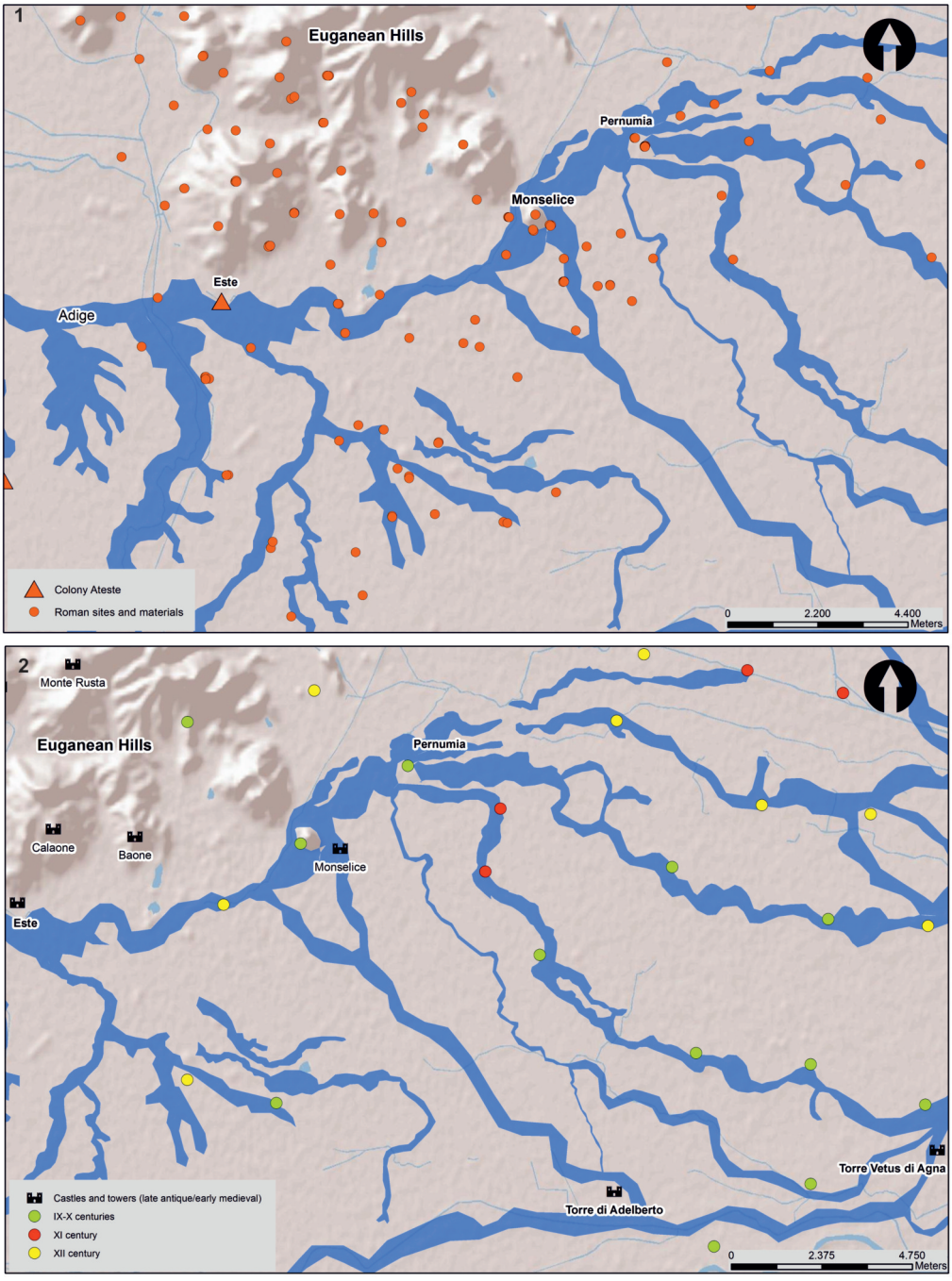

Fig. 5. Distribution map of Roman (1) and Medieval settlements (2) in relation to the old Adige river system.

