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EDITORIAL

In this ninth volume of the European Journal of Post-Classical Archaeologies we publish the contributions of the Spring School held in Tenno (Trentino, Italy) in April 2018, which was devoted to the methods of "Participatory Research in Archaeology. Archaeology for the future? Legal issues and good practices". The event was generoulsy funded by the University of Padova (call Winter-Summerschool 2017) and broght together researchers and PhD students interested in discussing the legal framework and constraints that this kind of participatory approach involves and how good practice in community projects could represent a turning point for the immediate future of archaeology. Participatory Archaeology has a similar meaning to "Community Archaeology" and both are included in the wider label of "Public Archaeology", although the terms are not at all synonymous. Community and Participatory Archaeology should not be confused with communication or education strategies, although these are also of great importance, but it takes collaboration between "professionals" and "the public" or the "audience" to a very different level. Community or Participatory Archaeology follows the now popular formulation by Gabriel Moshenska of "archaeologists working with the public" (Moshenska 2017, p. 6; reflected in this volume by Suzie Thomas at p. 149), but we would add an extra dimension in the form of a final objective of "working also **for** *the public".*

An important question emerges here: what public? Does this refer to "non-professional (in the sense of archaeology) groups and individuals" who intend to be involved in research "with the goal of finding out more about archaeological heritage through participatory practices" (as suggested by Thomas)? Or should we include under this label the indifferent and those who reject the past and its heritage? This inevitably leads us to reflect on the various meanings today of communities and on which "participatory practices" are appropriate for their involvement.

These problems, in turn, lead us to reflect on the cultural policy guidelines proposed, after Second World War, by institutions on the world (UNESCO, International Union for Conservation of Nature (IUCN), World Bank), European (Council of Europe, European Union) and national (between principles included in the Constitutions or issued with specific acts) level. Guidelines, summarized in the contributions of Adrian Olivier and Lara Delgado Anés with José María Martín Civantos, reveal contradictory or incomplete ideas. This is not only because they have different aims – "the management of landscapes and uses of land are represented by a combination of different demands and interests linked to agriculture, forestry, livestock, conservation of nature, conservation of cultural heritage, archaeology and local populations" (Delgado Anés, Martín Civantos) – but also because they fluctuate between proposed identities (local, national or European), legislation linked to professionalism and protection from above (see the Valletta Convention) and openness to public participation (Conventions of Florence and Faro). These contradictions are reflected in the great variability of national and/or regional norms regarding the possibility of public participation in Cultural Heritage in Europe (discussed in the contributions of Francesca Benetti, Clemente Pio Santacroce for Italy, Katharina Möller for Germany, Raimund Karl for Austria, Mia Rizner for Croatia, Lara Delgado Anés, José María Martín Civantos for Andalusia in Spain). This ranges from the harshest exclusion (in Italy and Austria) to various modes of involvement, more or less open, that confirm that Europe is today a sum of states, each of which is attentive to its particular interests, even though they superficially refer to the search for a common heritage identity. Research into historical identities, pursued in the past, does not fall within the objectives of community archaeology, which highlights the multiplicity of stories that can be drawn from the infinite information we can document in a region.

Most of the contributions focus on the variegated "participatory practices" adopted in concrete projects, noting limits, methods, successes and difficulties. Projects above all try to involve public participation in all stages of the project: starting from the planning stage, continuing with real research and concluding in publication and management of the results. Different positions are, however, taken by the authors on who has or should coordinate and lead the projects so as to achieve the difficult equilibrium between bottom up and top down approaches. The result often does not reflect the "ordinary perception and needs of the communities" (Alicia Castillo Mena), which can emerge only through reflection and comparison: people need the past … but not "our concept" (academic) of the past and the value that we as academics attribute to it". Most papers consider the possibility of assessing the impact or results of the

projects in the territories involved, a subject to which most discussions were devoted during our week in Tenno. The importance of the subject led us to contact Brendon Wilkins to delve more deeply into the problem of evaluation. Best practice and the actual degree of satisfaction and success of a project can be assessed in relation to the effects on "archaeology and heritage, individuals, community/society" (a gradation in three levels). However, this judgment cannot be reserved for experts, but must be extended to the various components of local communities. The social impact assessment is also linked to the collection of resources, through crowd-funding and crowd sourcing, discussed by Wilkins using the example of the Bronze Age site excavation at Flag Fen, near Peterborough (UK).

The actual role assigned to the communities finally leads us to reflect on the themes, strategies and aims of the projects. Lara Band, in the Project section, offers us a good example with the well-known project CITiZAN, which from 2015-2018 involved 1000 people in the recording of coastal and intertidal sites in England which were threated by climate change. This project, which had a notable social and media impact, was re-proposed for 2019-2021, including, in addition to recording, multiple collateral initiatives (training sessions, public presentations, websites and media activation) as are typical of participatory archaeological projects.

A systemic approach that proposes a reunification of knowledge offers a scientific justification for the "holistic" protection of heritage, and suggests an archaeology of sustainability in the context of possible economic and social uses of results, has been tested in a dozen projects in northern Italy (Gian Pietro Brogiolo, Alexandra Chavarría Arnau). Concrete objectives are able to avoid the construction of political identities, such as that described by Fabio Pinna for Sardinia, where archaeology is well-funded by the region with the political objective of creating an identity linked to the Nuragic civilization of the Iron Age.

It is also undeniable that community projects very often drag archaeologists in complex social and political environments or ethical issues linked to the kind of conflictual heritage which is involved in the project (as in Thomas' paper). Participatory projects take specialists out of the ivory tower that academia represents into a wider, in some cases unknown world, and, in the same way as stratigraphic excavation or GIS managements require specific innate qualities of the archaeologist, participatory research also requires particular skills such as being "open, friendly and effective communicators, adaptable, good listeners, able to accept varied opinions, efficient record keepers and evaluators, team workers" (Gemma Tully).

The concluding paper by K. Anne Pyburn, and which is more than a conclusion, summarizes and discusses the topics addressed in the seminar, ordering them into eight key subjects or themes: Experts versus expertise, Agents versus agency, Discovery versus interpretation, Democracy versus sovereignty, Public versus community, Education versus collaboration, Legal versus ethical, Protection versus appropriation.

The three papers of the Beyond the Theme sections are linked, in a different way, to research perspectives on past local communities. Enrico Zanini, in relation to the research conducted in Vignale (Grosseto), hopes for a "form of dialogue with the landscape" that recomposes the "wear", produced by excavation, through diachronic routes able to connect activities that are repeated over time: the "warp", understood as anthropic activity (the road, the furnaces, the vineyards), compared to the "landscape weft", dictated by the earth and water. Carlo Citter compares road networks documented in the cadastral maps of 1823 and predictive analyses using GIS (in particular cost surfaces and attractors), emphasizing continuity, starting from the Bronze Age, of the network of local connections through which peasants, merchants and owners moved in relation to a central place (and also, it should be added, in relation to places and resources). Francesca Sogliani and Dimitris Roubis present a systemic and multidisciplinary research model applied to the settlement at San Giovanni in Fiore, Calabria, including written sources, ethnoarchaeological data, photo-interpretations, geological and geopedological research based on excavations, surveys, remote sensing, geophysical surveys, pollen and botanic analysis.

Finally, in the Retrospect section dedicated this time to Ireland, Tadhg O'Keeffe not only draws the history of medieval archaeology in that country, but also addresses some issues: "identity and cultural essentialism, the concept of continuity and change, the relationship of pattern to process, the meanings of words", that emerge above all in the relationship between the native, "Gaelic-Irish" population with respect to the "colonial" castle-owning Anglo-Norman class.

