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R.P.C.M. Apulia
(Reconstructing Prehistoric Communities' Mobility in Apulia)

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Esame finale anno 2022

To my wife, Elisa
without her nothing, with her everything

To my daughter, Iside
little spark of our life

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To Iside,
she maybe will not read all this, but it will tell her... one day.

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1. Introduction

The activity that will be presented on the following pages arose from the Ph.D. project “R.P.C.M. Apulia” (Reconstructing Prehistoric Communities' Mobility in Apulia) led by the author in an agreement between the Universities of Münster, Germany, and Bologna, Italy, in cooperation with the Soprintendenza Archeologia, Belle Arti e Paesaggio of the province of Barletta-Andria-Trani-Foggia.

The research originates in the necessity to bring a new systematic archaeological perspective to the prehistoric background of northern Apulia (a southern Italian region; fig.1). The choice of this area was made because of its importance with respect to several aspects.



Fig.1 – Apulia. In red the considered area.

The region of Apulia has been subject to human presence since the Palaeolithic and increasingly became one of the most important centres for trading, ideas, and people. It is remarkable to notice how archaeologists discovered links between Apulia and the Balkans or the eastern part of the Mediterranean Sea, for example. Therefore, the aim of the project is to shed new light on a specific chronological arch from the Ancient Neolithic to the Early Bronze Age of the northern part of Apulia, because, nevertheless the role the region played in the past, related studies mainly date to the 1970-80ies with only some sporadic exceptions.

Moreover, the relationship between the communities and the landscape will be addressed in order to evaluate how prehistoric people could use the land and how they could move into this area and keep in touch with one another.

To reconstruct these dynamics in prehistory, it was first of all necessary to create a database containing all existing information about sites, to validate them and classify them according to a specifically built model. The storing was conducted with the software ArcGIS v.10.1, and the sites have been georeferenced on the map as points.
The database provided the basis on which the analysis concerning the mobility and perception of the landscape will be developed. Specifically, the analysis will include:

- Least-Cost Path Analysis;
- Fuzzy Viewshed Analysis.

The former was taken into consideration to evaluate the mobility in the study area and thus, to generate sample paths on the base of the time needed to reach a specific point with respect to the terrain trend.

The visibility analysis was conducted to grasp how the groups perceived the landscape through sight. Even though apparently such data seems a mere information, visibility plays an important role, especially during the Copper Age, as far as the dominion and control of the trading ways is concerned.

The data coming from the above-mentioned analysis has been used to read into the settlement choices and to connect them to the development of new socio-economic relationships. To verify the data in the field, surveys were planned and conducted to validate the results of the analysis and to gain new archaeological evidence (especially where sites were not investigated for a long time).

The aforementioned motivations are supported by personal involvement of the author in local investigations that yielded knowledge of the archaeological background in several aspects. Examples were the excavations and the research in Grotta San Biagio (Ostuni, Brindisi) and in Coppa Nevigata (Manfredonia) that permitted to get in touch with the archaeological scenario of Apulia. These experiences triggered the will to analyse in-depth the cultural relationships that arose and developed in a region that played a main role across time.
Specifically, it became suddenly clear that, in order to accomplish this scope, it was necessary to change the investigation approach and hence the perspective through which I had to look at the data. Therefore, the question was:

“How could I gather and analyze data able to give me extra information on the lifestyle of the prehistoric communities?”
The response was the landscape. Often not fully considered, the research on this element came into use since the 1970s, when the term “landscape archaeology” began to appear in archaeological literature, and then it began to gain track during the 1990s with the post-processual movement (Flemming 2006, 268-269). Currently, landscape archaeology is interested in an interdisciplinary approach, merging aspects such as ecology, economic geography, anthropology and sociology (Johnson 2012). An example for this is the recent investigation led by Hamilton and Whitehouse (2021) focused on the landscape and the perception of the surroundings by the individual, hence exploring aspects like the soundscape or others related to the sensorial experience of the people from a determined point.

Therefore, the consideration of the landscape as the main aspect, to which the research questions are addressed, finds a fundament in the conviction that it is a social construct. In other words, as Hirst stated (2020):

“*The same piece of ground holds different meanings to different people, and that idea should be explored*”

In conclusion, the new and innovative approach involved in the study and analysis of northern Daunia takes its first steps from within the landscape because through it this and the following research will enable us to comprehend how the past communities evolved until today.

2. Background

Apulia is the easternmost region in south Italy. It lies between the eastern Apennine Mountains, the Adriatic and Ionian Seas. The region is largely flat or slightly hilly with two exceptions in the northern part, the Gargano promontory and the Daunian Mountains. Among the flat areas, the Tavoliere stands out, a huge and fertile flat land that represents the vastest plain of Italy after the Padania Plain (fig. 2).
Due to its location, the region has been in contact with the Balkans and the eastern Mediterranean Sea from prehistoric times onwards, but also with the inner regions of Italy, thus becoming an important hub for cultural exchanges.

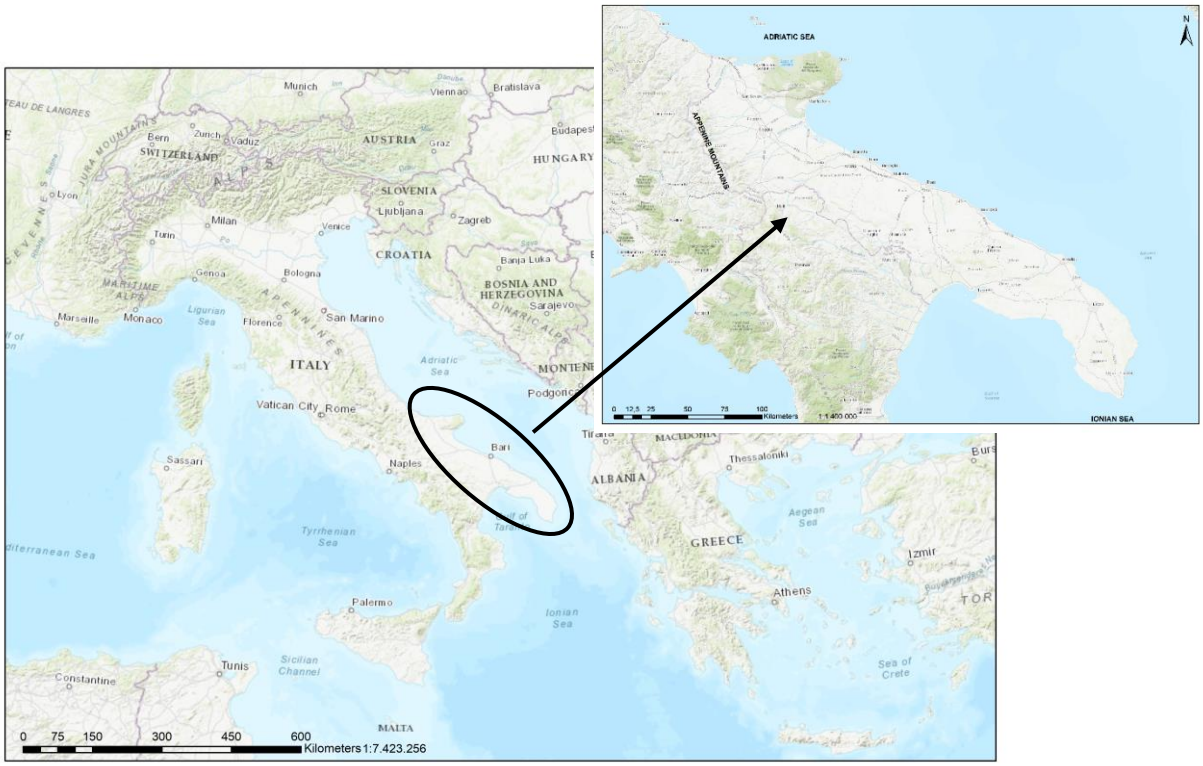


Fig. 2 – Location of Apulia (image edited by the author)

It is easy to understand the reason why scholars are prone to investigate this region. In terms of archaeology, geology, history and so on, Apulia played (and plays) a major role in which the region has been seen as the focus of human evolution and, more generally, the anthropological phenomenon.

The choice of focusing the project on the north part of Apulia originated from the will to gain new insights into prehistory in which this area became a cornerstone regarding the development of new ideas, cultural and economic models. Remarkably, the earliest Neolithic traces were found here.
Furthermore, the research aims to comprehend also the landscape with its cultural and geographical facets and the relationships created between it and the human inhabitants.
We know that the territory played a main role in settlement choices because the communities needed raw materials for their survival, fertile soils and water, but also ways of communication for trading; all these necessities could be satisfied by the landscape used as a study area. The Tavoliere offered its inhabitants fertile and flat soils, whereas the Gargano promontory yielded valuable raw materials such as flint; the rivers and valley passages could facilitate the connection between communities.

If what moved on the surface appears quite hard to interpret because of the colourful history of the events that happened here, also the "underground" arises as an interesting subject foracademics. Geologically, Apulia displays some particular *unica* that places it in the interest of the scientific community. For instance, the Gargano represents a geological context model regarding the study of carbonate systems and can be compared to similar situations in the Mexican Gulf, China or the Middle East (Morsilli 2016, pg.15).

Because of these characteristics, I chose to introduce the use of innovative investigations in order to deepen and enhance the data able to give feedback concerning the land exploitation by the prehistoric communities. This kind of approach permitted also to have a clearer diachronic frame of an important region almost completely neglected until now.

2.1. Geological Background

Geologically, the considered area presents diverse environments like the west hillside of the Gargano, the Adriatic coast, the Fortore river valley and the north Tavoliere Plain (fig.1). Therefore, a geomorphologic variety between hilly and flat lands exists which offers all that is necessary to settle in this part of the Italian peninsula.

2.1.1. The Gargano

The Gargano displays a complex geological stratigraphy largely formed by carbonate rocks dating between the Upper Jurassic and the Eocene; occasionally, Oligo-Miocene and Pliocene carbonate rocks emerge in some places of the promontory's surface. The presence of other kinds of rocks is also recorded (Triassic chalk outcrops and carbonate in association with Palaeocene igneous rocks). As far as the Quaternary is concerned, it has been noticed that sediments cover the carbonate sequence (Morsilli 2016) (fig. 3).

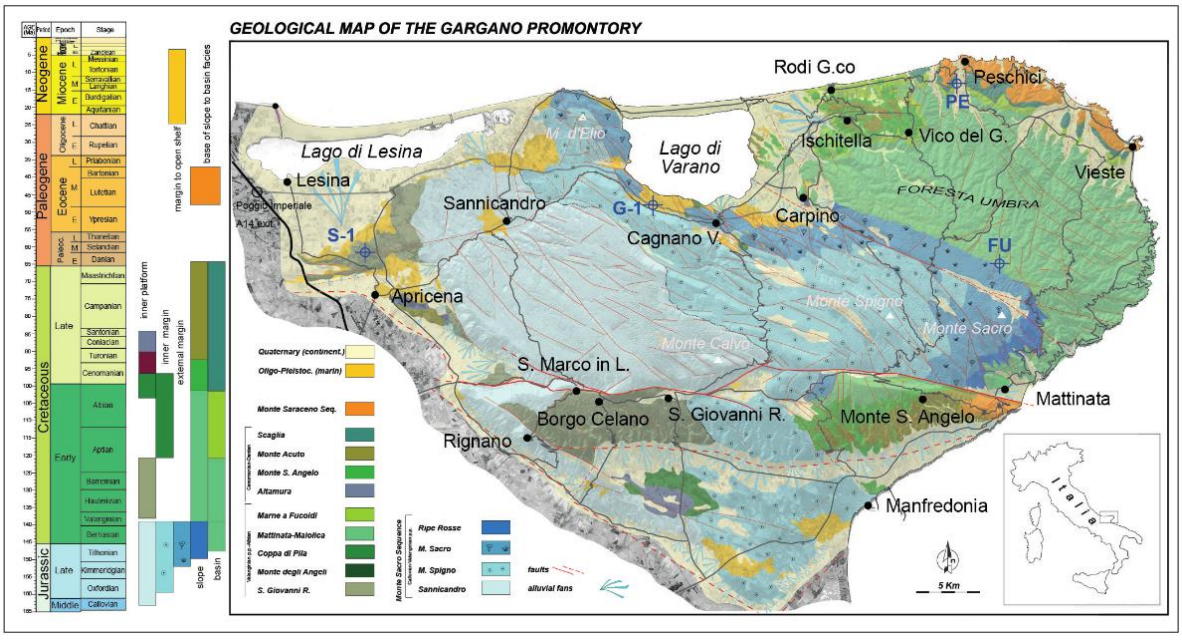


Fig. 3 – Geology of the Gargano (Morsilli M. 2016)

Palaeogeographically, the rocks from the Gargano belong to the Apulia Carbonate Platform that bordered on the southern Tethys Sea edge during the Mesozoic (fig. 4).
The Platform is placed on the southwest edge of the Adriatic tectonic plate in the central Mediterranean and creates a peninsula which divides the Adriatic from the Ionian Sea (Mastronuzzi/Sansò 2002).
It is notable that the Gargano promontory and the Maiella Mountains (central Abruzzian Apennine) are the places where the transition from the platform to the basin *facies* is visible on land (Morsilli/Bosellini 1997).
Structurally, the promontory appears as the foreland of the south Apennine Mountain system and presents irregular structural and geophysical features causing the current formation and the high seismic activity (Amato/Bianchi/Agostinetti 2014; Argnani *et al.* 2009).

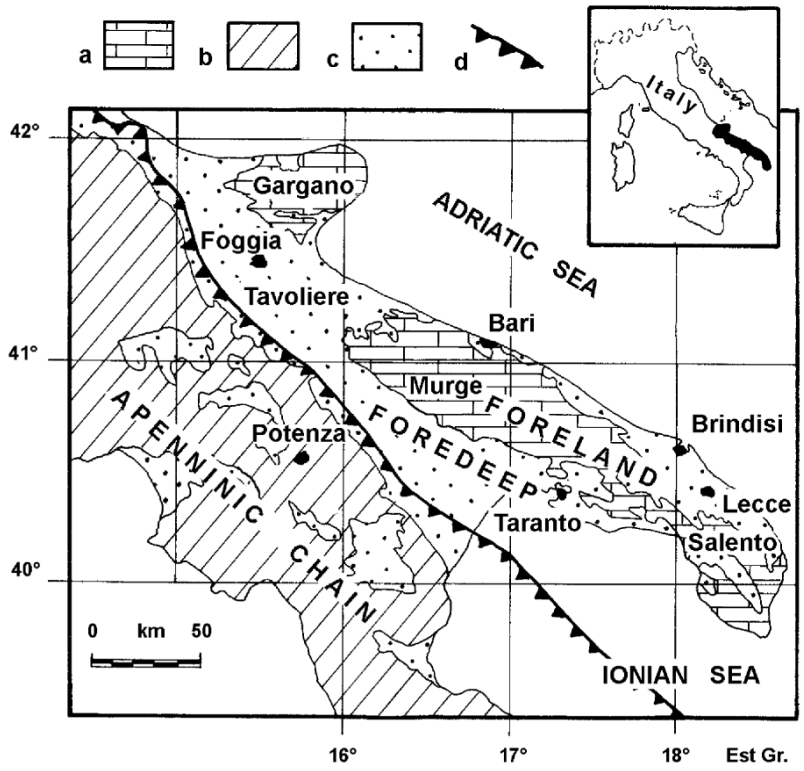


Fig. 4 – Geological outline of Apulia. A) Apulian Carbonate Platform; b) Apenninic units; c) Mio-Plio-Pleistocene covers; d) Apennine (Mastronuzzi/Sansò 2002)

The related investigations revealed that the Gargano has also a rich fault line complex and a slight northwestern orientation (fig. 5a, b). In the structural frame, the fault lines with an east-west orientation, of which the main exponent is the Mattinata Fault Line, turn out to be of major importance (Guerricchio/Wasowski

1988; Billi *et al*, 2007). The interest for them arises from the consideration that the Mattinata Fault may be responsible for the seismic activity of the Gargano. Other authors are more prone to indicate fault lines with different orientations (east-west, northeast-southwest, northwest-southeast) as cause for superficial and deep earthquakes and not the Mattinata fault line because there is not clear evidence directly linked to the telluric activity to the Mattinata Fault Line (Favali *et al*. 1993).

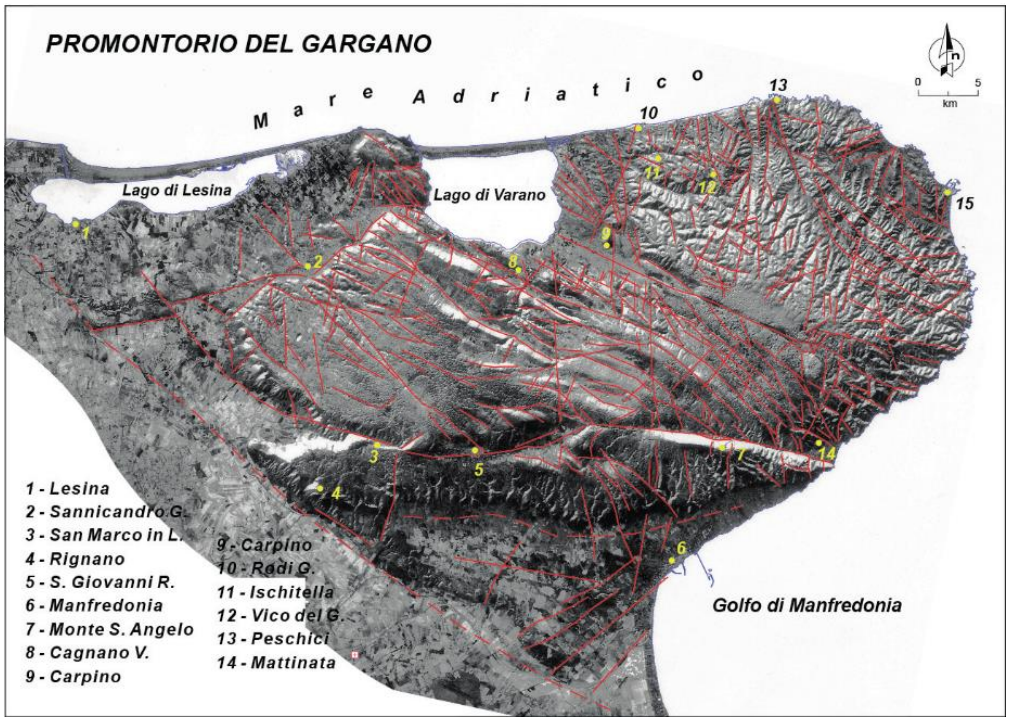


Fig. 5a – Distribution of main faults on the Gargano. In red the fault lines; in yellow the main cities around the promontory area (Morsilli 2016)

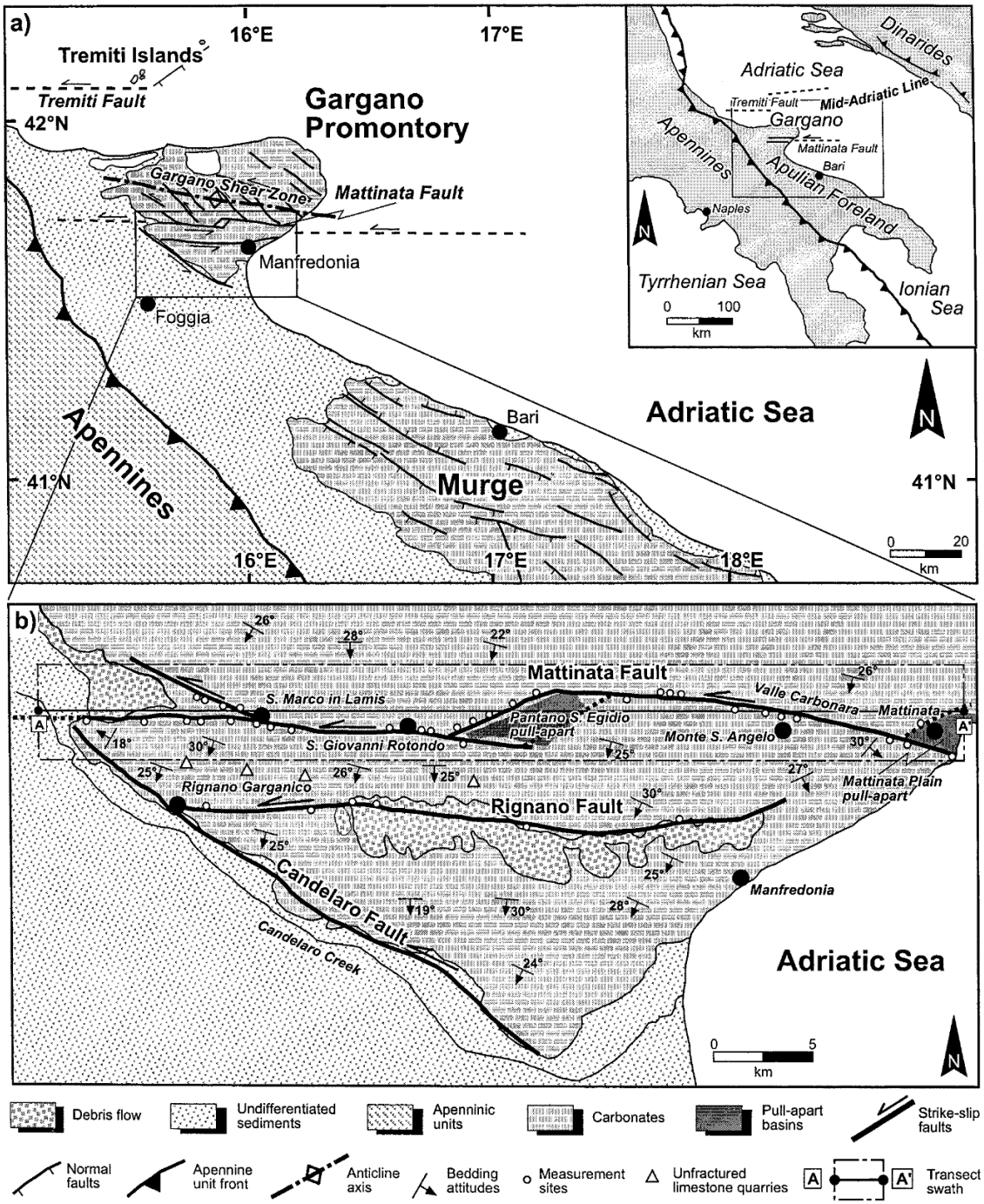


Fig. 5b – Detail of the Gargano's main fault lines (Salvini *et al.* 1999)

Another interpretation formulated by Guerricchio (1983, 1986) concerns the karst phenomenon occurring in the west-central area that, after an intensive seismic activity, would have produced a division in blocks of three main fault lines and the Torrente Candelaro Fault Line (border between the Gargano and the Tavoliere Plain with a northwest-southeast orientation).

Regarding the morphology of the promontory, it is necessary to consider that several phenomena like tectonics or structural characteristics played a fundamental role in shaping the current surface. As far as the overall morphological complex is concerned, we could state that there is a division into four main areas (fig. 6):

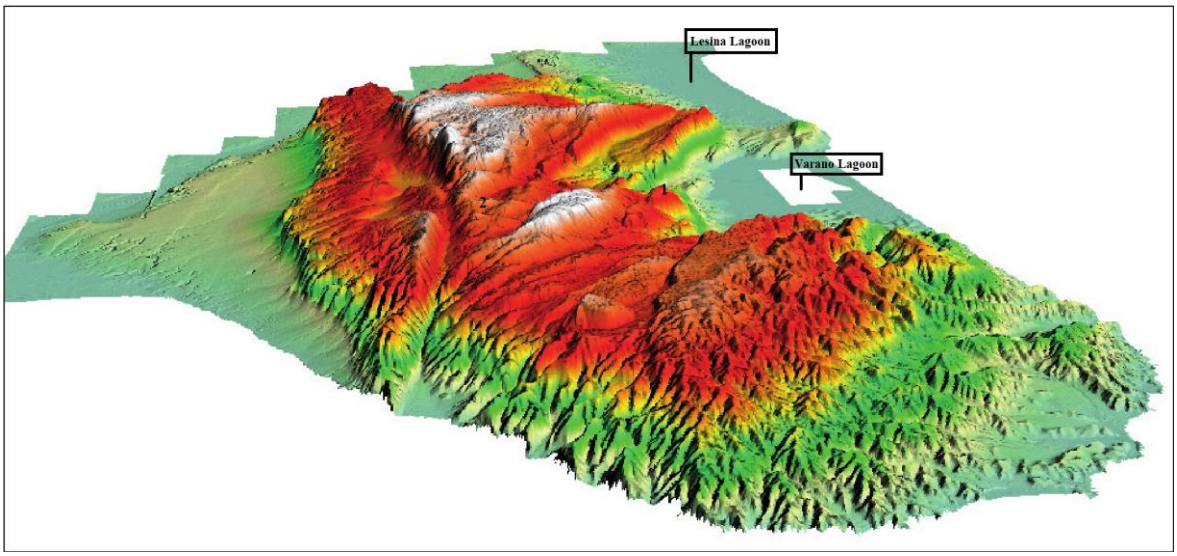


Fig. 6 – 3D Gargano elevation model from digital terrain model. 1) Monte Calvo; 2) Montenero (image edited by the author from Morsilli 2016)

- the north-eastern area, characterized by hills between 0 and 700 metres and a vast superficial river network. The morphology appears to be mostly formed by narrow valleys and hills fully covered by vegetation. This rough landscape changes in the proximity of the Varano Lake (between the cities of Vico and Ischitella) where there are small plateaus without superficial hydrography and a distinctive karst morphology;

- the western-central area, embracing the main peaks – i. e. Monte Calvo and Montenero – and mostly formed by a karst plateau without a superficial hydrography (fig. 6). The surface is quite rough, above all towards the east and the north, presenting tectonic ridges and slightly sloped valleys.

- the southern area south of the Mattinata Fault Line which is defined by marine terraces split by hypothetical tectonic cliffs as origin. The area is formed by a vast triangular tectonic terrace reaching 200 metres elevation and delimited by the Candelaro Torrent (southwest) and the Gargano's relieves (north) (Billi *et al.* 2007). The hydrography is scarce and the

landscape displays rocky areas and blind valleys; instead a high concentration of alluvial deposits is recorded.

- the coastal and lagoon area, placed in the north, is characterized by sandy regions whose formation has generated the Lesina and Varano Lagoons respectively (fig. 6) (Morsilli/Scirocco 2000; De Santis/Caldara 2015; Morsilli *et al.* 2017).

A final observation regarding hydrology is that, in spite of the superficial river network, the karst phenomena and the permeability aspects of the rocks permitted the development of an aquifer covering the whole Gargano area (fig. 7). The aquifer is completely separated under the Tavoliere Plain because of the Candelaro Torrent Fault Line (Cotecchia/Magri 1966).

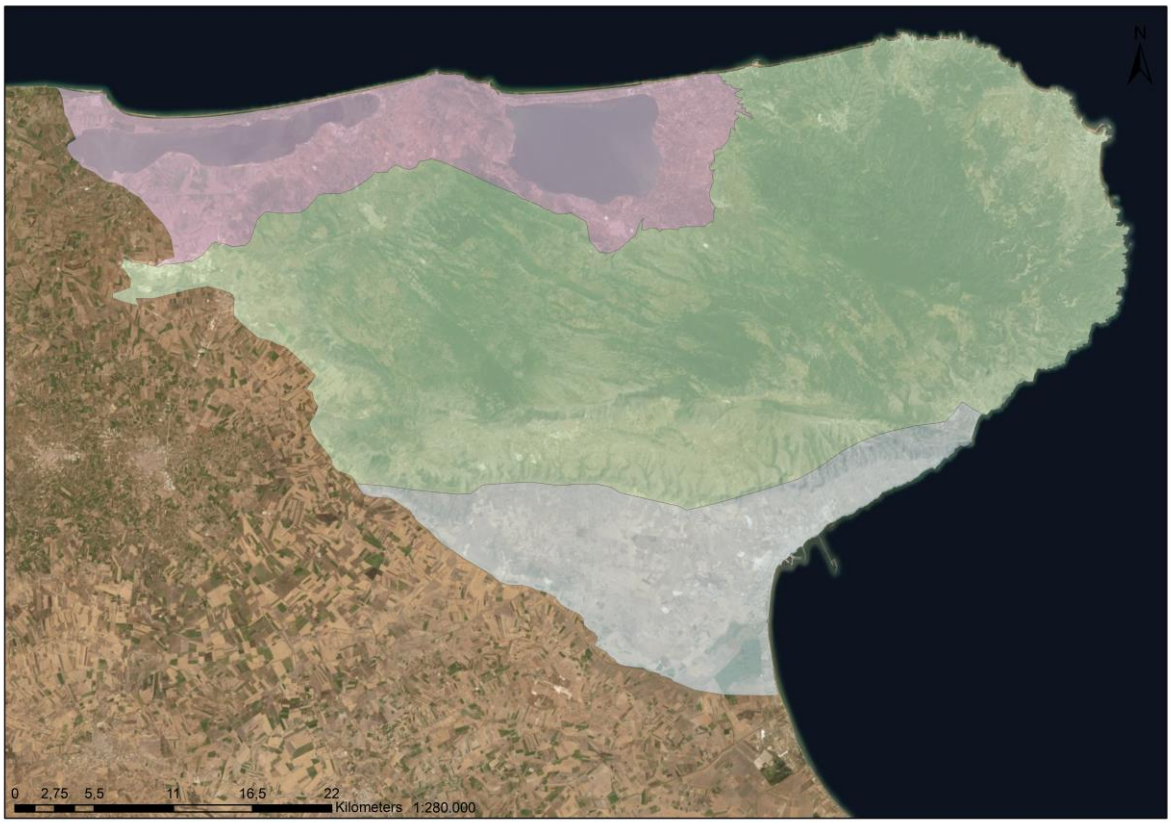


Fig. 7 – Gargano underground water complex divided per area: north (purple), central-east (green) and south (blue) (image edited by the author)

To sum up, the Gargano Promontory represents an impressive landmark because of its singularities linked to geology, palaeontology, and geomorphology (Morsilli 2016).

2.1.2. The Fortore valley and the Adriatic Coast

The Fortore river is second regarding length and flow rate in Apulia after the Ofanto river. It originates at Monte Altieri (Campania) and flows into the Adriatic Sea (close to Lake Lesina). It runs between the provinces of Foggia (Apulia), Campobasso (Molise) and Benevento (Campania) (fig. 8).



Fig. 8 – The Fortore flow between the provinces of Foggia, Campobasso and Benevento. In red the Altieri Mountain (image edited by the author)

Like most of the Mediterranean rivers, it has an abundant wintry flow rate with occasional flooding, whereas during the summer the flow rate is low which is due also to hydraulic engineering accomplished during the 20th century (Caldara *et al.* 1998).
Geologically, the hydrographic basin is set on clays, sands, conglomerates and *flysch* with uneven sides. Like the Gargano area, the valley has been subject to telluric phenomena due to the tectonic alignment traced down from the epicentre distribution. This line runs along the right side of the Fortore valley and is oriented south-southwest-north-northeast. It is properly along this side that the major tsunamogenetic earthquakes would have occurred during the prehistoric period, generating changes above all on the coastal plain and, more in general, on the Adriatic coastal line (Gravina *et al.* 2005).

The Adriatic coastal landscape is composed by three morphological units: the Fortore coastal plain, Punta delle Pietre Nere and the Lake Lesina coastal barrier (fig. 9).



Fig. 9 – Adriatic coast. Morphological units: a) Fortore mouth; b) Punta delle Pietre Nere; c) Lake Lesina (image elaborated by the author).

The first unit corresponds to the river's mouth plain and runs from Marina di Chieuti (east side of the Apennine) to Punta delle Pietre Nere (roughly 30 km). It is mainly formed by terrigenous sands taken away from the coast by the Fortore and Biferno (a river of the region Molise and transported along shores from west to east. The sandy deposits are structured in complexes forming swamps, dune belts and beach ridges. The coastal plain has an elevation between 6 metres (foot of low a cliff) and the present sea level (Mastronuzzi *et al.* 1989).

Punta delle Pietre Nere, located between the Fortore River coastal plain and the Gargano promontory, is a small outcrop made by igneous rocks, irregular gypsum deposits and black limestone referred to the Upper Triassic age. According to recent investigations by Mastronuzzi and Sansò, it is possible to record a strong

uplift rate of the outcrop since the Middle Holocene, considering the bioherm to estimate the rise of the sea level. The bioherm, dating to the Holocene, is made by coralline algae and large globular colonies of *Cladocora coespitosa* developing at a depth of 5-15 metres (ca. 6200 years BP) and at a eustatic sea level of about -3.5 metres (fig. 10).



Fig. 10 – Outcrops at Punta delle Pietre Nere. In the foreground the Middle Holocene bioherm with the *Cladocora coespitosa* (image by Mastronuzzi/Sansò 2012)

At this condition, an uplift rate between 1.5 and 3.0 mm/year can be estimated. Similarly, an uplift rate based on the current altitude (ca. 2 metres above the present sea level) of the raised beach sediments of the Fortore coastal plain has been calculated. Moreover, the authors stated also that the erosive marks and the biogenic incrustations affecting the bioherm surface could demonstrate that the uplift was due to a seismic phenomenon. Indeed, the pre-seismic activity produced a slow subsidence of the coast which rapidly increased in one century before a large earthquake, followed by a coseismic uplift of more than 0.5 metres in elevation (Mastronuzzi/Sansò 2012; Mastronuzzi/Sansò 2002).

Lake Lesina is separated from the sea by a sandy coastal barrier 22 km long, 350-1400 metres wide and up to 8 metres high. Concerning the development of the lagoon system, a first morphological investigation attempt has been led by De Pippo *et al.* (2001) stating that the system formed about 3000 BC according to a progressive development of conglomerate littoral spits initially orientated northwest-southeast and afterwards west-east.

Further analysis, combined with radiocarbon age determination, underlined the presence of two washover fans on the Lesina coastal barrier, Sant'Andrea and Foce Cauto respectively. The investigations allowed to determine the closing of the two washover apexes by the first dune belt at 2430 years BP (Sant'Andrea fan) and about 1550±50 years BP (Foce Cauto fan) (Gianfreda *et al.* 2001) (fig.11a, b).



Fig. 11 – A) Lesina coastal barrier. In red Sant'Andrea fan; in yellow Foce Cauto fan. B) Foce Cauto aerial photo (A: image elaborated by the author; B: Mastronuzzi/Sansò 2012).

Moreover, the same authors stated that the washover development was caused by a tsunami event verified between 395 calBC and 247 calBC, according to the geomorphological and sedimentological evidence (Gianfreda *et al* 2001).

All geomorphological data described indicates a close development and relationship running along the Adriatic coastline. Detailed analysis detected six morphological phases (A-F) revealing the shoreline progradation throughout time by specific chronological samples (fig. 12).

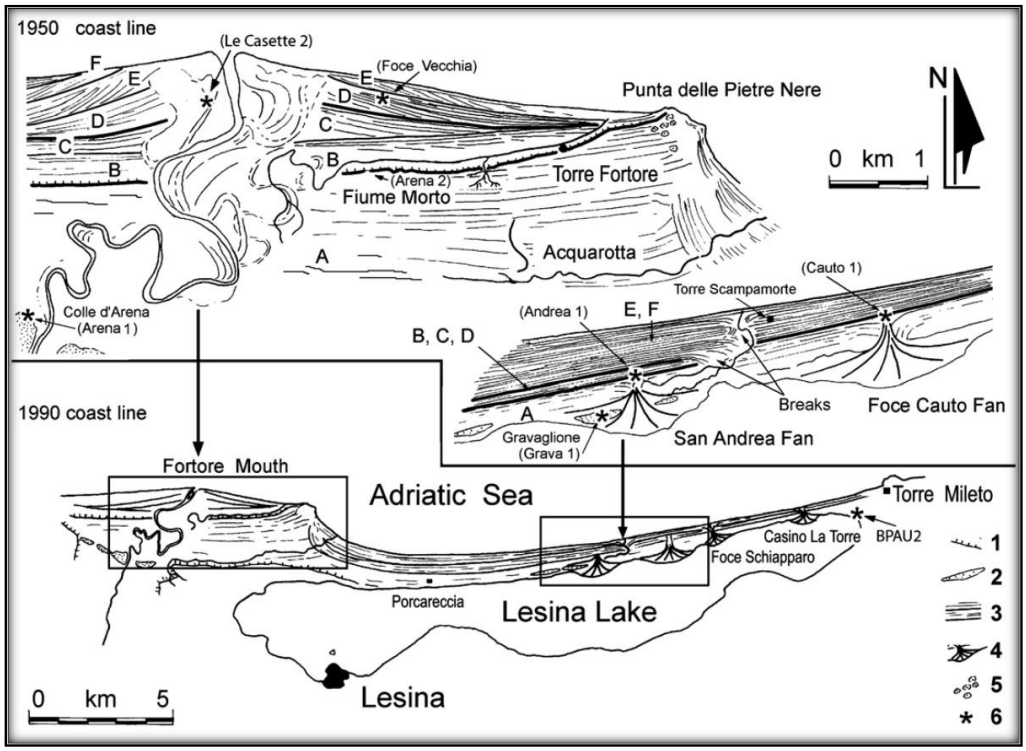


Fig. 12 – Scheme of Fortore river coastal plain and Lake Lesina coastal barrier. Capital letters identify the geomorphological units (A-F). Legend: 1) cliff shaped into pre-Holocene conglomerates; 2) Colle d'Arena-Gravaglione dune belt; 3) late Holocene dune belts; 4) tsunami washover fans; 5) sinkholes; 6) sample point for dating analysis (Mastronuzzi/Sansò 2012)

Unit A is the innermost of the Fortore plain comprising an elevation between 6 and 3 metres, a depth of about 1.5 km and embracing a territory from Marina di Chieuti to Torre Mileto (fig. 16), corresponding to the cliff base shaped into pre-Holocene conglomerates (fig. 13). The unit consists of Eolian sands and small pebbles while the surface is marked by dune ridges of which the highest (about + 22 metres) corresponds to the Colle d'Arena ridge and is characterized by fine sands, loose terrigenous and faunal complexes of pulmonate gastropods (*Helix*

sp.). ^{14}C analysis on the *Helix* permitted to date the ridge to 4340±80 BP (3138-2861 calBC, 2σ calibrated age) (figs. 12-13, "Arena 1" dating sample).
The dune extends to the east forming the innermost part of the coastal barrier closing the Lesina Lake and reaching its maximum elevation in Gravaglione (8 metres p.s.l.) (fig. 15). Also in this locality, samples for ^{14}C dates have been taken which confirm a chronology of 4450±40 BP (3143-3008 calBC, 2σ calibrated age) (figs. 12 and 14, "Grava 1" dating sample). Therefore, Colle d'Arena-Gravaglione likely had to constitute the first stage of the Lake Lesina coastal barrier development.
Another sample has been taken along the seaward edge between the Eolian sands and the beach deposits. The analysis has been led on marine bivalves *Lima* sp. yielding a ^{14}C conventional age of 3030±190 BP (1216-208 calBC, 2σ calibrated age) and underlining an uplift rate of roughly 1.5 mm/yr (figs. 12-13, "Arena 2" dating sample).

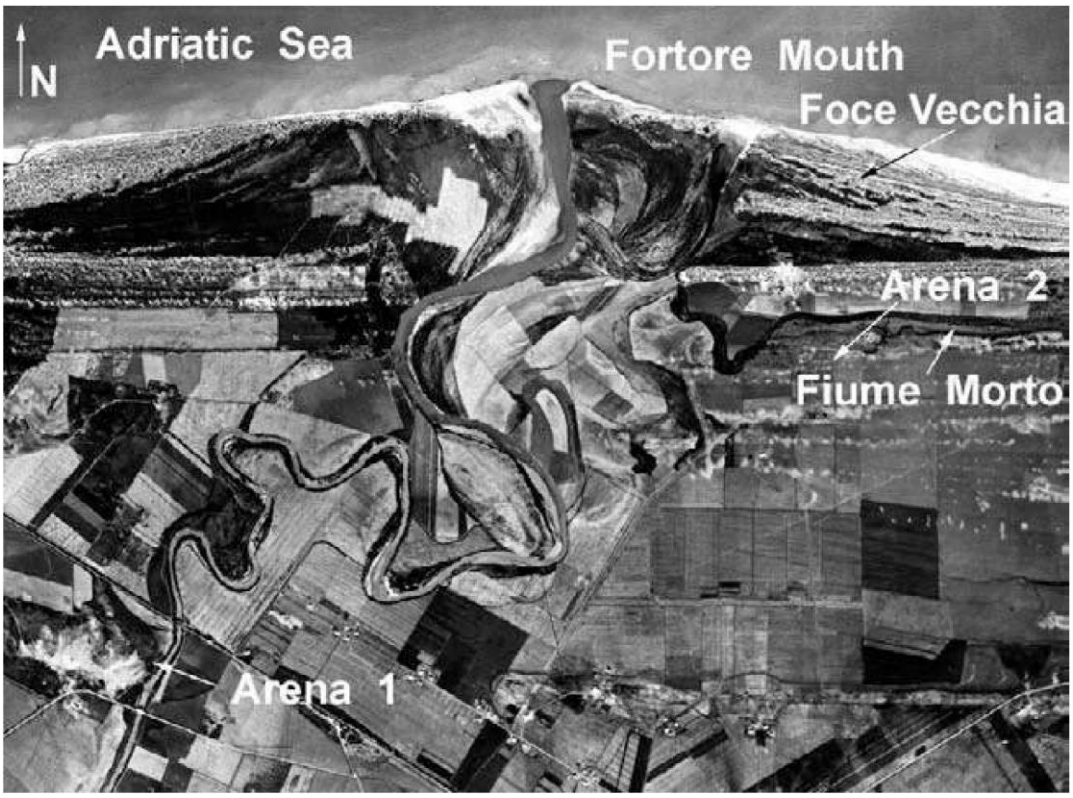


Fig. 13 – 1956 aerial photography of the Fortore river delta area with sample locations (Gravina *et al.* 2005)

Unit B is roughly 500 metres wide and divided from the older Unit A by a small morphological cliff running parallel to the current shoreline. It lays at 2 metres above the present sea leavel and it is characterized by the presence of a small river flowing east to the Fortore River on the inner part; the outer side presents a series of dune ridges with an east-west orientation.

The investigations showed that this Uuit closes the Sant'Andrea washover, inviting to speculate that its development started shortly after the tsunami (Gianfreda *et al.* 2001). Again, ^{14}C analysis was conducted on pulmonata gastropod specimens collected inside the first dune ridge, yielding a conventional age of 2430±40 BP (597-402 calBC, 2σ calibrated age) (figs. 12, 14, 15, "Andrea 1" dating sample).

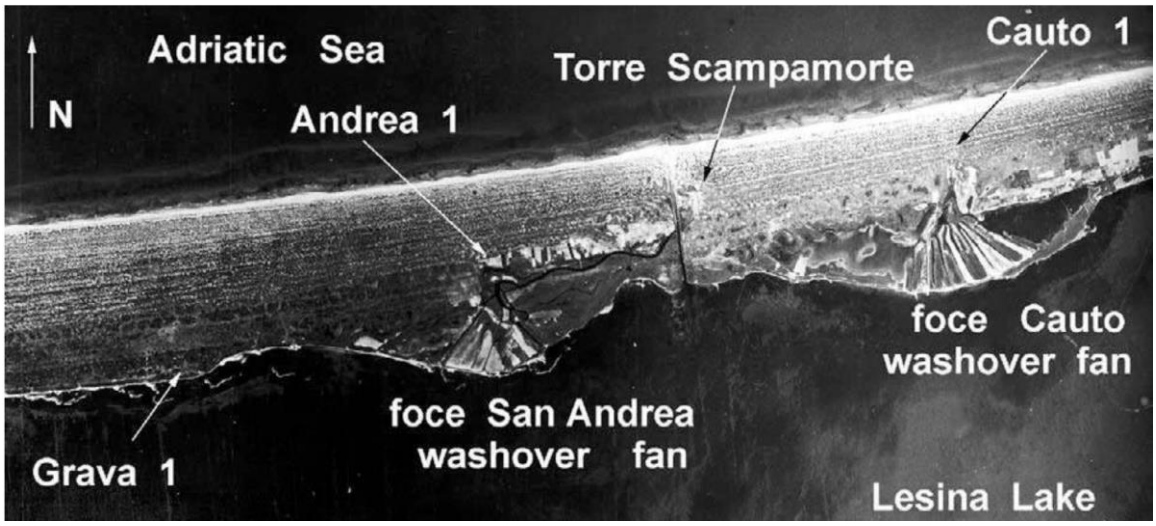


Fig. 14 – 1956 aerial photography of the Lesina coastal barrier with sample locations (Gravina *et al.* 2005)

Unit C lies on the current Fortore river delta area with a width of ca. 300 metres (fig. 13). It is divided by a dune ridge from the previous unit. Geomorphological investigation revealed that the dune ridges of this unit are more curvilinear in shape indicating, hence, the development of a small cuspate delta.

Unit D is located on the river delta reaching a maximum depth of about 400 metres. The observed dune ridge placements suggested the presence of a cuspate delta. A sample of *Helix* sp. taken in the area of Foce Vecchia indicated a ^{14}C conventional date of 1590±190 BP (22-783 AD, 2σ calibrated age) (figs.12, 13, "Foce Vecchia" dating sample).
Morphologically, the first ridge of the unit reaches and closes the apex of the

Foce Cauto washover fan towards the Lake Lesina coastal barrier which was generated by a large tsunami. A second sample on *Pomatia* sp. taken on the above-mentioned ridge displayed a ^{14}C conventional age of ca. 1550±50 BP (410-609 AD, 2σ calibrated age) (figs. 12, 14, 15, "Cauto 1" dating sample).

Unit E constitutes a large delta currently recognisable in the aerial photography taken in the 1950ies (fig. 13). At present it is almost completely eroded except on the western flank of the Fortore delta where it is preserved, and it merges into unit D towards the Lesina coastal barrier (Tessari U. *et al.* 2003) (figg.14, 15).



Fig. 15 – 1956 aerial photography of the washover fans in the area of Torre Scampamorte with sample locations and the merging area of the units D and E (Gravina *et al.* 2005)

The last unit, F, is described by a narrow beach detectable only from the aerial photographs of the Fortore river taken in the 1950ies (fig. 13). Today it is completely eroded, while along the Lesina coastal barrier it closes unit C at the washovers Casino La Torre fan and Foce Schiapparo fan and the dune ridge at Torre Scampamorte (figs. 12, 15). The two washovers originated from the tsunami related to the earthquake on July 30th, 1627 (Gravina *et al.* 2005; Mastronuzzi/Sansò 2012) (fig. 16).

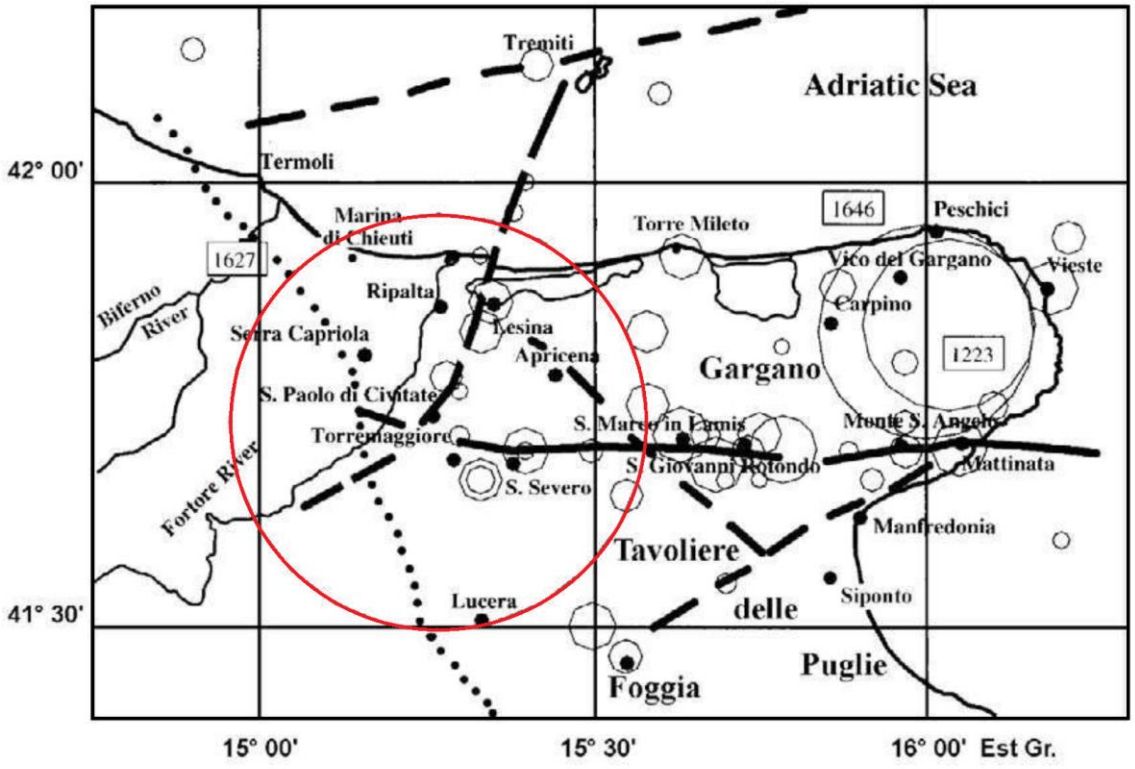


Fig. 16 – Spatial distribution of the seismic events from 1000 AD to 1980. Circles display the focal volumes of damaging earthquakes, in red the one related to 1627; bold line indicates main fault lines; dashed line indicates the supposed main fault lines; dotted line indicates the limit Apennine units (to the west) and Bradanic Foredeep units (to the east)
(image edited by the author from Gravina 2005)

From the analysis results that both the morphologies of the Lesina coastal barrier and the Fortore river coastal plain were influenced by strong seismic events causing a gradual sweeping change of the landscape. This transformation influenced the area not only physically, but also in the way of how it was settled due to the changing space and the climatic conditions (see following paragraphs).

2.1.3. The Tavoliere Plain

The Tavoliere represents the widest plain in Italy, after the Padania Plain, with an extension of about 4300 km^2 (fig. 17). The area finds its borders in the Fortore river valley to the north and in the Ofanto river valley to the south (fig. 18).



Fig. 17 – Tavoliere Plain with the Gargano promontory in background (www.puglia.com)

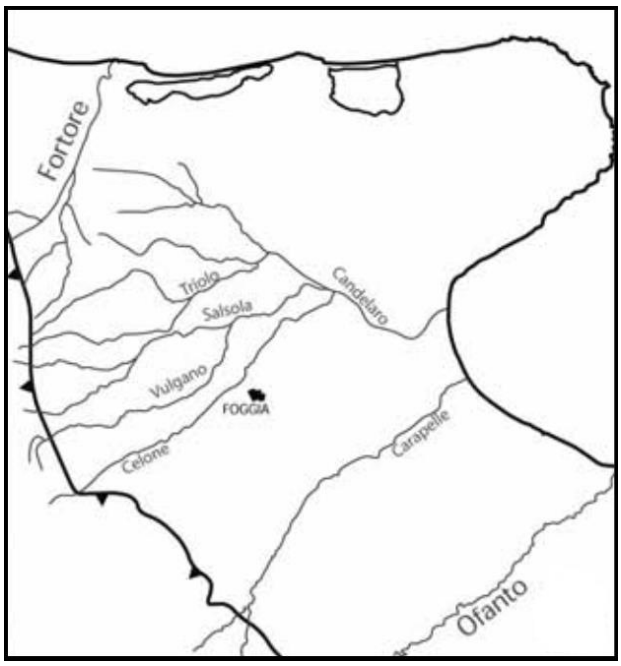


Fig. 18 – Tavoliere's borders (image edited by the author on the base of Moretti *et al.* 2010)

After the agrarian reclamation during the first years of 1900, the whole territory was involved in an intensive agricultural restructuration, also due to the presence of sweet water resources. Indeed, this territory is the only one to have a large superficial river network. Moreover, the field irrigation is enhanced also by the presence of underground water that, due to the geological features, is stored in Quaternary deposits.
Geologically, the Tavoliere Plain belongs to the Bradanic Trough domain, being its northern portion and bordering to the Daunian Mountains (or Subappennino Dauno) to the west and the Gargano promontory to the east (fig. 19). Once the Bradanic Trough basin was filled, diverse terracing phases related to the glacio-eustathic oscillations and discontinuous uplift events began (De Santis V. *et al.* 2010; Caldara/Pennetta 1991, 1993; Boenzi *et al.* 1991).

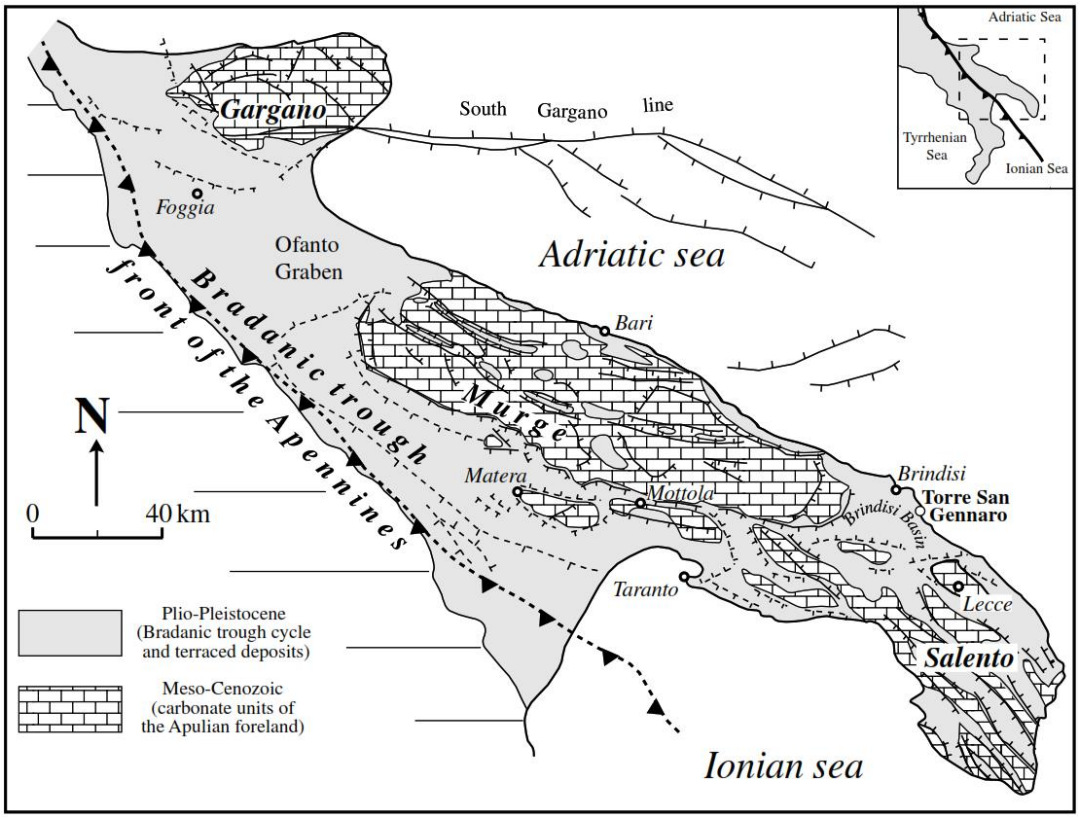


Fig. 19 – Schematic sketch of Bradanic Trough (Moretti 2000)

The events mentioned above arose when, during the Pliocene, the marine transgression drowned the lowest areas of the continent, leaving only the higher areas above the water. This phenomenon permitted the deposition of fine sands and clay filling up hollows and leaving coarser sediments around the shores. The deposits were implemented by layers of marine depositions during the Pleistocene.

In the northern area of the Tavoliere, the deposits from the Plio- and Pleistocene filled the major structural trough. Structurally, the Plain is part of the Apennine system; it is placed between the foothills and the depression currently occupied by the Adriatic Sea. On the contrary, the Gargano and the Murge uplands belong to the secondary core of the Apennine range since they were isolated by the Bradanic Trough (Jones 1987).

Morphologically the Plain displays a series of low flat hills with a surface oriented northeast, especially in the area of the province Foggia, which are called “terraces” indicated by some scholars (fig. 20). These represent the edges of paleo-surfaces with a variable height due to erosion and depositional phenomena mainly covered by alluvial sediments laying directly on Subapenninic clays. However, investigations demonstrated the discontinuity of this layer, since in the geological sheet of San Severo and Ascoli Satriano it lies on a marine unit likely afferent to the Middle Pleistocene.

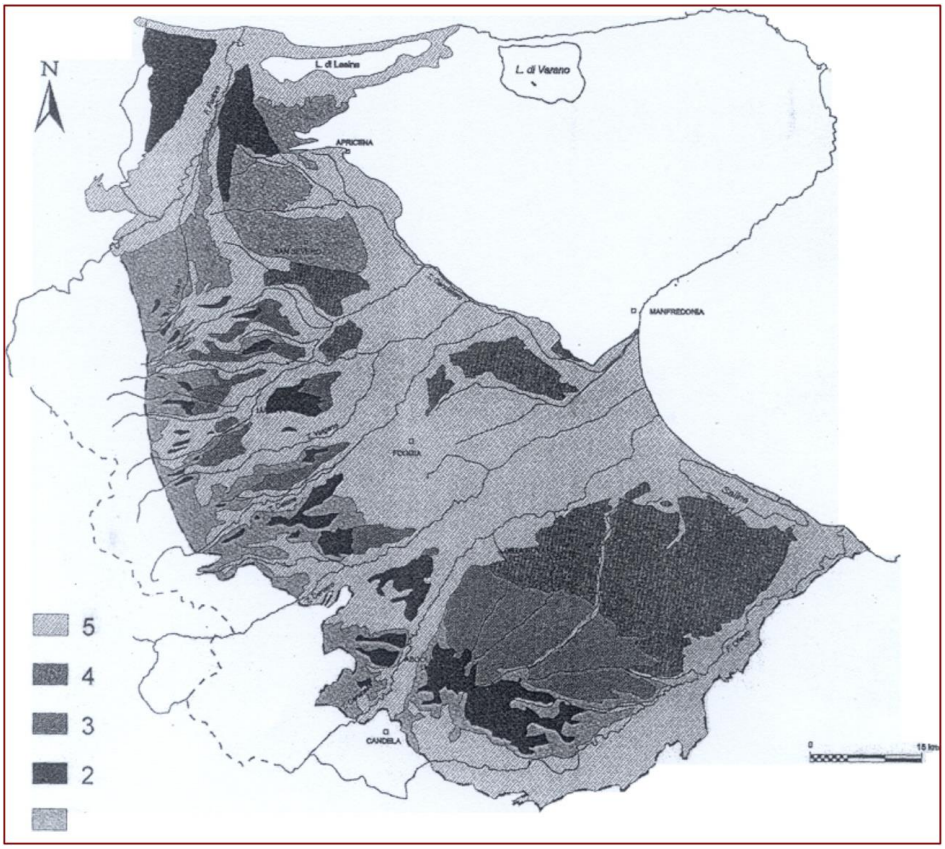


Fig. 20 – Sequence of Tavoliere terraces according to the Italian Geological Chart (scale 1:100.000). 1) “argille Subappenniniche” and “sabbie di Monte Marano”; 2) “conglometato d’Irsina”; 3) 1st order marine deposits; 4) 2nd order marine deposits; 5) fluvial terraced and alluvial recent deposits (Pennetta, http://territorio.provincia.foggia.it/PTCP)

The paleo-surfaces have been protected by the sediments which covered them, displaying an alluvial *facies* as far as the quotas measured on the up- and downstream areas of the same deposits are concerned.
All the recognized units have been subdivided into systems and grouped into the Apulian Tavoliere supersynthem linked to regional uplifting that involved the Bradanic Trough from the end of the Low Pleistocene and the beginning of the Middle Pleistocene (fig. 21).