the Early Middle Ages between Este, Monselice and Pernumia, we see how the general trend is that villages, castles and other settlements were placed, without exception, on the banks of the river (fig. 5.2). The chronological context of this settlement pattern ranges from the 6th to the 12th centuries. Therefore, despite the flooding of the fluvial channel in the year 589 and the subsequent flooding of its surrounding territory, some elements of this hydraulic network apparently remained active even after the Adige changed its path during the 10th century (Meneghel 2004, p. 299). This had an effect on the settlement that could be defined as "resilience", in terms of the occupation of the territory (Brogiolo 2015, pp. 51-52). It was probably a progressive event that allowed the population to continue occupying the same habitat, although they had to redesign the agricultural systems, roads and settlements. It is perhaps for this reason, and as a precaution against further catastrophic events, that the population decided to improve the riverbanks and systematically settle on them. It seems that this was the moment when the loss of the original function of the agricultural structures occurred. The axes in the planning and development of the territory, now replaced by the river networks, were the element generating the occupation dynamics in the Early Middle Ages.

It is interesting to observe the distribution of the fortifications in the area. These are located on the top of the hills or along the Adige River. From this distribution, we can distinguish between the castles near the river and the castles in the hills (Barausse, Favilli 2017). The same happens with the tower-houses or fortified houses, interpreted as potential customs or river control points for trade (Brogiolo 2016a and 2016b). This is logical if we think that the hydrographic structure of the Paduan territory favoured communication between cities/suburbs and the major urban centres of the region, making this area a crossroad for the commerce between the mountains, where the rivers originate, and the Adriatic Sea, where the great emporium of Venice and the port of Chioggia were located.

Therefore, the influence of the river courses on the structures of the territorial organization in the Early Middle Ages (*curtes*), on the topography and shape of the settlements, and on the presence of ports and markets as well as fortifications, monasteries and churches is clear (Canzian 2003).

It would be important to focus on the relationship between the communication system by land and water since the Middle Ages, and the continuity of the old substrate (Matteazzi 2013), which is also linked to the rise and disappearance of settlements (Tognana 2009). The medieval

Fig. 6. Different radial systems on the territory of Monselice, which worked as the central place of a territory articulated around roads and waterways.

villages generated radial or star-shaped road systems, which are the second-most dominant form detected by the archaeo-morphology study within the current structure of the territory, as can be seen around Monselice (Pernumia, Cartura, Tribano, Solesino) (fig. 6). In most cases, the centres of the radial systems correspond to settlements known from the 9th to the 11th centuries (Barausse 2017).

In Pernumia, where we recognized minor branches, it is interesting to note that the roads still in use have been developed following the banks of these branches. Observing the DTM-LiDAR and the Austrian cadastre, many examples of riverbeds that are the axes of the territory from west to east can be found (e.g. roads Cornoledo and Trinità) (fig. 7). In addition to the roads, the morphology of these riverbeds was still partly

detectable at the beginning of the 19th century thanks to the arrangement of land parcels, which adapted to the limits of the old waterways, allowing us to recognize their layout.

4. Management of water and the local economy: from fishing to agrarian irrigation and milling

Between the 11th and the 15th centuries, the city of Padua was a strong central power and decided to promote important interventions on road and hydrographic networks, both in terms of opening up new ways and new channels and, above all, in terms of restructuring and maintaining the territory (Bortolami 1987, pp. 22-23; Simonetti 2009). In the

Fig. 7. Austrian cadastre of Pernumia where the medieval road system is still preserved.

territory, many old centres strengthened their presence, becoming rural municipalities and autonomous promoters of interventions for the recovery of uncultivated areas and land reclamation. Particularly active in this sense were the centres of Monselice, Pernumia and Abano.