Carlo Citter*

From roads to mobility. A theoretical framework and a case study to investigate the medieval connections network

This paper briefly reviews the main methods to study historical mobility over time. Then, it focuses on a region in southern Tuscany to run a network analysis. We wish to evaluate the potential connections from a central place to its surrounding hinterland between the Late Antiquity and the Early Middle Ages and to estimate the *longue durée* of some geographical corridors. Some corridors have been used at least since the Etruscan period (7th century BC). The Romans shaped a series of paths within these corridors to connect fiscal estates' centres, such as those owned by the emperor for his institutional role (2nd century AD). This network was resilient to political and climate changes in the Middle Ages and beyond.
Keywords: historical mobility, GIS, spatial analyses, long durée

Questo articolo presenta i metodi di studio della mobilità antica e si focalizza poi su una regione nella Toscana meridionale per condurre una network analysis*. Lo scopo è quello di valutare le potenziali connessioni da un* central place *al suo territorio tra il tardo antico e l'alto medioevo, stimando la* longue durée *di alcuni corridoi geografici. Alcuni di essi sono stati in uso almeno dal periodo etrusco (VII sec. a.C.). I Romani hanno poi dato forma a una serie di percorsi all'interno di questi corridoi per connettere proprietà fiscali, come quelle possedute dall'imperatore per il suo ruolo istituzionale (II sec. d.C.). Questa rete fu resiliente a cambiamenti politici e climatici avvenuti nel medioevo e oltre.*
Parole chiave: *mobilità storica, GIS, analisi spaziali, diacronia*

1. Current approaches on historical roads and mobility[1]

1.1. Roads and routes

Medieval archaeologists are usually less interested in routes than in settlements, though in the last decades things changed a little all around Europe[2]. Topographers are very active, especially in the Mediterranean. They promote studies on Roman and medieval roads, according to traces within historical maps and aerial photos and to material remains. This ap-

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[1] I wish to thank Susan Oosthuizen who kindly read and commented this text and helped me in wording.

[2] Innovative approaches in the last decade are Fábrega Álvarez, Parcero Oubiña 2007; Herzog 2013; Verhagen 2013; van Lanen *et al.* 2015.

proach is robust, because it produces a consistent amount of data to support the reconstruction of a road[3]. On the other hand, it often focuses on connecting A to B, and on major roads. Sometimes, it also presumes that a central authority projected any given road. The step forward is to consider a route, rather than a single road. It still connects A to B, but its path varies over time, due to climate changes, political events, and so on. The via Francigena or Romea, the route connecting England to Rome via France, is a typical case study (Stopani 1998). In fact it is not a Roman major road: pilgrims started shaping its path at least since the 7th century AD. Actually, there is a robust literature on Roman roads that takes this into account too[4]. Thus, researchers have now accepted a less rigid idea of connectivity.

In the last three decades, there have been two new developments in this field of research: new theoretical approaches and computer applications. The first one is a series of new approaches to landscape studies that opened new questions. The economic aspect is of course relevant, but it is not the only one. Routes within a historical landscape can shape a hierarchy of central places and land-ownership and contribute to maintain the relationships among different communities[5]. They can also relate to belief, being part of wider symbolic paths (Semple 2008).

The rapid development of the digital humanities produced several attempts to shape a route with a GIS-based simulation[6]. The latter had less impact on literature, being often considered a deterministic approach. In fact, it presumes that humans always opted for the least cost path, which is proved to be not completely true. Things change radically, if we turn from predict to postdict, i.e. to analyse, which factors influenced a path we have reconstructed. A GIS-based simulation is thus helpful to evaluate the changing impact of both human and natural factors over time[7].

1.2. Mobility and the longue durée

Current advanced approaches shift the focus from a single route to potential mobility in a given geographical context. The concept of mobility is wider than that of route. Settlements can be connected one another

[3] It also allows to stress the role of the road as generator and/or attractor of settlements and service to people on the move - see Corsi 2000.

[4] The idea that even the main roads were a bundle more than a single path is already in Chevallier 1972 and Radke 1981.

[5] See for instance Oosthuizen 2017 on the fragile environment of the Fenland.

[6] They are grouped under the label "least cost path" and produced an abundant literature. See Polla, Verhagen 2014. The best overview of a GIS approach is Herzog 2013.

[7] A critical evaluation of pros and cons in Citter, Patacchini 2018.

with or without a road. Thus, a study of potential connections unveils a complex network linking all the settlements, not only the main ones. In addition, it makes possible to connect distant regions through the sum of local mobility networks. This new approach, promoted mainly by French archaeogeographers[8], changes the way we study the mobility over time. In fact, it reduces the impact of top-down projects, while stressing the bottom-up making of local, regional and long-distance connections.

Following this approach, we can define most of major roads recorded in the historical maps as the *transformission* of existing paths[9]. Thus, these routes are the sum of thousands of segments of local pre-existing mobility and the *longue durée* is the only possible time span. Correctly, archaeogeographers remark the role of resilience of old paths over time.

Something similar raised from the side of GIS-based approach too. The concept of natural corridors, where the mobility is naturally easier is quite well developed[10].

2. From roads to mobility: a case study

2.1. Introducing the selected area: the geographical settings (fig. 1)

The selected area is a small portion of western central Italy. The latter is delimited by the Tyrrhenian sea to the west, by the Apennines to the north and east and by the river Tiber to the east and south. Within this large area of about 40,000 square km we selected a small portion to run an analysis of the mobility network between AD 400 and 900: the territory of *Rusellae* near Grosseto.

We chose it because we made several excavations[11], geophysics (Campana 2018), surveys (Citter 2011; Vaccaro *et al.* 2013), and a complete scrutiny of all the published written sources, that includes historical place-names (Chirico, Citter 2018). This area has a good digital map service, that includes the georeferenced historical 1823 cadastre, though it is still not fully covered by free on-line LIDAR survey. For this study we used a 10 m cellsize DTM (Tarquini *et al.* 2007 and 2012).

[8] An overview of the discipline's theoretical framework is Chouquer, Watteaux 2013.

[9] This word comes out of *transformation* + *transmission* and it explains the concept of an ever changing feature - see Chouquer 2007, pp. 181-183.

[10] See among the others Whitley, Hicks 2003, though it is not focused on Medieval Europe.

[11] The town of Grosseto (Citter 2007), the town of *Rusellae* (Cataldi, De Benetti 2013), the hilltop site of Poggio Cavolo (Vaccaro *et al.* 2008) the Roman temple of *Diana Umbronensis* (Sebastiani *et al.* 2015). Further notes on the medieval sites of La Canonica and Moscona are in Nicosia, Poggesi 1998.

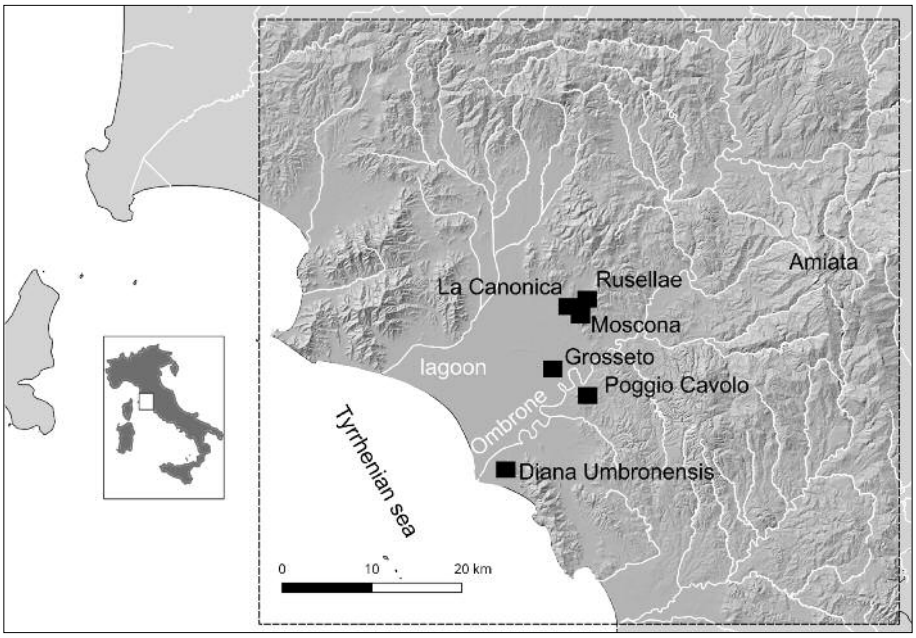


Fig. 1. The selected area within Italy. Main geographical features are emphasised.

