Volume 5
May 2015

pca

european journal of
postclassical archaeologies

SAP
Società
Archeologica

pca

european journal of
postclassicalarchaeologies

volume 5/2015

SAP Società Archeologica s.r.l.

Mantova 2015

pca

Post-Classical Archaeologies (PCA) is an independent, international, peer-reviewed journal devoted to the communication of post-classical research. PCA publishes a variety of manuscript types, including original research, discussions and review articles. Topics of interest include all subjects that relate to the science and practice of archaeology, particularly multidisciplinary research which use specialist methodologies, such as zooarchaeology, paleobotany, archaeometallurgy, archaeometry, spatial analysis, as well as other experimental methodologies applied to the archaeology of post-classical Europe.

Submission of a manuscript implies that the work has not been published before, that it is not under consideration for publication elsewhere and that it has been approved by all co-authors. Each author must clear reproduction rights for any photos or illustration, credited to a third party that he wishes to use (including content found on the Internet). For more information about **ethics** (including plagiarism) and copyright practices and guidelines please visit the web site www.postclassical.it.

PCA is published once a year in May, starting in 2011. Manuscripts should be submitted to **editor@postclassical.it** in accordance to the guidelines for contributors in the webpage http://www.postclassical.it

Post-Classical Archaeologies's manuscript **review process** is rigorous and is intended to identify the strengths and weaknesses in each submitted manuscript, to determine which manuscripts are suitable for publication, and to work with the authors to improve their manuscript prior to publication.

This journal has the option to publish in **open access**. For information please visit the web site www.postclassical.it

How to **quote**: please use "PCA" as abbreviation and "Post-Classical Archaeologies" as full title.

Cover image: courtesy of Schaffhausen, Stadtbibliothek (Switzerland), Gen. 8, f. 271v – Klosterneuburger Evangelienwerk, retrieved from www.e-codices.unifr.ch/en/sbs/0008/271v/0/Sequence-1030

"Post-Classical Archaeologies" was approved on 2015-05-13 according to ERIH PLUS criteria for inclusion. Classified A by ANVUR (Agenzia Nazionale di Valutazione del sistema Universitario e della Ricerca).

DESIGN

Paolo Vedovetto

PUBLISHER

SAP Società Archeologica s.r.l.
Via Fienili 39/a, 46020 Quingentole, Mantova
www.archeologica.it

PRINTED BY

Tecnografica Rossi, Via I maggio, Sandrigo (VI)

Authorised by Mantua court no. 4/2011 of April 8, 2011

For subscription and all other information visit the web site www.postclassical.it

ISSN 2039-7895

pca
european journal of
postclassicalarchaeologies

volume 5/2015

CONTENTS PAGES

DOSSIER - OPEN ACCESS AND OPEN DATA IN ARCHAEOLOGY

RETROSPECT

PROJECT

REVIEWS

PCA 5 (2015) ISSN: 2039-7895 (pp. 47-68)
Post - Classical Archaeologies

research

Flooding in Northern Italy during the Early Middle Ages: resilience and adaptation

GIAN PIETRO BROGIOLO

Università degli Studi di Padova, Dipartimento dei Beni Culturali, p.zza Capitaniato 7, Padova,
gpbrogiolo@unipd.it

Alluvial phenomena are well documented by archaeologists all over Northern Italy, and have been often linked to events reported by literary sources (e.g. the flooding of 589 described by Paul the Deacon). This paper will discuss, on the basis of the archaeological documentation of several case studies, flooding in the Middle Ages, considering it both as a periodical threat in certain regions and as resilience, or rather as the capacity of the local people to bring the land back to its original appearance. The paper also discusses the economic and social impact of alluvial phenomena. They were a hazard for populations forced to change settlement distribution, but also offered new economic opportunities, through the exploitation of wetlands and forests.
Keywords: Middle Ages, Northern Italy, flooding, settlement distribution

I fenomeni alluvionali sono ben documentati archeologicamente in tutta l'Italia settentrionale e spesso sono stati identificati con eventi riportati dalle fonti scritte (ad es. l'alluvione del 589 menzionata da Paolo Diacono). Sulla base di alcuni casi studio, l'articolo tratta del fenomeno delle alluvioni nel medioevo, considerandole sia una minaccia costante in certe regioni, sia dal punto di vista della resilienza, o meglio della capacità delle società locali di riportare il territorio alle condizioni originali. L'articolo discute anche dell'impatto economico e sociale di queste catastrofi naturali, che furono da una parte un rischio per le popolazioni antiche, a volte costrette a cambiare la distribuzione dell'insediamento, ma dall'altra offrirono anche nuove opportunità economiche, tramite lo sfruttamento di paludi e foreste.
***Parole chiave**: medioevo, Italia settentrionale, alluvioni, distribuzione degli insediamenti*

There is ample literature relating especially to the Late Middle Ages and modern times regarding natural disasters (Juenha, Mauleshagen 2007). The specific topic of floods, which we will be dealing with in this paper, was the subject of a monographic work in issue 19 (2013) of the journal "Environment and History", with articles concerning the experience of urban communities in Austria between 14th and 15th centuries,

Received: 10-10-2014 - Accepted: 25-11-2014 - Revised: 20-12-2014

the eastern coasts of England and the southern coasts of the North Sea (Galloway 2013). According to these scholars, the changes brought about by flood phenomena can be explained only in social-economic terms, with the introduction of habits and practices that by means of specific adaptation minimized the risk and maximized recovery from damage. The principles, also adopted during the Early Middle Ages, concern the localisation of the settlements in elevated positions, the digging of floodway channels and, on a more local scale, of deep channels around the fields to drain the land, the seasonal exploitation of the areas periodically flooded, and the introduction of certain crops, decided by the multiple factors that determine the choice of edible plants (Chevalier *et al.* 2014). In this perspective equally fundamental were the technical solutions adopted to consolidate the lacunal bars, thanks to the transportation of large masses of earth and rubble to raise the land to the level required, and in the creation of new buildings set on platforms made of poles, to stabilize the sandbanks.

For the early medieval period, the situation has often centred on a comparison between written sources and material data (Squatriti 2010), sources that point to generalised changes and to phenomena localized in space and time. For example, an anonymous source from the beginning of the 10th century thus describes the effects of flooding on the city of Modena: the ground is often occupied by large amounts of water, the rivers change bed, ponds and marshes multiply, the inhabitants flee, the buildings are submerged by the waters and by large amounts of detritus (*Mutinensis urbis descriptio*, *RR.II.SS.*, II, 2, col. 691).