By the middle of the 11th century, the agricultural development of uncultivated lands and the humanization of the countryside were well established, leading to the progressive reduction of the forest, the excavation of drainage ditches and the construction of bridges and roads (Bortolami 2002, pp. 50-51). Gradually, the agricultural landscape was transformed considerably, as evidenced by the many place-names derived from deforestation practices, such as *runcare*, *brusare* or *ardere* (CDP I-II, 1879). The founding of monasteries also increased, such as with St Stefano di Carrara in 1027 (Brogiolo, Ibsen 2009, p. 181).

In the territory of Pernumia, at the beginning of the 11th century, the landscape around the centre was dotted with valleys, marshes and natural ditches, and sometimes lakes, as witnessed by the geomorphological data and the analysis made on the DTM-LiDAR. At this time, ponds and marshes were a living part of the rural economy, providing reserves for hunting and fishing, and were supplementary to those linked to the cultivated area, which were modest and concentrated in the higher areas. Before 1225, local laws (*statuti*) ensured the construction throughout the territory of Pernumia of a network of ditches and channels to guarantee capillary irrigation all over the land.

The situation was similar in Monselice, which, between the 6th and 10th centuries, became the capital of the southern part of the Paduan territory (Brogiolo, Chavarría Arnau 2017). The countryside was developed following colonization (Bortolami 2002, p. 45). The whole countryside was transformed by individual and collective initiatives of reclamation of uncultivated land, which had the effect of strengthening the overall rural system. It created a dense network of fences, erected to mark ownership of private roads, with communal ditches and larger drains, crossed by bridges.

Despite these initiatives from the city of Padua, in the year 1500 the streams still flowed freely on the Venetian mainland, with vast expanses of wetlands, often called "lakes", like those of Vighizzolo or Griguola that we can see on the map *De acquis et acquarum provisionibus*, dating to the middle of the 16th century (fig. 8). For this reason, in the early 16th century, the Republic of Venice noted that it was not possible to ignore the intimate connection between the lagoon system and the basin of the region. Thus, in 1545, drainage of wetlands received a new impulse with the partial drainage of these lakes. In the year 1557, the Magistrature

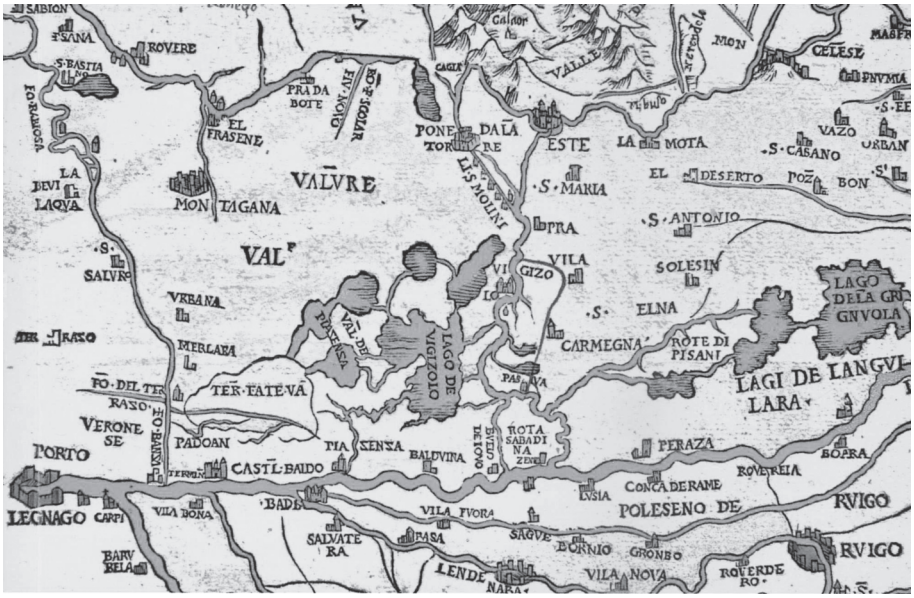

Fig. 8. *De acquis et acquarum provisionibus* map (after Maratini, Vigato 2014).