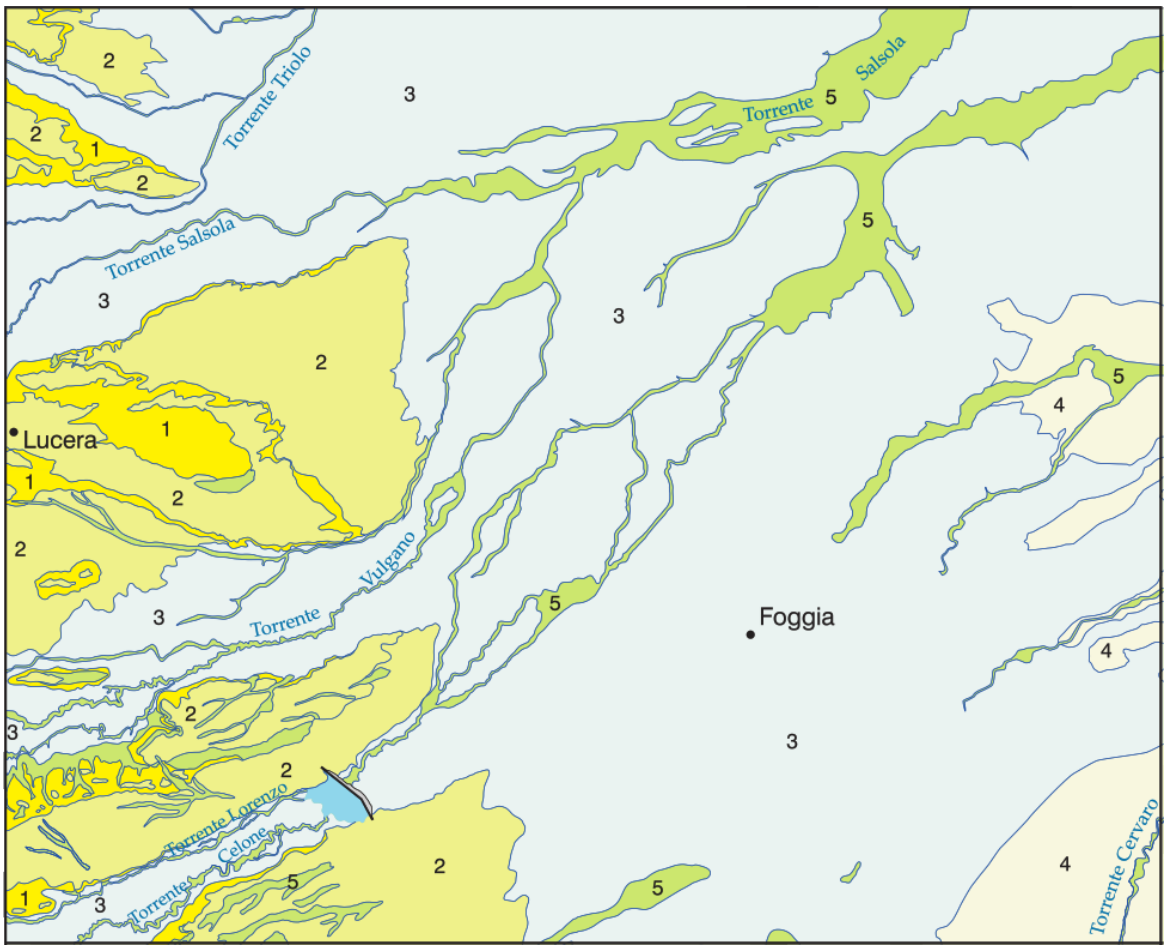


Fig. 21 – Apulian Tavoliere supersynthem excerpt (Foggia area). 1-4 supersynthem: 1) subapenninc clays – Lower Pleistocene; 2) Lower (?) and Middle Pleistocene synthems; 3) Middle (?) – Upper Pleistocene synthems; 5) alluvial and colluvial deposits, eluvial products and slope debris – Holocene (Ciaranfi *et al.* 2011)

The uplift phenomenon implicated a progressive, whilst rapid, shifting of the lower layer towards the east and consequentially the detachment among the foredeep and the area in which the deposits were represented as coastal or alluvial *facies*. This latter area takes the name of the Apulian Tavoliere (Ciaranfi *et al.* 2011).

Concerning the hydrography, the Plain is cut through a river network that springs from the Apennine piedmont area and has quite a moderate flow rate according to the Italian average. However, according to some past investigations it has been hypothesized that the current river regime is not so different from that which was present during the Middle Holocene (ca. 5500 calBC). Moreover, the flow trend is not regular and characterized by meanders which were shaped by the uplifting and depositional phenomena which occurred during the past eras.
Like the Gargano also the Tavoliere presents an underground water circulation influenced by the geological structure that is characterized by three kinds of

aquifers with different depths (fig. 22). The water has been traced down in the deepest level afferent to the calcareous-dolomitic rocks dated to the Mesozoic and in the upper level belonging to the Plio- and Pleistocene and ultimately to the Quaternary. Especially the upper aquifer level, linked to the Quaternary alluvial deposits, played an important role in the past concerning the water capture in the area of Capitanata (i.e. the province of Foggia).

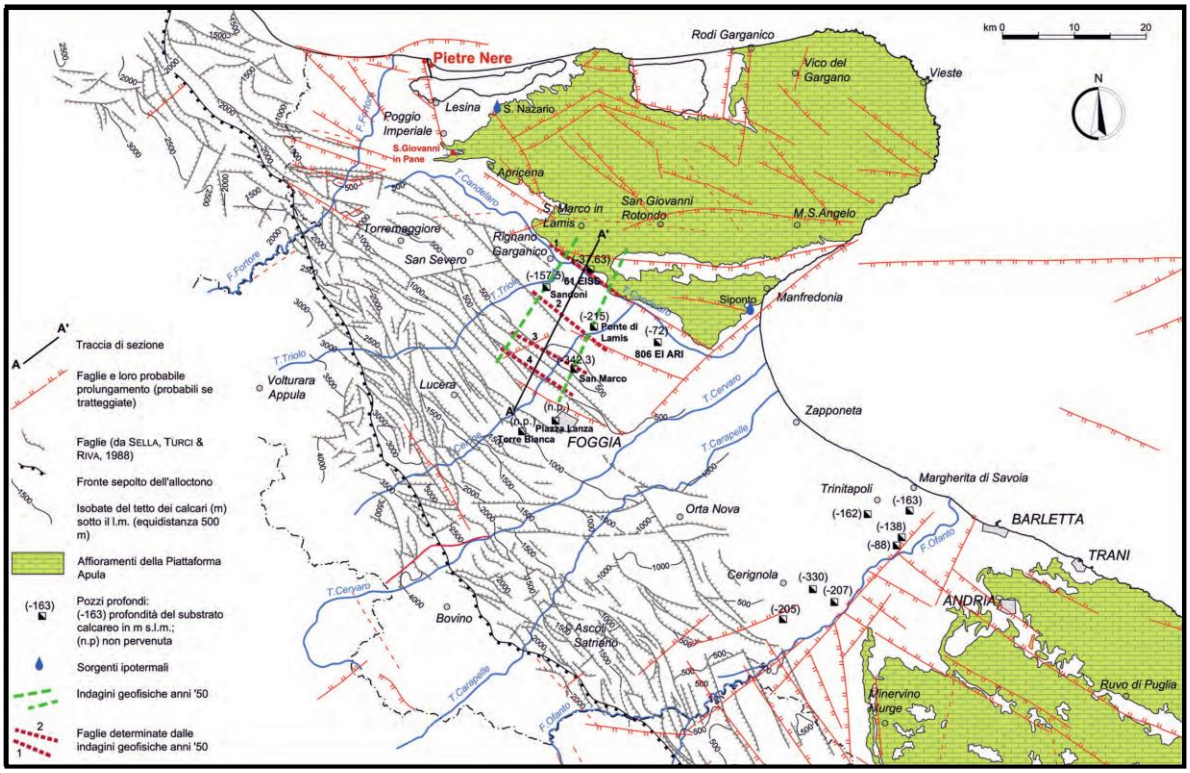


Fig. 22 – Tavoliere Plain system of fault lines (in grey) (Cotecchia 2014)

According to the geological structure, the upper aquifer level is fed by four kind of areas (fig. 23):

- zone A: feeds the underground waters going to the north towards Lake Lesina where there are ca. 270 km^2 of absorbent soils;

- zone B: feeds the underground waters going to the Candelaro Fault Line, where there are ca. 800 km^2 of absorbent permeable soils;

- zone C: feeds the underground waters going to the Manfredonia Gulf, where there are ca. 650 km^2 of absorbent permeable soils;

- zone D: does not give a notable water improvement to the superficial aquifer of the low Tavoliere because the water circulation is under pressure.

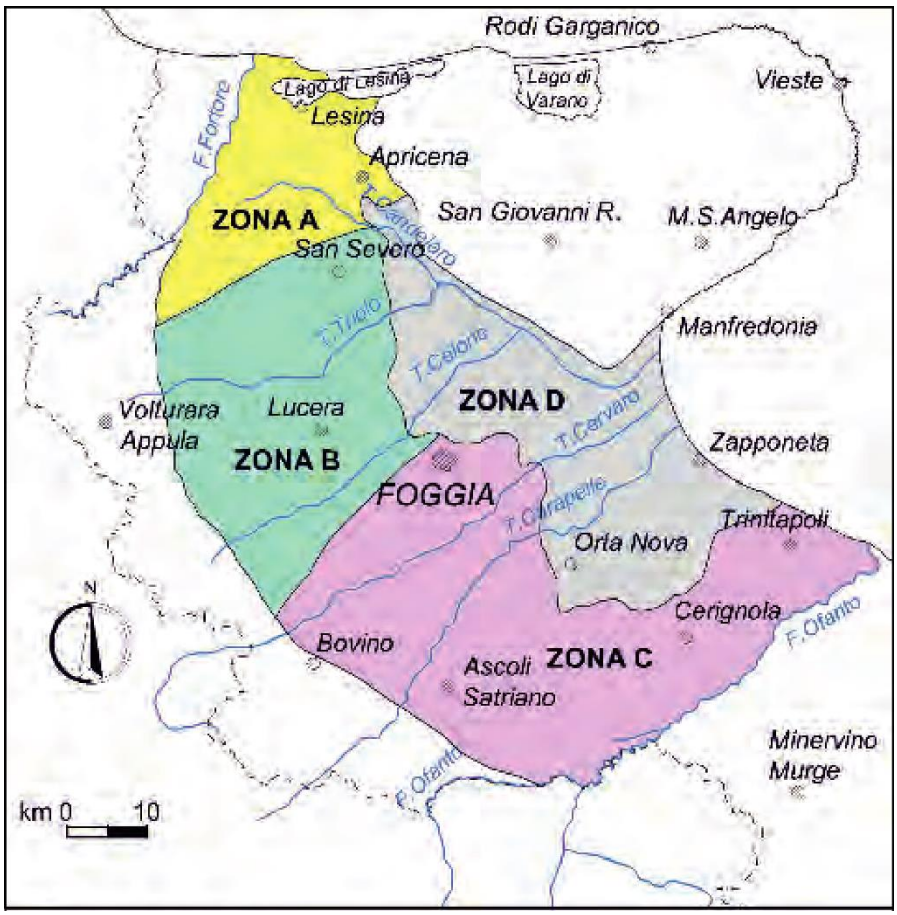


Fig. 23 – Partition of the areas that contribute to feed the superficial Tavoliere aquifer (Cotecchia 2014)

The whole volume of the aquifer amounts to roughly 32.000 mm^3 subdivided between a mainly sandy-arenaceous formation and a formation of conglomerates with sandy concrete (Cotecchia 2014) (fig. 24).

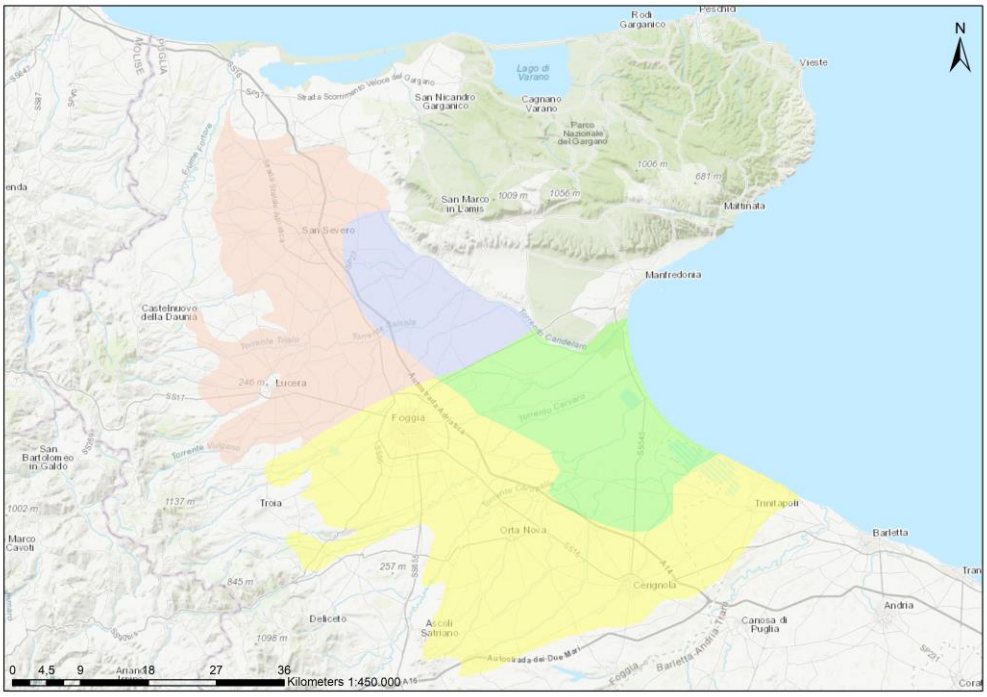


Fig. 24 – Distribution outline of the hydrological underground complex of the Tavoliere. In red) the northwest complex; in blue) the northeast complex; in yellow) the central-east complex; in green) the southeast complex (image edited by the author)

2.2. Archaeological Background

Apulia is an important testimony of human development during a long chronological arch reaching from the Palaeolithic to the modern period. Because of its location, the region covered (and covers) a *trait d'union* role between the diverse cultures coming from the neighbouring areas.
This phenomenon is widely spread all over the region, but it seems to have a special focus in the northern area where, from prehistory onwards, different cultural flows met and funneled an exchange process between groups. An example of this allogeneous influence is possible to trace down in the material production between the end of the Copper Age and the Early Bronze Age, like the Balkanian Četina *facies* found in Apulian contexts (Gravina 2017) (fig. 25).

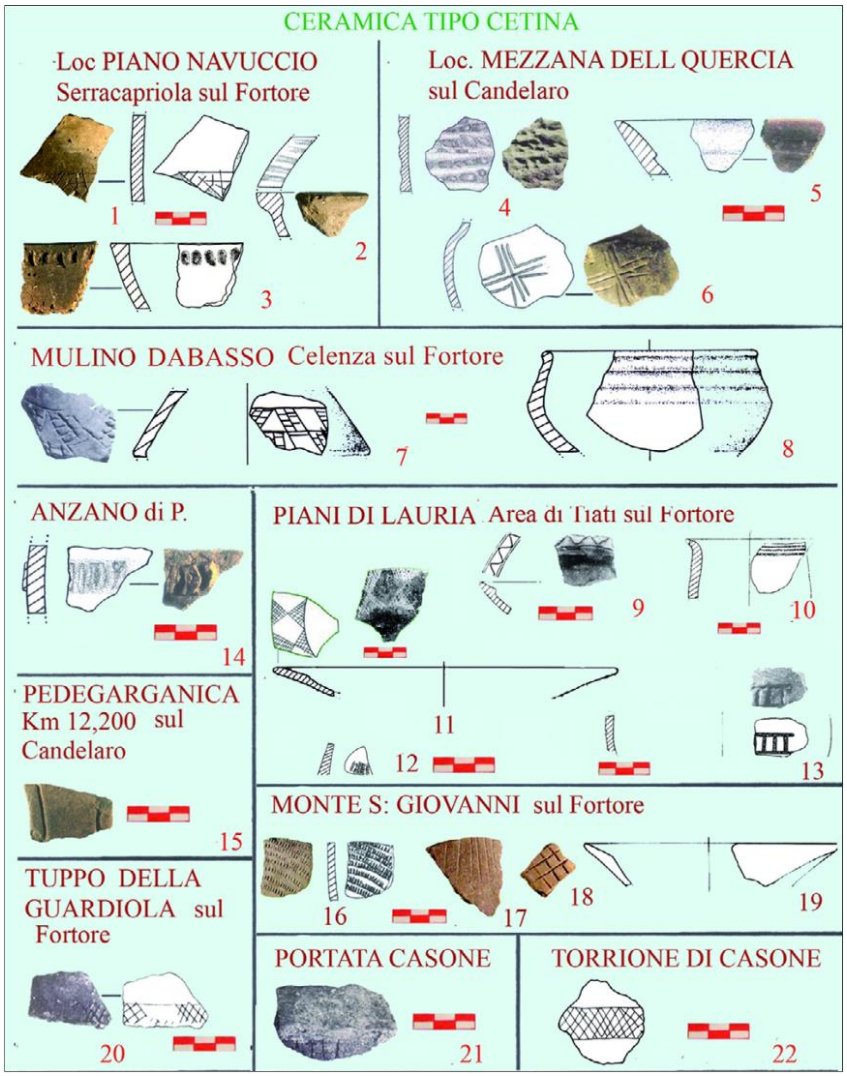


Fig. 25 – Examples for the Četina pottery style from north Apulian sites (Gravina 2017)

Briefly, the Četina *facies* was found in several sites in Dalmatian and Central Dalmatian hinterland, thus considering these areas as the provenience territory. In specific, the cultural aspect is known from its burial contexts and funerary rituals consisting of inhumation and cremation under stone tumuli with single or multiple burials. The tumuli were organized in form of clusters which best documented were those situated along the Četina River (Dalmatia) (Gori *et al.* 2018, pgg.198-200).
The cultural aspect is studied by several authors recognizing it an important role in the Early Bronze Age frame, as Govedarica stated (Govedarica 2006, pg.29):

"*The Cetina culture is certainly the most significant heritage of the early Bronze Age in the eastern Adriatic area.*"

Recent investigations tend to include in the primary Četina area also the Adriatic areas of the islands of Hvar, Korčula and Palagruža, the peninsula of Pelješac and the coast of the Montenegro and North Albania with the relative hinterland.
The presence of Četina-type evidences in the aforementioned areas and in northern Apulia would trace the likely trans-Adriatic route: Central Dalmatia - Korčula - Lastovo - Palagruža - Tremiti - Gargano Promontory.
If to these route it adds the well-known archaeological record found in Olympia and Lerna (i.e. Peloponnesus), it could consider the Balknanian *facies* as a cultural phenomenon spread in the Mediterranean area during the III Millenium (Govedarica 2006, pg.29).

Anyway, in the northern Daunia this extraordinary and complex process permitted local cultures, across time, to develop an own material production with peculiar decoration motives and styles (especially on pottery) as an outcome of the combination between local and foreign aspects.
Therefore, it is easy to comprehend how the interpretation of the chronological sequence has not been so clear and consistent, especially for the first researchers, above all because in most cases the finds came from surveys.
Nevertheless, the collected evidence displays that with the onset of the Neolithic the communities had a strong impact on the territory. The advent of the early farming groups, for which north Apulia was one the first locations they set foot on in Italy, succeded in shaping and modelling the landscape through activities like agriculture, livestock breeding, hunting and fishing.

For the research presented here, I decided to found my analysis on the chronological sequence related to the evidence coming from to the work on field done by A. Gravina. The investigations led by this scholar started around the late 1960ies and are still in progress; they truly modified the knowledge of the

prehistoric reality perceived until that moment. This choice arose from the necessity to order the data systematically and introduce it to innovative analysis in order to gather new insights on the relationships between humans and the landscape (see following chapters).
To clarify the chronological relations of the work frame and to help to understand the sequence of cultural phenomena in Apulian prehistory, an archaeological background according to the material used in this thesis is presented.

2.2.1. Early Neolithic

The Early Neolithic settlements were constituted by villages with a variable extent which were surrounded by ditches. Mostly they can be found on the Tavoliere Plain where the flat terrain and the presence of sweet water permitted optimal living conditions.
First traces of these settlements were acquired by J. Bradford who analyzed the aerial photos taken by the R.A.F. in 1945 during training flights and camera tests. At that time the British officers identified a considerable number of visible features spread all over the Tavoliere Plain and thus revealed one of the most important archaeological discoveries of this area. Indeed, 150-200 settlement sites were identified which were visible due to crop-marks, suggesting parallels with the Neolithic ditch-enclosed sites at Matera in south Apulia and Sicily (fig. 26).

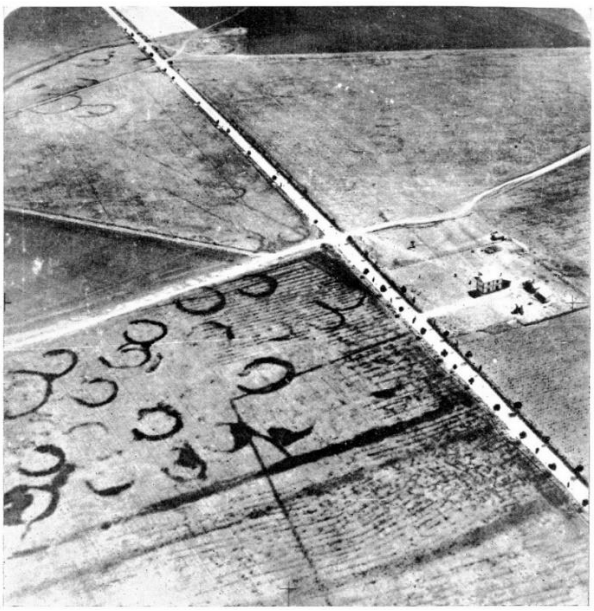


Fig. 26 – Example of R.A.F. aerial photography displaying cropmarks on the Tavoliere Plain (Bradford 1949)

Further investigations supported Bradford's studies and demonstrated how the Tavoliere Plain was a scenario of a complex system of villages operated by the first groups that populated this territory. This phenomenon was supported by the river network which was extensive at the time and allowed the people to move from different areas to the flat and fertile Plain.
The intensive field investigations yielded collections of pottery sherds ascribable to the Neolithic and Copper Ages; sites were situated on gentle hillocks (locally identified with the word *Coppa*) (Bradford/Williams-Hunt 1946).
The relationship between the groups and the landscape was clear to Bradford. In his investigations he continued to analyse the prehistoric presence on the Tavoliere Plain and noticed the traces of ditch enclosures and their various shapes, which he thought to be part of dwelling structures (Bradford 1949) (fig. 27)

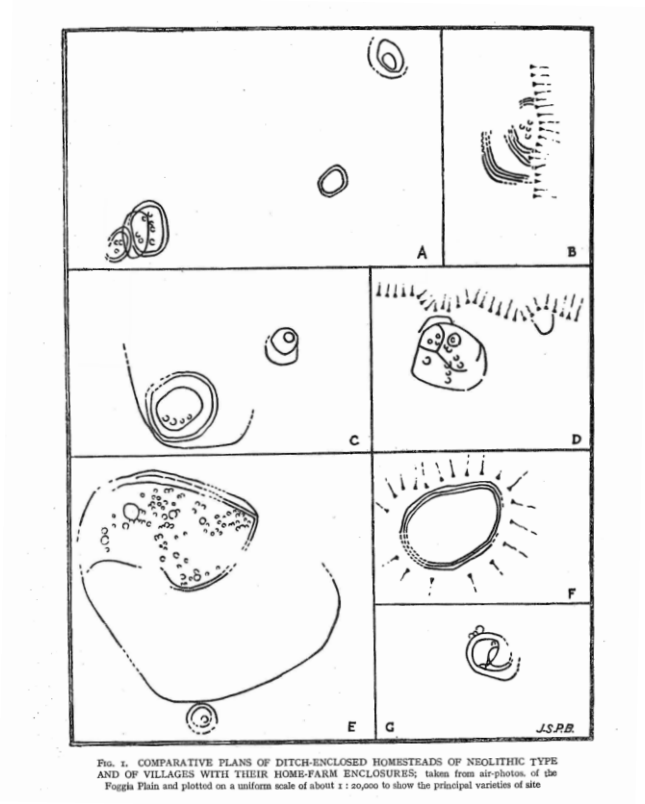


FIG. 1. COMPARATIVE PLANS OF DITCH-ENCLOSED HOMESTEADS OF NEOLITHIC TYPE AND OF VILLAGES WITH THEIR HOME-FARM ENCLOSURES; taken from air-photos. of the Foggia Plain and plotted on a uniform scale of about 1 : 20,000 to show the principal varieties of site

Fig. 27 – Ditch enclosure examples drawn by Bradford J. traced through aerial photography in the Foggia Plain (Bradford 1949)

Bradford's insights were the preparatory steps for the following studies like those led by Alvisi (1970) and Odetti (1975) during the 1970ies. The two academics focused their analysis on aerial photography to enhance the knowledge about the

sites and to verify their presence on the territory. Particularly Odetti traced down around 1028 villages on the whole Tavoliere Plain.
During the same decade, Santo Tinè gained important data from the excavations of the settlements of Guadone (southern suburbs of the current city of San Severo) and Passo di Corvo. The exploration of the ditches allowed to speculate a use of the ditches as a border for land used for agricultural purposes (Tinè 1983). Other, more recent interpretations see this encircled space as a means for distinguishing the untamed wilderness from the settled area (Skeates 2005), but the question regarding the use of the ditches remains and is not definitely solved even today.

Unfortunately, the aerial photography project led by the R.A.F. focused on the Tavoliere area but left a lack in the documentation of the Fortore river valley and the Gargano Promontory. Research in these areas was enhanced by Gravina when he started an intensive survey activity around north Daunia.
Therefore, we could consider his work as a milestone concerning site placements in the territory, also because his archaeological interest embraces a chronological arch from the Palaeolithic to the Medieval period.
Gravina's research displayed a rich material culture but a blurred chronological frame in which the cultural sequences were distinguished based mainly on pottery, which was used to define the transition of a *facies* to another; in some cases it permitted to identify variants of pottery productions in specific areas. In terms of absolute chronology, the Neolithic phases can be set between 6000 and 5200 calBC.

The Early Neolithic displays a material production defined by the Impresso Pottery characterised by a decoration of simple impressions made with fingernails or *cardium* shells and with shapes like bowls or jars (Cocchi Genick 2009). The surfaces were left rough or in some cases polished with straw (fig. 28).
The Impresso culture is widely spread in north Daunia and in other areas of southern Italy, like in Basilicata. Because of its spread and potential comparisons with the eastern Mediterranean Sea, some scholars speculated that it came from a region embracing the coastline between Cilicia and Palestine (Tinè 1983).



Fig. 28 – Impresso pottery sherds from the site Coppa Pallante, San Severo district (Gravina 1983)

Chronologically close to the early Impresso pottery, a new decoration style evolved generically named *Stile delle Ceramiche Impresse Evolute* (i. e. "Advanced" Impresso Pottery Style). The term "advanced" was used to distinguish the new kind of impressions represented by a more complex decoration often situated on the upper half of the vessels' body.
This cultural aspect found its expression in the village of Guadone from which it took the name *Guadone Style* (chronologically between 5800 and 5300 calBC). Guadone is a southern suburb district of the modern city of San Severo. The Neolithic settlement was brought to light during the city's expansion works (Gravina 1985). The excavation yielded some structures related to a Neolithic village, specifically two small hypogeous chambers later identified as silos for storing purposes. The rest of a C-shaped ditch with an inner diameter of 25 meters was found as well, with similar dimensions as the ditches of the Tavoliere settlements (Gravina 1980).
The advanced Impresso pottery is divided into two classes named as A and B, with respect to their manner of making. Class A is characterized by coarse ware and vessels like cups or vases with necks; the decoration consists of impressions or engraved linear motives. Class B, on the other hand, is represented by a fine ware with shapes like bowls, and polished surfaces. The decoration properly associated with the *Stile Guadone* presents a complex syntax well organized on the vessels' body surface which is arranged to create linear or geometrical motives (Tunzi 2015; Gravina 2018) (fig. 29).

Some scholars like Vincenzo Tinè compared this decorative production to those from the Balkans and the Middle East; similar pottery can also be found in the regions of Molise and northern Calabria (Tinè 1983, 2002).

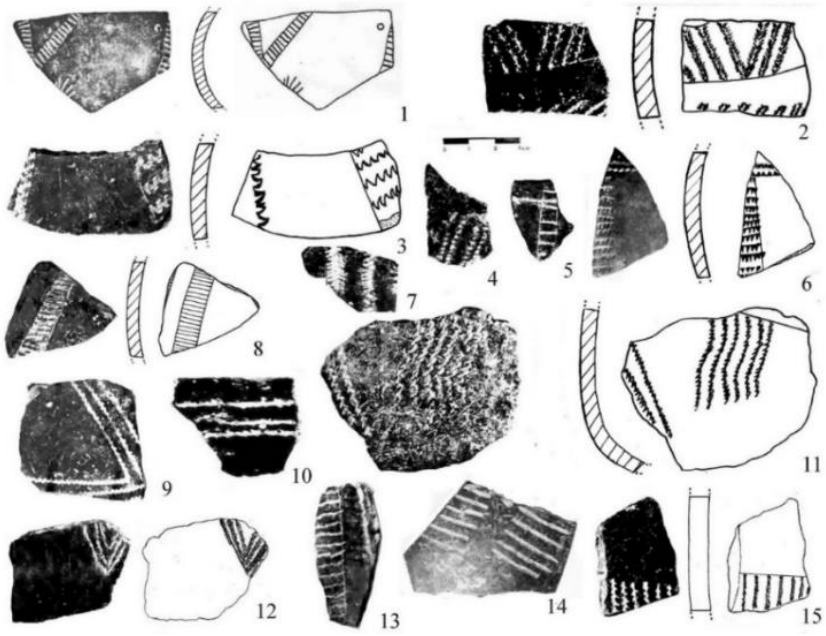


Fig. 29 – Examples of *Guadone Style* pottery from the Neolithic village of San Rocco-Guadone, San Severo district (Gravina 2018)

To the second half of the Early Neolithic belongs the pottery style *Lagnano da Piede*, named after the village in which it was first discovered (in the current county of Ascoli Satriano, FG).
The settlement was investigated in the 1970ies by S. Tinè and afterwards, during an excavation campaign in 2012, also by the Soprintendenza. The inspections brought to light four ditches, several smaller compounds and a conspicuous number of archaeological finds (Mallory 1984-1987; Tunzi 2015).
The pottery is characterized by motives displaying a transition from the impression style (i.e. the *Guadone Style*) to a new aspect that creates a mixture between painting and impression. A special peculiarity is the appearance of anthropomorphic and zoomorphic schematic representations on the vessel walls. The painted pottery displays, as a typical motif, dark narrow lines grouped in parallel bands that, on the Tavoliere Plain, are associated with the engraving technique (fig. 30).

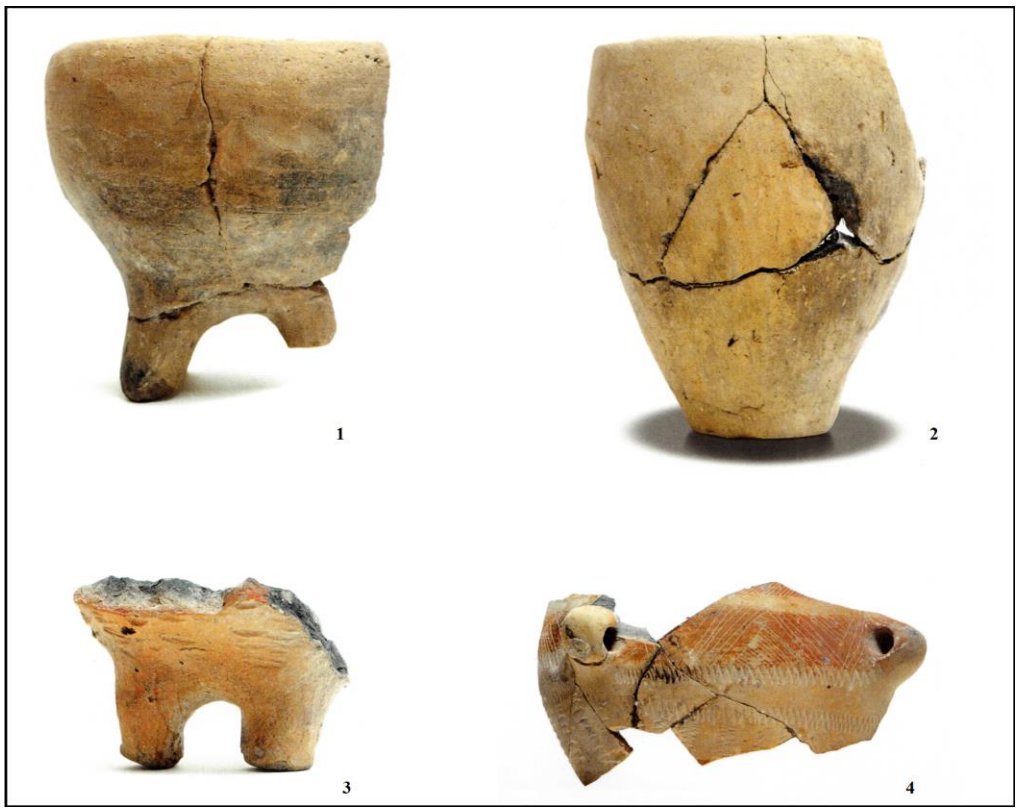


Fig. 30 – *Lagnano da Piede Style* pottery from the village of Lagnano da Piede: 1) polypode vessel; 2) ovoid vessel; 3) polypode bottom of vessel; double-handled vessel with neck (Tunzi 2015)

At the end of the Early Neolithic (^{14}C dates: 5050±100 and 4590±65 a.C. from the site of Scaramella San Vito and 5175±200 from the site of Masseria Giuffreda), a new material production evolves called *Masseria La Quercia Style* (Cocchi Genick 2009).

This Neolithic aspect took its name from the eponymous site situated on the southwestern foothill of the Gargano.

The village of Masseria La Quercia was investigated by Jones who distinguished, from the aerial photography, a settlement with a diameter of 700 metres and eight ditches clustered in 4 groups each and separated by a strip a 100 meters wide. Within the ditches, 4 compounds at least were found, with a diameter of ca. 380 metres (Jones 1987) (fig. 31a)

The pottery production is characterized by red or dark painted geometric motives like group of lines, triangles and diamonds. Moreover, the painted decoration is associated with impressions or engraved lines that overlapped the painted patterns. Remarkable is the presence of schematic anthropomorphic decorations that are interpreted as people praying (Scopece 2008-2009) (fig. 31b).

The pottery is widely spread on the Tavoliere, especially in the central area, for example in the villages of Passo di Corvo, Villa Comunale di Foggia, Scaramella San Vito and Monte Aquilone. Some authors, such as V. Tinè, found

comparisons in the burnished ware from the levels Va and IVc from Ugarit (end of VI – beginning of VI millennium BC) (Tinè 1983).



Fig. 31a – Aerial photo of the village of Masseria La Quercia with crop-marks. Black arrows indicate the ditches (Tunzi 2015)

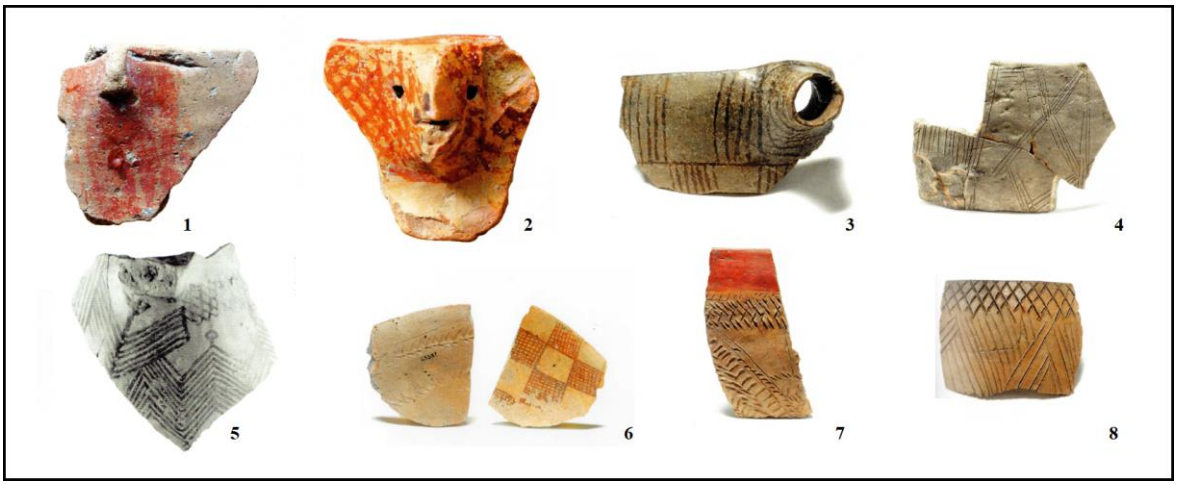


Fig. 31b – *Masseria La Quercia Style* pottery: 1) rim with anthropomorphic decoration from Monte Aquilone; 2) rim with anthropomorphic decoration from Villa Comunale, Foggia; 3) bowl rim and wall from Masseria La Quercia; 4) *olla* wall from Masseria La Quercia; 5) wall from Masseria La Boccuta; 6) bowl rim and wall from Masseria La Quercia; 7) *olla* rim and wall from Masseria La Quercia; 8) bowl rim and wall from Masseria La Quercia (Tunzi 2015)

As far as the placement of the sites is concerned, the Early Neolithic displays a variety of situations depending on the area in reference, that is the southwest foothills of the Gargano promontory, the Tavoliere Plain and the Fortore river valley.

As far as the Gargano promontory region is concerned, there is no regular settlement pattern. Rather, the sites are focused on the southern shore of Lake Lesina, where surveys brought to light evidence of lithic instruments or pottery sherds which could, however, not always be clearly dated to a specific aspect, at sites like Zurrone, Santo Spirito and Frezzo. In some cases, the finds demonstrated that villages had a small size and where thus likely clustered and connected to each other (Gravina 2005, 2021).
Avoiding the actual foothills, settlements were placed along the valleys shaped by the rivers and likely connected to the water courses. Examples are Cicerone, Ciccalento and Masseria Mezzana della Quercia. It is certain that the vicinity to such an important source of sweet water permitted some sites to have more than one occupancy phase; for instance Masseria Mezzana della Quercia shows settling ascribable to the Early and Final Neolithic and to the Copper Age.

The Fortore river valley[1] presents a site placement pattern following the river's morphological changes; likewise, the coastline has changed in the course of time. Recent investigations started to analyze the variations of the coastline in the past and permitted to speculate that some sites like Zurrone were directly connected to the sea and hence likely to activities like fishing (Mastronuzzi/Sansò 2002, 2002a; Gravina 2005a, 2014a).
The data, however, suggests that there was a discrepancy between the right and the left shores of the river valley and the final segment of the river where settlements cluster densely. Moreover, it is also noteworthy that the majority of sites is situated on the left side of the shore, which grants access to the Molise areas (fig. 32).
Remarkable sites in this respect, both due to their logistic position (cf. below) and their longevity were San Matteo di Chiantinelle, Masseria dell'Ischia and Macello Serracapriola-Conventi dei Cappuccini.

[1] In this study the analysis is focused on the middle and low region of the valley.

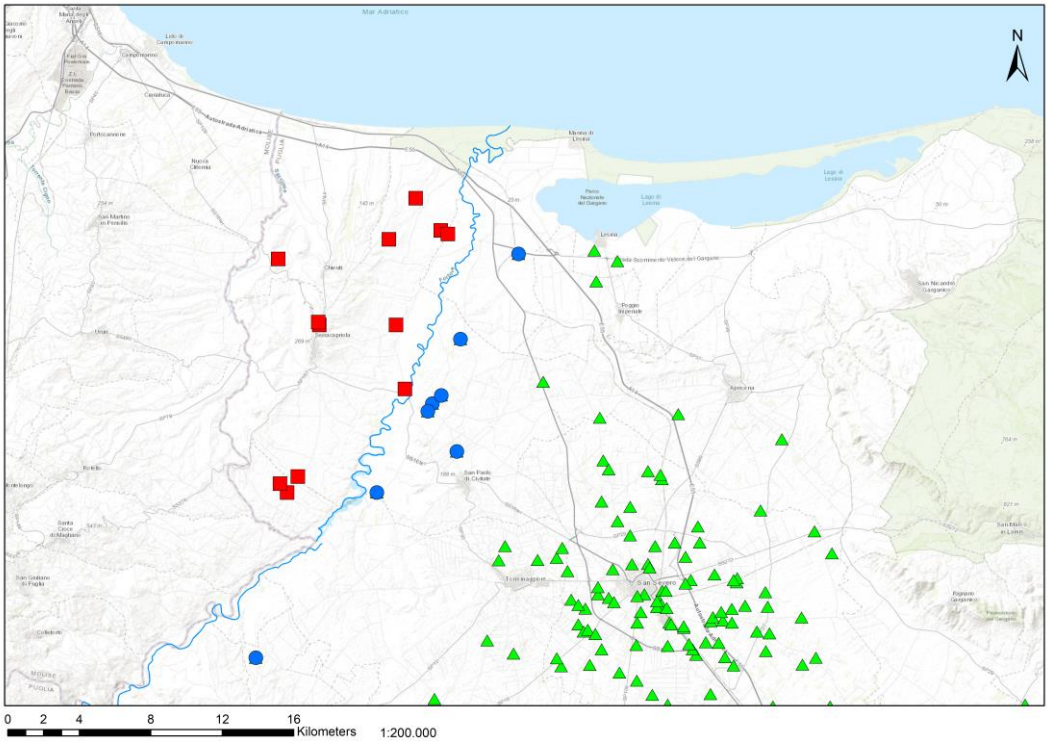


Fig. 32 – Distribution map of Early Neolithic sites. In red) sites placed on the right side of Fortore shore; in blue) sites placed on the left side of Fortore shore; in green) sites placed along the southern shore of Lake Lesina and on the Tavoliere Plain (image edited by the Author)

Among the sites situated on the right side of the river shore, Piani di Lauria stands out. It may have acted as a hub towards the inner region of the Tavoliere. The site was characterized by an intensive exploitation from the Early Neolithic on and continued until the Iron Age (see following chapters); moreover, from aerial photography it is possible to recognize the presence of small villages surrounded by ditches (Gravina 2014a) (fig. 33).

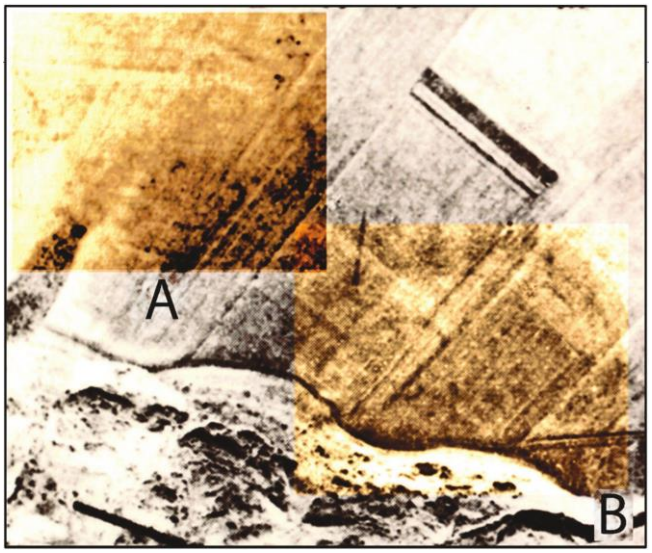


Fig. 33 – Aerial photography of Piani di Lauria. Letters A and B mark the ditch traces (Gravina 2021)

In conclusion, the placement of the settlements as evidenced from the investigations shows that the Tavoliere Plain played a main role in the subsistence of communities, offering settling space and easily workable soil (fig. 32, see green triangles). For this reason, during the Early Neolithic this region hosted the bulk of the settlements even though this pattern was destined to evolve drastically from the Middle Neolithic onwards.

2.2.2. Middle Neolithic

The Middle Neolithic is a transitional moment towards new socio-economic changes that would become imminent during the Final Neolithic. New cultures and different climate conditions transformed settlement choices and ways to exploit the landscape (Fiorentino *et al.* 2013). The prehistoric occupancy of the territory recorded a drastic reduction of around 70-80%. Nevertheless the Tavoliere Plain still continued to be the main settlement area. The Gargano and the Fortore Valley were almost completely abandoned (Gravina 2010).

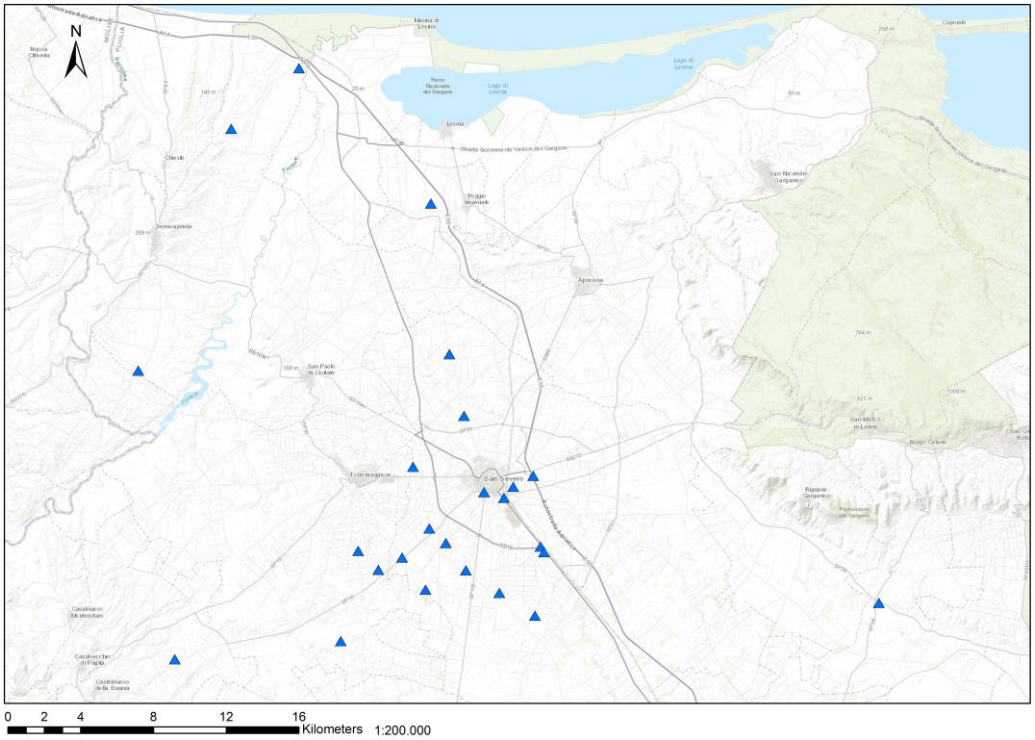


Fig. 34 – Middle Neolithic site distribution map (image edited by the Author)

A transition cultural phase is marked by the *Ceramiche dipinte in bianco* (i.e. "White Painted Stripes Pottery"). The pottery production presents a fine ware called *figulina* which is decorated with painted motives in white or in white and red and motives consisting of circles, diamonds, triangles and stripes. The most common vessel shapes are vessels with a small foot, bottle-shaped vessels, bowls and cups. This kind of pottery was found mainly in sites in the Tavoliere area like Passo di Corvo and Villa Comunale di Foggia, but some sherds were brought to light also in other regions like Basilicata. Scholars like S. Tinè compared this to pottery with similar contexts dating to the half of the fifth millenium calBC from Albania and Greece (Tinè 1983, 172) (fig. 35).

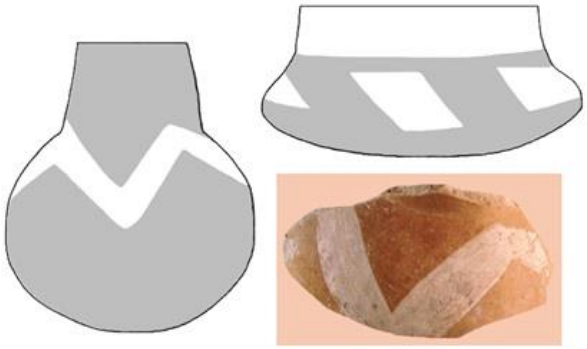


Fig. 35 – Pottery samples from the *facies Ceramiche dipinte in bianco* (Cocchi Genick 2009)

After this phase follows the typical Passo di Corvo pottery, which is the *Ceramica a Bande Rosse facies* (i.e. "Red Painted Stripes Pottery") that we could consider as the beginning of Middle Neolithic (between 5500 and 5000 calBC) (Tinè 1983, 63). The production is characterized by *figulina* pottery with a polished yellowish surface, often with a glazed effect. The painted decoration presents motives such as geometric figures (circle, triangle and diamond) or stripes creating zig-zag or straight or wavy effects. Regarding shapes, the most common vessels were bottles, hemispheric bowls and vessels with a high cylindrical neck.
As mentioned before, a crisis that involved the Neolithic is reflected also in this phase, where the presence of this *facies* is not distributed widely. In addition, this period showed a likely demograpghic drop suggested by a limited capability in territorial expansion by the Passo di Corvo groups. In any case, it is very remarkable that similar pottery was found at the site of Catignano (in the neighbouring region of Abruzzo), which gives room to speculate about a connection with this area (Gravina 2010, 67-69) (fig. 36).



Fig. 36 – Pottery samples from the *facies Ceramica a bande rosse*: 1) vessel with high neck from Passo di Corvo; 2) *Patera* in Catignano style from Scaloria Cave (Muntoni I. M. 2015). Map of Italy: in red) Abruzzo; in yellow) Apulia (image edited by the Author)

Furthermore, during this time it seems that also the connections with the Balkans were drastically reduced in comparison with the Early Neolithic. Rare finds from the *facies* from Passo di Corvo were made in the neighbouring countries: some sherds were found in Albania and Dalmatia, for example in the Gudnja Cave (Batovic 1975). Additionally, still today it is recorded in Daunia any trace of eastern influence like the Danilo *facies* that it should rise in this moment in Croatia (the proper chronology of the Danilo culture is still under study).

The Passo di Corvo *facies* was accompanied by a new development characterized by trichromic painted pottery, which is called like this because for the first time, painted decoration was executed using motives in three colours. This new aspect was first discovered in Scaloria Cave situated in Manfredonia (Apulia), where the investigators discovered a series of painted pottery vessels placed close to small water puddles or on stalagmites connected to water dripping down from the ceiling. It was clear that they had found one of the most important ritual sites of the Neolithic in this area (Tinè/Isetti 1981; Elster *et al.* 2016) (fig. 37).
The exploration of the cave yielded two different pottery types which were named, according to their find location in the higher or lower chamber of the cave, *Scaloria Bassa Style* and *Scaloria Alta Style*.

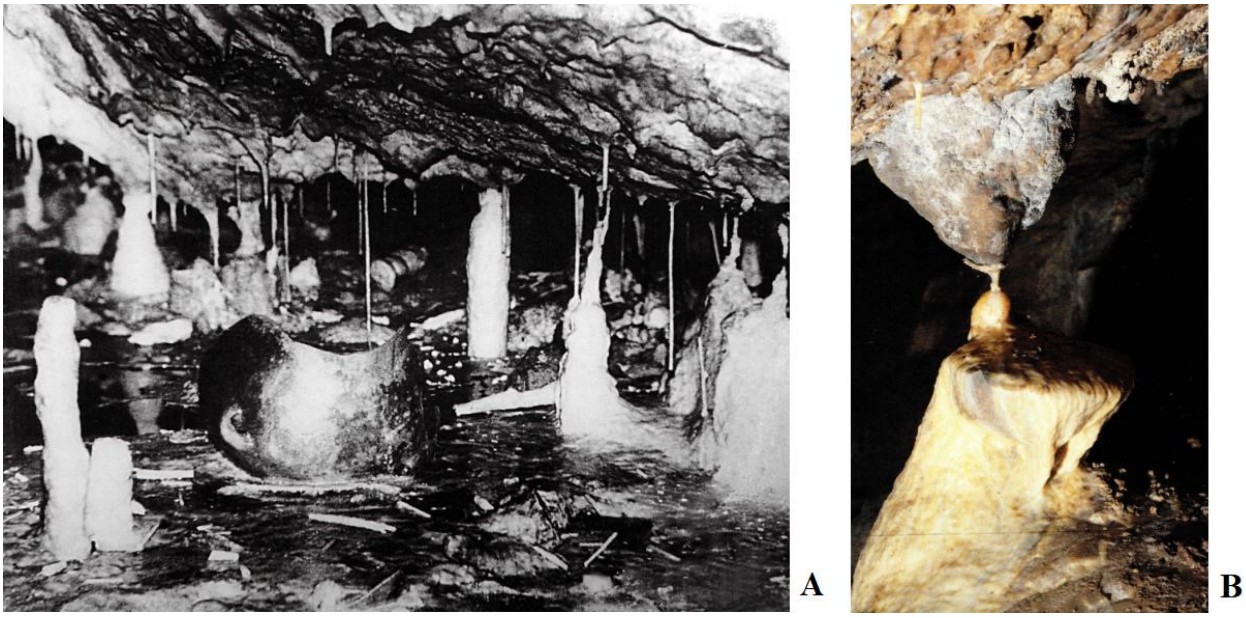


Fig. 37 – Scaloria Cave: A) Vessel in water puddle; B) Vessel on stalagmite (Tunzi 2015a)

Evidence for the first style was brought to light in Passo di Corvo and rarely in the Daunian area (^{14}C date: 3530±70 BC). One of the few samples comes from the site of Ciccalento situated at the southern hillside of the Gargano (Gravina 1999) (fig. 38). Further evidence of this pottery style was found in southern Italy and on some islands (Sicily and Eolian Islands) (Tinè 1983; Cocchi Genick 2009).

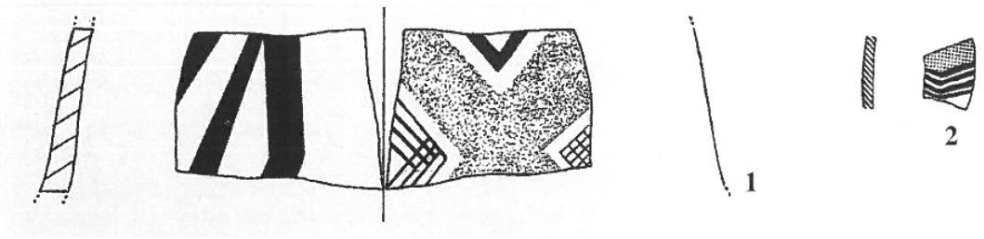


Fig. 38 – *Scaloria Bassa Style* pottery samples from the site of Ciccalento (Gravina 1999)

The comparison of these sites with the pottery from Scaloria Cave helped to understand that the *Scaloria Bassa Style* production was used in a ritual context, but likely also for rituals in the settlement. Surely, it was not used as common ware.
The decoration is characterized by painted red stripes bordered by black geometrical figures (like triangles or diamonds) obtained by a technique called “a risparmio”.

This kind of technique covers the body of the vessel with an animal fat film where the decorational motif should not be coloured. During the burning of the clay vessel, the fat film was destined to melt whereas the colour was fixed permanently. The pottery shapes were bottles, glass-shaped vessels and bowls.

From a secondary branch of the Scaloria Cave comes the *Scaloria Alta Style*. It is characterized by a *figulina* pottery production decorated with red stripes bordered by thick black lines developing hook or meander shapes or flame motives. The pottery shapes comprise hemispherical cups, bowls and vessels with necks (fig. 39).
In contrast to the first style, the *Scaloria Alta Style* is recorded in more Daunian sites like Coppa Pocci, Ciccalento, Masseria Li Gatti and Oliveto Masselli; moreover, since the decoration shows Transadriatic influences, some academics speculated a relationship with groups living without the Daunia region.

Since this kind of pottery was not found in large quantities but just in small pieces on some sites, some scholars speculated that it was the result of several external influences which should explain the small diffusion and the finds in association with other kinds of pottery (Cocchi Genick 2009). Others, instead, interpret the pottery as a specific trading good or a ritual pottery (Cassano 1993). On the other hand, Gravina (1984, 1985) sees in this scarcity of evidence the reflection of the contraction of site numbers on the Tavoliere; hence the trichromic pottery found on the Plain should be the sign of connections between Daunia and the main production centres (for Italy: Ripoli, Capri-Lipari; for the Balkans: Danilo and Dimini).
Moreover, it was noticed that the presence of the *Scaloria Alta Style* constituted a major percentage on sites with bichromic pottery (i.e. White/Red Striped Painted Pottery *facies*); thus it could be speculated that the production was assigned to local specialized craftsmen (Scopece N. 2009).



Fig. 39 – *Scalora Alta style* pottery samples: 1) Vessel with flame motif; 2) vessel with neck (Tunzi 2015)

Therefore, the rise of the trichromic pottery signified the advent of a new socio-economic organization that started to define itself more clearly with the following *Serra d'Alto facies* and was established increasingly during the final moment of the Neolithic.
The new *facies* takes its name from the eponymous village in the countryside of Matera (Basilicata) and develops during the first half of the fifth millennium calBC. As far as research is concerned, this cultural phenomenon seems to be largely attested in the area around Matera, firstly; with some chronological delay it spreads across almost the whole southern half of the peninsula, occuring in south-central Apulia, Calabria, Campania, the Aeolian Islands and northwest Sicily. Another hypothesis, formulated by Pessina and Tinè, see the diffusion of the aspect starting from central Apulia and only afterwards continuing towards the neighbouring areas and then the rest of south Italy (Pessina/Tinè 2008; Cocchi Genick 2009).

Unfortunately, the documentation of this pottery and its distribution is not clear and does not allow to create a complete frame. But from the data accessible today it is possible to understand that new social models were introduced which changed the way to live and exploit the landscape. The settlements seem to have a tendency to choose portions of the territory which were not considered until that moment and sometimes also in great distances from other villages. In this way, the new site placements permitted to generate bonds with neighbouring but also far-away communities which was likely unknown before, which resulted in the circulation of new ideas and products (Filloramo 2010). Some scholars like Geniola or Gravina speculated that this renovated movement was triggered by the favourable climate conditions verified during the Middle Neolithic (Geniola 1979; Gravina 1999).

Concerning the pottery production of the Serra d'Alto facies, it is considered the highest technological and stylistic level of the Neolithic pottery production. The pottery consists of *figulina* vessels with painted decoration in brownish colours. The decoration is geometric, sometimes miniaturist, with a complex syntax displaying motives like spiral-shaped meanders, lattices and S-beams organized in stripes or metopes (Pessina/Tinè 2008). Characteristic is the handle which looks like a crinkled ribbon or with an animal shape placed on the handle apex (fig. 40).

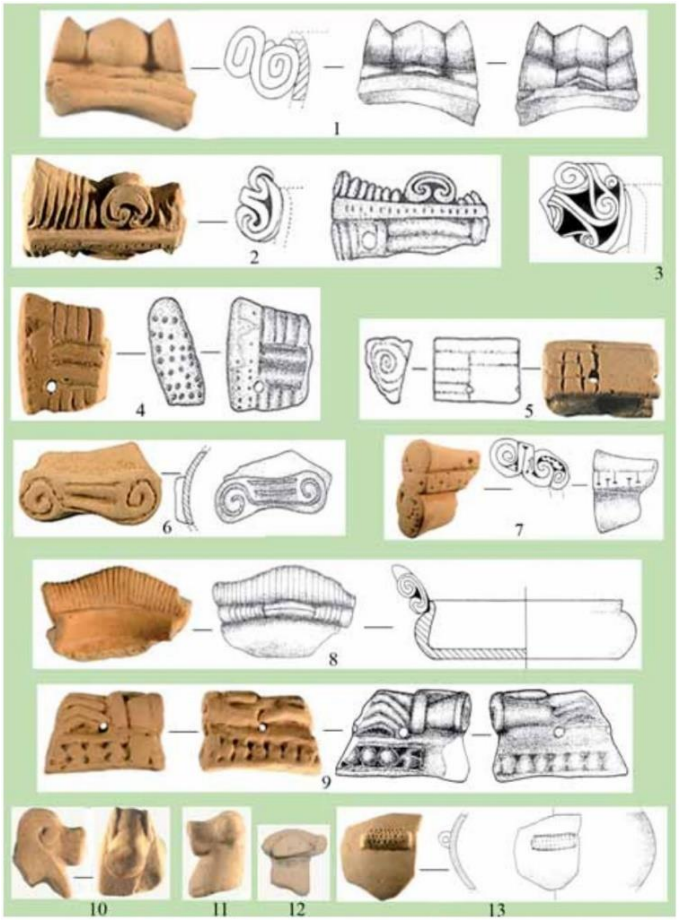


Fig. 40 – Serra d'Alto pottery samples from the village of Casino San Matteo-Chiantinelle. 1-9) crinkled ribbon handles; 10-12) zoomorphic shape apexes; 13) cylinder shape handle (Gravina 2009)

As in the pottery from Scaloria Cave, the *Serra d'Alto* facies did not cover the whole Daunia region but it is recorded in a small number of sites and often in ritual or funerary contexts. Gravina speculated that the lack of this pottery in site stratigraphy could be due to settlement patterns, since the villages of this *facies* do not display any connection with the previous cultures and hence favouring nearby locations (Gravina 2021) (fig. 41). It is necessary to point out that most of the information at our disposal comes from surveys from the last decades, and moreover, we have to take landscape changes due to human activity into account. This has not permitted a comprehensive study of this area.

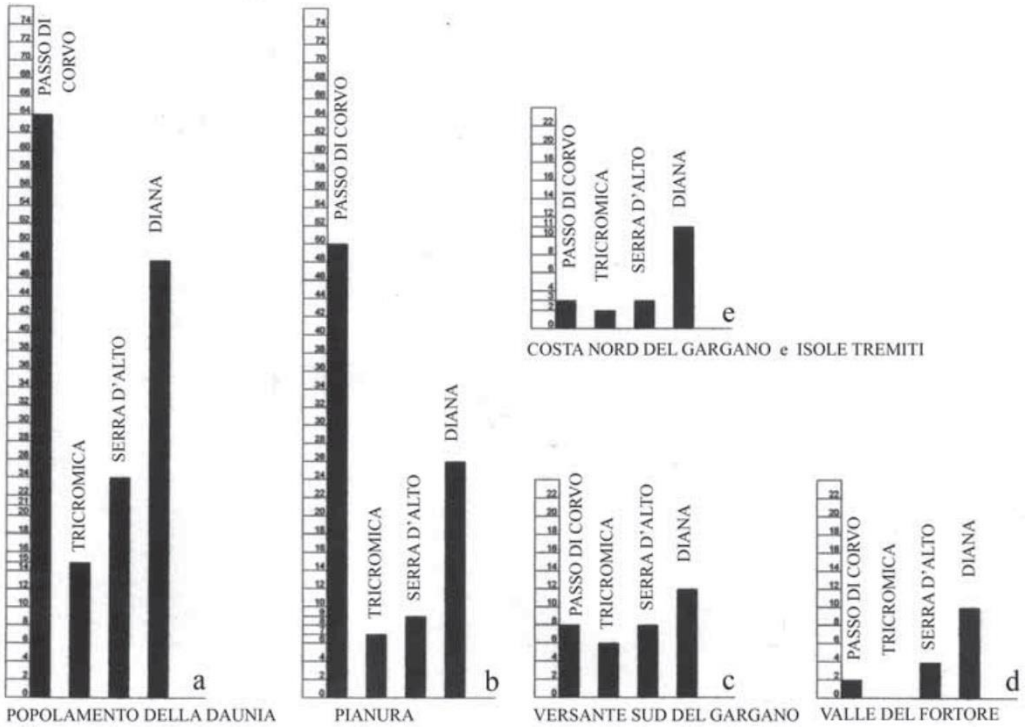


Fig. 41 – Neolithic *facies* present in the Daunia region divided by area: a) General view; b) Tavoliere Plain; c) Southern Gargano hillside; d) Fortore River Valley; e) Northern Gargano Coast and Tremiti Islands (Gravina 2021)

Nevertheless, important evidences of the *facies* were brought to light, especially in the Lower Fortore River Valley, which allows us to hypothesize about a connection network with the Danilo culture (Balkans). Traces of this influence were noticed on sites of the northern Gargano coast, like Vieste, and in the Fortore Valley, like Casino San Matteo-Chiantinelle. This latter settlement is situated on a small plain on top of the hills surrounding the area between the cities of Serracapriola and Ripalta, on the left side of the river shore and not so far from the Molise regional boarder. The investigations revealed evidence of one of the bigger Daunian Serra d'Alto villages and a huge number of fine pottery sherds showing Transadriatic influences from the Danilo culture (Gravina/Geniola 1976-1978; Gravina 2014). Scholars noticed signs of the eastern influence in the slow abandonment of the ditch, or better in its ritual meaning, and in the appearance of "Mother Goddess" statues that seem to have parallels in the Aegean and Balkan productions.