The area consists of alluvial plains of different extension, and mountains. The highest one, Monte Amiata, reaches 1,700 m. while most of the land falls into a low- to mid-hill category, i.e. up to 400 m asl. The main river (fiume Ombrone) flows from north-east to south-west and it has several smaller tributaries that flow mainly within narrow valleys. The coast used to be a lagoon to extract sea salt and for fish-ponds until the end of the Middle Ages and even later. The main resources have always been pasture and woods, with a considerable portion of coastal areas cultivated for crops. Since the Late Middle Ages, marshes became the main problem for this region, due to health diseases and one of the main causes of depopulation[12].

2.2. Introducing the selected area: framing history and settlement patterns AD 400-900

Rusellae is an Etruscan town and, later, a Roman *municipium*. We don't know when they appointed a bishop there, but he is first mentioned in AD 499. During the 6th century *Rusellae* was a Byzantine stronghold

[12] Marshes and diseases could have been present even before, but their impact is still under scrutiny - p.c. Mariagrazia Celuzza who is studying the medieval cemetery of *Rusellae*.

while the Lombards possibly appointed a *gastaldus* there, since a district is mentioned in the sources (Citter 2007, p. 452).

Major towns and great harbours remained active in northern Tuscany between AD 400 and 600, while in southern Tuscany, where *Rusellae* is positioned, the network collapsed (Cantini, Citter 2010). However, they did not vanish as recent studies point out. Extensive and long lasting surveys produced a reliable base information about the settlement pattern (Citter 2011; Vaccaro 2011; Campana 2018). Sparse minor settlements did not vanished, but their impact on the landscape had already dropped down by AD 300. Large villas flourished until ca. AD 500, while a handful of them survived between AD 550 and 600. Most of the area falls within large imperial estates of the *res privata* or *res caesaris*, whose transmission to the royal goods in the Early Middle Ages is proved to be surprisingly matching (Chirico, Citter 2018). They persisted in the Middle Ages until the Communal towns promoted a new phase of developing trades after AD 1100 (Vallelonga *et al*. 2018). Grosseto developed from a small to a large village between AD 700-800, when at least two churches are witnessed, and expanded up to AD 1300.

2.3. Moving all around and creating networks over time

In this paper we wish to start from a network analysis and go further[13]. We wish to study the potential connection from a central place to its surrounding hinterland. Then, we wish to evaluate the main routes' resilience over time by comparing the result with the first precise picture of this area: the 1823 historical cadastre.

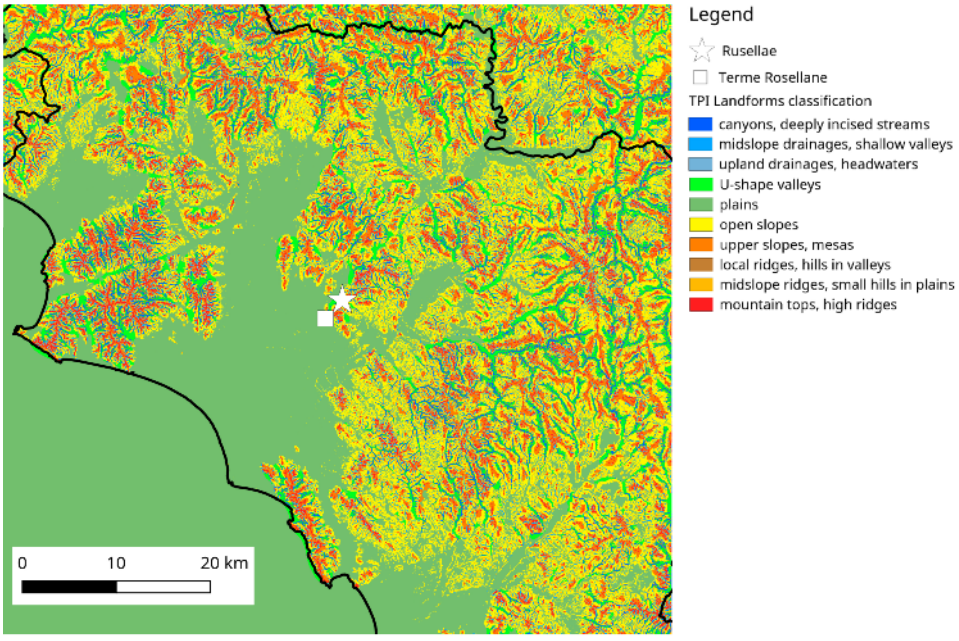
Network analyses base the evaluation on a cost surface, which is itself an estimation. The researcher should make it according to environmental and human factors that influence mobility[14].

In this case study we used the TPI landform classification algorithm to evaluate the morphology of the selected area[15] (fig. 2-a). In a few words, it classifies each cell of the raster map by analysing its surroundings at two different radii (in this case 100 m and 1000 m). Thus, a cell at 100 m asl could be a height in a plain and a valley bottom in a mountain. Slope is evaluated in the same way within this algorithm. The returned map is the most accurate description of a landscape from the morphological point of view.

[13] We used QGis 2.18 and SAGA 2.3.

[14] See Herzog 2013 and 2014 with detailed analyses of the base map and of the factors to consider. The procedure we use in this case study can be ascribed to the main category of central point networks mentioned in Herzog 2013, pp. 10-12.

[15] Topographical Positioning Index. Details about the algorithm in Weiss 2001 and Seif 2014.



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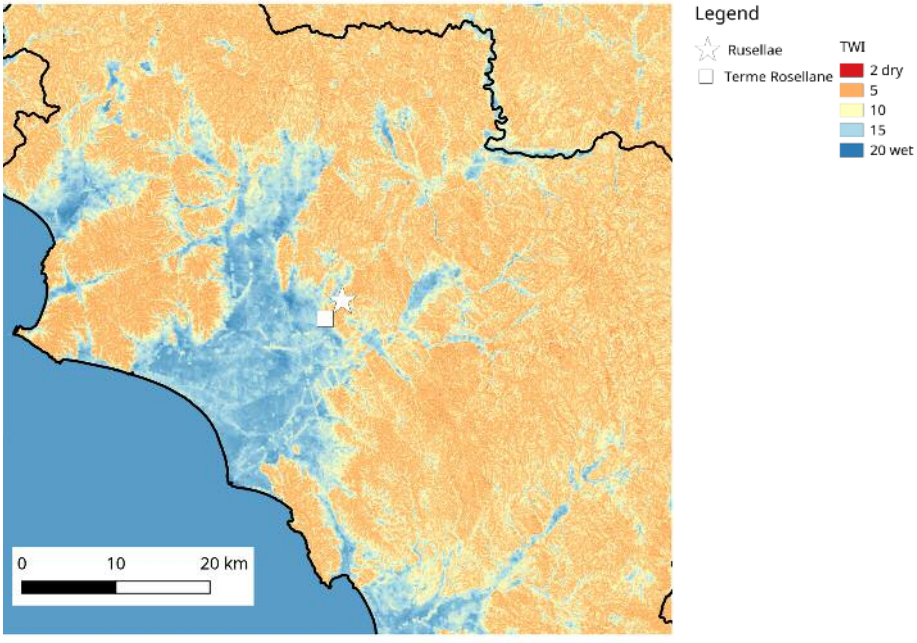

B

Fig. 2. The TPI (a) and TWI (b).