of the *Beni Inculti* made the so-called *Retratto di Monselice*, a land reclamation made between Este and Battaglia, which reclaimed 10,000 fields and valleys for agriculture. This meant the consequent loss of much of the previous cultural landscape located in Galzignano, Valsanzibio, Arquà and Baone, between the Monselice channel (from Este to Battaglia) and the Euganean Hills. The following year, in 1558, another major reclamation took place in the area between Monselice and Montagnana, known as Consortium of the *Retratto del Gorzon*, which dried progressivly the "lakes" of Vighizzolo and Griguola, and created a new hydrographic landscape that not only sought new lands for cultivation, but gradually eliminated one of the key resources in the economy of the Padan Plain society, which was fishing. These lakes had been, for centuries, one of the largest lacustrine basins of the lower Padua region, and the natural overflow for the complex river system that flowed into it. The impressive hydraulic work undertaken by the Republic of Venice, with the excavation of the Gorzone channel, was the beginning of the partial reclamation of this area. This was followed by the reclamation of other valleys, geographically more distant, by the excavation of drains, or the deviation of existing watercourses (for example, the Fratta west of Montagnana) (fig. 9) (Maratini, Vigato 2014, p. 167).

Fig. 9. Map of *Retratto del Gorzon* (at the ethnographic museum of Stanghella, Padua) designed by Ercole Peretti in 1633, but which depicts the reclamation made in the mid-16th century. The lakes of Vighizzolo and Griguola are still visible, surrounded by a complex system of channels used to irrigate the new lands before draining them completely.

In addition to the recovery of these areas for cultivation, from the 12th or 13th centuries onwards, feudal lords and monks favoured the revival of craft activities and then commerce through the waterways. The first direct connection to Monselice was built between 1189 and 1201 through the Battaglia channel, when the city of Padua began questioning ancient feudal rights and claimed them, especially those regarding concessions for navigation and the use of hydraulic power, which later passed to the Carraresi lordship and finally to Venice. Some of the minor waterways from the eastern slopes of the Euganean Hills were used for the transport of trachyte and other quarried stone materials.

The hydraulic power of these channels also was used to turn the mills. They were more than a hundred on the Euganean slopes, and many others were distributed over the waterways that surrounded Padua (Grandis 2001, 2003). The watermill first appeared in the cartography of Padua in the 9th century AD, but it is difficult to determine whether its presence can be dated to an earlier period.

The Austrian cadastre states that some watermills were still operating during the first half of the 19th century, and some even remained until the second post-war period. The factories scattered along the channels Battaglia and Bisatto had the wheel parallel to the factory (vertical), but perpendicular to the main flow, deriving the water from a side drain that moves the wheel, which was made with shovels. Thanks to this deviation of the flow and the difference in height of the riverbed created just below the wheel, the water had constant power, and therefore the grinding of cereals would not stop. In some cases, such as in Pontemanco (Due Carrare), this stability in energy supply permitted the installation of several wheels (up to 12).

A common element in both the hills and the plains is the presence of only vertical wheels, while there is no archaeological evidence or documentation of horizontal watermills. The difference between these two types of mills is related to the driving force available: while the vertical wheels paddle smoothly in an optimal manner with a low turnout of water, horizontal ones require a significant and strong water flow.

The distribution of the watermills in the hilly area was influenced by water availability. For this reason, there was a lower concentration of watermills along the eastern side, while the western side had many waterwheels. Noteworthy is the concentration of wheels on *Calto della Contea*, between Castelnuovo and Zovon. Those watermills were located near the watercourse, with collateral branches of small streams assembled in the *gorgo*, a large reservoir located upstream of the mill, which extended over an area between 300 and 600 square metres. The reser-