As far as south Italian pottery is concerned, comparisons can be found with some contexts of the area between Matera and southern Apulia. Examples of figurines originate from Casino San Matteo-Chiantinelle, respectively named "A" and "B" and found during surveys. The two figurines show a female shape without a head, with pronounced steatopygia, an iconography connected to possible fertility

rituals especially in southeast Europe (Geniola/Tunzi 1980; Striccoli 1988; Gimbutas 1989; Gravina 2008) (fig. 42).

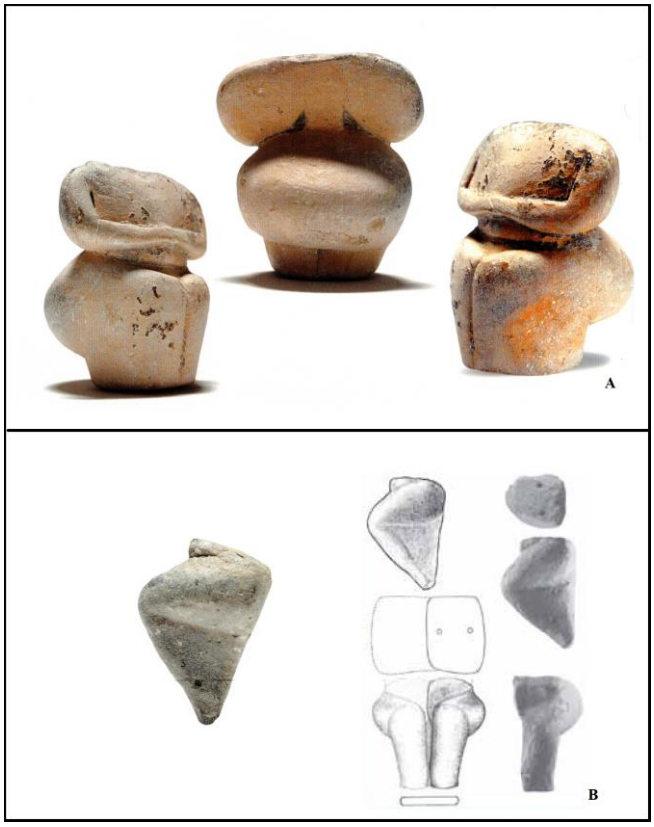


Fig. 42 – "Mother Goddess" examples from the site of Chiantinelle (Tunzi 2015b; Gravina 2000)

Another important *Serra d'Alto* centre was the village of Chiarappa which was situated close to the delta of the Fortore river. Likely, its position was chosen deliberately because from here it was possible to keep in touch with two important areas: the river course and the coast (fig. 43).

As far as the right side of the shore is concerned, *Serra d'Alto* evidence is scarcely attested in the central part of the valley; an example is the site of Piani di Lauria. The village was set on top of a hill from which it was possible to dominate the watercourse. Indeed the site had an important role also during the following periods.

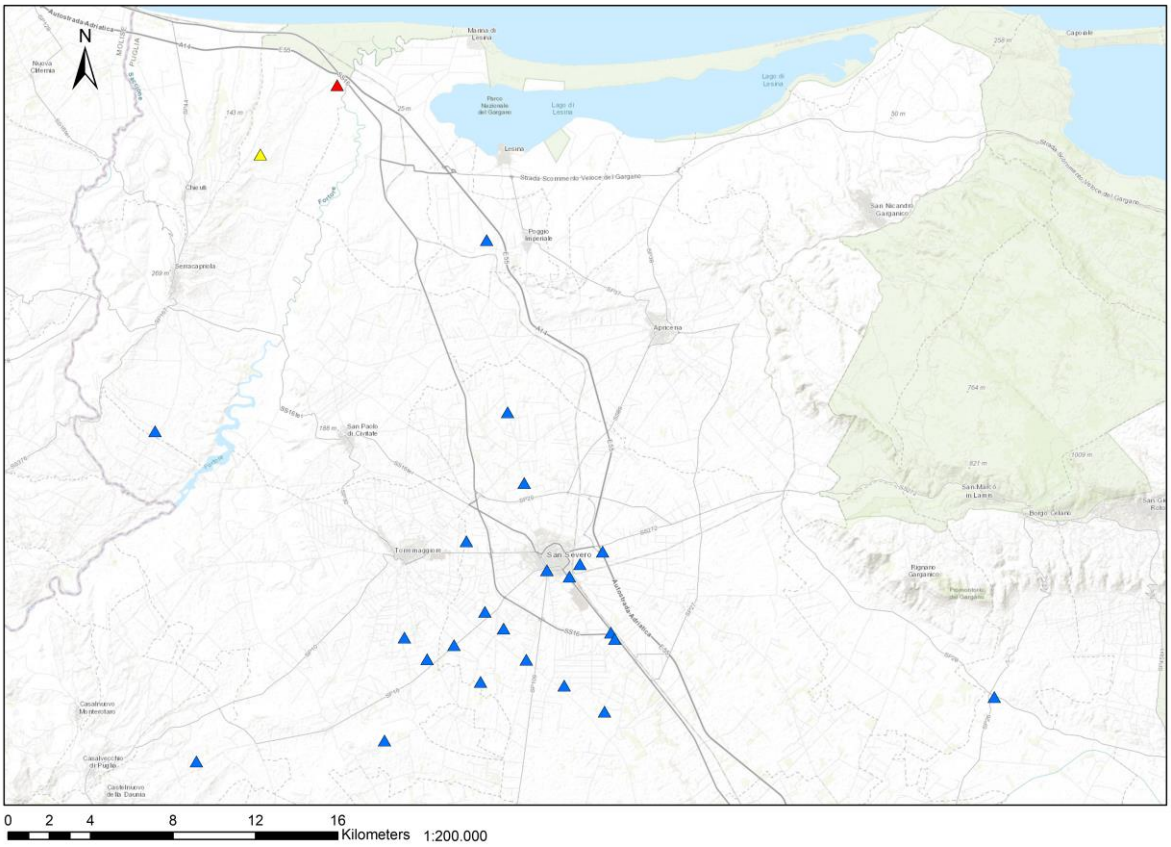


Fig. 43 – Site placement: in red) Chiarappa; in yellow) Casino San Matteo – Chiarappa (image edited by the author)

2.2.3. Final Neolithic

The final moment of the Neolithic (4100 BC) is characterized by the Diana *facies* and its aspect *Diana-Bellavista Style*. The Diana *facies* was first discovered at the eponymous site of Lipari (Sicily), while the *Diana-Bellavista Style* can be considered the peninsular aspect of the *facies* since it was discovered in Masseria Bellavista (Taranto, Apulia).
According to the data collected from the survey, the new cultural phenomenon presented a slight diminishment in site numbers with respect to the previous Middle Neolithic, and the tendency to choose places close to potential trading/communication ways, like watercourses or the seacoast. Examples are the sites of Piani di Lauria or Chiarappa, situated along the Fortore Valley; Mezzanella di Brancia or Ciccalento, placed along the southwest Gargano hillside; Cammarata, close to Lake Lesina. These sites occupied a strategical position as far as communication ways are concerned; indeed they continued to thrive also during the Copper and Bronze Ages because they were situated in areas from which they could control the landscape and the trading routes (Gravina 1984, 1984a, 1999a; Muntoni *et al.* 2018) (fig. 44).

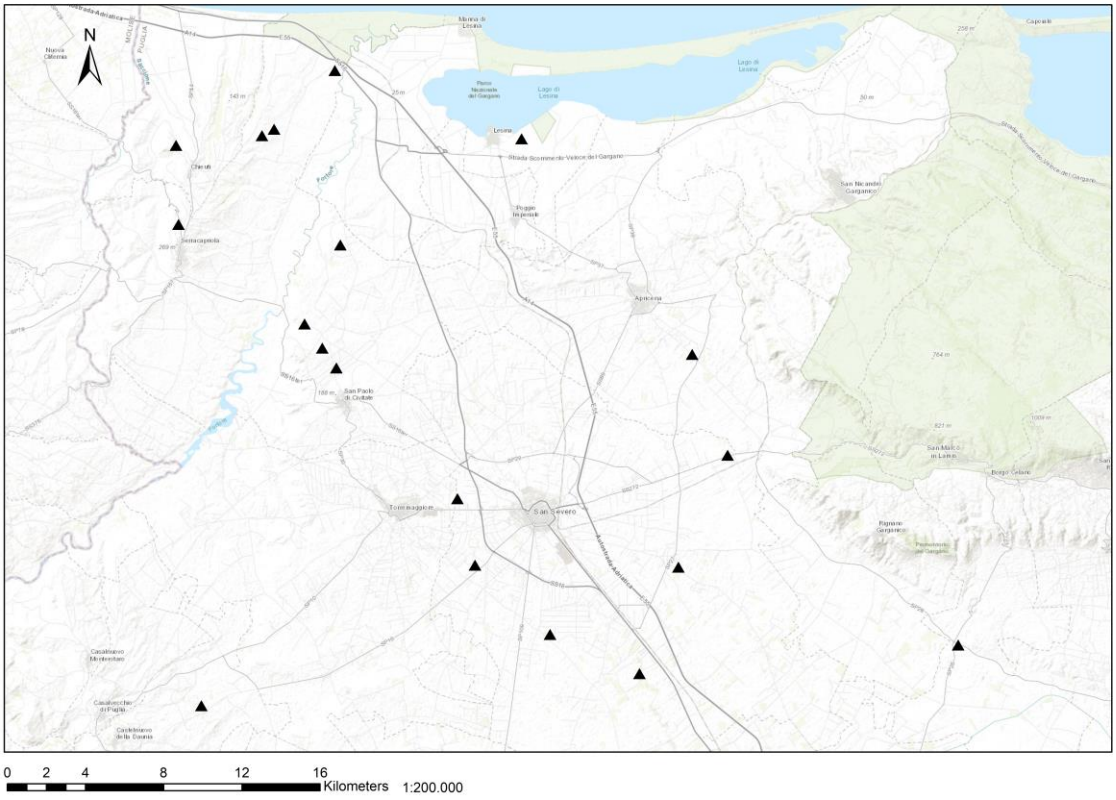


Fig. 44 – Final Neolithic distribution map (image edited by the Author)

The pottery production is characterized by a dark grey/black coarse or semi-fine ware with polished surfaces and reel-shaped handles, often placed close to the rim. Decoration motives were recorded on bowls, for instance, in the shape of geometric shapes crafted with engraving or impression techniques (fig. 45).

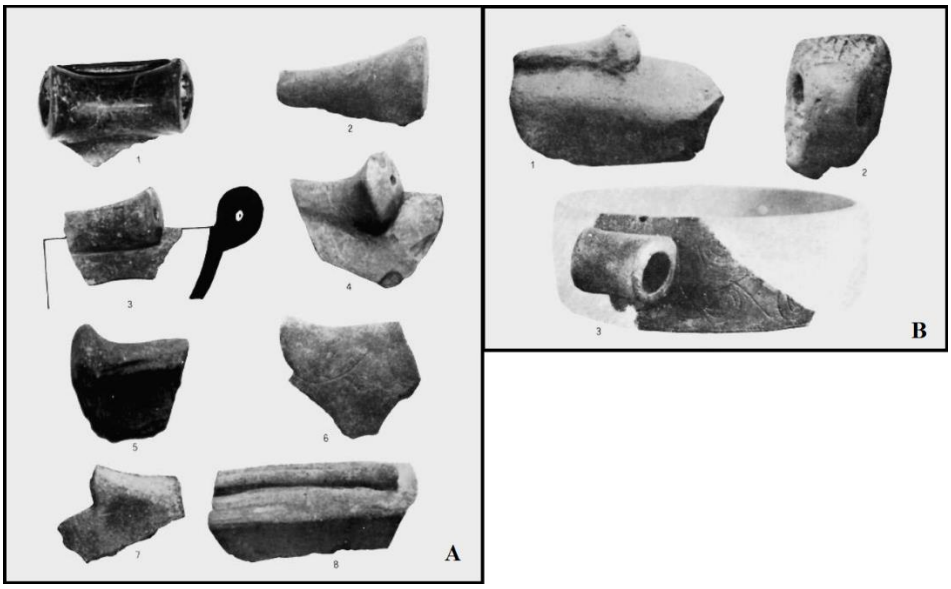


Fig. 45 – Samples of *Diana facies* pottery. A) Coppa Pallante (1-2), Casino San Matteo-Chiantinelle (2,6-8), Pian Devoto (4-5); B) Casino San Matteo-Chiantinelle (1-3) (Gravina 1984)

2.2.4. Early-Middle Copper Age

As mentioned above, the chronology considered in this study is based on the results of surveys conducted since the end of the 1960ies and hence it was decided to adopt this chronological sequence. As far as the Copper Age is concerned, the evidence presents a blurred frame that often does not allow to recognize a chronologically fixed transition between the cultural phenomena. For this reason, the Early and Middle Copper Ages are dealt with as a macro-group. As is true for the rest of Apulia, the Copper Age is a period characterized by the introduction and development of new technologies and social changes which can be traced back in their beginnings to the Final Neolithic in the *Diana facies*. Therefore, with the advent of the metal age differences are detected in the funeral rituals, for example the use of hypogeous complex structures and the creation of specific grave goods.
From a social point of view, close relationships with the Aegean and the Balkans or with northern regions start to evolve. The circulation of external ideas worked as a trigger for the development of new social and economic models that changed how to live and exploit the landscape. For instance, an increase of the variety of funerary rituals was noticed, with a tendency to divide the dead into subgroups through the use of different burying areas or common structures. This bias was interpreted, likely, as the birth of an inner subdivision of communities, even though any concrete evidence for this in settlements could not be found. On the contrary, evidence for these differences was traced in the burial contexts, where the presence of metal weapons, like the dagger, seem to be a symptom of a social discrepancy (Renfrew 1982; Cazzella/Guidi 2011).
Another element denoting the complexity of this newly evolving social structures was the introduction of metal into the material production. It underlined the potential presence of specialized craftsmen who were able to manufacture tools that allowed to enhance, for example, working activities. One of the most important new artefacts was the metal plough with which it was possible to work the soil faster and, above all, difficult terrain left abandoned until that moment (Sherrat 1981). This innovation, together with the introdution of the wagon, meaning a major increase in mobility, and the new breeding techniques aimed to obtain secondary products were likely the reasons that encouraged the communities to settle new region of the landscape (Shetter 1983; Pacciarelli 2015).

As far as data related to the population of northern Daunia is concerned, the number of the sites remained almost stable, but the placement changed in favour of locations close to ways of communication. The Tavoliere Plain was abandoned, from a settlement point of view, while the Fortore Valley, the shores

of Lake Lesina and the northwestern Gargano foothills started to be populated by sites. This placement permitted to exploit the landscape in different ways in accordance to the new economic dynamics; therefore, the possibility to control the valleys or significant land passages could be crucial in playing a main role in the social economic networks rising between Daunia and the outer regions (Gravina 1980a, 2014; Cazzella *et al.* 2011; Filloramo *et. al.* 2021a) (fig. 46).

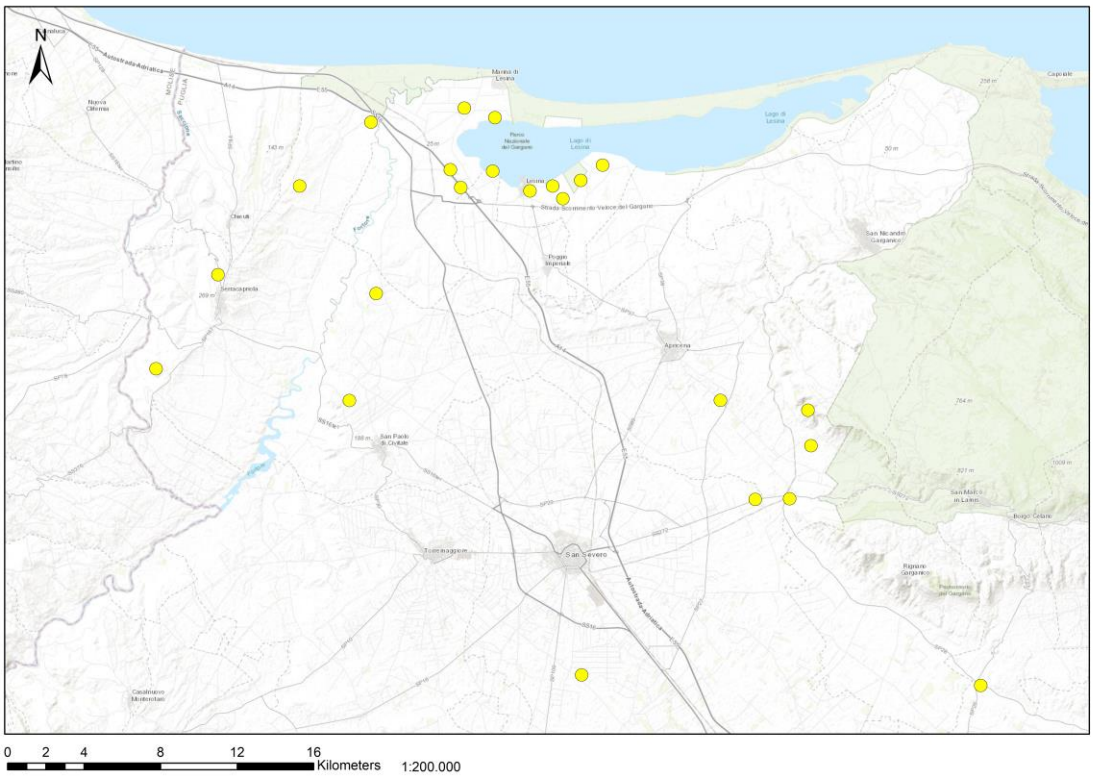


Fig. 46 – Distribution of sites during the early-middle Copper Age (edited by the Author)

These changes were reflected also in the material culture in which the influence of cultural phenomena coming from the neighbouring regions becomes clearer. Evidence for this is perceived in the *facies* Macchia a Mare (ca. 4100-3700 calBC) that marks the beginning of the metal era. This culture takes the name from the eponymous site situated on the northern Adriatic coast of the Gargano and is characterized by a specific lithic production showing the so-colled *scalpelli garganici* (i.e. chisels) and the *astiformi* (i.e. tools with an elongated shape) (fig. 47). This kind of tool production was typical for the Gargano, indeed with the raw material coming from the promontory where the first extraction points can be found. This activity led to the opening of flint mines in several areas of the northern cliffs of the Gargano, such as the Defensola mine (Vieste, northern Apulia), and triggered a flint exchange network that brought this raw material

also out of the Daunian area (Calattini 1981; Gravina 1999; Tarantini/Galiberti 2012).

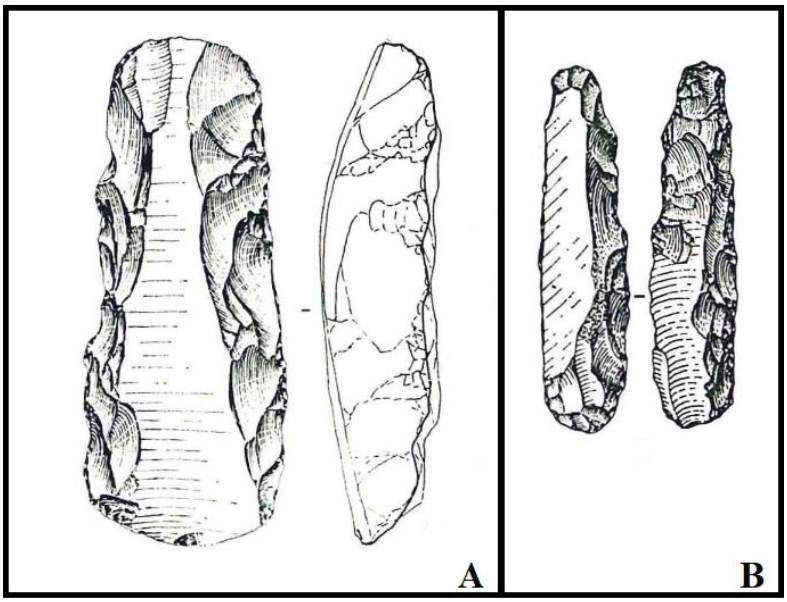


Fig. 47 – Sample of lithic production from the site of Copparone (Gargano): A) *scalpello garganico*; B) *astiforme* (Calattini M/Cresti 1980)

Concerning the pottery, it presents shapes like a characteristic truncated cone bowl with polished surfaces and blackish colour, while the decoration displayed thin engraved lines creating a zig-zag motif under the inner rim. While the first evidence was found in the site of Macchia a Mare or around this area, recent investigations trace this *facies* also to contexts placed along the southwestern foothills of the Gargano, like Mezzana della Quercia and Brancia Km 10, and in south Daunia, like Coppa Nevigata (Palma di Cesnola 1981; Gravina 2009). Moreover, further research shows that this *facies* is comparable with material from the sites of Paterno (Abruzzo) and Zinzulusa Cave (Calabria) (Ingravallo 1998; Gravina 2009). The presence of this evidence in diverse regions encouraged some scholars, like Cremonesi, to speculate about the birth of a cultural network that marked the end of the Neolithic and the beginning of a new period more focused on relationships with other regions. However, this consideration is mostly supported by data coming from superficial investigations, such as in Grotta delle Veneri (Apulia). In order to have a more stable frame a systematic study of the contexts would be necessary (Cremonesi 1981; Cazzella/Silvestrini 2005) (fig. 48).

The circulation of ideas and models between neighbouring communities favoured the rise of a complex cultural phenomenon formed by several aspects tied to each other in a dense network embracing the whole peninsula. In this general frame, during the transition between the Neoltihic and Eneolithic, Apulia played a major role because of its location in the centre of communication routes encompassing the Ionic, the Adriatic and involving also the inner Apulian Ofanto river valley, thus favouring trade from southern areas (Radina 2011).

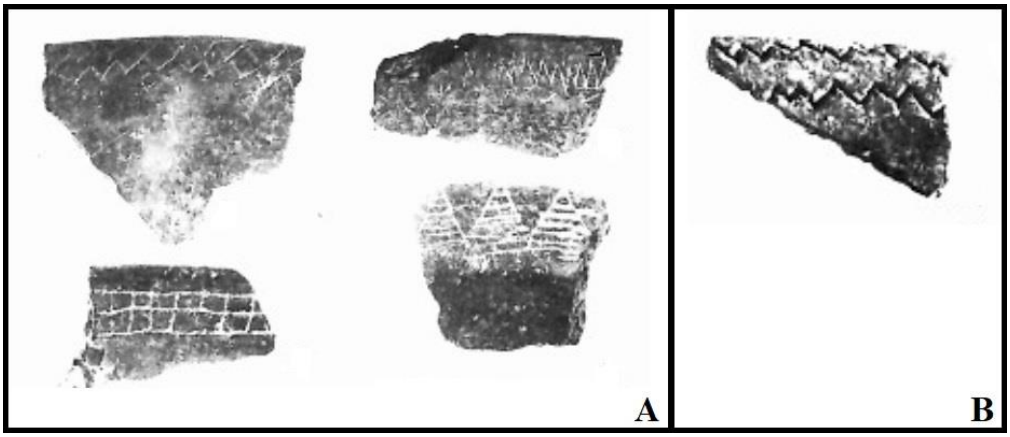


Fig. 48 – Sample of Macchia a Mare *facies* pottery sherds from: A) Paterno Site (Abruzzo); B) Grotta delle Veneri (Apulia) (Cremonesi 1981)

This ongoing cultural exchange became increasingly clear to academics above all when, towards the middle Eneolithic, the *facies* Piano Conte (3700-3300 calBC) could be defined that appears in Daunia almost in a chronological overlap with the *facies* Macchia Mare.
This new culture derives its name from the eponymous Sicilian site of Lipari (Aeolian Islands), and its presence can be traced down in several sites of south Italy, thus opening a long-standing debate about its spread and its origin. Current research is prone to consider Piano Conte as a material cultural aspect which proliferated all over south Italy and which was locally adapted according to the perspective of likewise communities Therefore, it should be seen as a common cultural aspect, hence not a *facies* originating in Lipari, but rather highlighting the presence of a strong relationship between the southern areas of the peninsula (Roberto 2010; Del Fattore *et al.* 2017).

In northern Daunia, the Piano Conte aspect appears in sites placed along strategical areas such as the Gargano foothills, the shores of Lake Lesina, close to the border to Molise and on the southern edge of the Tavoliere area. The reason for this occurrence at these places seems to support the aspect of the importance

of rising circulations of the material culture. Moreover, some of the settlements can be found in the same places occupied by the Final Neolithic communities (Filloramo *et al.* 2021).
Regarding the material production, the pottery presents distinctive traits characterized by linear engraved motives spread around the upper side of the vessels' body or around the inner surface of the vessels, mostly bowls. In the typical Aeolian style, on the other hand, the decoration presents sometimes also radial engravings on the rim.
Moreover, the lines are rather deep and wide so that they could be considered as parallel furrows, maybe created by a straw, and arranged in some cases to form an irregular wavy design. Another typical feature of this production are subcutaneous handles, small cylinder-shaped handles or handles reminding of an elephant trunk. As far as vessel shapes are concerned, it is possible to distinguish between open shapes like truncated cone-shaped bowls and closed shapes like vessels with necks (Pacciarelli 2008; Gravina 2015) (fig. 49).

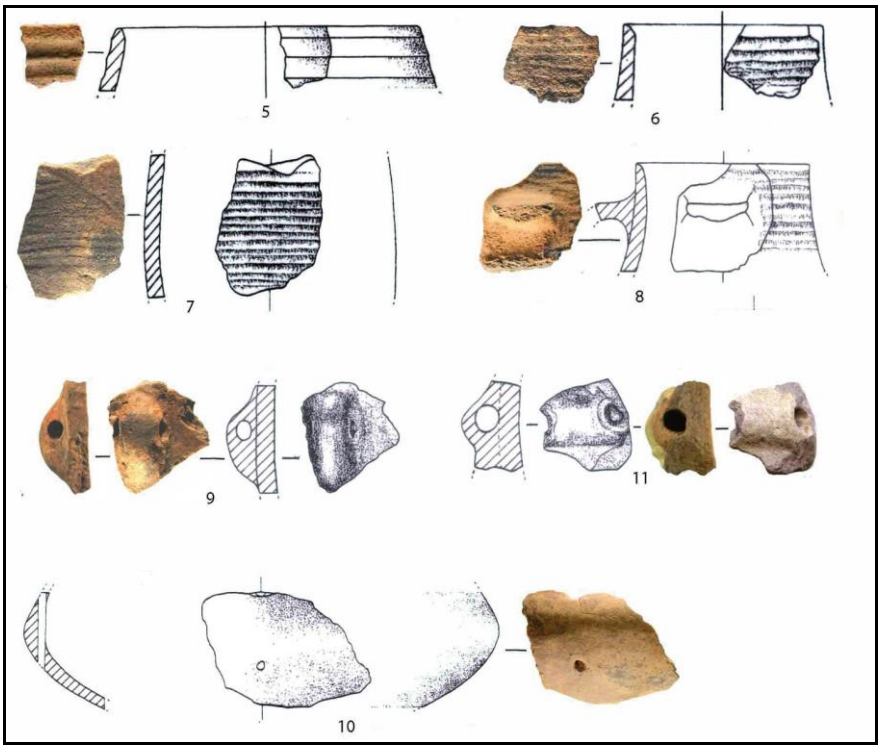


Fig. 49 – Sample of Piano Conte pottery from Brancia Km 10: 5-6,8) vessel with neck; 7) *Olla*; 9, 11) handles; 10) *subcutaneous* handle (Gravina 2014)

2.2.5. Final Copper Age

The social and economic dynamics continued to shape the communities' behaviour and the means of exploitation of the landscape which again stressed areas with a high strategical factor.
The settlements, reduced in number and placed around the border of the study area, were set closer to communication ways like the Fortore river or the southwestern foothills of the Gargano; the Tavoliere Plain was left empty and likely exploited as a corridor linking the southern and northern regions of Daunia (Filloramo *et al.* 2020, 2021, 2021a) (fig. 50).

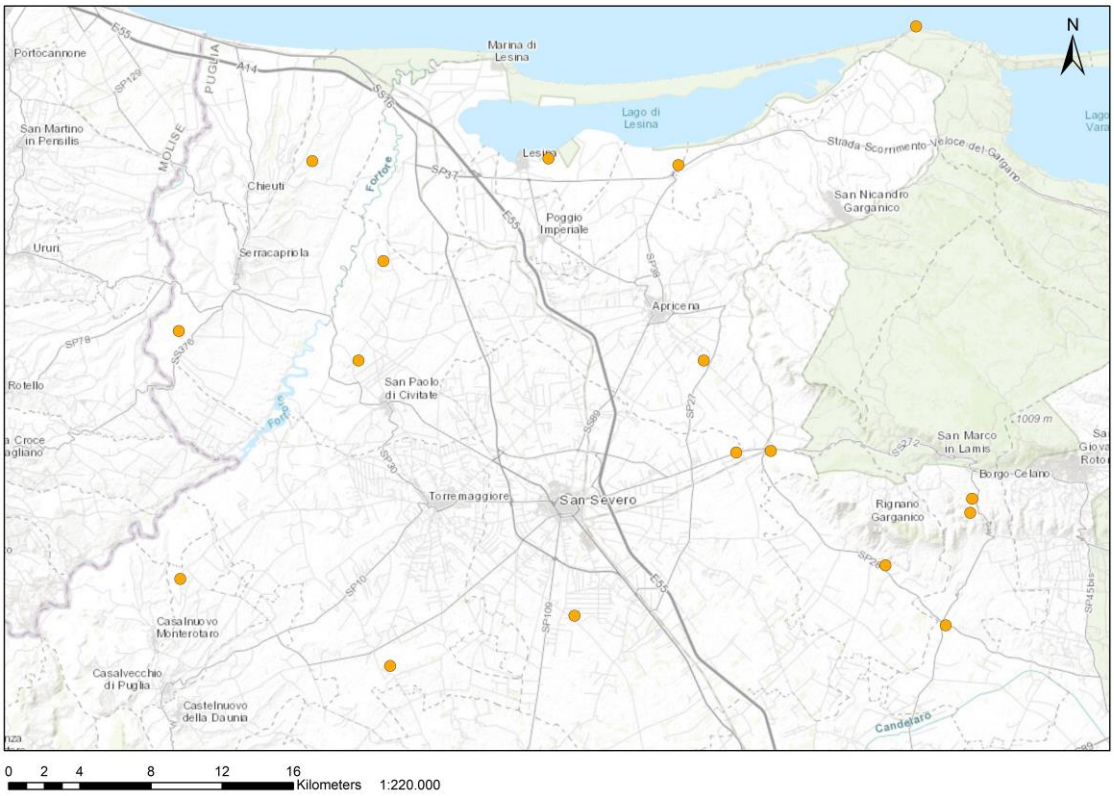


Fig. 50 – Distributon of Final Copper Age sites (Image edited by the Author)

From our investigations we learned that the major part of the settlements continued to occupy the same spots as during the early and middle Copper Age, in some cases even reaching back to the Final Neolithic. Just a small number of sites were placed in new areas like the top of the hills of the inner Gargano or the middle Fortore valley.

The dynamics found in the Final Copper Age are evidence for a complex mesh of cultural aspects due to overlapping and, sometimes, merging transitions and new

influences. This still unclear picture fomented a long-standing debate about the chronological sequence that is still in progress until today.

The passage to the final moment of the Eneolithic is characterized by the *facies* Gaudo, whose presence is recognizable in south Italy. The culture takes the name from the site of the countryside around Paestum (region of Campania), called Contrada Spina-Gaudo, where it was detected in some graves in 1943. Recent ^{14}C analysis from the bones of "individual B" of grave IX are held to mark the beginning of the *facies* around 3360-3010 calBC (Lippi/Mallegni 2011). The end of culture is located around the 2800 calBC, meaning that Gaudo lasted for quite a long time and was eventually succeded by the emerging Laterza *facies* (Pacciarelli/Talamo 2011).

The *facies* Gaudo, considered as a funerary culture since most of the finds are related to graves, can be found mainly in Campania, but further investigations demonstrated its presence also in Calabria, Basilicata, Lazio and Apulia. Even though it is found in various contexts, again it is difficult to clearly define its inner structure and cultural background because, as is also true for the following *facies* Laterza, it changed in accordance with the local communities that absorbed it. An example is the beginning phase in which the pottery production shows elements from the southern late Early Eneolithic *facies* of Taurasi, as is evidenced by jugs with slight engravings on the neck or rarely handles reaching from the shoulder to the neck of the vessel. Then again, the final stages display common aspects with Laterza, for example in the presence of glass-shaped vessels with biconic bodies and cylinder necks. Instead, a typical shape of Gaudo were the so-called *gemini vases* or *vaso a saliera,* i.e. two small vases joined by a clay bridge and decorated with engraved lines.
Remarkable is also the metallurgic production, with typical daggers consisting of a triangular blade and a central spine in relief (Cocchi Genick 2009) (fig. 51).

Concerning the presence of Gaudo within the study area, the data was scarce in the archaeological record. Specifically, only in the settlement of Mulino di Caldoli (southeast shore of Lake Lesina) pottery sherds related to the final moment of Gaudo and the following rise of the Laterza culture were found. However, the finds in other Apulian areas, such as at Radogna, Selinelle and Madonna delle Grazie, induced some scholars to speculate that the *facies* was a cultural phenomenon spread in the southern and central peninsula. Like Piano Conte, it was suspected to have a tendency to create networks between the communities tying diverse areas each to other (Gravina 2003; Tunzi 2015).



Fig. 51 – Sample production of Gaudo *facies*: 1) *askos* shape vase; 2) jug; 3) *pyxis*; 4) mug; 5) vessel shaped like walnut-shell; 6) double-handled *olla*; 7) *hemini vessels* / *vaso a saliera*; 8) copper dagger with central rib (Cocchi Genick 2009)

The final moment of the Copper Age is marked by the birth of the *facies* Laterza (2900-2350 calBC), firstly discovered in Taranto (southern Apulia). The eponymous site was a necropolis discovered in 1966 and characterized by graves *a grotticella* and *a fossa*, with the entrance generally sloped towards the chamber (Biancofiore 1967, 1971) (fig. 52a).
Regarding the spread of this cultural aspect, it was recorded in several regions of central and south Italy, for instance in Lazio, Campania and Basilicata, where it was mostly discovered in funerary contexts, whereas evidence for settlements was brought to light rather on the Tyrrhenian side of the peninsula. Despite its large presence, its contextualization remains a long-standing debate because the Laterza aspect seems to change in accordance with the diverse groups that absorbed it. In particular, it became manifest in funerary rituals, however with such great variations that some scholars are prone to consider the rituals not a reflection of the groups themselves (Tunzi/Monaco2010).
The material production is represented by vessels like the *patera*, big truncated cone-shaped bowls, amphoroid vessels and the mug shapes. Handles also appear as distinctive elements in the shape of small clay button on the largest diameter. The decorations are characterized by slightly engraved motives on the outer wall of the body and vertical engraved lines on the inner part of the rim which was sometimes raised and became itself an ornamental element (fig. 52b).

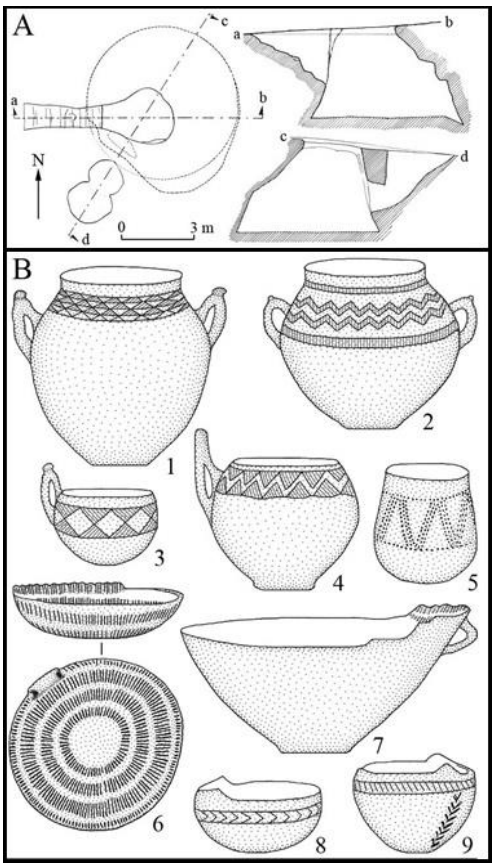


Fig. 52 – Laterza *facies*: A) map and section of grave 3 from the Laterza necropolis; B) samples of typical Laterza pottery from grave 3 (Cocchi Genick 2009)

Due to its spread and the phenomenon that Laterza was absorbed by otherwise differing cultural phenomena, several aspects of the Laterza *facies* emerge. For instance, during the late moment of the culture, an aspect called *Cellino San Marco* developed in Apulia which was discovered at the eponymous site in Salento (south Apulia) and characterized by the substitution of the *patera* with a slope-walled mug. On the other hand, in Lazio the pottery acquired some elements from the so-called *facies* of Ortucchio and in some cases was also accompanied with or substituted by features from the Bell Beaker culture or the *facies* Četina (Balkans) (Lo Porto 1962-1963; Pacciarelli/Talamo 2011).

Concerning Daunia, the spread of the Laterza culture is attested in the majority of the settlements, sometimes in association with Piano Conte pottery because of a chronological *continuum*. The settlements in consideration are set along straight communication ways, for example Piani di Lauria, Chiarappa, San Matteo-Chiantinelle and Colle Creta in the Fortore river valley; close to Lake Lesina Lake, sites such as Cammarata, Mulino Caldoli and Torre Mileto are recorded. The Gargano was interesting for the *facies* Laterza as evidenced by sites like Ciccalento and Chiancata La Civita (Gravina 2002; Filloramo *et al.* 2021).

Rarely appears the aspect of Cellino San Marco, such as in the necropolis of Casone in the countryside around San Severo (De Juliis 1975a) or in Masseria Sculgola in the centre of the Fortore valley (Gravina A. 2015); other evidence originates from southern Apulia like Capuccini Cave (Ingravallo 2002) (fig. 53a, b).
In this frame of unrest between rising cultures, also new influences coming from outer regions as the Balkans can be recorded. Indeed, in Piani di Lauria and Coppa di Rosa pottery sherds related to Laterza-Četina aspect can be found, hence symptom of an increasingly growing relationship between diverse communities (Gravina 2021) (fig. 54).

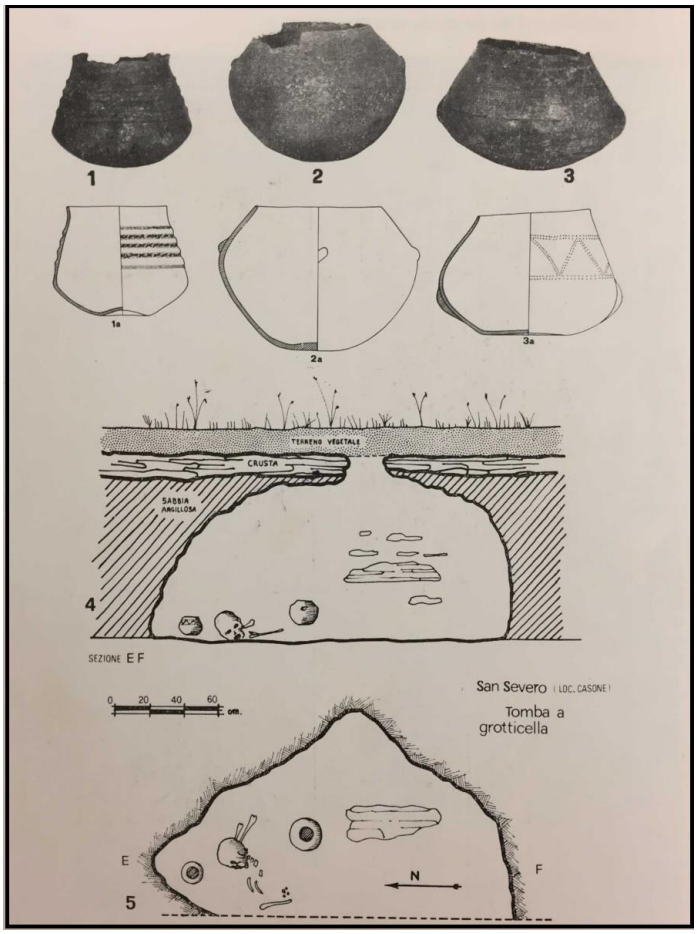


Fig. 53a – Cellino San Marco: 1-3) grave goods; 4) section of the *grotticella* grave; 5) plan of the grave (De Juliis 1975a)

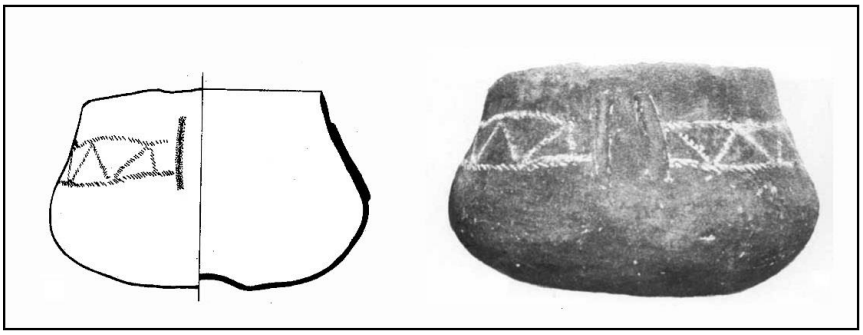


Fig. 53b – Sample of pottery from the Cellino San Marco aspect from Masseria Sculgola (Gravina 1975, 2003; image edited by the Author)

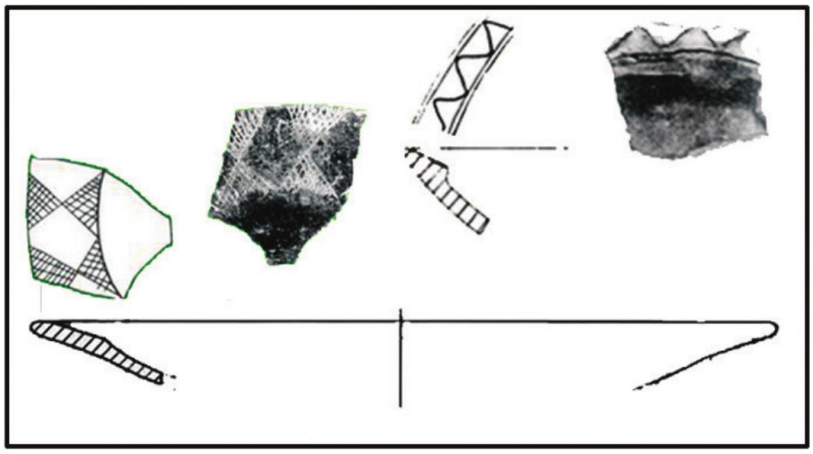


Fig. 54 – Sample of Laterza-Četina pottery sherds from the settlement of Piani di Lauria (Gravina 2021)

2.2.6. Early Bronze Age

The northern Daunian Early Bronze Age shows further changes regarding the use of the landscape which is due to increasingly good climate conditions that permitted to consider some areas unused until then. In particular, the Tavoliere Plain recorded a medium temperature higher during the Piano Conte and late Early Bronze Age times, likely causing a dryer climate situation that brought people to choose other areas for their activities. It must be noticed that with the beginning of the Middle Bronze Age the Plain was definitely abandoned. Between Laterza and the first phase of the Early Bronze Age, the Tavoliere was populated by few settlements, likely due to a better climatic situation.
The inhabitants of settlements started to modify their behaviour occupying areas not considered during the Final Copper Age, like the the Tavoliere Plain mentioned above; instead, the Lesina shore was left in favour of the Fortore valley and the Gargano foothills. Eventually, a group of sites shows continuity with the places already occupied during the Final Eneolithic (Filloramo 2020, 2021) (fig. 55).

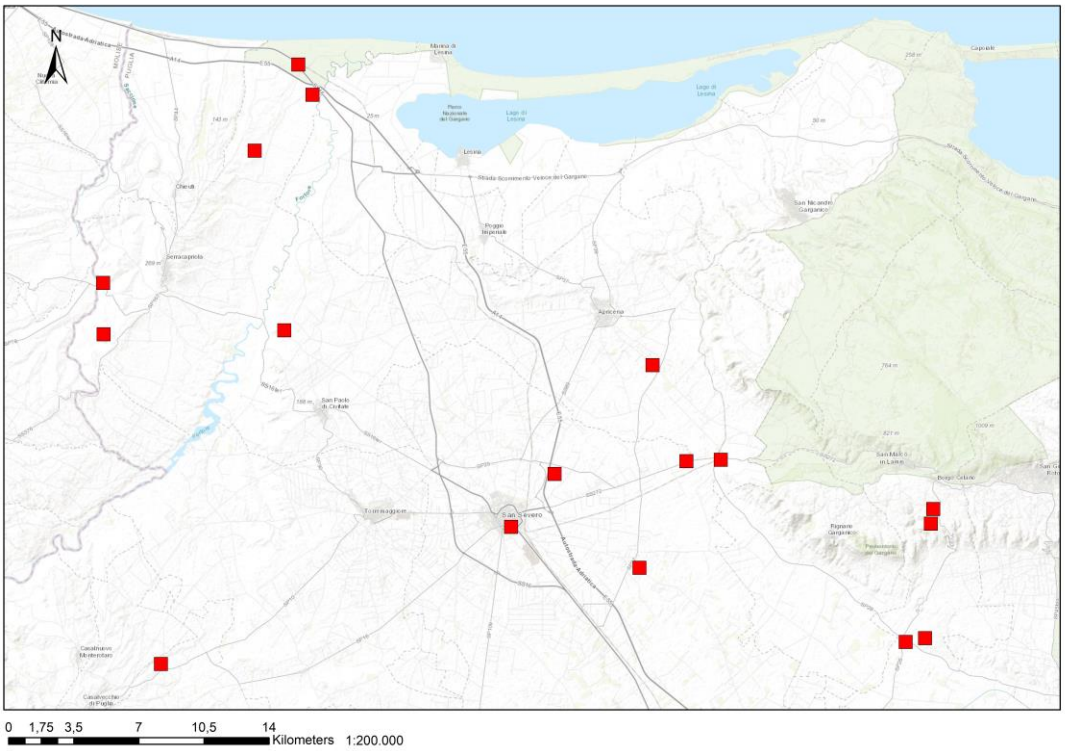


Fig. 55 – Sites of the Early Bronze Age (image edited by the Author)

Therefore, it is clear that the new dynamics possibly changed the communication routes connecting the inner and outer areas of the peninsula. Indeed, during this time, strategical placement of settlements was of great importance, with the inhabitants thus able to take under control wide portions of territory. Trading should involve the exchange of raw materials such as wood or flint of which the Gargano was the main extraction point, like some investigations regarding flint circulation are demonstrating (Delluniversità *et al.* 2019).
Sites like San Matteo-Chantinelle, Colle Arsano, Coppa Cardone or Piani di Lauria, for instance, permitted to keep in contact with groups coming from Molise or with those able to navigate the Fortore river (for the dynamic details see following chapter). The rise of networks created by settlements placed in diverse areas able to control a specific territory is remarkable; for example, that is the case at Brecciara that, together with the sites of the Molisean coastline, dominated the whole coast between the two regional boarders. Therefore, the possession of the territory by the communities has to be strongly emphasized (Filloramo *et al.* 2020, 2021).
Moreover, this settlement system created the so-called *gemini villages*, especially during the Middle Bronze Age: two settlements were placed one in front of the other on top of hills controlling the access to a valley. An example was found at Piani di Lauria and Pezze della Chiesa (fig. 56).

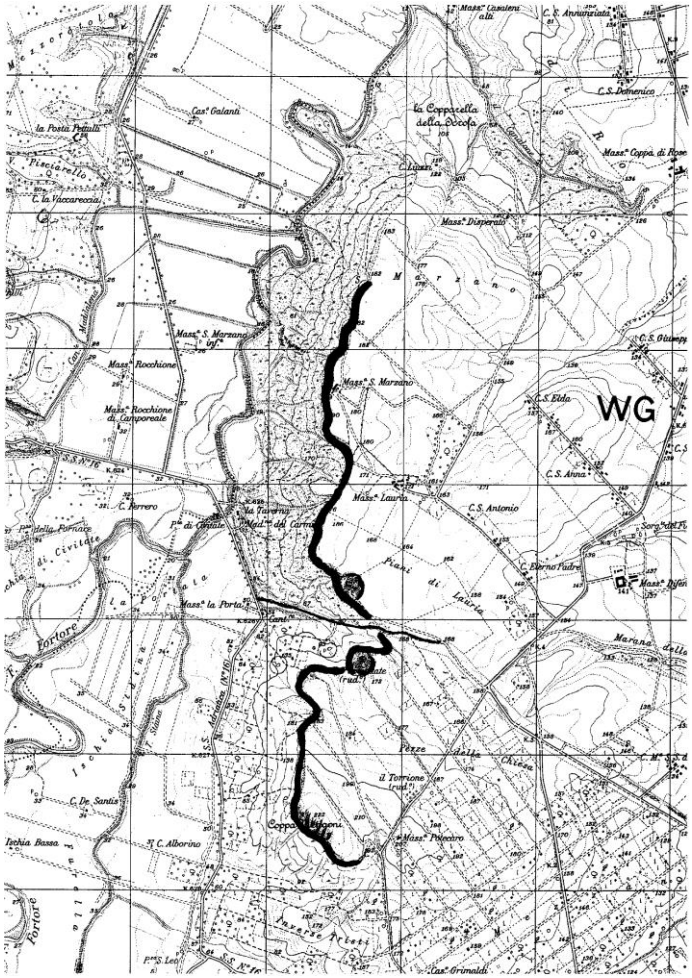


Fig. 56 – Example of *gemini villages* at Piani di Lauria. The access to the river ford was controlled by the settlement of Piani di Lauria (right side of valley) and Pezze della Chiesa (left side of valley) (Gravina 1999).

From an archaeological point of view, the investigations brought to light finds that are ascribable to this time, but it is not possible to give an absolute cultural frame. The pottery sherds reveal vessel shapes and a clay typical for the Early Bronze Age, but unfortunately they do not show a particular decoration which enables to link it to a specific culture (fig. 57). This problem was observed with evidence from settlements, sporadic finds areas and cemeteries (for example, the Tagliavia graves) (Gravina 2014).

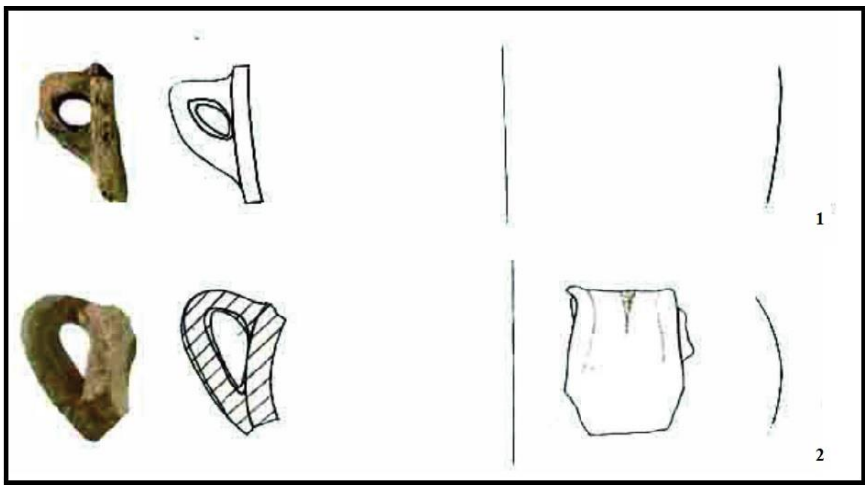


Fig. 57 – Example of Early Bronze Age pottery from Mezzanella di Brancia: 1) *ansa a gomito*; 2) *ansa ad occhio* (Gravina 2014)

From this chronological and cultural *excursus* it becomes obvious that north Daunia played an important role as hub, since it was placed in between the eastern area of the Mediterranean and the inner regions of the peninsula. Exchange started when the discovery, exploitation and trading of raw materials, like flint from the Gargano, led to the formation of connections between neighbouring communities. The established network increasingly triggered the social and economic approach to the landscape. An example for this was the early appearance of copper artefacts on sites rather close to Apulia, such as Santa Maria in Selva (Macerata, Marche), Fossacesia (Chieti, Abruzzo), Chieti (Abruzzo) and Lipari Acropolis (Aeolian Islands, Sicily).

2.3. GIS Background

GIS is an acronym for Geographic Information System and identifies a computerized system able to process spatial data, like maps or images, with specific references to a location on Earth's surface.
Overall, the term "spatial data" means a set of observations and measures made in a geographical space corresponding to locations on the Earth's surface. These processes are defined with a spatial measurement framework, i.e. a coordinate system, grabbing their spatial relationship (such as proximity, connectivity and direction) in the real world (Zhu 2016, 9).

The first applications of GIS in the archaeological field appeared in the 1980s in North America and were mostly related to the modelling of the surface referring to the archaeological record, as a consequence of diverse kinds of polynomial functions, and the creation of DEM rasters and digital thematic maps of archaeological contexts or excavations areas.
This kind of technology was adopted in Europe in the 1990s and involved, in the beginning, mostly Cultural Resource Management (CRM) projects. The application of GIS and the introduction of studies that supported it allowed the development of a new approach in the field of Landscape Archaeology. Through the involvement of aspects such as culture, society, economy or politics it was possible to analyse in-depth the development of ancient communities, generating new models in order to build theories (Scianna/Villa 2011, 337). In other words, all these aspects triggered the improvement of spatial investigations through the use of tools that helped in data interpretation and namely the reconstruction of a human-environment integration. This is the aim pursued by specific GIS analysis, such as visibility, inter-visibility and cost-surface, all of which scrutinize the interaction and perception between the individual and the environment.
In this perspective, archaeology accomplishes sophisticated solutions to complicated research questions. One of these results was achieved by the Least-Cost Analysis that was used, above all, to reconstruct ancient route network systems (Bell/Lock 2000; Fábrega Álvarez/Parcero Oubiña 2007; Verhagen/Jeneson 2012) or to identify specific locations that hold a central position in a territory (Hare 2004). Therefore, this kind of investigation tries to scrutinize the behavioural assumption of the human tendency to economize the travelling cost in the landscape. This bias is well expressed by White and Surface-Evans's words (2012, 2):

"*As cost increases, the likelihood of interaction decreases. In other words, people are more apt to travel to and interact with areas with greater ease of access.*"

Moreover, the same authors stated that this observation works as (2012, 2)

"a heuristic device for developing baseline models of patterned movement within a landscape that can be used as part of a comparative framework to further explore complex archaeological questions."

White and Surface-Evans wanted to underline how this approach can be helpful to solve those interactions that lie at the core of many complex social, political and economic archaeological questions.

A similar scope was covered by visibility analyses, even though their employment was not common in the beginning. Whilst the New Archaeology, which evolved between the 1970s and 1980s, brought a quantitative revolution in the investigation methodologies, the interest for visibility did not seem to interest the scientific community particularly. An exception can be found in the investigations of the prehistoric monuments of Orkney, edited by Renfrew (1979) and Fraser (1983). The studies, which we could define as statistical non-GIS visibility studies, were aimed at scrutinizing the location of prehistoric cairns that were likely placed in order to delineate a specific portion of territory or activity areas in the wider landscape. The methodology involved several observations from fixed points in the landscape intending to gather information to create maps with overlapping areas of increasing and decreasing visibility. In other words, a series of intervisibility maps was generated which was able to express the reason for the cairn location (Wheatley/Gillings 2000, 180).
Another study, considered as a milestone of the visibility of non-GIS analysis, is Tilley's *A Phenomenology of Landscape* (1994). In this work, the author tried to delineate a framework with which to comprehend the relationships between people and the features of the landscape.
Always in the early 1900s, the first applications of GIS visibility appeared in the studies of Gaffney and Stančič (1991; 1992). The analysis was employed to establish the intervisibility of the Roman towers on the island of Hvar, determining thus a placement suited to visibility needs. Following studies pursued to enhance this investigative approach as observed in Madry and Crumely's paper in which the authors analysed the visibility of Iron Age roads from hillforts (1990) or in Fisher *et al.* (1997) where the authors tried to deal with the issue of the lack of spatial statistics in GIS software.
From 2000 on, the investigation focused also on diverse aspects that influence visibility; some of them are physical, like bodily constraints regarding the field of view, whereas other restraints are cognitive for they are subject to cultural preconceptions which can influence the perception of the environment (Wheatley/Gillings 2000, 7; Wheatley 1993, 135; Lake/Woodman 2003).

In this perspective moves the current study of Van Dyke *et al.* in which the authors use the term *viewscape* to underline that the research moves beyond mere GIS models of viewshed or line-of-sight. In other words, the scope is to analyse the experiential dimension of visibility on the landscape of Chacoan (Colorado), introducing also other perception data, for example results from *soundscape* investigation (2021, 197).

The research project of northern Daunia settles into this special investigative frame. In it, I will try to enhance the approach considered firstly by Delano Smith (1978) and Jones (1987). They showed the possibility to merge the archaeological record with environmental data in order to reconstruct the anthropic landscape. However, the studies were not applied to the whole of northern Daunia, but rather specific areas like the Tavoliere Plain in accordance with the research status of that time.

3. Methodology

Although it is largely demonstrated that Apulia had a special importance during history, it is not easy to give a consistent chronological frame especially for prehistory. This is due to difficulties like anthropogenic activity, like agricultural land use and urban expansion that affected the territory, changing its aspect and, sometimes, also erasing archaeological evidence.
For this reason, a methodology for the investigation was applied that is able to take into consideration the landscape changes in relation to ancient site placements, as displayed in the scheme below:

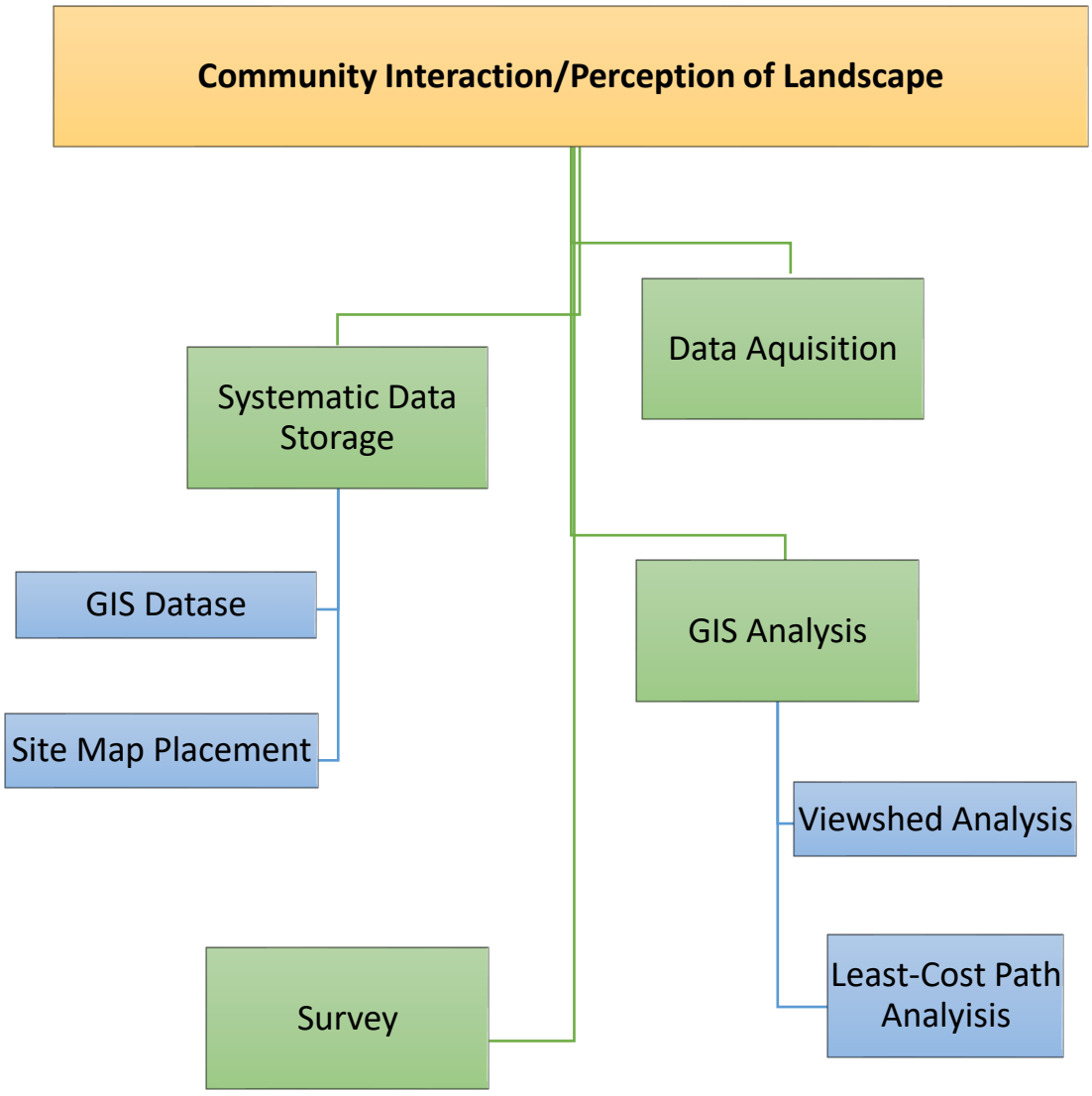


Fig. 58 – Structure of the methodology of the investigation.