The TPI raster map has been reclassified according to the possibility for a man to move within its cells. The output is a simplified raster map, whose cells have 6 values within a range from 0 to 100[16]. We repeated the procedure with the TWI algorithm[17] (fig. 2-b). It evaluates the slope in a given point and the potential humidity catchment area flowing into that point. We summed the two reclassified rasters within the raster calculator[18] (fig. 3-a). The output is our cost surface, i.e. the base to run a further algorithm that calculates the possibility to move from a given point in any direction, according to that specific cost surface[19] (fig. 3-b). Of course, the cost surface can incorporate other factors like marketplaces, towns, harbours and so on. We focused on geographical ones to wonder, whether there could be major channels of movement within this territory, no matter the period we are studying.

The last step is to simulate a stream network originating from a centre. We chose the site of Terme Rosellane, a large series of 1st to 3rd century AD richly refurbished buildings 2.5 km SW of the political centre, the town of *Rusellae*, and we generated a stream network from it. It is likely that it used to be the main fiscal and judicial centre of the selected area. The streams represent the potential connections between the centre and the territory in any direction, according to that cost surface[20]. The returned map shows a network of polylines that amazingly allow Terme Rosellane to connect with all the other fiscal estates' centres

[16] They are related to the difficulty of walk through the cost surface, where 0 means no difficulty at all, while 100 means almost impossible to walk through. The original TPI landforms classification returns 10 classes. In this case we opted to reclassify as follows: canyons, deeply incised streams as 50, midslope drainages, shallow valleys as 20, upland drainages, headwaters as 30, U-shape valleys as 20, plains as 10, open slopes as 0, upper slopes, mesas as 30, local ridges/hills in valleys as 20, midslope ridges, small hills in plains as 20, mountain tops, high ridges as 10. We assume that to walk through an open slope is usually easier than anywhere else. Plains could be easy, but they have no slope at all and this could mean stagnation especially during the colder and wetter so called Late Antique Little Ice Age. Upper slopes and local ridges can be difficult to reach. Of course, other classifications are possible. See also the notes at 3.3 about who is moving within this landscape. We assume a single person without heavy baggage.

[17] Topographical Wetness Index. For details see Sørensen *et al.* 2006, Pei *et al.* 2010. For a use in archaeology see Brogiolo, Citter 2018. We reclassified as follows: 2 to 7 = 0, 7 to 10 = 10, 10 to 15 = 20 and 15 to 20 = 70. The last class stresses the cells overlaying the ancient reclaimed lagoon by considering them as an obstacle.

[18] The raster calculator is a simple procedure. The researcher overlays two or more raster maps and runs the calculation (in this case a sum) of corresponding cells. For instance: a cell, whose value is 10, overlays a cell, whose value is 5. The sum in the raster calculator returns a cell, whose value is 15. The procedure is repeated for all the cells. We ascribed a value of 60% to the TPI and of 40% to the TWI. Thus the formula is TPI_reclassified * 0.6 + TWI_reclassified * 0.4. This allow, for instance, to let the algorithm feel the presence of the coastal lagoon west of Grosseto.

[19] This algorithm is called r.walk and it is incorporated within QGis as one of the GRASS tools. It simulates the difficulty to move all around a given point by sensing the cost surface as a friction layer.

[20] We run the algorithm "channels network and drainage basins" from SAGA with a threshold of 7. This makes the map less redundant.

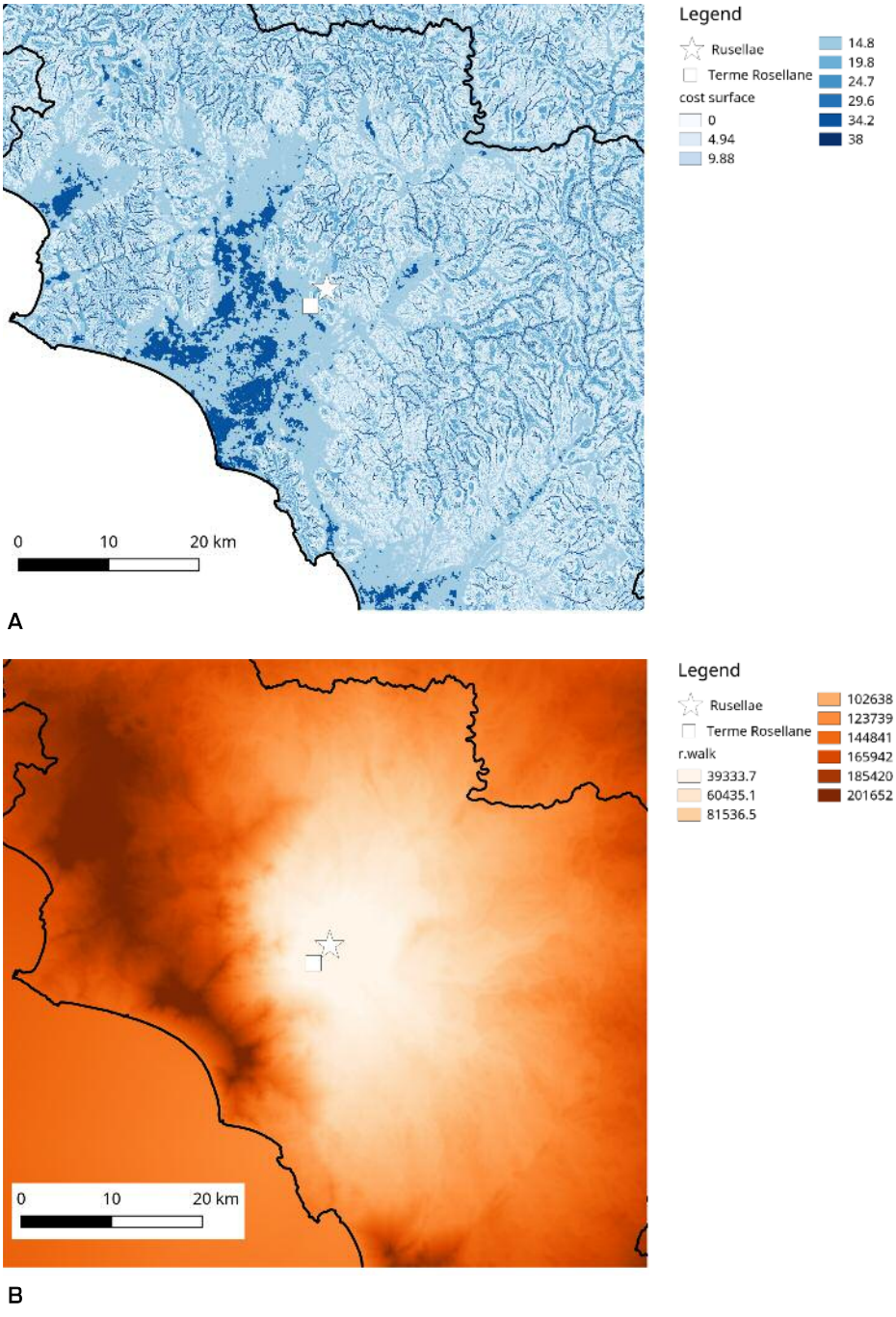

Fig. 3. The cost surface (a) and the r.walk (b).

apart from Le Paduline and Portiglione, which are the two main harbours of the region[21]. They could be both easily linked to Terme Rosellane via sea/lagoon. We selected only the fiscal estates' centres that still used to be active between AD 400-550, but the whole system had been shaped around AD 100-130 on a previous set of early imperial villas. Thus, the time span of these connections is of at least six centuries.