Rather than any specific episode, this description reflects a long-lasting condition that many areas of low plains suffered during the Early Middle Ages. In a more detailed account, Paul the Deacon notes, in his *History of the Lombards*, how on 17 October 589 in the areas of Venice and Liguria and other regions of Italy there was a flood the likes of which had not been seen since the times of Noah (Dall'Aglio 1998). Land and homes collapsed and animals and men were decimated. Paths and roads were wiped out and the Adige swelled to such a point that the water reached the top windows of the church of San Zeno, built in the western suburb of Verona. Even the walls were partly ruined and two months later the city was largely destroyed by fire (*Historia Langobardorum*, III, 23; Gregorio Magno, *Dialogi*, III, 19, 1-3, mentioned by Paul the Deacon, refers that the water miraculously did not enter the church; the *Liber Pontificalis*, *Pelagius II*, I, p. 309 also makes reference to the flood). Climatologists have suggested on the basis of multiple data (widening of glaciers, evolution of riverbeds, growth rates of plants or stalagmites and, more in general, changes in vegetation), that this episode took place

in a particularly rainy and cold period, which lasted from the 5th to the 7th century, culminating in around 600 (Giraudi 2005; Cheyette 2008; Holzhauser *et al.* 2005; Pinna 1990; Camuffo, Enzi 1996). It was then followed by an improvement in the climate which, with fewer extreme ups and downs (and a new cold period in the 9th century), continued until the 12th century. Among historians, Paolo Delogu (Delogu 2012) has fully accepted the conclusions of the climatologists, while Paolo Squatriti invites caution since in his view these studies, especially in Italy, are still in their infancy (Squatriti 2010, p. 809). It has been the task therefore of a group of archaeologists to look for traces on the land, not overly difficult considering that there are multiple testimonies in almost all regions of archaeological instability, both for the periods comprising the traumatic event recounted in literary sources, as well as for others before or after 589. For example, the noticeable episodes of flooding of Modena and Riva del Garda have, each time, been attributed to the event, as have the formation of the lakes Gerundo and Moso between the rivers Adda and Serio, changes in direction of the Adige as well as many other episodes. No traces have been found, however, in Verona, despite the fact that the consequences of the fire following the flooding have been archaeologically documented (Hudson 1989). This suggests caution in generalising about the repercussions of an episode that was certainly real, but whose outcome varied from place to place.

The aim of this paper is not to compare sources with material data, even though at the end I will discuss, on the basis of the archaeological documentation available, flooding in more general terms in a chronological period that embraces the whole of the Early Middle Ages. The angle adopted is to consider flooding both as a periodical threat in certain regions and as the capacity of the local people to resist and bring the land back to its original appearance, or to know how to adapt to the changes. The questions we will be attempting to answer are where, why, with what environmental consequences and with what answers as regards containing the damage, resilience, adaptation and re-conquering of the temporarily abandoned agricultural areas.

1. Where

In Northern Italy, alluvial phenomena produced by flooding and overflowing rivers and torrents, which cause an accumulation of detritus shifted by the impetus the water, involve both slopes – causing landslides such as in Valtrompia – and foothills (with actions brought about by colluvium), and valley floors where the detritus progressively creates elevated areas

Fig. 1. Location of the sites mentioned in the paper.

of the occupation layers. The consequences in the areas of low plain are more complex and have more marked effects, giving rise to a plurality of further phenomena (Castiglioni *et al.* 1998; Calzolari 1986): (a) an increase in the level of and changes in the river bed, with the resulting creation of multiple shore banks raised a few metres above the level of the surrounding plain, while the lower parts are occupied by marshes and lakes (a census taken in the area between Parma and Reggio, in Cremaschi, Marchesini 1978); (b) marsh formation around certain hill systems, such as the Euganean Hills, brought about by the different height between the banks of the riverbeds and the foothill, which remains at a lower level (Mozzi 2005); (c) the advancing coastline, with the loss of sea outlets – as is the case of Adria, now over 20 km from the sea – and Concordia, now 8 km from it; (d) infill of port channels that used to come right up to the city on dryland, as is certainly the case of Aquileia and probably Altino; (e) finally, the development of lagoons with the combination of alluvial phenomena and coastal subsidence (Bondesan, Meneghel 2004).

2. The causes

In all instances of flooding, natural causes, either unusual or exceptional rain, are accompanied by others caused by anthropogenic activity. Even today every traumatic episode can be associated with deforesta-

tion, urbanisation, a lack of maintenance of riverbeds or other more specific causes, and often it is hard to attribute the percentage of responsibility due to natural factors and to human ones.

Even more difficult it must have been before there was full knowledge of the effects of environmental and geomorphological changes over a long period of time. Paul the Deacon, as we have seen, establishes an exact date (17 October 589) for the great flood, which we today know to have been only one episode in a difficult climate cycle caused by a lowering of the temperature and associated with an increase in rainfall which lasted at least a couple of centuries. Still less did contemporaries realize they were living in the subsequent warm period that lasted from 8th to 12th century. This aspect, i.e. the perception that the man of the early medieval period had of environmental changes, would be a specific subject to develop, perhaps comparing the results with the information about the modern age, when the problem begins to be treated in a more scientific manner. A case in point, for example, is that of the *magistrati delle acque* (magistrates of the waters) of the Republic of Venice who, from the 15th century onwards, produced a huge amount of specialist studies and themed cartography concerning the workings of the rivers that flowed into the lagoon. This was their starting point for launching important projects that included hydrogeological adjustments to the mainland around the lagoon.

3. The consequences

The accumulation of detritus in populated areas produces a variety of effects that geomorphological and archaeological studies are able to document, distinguishing first of all between those that can be measured locally as against other phenomena that has farther reaching consequences.

3.1. Local consequences

In some cases alluvial deposit in agricultural or inhabited areas buries the soil and ancient occupation layers under metres of gravel or sand, without the settlement network being lost forever. We can define this situation as "resilience" and theorise that its recovery depends on two factors: the population evidently survived and the event was episodic, which allowed for a remedy. Following the event, property boundaries and roads are redesigned at the new occupation layer, as has been recorded in Brescia where alluvial deposit of gravel, often several metres

Fig. 2. Riva del Garda (Trento), 7th-century burials cut alluvial detritus discharged from Albola torrent (after Bassetti *et al.* 2013).

high, has been identified outside the walls on the west and south sides of the city (Brogiolo 1993), in Milan (Caporusso, Cremaschi 1988), in the suburb of the Roman *vicus* in Riva del Garda (Brogiolo 2013), in Lombardy (Veggiani 1982) and in many parts of Romagna (Veggiani 1979, 1983, 1986; Franceschelli 2008).

Well studied are the alluvial phenomena that have affected the Riva del Garda plain (Bassetti *et al.* 2013), conditioned by the alluvial contribution from the Albola and Varone torrents. Erosion and sediment are the results of rapid and violent episodes that, alternating with periods of relative stability, have produced the broad cone shape on which the Roman settlement of Riva del Garda was founded. Traces of disasters are clearly visible in the stratification of gravel, sand and silt found from the Roman period (1th and 2nd centuries AD in viale Roma) to the Middle Ages, with a particularly acute phase between the 6th and 7th centuries: in piazzale Pilati, where soil, probably agrarian from the Roman period (1st-5th century AD), recorded at a depth of 2 m, is covered by alluvial detritus discharged from the Albola torrent between the 6th and 7th centuries AD; in the area of the former Pilati car park, where 14 burials dated between the end of the 6th and the beginning of the 7th century cut alluvial detritus

1.60 m thick that had accumulated over older topsoil of late antiquity (fig. 2). In viale Roma a series of floods were recorded during the Early Middle Ages with some first walls, built on top of the alluvial deposit, positioned on top of the level of late antiquity and later affected by new flooding over a metre high. On top of this, between the 10th and 11th centuries, a building was constructed that was later damaged by a landslide from the eastern slope of Monte Rocchetta.

To put an end to this continuous arrival of detritus, in a period not precisely recorded but before the 12th century, the Albola torrent which until then had entered Riva to the west of the Roman and early medieval settlement along the road that is still called Fiume, was moved to the east of the settlement on a more westerly course than the present one, recorded in modern maps next to its final course.

Despite such disastrous events, the Roman road and probably the layout of the town of Riva are still as before, the only changes being the occupation layers raised, most likely because of the importance of the port to the inland areas of Sommolago and Giudicarie.