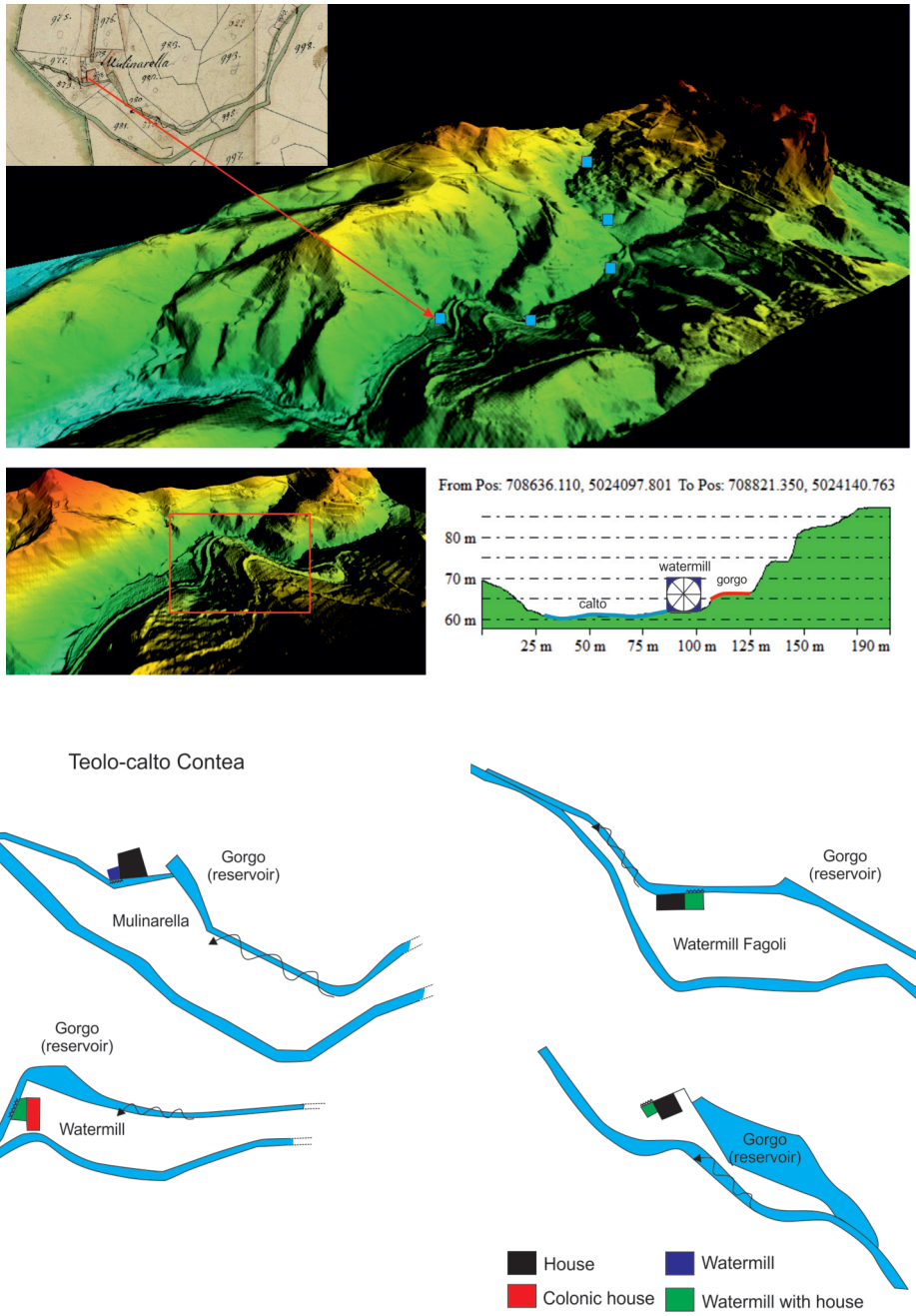

Fig. 10. Watermills on the *Calto della Contea* showing the typical structure of water mill factories in the Euganean Hills.