This procedure does not return a path like in the least cost path, but a series of segments. They are the best routes to move through that given landscape (i.e. our cost surface) from the selected starting point[22] (fig. 4-a).

We wished to evaluate, whether these potential routes left a trace in the 1823 cadastre. Thus, we selected only those connecting Terme Rosellane with each late antique fiscal estate's centre, and we run a 100 m buffer on both sides around them. Then, we digitised the 1823 cadastre's roads and parcel boundaries falling within the buffer, whose orientation is coherent with that of the routes to late antique estates[23]. Despite the raster resolution and the narrow buffer, the outcome is that there is a match of 42%[24]. This datum is much more significant, because most of the estates' centres had already been abandoned by AD 600 and were no longer settled. Others have been substituted by medieval castles on the hilltop nearby, but continuity is not proved[25]. We excluded a consistent portion of 1823 cadastre's roads that run parallel to the buffer because they fall outside it, even if by only a few meters in some cases. There is a further remark: the cadastre records only parcel boundaries. If a parcel is divided into several fields with different orientation, this is not recorded. Thus, there are several reasons to consider that this match is an underestimation.

We moved to the Early Middle Ages, between AD 600-900. We considered the Lombard cemeteries, the churches and the royal estates mentioned in the written sources between Lombards and Carolingians[26].

[21] For Portiglione see recently Vaccaro 2018.

[22] Water and men do not move in the same way. But we already achieved a good compromise by assigning the steepest slope cells a high value in the cost surface. In addition, the r.walk algorithm incorporates several calibrating factors specifically focused on human movement.

[23] It is not unusual, for instance, that a road ends in a parcel boundary with the same orientation. This increases the relevance of those roads as old signs in the landscape. We selected only roads and parcel boundaries, while we did not consider channels, streams and rivers, apart a few channels and ditches that are parcel boundaries.

[24] In particular 24% roads, 18% parcel boundaries.

[25] Only 3 used to be inhabited by AD 1823, being one of them the centre of the stream network: a small village of no relevance.

[26] We considered also some churches that are not mentioned within written sources but well dated thanks to archaeological excavations.

We run the same procedure focusing on the town of *Rusellae*. The stream network is very similar, because the two centres of the evaluation are close to each other. But the settlements included in the two evaluations are different. Despite this, all the early medieval settlements match exactly with the late antique routes to fiscal estates' centres and/or to the additional extensions run by *Rusellae* (fig. 4-b).

Some major routes point toward royal estates that fall out of the early medieval jurisdiction of *Rusellae* but very close to its boundary and within the selected area[27]. We added them into the calculation. The match is lower if we consider only the additional paths[28], but if we consider them altogether it is 38%. The main result is that 20% of the roads drawn in the 1823 cadastre overlie a potential connection among Terme Rosellane and late antique estate centres on the one hand and among *Rusellae* and early medieval settlements on the other. Most of them had already been abandoned long before the cadastre was drawn.

It would be intriguing to keep on with the timeline. But after year 1000 the incastellamento and the emerging power of Pisa along the coast and Siena in the inland make it difficult to find a proper centre from which to run a new stream network. Grosseto inherited the bishopric of *Rusellae* in AD 1138, but its role, from a political point of view, never went beyond a short radius from the town itself. The best solution for further attempts would be to split the area into smaller ones and to run the procedure focusing on each main castle[29].

3. Concluding remarks. From roads to mobility: a theoretical framework

3.1. Pros and cons of current approaches

Researchers often studied medieval roads to know the fate of the Roman ones. This leads to an underestimation of the medieval mobility network. Because the focus was on major roads, their impact is overestimated too. At least in Italy, excavation of roads is still underdeveloped and, from an administrative point of view, it is not easy to plan trenches along a path[30].

[27] The jurisdiction had an effective role only on churches. Thus, we uploaded only the churches belonging to the bishopric of *Rusellae*, while for cemeteries and royal estates we clipped to the selected area.

[28] In fact it reaches the 32%.

[29] However, if we simply upload the 12th-13th century castles within the selected area we notice that 12 on 149 fall within the 250 m buffer from the routes to fiscal estates' centres and early medieval extensions. This figures raises to 62 on the whole stream network generated from Terme Rosellane.

[30] The whole system of excavation's permission is focused on the concept of settlements and cadas-

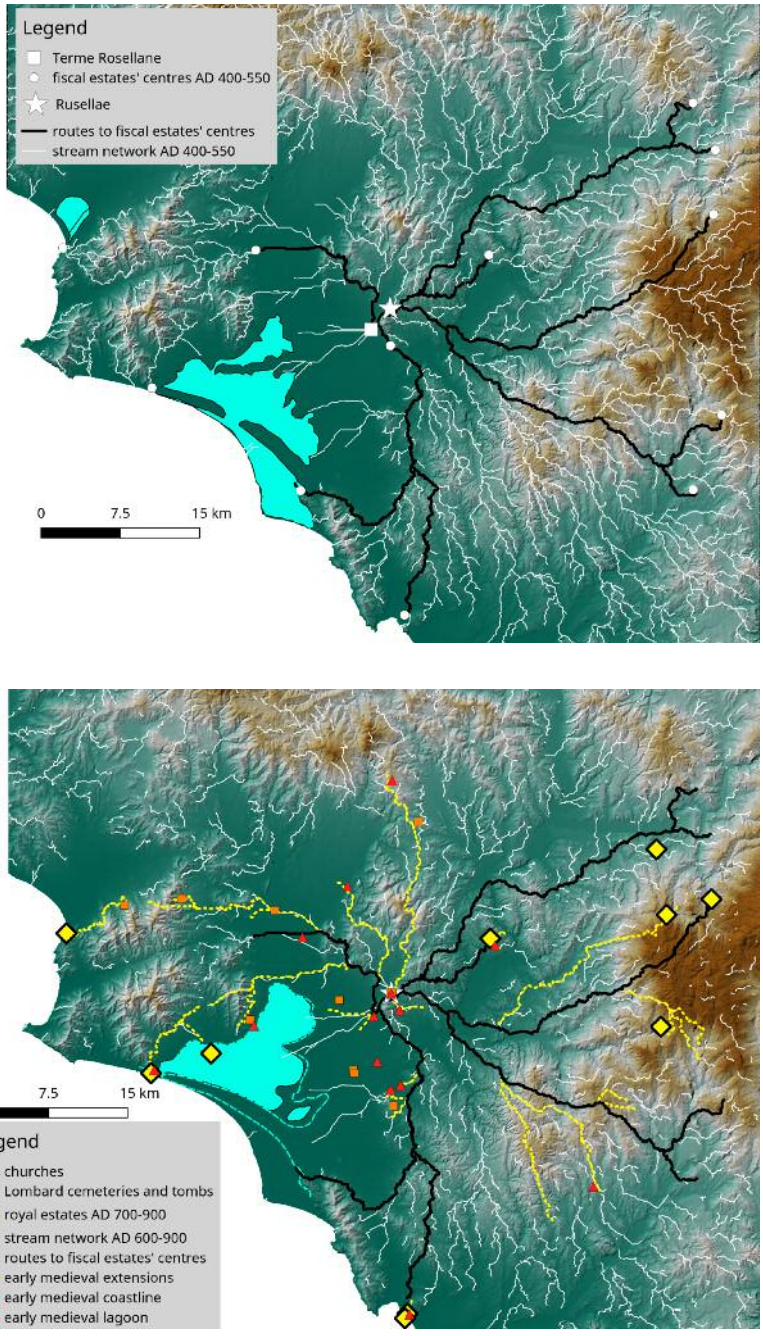

Fig. 4. A: the evaluated stream network for the period AD 400-550 and the fiscal estates' centres; 1-Le Paduline and 2-Portiglione. B: the evaluated mobility and the early medieval settlements AD 600-900.