An even more significant example of resilience is recorded in Romagna between Faenza and Lugo, where traces of centuriation are clearly evident from the drainage and irrigation network. However the ancient subsoil was at a variable depth of up to 5 m from the current levels of coun-

Fig. 3. Depth of the traces of centuriation between Faenza and Lugo (Ravenna): 1) from 0 to –0.80 m; 2) from –0.80 to –1.50 m; 3) from –1.50 to –2.0 m; 4) from –2.0 to –3.5 m; 5) over –3.50 m (after Franceschelli 2008, fig. 4).

tryside and covered by consistent layers of alluvial strata (fig. 3). This not only means continuity but also conservation of the system grid over the long period, despite the changes in the levels of the soil (Chouquer 1981; Franceschelli, Marabini 2004, 2007; Franceschelli 2008) and a regional context that suffers from numerous critical problems, in particular in the areas of Cesena and Rimini (Veggiani 1979; 1983).

In other circumstances and places flooding causes the loss of the previous organisation, as in certain parts of the Lomellina area, buried and between 7 and 9 m of detritus. This may depend on phenomena taking place through time, as a result of which the population decided to move to safer areas. Archaeological research, however, is needed to verify which theory is correct, as in the case of Modena, well studied by geomorphologists since the beginning of the 1980s (Cremaschi *et al.* 1980; Cremaschi, Gasperi 1988, 1989; an updated synthesis in Gasperi, Pizziolo 2009). The Roman city was founded on ground that was partly marshy, drained by artificial canals and stabilized by an efficient system of sewerage that disposed of the superficial waters. This organisation was unable to avoid episodic overflowing, already taking place in the Imperial age. This was however remedied, as in the case of viale delle Rimembranze, where above the layers of silt deposited after flooding new paving was added. It was this resilience that conserved the urban look of the city. Quite a different effect was bought about by the extended phase of flooding that took place after 570 and continued probably for about a century, partly because it was affecting a city that had been already been declining since the 4th or 5th century, with buildings reduced to ruins (in via Costa), and unable to provide a solution to contain the dramatic effects of a prolonged environmental disaster.

The causes of these problems were to be found in the diversion of the Fossa - Cerca torrent, which formed a number of meandering watercourses that caused an accumulation in over about a century of at least three overlapping cycles of sand and silt deposit, with an estimated total of 5-10 million cubic metres (Cremaschi, Gasperi 1981, pp. 302-303). The persistent condition of environmental disruption however did not lead to the abandoning of the city; at the end of the 7th century the *Carmen de Synodo Ticinensi* was able indeed to praise Cuniperto for having restored Modena to its *pristino decore* (MGH, *SS.RR.LL.*, pp. 190-191). This period however is not well documented, although it is plausible to assume that the city moved westwards, where the new city centre grew up during the Carolingian age around the Cathedral, favoured by a hydraulic system introduced when new channelling was built (Gelichi 1988, pp. 555, 570).

3.2. Regional consequences

These are measured not so much in the amount of accumulated debris, but rather in their lasting consequences on cities and territories, where they significantly change their previous structure. Very often these systemic changes are the result of multiple causes, not only environmental but also economic and geopolitical and interacting with each other in such a way that makes it hard to determine which the main one was. In general, we can define the human response to these phenomena of prolonged disruption as "adaptability" to new environmental conditions. Some examples will help us understand the strategies adopted in the Early Middle Ages.

(a) *Dislocation of settlements on the banks of active rivers*. In the heart of the Po Valley distribution maps show how many of the settlements are located along rivers. The excavations of the town of Piadena, founded on a bend of the river Oglio, Nogara on a branch of the Tartaro (Tartarus), Bovolone on the Menago (Piadena: Brogiolo, Mancassola 2005; Nogara: Saggioro 2012; Bovolone: Saggioro *et al.* 2005) have recorded villages of a certain size that developed from the Carolingian age and were linked to an economy that used the land for agriculture and fallow, also exploiting the river as an artery connecting the region. This settlement strategy was therefore determined not only by the choice of a fluvial bar to contain the damage caused by flooding, but also by the economic opportunities offered by the waterways. It should be emphasized however that this was adopted at a time of good climate, warm with little rain, favourable too to gaining new agricultural areas, about which some information is provided in the written documentation. One such example is an area adjacent to the *comitatus* of Monselice, adjacent to the Valli Grandi Veronesi, which in Roman times corresponded to an area of lowlands, centuriated and marked by numerous settlements of villas and villages (Tozzi, Harari 1990; Calzolari 1993). After becoming a swamp at the end of the 6th century, it was reclaimed and reorganized only in the 19th century. It is, incidentally, an area in which due to the lack of an agrarian sequence that persisted for 1200 years, it is easier to recognize the palimpsest from the Bronze Age to Roman times (De Guio *et al.* 1999; Cima 2012). In the adjacent area to the east, a document of 840 ca. (CDV, n. 156, pp. 219-220), fixing the boundaries between the *comitatus* of Monselice and Verona, records, in addition to parts of the natural landscape dominated by swamps, forests and rivers: a church transferred (presumably along with its village) to a new location and a *fossa Alta* and a *fossatus*, for which it is specified that *factus fuit*

manibus hominum between a town whose name *Casellas* clearly indicates the characteristic wooden houses and a forest *que vocatur Sanguinedo*. Two entries that show us a settlement in transformation, with a town that disappears (Argile), because it moves with its church, and the foundation of another (*Casellas*) accompanied by the conquest of new spaces for agriculture, made possible by the excavation of a drainage ditch.

(b) *The settlement strategies of the Lombards* in the countryside from Friuli to Lombardy were, as is known, to opt for high plains. This choice is generally explained as a result of continued Byzantine control in the central plain around major rivers. In fact it may have been determined also, and perhaps above all, by the desire to avoid areas that were particularly unstable in the cold and rainy period (late 6th to early 7th century), during which the invaders established themselves in Italy. Interesting, from this point of view, is the case of Montichiari, in the high plains east of Brescia, on the Chiese river (Breda 2007) (fig. 4). West of the river, six villas/Roman farms are located in a centuriated area that continues to be used, as evidenced by the three Lombard necropolis of Breda dei Morti, Bredazzane and Montechiaresa. Occupied east of the river in the Early Middle Ages were the hills of San Zeno and San Giorgio. On the San Zeno hill (129 m above sea level) there is a large necropolis with 325 graves, used by some 12 families (with a total of about 60 individuals) for five generations over a century (De Marchi 2007, p. 60). It is divided into lots and is oriented on a road with a north-south axis. On the hill of San Giorgio (133 m above sea level), a small necropolis with 11 burials without goods, dated to the 7th century (Breda 2007), is followed by the founding of the church that gave its name to the place. There is no lot division, confirming a large undivided property.

The phase distinguished by an allochthonous population therefore involved both the centuriated plain area and the two hills, although we do not know whether they were chosen to expand the agricultural landscape on dry land or as part of the new strategies of exploitation of uncultivated land. The vast necropolis could be related to a village high up, while the necropolis on the low plain and the one on the hill of San Giorgio could be related to farms.