The bottom-up scheme reveals that the basis of the research was constituted by the acquisition of the archaeological data and then their sifting to verify the information, especially that related to the geographical placement. Afterwards, it proceeded with the analysis operated in a GIS environment, choosing as investigation typology the Least-Cost Path Analysis (hereafter LCPA) and the Viewshed Analysis (hereafter VA) to gather new insights on the perception and exploitation of the landscape.

The methodology applied tried to obtain more than results merely coming from a "button pushing" operation. The research would like to achieve innovative and new insights responding to the question:

"*What could the landscape suggest/offer for the comprehension of the past?*"

Therefore, moving away to the more common question, often also approach, of:

"*What could we do to comprehend the landscape and its past?*"

The difference is in the perspective that we want to assume; indeed, in the first issue we put the landscape as the main actor of our research, considering that it was the principle scenario in which the whole history played through. Therefore, being a custodian of our past, we should try to analyse the landscape, or better its signs, in-depth; otherwise we will continue to see just what we can decrypt from the material evidence, losing something more important.

3.1. Data Storage Process

For the first time, all the bulk of the information about the Daunian prehistory related to the project was collected and sifted to verify it. Afterwards, the data was introduced to a systematic scheme in order to enhance the comprehension of the historical and cultural frame.

The collection data campaign started considering the following principal sources:

- scientific publications related to Daunia embracing a period from the end of the XIX century to today;

- private archives, such as the Russi Archive (donated to the Superintendence of Foggia);

- private conversations with local amateurs continuously involved in research projects led by the University or the Superintendence (for example, A. Gravina is one of them);

- aerial photography archives (for example, the National Collection of Aerial Photography or the Istituto Centrale per il Catalogo e la Documentazione);

- satellite images (for instance from Google Earth Pro and the National Geoportal of the Ministero dell'Ambiente e della Tutela del Territorio e del Mare);

- geographic institutes for cartographic information and data (such as the Geographical Military Institute);

- institutional documentation from the Superintendence, such as the databases linked to the regional territorial landscape plan or the thematic and technical cartography;

- preventive archaeology reports, like the reports for the creation of the Aeolic Parks.

The information gained from these sources consisted of the archaeological record, the cultural environment, the surrounding landscape and geographical position. Therefore, for the first time, a systematic codification was applied to all this data

which was previously spread in several publications and works, to create a specific geodatabase in the GIS[1] environment.

The database was designed to function as a replicable model applicable also for other research projects or systematic data storing processes. In this specific case, it was necessary to organise the site information, hence simplifying the analysis of each site and the related context in the diverse periods.
Firstly a chronological subdivision was set up; then, three macro-groups pertinent to the periods were generated and then a second differentiation between their phases (fig. 59). It is easy to understand the benefits derived from this adopted scheme: each site was recorded in different layers in accordance with the proper chronological classification, thus allowing diachronic analysis through the chosen layers or just to a chronological phase.

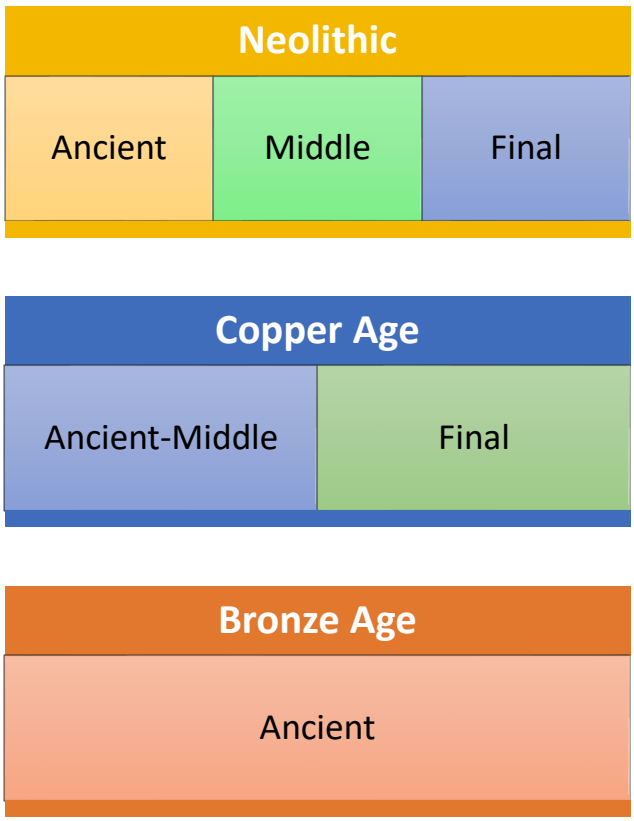


Fig. 59 – Macro-subdivision of the database according to periods and related phases.

[1] For this study and all its analysis, the software ArcGIS v. 10.1 was used because it presented a good accuracy in the LPCA and VA tests, with respect to the following version at my disposal.

Secondly, another scheme was created which is related to specific information linked to the site to simplify the searching process both within the project database and outside (for instance for archive in-depth research). To enhance the accuracy as much as possible, each database record was harmonized according to pre-set parameters as in fig. 60.

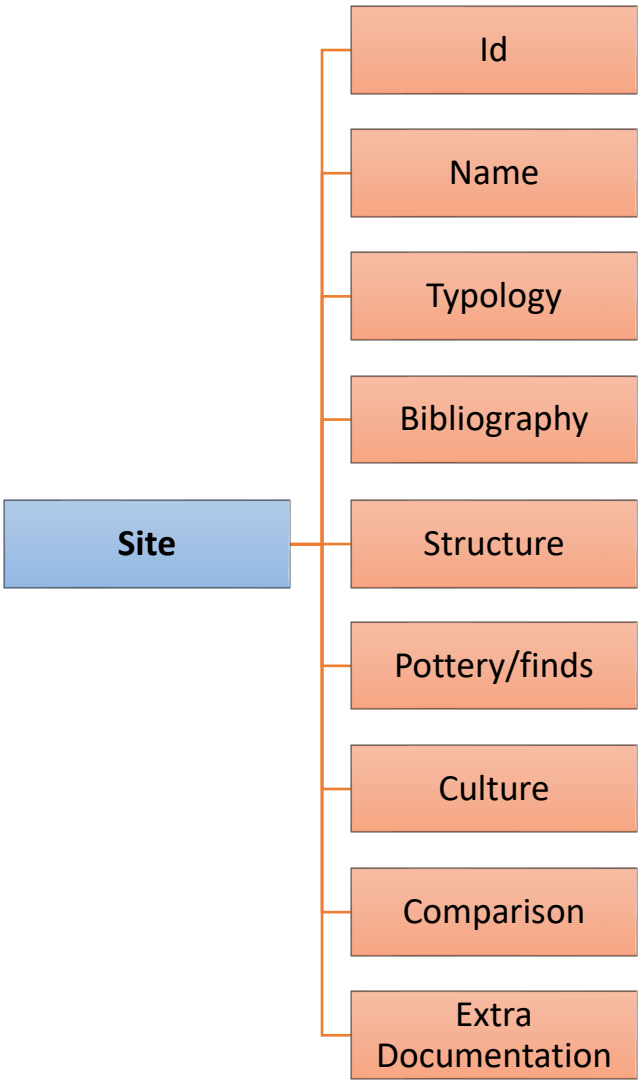


Fig. 60 – Database field structure.

However, before filling the database fields, it was necessary to codify the information according to a precise order, hence interpreting what the authors meant; for example, they may have used slightly diverse toponyms, positions, and typologies for the same site. In particular, the improper use of the word “site” which had been applied to several diverse kinds of archaeological evidence was changed.

After several crosschecks, it was possible to comprehend how to cluster the "sites", identifying three classes:

- Settlements (where concrete evidence for structures was found);
- sporadic find areas (where a very scarce quantity of finds was found that did not permit to think the presence of a village);
- necropolis.

Therefore, each mention was recorded in a proper layer to have a framework as clear as possible. The result is displayed in the scheme below:

Chronological Phase	Settlement	Necropolis	Sporadic Find Area
Ancient Neolithic			
Ceramiche Impresse Facies	21		
Ceramiche Impresse Evolute Facies	49		
Guadone Style	9		4
Masseria La Quercia Style	4		
Ascribable to the Ancient Neolithic, but not determinable	58		56
Middle Neolithic			
Bande Rosse Facies	2		
Scaloria Alta Style	3		
Serra d'Alto Facies	9		2
Ascribable to the Middle Neolithic, but not determinable	11	1	5
Final Neolithic			
Diana Facies	4		2
Diana-Bellavista Facies	11		3
Ascribable to the Final Neolithic, but not determinable	4		3
Anciant-Middle Copper Age			
Macchia a Mare Facies	1		
Piano Conte Facies	7		
Ascribable to the Ancient-Middle Copper Age, but not determinable	15		7
Final Copper Age			
Gaudo, Laterza Facies	1		
Laterza Facies	14		1
Cellino San Marco-Laterza Facies		1	

Ascribable to the Final Copper Age, but not determinable	2		2
Early Bronze Age			
Ascribable to the Early Bronze Age, but not determinable	17	1	12

To have a conceptual guideline of the data provenance, some references as a bibliography (at least the most essentials per site), comparisons (found during previous studies) and main cultural phases with the related finds were introduced. Because of the presence of structures in many mostly Neolithic villages, it was necessary to explicate also this in the fields “structure” and “Extra Documentation”. The fields contain information on the typology of the structures brought to light and the presence of documentation, such as aerial photography or field photos or drawings (fig. 61).

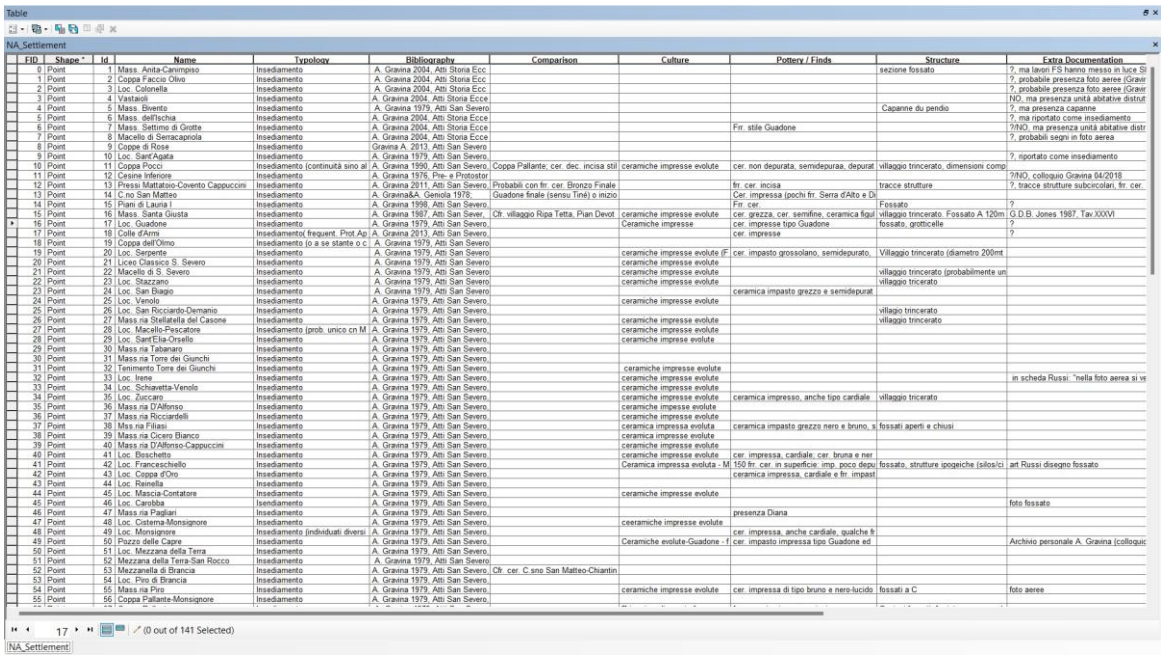


Fig. 61 – Example of database table (image by the author).

The database described above was linked to a shapefile able to express each row in the geometrical shape of a point, hence just an archaeological context, and placing it on the map through the pre-set geographical coordinates.
It is necessary to point out that the site placement involved a good part of the preliminary investigations because of the time and difficulty to verify the sources

and pinpoint the definitive location. For this reason, also Prof. Armando Gravina was involved because of his continuous long-standing survey work in the study area[2].
The site coordinates were recorded according to the Universal Transverse of Mercator projecting (or UTM), whereas WGS84 was used as the geodetical basis and as time zone the number 33 North. That way, all the collected documentation was harmonized in terms of the current cartography.
It is necessary to point out that the same coordinates were applied for the georeferencing process of the whole project developed in ArcGIS and all the features involved.

For this aspect, mainly three kinds of maps were considered in accordance with the scale and hence the type of study to use them for. In particular, i the Geographical Military Institute proved a valuable source for what concerns the so-called *Tavolette*[3] scale (1:25.000) for preliminary inspections and surveys. This kind of map depicts how the terrain is structured through symbols, such as trees for woods or rivers or mountains, and contour lines to signify the elevation. Moreover, the chart gives also information about area toponyms (in a general way, being a 1:25.000 scale), giving hence fundamental support in what concerns the comprehension of the landscape and its identification according to the local culture (fig. 62).

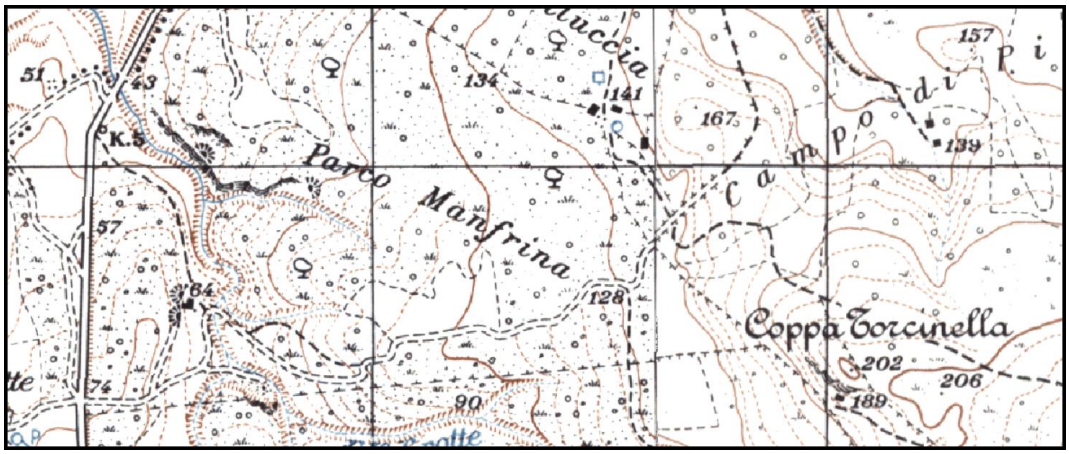


Fig. 62 – Example of IGM from the*Tavoletta* of Poggio Cardalicchio (National Geoportal).

[2] I would like to thank Prof. Armando Gravina for the helpful information to localize the Daunian sites during my stay in San Severo.
[3] The *Tavolette* are a type of cartographical subdivision; according to the cartography each map is considered as *foglio* (scale 1:100.000), then divided into four *quadranti* (scale 1:50.000) and again in four *tavolette* (scale 1:25.000). Therefore, each *tavoletta* covers a surface of 10 km x 10 km (it means, 7'3'" Longitude and 5' Latitude).

For the site placement, the Regional Technical Cartography (Italian acronym for CTR) was used because its scale of 1:5000 allowed to gather more information regarding aspects of the landscape and because it proved useful for an accurate site placement on the map.

As in the previous map, the CTR displays the terrain elevation trend and features (for instance woods or river) but also a more detailed subdivision of the zones according to their local toponym and modern-day buildings. Moreover, the map shows a rough plot plan of the lands (fig. 63).

This kind of accuracy in combination with the literature cross-checking permitted to identify the appropriate location of the sites. The final result of this preliminary investigation was the creation of several distribution maps according to the site typology and chronology, as in the table above**.**

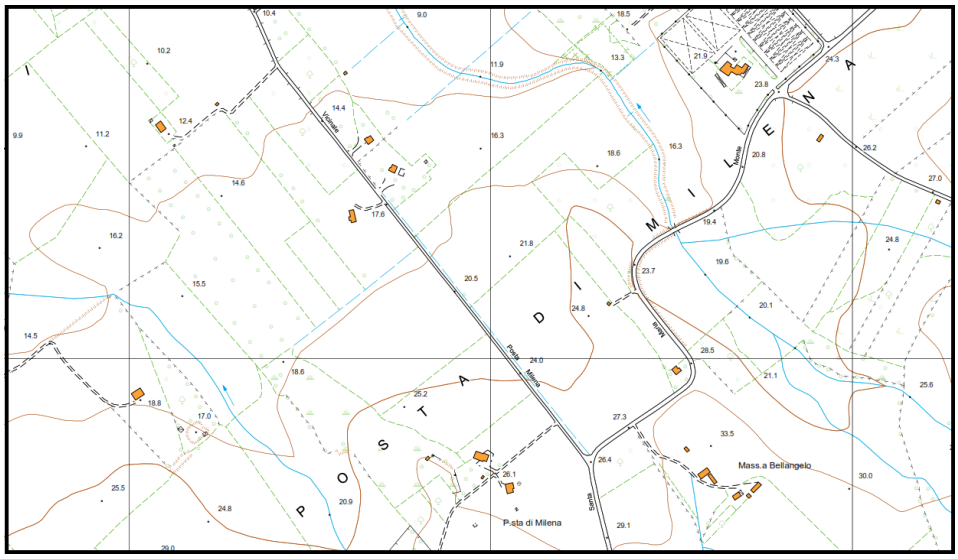


Fig. 63 – Example of CTR from the area of Coppolino (image by the author).

3.2. GIS Analysis

Both investigations were operated on the topographic model of a Digital Terrain Model (hereafter DTM) as the representation of the bare earth with data files containing the elevation values of the terrain in a digital grid. Therefore, vegetation, buildings and other cultural features are previously removed digitally. In this specific case, the DTM has a resolution of 8 x 8, i.e. 8 meters to the ground, enough to gather accurate data. The raster, taken from the website of Territorial Information System developed by the Regione Puglia (www.sit.puglia.it), is composed of several tiles merged to get a single image. Each tile corresponds to a specific portion of the territory that was split following the CTR subdivision. The merger operation was performed by ArcGIS.

Once the digital surface on which the analysis took place was established, a Viewshed Analysis was conducted in order to generate the simulation of the sight of a target from a source point located both on an elevated and a flat area. In this way, it is possible to identify those features responsible for the spatial distribution of the settlements.
This is possible due to the estimation of the line of sight for a point location. In other words, for each raster cell a straight line can be interpolated between the source point and every other cell within the elevation model. Therefore, if the heights of the cells involved in the calculation do not cross the line there is a line of sight (fig. 64b); otherwise, if the line exceeds the height of any cells, there is no line of sight (fig. 64c) (Wheathley 1995).

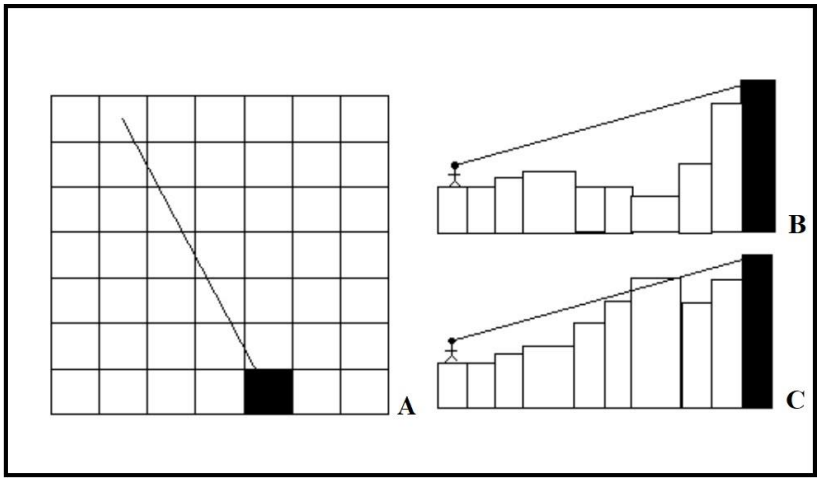


Fig. 64 – Schematic illustration of line of sight estimation. A) Interpolation of line between two cells of the elevation model; B) Presence of line of sight; C) Cell heights exceed the line (image elaborated by the author from Wheathley 1995).

Therefore, the calculation is also influenced by specific parameters that the researcher has to set in advance in order to calibrate the GIS algorithm. For this study case, the considered elements were the target height and the observation radius. The first was fixed to 1.65 m as the average height of a prehistoric individual; the second parameter was defined as 15 kilometres as the maximum distance an individual could see in optimal weather conditions (fig. 65) (Wheathley/Gillings 2000, 2002).

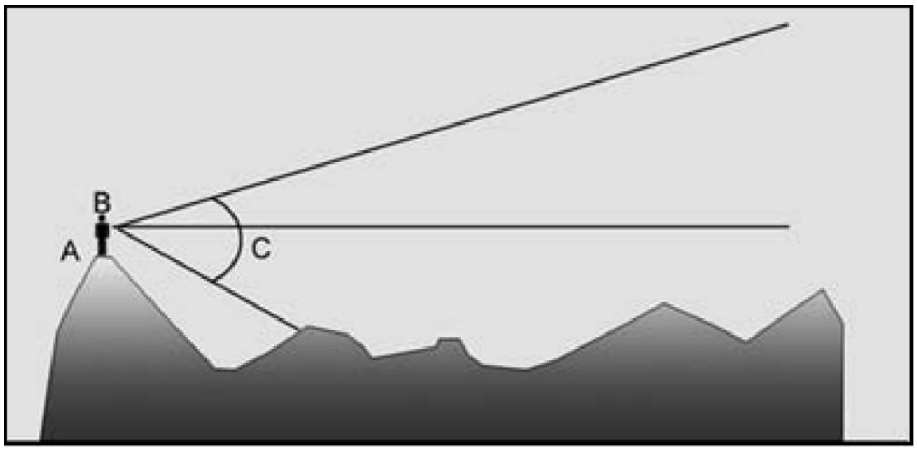


Fig. 65 – Scheme of the parameters involved in the VA. A) Observer location; B) Observer height; C) Radius of visibility (image by the author from Pecere 2006).

The result of this discrete calculation is a binary image: a raster conventionally coded with the value of 1 for all cells visible from the source point and with the value of 0 for those with no line of sight. Although this approach could produce important information, it was necessary to expand the analysis in order to gain more insights from the calculations. For this reason, the Fuzzy Viewshed Analysis was chosen as visibility investigation method in order to determine not only the areas falling into the visibility spectrum but also the drop in visibility. In general, the Fuzzy logic is a form of many-valued logic in which the values are included in a scale between 0 and 1, thus giving different degrees of the data in study. In this way, the result of the analysis will be more positive if towards 1 or negative if towards 0. In contrast, in Boolean logic the values are coded in a binary way, hence the result is expressed just with the integer numbers 1 and 0 (Stefanakis *et al.* 1999; Kainz 2011).

As far as the history of this research is concerned, it was Fisher who was the first to apply the fuzzy logic method taking into account the decay of visual clarity with the distance. Considering older studies (Higonuchi 1983; Kendel 1986; Burrogh *et al.* 1992), Fisher proposed to apply the analysis to different degrees of clarity of a target by an observer under different circumstances. He applied the fuzzy logic instead of the binary "visible/not visible", representing the visibility data through a degree scale ranging from 1 (visible) to 0 (not visible) in which the values in between can be characterised in terms such as "usually visible", "sometimes visible" and "visible only under very favourable conditions".
To do that, Fisher generated fuzzy membership values considering a distance decay function based on the distance from the observer. Similarly to the approaches by Higuchi (1983) and Felleman (1986), a model was created in accordance with the drop-off visibility zones: foreground, middle-ground and background.

Fisher adopted the following formula:

$$\mu(x_{ij}) = \begin{cases} 1 & \text{for} \quad d_{vp \to ij} \leq b_1 \\ \dfrac{1}{\left(1+\left(\dfrac{d_{vp \to ij}-b_1}{b_2}\right)^2\right)} & \text{for} \quad d_{vp \to ij} > b_1 \end{cases}$$

Where (x_{ij}) indicates the fuzzy membership at the cell at row *i*, column *j*; $d_{vp \to ij}$ is the distance from the viewpoint to row *I*, column *j*. B_1 is the radius of the zone around the viewpoint in which perfect clarity of the seen target is attested, b_2 is the distance between b_1 to the so-called crossover point (i.e. the membership value of 0.5).
It is necessary to point out that the target and the b_1 value are directly proportional, meaning that if the observed object will be small, b_1 will be correspondingly small.

Therefore, it is possible to interpret the sight range as (fig. 66):

- Foreground, what lays within 1 km from the viewing point;

- Middle ground, where the clarity starts to degenerate and it corresponds to the end of the b_1 region and a little portion of b_2. It depends on the acuity of the observer;

- Background: it coincides with the region in which the observer can perceive only broad landscape features (Fisher 1994, pg. 165).

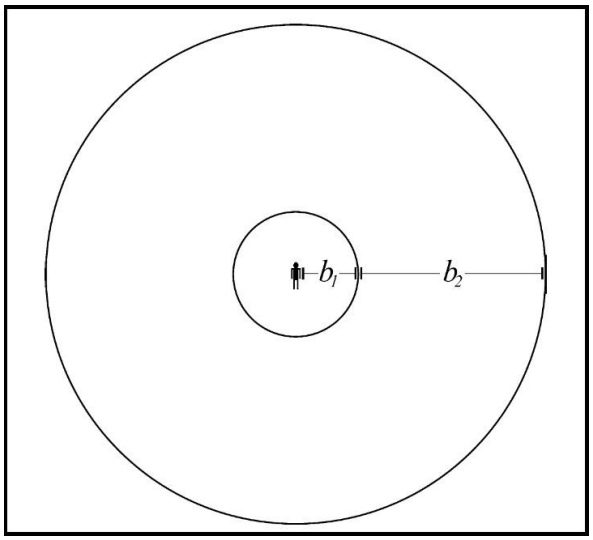


Fig. 66– Scheme of the clarity decay range: B_1) Distance between the observer and the limit of the foreground; B_2) Distance between the b_1 border and the beginning of the "crossover point", where the visibility starts to decay (Ogburn 2006, pg. 409).

Despite the innovative approach proposed by Fisher, for research it was necessary to choose a similar calculation able to show a more accurate result. Therefore, the results presented by Ogburn were considered which , expanding Fisher's formula, added a new parameter to the analysis: the size of the target. In other words, by exploiting the trigonometric relationship between target size and distance from the observer it generated a "target size-sensitive fuzzy viewshed", as defined by Ogburn, where the fuzzy membership values change in accordance with the distance and in relation with the size of the observed object (Ogburn 2006, pg. 409).
To do that the author modified Fisher's formula replacing the sum of *b1* and *b2* (i.e. the "crossover point") with a variable that indicates at which distance the target loses, likely, a certain level of clarity.

Ogburn identifies this “breaking point” with the distance at which an object has the highest level of recognition that happens when it subtends a visual arc of 1’.

Mathematically:

$$\tan(\beta/2) = s/2d$$

The formula describes the trigonometric relationship between the object width (s) and the visual arc (β), both related to the distance from the viewer (d). From this equation derives:

$$a = \frac{1}{2\tan(\beta/2)}$$

In this way, the formula determines a distance multiplier (a) for a given arc; therefore, when multiplying the width of an object by (a), the result is the visual arc at which it subtended the object (Ogburn 2006, pg. 410).
Consequentely, Ogburn substitutes, in Fisher’s formula, the visual arc value with the $b_1 + b_2$ value in order to obtain a more gradual drop-off in sight clarity than in Fisher’s calculation (fig. 67)

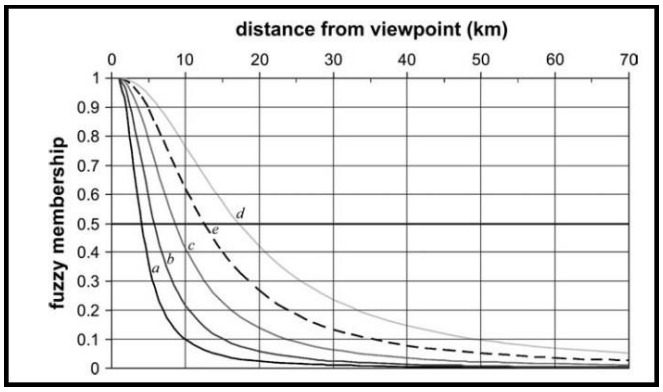


Fig. 67 – Graph of the clarity decay in fuzzy membership (value from 1 to 0) over distance (in km) as calculated by Ogburn operating different variations of Fisher’s formula. The curve *a* identifies Fisher’s original formula: b_1 = 1 and b_2 = 3. Curve *b*, *c* and *d* display the drop-off according to Ogburn’s modification in which the object is 5 mt wide, b_1 = 1 in all three curves and the visual arc value is 3’ (curve *b*), 2’ (curve *c*) and 1’ (curve *d*). The curve *e* uses a visual arc of 1’ with a factor of 2 incorporated into the denominator in order to give back a less gradual drop-off (also in this case b_1 = 1) (Ogburn 2006, pg. 409).

This last approach was considered appropriate for the research because, when analysing contexts surrounded by the open landscape, it becomes important to gather information on how an observer could perceive a subject or object at a long distance.
The analysis was computed into the GIS environment through the ArcGIS toolbox, called Fuzzy Viewshed developed by the researcher Alberti from the Univerisity of Malta.
The tool, which is built on the Ogburn's calculation, fixes *b1* at 1000 mt, like Fisher and Ogburn suggested, while *b2* is computed by the toolbox multiplying the target height (chosen by the user and expressed in meters) with a distance multiplayer of 3440 (obtained through Ogburn's equation) and constituting to a visual arc of 0.01667 degrees (i.e. 1 arc-minute). Therefore, *b1* is subtracted from that value and hence the *b2* value is generated.

Concerning the parameter setting, the observed object was fixed to a height of 1.65 mt devising as target a person with a medium height for that time, a value suggested by Weathley and Gillings (2000, pg. 6). As surface model, the DTM was used (fig. 68) (Alberti 2017).

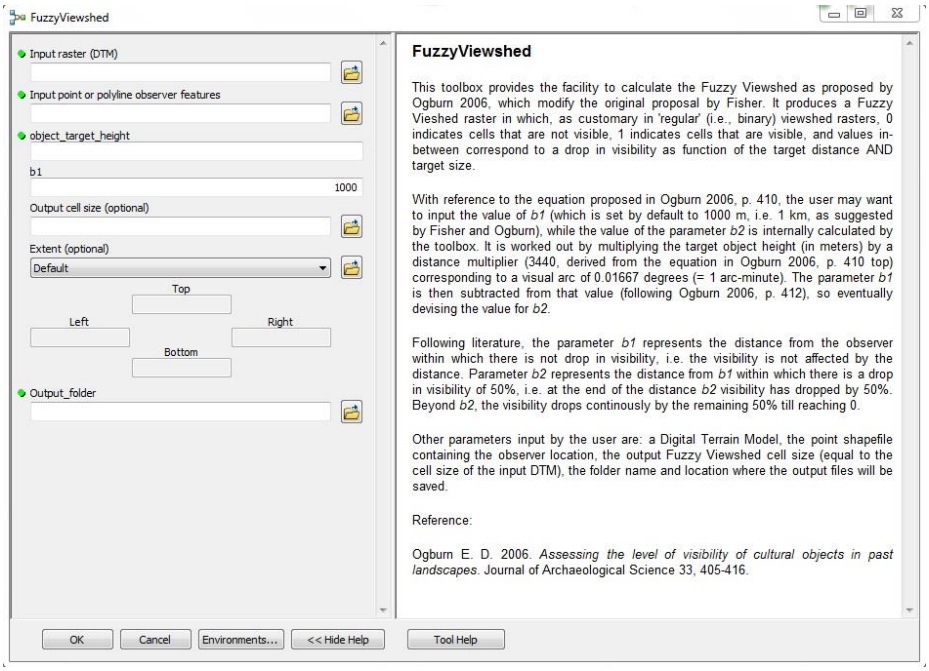


Fig. 68 – Toolbox data input window (Alberti 2017).

The final product is a raster with a visibility spectrum showing the clarity drop-off through a shade scale from the observer point to a maximum radius of 15 kilometres, where it was possible. The radius changed according to the morphology of the surrounding landscape, hence how the line-of-sight could move freely into the space around the observer point (Filloramo *et al*. 2021b).

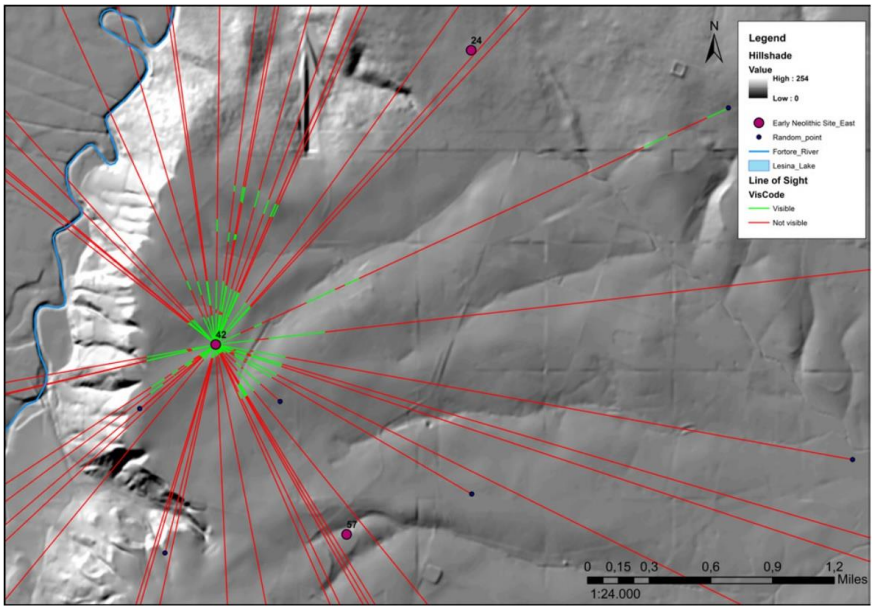


Fig. 69 – Example of line-of-site applied to the site of Piani di Lauria (purple dot). The discontinuous green line shows the presence of obstacles like the ridges of the hill (Filloramo *et al.* 2021b, pg. 126).

The second step of the GIS analysis concerns the geospatially-focused approach of the LCPA that permits to analyse the landscape under the aspect of mobility, keeping as an assumption that humans make decisions about their movement with a firm awareness of the surrounding territory. Moreover, the choices attempt to minimize the cost of the movement.

The closeness, or neighbourhood aspect is considered as the core concept of the spatial information with reference to Tobler's first law of geography that states:

Everything is related to everything else, but near things are more related than distant things.

From Tobler's words, the important role of the nearness in the estimation of the least cost path is issued, because this kind of analysis is a quantitative geographic

technique strictly linked to this parameter (Etherington 2016; Kuhn 2012; Tobler 1970, 236).

In any case, the cost can assume several interpretations like travelling time (the fastest path linking two points) or energy (the path involving the lowest energy consumption), in accordance with the research scope (Herzog 2010, 2014; Minetti *et al.* 2002; Pandolf *et al.* 1977). In the specific case, the investigation aims to analyse the movement between the sites, hence the cost is interpreted as travelling time.
To calculate this aspect it was necessary to introduce Tobler hiking's function into the process that puts the topographic gradient and the velocity of an average hiker in relation (fig. 70):

$$\mathrm{W} = 6\exp\{-3.5 * \mathrm{abs}(S + 0.05)\}$$

where W is the walking velocity, *S* is dh/dx = slope = tan (theta). The velocity is given in km/h; on flat terrain this works out to 5 km/h, while for off-path travel it has to be multiplied by 3/5 (i.e. 0.6) (Tobler W. 1993, pg. 4).

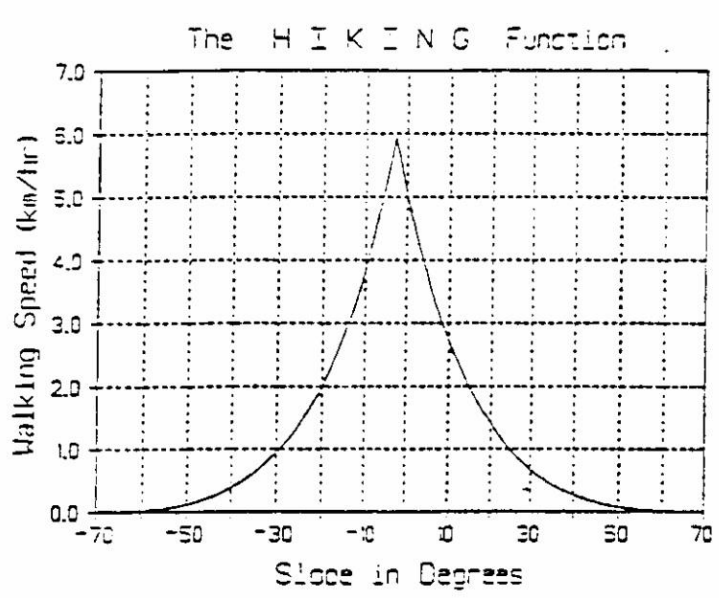


Fig. 70 – Tobler's hiking function graph (Tobler 1993, 4).

From this premise comes Tripcevich's equation that permits to convert the terrain degree trend (i.e. the slope) to time into the ArcGIS environment (Tripcevich 2009). The researcher estimated the reciprocal of Tobler's function in an Excel file by using the following equation:

TIME (HOURS) TO CROSS 1 METER or the reciprocal of Meters per Hour = 0.000166666*(EXP(3.5*(ABS(TAN(RADIANS(slope_deg))+0.05))))

The result is a table expressing the vertical factor for any slope degree (fig. 71)

Slope (deg)	Vertical Factor
-90	-1
-80	-1
-70	2.099409721
-50	0.009064613
-30	0.001055449
-10	0.00025934
-5	0.000190035
-4	0.000178706
-3	0.000168077
-2	0.000175699
-1	0.000186775
0	0.000198541
5	0.000269672
10	0.000368021
30	0.001497754
50	0.012863298
70	2.979204206
80	-1
90	-1

Fig. 71 – Part of the Tripcevich's reciprocal calculation table (Schild 2016, pg. 27).

Once established how to calculate the cost in terms of travelling time, the following step was to collect and generate all the features involved in the GIS analysis. In other words:

- the DTM, as surface containing the elevation data;
- the slope, as surface trend raster;
- the sites involved as source/destination points.

As far as the slope was concerned, the surface trend in degrees was computed from the DTM, generating a raster in which each slope is identified by a colour ramp (fig. 72). For this data, the tool *Slope* was used that, in brief, adapts a plane to the elevation values of a 3x3 cell neighbourhood around the centre cell. The slope value of the plane is estimated using the average maximum technique, while the aspect for the processing cell is the direction towards which the plan is addressed. Therefore, "the lower the slope value, the flatter the terrain; the highest the slope value, the steeper the terrain" (Esri's Help - How Slope Works).

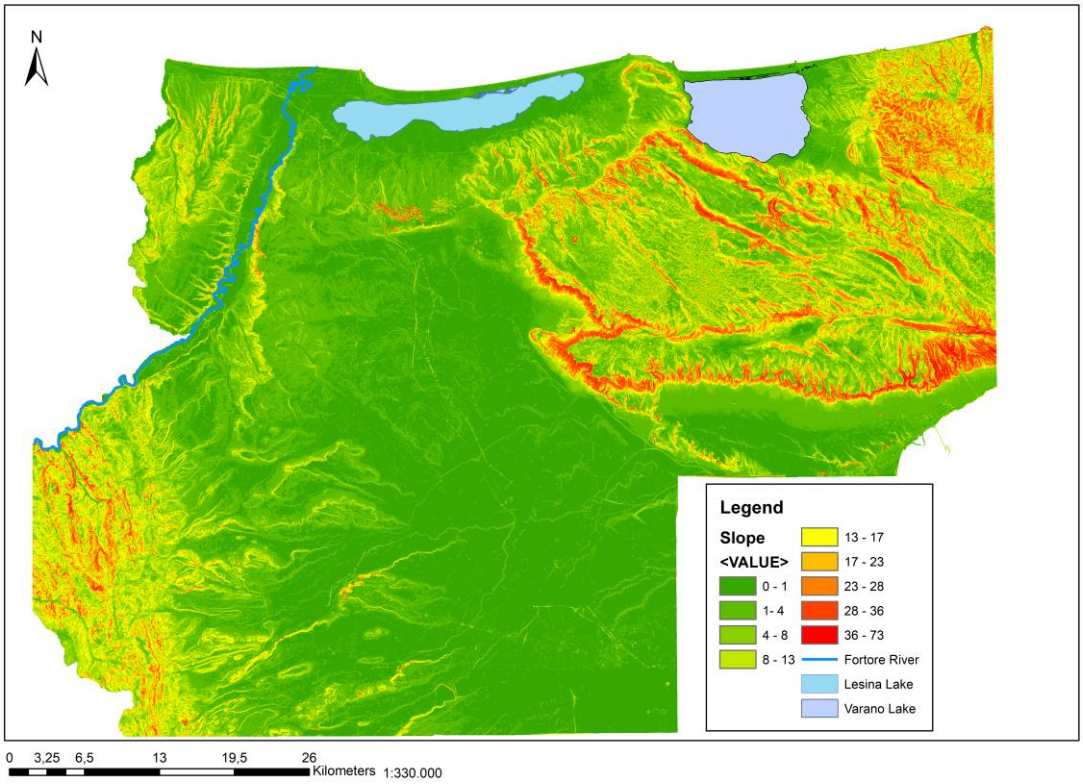


Fig. 72 – Slope raster edited in ArcGIS (image by the author).

Regarding the sites, they were used as source and destination points for all chronological moments. Because of the high number of sites, the only exception was the Ancient Neolithic where the settlements considered were those placed at the borders of the study area, in order to analyse the incoming and outgoing routes, while the core area, i.e. the most populated zone, was subject of a Thiessen analysis because of the closeness of the sites that suggested certain communication links between them.

The above-mentioned data was used as input into the *Path Distance* tool in order to generate an accumulated cost raster, i.e. a surface expressing for each cell the travelling time cost value from the source to the destination (fig. 73).

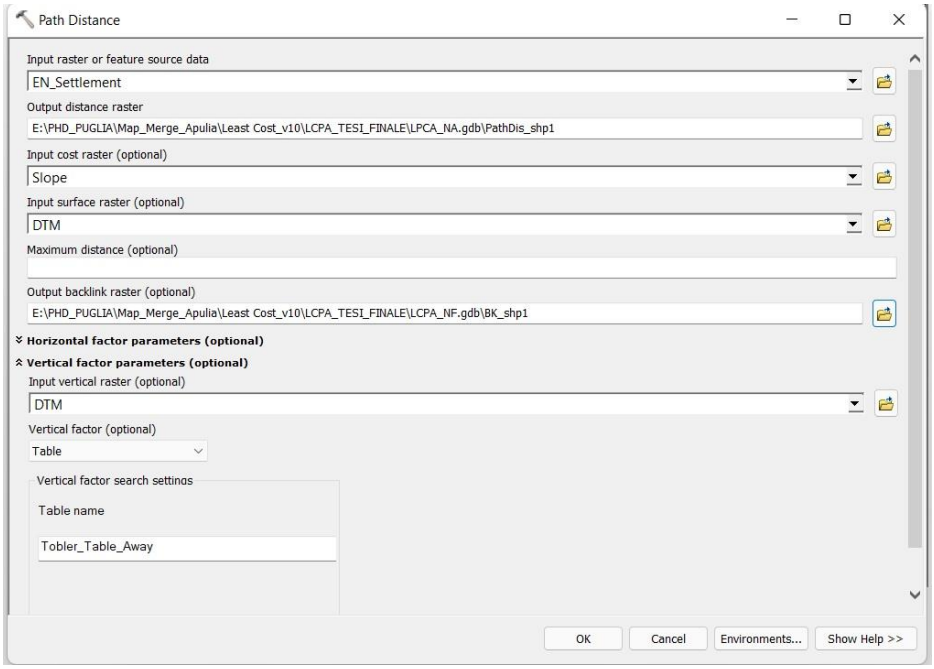


Fig. 73 – *Path Distance* tool window (image edited by the author).

The calculation works by using the Dijkstra's Algorithm to find the least-cost distance (Dijkastra 1959)

$$lcd_{i,j} = \min \sum_{i=1}^{j-1} e_{i,i+1}$$

Where *lcd* is the least-cost distance between *i*, the start vertex, and *j*, the end vertex, that is the minimum possible sum of the edge weights between vertexes placed along the shortest path. In other words, the algorithm works in an "interactive vertex by vertex spreading manner" generating a tree-shape calculation in which the root is the source point and from which it branches out towards other vertexes searching the shortest path. Eventually, the accumulated sum of the edge weights that conduct to the vertexes, forming the tree, are converted into an accumulated surface (or friction surface) (Etherington 2016, 42) (fig. 74). Therefore, it is possible to consider the new raster as an anisotropic surface, i.e. a surface in which the movement is direction-dependent (Collischonn/Pilar 2010).
Afterwards, the new raster was employed to convert the tree branches into a vector least-cost path through the use of the tool *Cost Path* and the conversion in a polyline shapefile.

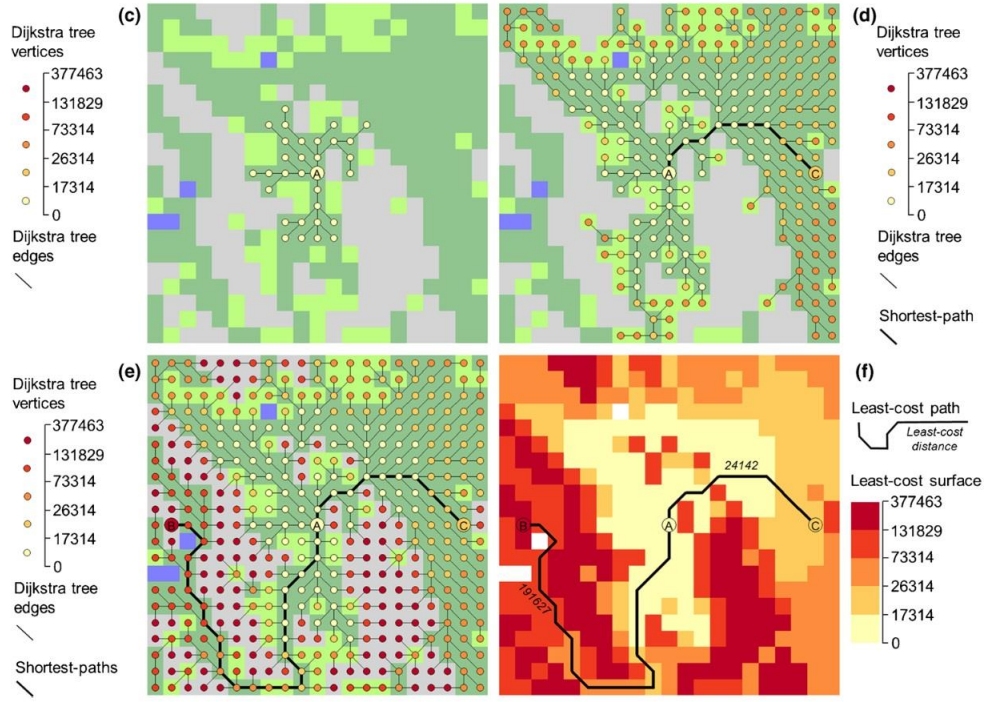


Fig. 74 – Example of Dijkastra's Algorithm tree: c-e) how the algorithm estimates the shortest path; f) once it computes the path, the tree branch is converted into a vector least-cost past path (Etherington 2016, 42).

It is necessary to point out that the calculations were run in the same way for each period, except for the Ancient Neolithic where it was chosen to introduce the data coming from the geological investigation led by Gravina, Mastronuzzi and Sansò (2005) (see chapter 2).
Although the research should be improved with extra samples, it was thought to consider, for the first time in this kind of analysis, the ancient coastline border to gather new insights for the following investigations (fig. 75).

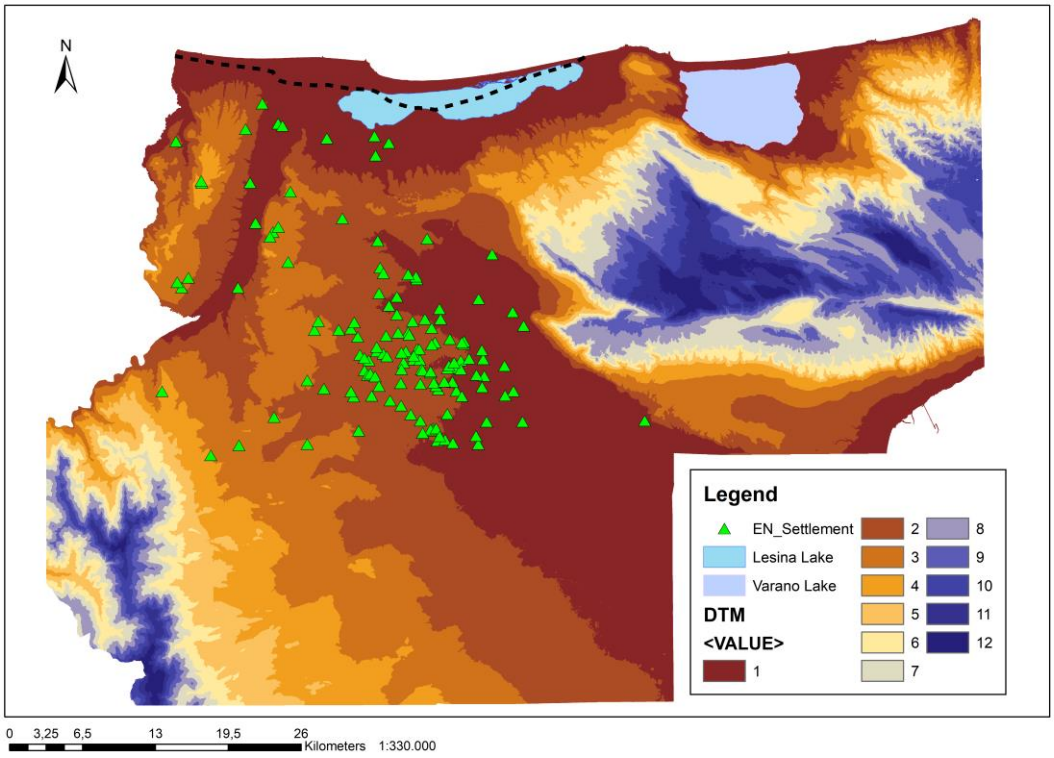


Fig. 75 - The DTM used for Early Neolithic LPCA with highlighted ancient coastline (dashed line) and Early Neolithic settlements (green triangles) (image in ArcGIS by the author)

After the acquisition of all networks, the investigations continued to scrutinize the possible routes connecting each settlement to the diverse inner and outer areas. The aim was to trace down the correspondence between the site placement and social and economic rising trends developing, above all, since the end of the Final Neolithic, and thus to understand the reason for settlement choice.
Moreover, the investigation tried to check if the generated paths survived diachronically by overlapping the networks belonging to different periods; similarly, this possible overlap was investigated between the paths, transhumance routes and modern paths. To have a more complete frame, the following step of the research aimed to find these traces also in the landscape through planned surveys.

3.3. Survey

The GIS analysis is linked to the research in the field through survey activity that allowed to confirm what was found in the literature and to gather new insights. For this activity, the Italian Territorial Maps (scale 1:25.000 and 1:5000) and the Cadastral Maps (scale 1:200) were used because of their accuracy in the parcelling out of the land and hence in the identification of the areas under investigation.
The map is divided in *fogli* (i.e. macro-area identified by a specific number), and each one contains the specific land portion classified in numbered parcels (fig. 76). In this way, it is possible to focus the research on the right field.

Besides the above-mentioned maps, also images from historical aerial photos and satellites were used to trace the territory variations for better identification of the areas under investigation.

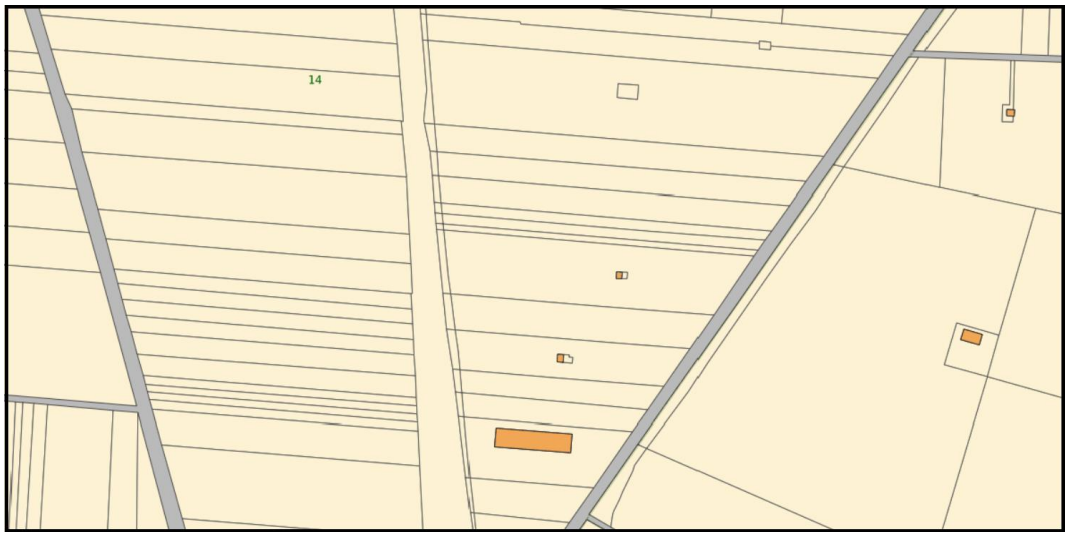


Fig. 76 – Example of cadastral map from San Severo, *foglio* n. 15 (image by the Author)

The investigations were addressed to seven areas falling into the municipalities of Lesina, Serracapriola, San Paolo di Civitate, San Severo, Rignano Garganico and San Marco in Lamis. All municipalities lie in the north of Apulia and were chosen due to the number and the placement of the sites. Moreover, this selection was made to compare different kinds of landscapes; therefore, in accordance with the GIS analysis, three promising micro-regions were traced:

- the first is situated on the left shore of the Fortore River. The area reveals an opening towards the inner regions of the Peninsula;

- the second area is located on the right shore of the Fortore River. The area was chosen because it plays a role as a hub between the Alto Tavoliere Plain and the inner Peninsula;

- the third area is located on the Alto Tavoliere. It represented the most populated area, especially during the Ancient Neolithic, and is firmly connected to the Basso Tavoliere.

The sites placed in these micro-regions enjoyed a good overview of their surroundings, sight contact to each other in good weather conditions and a walking distance from the main connection ways, such as the Fortore River which was in a distance of maximum 3 km from the considered sites situated on the shores.

The survey data was acquired using a handheld Etrex20 Garmin GPS, with which were recorded points, tracks and perimeters of the areas. Regarding the maps, the Garmin TreckMap V5 Pro was downloaded into the Etrex20, which is one of the newly updated maps and contains also the DTM derived from the Italian Territorial Map.
Concerning the satellite system setting, the GLONASS System was chosen in order to enhance the satellite coverage.
As far as the evaluation of the data observed on the field was concerned, a scale value for visibility on the ground, archaeological record and density was created. The visibility scale presented a range from 0 (impossibility to see the bare ground) to 5 (optimal visibility); as far as the archaeological density was concerned, it was put in relation to the presence of the archaeological record and square meters containing finds. In other words, if within a 5 sq. m. surface the record is equal to 0, the evaluation would be rated as "scarce"; instead, beyond a 15 sq. mt and an array of more than 15 fragments, the evaluation would correspond to a "high concentration" (Filloramo *et al.* 2020).

4. Results

4.1. Least-Cost Path Analysis[1]

4.1.1. Early Neolithic

This phase consists of 141 sites categorized as settlements and 60 points indicated as sporadic find areas that are spread almost all over the considered area. The analysis was run just on the settlements since these sites were considered as clear and structured inhabited centres.
It has to be pointed out that for the Early Neolithic it is hard to talk about a deliberate placement of settlements for economic reasons because the society was still anchored to sustenance activities and probably did not have specific interest in the control and domain of the territory. Therefore, the aim of this analysis was rather to gather information on what kind of mobility occured, data never gathered until now.
The estimation was run on defined sites, excluding the core of the bulk of the sites placed in the Tavoliere area because their closeness to each other lead to assume a straight correlation between them (fig. 75).

[1] For the result of the single analysis consults the tables in the Appendix chapter at the relative period section

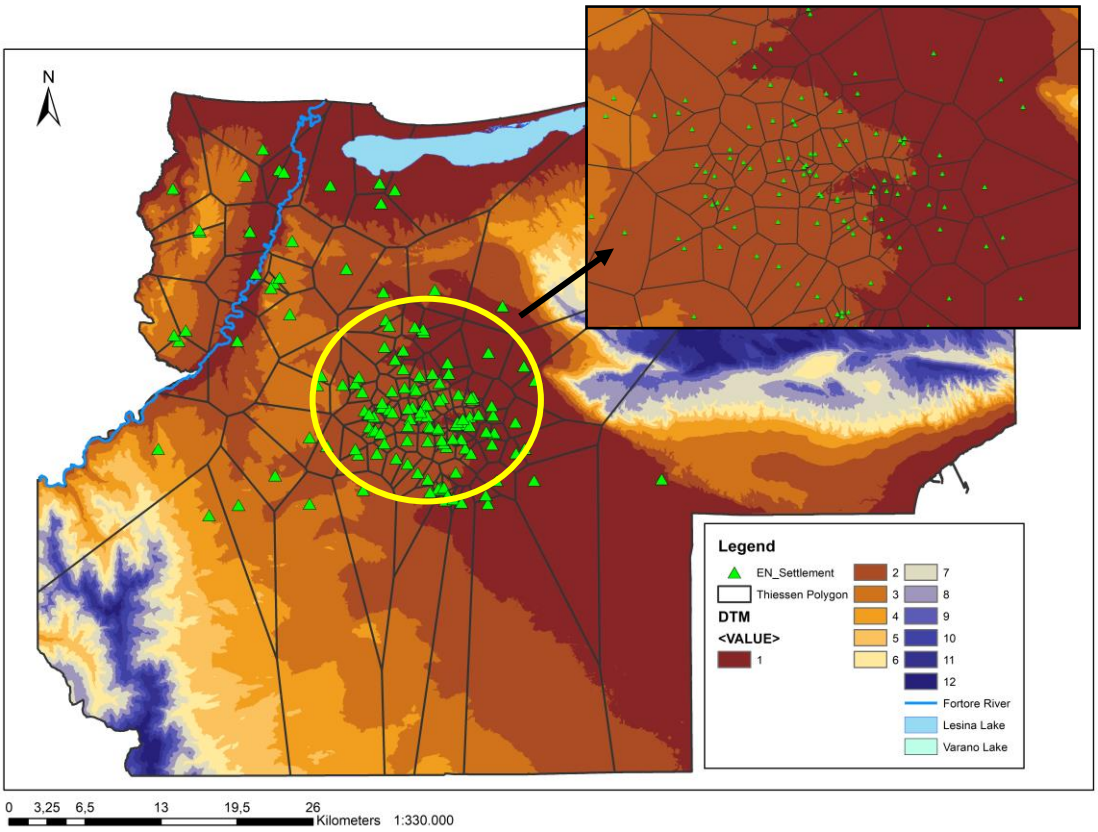


Fig. 75 – Thiessen polygons applied to Early Neolithic settlements. As is visible in the detail square, the sites falling into the Tavoliere area displayed a straight correlation assuming a well-connected network between them (image by the author).

Therefore, the settlements placed along the edges and close to the connection way of the study area were preferred:

- South-western foothills of the Gargano;
- Molise regional border;
- Fortore River valley.

Moreover, it was observed by Gravina *et al*. (2005) that during this Neolithic phase the coastline was different from the present one; hence, to reconstruct the environment, a line able to model the DTM and the analysis was traced (fig. 76, dashed line).

4.1.1.1. South-western foothills of Gargano

The sites considered are four (fig. 76):

- Ciccalento;
- Località Piro di Brancia;
- Mezzanella di Brancia;
- Mezzana della Quercia..