That said, the topographical approach is well rooted and trained, its results are convincing; but it focuses on connecting two points and it is hard to manage at different geographical scales. This provokes a misunderstanding of the meaning of a path at different scale levels. In addition, it stresses the role of the top-down process, which is not always correct (see below 3.2). The digital revolution could help a great deal, but it did not, because it consisted mostly of a digital version of a not-digital thought. On the contrary, archaeogeography, whose theoretical framework owes much to geography, considers both the changing scale factor and the *longue durée* as pillars and stresses the bottom-up process of mobility making[31].

GIS approaches start with the least cost path. It evaluates the path from A to B by moving each time in the least cost cell among the surrounding ones. This is quite tricky, because the cost is a floating number. For the algorithm decimals are relevant, while for a human moving within a landscape they are not. The determinism is also hidden in the assumption that I always choose the straight path[32]. We can reduce the impact of this weak point, but we cannot solve it completely. Further possibilities are available with different procedures and outcomes[33].

A further crucial weak point is the cost surface that is the base from which to evaluate the least cost path. It is a raster map, whose cells each have a given weight. Who decides how should they be weighed? There is no automatic procedure to weigh each cell. But it should not be subordinated to the researcher's free will. The concept of attractors seems to be a good compromise. The researcher shapes the cost surface according to a set of weighed environmental and human factors evaluated as attractors/detractors and facilitators/obstacles. In this case the weights are explicit and readers can criticize the whole procedure in detail. A further useful concept is postdiction rather than prediction[34]. Least cost path originated from the mainstream of predictive models in archaeology, but in most cases the path is known from other sources, being the key question: why did it run like that? Thus, we can shape the cost surface until the evaluated path matches the existing one or the most part of it (postdiction)[35].

tral parcels. Thus, to plan a series of trenches along a path that fall within different parcels and Counties could be really challenging.

31 See below note 39.

32 An army going to face the enemy is eager to search for the shortest path. However, a merchant going to a marketplace would be interested in visiting smaller ones along his route, even if this would cost some more miles. A pilgrim would be attracted by places of worship before the final destination and a longer path could be attractive too as a spiritual route toward sanctity.

33 Herzog 2013 for a detailed overview with pros and cons of each approach.

34 A detailed analysis of these theoretical issues in Citter, Patacchini 2018.

35 Due to the raster resolution — i.e. the cellsize — and the above mentioned constraints of the algorithm, it is unlikely that an evaluated path could match exactly the existing one. See Herzog 2013,

This produces a preliminary estimation of which factors could have influenced that shape, thus, helping the researcher to raise new questions[36].

The shift from single path to stream network opened new perspectives within GIS approaches to mobility. It consists of shaping the cost surface in order to simulate a stream network originating from a source (the settlement) flowing in any direction in a given landscape[37], by considering its opportunities and constraints too (Murrieta Flores 2012). Thus, we can evaluate the potential connections among a single settlement and its surrounding territory. The changing weights of the factors incorporated into the cost surface enables to enhance the human or the natural influence on mobility.

The match between the evaluated stream network and a narrow buffer on the 1823 cadastre is encouraging. It seems that these connections have been not only possible, but relevant enough to leave a permanent footprint in the cadastre[38].

The main Roman roads, whose long lasting use is proved by other data (Citter 2007), have no relationship at all with the picture we derive from this study (fig. 5). The reason is that the former were planned by the Romans by connecting those pieces of historical routes that fitted better with their goal: to link Rome to the Gaul with the shortest path. Where there was no previous path to use, they went straight. During the Early Middle Ages, the main Roman roads in *Rusellae*'s territory, such as *via Aurelia vetus* and *via Aemilia Scauri*, still played a role as attractors of settlements along a south-north axis. In this paper we considered for the first time a resilient and long lasting connection network that allowed efficient links between the coast and the inland over time. Thus, our overall evaluation of the Roman legacy needs to be reformulated.

3.2. Top down - bottom up: evaluating the making of a connections' network

There are of course roads that have been built in a given period to connect A to B. Literary sources often mention roads with a name or

p. 2 for an advice on this.

36 For instance, we could not get a good match with the path of the Roman main road named *via Aurelia vetus* in the area around Grosseto, until we incorporated the harbours into the algorithm. This reinforced the idea that not only in Latium, but also in Tuscany this road was built to connect the harbours as a military path.

37 Fábrega Álvarez 2006 and Llobera *et al.* 2011 are the seminal papers to introduce the reader to this approach.

38 This study is a further proof that the concept of transformission proposed by archaeogeographers is correct. In fact it does not prove the resilience over time of a single path as a whole, but of segments of different paths connected in different ways, according to different needs.

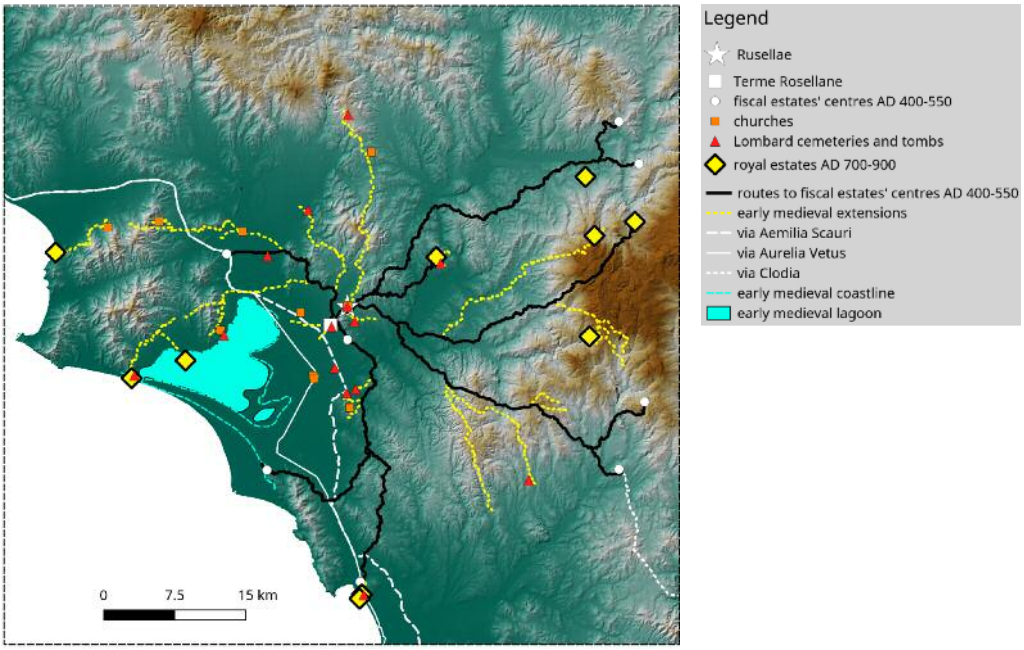

Fig. 5. Main Roman roads in the selected area and the mobility network among Terme Rosellane and the fiscal estates' centres.

with the name of the source and destination points. Sometimes we have also sources mentioning the date of construction[39]. But we should wonder, whether they built in the middle of nowhere or if they selected only those paths useful to reach the goal, according to the geographical constraints/opportunities and the political/cultural will of the moment. The output of this study goes in this direction. Thus, written sources suggest that sometimes a top-down process occurred, but this seems to be an exception. Most roads connecting medieval villages and castles are flanked by pre-Roman monumental tombs, Bronze Age hilltop sites and so on. Major Roman roads could thus be the sum of local mobility networks on a supra-regional scale. This complicated network is still visible in the 1823 cadastre, if we read it as a palimpsest or, rather, as an archaeological stratigraphy.