A recent survey in the territory of the eastern Trentino (high Valsugana, between Civezzano, Pergine and Bosentino) has emphasized a marked discontinuity in the settlement of the Lombards who, while in some cases using earlier settlements, seemed to prefer the higher areas rather than the valley floor where the Roman settlements were almost

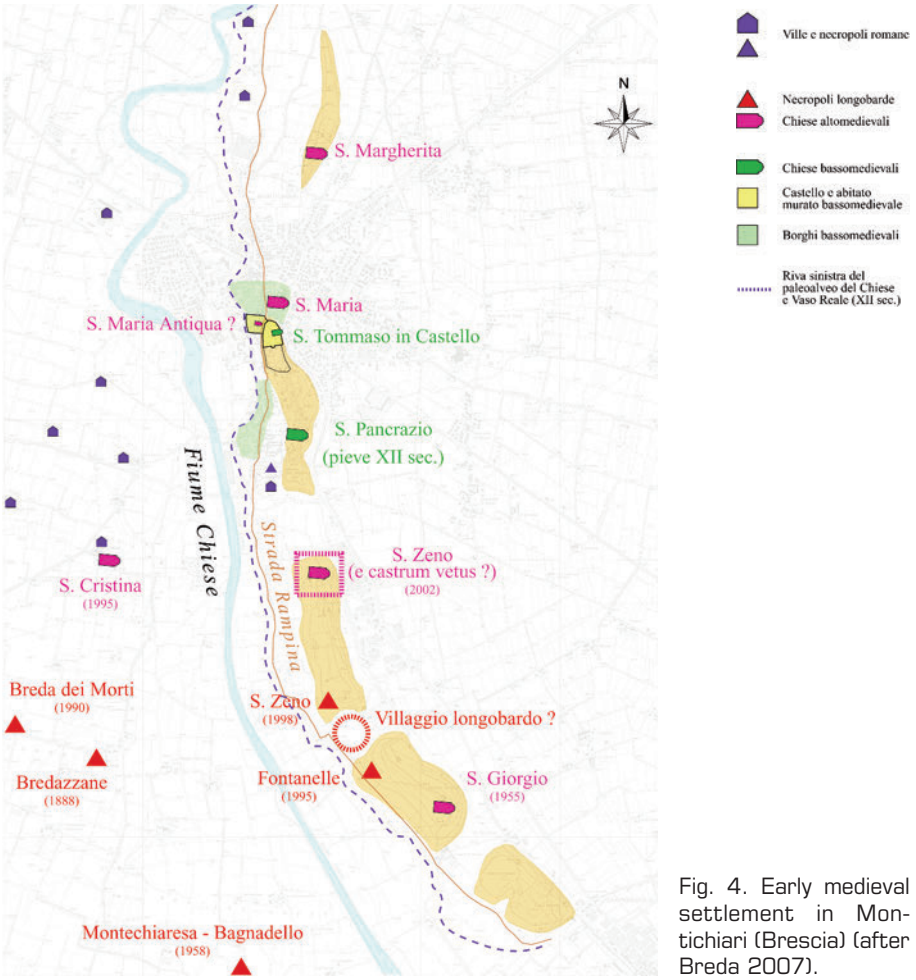

Fig. 4. Early medieval settlement in Montichiari (Brescia) (after Breda 2007).

exclusively localized (Forlin 2014) (fig. 5). This discontinuity has been associated not only with the change to the cold and rainy climate of the 6th/7th centuries (as witnessed in the proxy data of the sediment in Lago Nero di Cornisello and a stalagmite in the Ernesto cave in Valsugana, data that are strangely reflected later in the sediments of Lago di Ledro in Trentino: Magny *et al.* 2009) but also with the new economic model that adds agriculture to exploitation of the pastures high up. This model had already been proposed for Sommolago and for other parts of Trentino, but at a later date, between the 8th century and the 9th century, coinciding with the improvement in the climate, better suited to exploiting the heights. This exploitation did not however lead to the abandonment

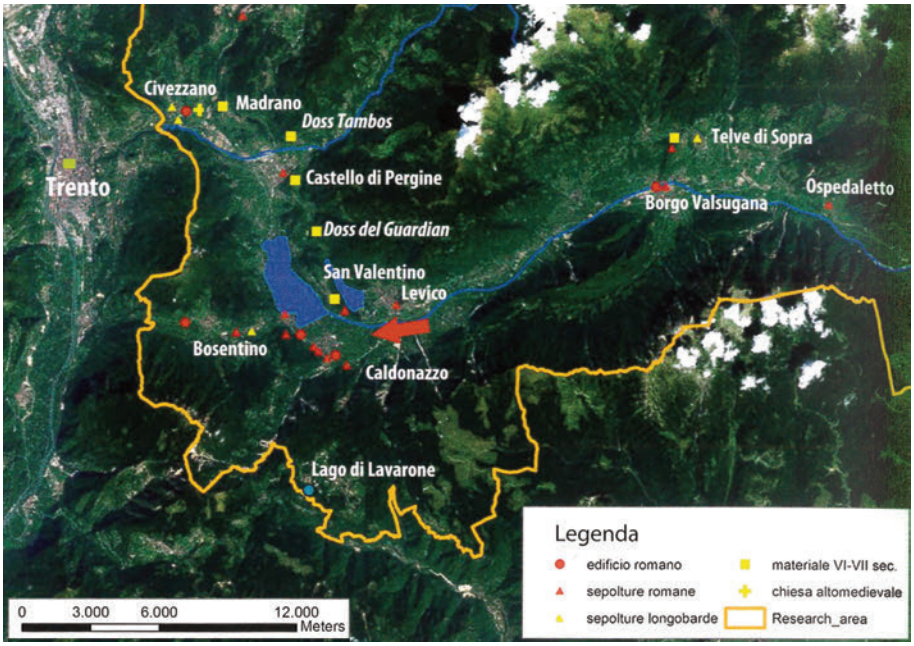

Fig. 5. Valsugana (Trento): discontinuity in the settlement distribution beween Roman Age and Lombards Age (after Forlin 2014).

of the settlements in the valley, which proceeded in continuity with the Roman ones (Brogiolo 2013).

These examples seem to infer that the Lombards used a variegated manner of settling, in which, especially in some areas, even environmental conditioning played a role, albeit within the new economic model of integration of agricultural landscapes and uncultivated land.

(c) The most complex change, which also had the most pronounced regional consequences, however, concerns the *northern Adriatic curve*, where the contraposition of declining cities like Adria, Este, Altino and Concordia, all affected by floods and infill, was represented by the birth of Venice. Historiography has generally explained this as a result of the Lombard conquest and the Byzantine response that led to the consolidation of the coastline with a series of settlements located on the old riverbeds, in an environmental framework that sees profound transformations of the lagoon environment. Geopolitical and environmental factors on which it is worth returning to linger, however, shift the focus from the sea to the mainland of the Paduan countryside, which experi-

ences political and natural phenomena that will, in the Carolingian period, favour the birth of Venice.

The political factor occurs between 568-569 (the Lombard invasion) and in 602, when Agilulfo conquers and destroys Padua, attributing its eastern (Saccisica) and northern territory to the Duchy of Treviso, a strategic decision that entirely takes away Padua's relationship with the sea, to which it was linked by watercourses consisting of the various branches of the *Medoacus* river. By 897 when the bequest of Berengar I restored Saccisica, although only in the ecclesiastical jurisdiction, to the control of the Bishop of Padua (*DD Berengario I*, n. 18), the die was already cast. Just north of Saccisica, at the mouth of a branch of the *Medoacus Maior*, the Doge Agnello Partecipazio had founded in 819 the monastery of Sant'Ilario e Benedetto, in a spot where there was already a private chapel. A Venetian outpost on the coast, it was used to control the trade to Padua (Calaon 2009). At the beginning of the 12th century, when the city of Padua was to build a canal linking the *Medoacus* and the lagoon near the monastery, Venice declared war and after defeating them forced the Paduans to restore the situation as it had been before.