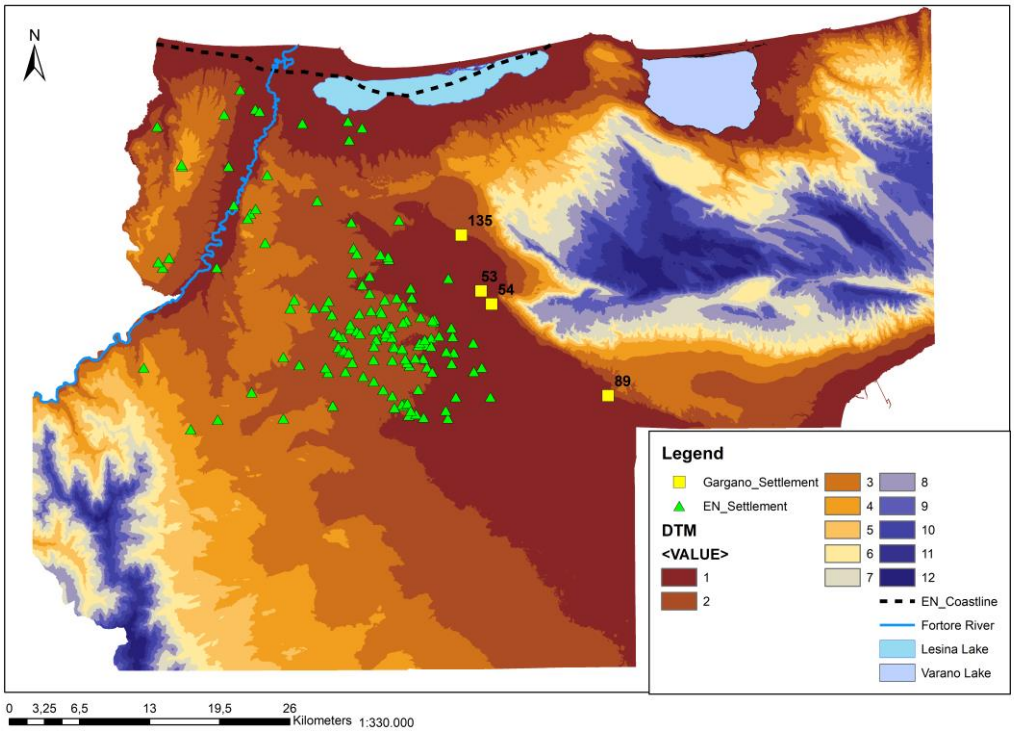


Fig. 76 – Distribution site map: yellow square are the Gargano sites (89 – Ciccalento, 54 – Località Piro di Brancia, 53 – Mezzanella di Brancia, 135 – Mezzana della Quercia). Green triangles are the rest of Early Neolithic sites (image by the author).

The sites are placed along a corridor on the foothill of the promontory where the Candelaro River passes close by. Therefore, thanks to the watercourse, the corridor could be one of the more used routes for mobility from the southern part of the Tavoliere towards the north and vice versa.

The analysis showed that all sites were reachable from the yellow starting points (fig. 76), whilst the estimations have some discrepancies. In specific, the corridor running through the foothills was probably not fully used; the only settlement having a route network covering this area completely is Località Piro di Brancia (fig. 77, id 54). Instead, the other sites seem to prefer the route passing through the Tavoliere Plain because of the terrain trend and position (see LCPA tables).

Therefore, it is possible to speculate that the considered sites were in contact, at least theoretically, because they were well-connected with each other; only the site Località Piro di Brancia (id54) could play a role as a hub in the foothill corridor.

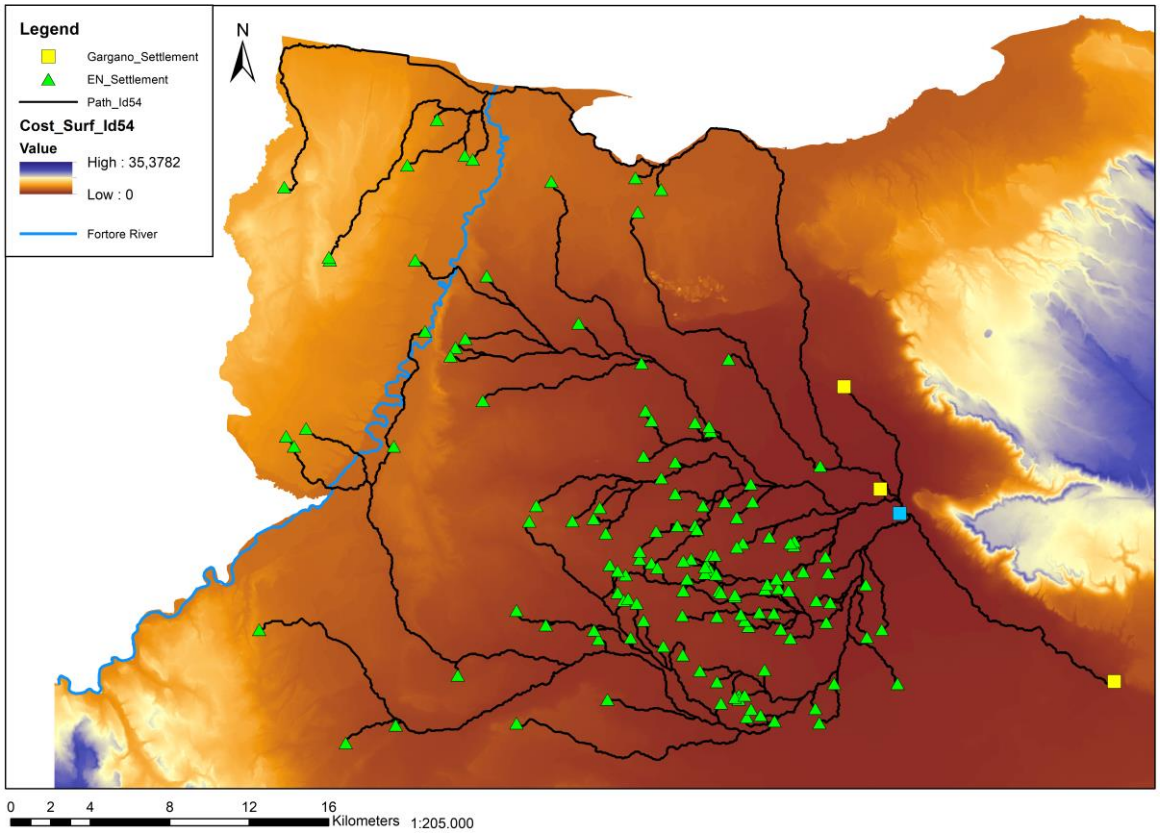


Fig. 77 – LCPA estimated from Località Piro di Brancia (id 54, light blue square) (image by author).

4.1.1.2. Molise regional border

The analysis involved two settlements (fig. 79):

- Masseria Bivento;
- Canale Carpano II.

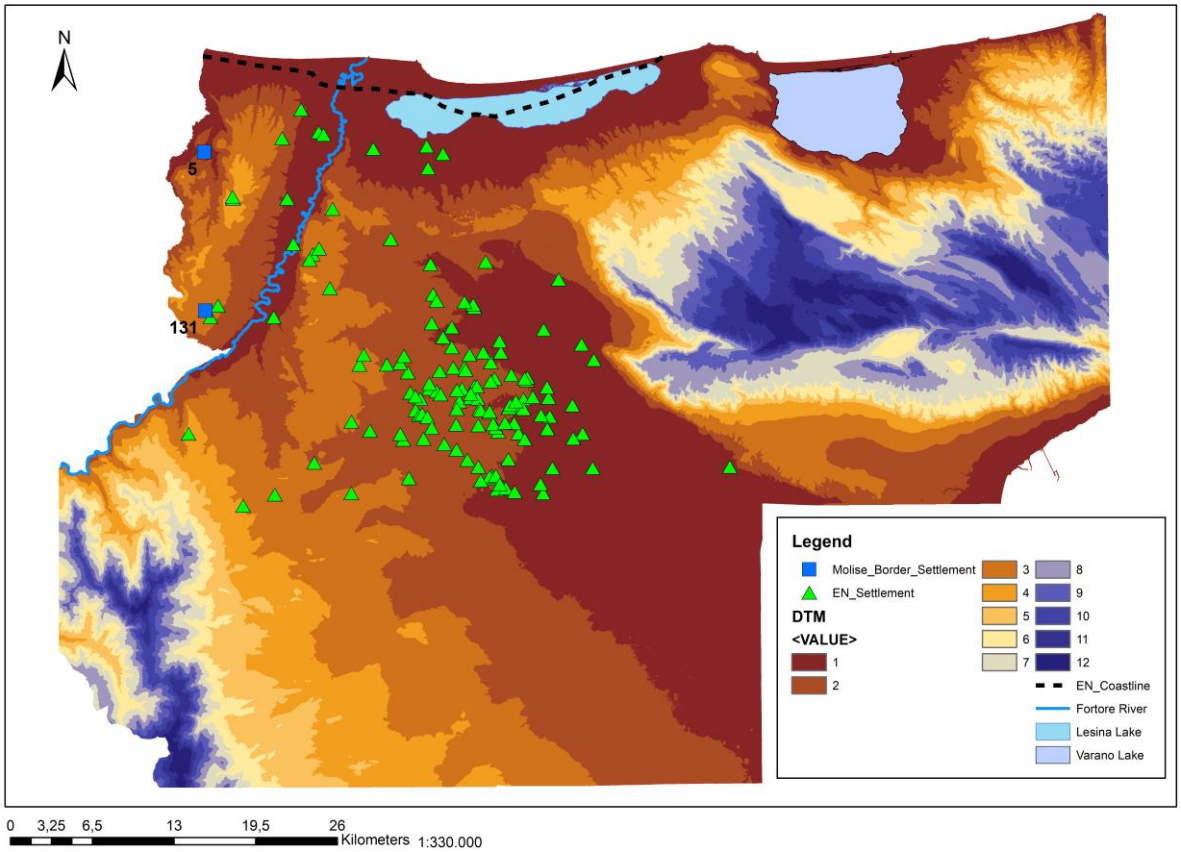


Fig. 78 – Distribution site map: blue squares are the Molise border sites (5 – Masseria Bivento, 131 – Canale Carpano II); green triangles are the rest of the Early Neolithic settlements (image by the author).

The choice of these two sites was due to their particular closeness to the border with Molise which lets us presume a likely communication with the nearby territories. Therefore, the analysis was run in order to comprehend the possible behaviour of these communities who populated a hilly place in clear distance from the main group of the sites.

The calculation marked that, in both cases, the river works as a barrier and at the same time as the main communication way in reaching the inner area of the Tavoliere. The path networks show that, in accordance with the starting point, the routes could have an ascending or descending orientation along the river course, where just in few spots it was possible to cross (fig. 79).

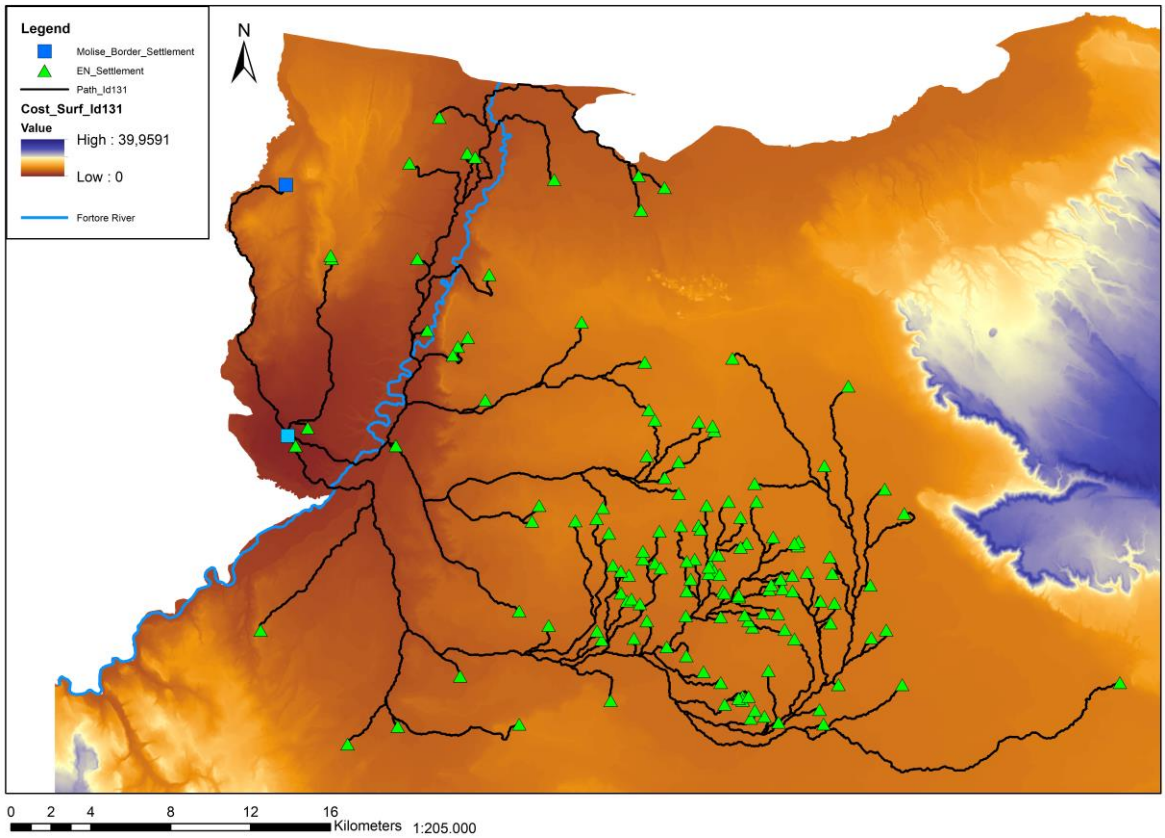


Fig. 79 – Example of LCPA applied to Canale Carpano II site (id 131, light blue square). In this case, the path moving along the river course shows an ascending orientation (image by the author).

Moreover, in accordance with the current river network and assuming that the main watercourses were present also at that time, it is possible to notice also the use of the Torrente Saccione (northern Molise border) and Torrente Staina (south-eastern Fortore side) to reach the sites.

4.1.1.3. Fortore River valley

For this computation, settlements within 3 km distance from the watercourse were chosen, assuming a short walkable roundtrip from the site to the river. This group consists of 14 sites placed all along the valley, therefore the investigation aims to scrutinize mobility in an environment with plenty of natural barriers and a site distribution, apparently, almost apart from the rest (fig. 80).

For some aspects, we could consider the analysis of the Fortore valley and the Molise border as part of a unique investigation frame: a kind of dialogue that occurred between the western district and the Tavoliere Plain.

The considered sites were divided in two groups according to their placement.

East shore:

- Masseria Anita-Canimpiso;
- Coppe di Rose;
- Piani di Lauria I;
- Piani di Lauria III;
- Piani di Lauria IV;
- Colle d'Armi;
- Masseria Fara Sentinella.

West shore:

- Vastaioli;
- Masseria dell'Ischia;
- Masseria Settimo Grotte;
- Località Sant'Agata;
- Cesine Inferiore;
- Canale Carpano I;
- Piano di Lauria bassa.

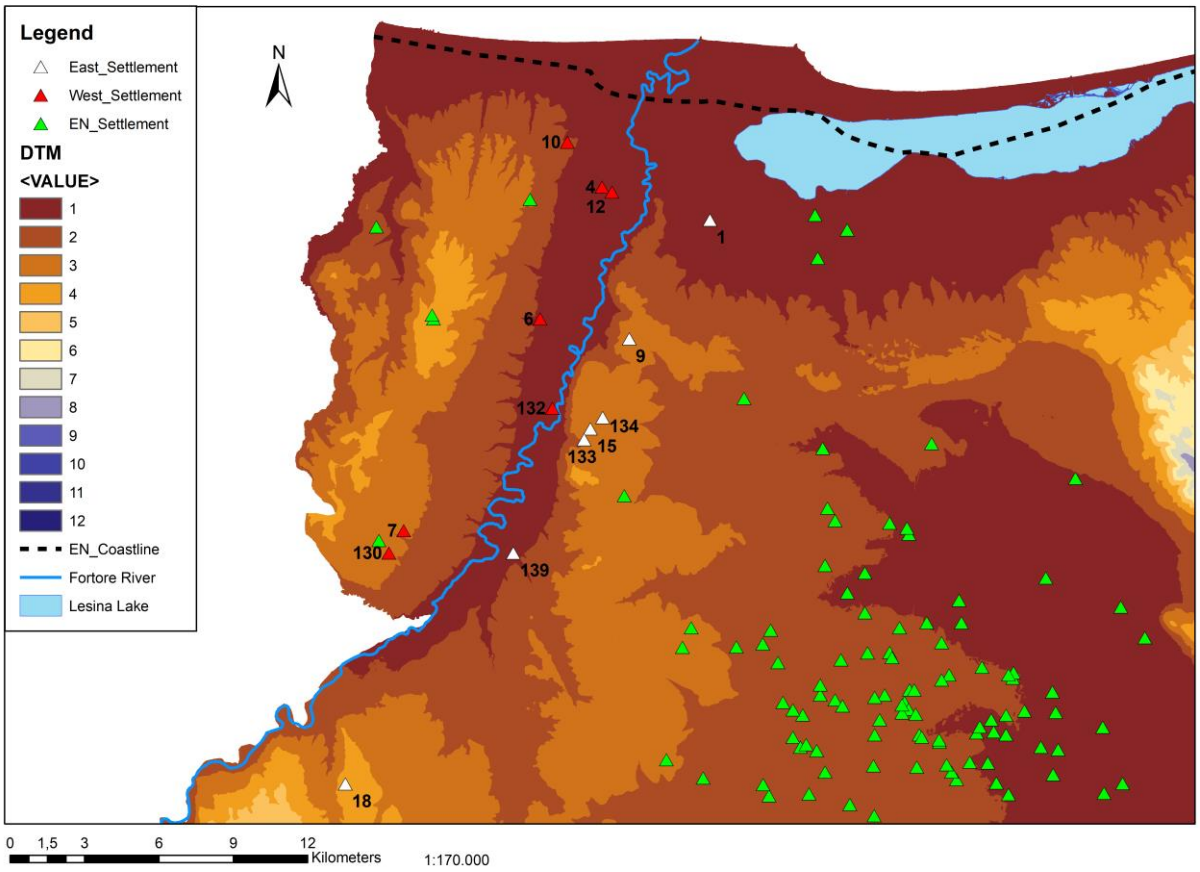


Fig. 80 – Distribution site map: white triangles are the east shore settlements (1 – Masseria Anita-Canimpiso, 9 – Coppe di Rose, 15 – Piani di Lauria I, 18 – Colle d'Armi, 133 – Piani di Lauria IV, 134 – Piani di Lauria III, 139 – Masseria Fara Sentinella); red triangles are the west shore settlements (4 – Vastaioli, 6 – Masseria dell'Ischia, 7 – Masseria Settimo Grotte, 10 – Località Sant'Agata, 12 – Cesine Inferiore, 130 – Canale Carpano I, 132 – Piani di Lauria bassa); green triangles the rest of Early Neolithic sites (image by the author).

As for the previous analysis, it is possible to see in this calculation that the river played a role almost as a barrier, emphasizing the affinity to one shore and not the other. The route network seems to mark the presence of two main clusters (fig. 81, area without circles) and two intermediate clusters (fig. 81, area within circles), in other words, the Tavoliere and river valley area and the respective areas in between. Where the first could represent the main batches, the second could correspond to intermediate points between the valley and the Molise border and the valley and the inner area of the Plain. In any case, it is clear that the watercourse was used as a communication way, even though not for going by boat but for crossing it at specific points (Filloramo *et al.* 2021, 147-149) (fig. 82).

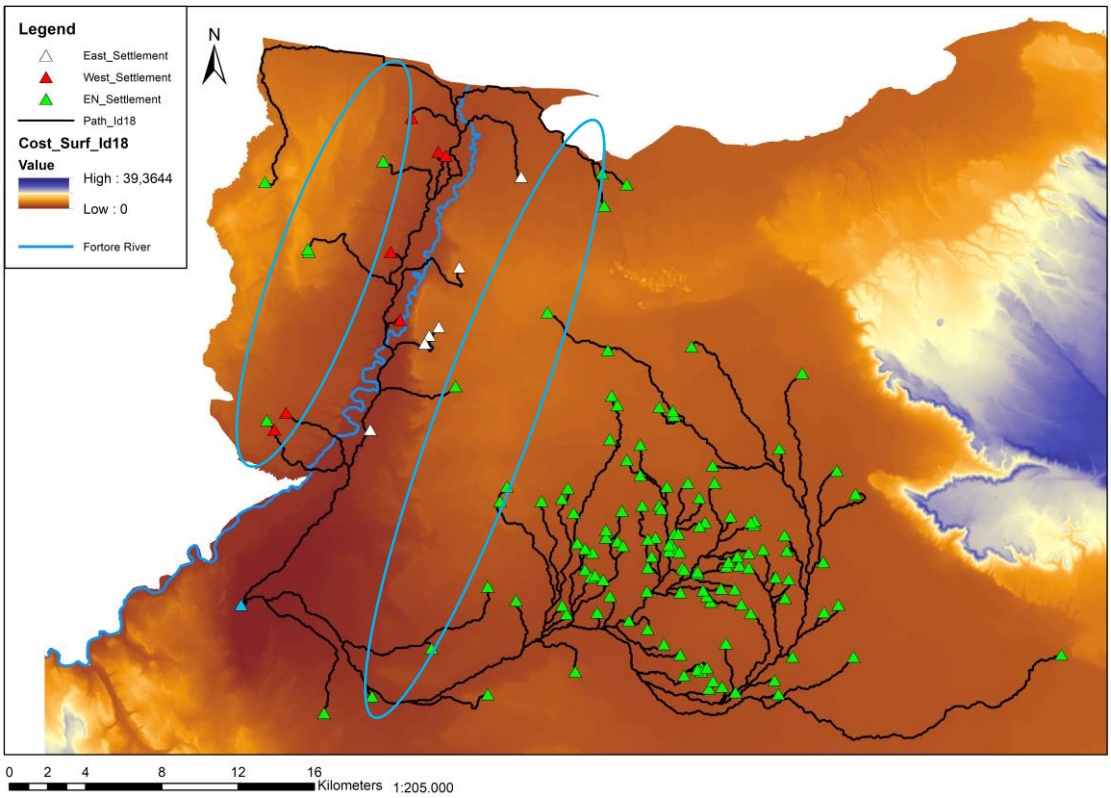


Fig. 81 – Example of LCPA applied to Colle d'Armi (id18, light blue triangle), site of the east shore. The light blue circles emphasize the area into which the intermediate groups fall (image by the author).

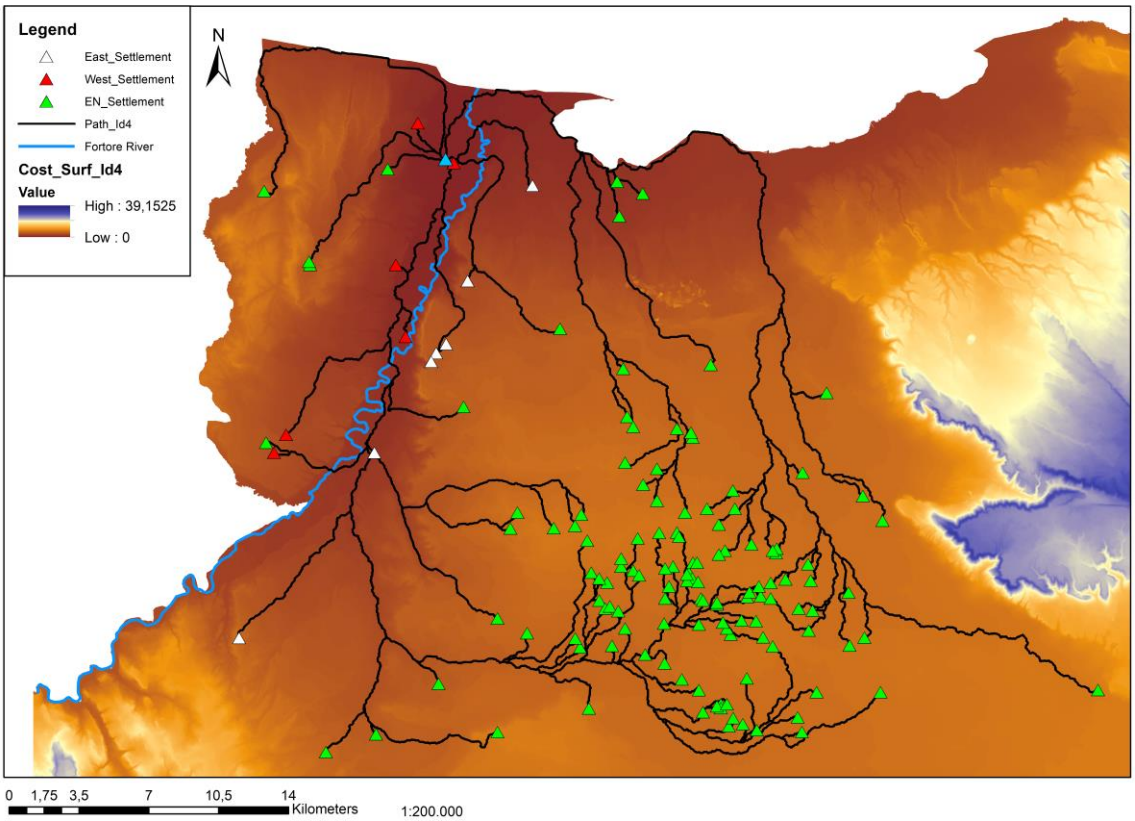


Fig. 82 – Example of LCPA applied to Vastaioli (id4, light blue triangle), site of the west shore (image by author).

A general consideration regarding the generated networks is that most of the paths, according to the starting point, are superimposable. The importance of this information could open new perspectives regarding the understanding of ancient mobility because it could emphasize the presence of clear and consolidated routes in use since the Early Neolithic (figs. 83-84).

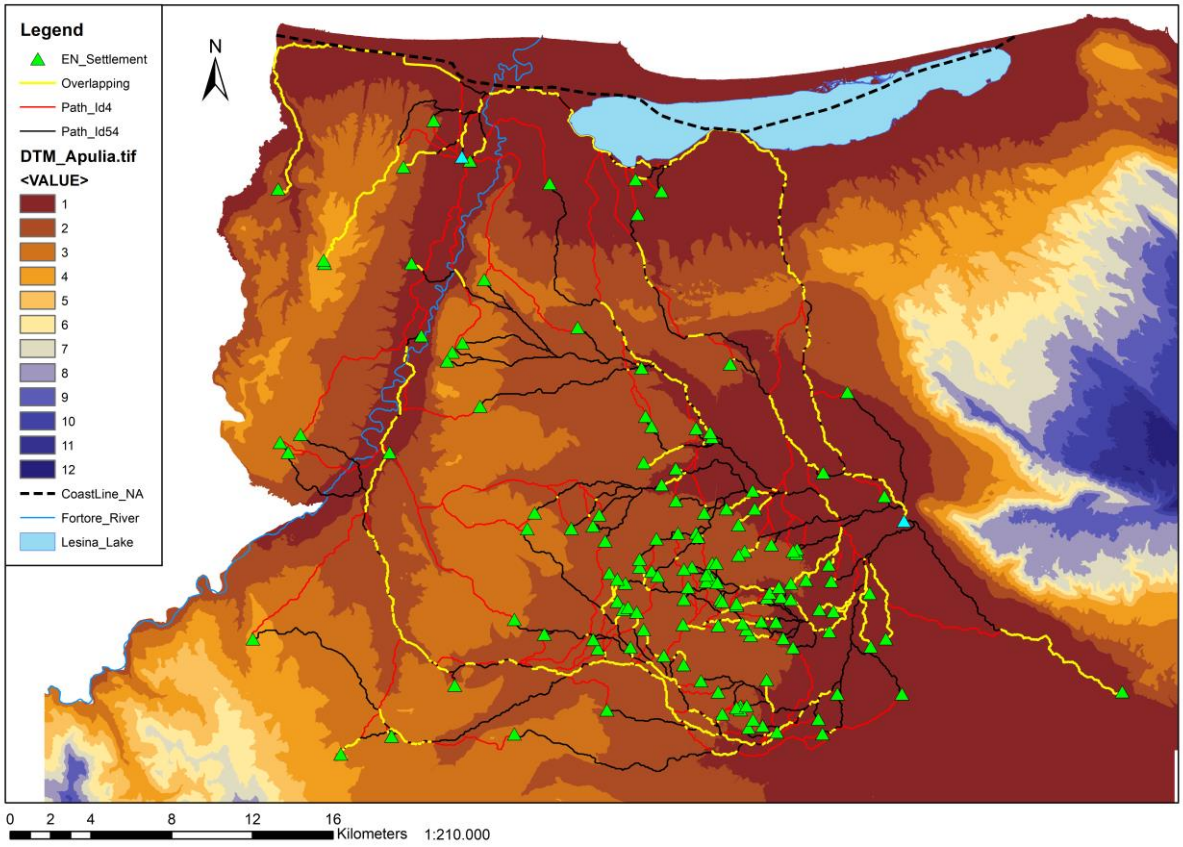


Fig. 83 – Example of network overlapping analysis between Vastaioli (id 4, light blue trinagle) and Località Piro di Brancia (id 54, light blue triangle). In light blue the two starting points; in red the network from Vastaioli; in black the network from Località Piro di Brancia; in yellow the overlapping segments between the two paths (image by the author).

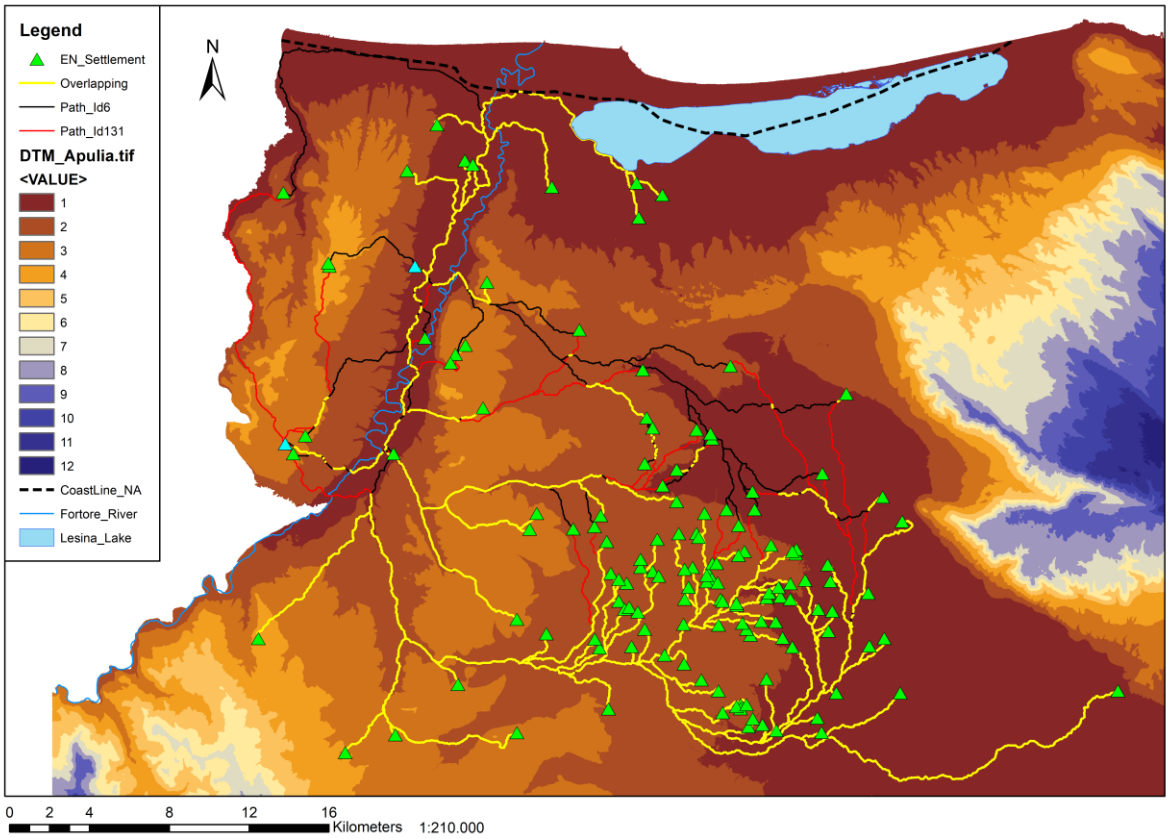


Fig. 84 – Example of network overlapping analysis between Masseria dell'Ischia (id 6, light blue triangle) and Canale Carpano II (id 131, light blue trinagle). In light blue the two starting points; in black the network from Masseria dell'Ischia; in red the network from Canale Carpano II; in yellow the overlapping segments between the two paths (image by the author).

As is possible to see from the two images above, the overlap concerns sites in a close position to each other, like antipodes; whilst we cannot talk about territory exploitation for economic reasons, which may be true for following periods, we could, however, consider this information as the base from which to begin new investigation on the relationships that tied Early Neolithic communities together. Surely, this theory should be checked with specific work on field.

Beyond the path superimposition, the relationship between the generated path, the roman viability and tratturo networks was analysed in order to trace down possible continuity in the use of specific routes from prehistory to more recent periods.
In detail, the roads system reported by Alvisi (1970) in the area between the border of northern Daunia and Molise was considered, giving an idea of the communication type. This system was used from the Pre-Roman Period to the Middle Age (fig. 85).

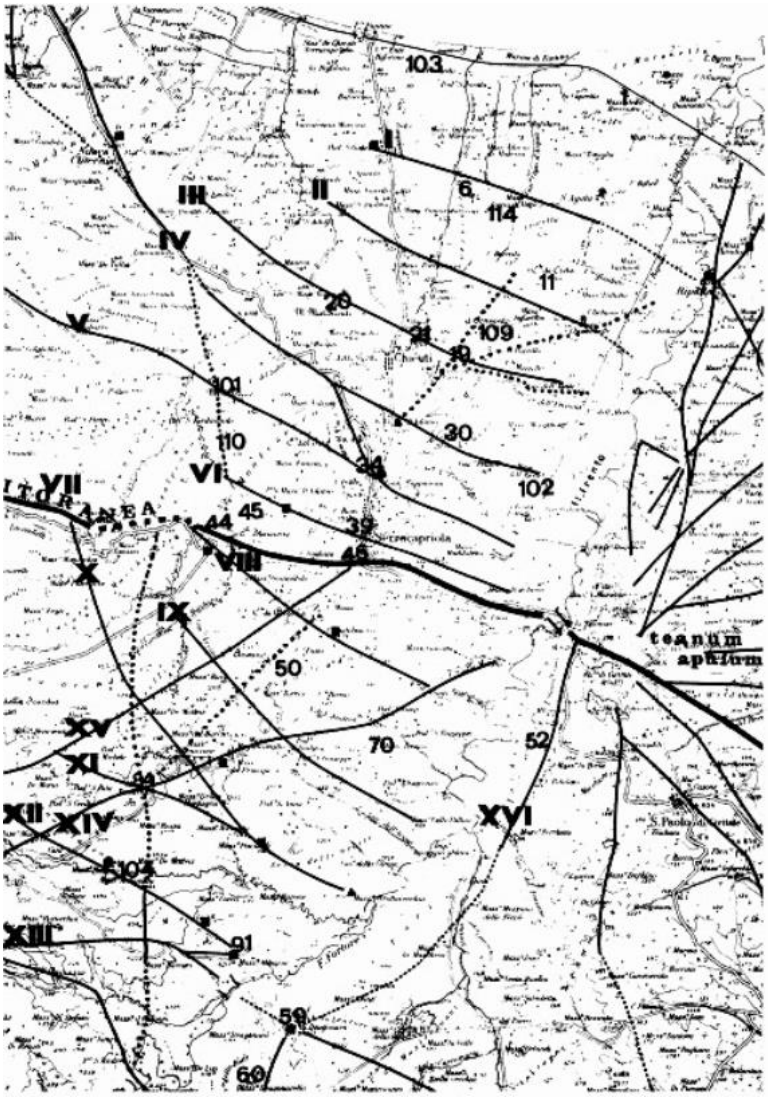


Fig. 85 – Roman road system outlined by Alvisi. The image was elaborated by Gravina: numbers) sites with Roman and Medieval pottery finds; thin lines) Roman road branches; thick line) the main Roman road called “Litoranea” (Gravina 1982, Tab .III,3).

Concerning the tratturo networks, the general frame on transhumance routes created by the Apulian Region was considered which shows the main routes starting from the systematic organization of these kinds of ways operated by the *Regia Dogana per la Mena delle pecore in Puglia*. This institution was created by Alfonso I, king of Aragon, in 1446 in order to control transhumance activity in southern Italy and reorganize the Tavoliere Plain as a huge basin able to host 2 million heads of cattle (Sarno 2014, 53).

Therefore, the GIS investigation showed how the LCPA paths followed, at least partially, in parallel or almost overlapping the Roman roads or the tratturo network (fig. 86).

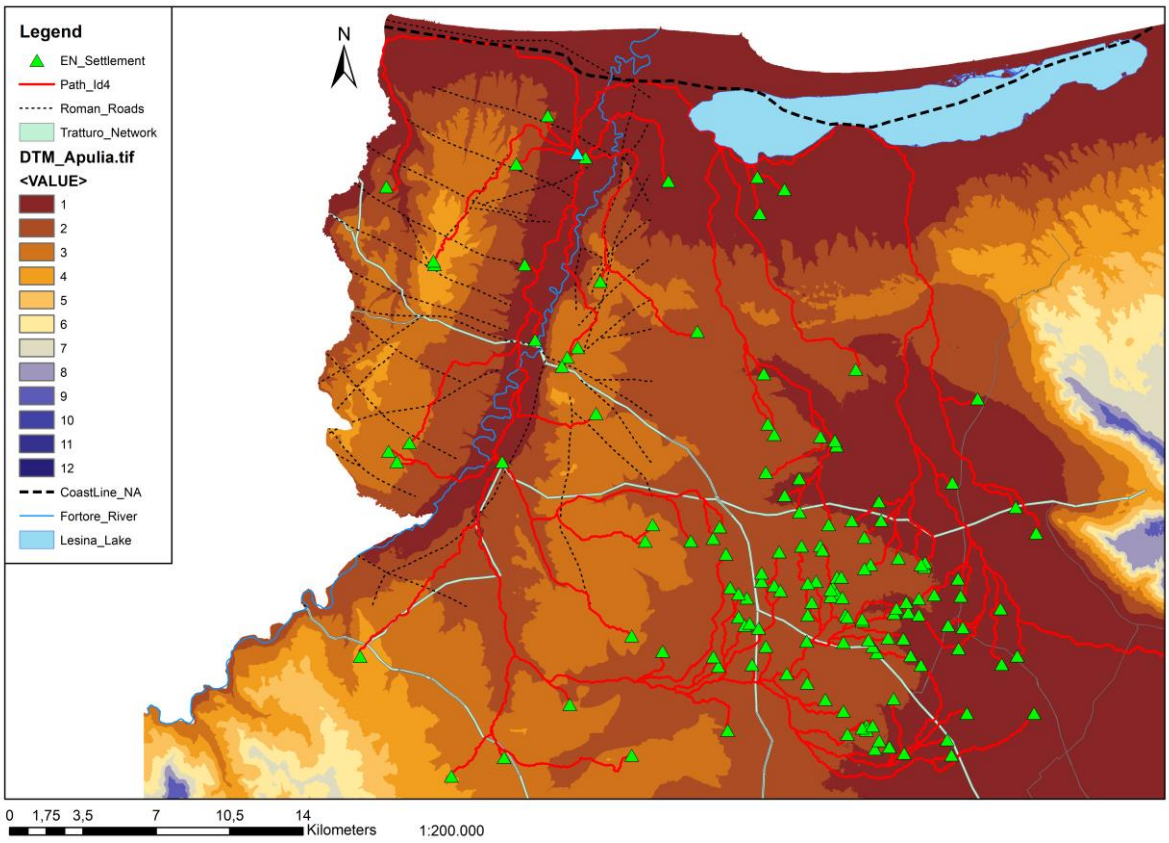


Fig. 86 – Distribution map of the Roman roads (dotted line), tratturo network (light blue line), path network generated from Vastaioli site (light blue triangle, id 4) (image by the author).

This inclination is clear, above all, along the Fortore valley where, applying multiple ring buffers with 50, 100 and 200 metres respectively, we can see how the path and track are close within a maximum distance of 200 metres (figs. 87-88). Moreover, a particular proximity is found with the tratturi Regio Braccio Nunziatella Stignano and Regio Tratturo Acquila Foggia.
So it is possible to suppose the persistence of a memory in the use of the territory: maybe some routes were abandoned, whereas others continued to be used in the following periods.

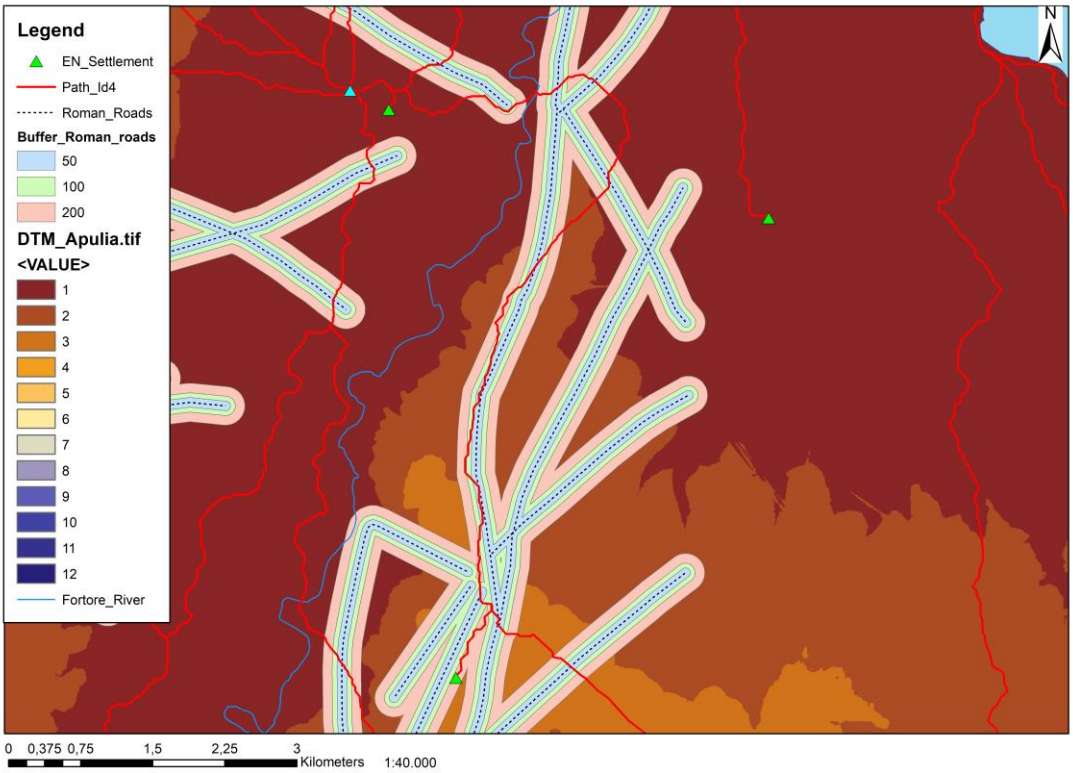


Fig. 87 – Example of alignment between Roman roads and LCPA path. Light blue triangle) path starting point; dotted line) Roman roads; the buffer reflecting 50, 100 and 200 metres distance from the Roman track (image by the author).

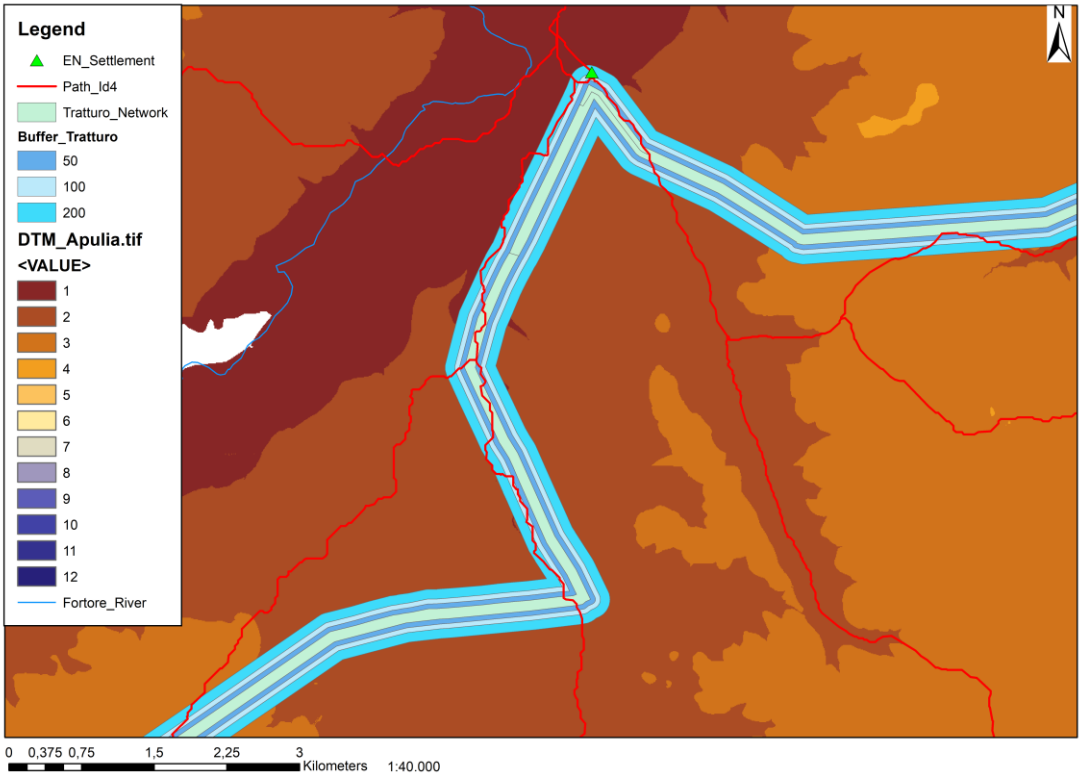


Fig. 88 – Example of alignment between tratturo track and LCPA path. Red line) Vastaioli site network path; green thick line) tratturo network; The buffer reflects 50, 100 and 200 metres distance from the tratturo track (image by the author).

Moreover, additional analysis showed that also the sporadic find areas demonstrae such a correlation with Roman viability and the transhumance networks. Indeed, the sites are placed in the proximity of these ways (fig. 89).

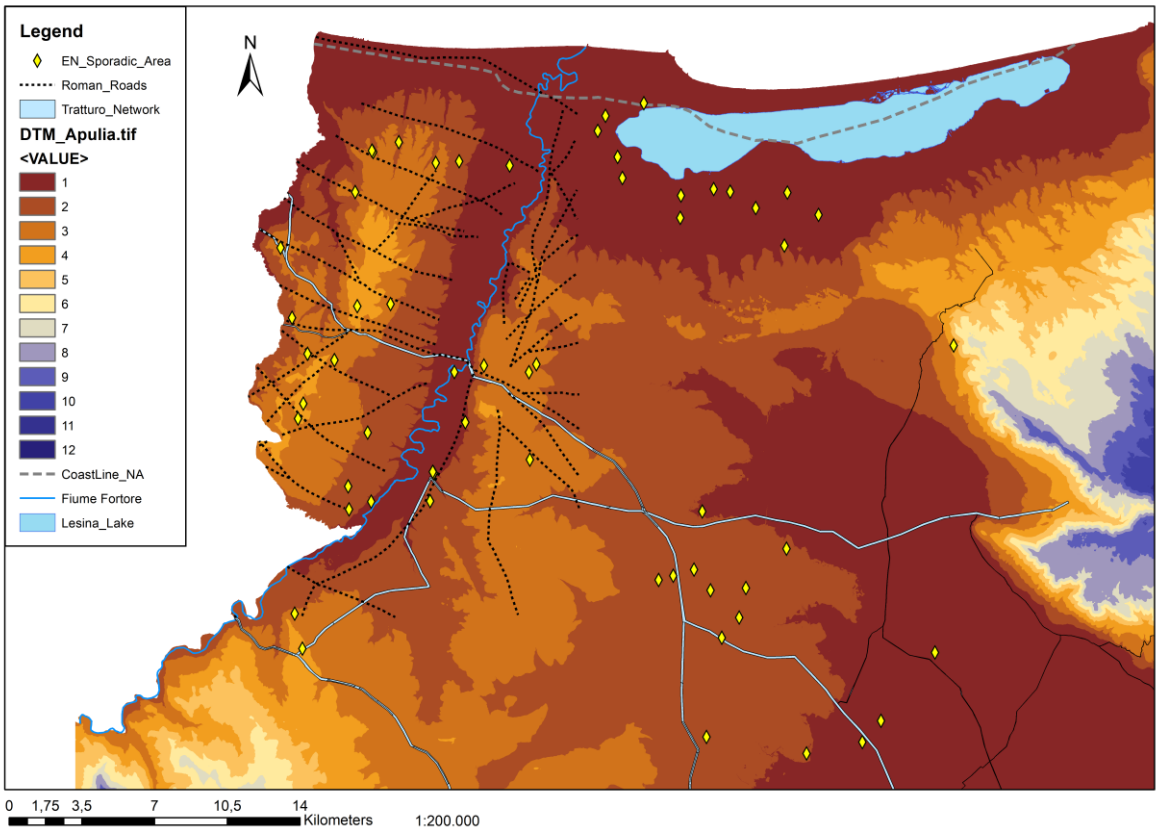


Fig. 89 – Distribution map of sporadic finds in correlation with the proximity of the Roman roads and transhumance networks. In yellow the sporadic find areas (image by the author).

Also in this case, a multiple ring buffer set at 200, 400, 800 and 1000 metres from the line representing the Roman road or the tratturo was applied.
The result was that the major number of points was close to roads within a range between 200 and 400 metres and only a few groups between 1000 metres and beyond (fig. 90).
As far as the tratturi are concerned, the proximity range was recorded between 600 and 800 metres, few points felt into the 200-400 metre range (fig. 91).

This data constitutes a reliable amount of information on likely mobility with respect to the generated paths. Therefore, it could demonstrate alternatively followed ways that were perhaps used further . Moreover, the sporadic find areas point, in their major part, to close settlements. We could therefore consider them as possible evidence of the mobility around sites or between close sites.

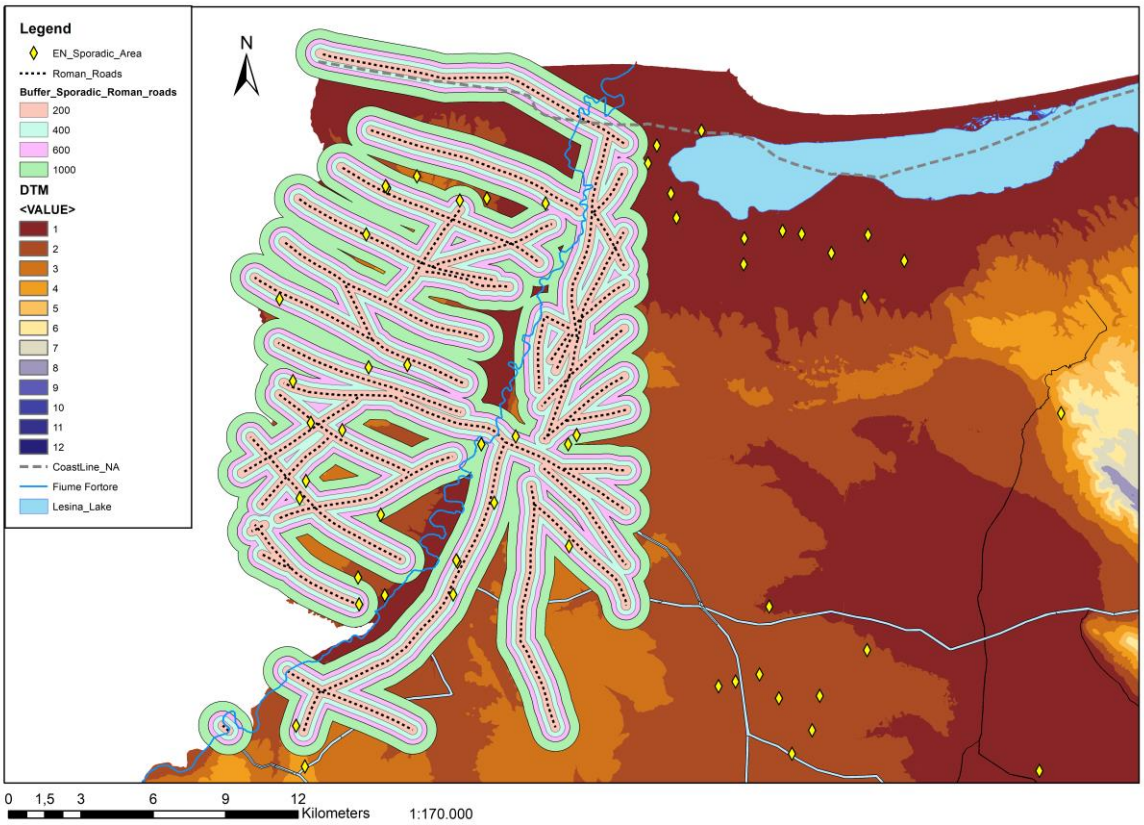


Fig. 90 – Multiple ring buffer applied to the Roman roads, values in metres (image by the author).

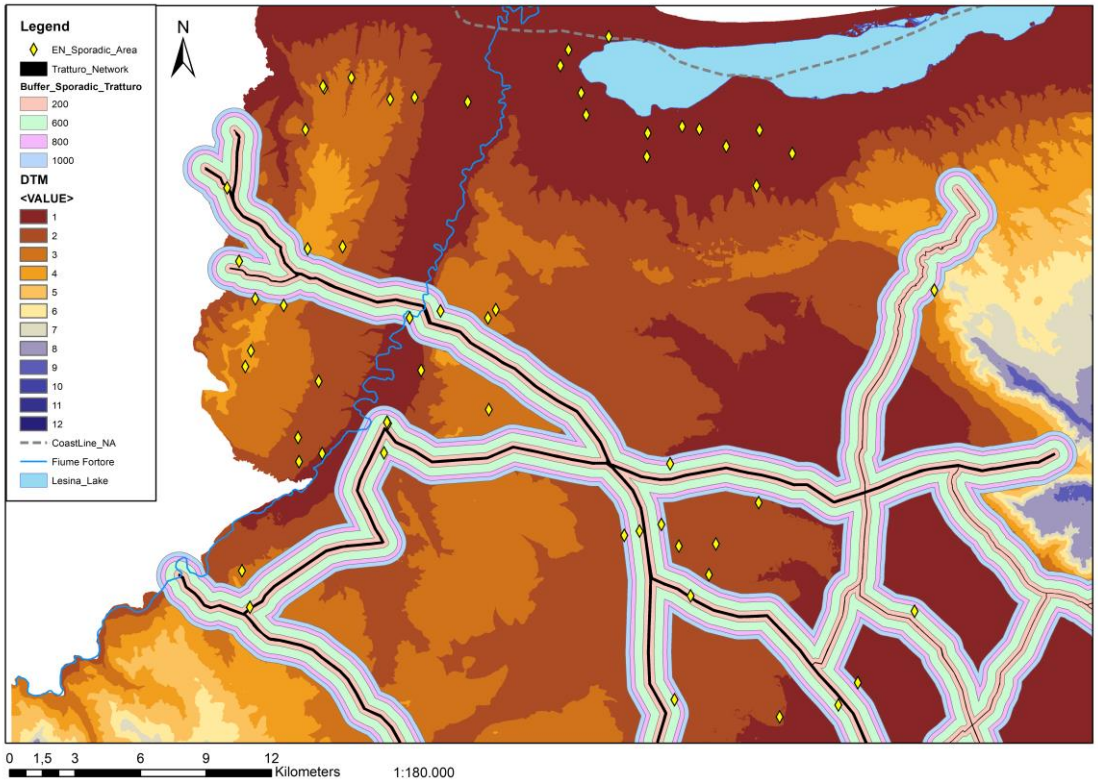


Fig. 91 - Multiple ring buffer applied to the Roman roads, values in metres (image by the author).

4.1.2. Middle Neolithic

The transition to the Middle Neolithic sees several changes under diverse aspects with respect to the previous chapters. The number of the villages shrunk drastically. The site distribution implies the presence of two groups: a central nucleus, placed in the San Severo area, and a periphery consisting of a few settlements distributed along the main border region (fig. 92) (Gravina 2010, 65-67).

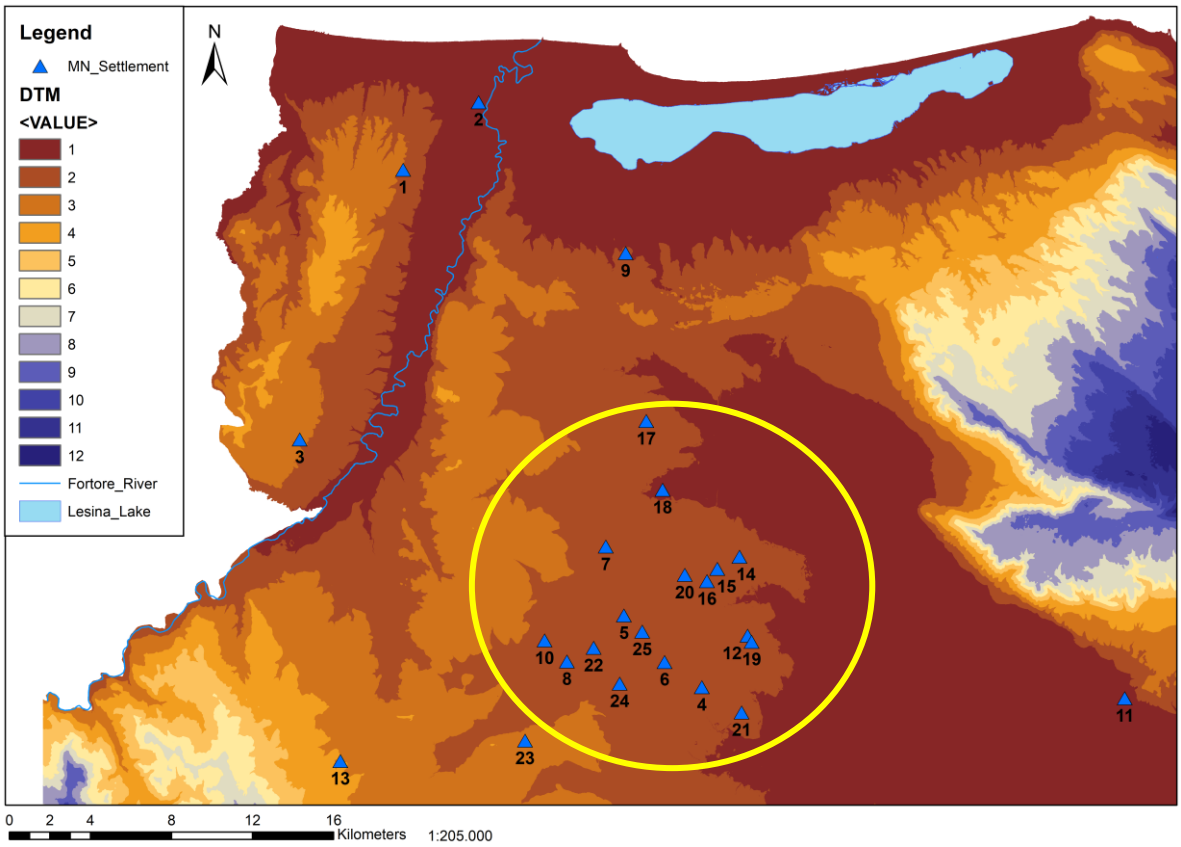


Fig. 92 – Distribution map of the Middle Neolithic settlements. The yellow circle defines the central nucleus area (see Appendix tables for the single analysis) (image by the author).

As for the previous analysis, the path calculation was run for each settlement to understand how mobility could have worked. The investigation revealed a series of mobility choices that show the creation of main trajectories.
As far as settlements within the central nucleus are concerned, the development of three principal paths can be noticed reaching towards the Fortore valley, Lake Lesina and the Gargano foothills. To these three routes, other minor branches are connected that permitted to reach sites located at a close and medium distance.

Examples of this kind of network are the settlements of Masseria Parisi (fig. 92, id25) or Località Boschetto (fig. 92, id18).
A diverse behaviour is displayed by the sites situated at borders. For them, the calculation generated two main separate routes that move through the Plain, one towards the north and the other towards the south (fig. 93). In this case, the sites involved are for example Casino San Matteo-Chiantinelle (fig. 92, id1), Masseria Settimo Grotte (fig. 92, id3), Pian Devoto (fig. 92, id13) and Ciccalento (fig. 92, id11).