French archaeogeographers have shown the potential of this approach and the flexibility of the chronological and topographical scale factors[40]. In

[39] It is the case of the projected road connecting Siena to the sea harbour of Talamone in AD 1309 - see Sordini 2014.

[40] Watteaux 2013. Here one can also find a synthesis of archaeogeographers' theoretical framework.

this paper we added the potential of GIS spatial analyses. We stressed the persistence and, in some cases, the resilience of the network over time. The percentage of 1823 cadastre parcel boundaries and roads segments within the narrow buffer of 100 m on the routes to fiscal estates' centres (42%) and on the early medieval extensions (32%) cannot be for fortune. It suggests that there used to be a long lasting route along some geographical corridors that was shaped according to ever changing needs. One of them is the cadastre itself, whose paths in most cases follow the same route, though just outside the narrow buffer. This ongoing process of making/unmaking paths does not need nor central authority, neither a planning. In this case the Romans willing to connect the fiscal estates' centres adapted themselves to an existing situation. In fact, within the selected area 40 Etruscan settlements intersect a 250 m buffer from the routes to fiscal estates' centres[41]. If we move back to the Bronze Age as a whole, without any further subdivision, and we repeat the same analysis, we notice that only 4 settlements satisfy the same conditions[42]. According to this scenario, it seems that the routes to Roman fiscal estates' centres have something to do with the making of the Etruscan mobility network, but also, though at a lower rate, with previous situations.

If we change a little our perspective, things change too. If we intersect the Bronze age and the Etruscan settlements with a 250 m buffer on the whole stream network generated from Terme Rosellane, figures increase significantly. In particular, there are respectively, 12 Bronze Age and 234 Etruscan settlements. They correspond, respectively, to the 27% and to the 34% of the settlements of each period within the selected area. Thus, we could argue that the Romans selected only those paths useful for their goal.

The main conclusion we can derive from this study is that past research has overestimated the importance of main Roman roads like the *via Aurelia* and the late medieval ones like the via Francigena or the via from Siena to Talamone. Of course, they had a key role in the political scenario of the time and they used to be attractors even later. But they tell us only a part of the story. The 1823 cadastre is an extraordinary chance to extract fragments of a long lasting process of *transformission* of mobility all around in a given area. In this paper we concentrated on

In particular, it is worth to quote pp. 81-94, where the author sums up her research on Vendée. It is the most clear example of the potential of this approach to study historical mobility.

41 The buffer's surface is 234 square km. The number of known Etruscan settlements in Grosseto's province is 1022, but only 679, corresponding to the 64%, fall within the selected area. The settlements falling within the buffer correspond to 6.5 % of those within the selected area. Their chronology spans between 700-200 BC.

42 The number of known Bronze age settlements in Grosseto's province is 109, while 44 fall within the selected area. I am grateful to Giovanna Pizziolo for this information.

the geographical constraints/opportunities, but it is only a first step. Some of them can soon turn into human factors, thus gaining a further role of attractors for an ever changing mobility network[43].

A further note is that the natural corridors generated from Terme Rosellane, a Roman large settlement close to *Rusellae*, though on the plain, seem to attract a considerable percentage of Etruscan settlements. This reinforces the idea that the Romans shaped those paths by selecting within a large and already functioning mobility network.

3.3. Farmers, merchants, pilgrims: which mobility am I studying?

Mobility comes out of a need to connect. But we should also ask, whether different needs produce different networks. This question is almost absent within a traditional topographical approach, but it is on the fore when using the stream network simulation as we did in this case study. Which factors should I incorporate in the cost surface? How much should they weigh one another? For a merchant a market place is much attractive, while for a pilgrim a place of worship is more fascinating. Are fresh water springs attractive as well?[44] Do I care about a mid-steep slope if I am a farmer travelling with a wagon to the nearby town?[45]

We have already mentioned the deep difference between the network of local connections and the long distance roads like *via Aurelia*. The former for peasants, merchants and owners moving or at least relating themselves to a central place within the region, the latter for armies moving straight from Rome to the north. But the sum of local networks makes a regional and then a national larger network. Thus, also the main Roman roads should be investigated according to a stream network focused on Rome, searching for the potential connection all around within an area that is Italy or even Europe.

[43] Sometimes a spring generates a place of pray/worship, a watershed becomes a political boundary, an easily accessible area becomes a marketplace.

[44] We incorporated the springs in several least cost path analyses on the Roman roads in Latium, but they resulted irrelevant.

[45] Merchants and messengers travelling along the network of caravanserais in the Middle East preferred a mid slope on a shorter path than a gentle slope on a longer one, because they used to travel in summer - see Tavernari, Citter 2014.

References

G.P Brogiolo, C. Citter 2018, *Paesaggi e sistemazioni agrarie nel baso corso dell'Adige da Montagnana al mare*, in G. Volpe (ed), *Storia e archeologia globale dei paesaggi rurali in Italia fra tardoantico e altomedioevo,* Bari, pp. 599-621.

S. Campana 2018, *Mapping the Archaeological Continuum. Filling Empty Mediterranean Landscapes,* Cham.

F. Cantini, C. Citter 2010, *Le città toscane*, in P. Delogu, S. Gasparri, M. Valenti (eds), *Le trasformazioni del V secolo. l'Italia, i barbari e l'occidente romano*, Atti del II seminario internazionale (Poggibonsi, 2007), Turnhout, pp. 401-435.

F. Cataldi, M. De Benetti 2013, *Roselle: le monete dagli scavi archeologici (1959-1991) e dal territorio*, Arcidosso.

R. Chevallier 1972, *Le voies romaines*, Paris.

E. Chirico, C. Citter 2018, *I beni pubblici e della corona dall'impero romano ai longobardi: il caso di Roselle (Grosseto)*, in C. Giostra (ed), *Archeologia dei Longobardi. Dati e metodi per nuovi percorsi di analisi*, Atti del convegno (Milano, 2017), Mantova, pp. 77-100.

G. Chouquer 2007, *Quels scénarios pour l'histoire du paysage? Orientations de recherche pour l'archéogéographie*, Coimbra-Porto.

G. Chouquer, M. Watteaux 2013, *L'archéologie des disciplines géohistoriques,* Paris.

C. Citter (ed) 2007, *Archeologia urbana a Grosseto. origine e sviluppo di una città medievale nella Toscana delle città deboli. Le ricerche 1997-2005. II: edizione degli scavi urbani 1998-2005*, Firenze.

C. Citter 2007, *La viabilità romana nell'area grossetana durante l'alto medioevo: alcuni spunti di riflessione per una geografia del potere*, in C. Citter A. Arnoldus-Huyzendveld (eds), *Archeologia urbana a Grosseto. origine e sviluppo di una città medievale nella Toscana delle città deboli. Le ricerche 1997-2005. I: la città di Grosseto nel contesto geografico della bassa valle dell'Ombrone*, Firenze, pp. 212-221.

C. Citter 2011, *Dati archeologici: insediamenti, viabilità, sfruttamento delle risorse*, in C. Citter, A. Arnoldus-Huyzendveld (eds), *Uso del suolo e sfruttamento delle risorse nella pianura grossetana nel medioevo. Verso una storia del parcellario e del paesaggio agrario*, Roma, pp. 41-54.