According to a reconstruction by geomorphologists (Mozzi, Furlanetto 2004, pp. 269-284), the *Medoacus*, coming from north west of Padua without passing through the city, split off just before Noventa into: (a) the *Medoacus Maior*, Roman and late Roman, with a course from dosso di Stra up to Porto Menai and dosso delle Giare, which delimited the northeast centuriation; (b) and the *Medoacus Minor* from Camin to Saonara, where it was to further divide with one branch going

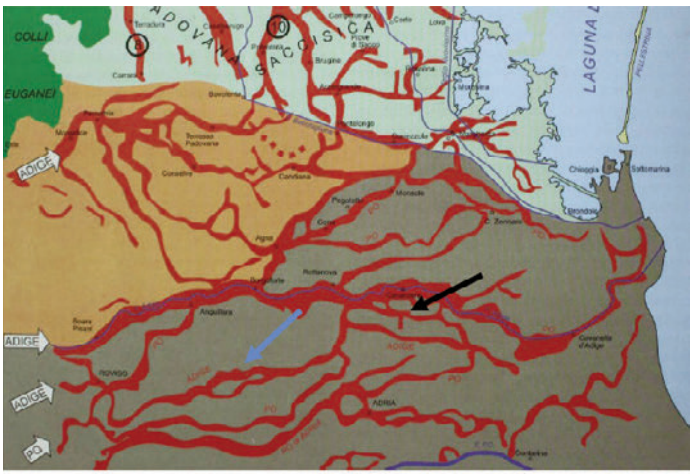

Fig. 6. Reconstruction of hydrography in Saccisica, low Padua plain and northern Adria plain (after Bondesan *et al.* 2003).

towards Sant'Angelo, dosso di Boion, Lova and a second towards Brugine, dosso di Arzergrande, Conche on the other (second branch of the *Medoacus Minor*); branches active since the 1st millennium BC to the 9th century AD (with the name of Brentone).

The vicissitudes of Saccisica, between the *Medoacus Maior* and the *Medoacus Minor*, are closely linked to the evolution of the hydraulic network fed by the two rivers (fig. 6), a reference point, here as throughout the lowlands, for the early medieval settlement, marked by a number of places of worship: at Lova, the parish church of Santa Giustina di Padua is dedicated to the saint, whose cult was particularly strong in the 6th century; at Corte, tributary headquarters of the properties of Saccisica, the churches of San Tommaso and Santa Maria are mentioned in 853; between Arzergrande, Vallonga, Codevigo and Fogolana, as well as a Roman temple in Vallonga, early medieval churches are still preserved in part elevation at Arzergrande (the church of Santa Maria under Piove: first mentioned in 1179) and Codevigo (San Zaccaria with liturgical furnishings of 6th and 8th centuries). Churches and early medieval demic centres are therefore located along the ancient river routes, partly because the banks were raised above the surrounding plain, and because they represented both the main and safest communication routes.

For Piove di Sacco too the relationship with the hydraulic network is evident if we look at historical maps (fig. 7). The large late medieval defensive wall does not in fact demarcate a regular town layout, such as we would expect in a village planned in the 12th or 13th century, but a polyfocal system organized along the route of an old abandoned branch of the Brenta. Near "dosso di Piove di Sacco" (Mozzi, Furlanetto 2004, p. 275), it veered off the main route to the west of Arzergrande, touched on Piove with a double meander, the first inside the village along what are now the roads via Garibaldi and Roma, the second in the suburb of St. Niccolò. After Piove, there were two possible routes: the first towards dosso di Campolongo that then continues to Corte and the lagoon, the second along via Boresse to go, beyond the current course of the Brenta, to Beverare and from there to the lagoon.

It was therefore due to their position with respect to the early medieval hydrographic network that Piove and Corte derived their prominent role in the organization of the tributary district of Saccisica (Castagnetti 1997). A role confirmed by the building, at the end of the 10th century, of a new hydrographic system positioned on the artificial channel of Fiumicello, which connects Piove with Padua. Derived from the *Medoacus Minor* - Brenta (now Bacchiglione), at Polverara, reaches Piove in a straight line, and from here Corte and the lagoon. The option

Fig. 7. Cadastral map (1845) of Piove di Sacco (Padova).

of a more northern course (and more direct between Padua and Venice), compared to the previous natural connection, could have depended on the increased importance, from the 9th century on, of the settlements along the Grand Canal, compared to Chioggia. Fiumicello is probably mentioned for the first time in 1061 in a donation of goods in the *Comitatus* of Treviso (CDP, I, n. 184, p. 244). But when was its excavation? A date *ante quem* is suggested by the existence in 1005 of the castle of Piove, whose moat was probably fed by its waters. If this hypothesis is correct, the construction of the castle and its connection by water to Padua and Venice would have been implemented by bishop Gauslino, perhaps in agreement with the *conti* of Padua and Vicenza, who settled there right in those years. Being the family of Doge Candiani, they had every interest in making a river route direct to Venice and not only with Chioggia and Brondolo, where the Brenta was directed. The document of 1005 governing trade, signed by the men of Sacco (in the presence of the bishop's steward) and the Doge (CDP, I, n. 82), could be a direct result of the opening of the new route.

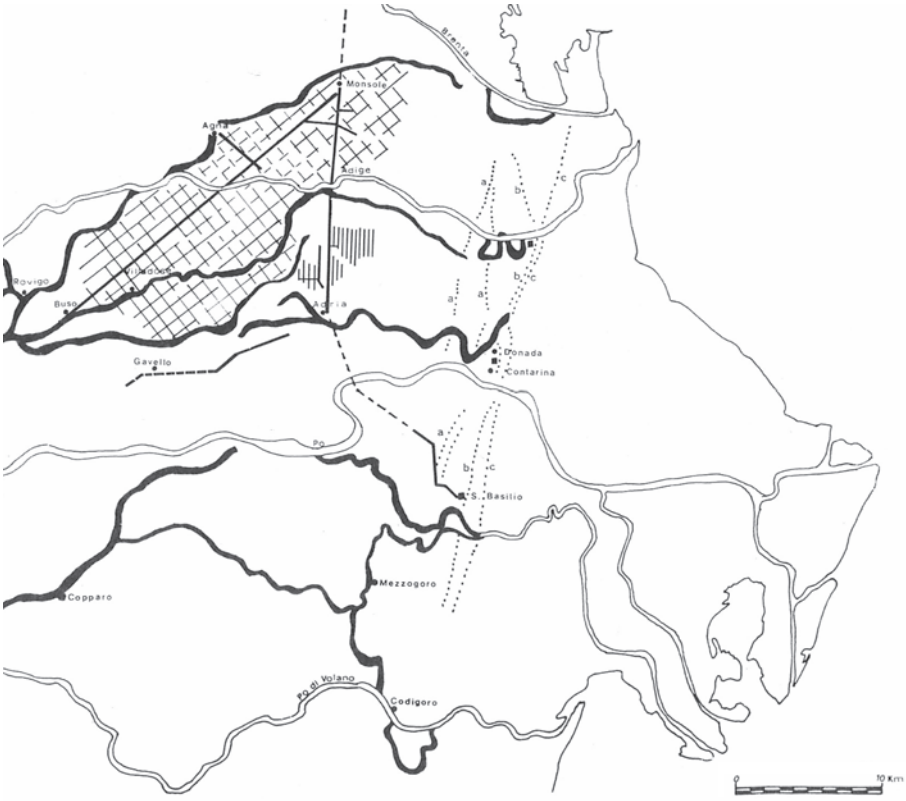

Fig. 8. Roman centuriation in the area north of Adria (Rovigo), between two branches of the Po (after Peretto 1990).