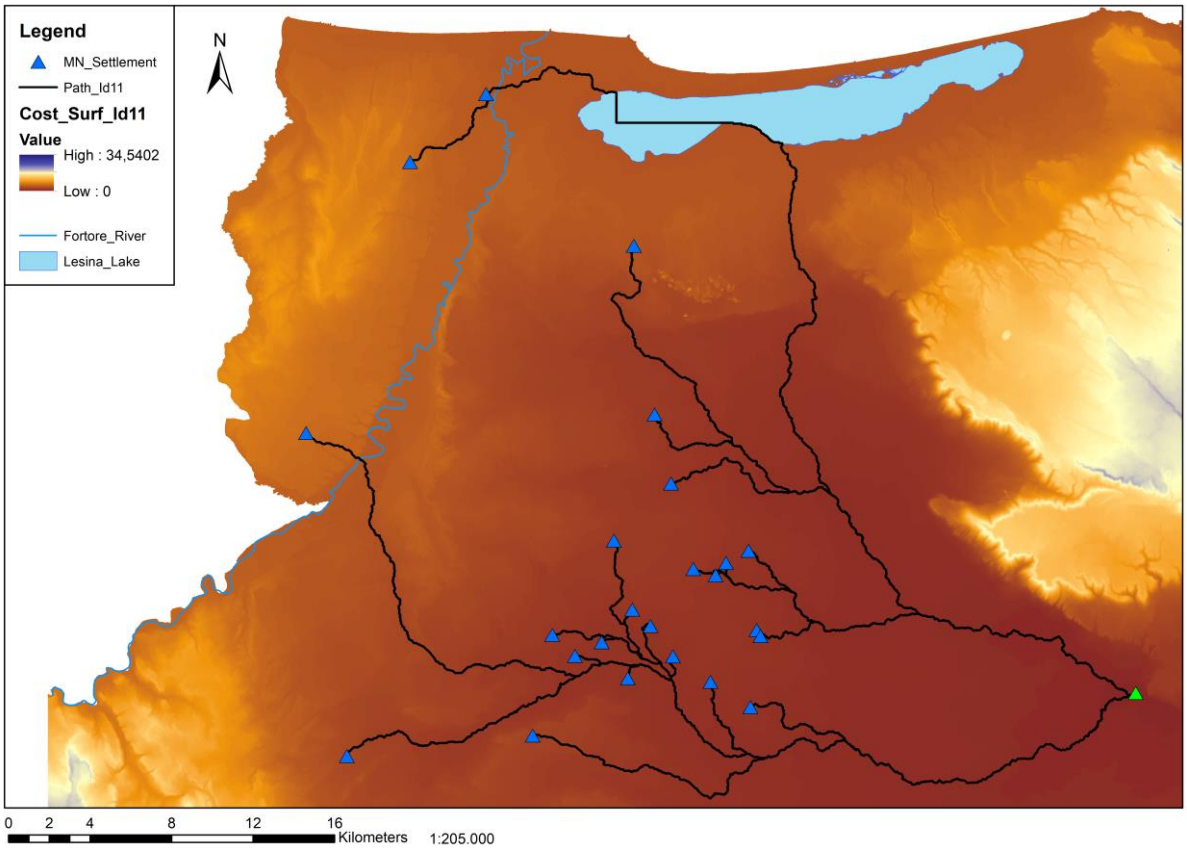


Fig. 93 – Example of LCPA applied to the site Ciccalento (id11). In green is the starting point of the analysis. The network displays the two main routes: the first going towards the lake, the second towards the river (image by the author).

The gathered data could indicate changes that stabilized by the end of the Neolithic. A new kind of mobility is more prone to follow social and economic developments.
In the Middle Neolithic, the analysis shows a site distribution reflecting a system able to facilitate the crossing of the Plain to reach a specific area or site. An example of this is reported in fig. 93, where the network shows a clear path dichotomy in which the two branches lead to different points. In addition, the

arrival point could be considered as starting position to reach further areas, such as Molise.

As far as path overlaps are concerned, we can assume that there was the use of common routes, above all those running along with natural communication ways such as the river or the foothills (fig. 94). On the other hand, connections with the Roman viability and the tratturo network are scarce. Just one exception was found regarding correspondence between all paths (not for id17 and 18) and a specific tratturo segment of the Regio Braccio Nunziatella Stignano and the Roman lane XVI[2]. Here, the paths follow almost the same tratturo line within a distance of 200 mt (fig. 95).

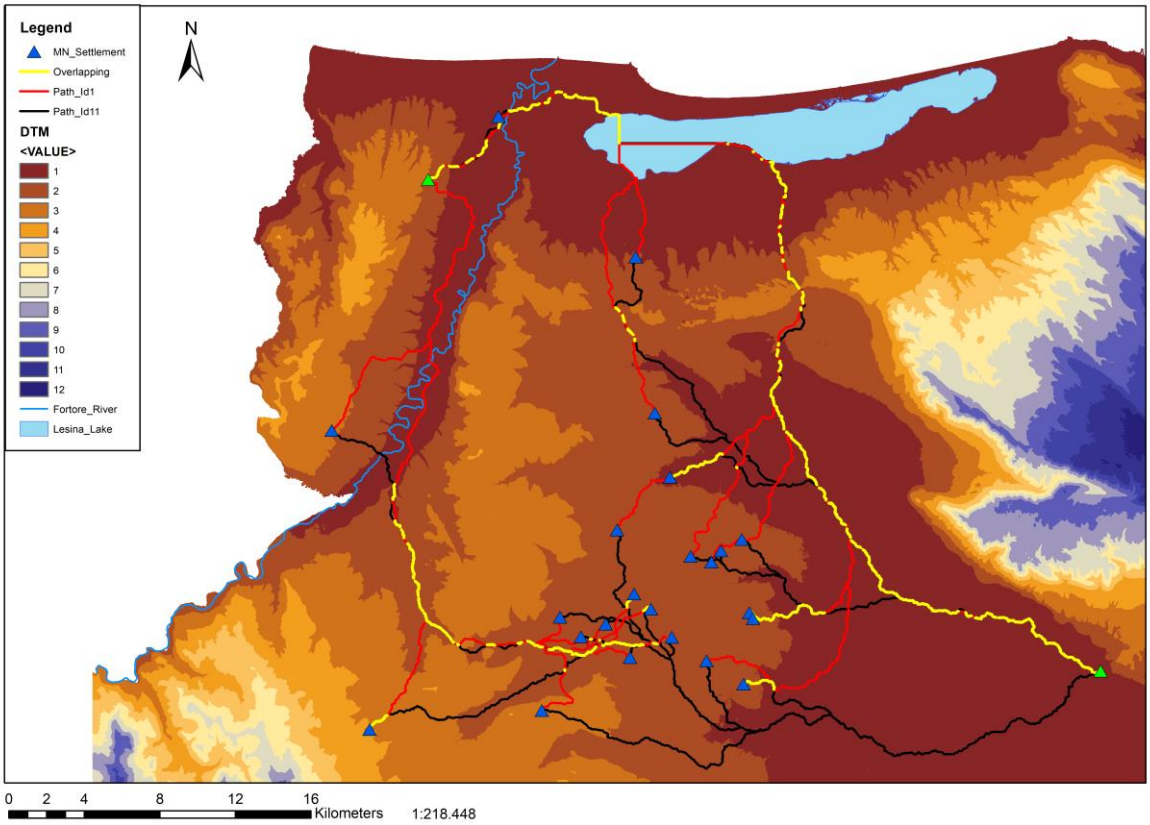


Fig. 94 - Example of network overlapping analysis between Casino San Matteo-Chiantinelle (id 1) and Ciccalento (id 11). In light green the two starting points; in red the network from Casino San Matteo-Chiantinelle; in black the network from Ciccalento; in yellow the overlapping segments between the two paths (image by the author).

[2] Roman roads numeration is referred to Gravina 1982, Tab.III,3.

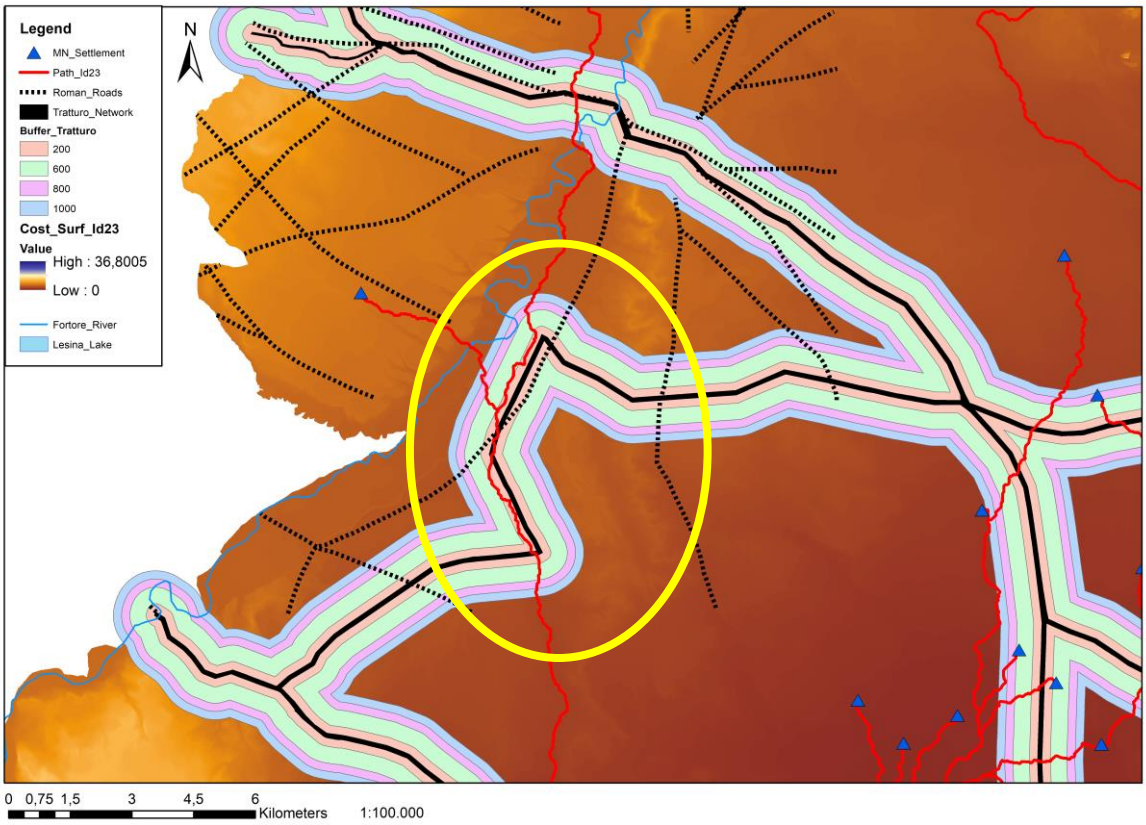


Fig. 95 – Example of buffer analysis detail applied to the tratturo network. The buffer distance is metres: 200, 600, 800, 1000. In red is the path generated from the site of Castellana (id 23); yellow circle marks the segment path aligned to the tratturo portion and the Roman road (image by the author).

4.1.3. Final Neolithic

Commonly the final Neolithic is interpreted as the phase when the first real change in social and economic fields and consequentially in the way to live in the landscape occured. It was the base that brought control to that approach of territory, which spread during the Copper and Bronze Ages.
The Final Neolithic site distribution seems to emphasize this aspect, and the related path networks as well. The settlements abandon the Plain in favour of locations that we could be defined as hub or "border point", i.e. areas more prone to be reached by routes coming from inner or outer regions such as the low Fortore valley (Gravina 1999a, 86).
The LCP analysis reveals that the Tavoliere is used as a corridor to reach the few sites placed there, whereas the Fortore valley and the Gargano foothills arose as main routes. Likely, the reason for this preference was that these two areas were in contact with other ways going to the south (Gargano foothills) and the west (Fortore valley) (see the Appendix tables for the single analysis).
In specific, the calculation allows to cluster the path networks in four groups in accordance with the same site placement and generated routes. The first class is referred to sites situated along Lake Lesina (id1) and on the western Fortore shore (id3, 4, 17, 19). These settlements present a path network consisting of two main branches that respectively follow the watercourse valley and the promontory foothills with N-S orientation. The central Plain is not crossed, but the sites placed in this area are reached by secondary lanes.
To the second cluster belong the sites placed along the eastern river shore (id5, 14, 16, 18) that develop a type of network appearing as a unique "s"-shape trajectory able to join the antipodes of the study area. Remarkably, this group is the only one to display a route system that crosses the whole Tavoliere.
The third group is composed of the villages that arose along the Gargano foothills (id6, 10, 12) with a S-N orientation network that used the promontory slopes as the main corridor to reach the northern part of the area. A second main path, with E-W orientation, is generated to arrive at the southernmost border sites.
Ultimately, to the fourth group belong sites located at the inferior edge of the area (id11) and in the Tavoliere Plain (id2, 7, 8, 9, 11, 15). They present a path system generating diverse branches going towards the sites.

When looking at overlaps between all paths, route divisions in which sporadic find area points seem to coincide with passage areas in proximity to communication ways between sites are clear (fig. 96). However, the superimposition is similar only for those settlements belonging to the same

territory portion. Therefore we could also cluster the mobility according to the locations (fig. 97).

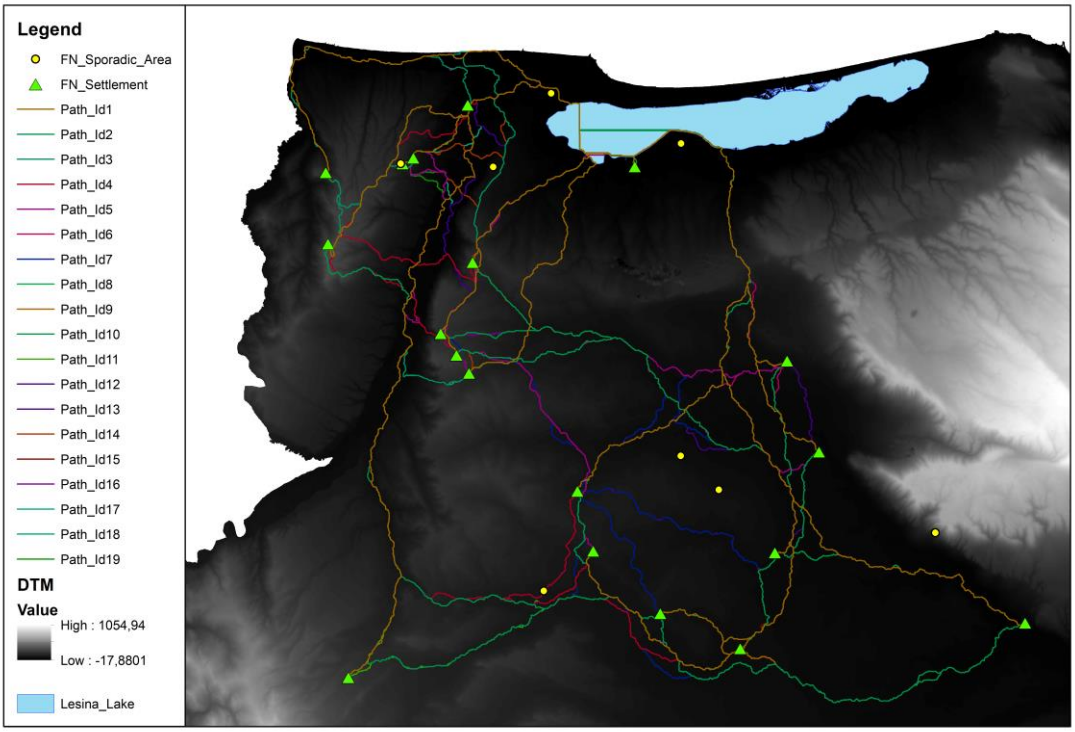


Fig. 96 – Example of path overlapping. Green triangles) Final Neolithic settlements; yellow points) Sporadic find areas; Multicolour lines) Network paths form each settlement (image by the author).

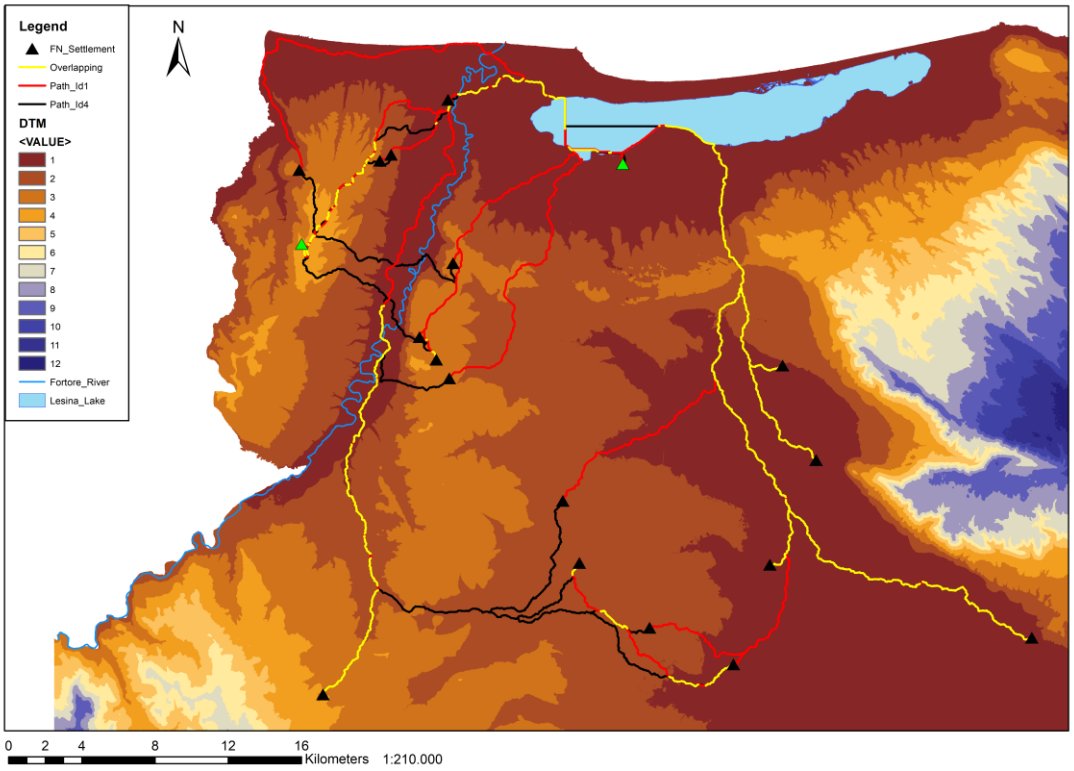


Fig. 97 – Example of path network overlapping analysis between Cammarata (id1) and Località Piano Navuccio (id 4) (green triangles). In yellow) path overlapping; in red) Id1 path network; in black) Id4 path network (image by the author).

As far as the other communication system is concerned, almost all sites used the trajectory of some northern Roman paths and those placed in the cetral river valley. Commom use with the tratturo network is scarce; only the Regio Braccio Nunziatella Stignano segment in front of the watercourse and the Regio Tratturo Aquila Foggia moving towards the inner part of the Plain have parallels with ancient paths (fig. 98).

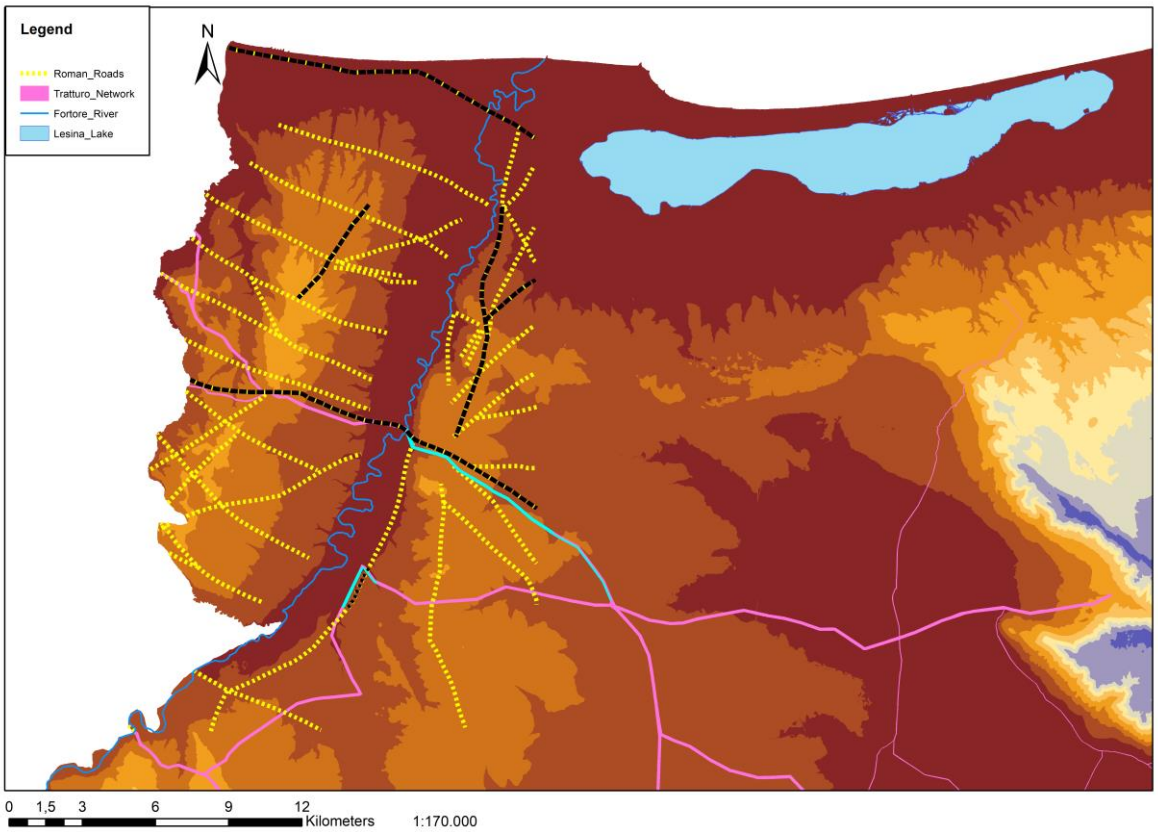


Fig. 98 – Map of the Roman (yellow) and tratturo (pink) system. In black the Roman roads and in light blue the tratturo segments exploited by the Final Neolithic paths (image by the author).

4.1.4. Early and Middle Copper Age

The site placement reflects, likely, the new social and economic trends: the settlements revalue the Lesina lakeshores while the Tavoliere Plain seems increasingly abandoned (see Appendix for distribution site map). The mobility, somehow, reflects this data, displaying a path system that, in most cases, moves around the Tavoliere Plain area.
Also in this case, it is possible to cluster the types of path networks according to the routes that sometimes coincide with previous ones.

The settlements situated along the lake shores (id1, 2, 3, 4, 5, 6, 7, 8, 23) seem to work as hubs, keeping the Fortore valley and the Gargano foothills in communication through a "U"-shape path network with N-S orientation. Remarkably, it is that Final Neolithic paths of the same area develop almost superimposable communication ways (fig. 99).

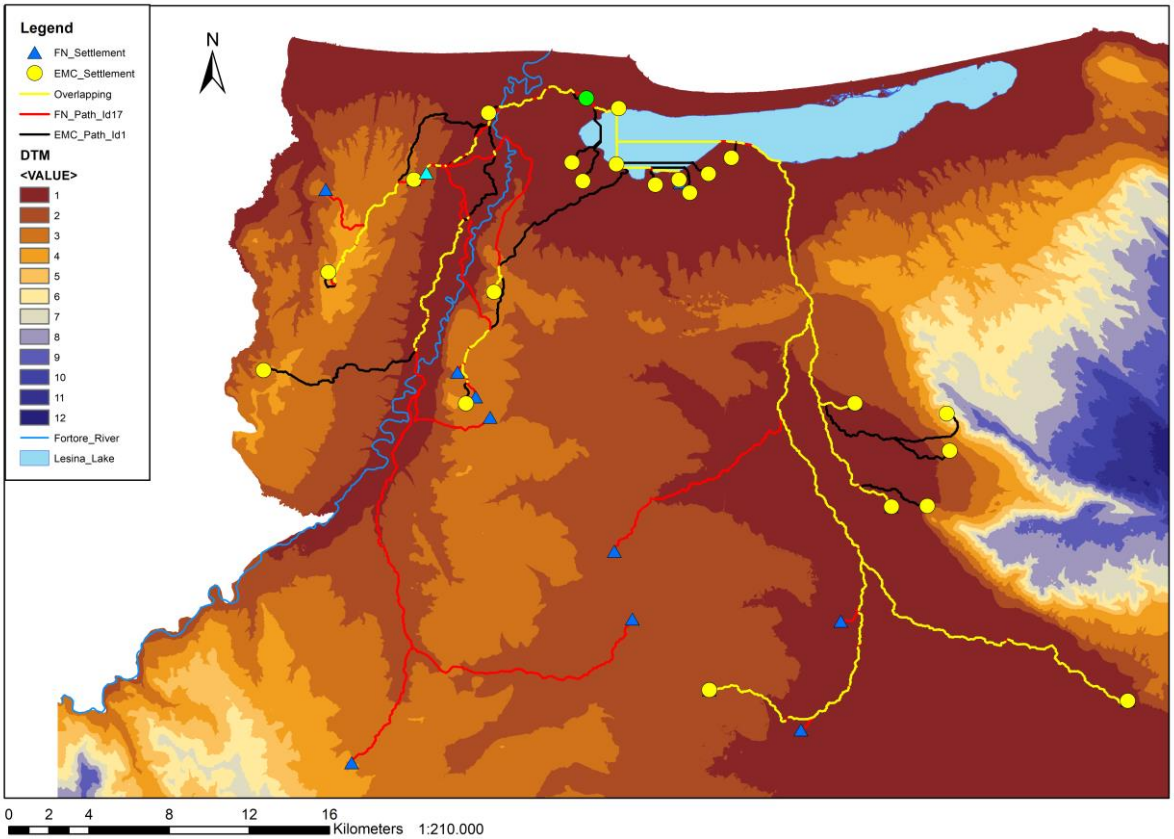


Fig. 99 – Example of path overlaps between Final Neolithic and Early Middle Copper Age. Yellow circles are EMC sites (source point Id1, in green); blue triangles are FN sites (source point Id17, in light blue); yellow line is the path segments overlapping; the red line is the FN path network; black line is the EMC path network (image by the author).

Moreover, a similar network structure can be observed for the sites located on the western side of the river (id9, 15, 18, 21). The exception is Colle Arsano (id21) that generates a path network that seems to have a circular trend, with a W-E orientation, since the two main routes run along the edges embracing the Plain and ending in the same area of the Gargano foothills (fig. 100).
This circular trend, but with an E-W orientation, was noticed also for the only site located at the edge of the Tavoliere Plain, Masseria Istituto di Sangro (id20). In this case, the path network generates two main branches ending in the area of Serracapriola, i.e. on the hills beyond the western Fortore shore.

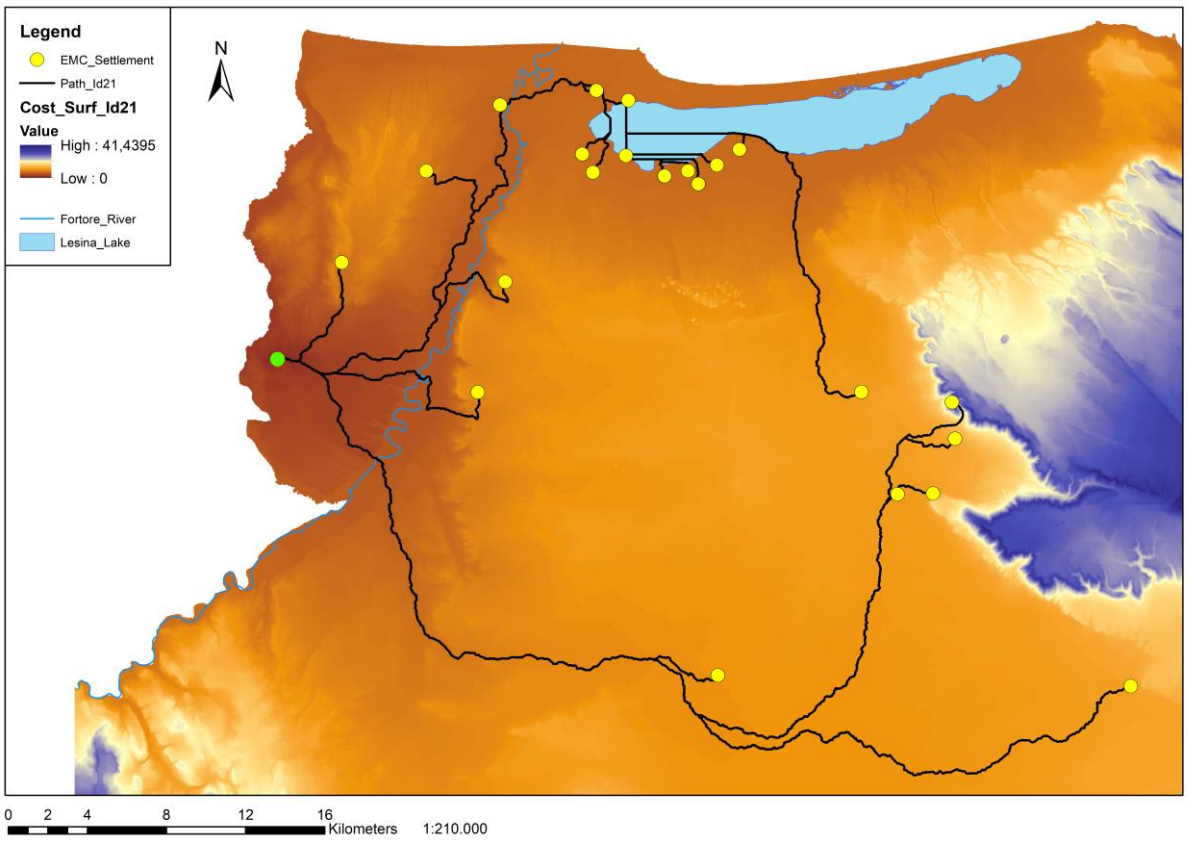


Fig. 100 – LCPA applied to Colle Arsano (green circle) (image by the author).

Diversely, the mobility patterns of the sites on the eastern shore (id17, 22) mark the lack of sites on the Plain; the trajectories draw a straight line across the Tavoliere to reach the sites on the edges of the area. The reason for this kind of choice – sites placed far apart from each other – could be the rising of new social and economic models that were more prone to use those portions of the territory that enabled them to permit faster and easier communication towards strategic sites or specific hub points in order to reach other close or far-away regions.

The settlements placed on the Gargano foothills (id10, 11, 12, 13, 14, 19) generate two groups of communication trajectories: the first is made up of sites situated in the central-northern area, corresponding to Mezzana della Quercia (id10), Castelpagano (id11) and Località Castate (id12). This group is characterised by a route consisting of a "C"-shape path with several secondary paths arriving in the low Fortore valley. Therefore, the route systems follow a unique line over to the western river shore. From this line stem diverse paths which allow to reach the sites along the route. The Tavoliere and other western sites are dealt with as marginal points. The network is oriented SE-NW.
Once again, the comparison with the Final Neolithic Gargano networks appears quite close due to the similar site placement.
The second group is formed by sites in the area of the southern foothills, i.e. Mezzanella di Brancia (id13), Brancia km10 – Volta Pianezza (id14) and Ciccalento (id19). It is characterized by routes with overlapping segments and a network similar to the one of Colle Asano and Masseria Istituto di Sangro with an E-W orientation (fig. 101). This singular structure might suggest that all these sites played a role as a communication hub between outer travellers coming from the northern or southern regions of the Peninsula. In other words, according to the destination, it was possible to choose a route over another to reach a specific point.
Moreover, the route trend would indicate that all these sites were involved in these communication networks because all the settlements could be reached by distinct and clear paths.

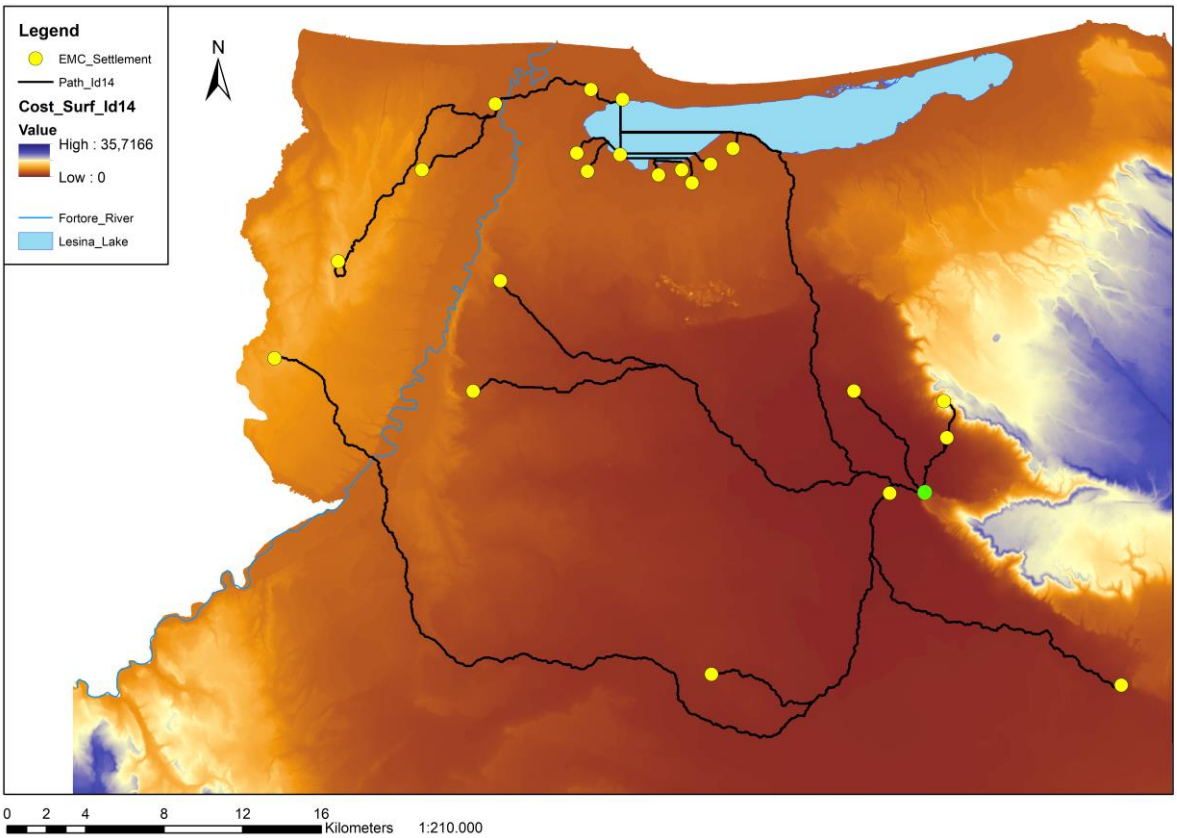


Fig. 101 – LCPA applied to Brancia km10 – Volta Pianezza (green circle) (image by the author).

As far as Roman and transhumance roads are concerned, the same use can be documented as in the Final Neolithic, with only the exception of the Tratturo Regio Aquila Foggia that is not considered (fig. 98).

4.1.5. Final Copper Age

This phase seems to display the same site distribution as the Early-Middle Copper Age, but with a a smaller number of sites. The abandonment of the Tavoliere is constant; the Plain now appears as a mere crossing area (Fillramo *et al.* 2021, 146; 2021a, 126).
New settlements arise on:

- Adriatic coast, Torre Mileto (id3);
- Lesina southern shore, Mulino di Caldoli (id2);
- Gargano western foothill, Cicerale (id14);
- Gargano inner valleys, Casino Crisetti (id8) and Chiancata La Civica (id13);
- Tavoliere southern study area edge, Torre Fiorentina (id5);
- eastern side of upper Fortore Valley, Colle d'Armi (id15).

Referring to the mobility analysis, the path networks generated show a correspondence with the previous calculations.

Therefore, the sites located on the Lesina southern shore (id1, 2) and the Adriatic coast (id3) cover the same routes consisting of a "U"-shape network with descending branches towards the Gargano foothills and the Fortore valley (fig. 102).

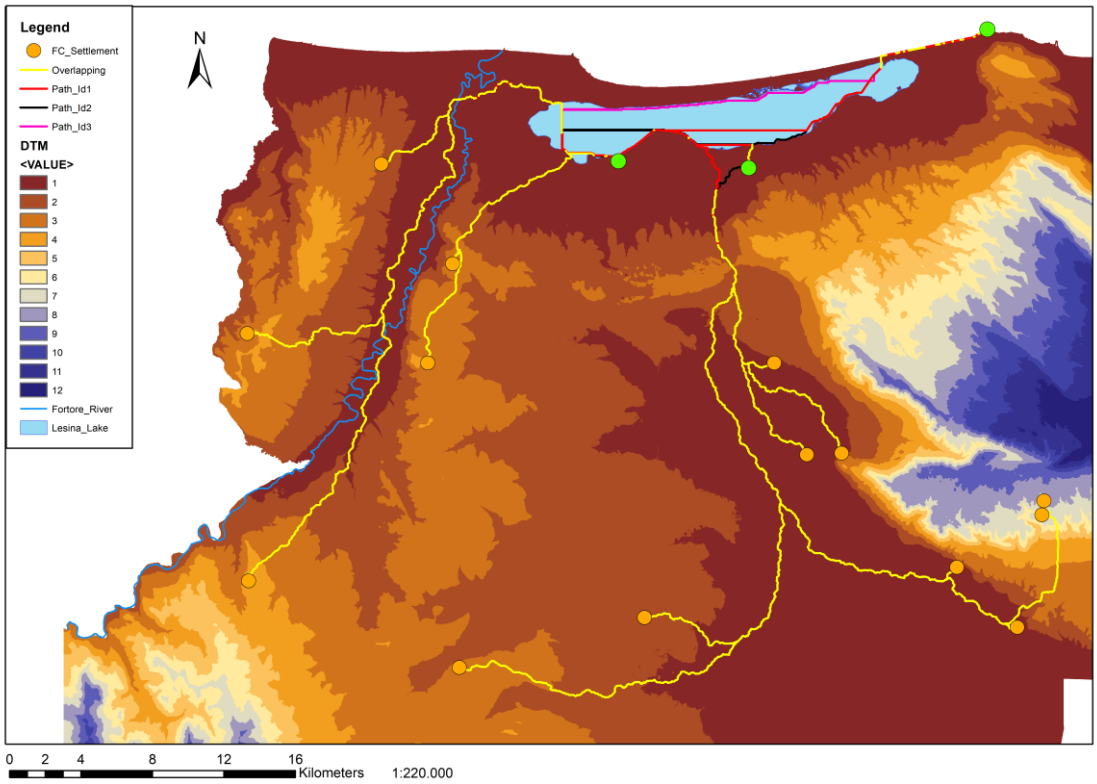


Fig. 102 – Path overlapping analysis between the id1, 2 and 3 networks. In green the starting points of the path; in yellow overlapped path segments; in red the Cammarata (id1) network; in black the Mulino di Caldoli (id2) network; in violet the Torre Mileto (id3) network (image by the author).

The Fortore valley is characterised by a very limited number of sites, two on the western side and three on the eastern one. The first two settlements are in continuity with the previous phase, and hence their path networks are similar, with the exception of some slight differences due to the presence of small secondary lanes leading to new sites.
The same can be said for the eastern side sites, but a diverse trend was recorded for Colle d'Armi from which the path network, similar to Torre Fiorentina, generates a series of tracks towards different directions. Therefore, there is not one or more main trajectories but several paths which allowed to move distinctively (fig. 103).
The aforesaid network might suggest that these two settlements specifically worked as switching points from likely routes coming from the southern Tavoliere.

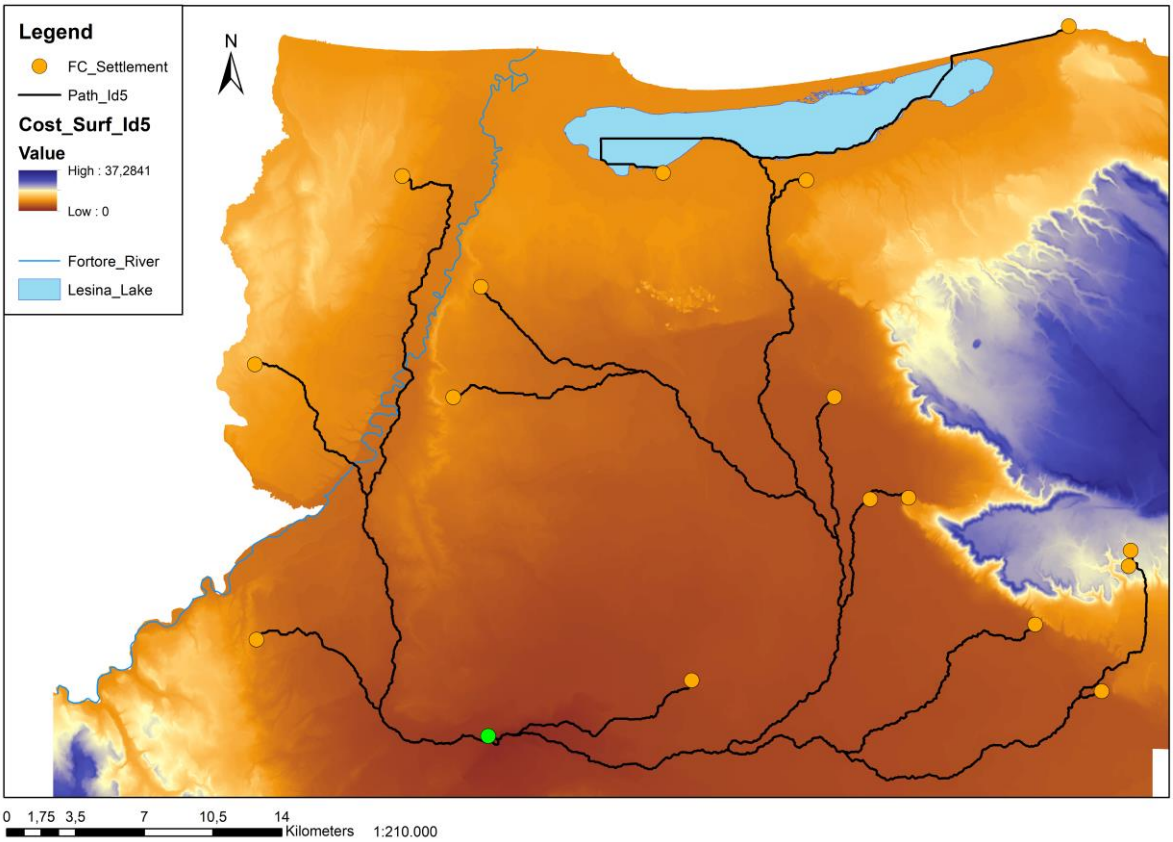


Fig. 103 – LCPA applied to Torre Fiorentina (in green) (image by the author).

The Gargano settlements, once again, present a similar network trend like that of the previous phase but a slight difference is due to the current distribution that is sparser. The effect of this placement causes trajectories with opener secondary paths, but the role played by the sites and tracks seem to be the same.

Concerning the further use of the territory, a scarce coincidence between the Final Copper Age paths and the Roman and transhumance roads was recorded. For the first, an alignment is noted for two roads on the eastern river shore at a distance of 200 metres, according to the buffer zones at 200, 400, 600, 1000 metres (fig. 104); while for the tratturo network just some segments run parallel within the distance of 600-1000 metres, placed close the eastern part of the upper watercourse valley (Regio Braccio Celano Foggia, Regio Braccio Nunziatella Stignano) and close the Gargano foothills (Regio Braccio Tratturello Ponte di Brancia Campolato) (fig. 105).

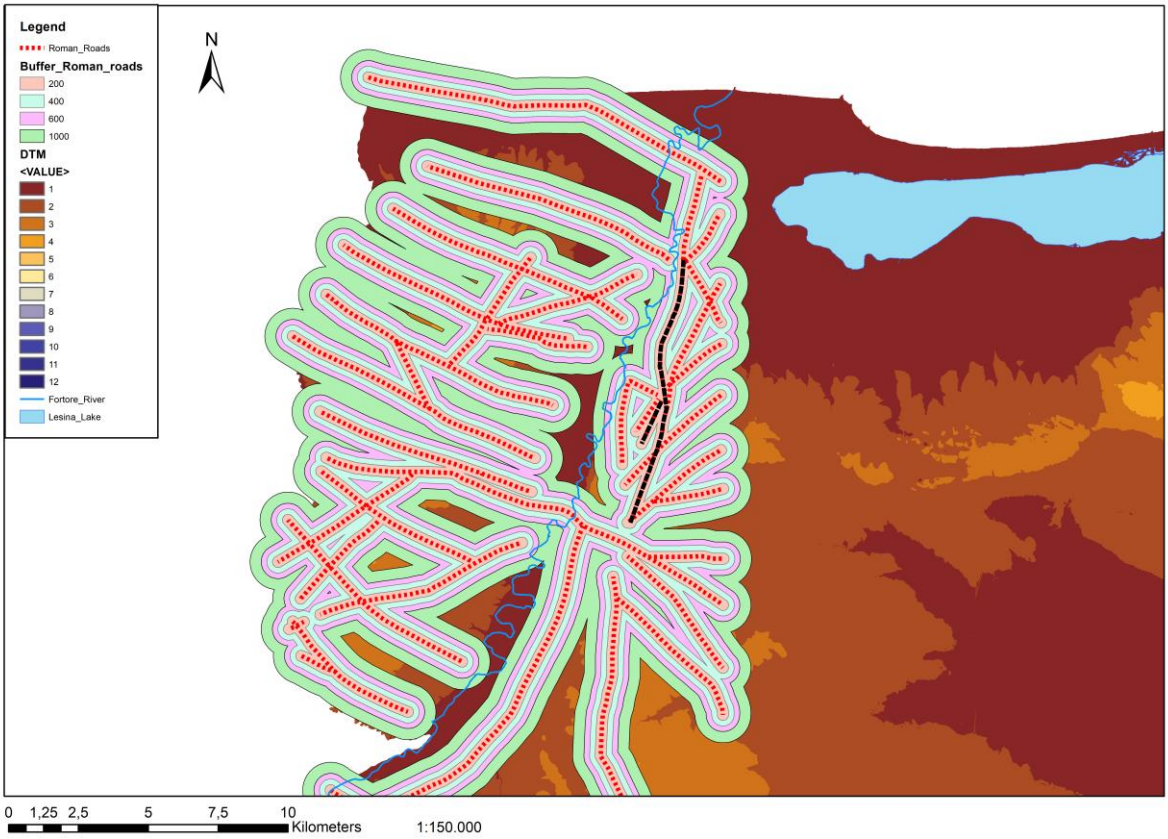


Fig. 104 – Buffer Analysis applied to the Roman roads. In dashed red the Roman tracks; in dashed black the Roman roads coinciding with the calculated paths (image by the author).

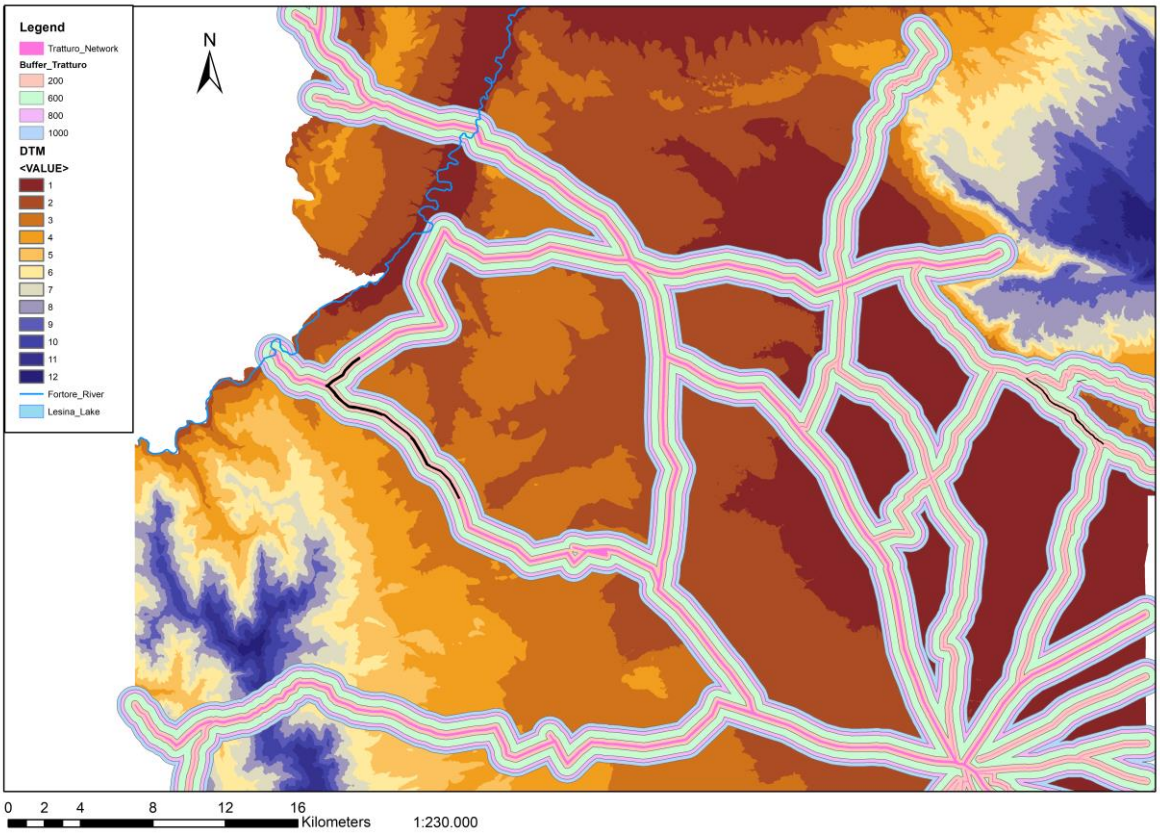


Fig. 105 – Buffer Analysis applied to the tratturo network. In pink the tratutturi; in black, the tratturo segment coinciding with the calculated paths (image by the author).

4.1.6. Early Bronze Age

The new site distribution shows a modification in the way the territory was used. This can be made plausible due to different locations or revaluated places occupied and left in previous phases (fig. 106) (Filloramo *et al.* 2021, 147).

Therefore, new sites are located at:

- Apulia-Molise border, Cantalupo-Tre Ponti (id5);
- western Fortore shore-Adriatic coast proximity, Brecciara (id14);
- inner Gargano valley, Monte Granata (id3);
- southern edge of the Tavoliere Plain, Masseria Iacovelli (id6).

On the other hand, revaluated places can found at:

- Apulia-Molise border, where the site Colle Arsano (id7) continues from the Early-Middle and Final Copper Age;
- on the western riverside, the site of Colle di Creta (id1) appears in the same area as the previous location already occupied during all Neolithic and Copper Age phases; the site of Chiarappa displays continuity from the Middle and Final Neolithic and the Early-Middle Copper Age;
- on the eastern riverside, Piani di Lauria (id8) arises in the same area as the previous settlements dated back to the Early and Final Neolithic;
- on the Gargano foothill, Mezzana della Quercia (id14) occupies the same location as sites from the Neolithic (Early and Final) and Copper Age (Early-Middle and Final); Masseria Mazzanella di Brancia (id13) continues from the Neolithic (Early and Final) and Copper Age (Early-Middle and Final); Brancia km10-Volta Pianezza occupies the same area as during the Early-Middle and Finale Copper Age: Ciccalento (id11) displays a long life through all the phases of the Neolithic and Copper Age;
- in the Gargano inner valley, the sites Casino Crisetti (id12) and Chiancata La Civica (id4) display continuity from the Final Copper Age;
- on the Tavoliere Plain, Località Guadone (id2) and Oliveto Torre dei Giunghi (id17) are settled in the same area as the Early Neolithic sites; Portata Casone is localized at the same coordinates as the Early and Final Neolithic villages.

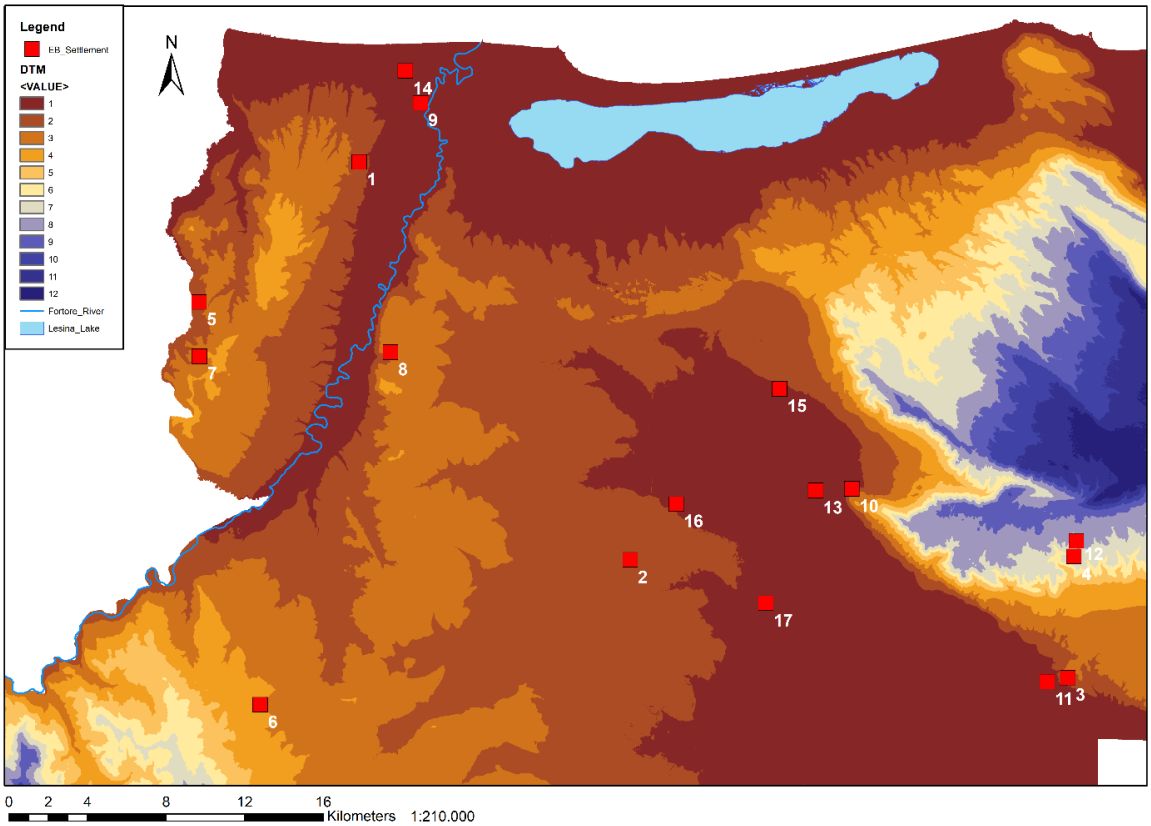


Fig. 106 – Early Bronze distribution site map. See Appendix for site list (image by author).

As is clear from the distribution map above, the new placement of sites shows the settlements clustered by location, the complete abandonment of the lake area and a partial revaluation of the Tavoliere Plain. These phenomena affect the mobility that can be classified into two types:

- To follow specific routes;
- To work as hub permiting a faster and easier sorting of the people flows through several paths.

To the first group belong those settlements located in a border position or, at least, without the central area. Examples are the sites at the Molise Border (id5, 7), the western riverside (id1, 9, 14), the southern edge of the Plain (id6), the Gargano foothills (id3, 11) and the inner Gargano foothills (id4, 12).
Inside this macro-group, it is possible to subdivide sites according to the orientation of the path network because the major part of them displays a “U”-shape, except id6 and 7 which present some variations.

Therefore, the western settlements Colle di Creta (id1), Cantalupo-Tre Ponti (id5), Chiarappa (id9) and Brecciara (id14) show a path network with a N-S orientation running through two main trajectories: the Fortore valley and the Gargano foothills. Despite some differences, the networks present overlaps of the principal communication routes (fig. 107).

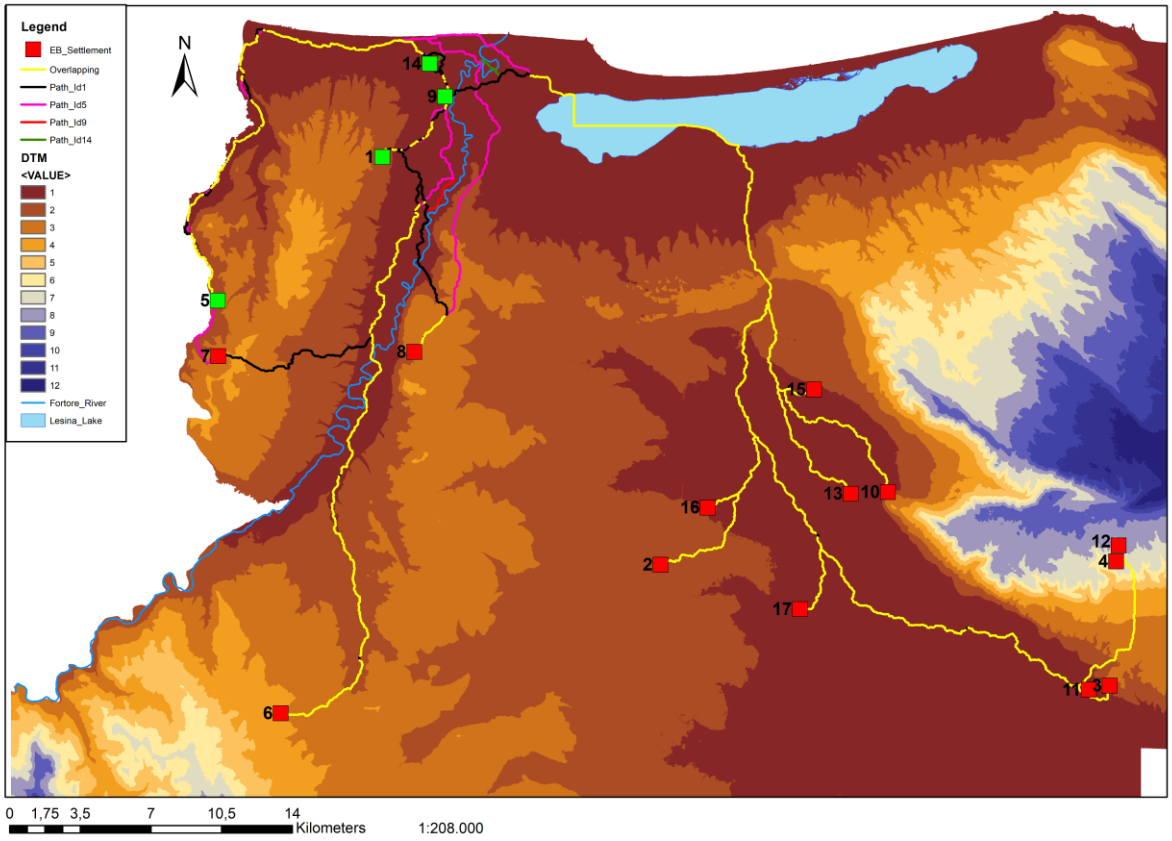


Fig. 107 – Example of network overlapping analysis of the western settlements (green squares) (image by the author).

The case of Colle Arsano (id7) is different because its medium position shows a path system with a circular trend. In other words, the two branches move in opposite directions ending in the Gargano foothill area. Moreover, the only communication way is the central-northern portion of the river valley, whereas the rest of the tracks cross the territory at different points.

A similar tendency was noticed also for Masseria Iacovelli (id6), situated at the south-western edge of the Tavoliere area, where the routes develop a network with a S-N orientation. The watercourse is followed as the main communication way, even though it is crossed in order to get to the sites on the Molise border and the western river shore. The other big route is defined by a long axis crossing the Tavoliere horizontally at the considered area edge. The path used for contacting

Piani di Lauria (id8, eastern river shore) remains particular since the calculation suggests a round track crossing the Plain instead of crossing the river as in the system generated for Colle Arsano (id7) (fig. 108). This is due to terrain trends and site position.

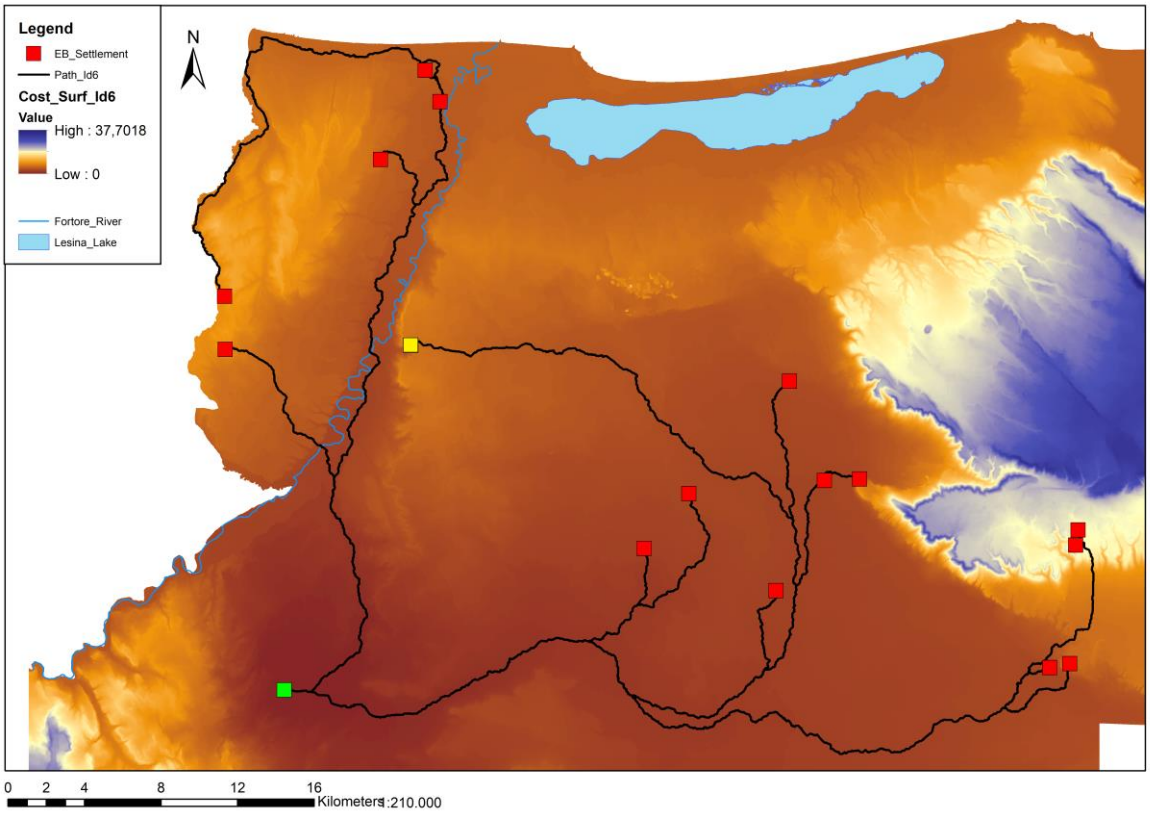


Fig. 108 – LCPA applied to Masseria Iacovelli (green square). The network shows all the paths reaching the sites, in specific the round track to arrive at Piani di Lauria (yellow square) (image by the author).