C. Citter, S. Nardi, F.R. Stasolla (eds) 2018, *Entre la terre et la mer. La* via Aurelia *et la topographie du littoral du Latium et de la Toscane,* Atti del convegno internazionale (Parigi, 2014), Roma.

C. Citter, A. Patacchini, 2018, *Postdittività e viabilità: il caso della direttrice tirrenica*, in Citter, Nardi, Stasolla 2018, pp. 57-75.

C. Corsi 2000, *Le strutture di servizio del* cursus publicus *in italia. Ricerche topografiche ed evidenze archeologiche*, Oxford.

P. Fábrega Álvarez 2006, *Moving without destination. A theoretical GIS-based determination of movement from a giving origin*, "Archaeological Computing Newsletter", 64, pp. 7-11.

P. Fábrega Álvarez, C. Parcero Oubiña 2007, *Proposals for an archaeological analysis of pathways and movement*, "Archeologia e Calcolatori", 18, pp. 121-140.

R. Farinelli 2007, *I castelli nella Toscana delle città deboli. Dinamiche del popolamento e del potere rurale nella Toscana meridionale (secoli VII-XIV)*, Firenze.

R. Farinelli, E. Vaccaro, H. Salvadori 2008, *Le chiese nel villaggio: la formazione dell'abitato medievale di Poggio Cavolo (Gr)*, in S. Campana, C. Felici, R. Francovich, F. Gabbrielli (eds), *Chiese e insediamenti nei secoli di formazione dei paesaggi medievali*, Atti del convegno (San Giovanni d'Asso-Montisi, 2006), Firenze, pp. 169-197.

I. Herzog 2013, *Least cost paths*, in G. Earl, T. Sly, A. Chrysanthi, P. Murrieta-Flores, C. Papadopoulos, I. Romanowska, D. Wheatley (eds), *Archaeology in the Digital Era*, Proceedings of the 40th CAA Conference (Southampton, 2012), Amsterdam, pp. 240-251.

I. Herzog 2014, *Least-cost paths – some methodological issues*, "Internet Archaeology", 36, https://doi.org/10.11141/ia.36.5.

M. Llobera, P. Fábrega Álvarez, C. Parcero Oubiña, C, 2011, *Order in movement: a gis approach to accessibility*, "Journal of Archaeological Science", 38, pp. 843-851.

P.A. Murrieta Flores 2012, *Understanding human movement through spatial technologies. The role of natural areas of transit in the late prehistory of southwestern Iberia*, "Trabajos de Prehistoria", 69(1), pp. 103-122.

S. Oosthuizen 2017, *The Anglo-Saxon Fenland*, Oxford.

T. Pei, C.Z. Qin, A. X. Zhu, L. Yang, M. Luo, B. Li, C. Zhou 2010, *Mapping soil organic matter using the topographic wetness index: a comparative study based on different flow direction algorithms and kriging methods*, "Ecological Indicators", 10, pp. 610-69.

F. Nicosia, G. Poggesi (eds) 1998, *Roselle. Guida al parco archeologico*, Siena.

S. Polla, Ph. Verhagen (eds) 2014, *Computational Approaches to the Study of Movement in Archaeology. Theory, Practice and Interpretation of Factors and Effects of Long Term Landscape Formation and Transformation*, Proceedings of the workshop (Berlin, 2011), Berlin-New York.

G. Radke 1981, *Viae publicae romanae*, Bologna.

A. Sebastiani, E Chirico, M. Colombini, M. Cygielman (eds), Diana umbronensis *a Scoglietto. Santuario, territorio e cultura materiale (200 a.C.-550 d.C.)*, Oxford.

A. Seif 2014, *Landform classification by slope position classes*, "Bulletin of Environment, Pharmacology and Life Sciences", 3(11), pp. 62-69.

S. Semple 2008, *Polities and princes AD 400-800: new perspectives on the funerary landscape of the South Saxon kingdom*, "Oxford Journal of Archaeology", 27(4), pp. 407-429.

B. Sordini 2014, *Il porto di Talamone, un piccolo scalo con ampi contatti*, in B. Figliuolo, P.F. Simbula (eds), *Interscambi socio-culturali ed economici fra le città marinare d'italia e l'Occidente dagli osservatori mediterranei*, Atti del convegno (Amalfi, 2011), Amalfi, pp. 483-506.

R. Sørensen, U. Zinko, J. Seibert 2006, *On the calculation of the topographic wetness index: evaluation of different methods based on field observations*, "Hydrology and Earth System Sciences", 10, pp. 101-112.

R. Stopani 1998, *La via francigena. Storia di una strada medievale*, Firenze.

S. Tarquini, I. Isola, M. Favalli, F. Mazzarini, M. Bisson, M.T. Pareschi E. Boschi 2007, *Tinitaly/01: a new triangular irregular network of Italy*, "Annals of Geophysics", 50, pp. 407-425.

S. Tarquini, S. Vinci, M. Favalli, F. Doumaz, A. Fornaciai, I. Nannipieri 2012, *Release of a 10-m-resolution dem for the Italian territory: comparison with global-coverage dems and anaglyph-mode exploration via the web*, "Computers & Geosciences", 38, pp. 168-170.

C. Tavernari, C. Citter 2014, *Percorsi potenziali/percorsi storici nella Siria del periodo islamico*, "Agri Centuriati", 11, pp. 115-137.

E. Vaccaro 2011, *Sites and Pots: Settlement and Economic Patterns in Southern Tuscany (AD 300-900)*, Oxford.

E. Vaccaro 2018, *Long-distance ceramic connections:* Portus Scabris *(Portiglioni-GR), coastal Tuscany and the Tyrrhenian Sea*, in G. Bianchi, R. Hodges (eds), *Origins of a New Economic Union (7th-12th centuries): Preliminary Results of the nEU-Med project* (October 2015-March 2017), Firenze, pp. 81-99.

E. Vaccaro, M. Ghisleni, A. Arnoldus-Huyzendveld, C. Grey, K. Bowes, M. MacKinnon, A.M. Mercuri, A. Pecci, M.A. Cau Ontiveros, E. Rattigheri, R. Rinaldi 2013, *Excavating the Roman peasant II: excavations at Case Nuove, Cinigiano (GR)*, "Papers of the British School at Rome", 81, pp. 129-179.

F. Vallelonga, S. Del Ferro, L. De Lellis 2018, *La via Aurelia e la viabilità minore tra Roma e Civitavecchia nel medioevo*, in Citter, Nardi, Stasolla 2018, pp. 131-172.

R.J. Van Lanen, M.C. Kosian, B. J. Groenewoudt, E. Jansma 2015, *Finding a way: modeling landscape prerequisites for roman and early-medieval routes in the Netherlands*, "Geoarchaeology", 30, pp. 1-23.

Ph. Verhagen 2013, *On the road to nowhere? Least cost paths, accessibility and the predictive modelling perspective*, in F. Contreras, M. Farjas, F.J. Melero (eds), *Fusion of Cultures*, Proceedings of the 38th CAA Conference (Granada, 2010), Oxford, pp. 383-390.

M. Watteaux 2013, *L'analyse archéogéographique des réseaux routiers dans la longue durée. nouvelles approches méthodologique et théorique*, in L. Beauguitte (ed), *Les réseaux dans le temps et dans l'espace*, Actes de la journée (Paris, 2013), pp. 74-100.

A.D. Weiss 2001, *Topographic Position and Landforms Analysis,* Poster Presentation, ESRI Users Conference, San Diego.

T.G. Whitley, L.M. Hicks 2003, *A geographic information systems approach to understanding potential prehistoric and historic travel corridors*, "Southeastern Archaeology", 22(1), pp. 76-90.