The events of the territory east of Padua are therefore emblematic of the strategies to contain the damage caused by flooding; containment implemented by establishing the settlement on fluvial bars, which turned from active into fossils, and by opening channels. Certain later acts indicate in more detail how reclamation took place using deep drainage channels which delimit from several sides each individual lot, and the convex profile of the fields that allows a more rapid storm-water runoff. The landscape described by the documents, and still visible in the historical maps of the modern age, thus suggests a control protracted through time, without any radical distortion of ancient agricultural landscapes, produced by the various branches of the *Medoacus*. Indeed I do not believe that the entire south-eastern plain of Padua was evenly centuriated (Matteazzi 2012), but that already in the Roman period it had many uncultivated areas and settlements located on the banks. A radical upheaval is found, instead, in the Pula area, where the Roman land of Adria (fig. 8), which

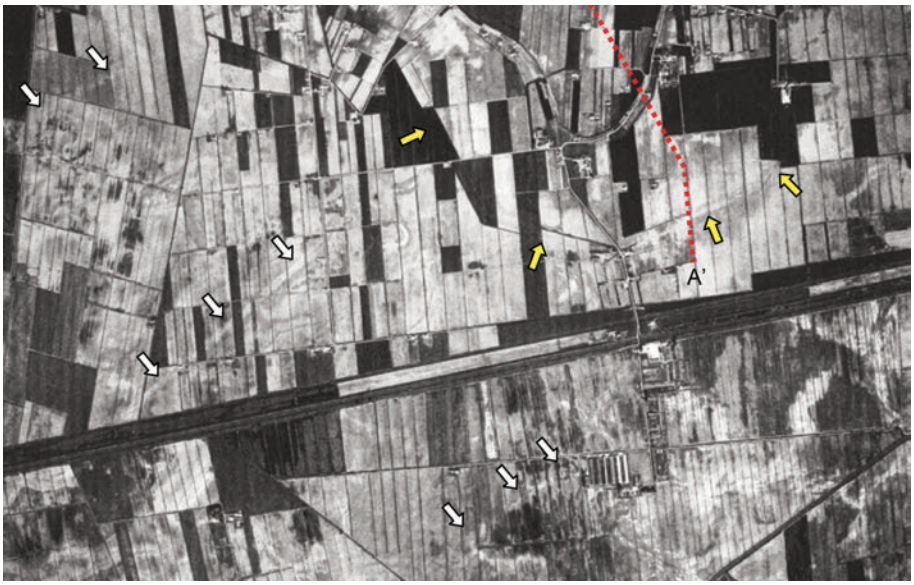

Fig. 9. Traces of the Roman centuriation buried in the area north of Adria (white arrows) (after Piovan 2008).

covered about 200 sq km between Rovigo and Concadalbero (Peretto 1990), is completely removed and buried by agricultural landscapes (fig. 9) reorganized after the formation of the two southern branches of the Adige (Piovan 2008), 20 km to the south of the Roman route, which passed Montagnana, Este, Monselice, Pernumia, Arre, Candiana and Santa Margherita. At first (probably after the rout of 589) along the course of the Adigetto, from Badia to Rovigo and Cavarzere, a route that in 955 is defined by the Adige Vecchio (CDP, I, n. 43) thereafter – but before 955 – by a second branch corresponding to today's Adige.

4. Conclusions

Flooding depends undoubtedly on the geomorphology of the area, but it is the climatic cycles that calibrate its intensity and duration. Slopes, alpine valleys and lowlands have been periodically affected and still today we see recurring episodes, increasingly extreme, that we justly impute to climate change, without knowing exactly whether they are dependent on natural or anthropogenic factors.

For the early medieval period archaeological data confirm the literary sources that recount the flood of 589, without specifying, however, its

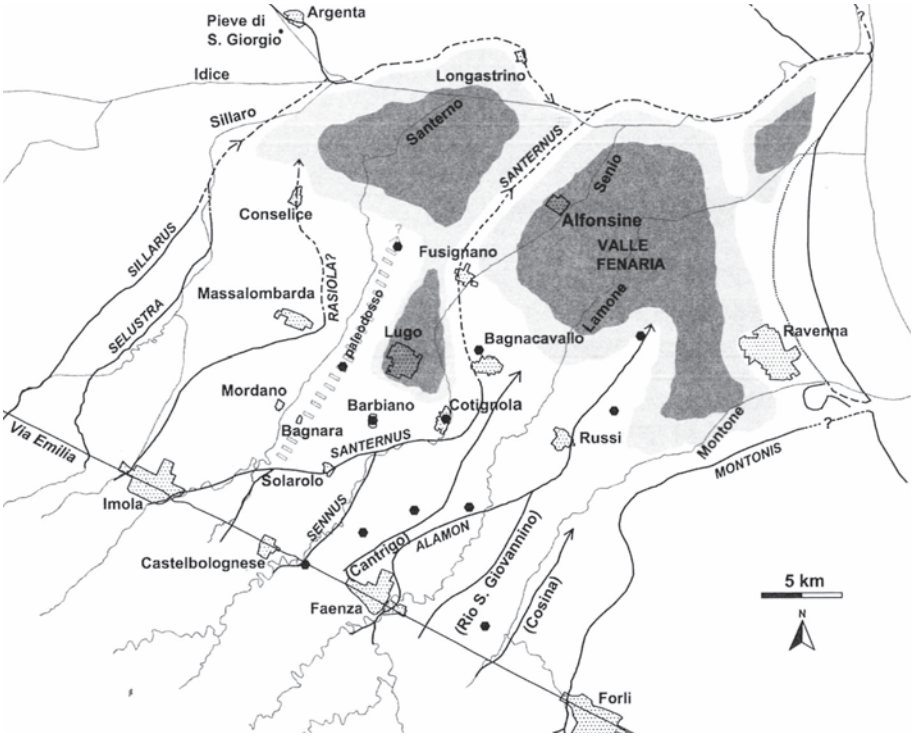

Fig. 10. Wetlands expanded over the centuriation between Faenza and Lugo in the Early Middle Ages (after Franceschelli 2008, fig. 6).

scope and duration. They also outline the time taken for the reorganization of the disrupted areas, in some cases rapid, in others slower. This is consolidated during the expansion phase of the 8th-9th century, in the new, more favourable climate cycle.

Considered in the long term, the situations described in this paper all move in the direction of a continuation, in different forms and intensities, of the exploitation even of the areas most subject to environmental disasters. There are few cases of abandonment, the best known archaeologically is that of Valli Grandi Veronesi, around which the settlement was able, however, to readjust to the new environment. Other similar disruptions, such as that of Polesine, a result of the double displacement of the Adige or those of lago Gerundo and the marsh of the Mosa (Meuse), formed between 6th and 7th centuries following the raising of the riverbed of the Po and the consequent diversion of rivers Serio and Adda, was remedied as early as the 9th century (Dossena, Veggiani 1984). When rapid restoration was possible, as at Riva del Garda, strategies were devised to contain the damage and impact, which al-

lowed the situation prior to the disaster to be recovered quickly. What we do not know is how flood defence worked in the Early Middle Ages; we can assume that initiatives were undertaken by the city for the defence of the entire county and local communities, alone or between them, though probably not as well organised as those seen in the late medieval age, when the statutes of ordinary citizens, such as that of Padua in the 13th century, established with extreme detail the duties of the local communities in the maintenance of river banks.