The last subgroup consists of the sites placed on the southern and inner Gargano foothills that generate, in accordance with their position, four path networks almost completely overlapping, with SE-NW orientation (fig. 109). The path system presents a route dichotomy in which the first branch goes to the north, running the Gargano foothill corridor up to Lake Lesina and then crossing the river, almost at the delta of the river, towards the sites situated on the western side of the Fortore valley. The second track, on the other hand, follows the edge of the considered study area, rising towards the river to cross it. Diversely from the first route, this one permits to connect the source points with just two settlements, Masseria Iacovelli (id6) and Colle Arsano (id7).

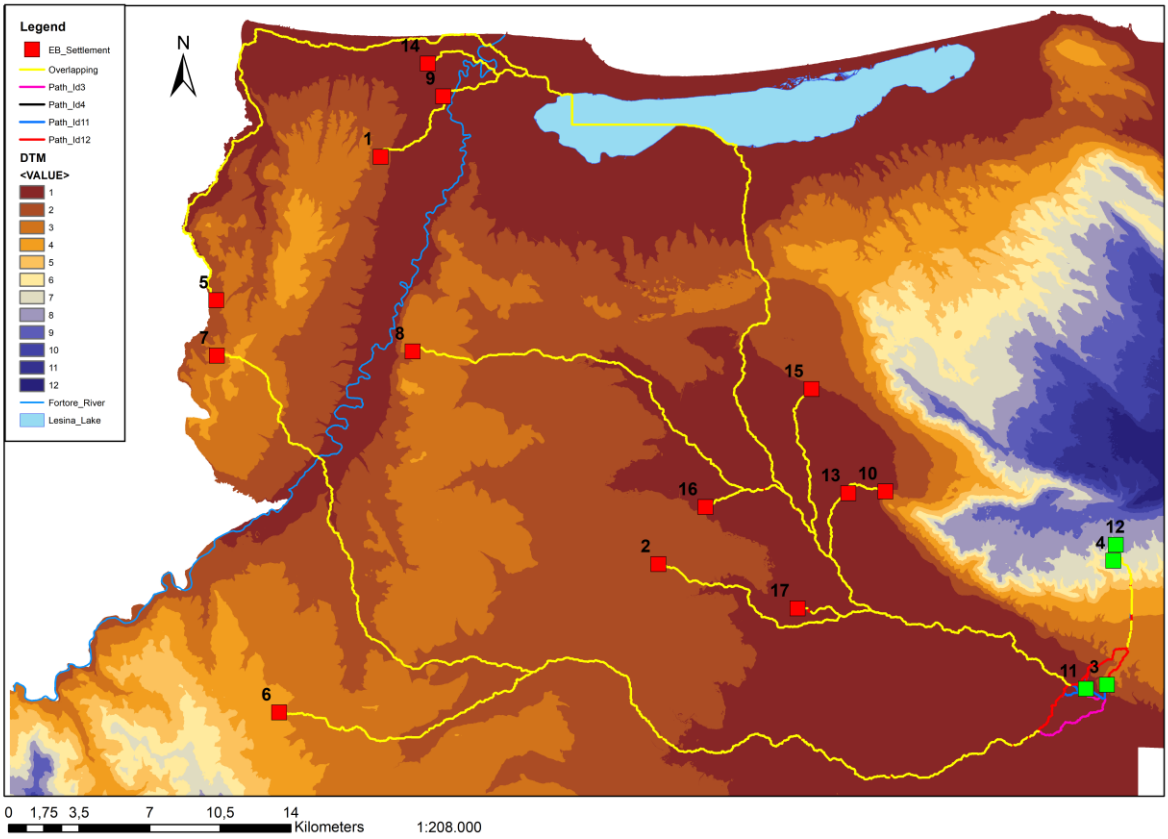


Fig. 109 – Overlapping analysis applied to the path networks generated from: (in green) Monte Granata (id3), Chiancata La Civica (id4), Ciccalento (id11) and Casino Crisetti (id12); in yellow the overlapping path (image by the author).

With this analysis, it is possible to assume that the placement of the sites coincides with mobility following clear trajectories likely to handle a flow into and out of the area, thus, a sort of crossing mobility established to reach further regions beyond northern Daunia. In this kind of system, it seems that the sites placed along the main ways are moved to the background respect the principal aim, i.e. to reach the outer regions.

Concerning the second site cluster of the macro-group, it is formed by the settlements placed on the eastern river shore side (Piani di Lauria, id8) and central-northern Gargano foothills (Brancia 10km – Volta Pianezza, id10; Masseria Mezzanella di Brancia, id13; Mezzana della Quercia, id15). The path networks generated from these settlements have the absence of a specific route in common which was used for mobility. Rather, they show a connection system that we could define as branched out since from the starting point originate several ways in order to reach the arrival sites. Nevertheless, the main corridors are still used, specifically the Fortore River valley (fig. 110).

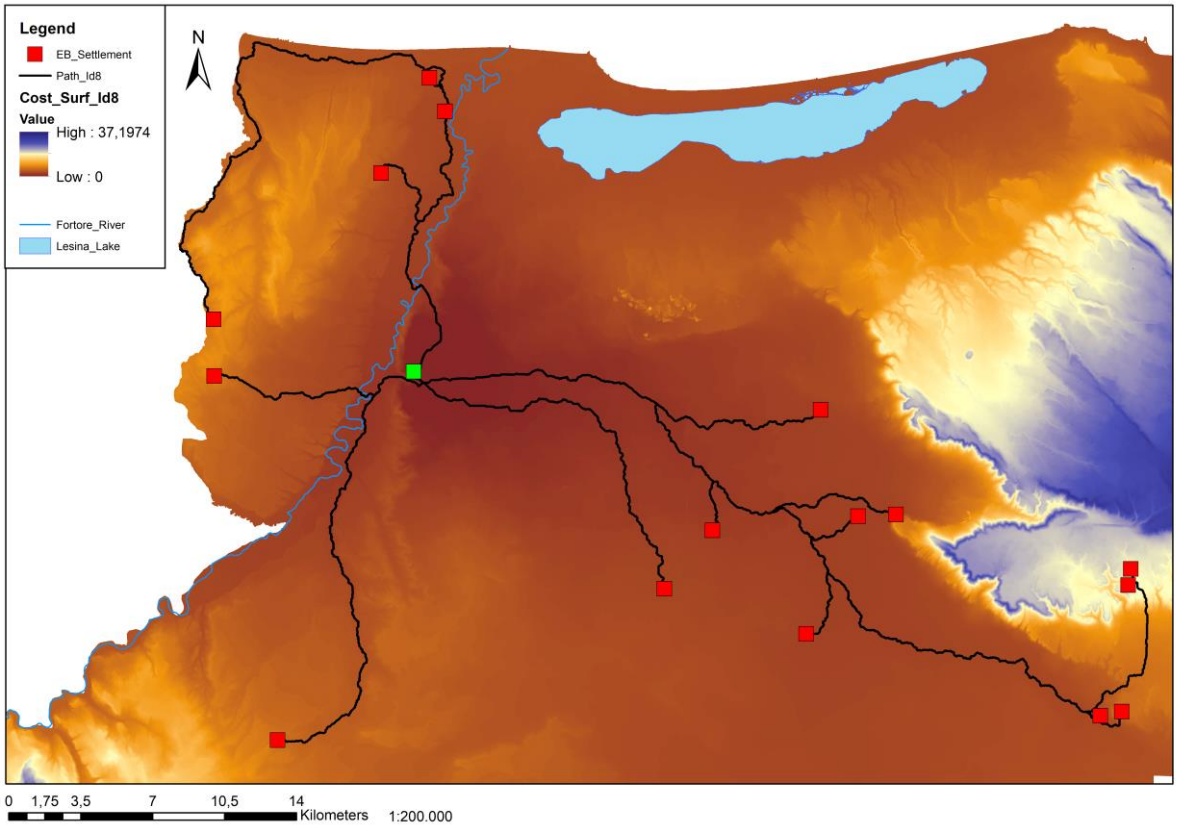


Fig. 110 – Example of LCPA applied to Piani di Lauria (id8) (image by the author).

The analysis shows that the Plain is completely crossed just by Piani di Lauria paths since the Gargano settlements generate networks that follow routes towards the lake and the southern area border, while the Tavoliere is traversed just to reach Piani di Lauria.
Despite these differences, the networks present some overlapping segments that for the sites Brancia km10 – Volta Pianezza (id10) and Masseria Mezzanella di Brancia (id13) result in a quite complete superimposition, also due to the close placement. Instead, considering all the above-mentioned settlements the analysis displays a small overlap in paths (figs. 111, 112).

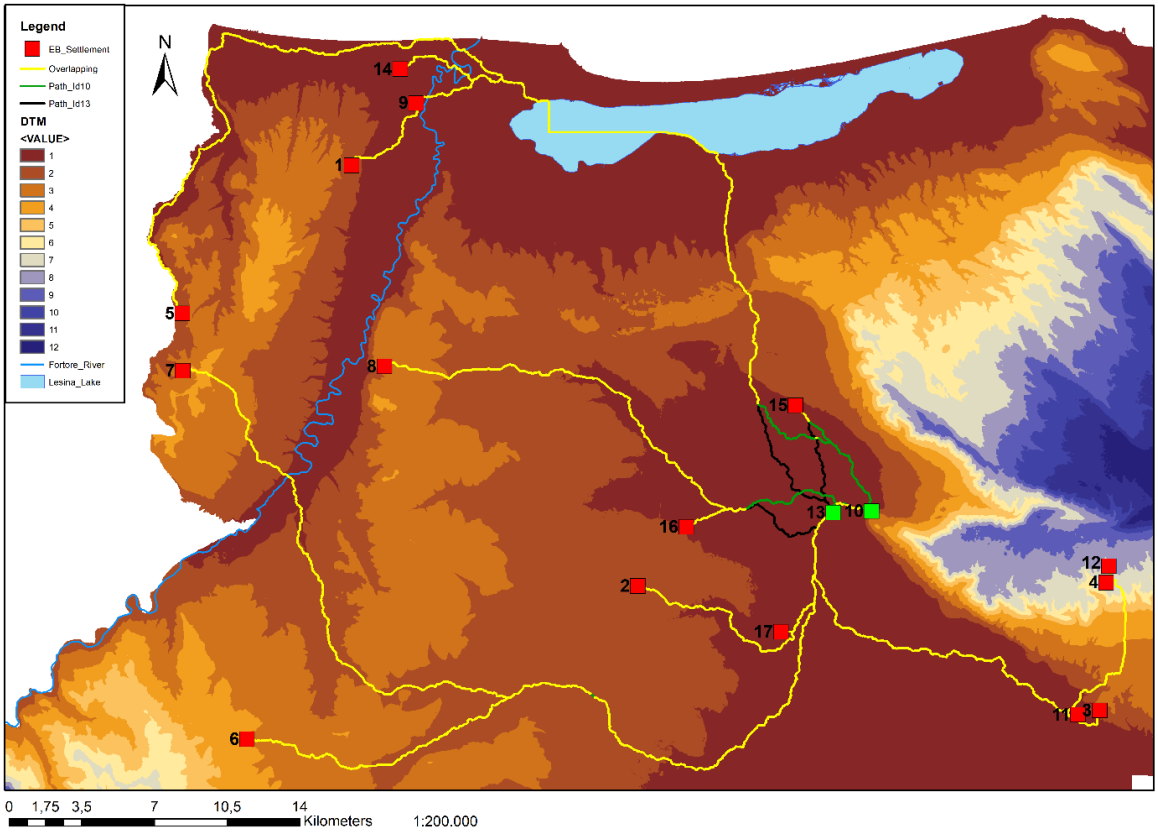


Fig. 111 – Example of overlapping analysis between Masseria Mezzanella di Brancia (id13) and Mezzana della Quercia (id15). In yellow the path overlap; green squares are the starting points (image by author).

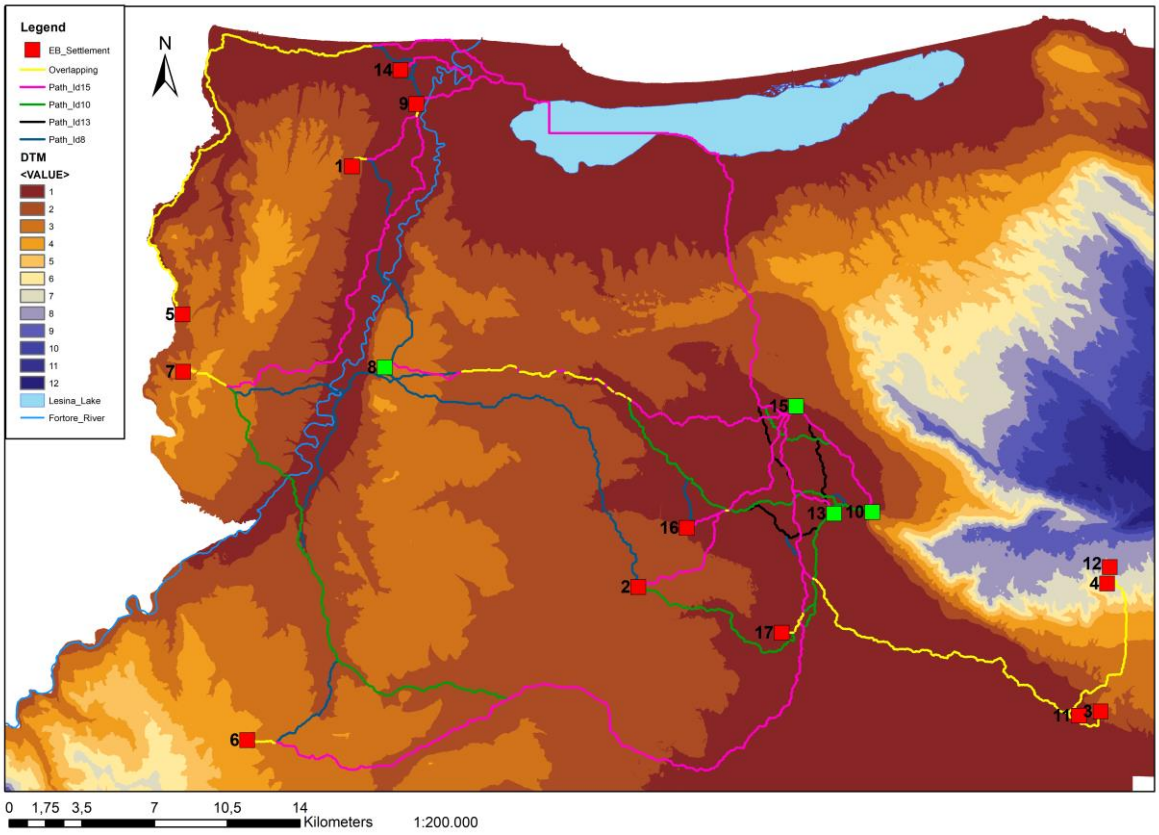


Fig. 112 – Example of overlapping analysis between Piani di Lauria (id8), Brancia km10 – Volta Pianezza (id10), Masseria Mezzanella di Brancia (id13) and Mezzana della Quercia (id15). In yellow the path overlap; green squares are starting points (image by author).

Ultimately, the settlements located on the Tavoliere Plain reflect a similar trend, hence there are not main routes but several tracks that allow to reach the sites. The Plain consists of three villages situated in the central-high Plain, i.e. Località Guadone (id2), Oliveto Torre dei Giunchi (id16) and Portata Casone (id17). Therefore, the analysis displays the creation of separate ways even more branched out in the territory than the previous ones with the longest paths overlapping each other (fig. 113).

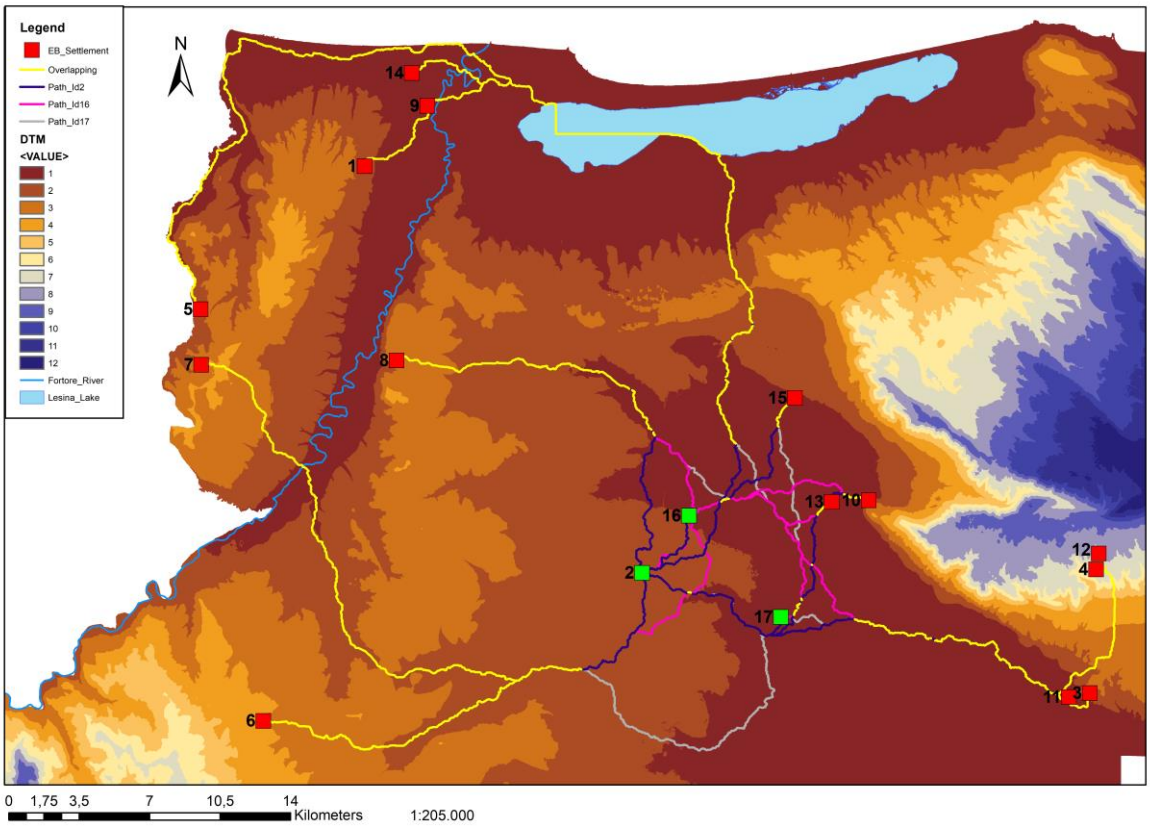


Fig. 113 – Example of overlapping analysis applied to Località Guadone (id2), Oliveto Torre dei Giunchi (id16) and Portata Casone (id17). In yellow the path overlaps; green squares are the starting points (image by author).

The GIS investigation for this group reveals a kind of mobility that is focused on the fast connection between sites, hence in this case the aim is properly to create a network rather than to cross the area. This aspect could be interpreted as the way with which the settlements were in contact to give insights on the routes followed by outer travellers to reach the villages, for example for trading purposes.
As far as sporadic find areas are concerned, these result in the proximity of some sites or paths with a multi-ring buffer analysis at 200, 500 and 1000 metres. The investigation shows that the proximity is comprised between 500 and 1000 metres, where it can be verified. Only Portata Casone covers the same area as the homonymous settlement. Therefore, a probable affinity between the site/path and the sporadic find areas could be deduced in those cases where the buffer shows a link (fig. 114).

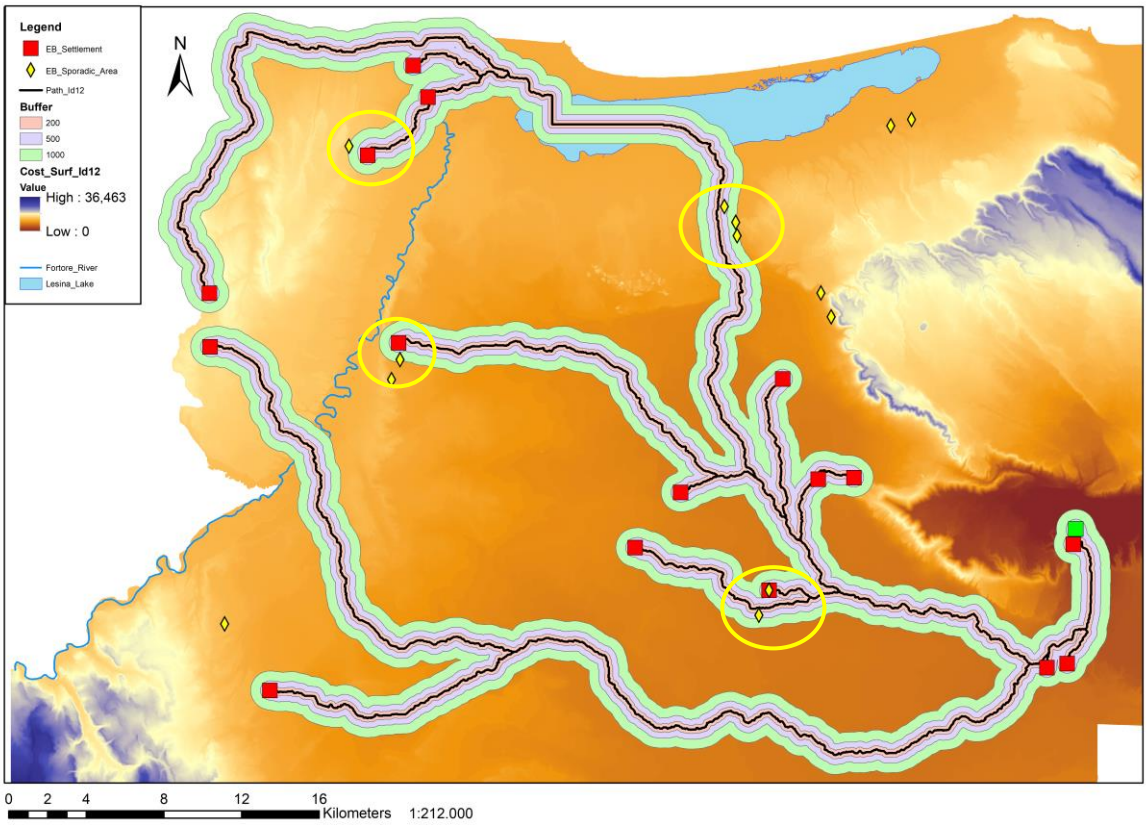


Fig. 114 – Buffer analysis applied to Casino Crisetti (id12, green square) LCPA in combination with the sporadic find area (yellow diamonds). The circles mark the affinity areas between path/site and diamond (image by the author).

Further analysis on the Roman roads shows a less common use with respect to the previous periods, despite the site placement of some locations directly on the Roman routes. Some crossing points are detected, but the only Roman path that finds confirmation in a constant use during the whole period is the one situated along the coastline. It is necessary to point out that during the Early Bronze Age the affirmation of new social and economic models became more solid and consequentially lead to the rise of new bonds between sites. This is the case at Brecciara (id14) that organized, with other coastal sites from Molise, a trading and territory controlling network. Therefore, that Roman road could be a perpetuated use of the same lane (fig. 115).
As far as the transhumance routes are concerned, a very scarce overlapping between the tracks was noticed, with the exception of some crossing points.

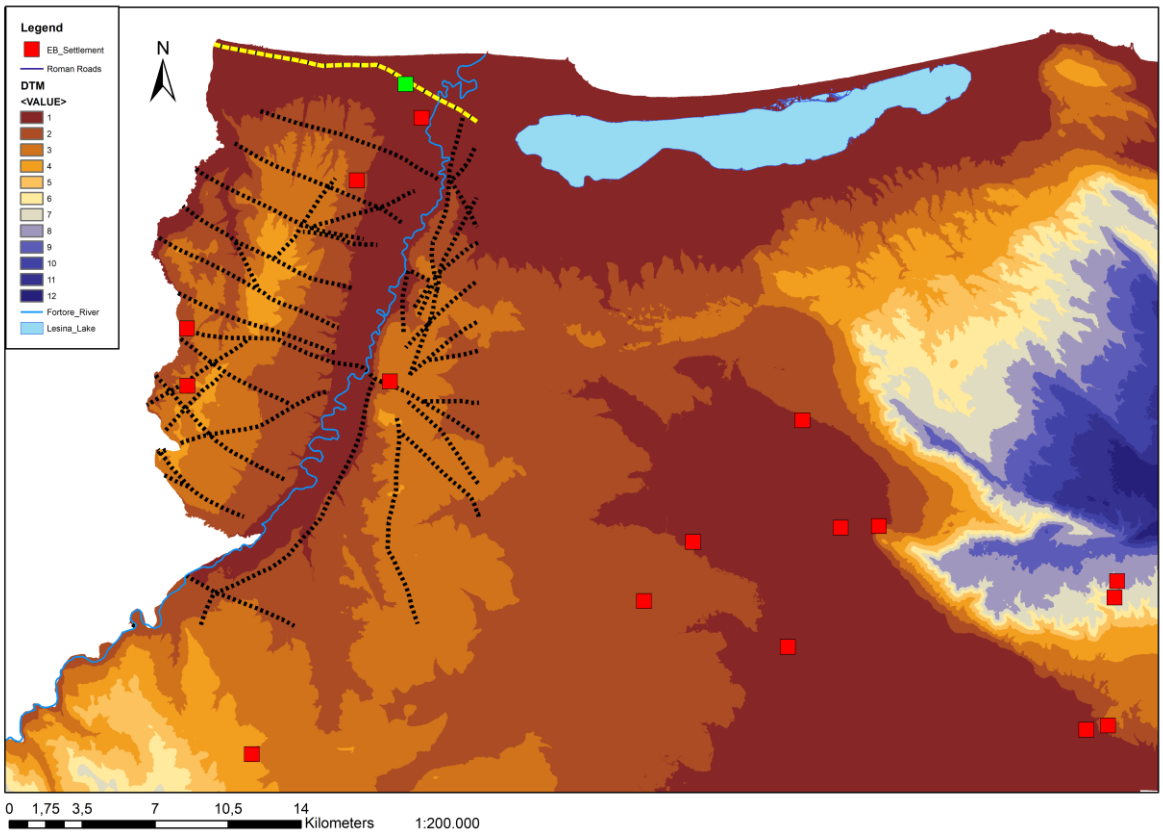


Fig. 115 – Relationship between Early Bronze Age sites and Roman roads. In yellow the Roman path in common with the calculations; the green square is Brecciara (image by the author).

In general, it was observed that from the Early Neolithic the path networks follow in some areas precise corridors traced by the principal watercourses. Assuming their presence from the first phases onwards and considering morphological changes in the course of time, we could accept (fig. 116):

- Saccione Torrrent;
- Fortore River;
- Staina Torrent;
- Candelaro Torrent;
- Triolo Torrent.

As the image shows, the watercourse tracks coincide with a certain number of paths, hence we could assume that they worked as corridors, helping to orient and simplify mobility in the specific areas and towards other areas (Filloramo *et al.* 2021a, 133).

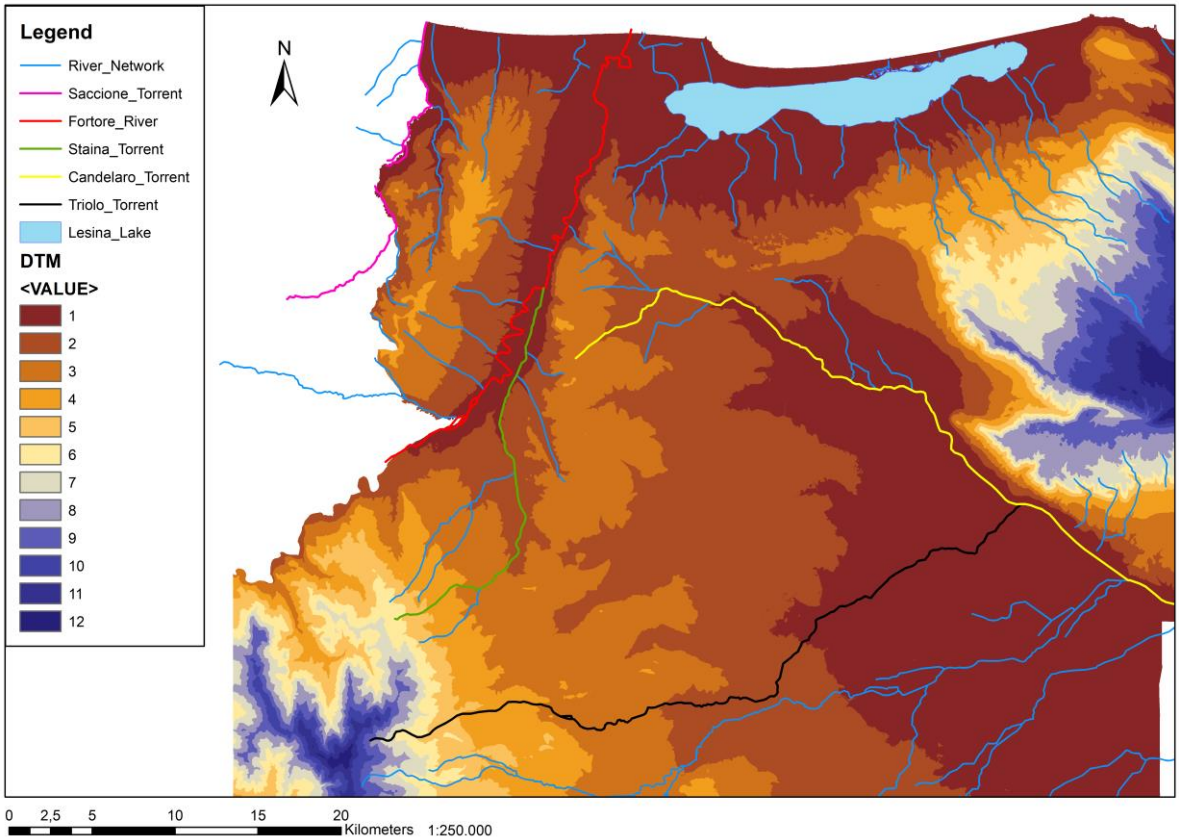


Fig. 116 – Northern Daunia watercourse networks. The lines are left as they are on purpose in order to give the idea of their extension beyond the Apulian borders. In different colour the main watercourses mentioned in the text (image by the author).

Moreover, a good number of paths, or whole networks, are overlapping both during the same phase and diachronically. Therefore, it can be assumable that the generated paths survived through time and wee constantly used by the communities; they demonstrate a deep knowledge of the territory.

4.2. Viewshed Analysis[1]

4.2.1. Early Neolithic

The visibility analysis was applied to the same settlements as the LPCA because, also in this case, the choice of a settlement site was oriented towards the reason of visibility of those sites placed in the "peripheral" areas. The core of the study area, as for the mobility, presents largely a good sight standard (fig. 117).

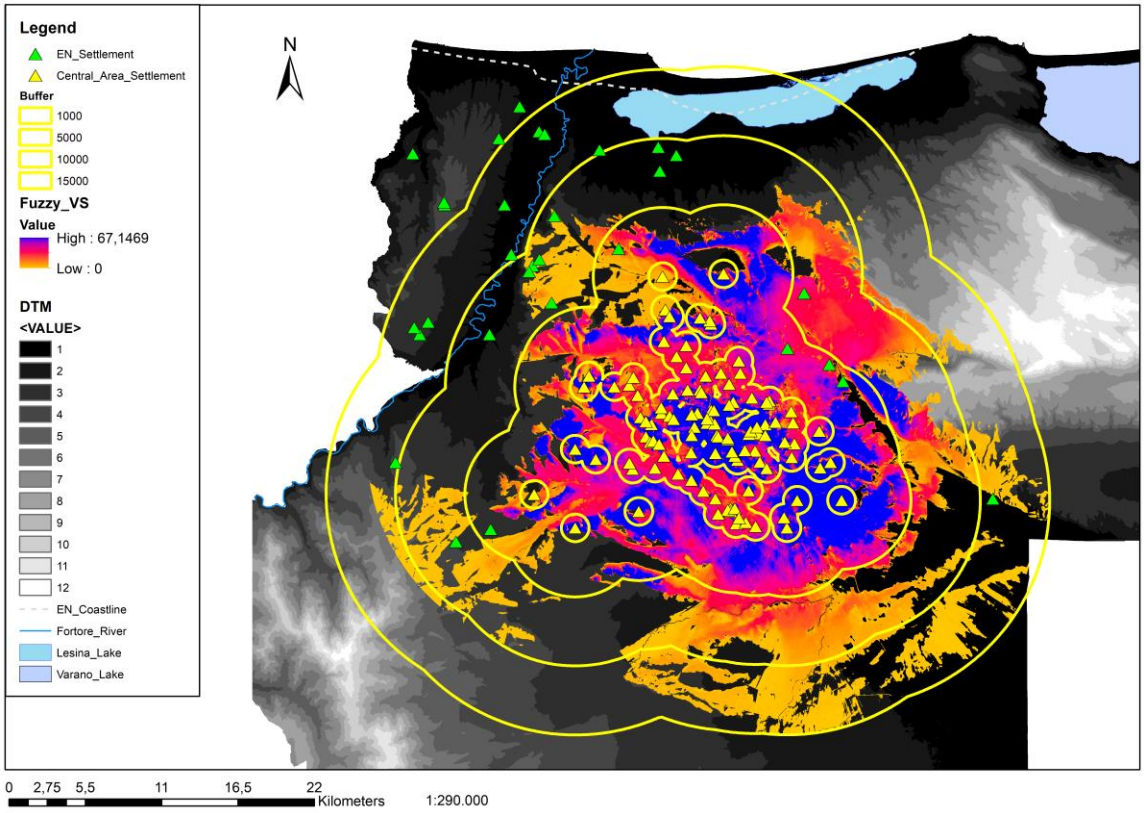


Fig. 117 – Fuzzy Viewshed Analysis applied to the sites placed in the core of the considered area. Yellow triangles are the observer points from which the calculation originates; green triangles are the rest of the EN settlements; yellow circles are the multiple ring buffers in meters, originating from the observer points (image by author).

In the complex, the analysis gives a visibility range that turns from blue (maximum visibility) to orangish shades (poor visibility) showing a strong intervisibility between the observer sites; on the other hand, the DTM surface identifies the absence of visibility. To have a better comprehension of the sight perceiving extension, a multiple ring buffer at 1000, 5000, 10000, 15000 meters

[1] For the result of the single analysis consult the tables in the Appendix at the relative period section.

was applied to the observer points. In detail, the highest value varies according to the source point position; the inner site corresponds the second to last circle, while the last one is linked to the more external sites.

4.2.1.1. South-western foothills of the Gargano

The analysis shows the kind of sight orientation the settlements could have had. In detail, it becomes obvious that the northern observer points, i.e. Mezzanella di Brancia (id53) and Mezzana della Quercia (id135), have a wide visibility spectrum within a distance radius of 6 km the surroundings. The 6 km distance falls into a range of acceptable sight clarity; after this threshold, the drop of sight is more significant since it is subject to further parameters such as weather conditions and individual eye-sight.
In both cases, the visibility is directed towards the low and central Candelaro Valley, hence the Gargano foothills, and in addition towards the Tavoliere Plain and the inner Gargano area. The major number of the sites fall into a distance range between 8 km and 15 km, which means that those points were scarcely or not visible at all according to the above-mentioned parameters (fig. 118).

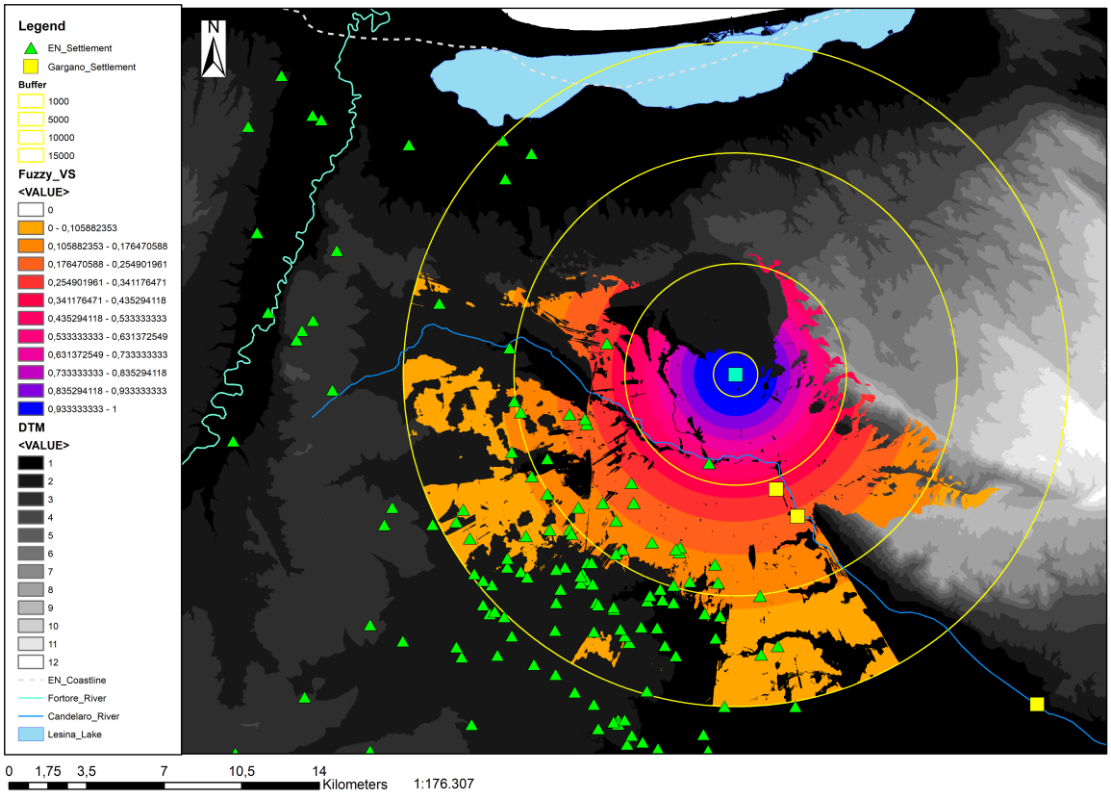


Fig. 118 – Fuzzy Viewshed Analysis applied to Mezzana della Quercia, where the maximum visibility value is 1 (blue) and the minimum 0 (light orange and no colour). Buffer is represented by the yellow circles with values in meters. Yellow squares are the Gargano sites; light blue square is the observer point; green triangles are the rest of EN sites (image by the author).

On the contrary, Località Piro di Brancia (middle Gargano foothills) reveals a visibility focused just on the inner Gargano inner hills, hence a limited spectrum with its peaks roughly at 8 km. Also, the sites seem to be out of sight, except Mezzana della Quercia placed at ca 7,4 km. Moreover, the data presents a discontinuous spectrum with blind points due to the natural barriers surrounding the site.
Ultimately, Ciccalento (id89) has a fragmentary visibility addressed to the inner hills and along the Candelaro river with the propensity to enlarge the spectrum towards the southern part of the river valley. Interestingly, the position permits to have a good sight degree, however linked to a narrow strip close to the sites.

In general, the analysis shows that just the first two sites display a visibility on other settlements placed in a close range of 6-7 km and with a radius of almost 360 degrees, hence defining them as the most complete. On the other hand, the others yield data that points to delimitations due to natural barriers surrounding the locations.

4.2.1.2. Molise regional border

The settlement of Masseria Bivento (id5) arose on a hilltop from which, apparently, it is possible to have a good sight on the valley; whilst the location is peripheral with respect to the Tavoliere, the surrounding territory offers the possibility to conduct subsistence activities. Nevertheless, the analysis shows that from this point the visibility was not particularly extended because the sight radius ends at ca. 8 km, with an elongated shape. Even though the calculation does not consider the Molise territory, it is possible that this portion of landscape was also visible from the observer point or from the immediate vicinity. It is remarkable that a land strip may be visible at ca. 33-38 km to the south. However, the data points to an unlikely event due to the distance and the need for the optimal conditions (fig. 119).

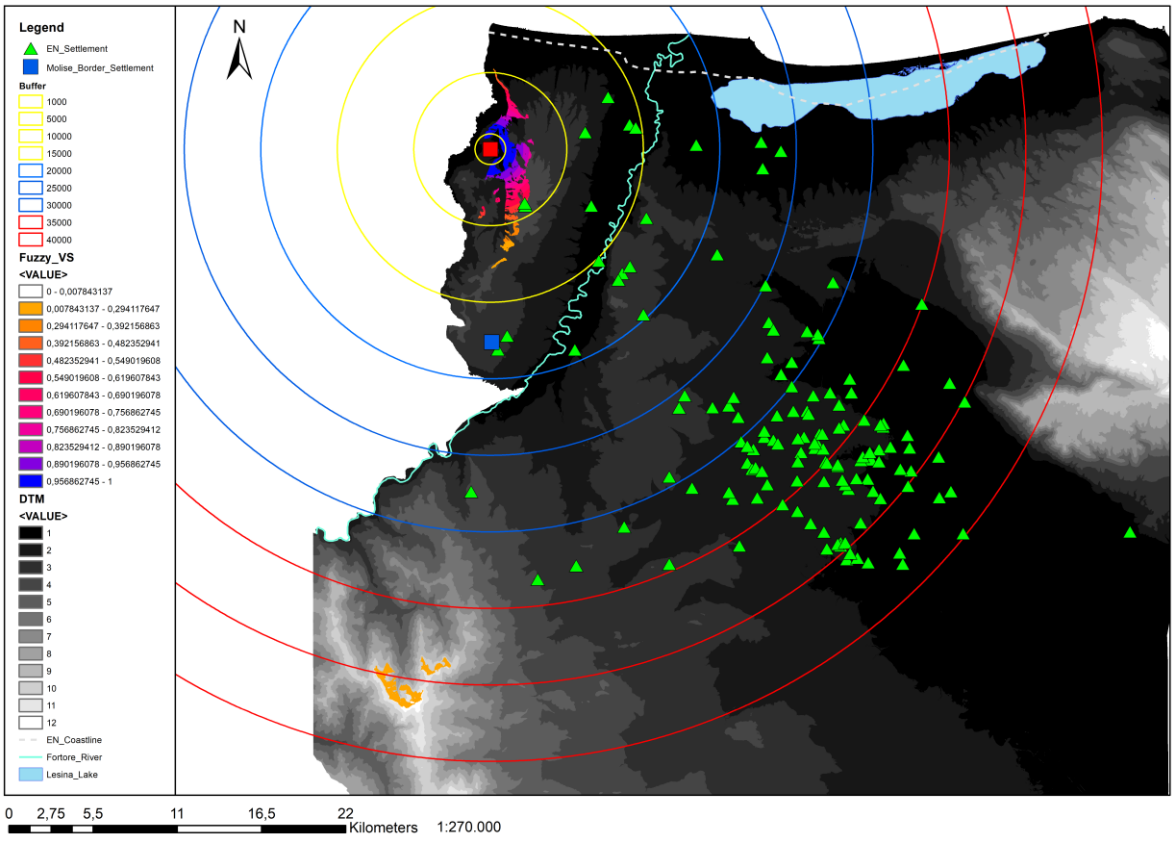


Fig. 119 – Fuzzy Viewshed Analysis applied to Masseria Bivento (red square). The buffer values are in meters and the colours identify the areas into which the visibility spectrum falls, respectively yellow and red (image by the author).

The second settlement, Canale Carpano II (id131), is located close to the border, like the first, and situated on a hilltop. In contrast to Masseria Bivento, the site displays a wide visibility record on both riversides and most likely also on the Molise territory. As displayed in fig. 120a, the sight range presents some gaps, for example along the river valley; in this case, a sign of a surface trend composed of depressions and slopes. In other words, the sight is interrupted where a downhill slope occurs that covers the related portion of the landscape, as expressed in the terrain profile graphs (figs. 120b-d).

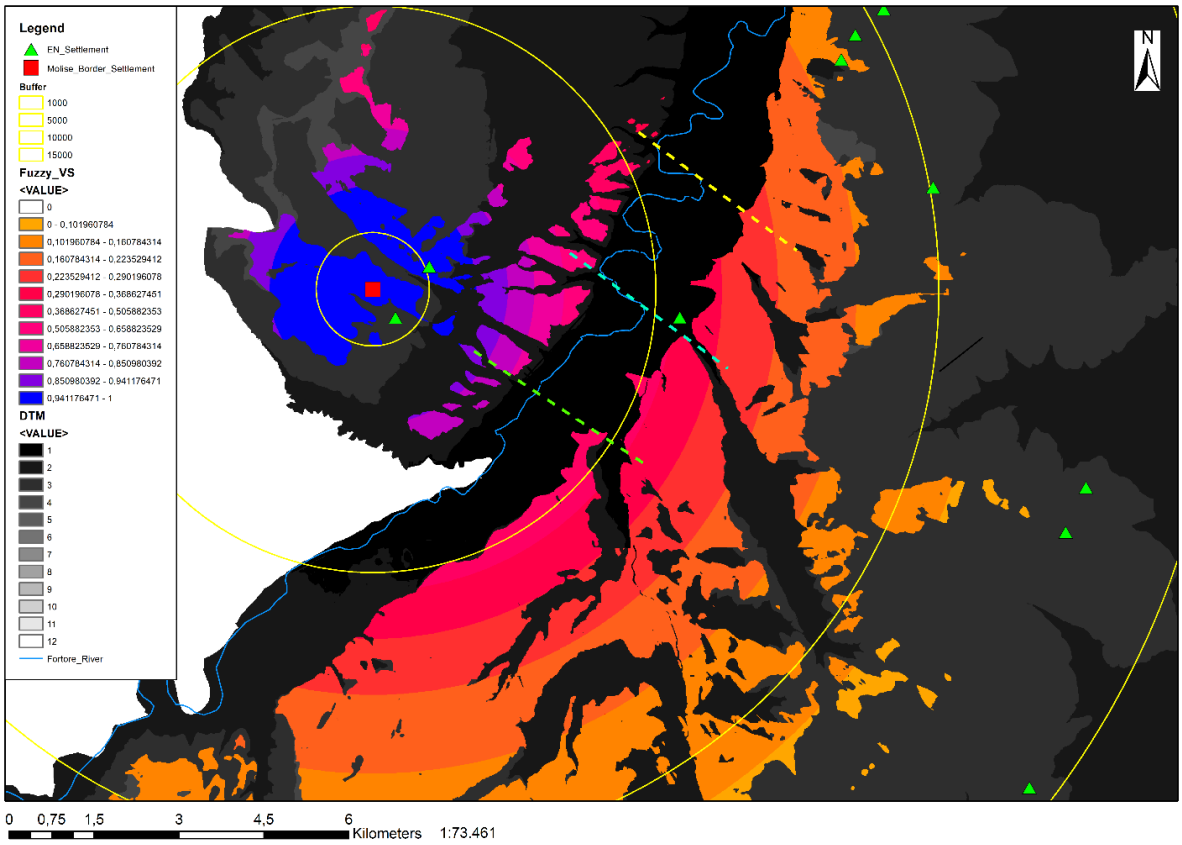


Fig. 120a – Fuzzy Viewshed Analysis applied to Canale Carpano II (red square). Yellow lines are the multiple ring buffer with values in meters; dashed lines correspond to the terrain profile samples linked to the related graphs; green triangles are the rest of the EN settlements (image by the author).

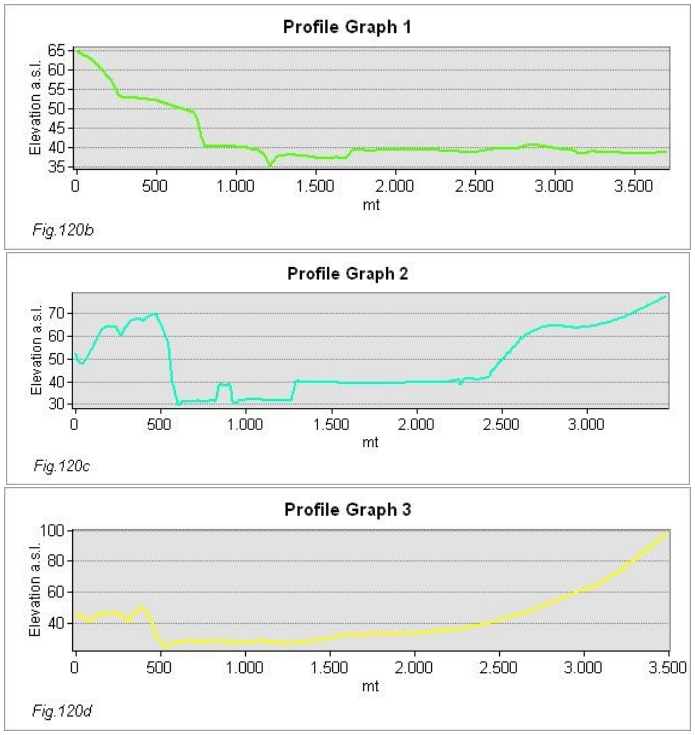


Fig. 120 b-d – Terrain profile graphs related to the samples in fig.120a. The same colours were used for both sample and graph line (image by the author).

The samples were taken in a distance between 2300 and 2400 meters from each other, in order to represent a regular landscape portion. The three graphs display an irregular surface consisting of a downslope which is followed by an upslope with diverse degrees of steepness. Probably these variations cause the lack of visibility and generate such blind spots.
However, the visibility spectrum displays the opportunity to have a good clarity until the threshold of ca. 7/8 km, which means that, from the observer point, a person – or a group – could be individuated on the landscape at least as shape. Beyond this point, a drop-off in clarity is recorded that could obscure the possibility to distinguish the subject under realistic conditions.

4.2.1.3. Fortore River Valley

The settlements of the eastern riverside could be clustered in two groups in accordance with the orientation of the visibility spectrum:

- major visibility of the inner eastern area and scarcely, or at all, on the western side;
- visibility observed, more or less, equally on both riversides.

To the first group belong Masseria Anita-Canimpiso (id1), Piani di Lauria I (id15) and Piani di Lauria III (id134), hence points situated on the low and central portion of the Fortore valley. The analysis marks an extended view on the inner area for id1 and id 134 with the capability to likely observe some sites situated close to the southern Lesina shore and in the north of San Severo. Instead, id 15 displays a limited visibility range towards the inner region, but a good clarity on the surroundings. Concerning the western side, just id1 and 134 present a limited number of visible cells, partially matching with Macello di Serracariola (id8), falling into the 7-8 km range (fig. 121).

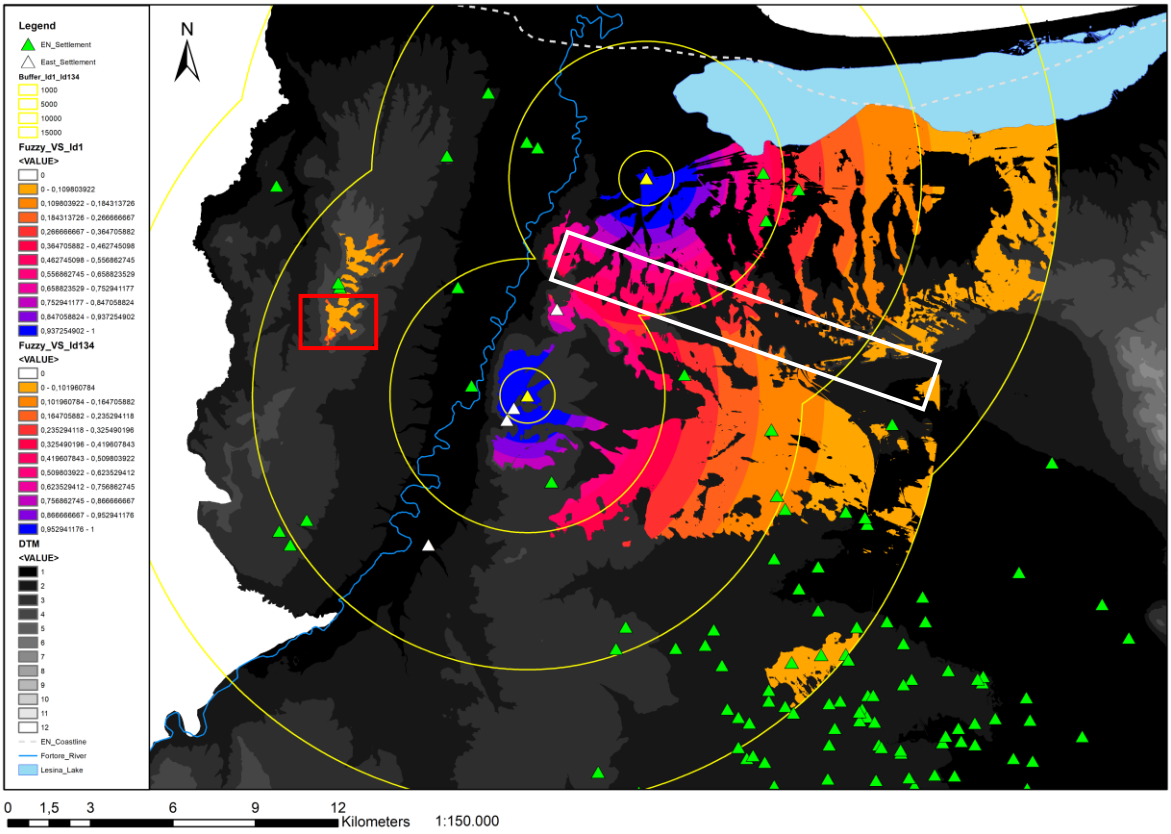


Fig. 121 – Fuzzy Viewshed applied to Masseria Anita-Canimpiso (yellow triangle close to the lake) and Piani di Lauria III (yellow triangle in the central Fortore Valley). Red square is the overlapping of the western side point; white rectangle is the overlapping of the eastern side point. Buffer values expressed in meters (image by the author).

The second group consists of Piani di Lauria IV (id133), Coppe di Rose (id9), Masseria Fara Sentinella (Id139) and Colle d'Armi (id18), hence those sites located from the central to the upper river valley. The sites present a distinct visibility on both river shores at long distances, too. Nevertheless the radius is wide, the clarity spectrum presents some gaps, yielding, in some cases, discontinuous data. An example is the data coming from Coppe di Rose where the analysis demonstrates a drop-off in clarity at long distances, at 7 km it displays a good degree of visibility, but several gaps occurs due to the surface trend (fig. 122).

Besides the clustering operation, the only settlements whose location demonstrated a direct visibility on the central and upper parts of the watercourse are Colle d'Armi, Piani di Lauria IV and Masseria Fara Sentinella.

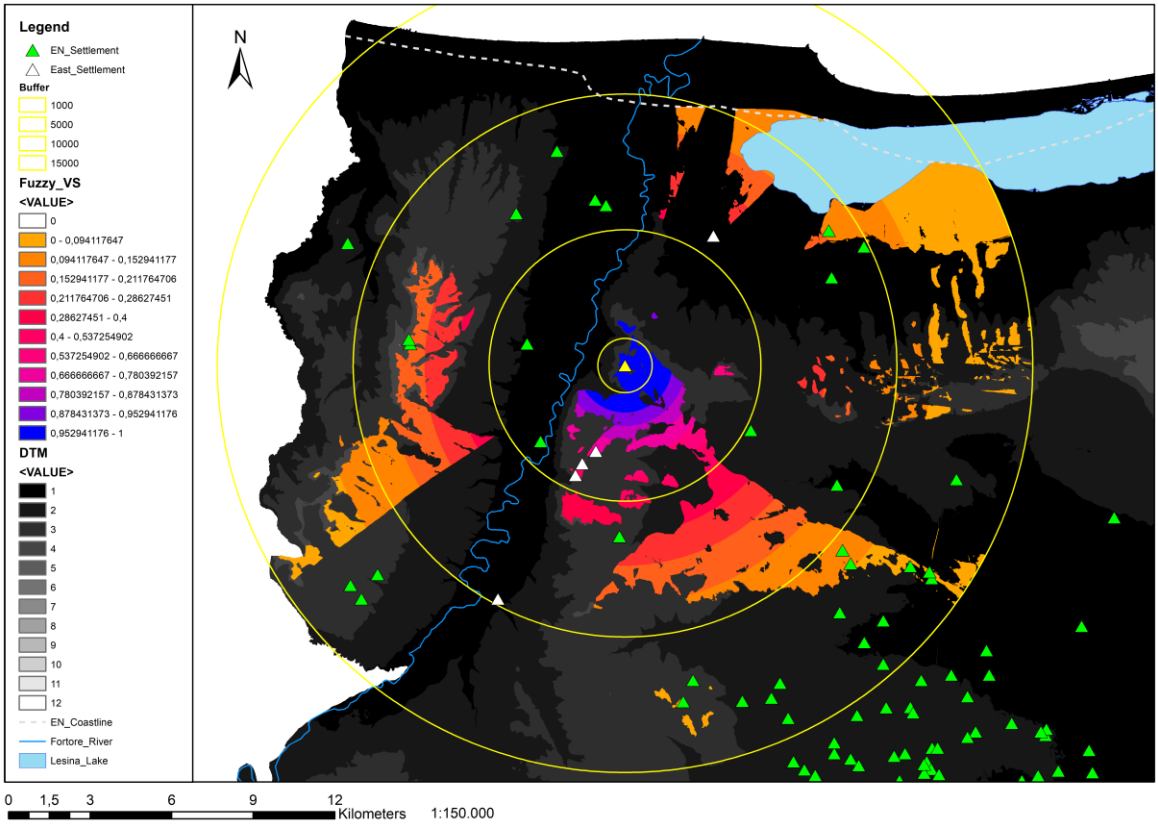


Fig. 122 – Fuzzy Viewshed applied to Coppe di Rose (yellow triangle). Buffer values expressed in meters (image by the author).

The analysis for the western side reveals a major tendency of visibility on both riversides. In most cases, the data presents a wide and extended visibility spectrum with direct visibility on the river; exceptions for this are Masseria Settimo Grotte (id7) and Canale Carpano I (id130).
In addition, the only settlements that show a limited sight range are Masseria dell'Ischia (id6) and Piani di Lauria Bassa (Id132), where the first generates a cone-shaped spectrum from the observer point to the eastern riverside and an outer very small part on the western side that reaches the maximum distance of ca. 6,6 km. Therefore, we could consider this side as limited from this specific location.
Instead, id132 presents wider visibility data but plenty of gaps likely due to the location because the settlement arose at the foothills of Piani di Lauria and therefore a lower area with respect to the other sites of the area. However, the major visible area is localized on the western side along the valleys.

In general, it was noticed that the analysis lead from each western site intercept a scarce number of eastern villages, it seems that for the placement was more important to see the landscape. Moreover, Masseria Settimo Grotte (id7) and

Canale Carpano I (id130) featured the only observer points with good, even though limited, visibility on the Molise territories (fig. 123).

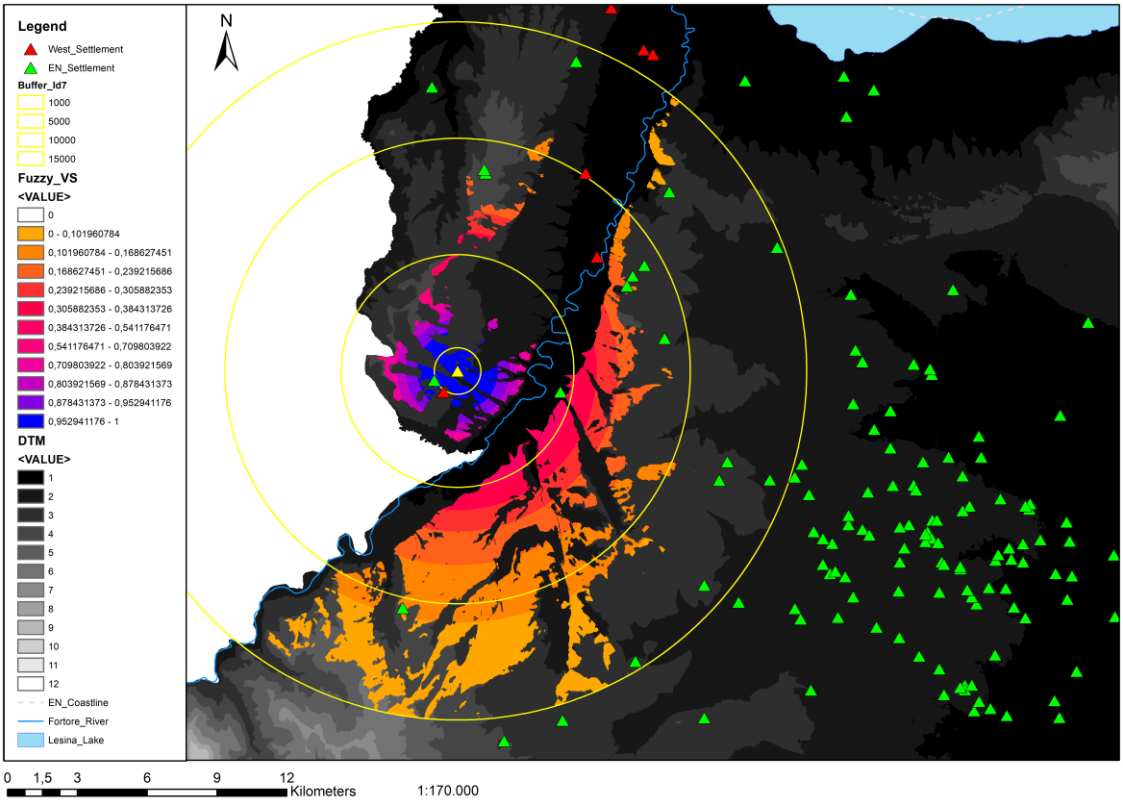


Fig. 123 – Fuzzy Viewshed applied to Masseria Settimo Grotte (yellow triangle). Buffer values expressed in meters (image by the author).