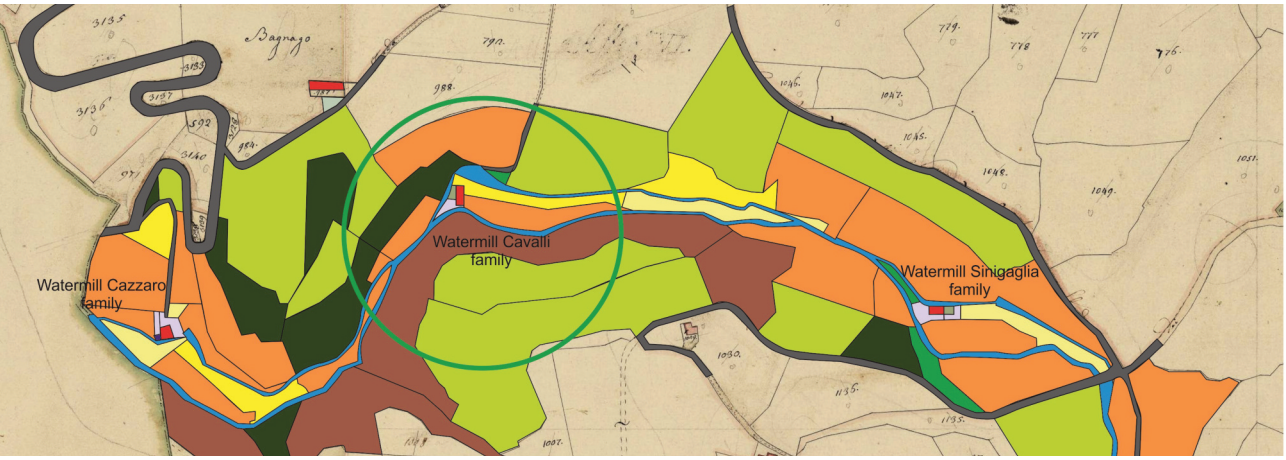

Fig. 11. Austrian cadastre with the owners of the watermills in *Calto della Contea*.

voir was placed about 10 metres above the wheel. From there, the water flowed to supply the boxes of the mill wheels (fig. 10).

Regarding the property of watermills, according to records from the 12th century, these hilly watermills were controlled for a long time by the powerful feudal families of Padua (St Sofia, Scrovegni, Orsato, Capodilista, etc.), some rural municipalities and religious institutions. In the Venetian period, almost all watermills were owned by the Venetian and Paduan aristocracy. The Cavalli family is a case of continuity, as they were owners of the watermill of Mezo in Teolo during the Middle Ages, and in the mid-19th century in the Austrian land registry, they still appear as the owners of a mill house with a farmhouse (fig. 11). According to the documents of the 15th century, the contracts between the owners and the managers of the Euganean mills are proof of the indirect management of the factories (Grandis 2001).

Industrialization led to the abandonment and disappearance of most of the watermills in the hills between the late 19th and mid-20th century. Sometimes, they were turned into houses.

5. Conclusions

In both the Padua plain and the Euganean Hills, many factors influenced the transformation or permanence of both settlements and their agrarian systems from the Bronze Age to the Modern era. The factors

that led to change or resilience were always related to environmental circumstances or human actions on the complex hydrographic network of the Adige River. However, these factors did not affect the different areas to the same extent: the area north of the axis formed by the current Cagnola-Bovolenta channel was geomorphologically more stable, allowing for the substantial fixation of agricultural structures from the classical period to modern times, while the southern area, where there are important cities as Este or Monselice, was affected by alluvial processes caused by the instability of the old basin of the Adige, that also would have caused the appearance of large swamps. In addition to the agrarian organization of the territory, the nature and extent of settlements and roads also were strongly linked to hydrography, especially since Late Antiquity and the Early Middle Ages, when most of the settlements of the plain were placed following the course of the fluvial branches. In the same way, the roads show a radial communications system that unites the central places like Monselice with other smaller centers dependent on them.

Another important aspect that has greatly marked this territory since the Middle Ages, has undoubtedly been the process of land reclamation from marshy and forest areas, which began from the 11th and the 12th centuries and culminated in the 16th century. This process not only affected the environment and the geomorphology of the territory, but also forced a change in the economy of the Padua plain and Euganean Hills. It went from a "forestry" society, which exploited the resources provided by the marshes and forests, to an agrarian society controlled by the noble families of Padua and Venice, who controlled large tracts of property and other resources related to the new landscape: hydraulic energy, channels and, therefore, water mills and rights of navigation/river trading.

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