In many of the examples given, the most significant aspect is the rebalancing of human activities including agriculture and the exploitation of uncultivated land, which flooding had expanded through the formation of forests and wetlands (such as in the area between Faenza and Lugo: fig. 10). The changes recorded had to deal not only with environmental conditions but also with the new economic models that, following the allocation of the Lombards, were less specialized than the Roman one. A change that is recognizable enough in the areas of high ground, such as in Trentino, but that was also probably applied in the lowlands, where large areas of uncultivated lands were available on the banks of rivers, flood plains and in and around the wetlands.

In each case the answer that the man of the Early Middle Ages was able to give was innovative and actually made the areas of disruption more competitive. For example, the social and economic stasis of the area northeast of Padua, where geological stability has preserved much of its cross-linked land division, is matched by the great social and economic vitality of Saccisica and the *Comitatus* of Monselice; territories affected, albeit with different effects, by the floods of the 6th century. I believe that the impulse is due partly, if not above all, to the many social and economic initiatives implemented by the aristocracies and local communities to cope with the inherent risk of environmental disaster. In other words it was the crisis itself that brought about innovative solutions and methods that turned threat into opportunity.

Acknowledgments

This paper was written as a part of a research line on Alpe-Adria Historical Landscapes (IRAAHL) supported by different projects: MEMOLA (financed by European Commission FP-7 2014-2017, nº 613265), PRIN 2010-2011 (financed by MIUR, 2010H8WPKL_010); PRAT 2012 (financed by the University of Padua, CPDA128591/12).

I would like to thank Leonor Peña-Chocarro for her bibliographical suggestions.

References

Historical Sources

Carmen de synodo Ticinensi, in MGH, *Scriptores rerum Langobardicarum et Italicarum, saec. VI-IX*, L. Bethmann (ed), Hannover 1878, pp. 190-191.

CDP, I = *Codice diplomatico padovano dal secolo VI a tutto l'undecimo,* A. Gloria (ed), Venezia 1877.

CDV = *Codice diplomatico veronese*, V. Fainelli (ed), I (Venezia 1949), II (Venezia 1963).

DD Berengario I = I diplomi di Berengario I, L. Schiaparelli (ed), Roma 1903.

Gregorio Magno, *Dialogi*, U. Moricca (ed), Roma 1924.

Mutinensis urbis descriptio sive additamentum ad vitam sancti Geminiani episcopi mutinensis, in *Rerum italicarum scriptores*, II, 2, coll. 691-692.

Pauli Diaconi, *Historia Langobardorum*, L. Bethmann, G. Waitz (eds), in MGH, *Scriptores rerum Langobardicarum et Italicarum, saec. VI-IX*, Hannover 1878, pp. 12-192.

Studies

M. Bassetti, N. Cappellozza, M. Cariboni, N. Degasperi 2013, *Modificazioni geomorfologiche e aspetti geoarcheologici del territorio del Sommolago. Elementi per una ricostruzione del paesaggio*, in G.P. Brogiolo (ed), *APSAT 3. Paesaggi storici del Sommolago*, Mantova, pp. 11-51.

A. Bondesan, G. Caniato, D. Gasparini, F. Vallerani, M. Zanetti (eds) 2003, *Il Brenta*, Verona.

A. Bondesan, M. Meneghel (eds) 2004, *Geomorfologia della provincia di Venezia. Note illustrative della Carta geomorfologica della provincia di Venezia*, Padova.

A. Breda (ed) 2007, *Longobardi nel Bresciano. Gli insediamenti di Montichiari*, Brescia.

G.P. Brogiolo 1993, *Brescia altomedievale. Urbanistica ed edilizia dal V al IX secolo*, Mantova.

G.P. Brogiolo 2013, *Paesaggi, insediamenti e architetture tra età romana e XIII secolo*, in G.P. Brogiolo (ed), *APSAT 3. Paesaggi storici del Sommolago*, Mantova, pp. 165-218.

G.P. Brogiolo, N. Mancassola 2005, *Il sito e gli scavi*, in G.P. Brogiolo, N. Mancassola (eds), *Scavi al castello di Piadena (CR)*, in S. Gelichi (ed), *Campagne medievali. Strutture materiali, economia e società nell'insediamento rurale dell'Italia settentrionale*, Atti del Convegno (Nonantola, San Giovanni in Persiceto 2003), Mantova, pp. 121-141.

D. Calaon 2009, *Ecologia della* Venetia *prima di Venezia. Uomini, acqua e archeologia*, "Hortus Artium Medievalium", 20, pp. 804-816.

M. Calzolari 1986, *Alluvioni e dissesti idrogeologici in Italia settentrionale nel VI e VII secolo d.C.*, "Annali Benacensi", 11, pp. 62-64.

M. Calzolari 1993, *Ricerche topografico-archeologiche sulla centuriazione tra il Bastione S. Michele e il Naviglio Bussé (Valli Grandi Veronesi). Nota preliminare*, "Annali Benacensi", 10, pp. 23-41.

D. Caporusso, M. Cremaschi 1988, *Milano, via S. Croce. Scavi MM Linea 3 . Significato archeologico e paleoambientale dei depositi di età romana*, "Archeologia Stratigrafica in Italia Settentrionale", 1, pp. 143-50.

A. Castagnetti 1997, *Regno, signoria vescovile, arimanni e vassalli nella Saccisica dalla tarda età longobarda all'età comunale,* Verona.

G.B. Castiglioni, A. Bondesan, M. Bondesan, A. Cavallin, G. Gasperi (eds) 1998, *Carta Geomorfologica della Pianura Padana*, Firenze.

D. Camuffo, E. Enzi 1996, *The analysis of two bi-millennial series: Tiber and Po river floods*, in P. Jones, R.S. Bradley, J. Jouzel (eds), *Climatic Variations and Forcing Mechanisms of the Last 2000 Years*, Stuttgart, pp. 433-450.

F.L. Cheyette 2008, *The desappearance of ancient landscape ad the climatic anomaly of the early Middle Ages: a question to be pursued*, "Early Medieval Europe", 16(2), pp. 127-165.

A. Chavalier, E. Marinova, L. Peña-Chocarro 2014, *Factors and issues in plant choice*, in A. Chavalier, E. Marinova, L. Peña-Chocarro (eds), *Plants and People. Choices and Diversity through Time*, Oxford-Philadephia, pp. 3-13.

G. Chouquer 1981, *Les centuriations de Romagne orientale: étude morphologique*, "Mélanges de l'École française de Rome – Antiquité", 93(2), pp. 823-868.

P. Cima 2012, Fossil Landscapes: *alcune linee sperimentali di* Remote Sensing *e simulazione all'interno del progetto AMPBV (Alto - Medio Polesine - Bassa Veronese)*, in G.P. Brogiolo, D.E. Angelucci, A. Colecchia, F. Remondino (eds), *APSAT 1. Teoria e metodi della ricerca sui siti di altura*, Mantova, pp. 117-131.

M. Cremaschi, A. Marchesini 1978, *L'evoluzione di un tratto di pianura padana (Prov. Reggio e Parma) in rapporto agli insediamenti ed alla struttura geologica tra XV sec. a.C. ed il sec. XI d.C.,* "Archeologia Medievale", V, pp. 542-562.

M. Cremaschi, G. Gasperi 1988, *Il sottosuolo della città di Modena. Caratteri sedimentologici, geopedologici, stratigrafici e significato paleoambientale*, in *Modena dalle origini all'anno Mille. Studi di archeologia e storia*, Modena, I, pp. 285-303.

M. Cremaschi, G. Gasperi 1989, *L'"Alluvione" alto medioevale di Mutina (Modena) in rapporto alle variazioni ambientali oloceniche*, "Memorie della Società Geologica Italiana", 42, pp. 179-190.

M. Cremaschi, M. Bernabò Brea, J. Tirabassi, A. D'agostini, P. Dall'Aglio, S. Magri, W. Baricchi, A. Marchesini, S. Nepoti 1980, *L'evoluzione della pianura emiliana durante l'età del Bronzo, l'età romana e l'alto medio evo: geomorfologia ed insediamenti*, "Padusa", XVI, pp. 53-158.

P.L. Dall'Aglio 1998, *Il* diluvium *di Paolo Diacono e le modificazioni ambientali tardoantiche: un problema di metodo*, "Ocnus", 5, pp. 97-104.

A. De Guio, R. Whitehouse, J. Wilkins (eds) 1999, *Progetto Alto-Medio Polesine-Basso Veronese: decimo rapporto*, "Quaderni di Archeologia del Veneto", XV, pp. 101-116.

P. Delogu 2012, *L'ambiente altomedievale come tema storiografico*, in P. Nanni (ed), *Agricoltura e ambiente attraverso l'età romana e l'alto medioevo*, Atti della Giornata di Studio per il 50° anniversario della "Rivista di storia dell'agricoltura", Firenze, pp. 67-108.

M. De Marchi 2007, *Le necropoli altomedievali di Montichiari, Monte S. Zeno, Monte S. Giorgio-Fontanelle, Breda dei Morti, Montechiaresa*, in Breda 2007, pp. 57-74.

G. Dossena, A. Veggiani 1984, *Variazioni climatiche e trasformazioni ambientali in epoca storica nel cremasco: il Moso e il lago Gerundo*, "Insula Fulcheria", 14, pp. 27-42.

P. Forlin 2014, *Paesaggi in trasformazione: insediamento longobardo, ambiente e oscillazioni climatiche nel Trentino orientale tra V e VII secolo*, in E. Possenti (ed), *Necropoli longobarde in Italia. Indirizzi di ricerca e nuovi dati*, Atti del Convegno Internazionale (Trento, 26-28 settembre 2011), Trento, pp. 504-515.

C. Franceschelli 2008, *Dynamique de transmission de la morphologie agraire: "pérennisation" et "effacement" de la centuriation romaine dans le plaine sud du Po*, "Agri Centuriati. An International Journal of Landscape Archaeology", 5, pp. 77-105.

C. Franceschelli, S. Marabini 2004, *Assetto paleoidrografico e centuriazione romana nella pianura faentina*, "Agri Centuriati. An International Journal of Landscape Archaeology", I, pp. 87-107.

C. Franceschelli, S. Marabini 2007, *Lettura di un territorio sepolto. La pianura lughese in età romana*, Bologna.

J.A. Galloway 2013, *Editorial introduction*, "Environment and History", 19(2), pp. 127-131.

G. Gasperi, M. Pizziolo 2009, *Note illustrative della carta geologica d'Italia alla scala 1:50.000, foglio 201. Modena*, Firenze.

S. Gelichi 1988, *Modena e il suo territorio nell'Alto Medioevo*, in *Modena dalle origini all'anno Mille. Studi di archeologia e storia*, Modena, I, pp. 551-576.

C. Giraudi 2005, *Late-Holocene alluvial events in the Central Apennines, Italy*, "The Holocene", 15(5), pp. 768-773.

H. Holzhauser, M. Magny, H.J. Zumbühl 2005, *Glacier and lake-level variations in west-central Europe over the last 3500 years*, "The Holocene", 15(6), pp. 789-801.

P. Hudson 1989, *Contributi archeologici alla storia dell'insediamento urbano veneto (IV-XI secolo)*, in A. Castagnetti, G.M. Varanini (eds), *Il Veneto nel medioevo. Dalla* Venetia *alla Marca Veronese*, Verona, II, pp. 329-348.

M. Juenha, F. Mauleshagen 2007, *Disasters and pre-industrial societies: historiographic trends and comparative perspectives*, "The Medieval History Journal", 10, pp. 1-31.

M. Magny, D. Galop, P. Bellintani, M. Desmet, J. Didier, J.N. Haas, N. Martinelli, A. Pedrotti, R. Scandolari, A. Stock, B. Vannière 2009, *Late-Holocene climatic variability south of the Alps as recorded by lake-level fluctuations at Lake Ledro, Trentino, Italy*, "The Olocene", 19(4), pp. 575-589.

M. Matteazzi 2012, *The structuring of the landscape in the low Padua Plain (Italy) during Roman times: new contributions from an archaeomorphological study of the territory*, "eTopoi. Journal for Ancient Studies", Special Volume 3, pp. 317-322.

P. Mozzi 2005, *Isole nella pianura*, in F. Selmin (ed), *I colli Euganei*, Sommacampagna, pp. 28-48.

P. Mozzi, P. Furlanetto 2004, *Tra Naviglio Brenta e Bacchiglione*, in Bondesan, Meneghel 2004, pp. 269-298.

R. Peretto 1990, *Viabilità romana in territorio polesano*, in *La* Venetia *nell'area padano-danubiana. Le vie di comunicazione*, Padova, pp. 97-110.

M. Pinna 1990, *Il clima nell'alto Medioevo*, in *L'ambiente vegetale nell'alto Medioevo,* Spoleto, pp. 431-459.

S. Piovan 2008, *Evoluzione paleoidrografica della pianura veneta meridionale e rapporto Uomo Ambiente nell'Olocene*, Tesi di dottorato, Università di Padova, Dipartimento di Geografia.

F. Saggioro (ed) 2012, *Nogara. Archeologia e storia di un villaggio medievale (scavi 2003-2008),* Roma.

F. Saggioro, D. Anastasio, C. Malaguti, A. Manicardi, L. Salzani 2005, *Insediamento ed evoluzione di un castello della Pianura Padana, Bovolone VR (1995-2002), Località Crosare e Via Pascoli,* "Archeologia Medievale", 32, pp. 169-186.

P. Squatriti 2010, *The floods of 589 and climate change at the beginning of the Middle Ages: an Italian microhistory*, "Speculum", 85(4), pp 799-826.

P. Tozzi, M. Harari 1990, *Tempi di un territorio. Atlante aerofotografico delle Valli Grandi Veronesi*, Verona.

A. Veggiani 1979, *Prove di un ciclo climatico di piovosità nell'alto Medioevo nel Cesenate,* "Studi Romagnoli", 30, pp. 87-101.

A. Veggiani 1982, *Variazioni climatiche e dissesti idrogeologici nell'Alto Medioevo in Lombardia e la rifondazione di Lodi*, "Sibrium", 16, pp. 199-208.

A. Veggiani 1983, *Variazioni climatiche e dissesti idrogeologici indotti dal deterioramento climatico nell'Alto Medioevo in Italia. I casi riminesi*, "Studi Romagnoli", 24, pp. 123-146.

A. Veggiani 1986, *Clima, uomo e ambiente in Romagna nel corso dei tempi storici*, in *Romagna, vicende e protagonisti*, vol. I, Bologna.