4.2.2. Middle Neolithic

As we have seen before, the Middle Neolithic presents a marked contraction of the number of new sites. We could say that this new organization could reflect also a new way to perceive the landscape, as the Fuzzy Viewshed Analysis would suggest.
The calculations underline how the sites could cluster in (fig. 124):

- ❖ Group 1;
- ❖ Group 2;
- ❖ Group 3.

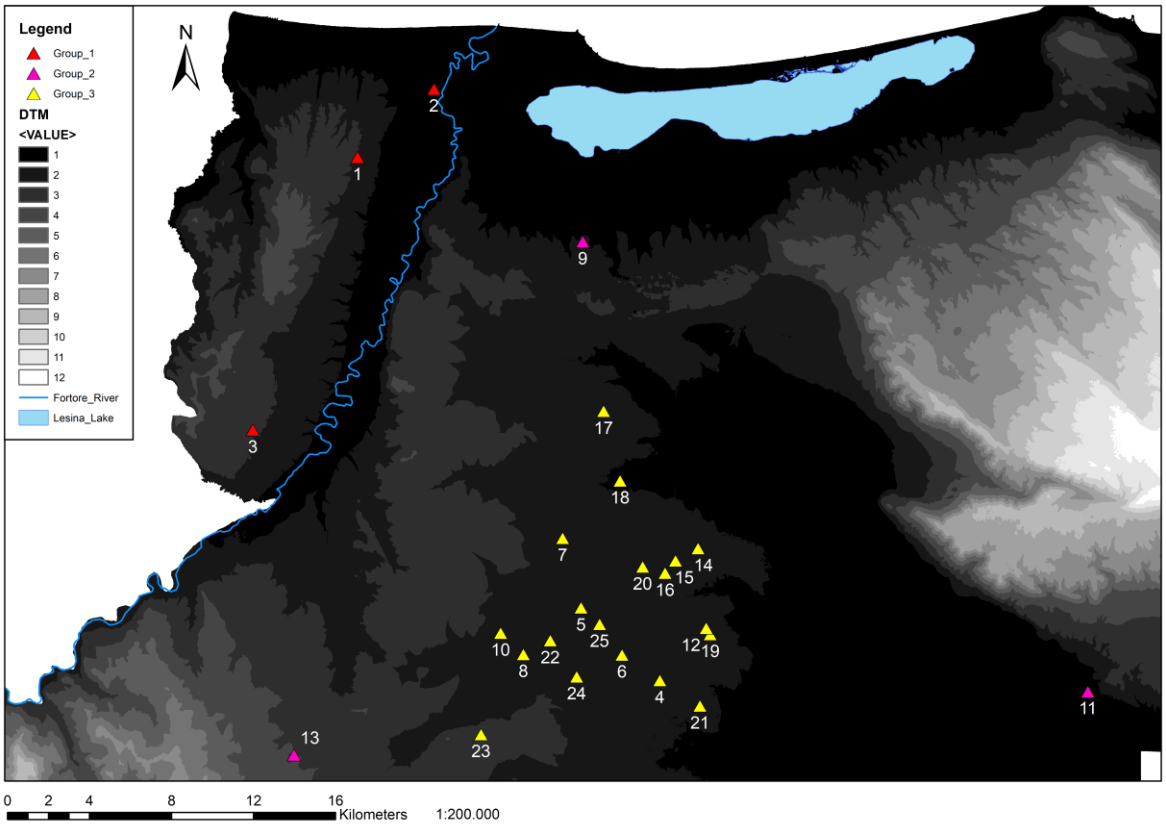


Fig. 124 – Site subdivision map in accordance with the VA results (image by the author).

Group 1 encompasses those settlements that demonstrated a visibility focused on specific sections of the territory. This is true for the sites situated along the Fortore valley such as San Matteo-Chiantinelle (fig. 124, id1) and Masseria Settimo Grotte (fig. 124, id3), which already existed in earlier times, and Chiarappa (fig. 124, id2), which appears as the only new foundation.
The analysis led on these three points shows a visibility focused mainly on the

river valley, presenting a huge lack on the central western hills and the northwestern Molise border because of the surrounding orography. In detail, San Matteo-Chiantinelle displays a narrow visibility radius around its centre that enlarges as a cone, oriented to the north, with a wide base towards the Adriatic coast and Lake Lesina. Nevertheless, the analysis estimates that, from the observer point, the site of Chiarappa and the Fortore course had to be visible because they fall within the 5 km buffer zone. The rest of the territory results in a possible perception under good conditions because it is subject to a gradual dropping in clarity (fig. 125).

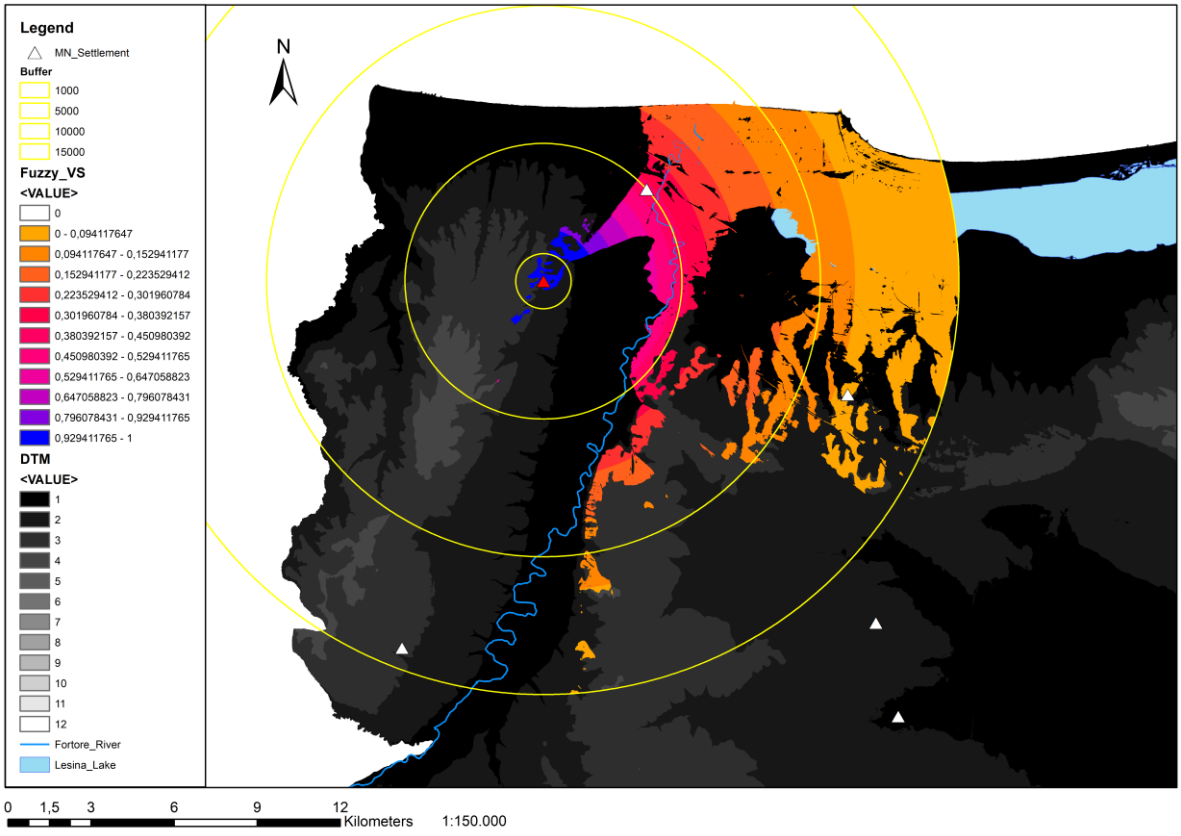


Fig. 125 – Fuzzy Viewshed applied to San Matteo-Chiantinelle (red triangle). Buffer values in meters (image by the author).

Chiarappa is located on a flat area in the vicinity of the Fortore River, demonstrating a good placement choice that will continue to be used in the following periods. The analysis reveals a visibility orientated towards the south, meaning that the coastline is not considered by the calculation. It can be stated that after a first range between 0 and ca. 3 km with a really good clarity, the data starts to split due to the natural barriers. This dichotomy encompasses good visibility towards the site of San Matteo-Chiantinelle and the watercourse and afterwards a gradual drop-off. Despite this, the visibility spectrum is not

particularly wide.
On the other hand, the site of Masseria Settimo Grotte does not present any variation with respect to the Early Neolithic calculation because the settlement occupies the same location.

Group 2 is linked to those sites that we could consider as placed in a peripheral position due to their distances to other sites. The settlements are situated at what we could identify as the edges of the study area, namely La Torretta (fig. 124, id9) at Poggio Imperiale[2], Ciccalento (fig. 124, id11) at the southwestern foothills of the Gargano and Pian Devoto (fig.124, id13) at Castelnuovo di Daunia[3]. Between these points, a new settlement is La Torretta, while the other two continue from the Early Neolithic.
The calculation shows a spotlight-like visibility on the territory that, only in the case of id9, intersects another site at a distance of ca 11 km. Comparing the spectrum, id11 and 13 are characterized by a really limited sight range that does not reach meaningful distances in clarity; while id 9 displays a very large visibility spectrum that covers the surroundings almost at 360 degrees with a specific northward orientation. Despite the small extent of visibility of the other sites, they are all oriented mainly orientated towards outer areas, away from the the Tavoliere Plain (fig. 126).

[2] Poggio Imperiale is a city in the municipality of Foggia. It is located ca. 4 km northward to Lake Lesina.
[3] Castelnuovo di Dauia is a city in the municipality of Foggia. It is located at the southwestern edge of the considered Tavoliere area.

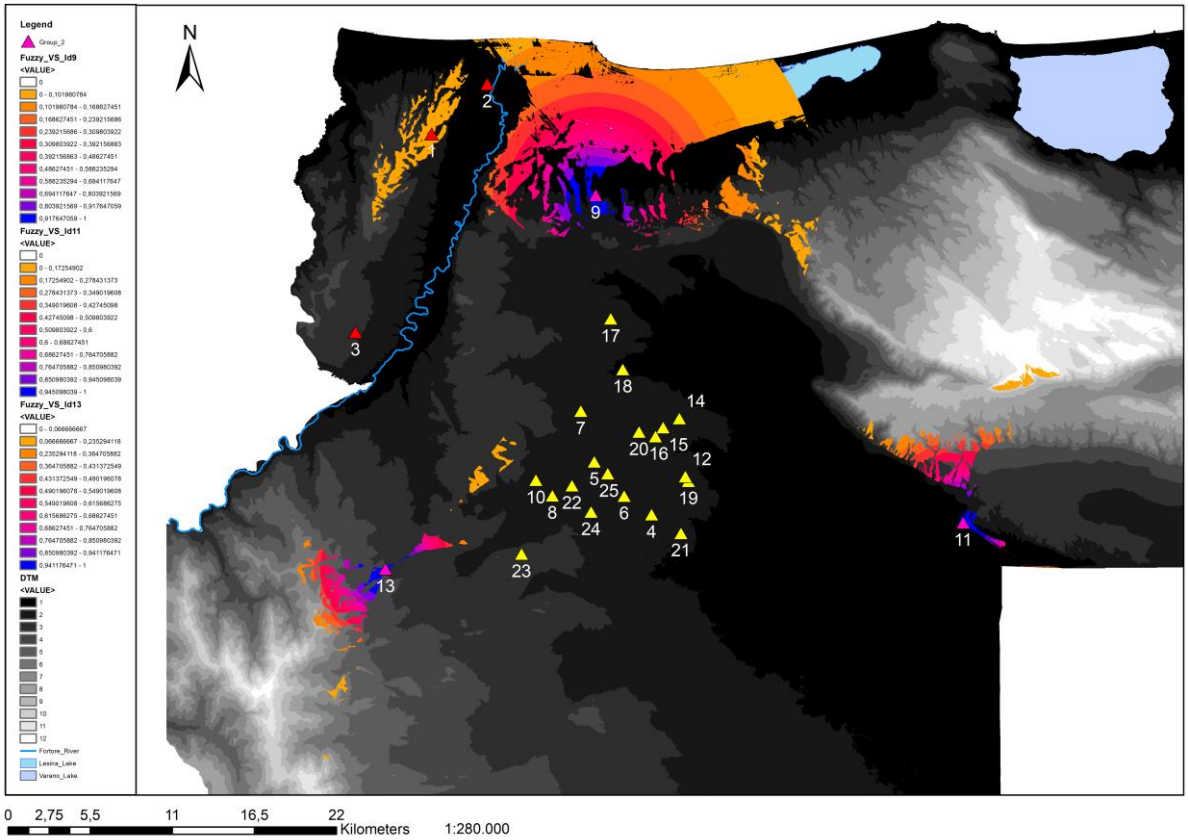


Fig. 126 – Fuzzy Viewshed applied to La Torretta (id9), Ciccalento (id11) and Pian Devoto (id13) (image by author).

The third group consists of those settlements that lie on the Tavoliere Plain and constitute the major number of points (fig. 125, yellow triangles). Despite the point proximity that generates an overlapping layer between all results of the Fuzzy Viewshed analysis that heuristically permits to understand how the area had to be covered, it becomes obvious that the individual sight orientation splits the group into two sub-clusters, i.e. group 1a and group 1b (fig. 127).

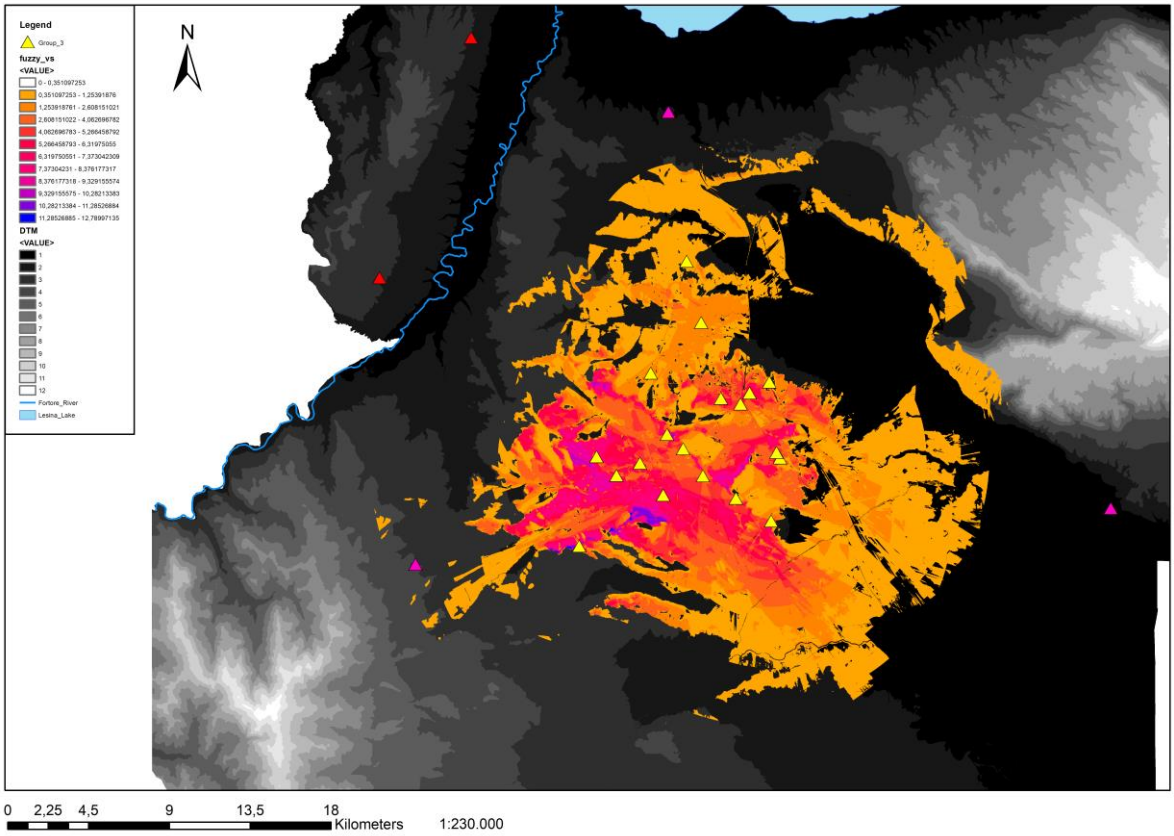


Fig. 127 – Fuzzy Viewshed applied to all the sites constituting group 3 (yellow triangles) (image by author).

The group 1a is formed by sites that show a northward sight orientation:

- Masseria Pagliari (id7);
- Li Gatti (id12);
- Località Franceschiello (id17);
- Località Boschetto (id18).

As displayed in fig. 124, the placement displays all points in external positions, except Li Gatti that appears in the centre of the site distribution. Therefore, the analysis reveals in all cases a visibility with a spectrum touching both the Gargano foothills and the Fortore River (or its proximity). It has to be noticed that the sight range is not continuous but presents gaps, making the spectrum sometimes fragmentary. Concerning the likely intervisibility, id7 and 18 falls into their close sight range, id17 does not perceive any sites, but id12 sees clearly the following sites of the group 1b: Località Orsello (id14), Coppa d'Ovidio (id15), Coppa Porci (id16), Torretta Santì'Andrea (id19) and San Rocco (id20) (fig. 128).

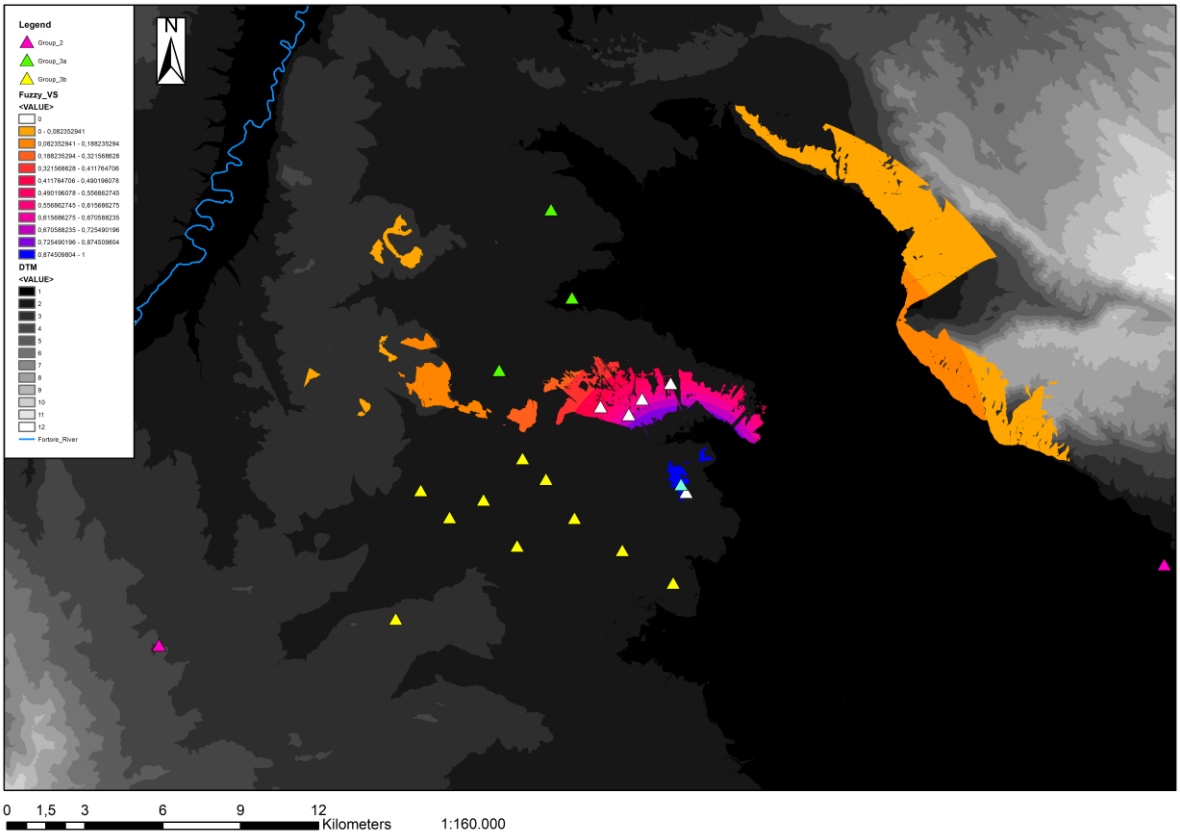


Fig. 128 – Fuzzy Viewshed applied to Li Gatti (id12). In light blue the observer point; in white the Group 3b sites that are visible from Li Gatti; in yellow the rest of the group 3b sites; in pink part of the group 2 sites (image by the author).

Group 3b is the most numerous (15 sites) and consists of those observer points with a sight range oriented southward:

- Masseria Istituto di Sagro (id4);
- Coppa Pallante (id5);
- Coppa Pocci (id6);
- Masseria Li Gatti (id8);
- Oliveto Masselli (id10);
- Località Orsello (id14);
- Coppa d'Ovidio (id15);
- Coppa Porci (id16);
- Torretta Sant'Andrea (id19);
- San Rocco (id20);
- Masseria Casalorda (id21);
- Località Florio-Ricci (id22);
- Castellana (id23);
- Località Santa Maria (id24);
- Masseria Parisi (id25).

Similarly to group 1a, the settlements present a wide visibility spectrum comprising the Gargano foothills and the upper Fortore Valley; but again, blind spots appear. Nevertheless, the sites result in falling into a close range of clarity and are therefore more closely connected to group 1a in most of the cases (fig. 129).

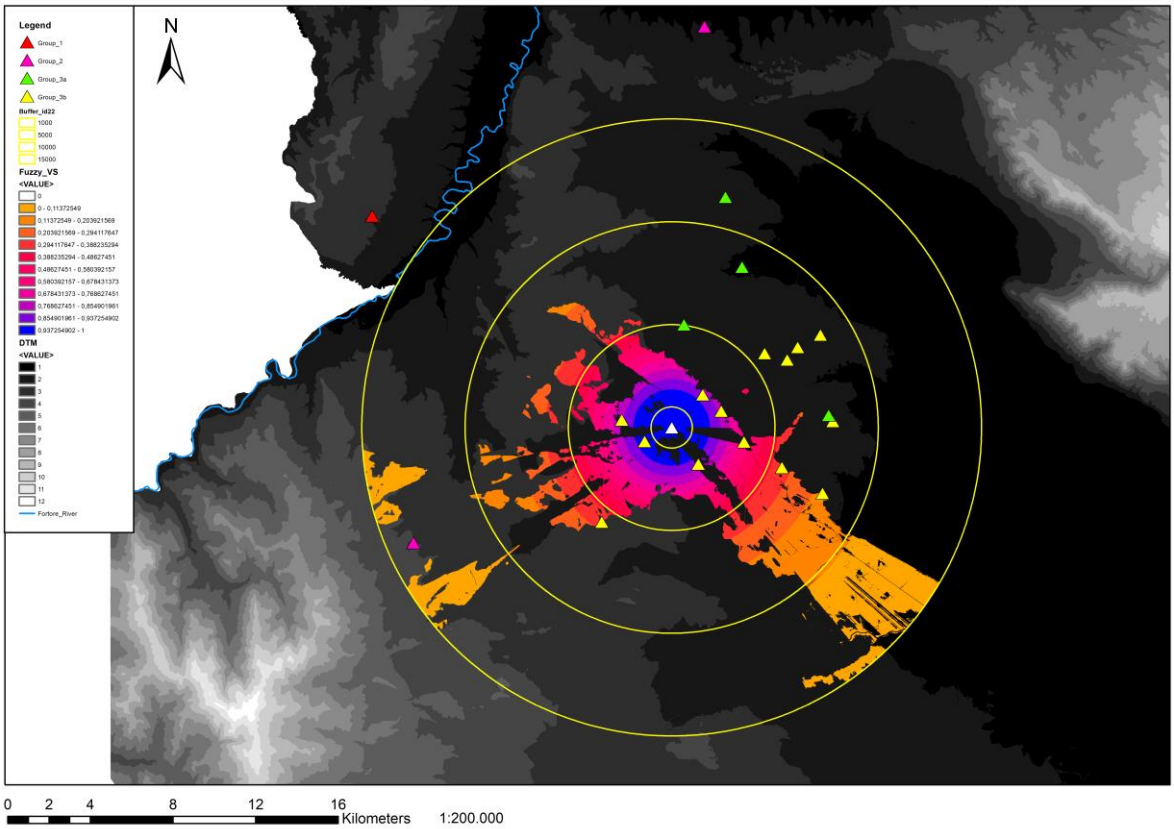


Fig. 129 – Fuzzy Viewshed applied to Località Florio-Ricci (id22). In white the observer point; in red site of the group 1; in pink part of the group 2 sites; in green the sites of the group 1a; in yellow the rest of the group 3b sites (image by the author).

4.2.3. Final Neolithic

The final phase of the Neolithic sees a slight contraction in the number of sites and also an opener placement on the territory. The settlement counts 19 points versus 25 of the previous phase, of which only six demonstrate a continuum to the Middle Neolithic (fig. 130):

- Masseria Istituto di Sangro (id2);
- Masseria Pagliari (id7);
- Coppa Pallante (id8);
- Ciccalento (id10);
- Pian Devoto (id11);
- San Matteo-Chiantinelle (id19).

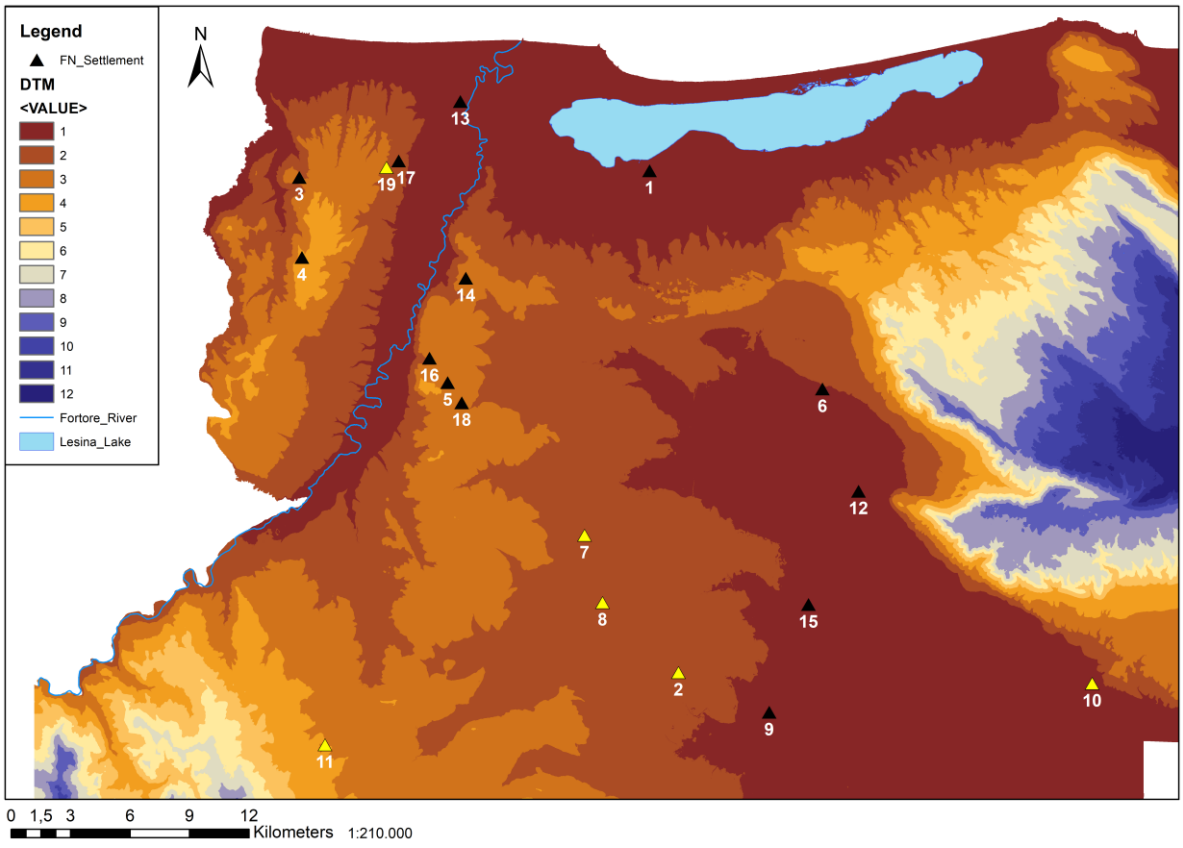


Fig. 130 – Distribution site map: yellow triangles are the Final Neolithic settlements continuing from the MN; black triangles are the rest of FN sites. For the correspondence between the sites and the id numbers see the Appendix at the distribution site table (image by the author).

The new placement has an effect on the visibility: it shows the capacity to observe a large portion of the territory and at long distances with a radius of almost 360 degrees. However, the data is not homogeneous because some sites

have a larger area of visibility without gaps, whereas others have lower visibility due to barriers on the terrain (fig. 131).

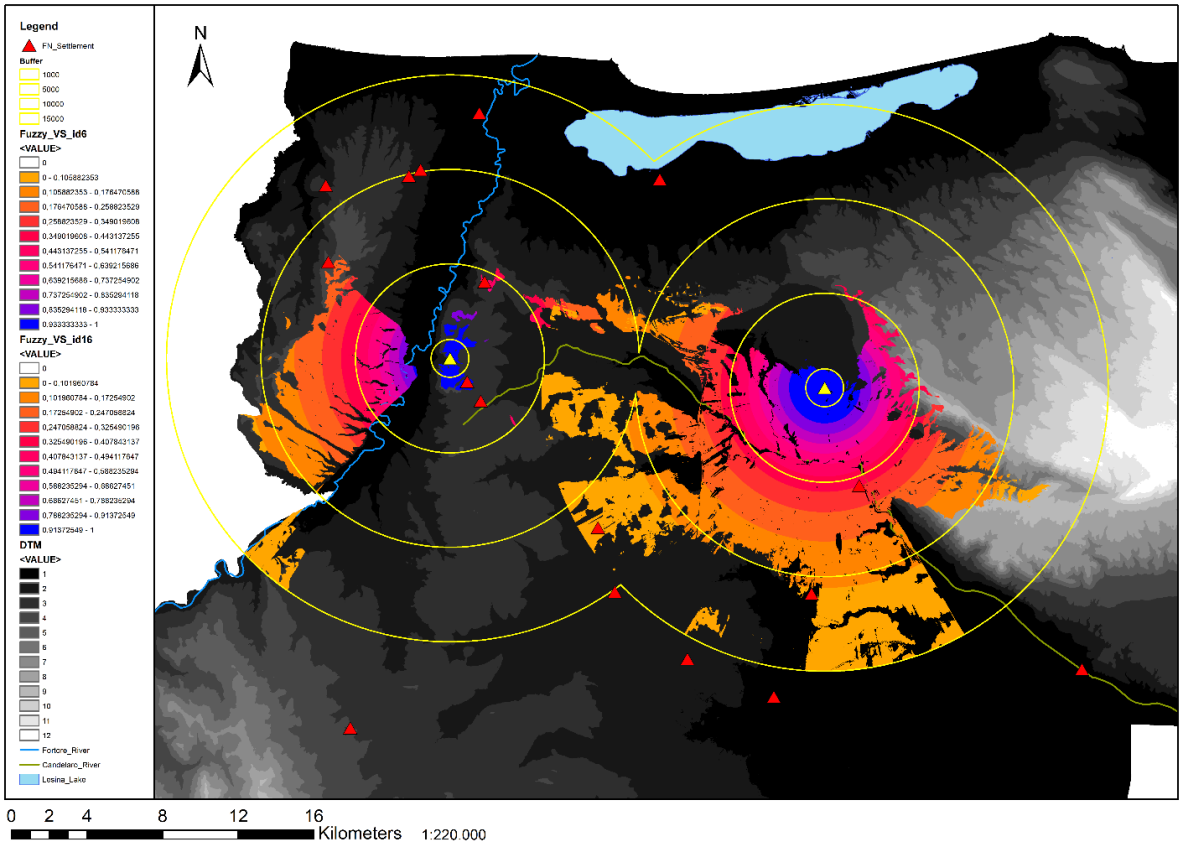


Fig. 131 – Fuzzy Viewshed Analysis applied to Mezza della Quercia (id6, on the right side of the map) and Piani di Lauria (id16, on the left side of the map). Yellow triangles are the site as observer points; red triangles are the rest of the FN settlements; buffer values expressed in meters (image by the author).

The phenomenon of a good visibility is recorded for the major part of the sites; just in five cases the calculation generated a small visibility spectrum, and within this group it is possible to subdivide the limitation of sight capacity to:

- a narrow territory portion;
- around the obsever point vicinity.

The first group consists of Ciccalento (id10), Pian Devoto (id11) and Colle di Creta (id17). These sites present the capacity to observe a limited portion of territory which is rather long than wide, but with a good clarity to a distance of 6-7 km. Despite the smaller sight radius, the visibility could help to keep the likely incoming flow of people and materials from the southern Tavoliere region (id10, 11) or from the Adriatic Sea (id17) under control.

On the other hand, the second group, formed by Malchieuti (id3), displays a very restricted view on the proper vicinity within a distance of 1,7-2 km. Despite the position – the site is located on a hilltop surrounded by several valleys close to the Molise border –,the collected data must be interpreted as a lack in visibility, especially in comparison with the rest of the results of the analysis. However, it is necessary to remember that the observer points are not fixed entities but individuals living in a landscape. Therefore, it is necessary to evaluate the possibility that the observer could move to a different point to gain a better perspective on the territory (fig. 132).

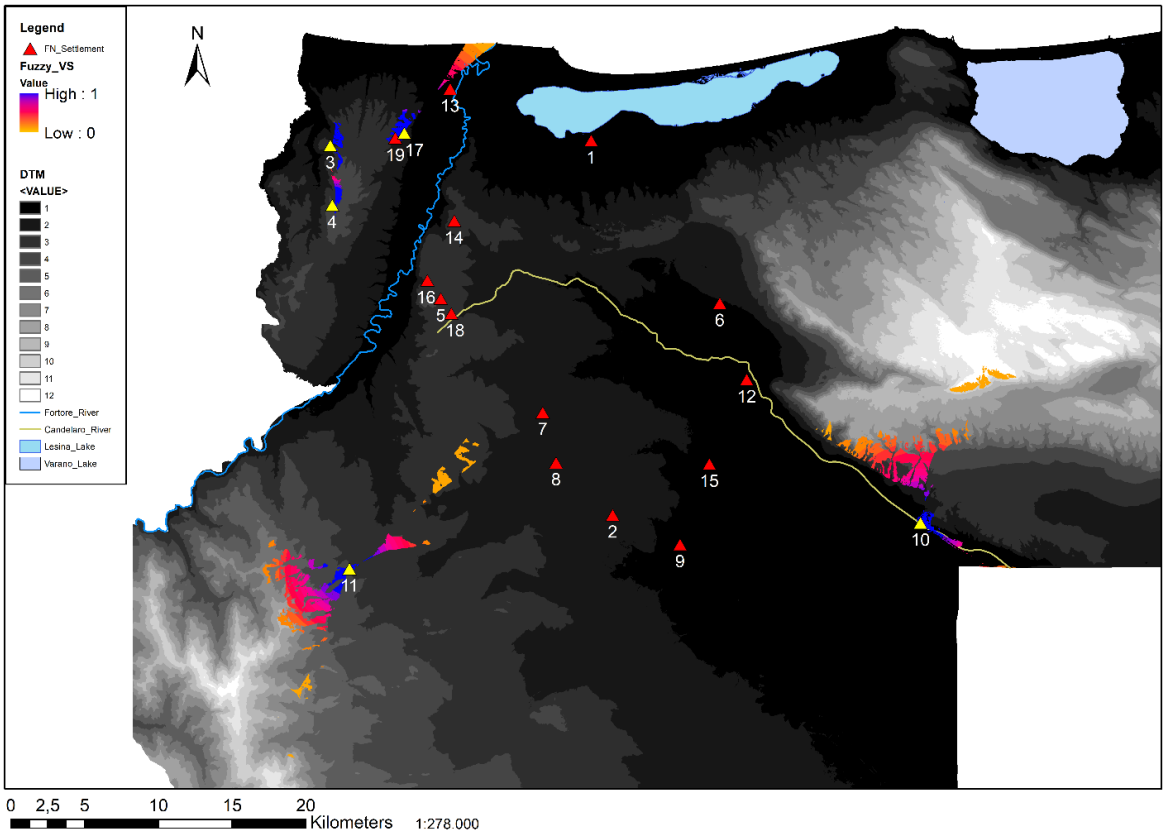


Fig. 132 – Fuzzy Viewshed Analysis applied to Malchieuti (id3), Località Piano Navuccio (id4), Ciccalento (id10) and Pian Devoto (id11). Yellow triangles are the observer points; red triangles are the rest of FN sites (image by the author).

In all cases, the analysis seems to reflect a rising awareness of the importance to control the landscape or the main communication ways which would allow travel in and out from northern Daunia, such as the Fortore and Candelaro River routes. The reason for this phenomenon could be the birth of new socio-economical dynamics that will become more pronounced in the following periods.

4.2.4. Early and Middle Copper Age

As was mentioned before, the site placement changes completely during the early-middle Copper Age, and the Tavoliere Plain is abandoned in favour of other areas such as the Fortore Valley, the Lesina Lake, the Gargano foothills and the southern edge of the study area (with only one site there).
Also, some sites persisted to be occupied from the previous period onwards (fig. 133), displaying chronological continuity between the Final Neolithic and the Early-Middle Copper Age, such as:

- Cammarata (id7, occupying not the same point but the area)
- Mezzana della Quercia (id10);
- Mezzanella di Brancia (id13);
- Località Piano Navuccio (id15);
- Piani di Lauria (id17, occupying not the same point but the area);
- Coppe di Rose (id22).

Moreover, also a continuum between Middle, Final and Early-Middle Copper Age was observed linked to the sites of:

- Chiantinelle (id9);
- Chiarappa (id18);
- Ciccalento (id19);
- Masseria Istituto di Sangro (id20).

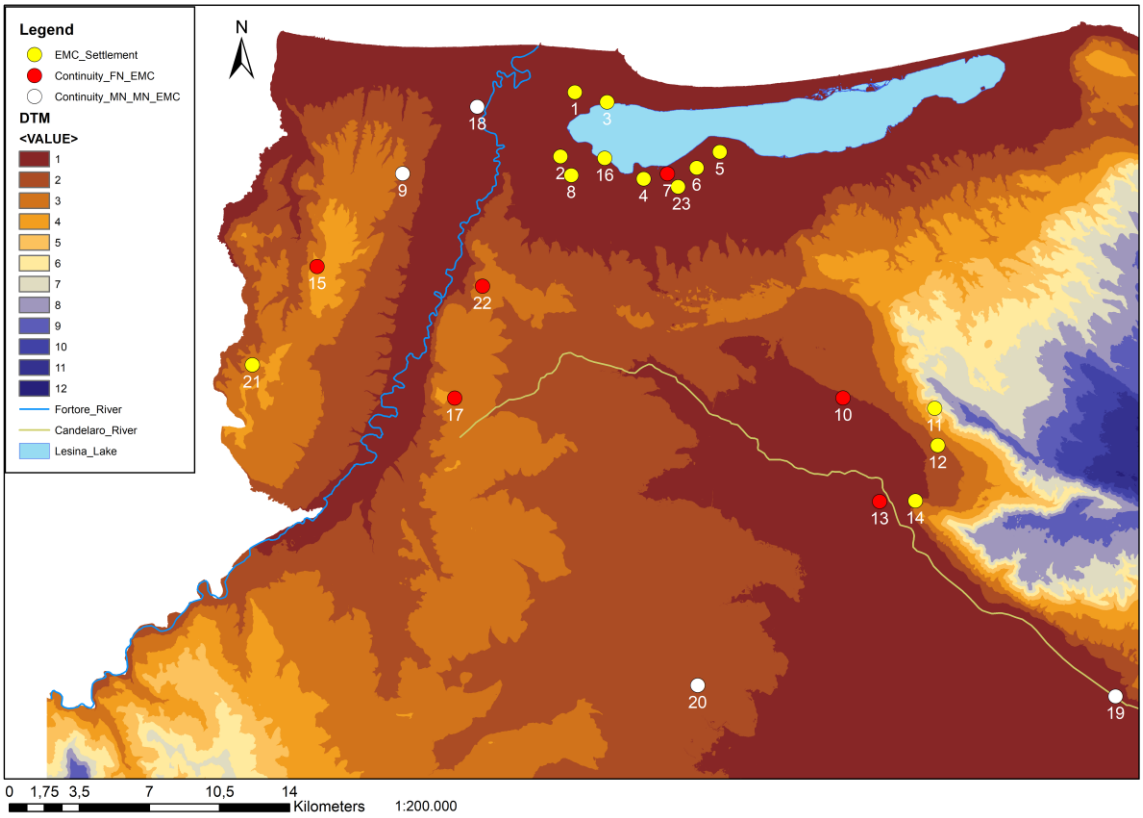


Fig. 133 – Distribution site map from the Early-Middle Copper Age. Red circles are the settlements in continuity from Final Neolithic; white circles are the sites from Middle Neolithic; yellow circles are new sites that appear in the EMC (image by the author).

Therefore, the analysis shows a sight spectrum which reflects the new placements. The perception of the portion of the landscape from the related observer point is remarkable. This aspect displays that the settlements had to have a deep awareness of the proper territory and developed the capacity to use it. All points show a large clarity range, except Località Piano Navuccio (id15) which presents the same location as during the Final Neolithic (fig. 134).

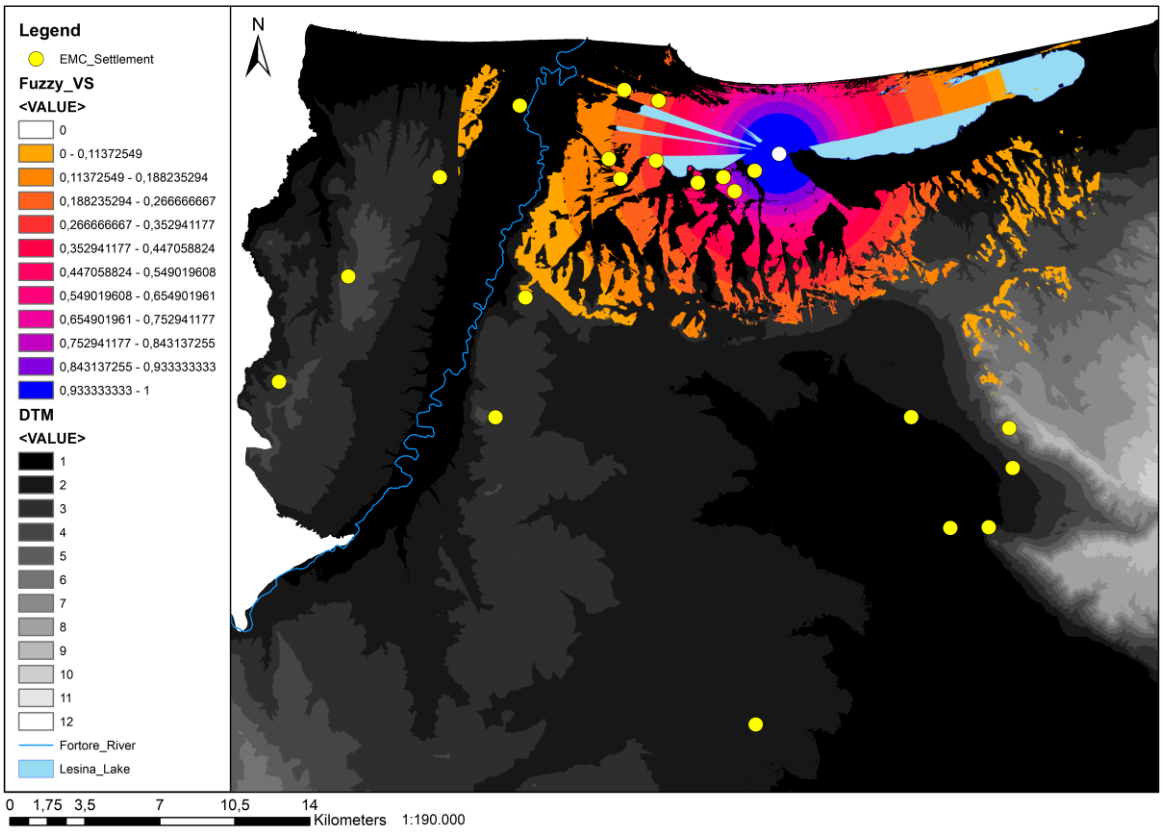


Fig. 134 – Example of Fuzzy Viewshed Analysis applied to Palude Grande (id5).

From a careful analysis of the results, the overlapping of the spectra at long and close distances is remarkable (depending on the site position); thus, a sort of sight network seems to be created between the sites through which they could keep the areas crossed by the main communication ways under control. In detail, the main routes are marked by the watercourses and the lake, which means Lake Lesina, the Fortore River, the Saccione Torrent, the Candelaro River and the Triolo Torrent (fig. 135).

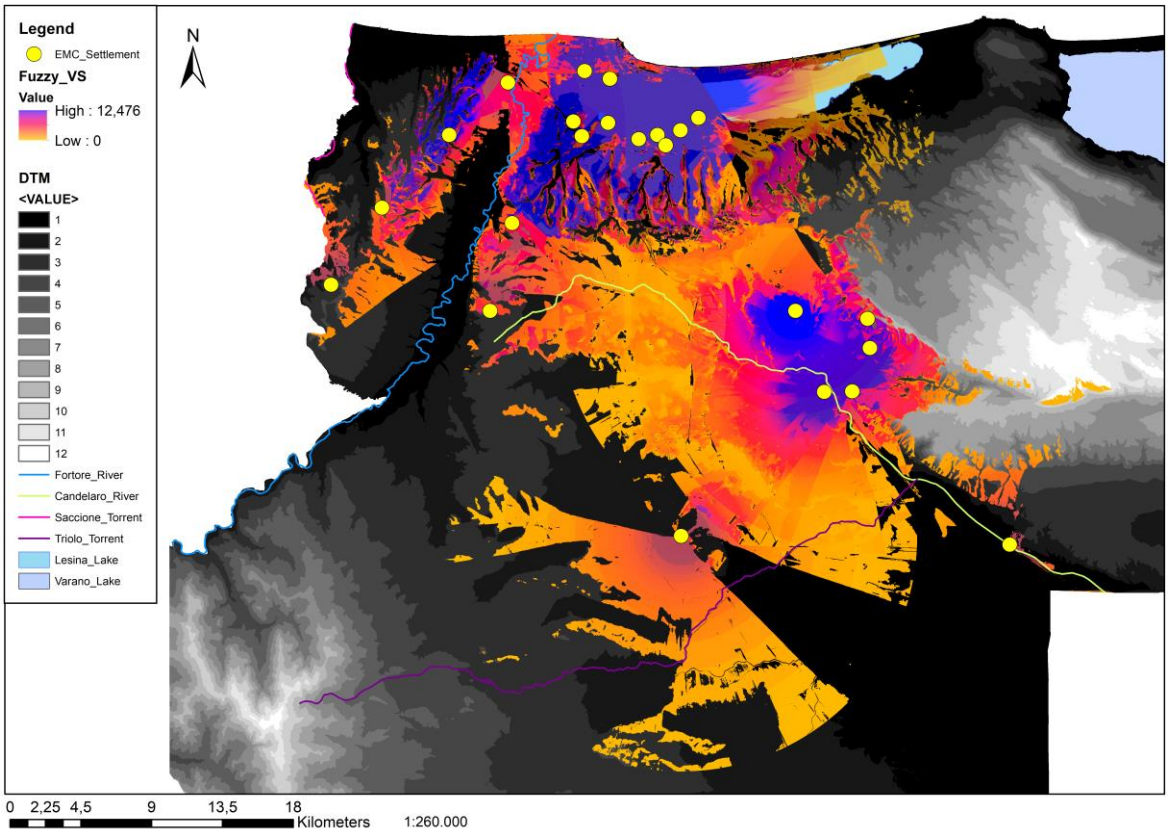


Fig. 135 – Overlap of all Fuzzy Viewsheds generated by the whole group of points (image by the author).

Fig. 134 gives the impression of a systematic placement designed to control, above all, the Candelaro (hence the Gargano area) corridor and Lake Lesina. The Fortore valley seems to constitute a connection branch further apart, although only at a first glance. So, it was necessary to deepen the analysis from the point of view of Colle Arsano (id21) because it was the closest site to the Molise border. For this detailed investigation, a DEM (Digital Elevation Model) with a resolution at 10 meters[4] was used on which the Fuzzy Viewshed Analysis was operated by using the same process as for the other sites (fig. 136).

[4] For this analysis the DEM tile corresponding to area in between the Apulian and Molise border was downloaded (Istituto Nazionale Geofisica e Vulcanologia – INGV, Sezione Pisa. https://tinitaly.pi.ingv.it/).

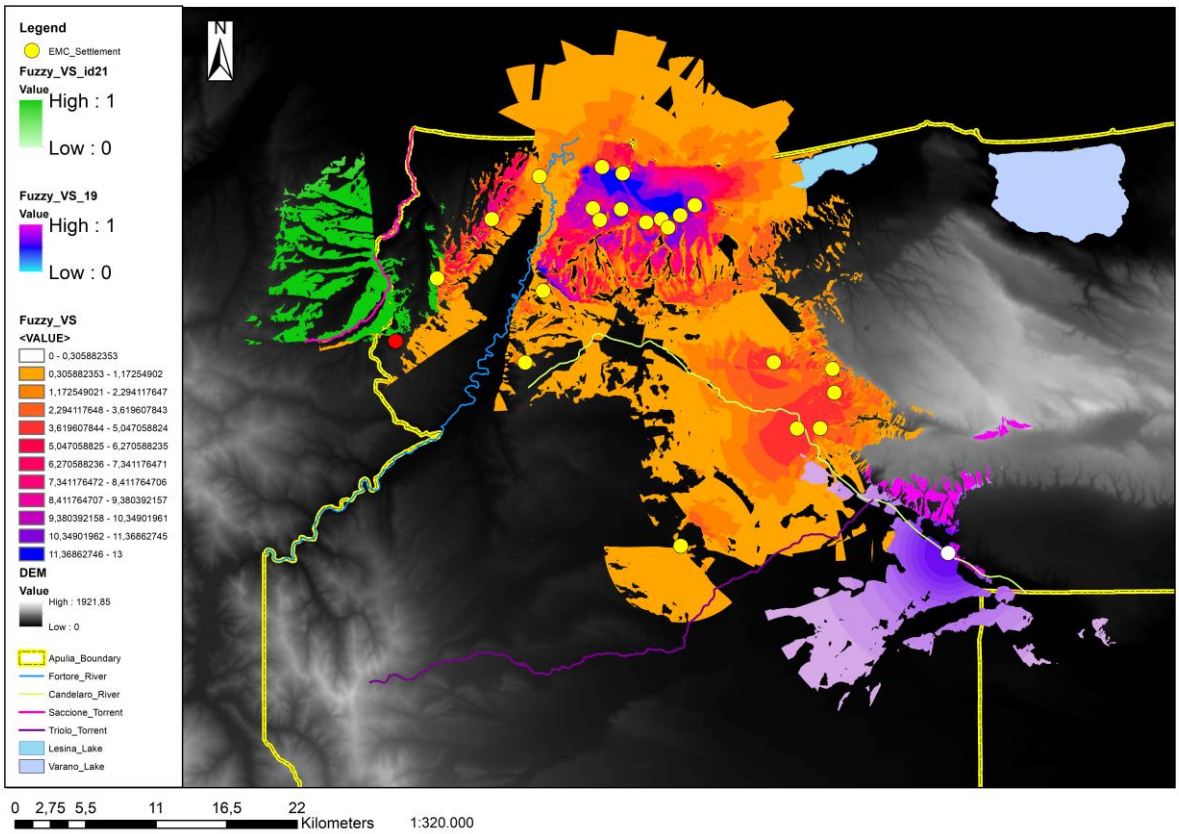


Fig. 136 – Visibility in-depth analysis applied to the DEM. Red circle) Colle Arsano; green shades) the visibility spectrum generated from Colle Arsano; white circle) Ciccalento; violet shades) the visibility spectrum generated from Ciccalento; orange-blue shades) fuzzy viewshed generated from the rest of the sites (yellow circles); dotted line in yellow band) Apulian boundary (image by author).

Because the new calculation involved a new surface raster, it was decided to run the analysis by taking all the settlements as observer points in order to obtain a general visibility raster (fig. 136, orange and blue colour ramp). Afterwards, the drop-off in clarity was tested individually on the sites that could have possessed a special hub position: Colle Arsano (fig. 136, green colour ramp) and Ciccalento (fig. 136, violet colour ramp). These operations were done in order to check the data separately from the rest.

The result showed that Colle Arsano was able to observe also the Molise territory; indeed, we could assume that the spectrum is almost completely oriented to the neighbouring region. Therefore, we could conclude that the apparent sight corridor of the western Fortore Valley could be part of that network system in which Colle Arsano played the role of "window" towards Molise. In this respect, Ciccalento could cover a similar role concerning the control of the Candelaro River and hence the southern Gargano foothills. In detail, the visibility spectrum appears more extended from the foothills to the inner area of the Plain. Ultimately, the settlements situated on Lake Lesina demonstrate a long-distance sight on the Adriatic Sea.

4.2.5. Final Copper Age

What was observed in the early-middle Coppe Age appears to be similar to the final Copper Age: new sites were placed surrounding the Tavoliere Plain and producing a sight network more extended with respect to the previous one; with it, it was possible to keep almost the whole area under control. Specifically, most of the sites around Lake Lesina were abandoned whereas others placed in the Fortore Valley and Gargano foothills continued to exist. Instead, new sites situated in strategic positions began to appear which were able to enhance the potential sight network (fig. 137).

The new settlements are:

- Mulino di Caldoli (id2);
- Torre Mileto (id3);
- Torre Fiorentina (id5);
- Casale Crisetti (id8);
- Cicerale (id14);
- Colle d'Armi (id15).

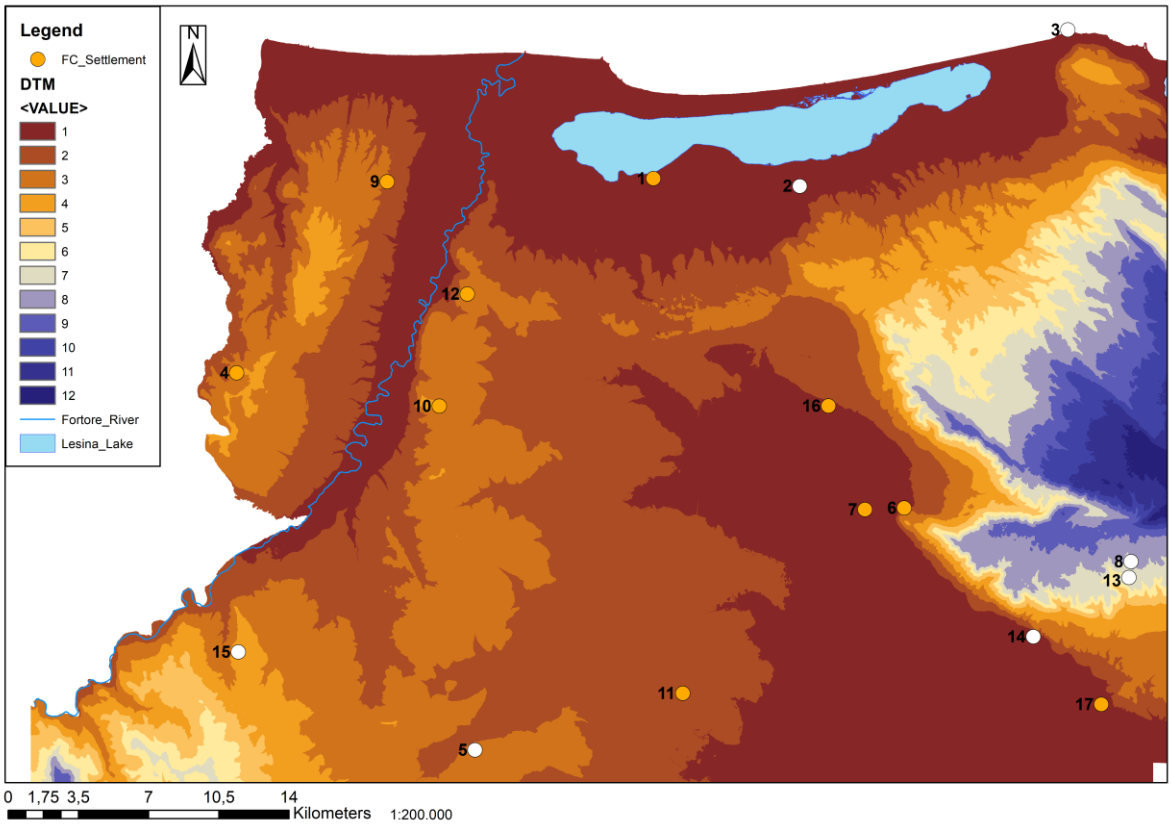


Fig. 137 – Distribution site map of the Final Copper Age. White circles are the new settlements; orange settlements are those continuing from the Early-Middle Copper Age (image by the author).

Therefore, as fig. 137 shows, the new sites arose in areas where it was possible to keep a sensible portion of the landscape under control. In detail, Mulino Caldoli (id2) was orientated towards the lake, the southern area immediately south of Lake Lesina and partially also towards the Adriatic Sea. On the other hand, Torre Mileto (id3) rises on a spur of rock along the coastline between Lakes Lesina and Varano; and since this poses a very special location, it was decided to analyse in-depth the visibility with the same process as for Colle Arsano for the EMC.

So the new analysis showed that the settlement had a good visibility on the sea in front of the coastline but hardly any view on the surrounding mainland. This aspect may lead to the conclusion that the site had to have a strategic position as an "outpost" in the network of this time (fig. 138).

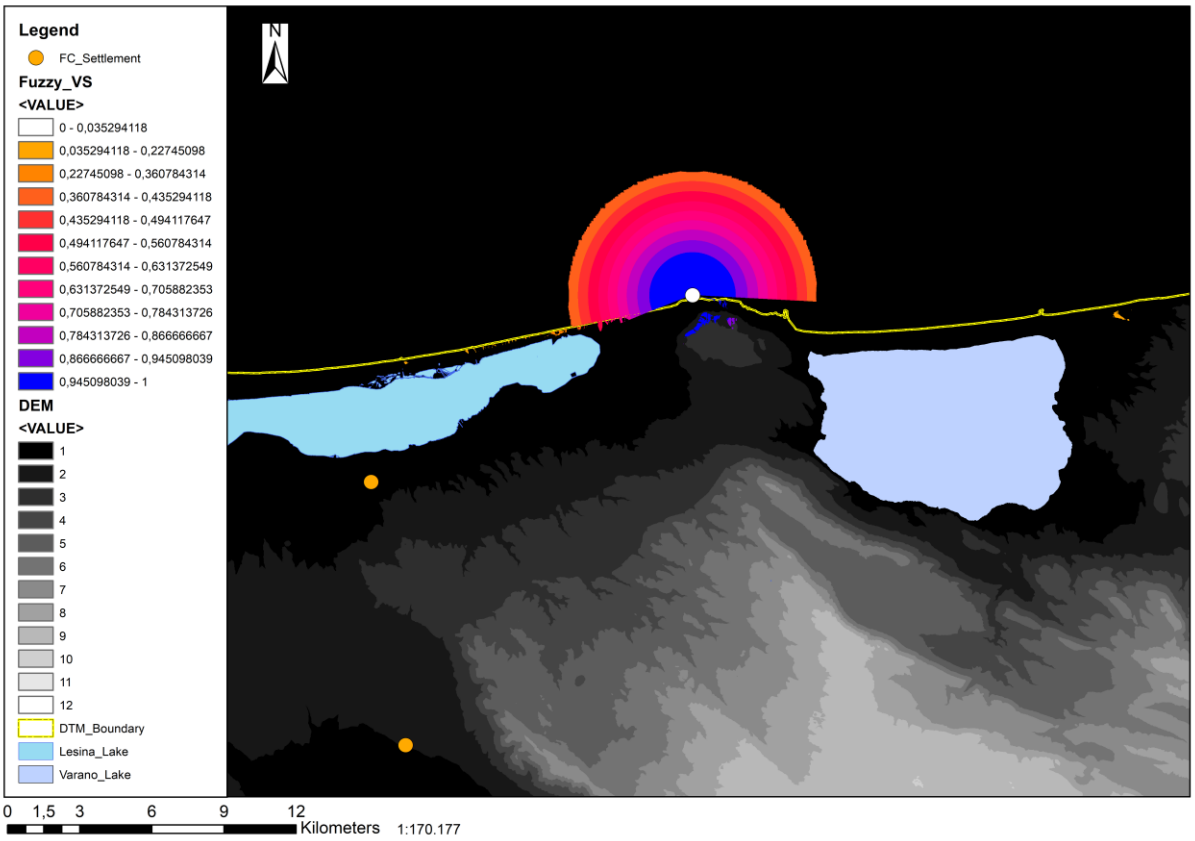


Fig. 138 – Fuzzy Viewshed analysis applied to Torre Mileto (white circle) by using the DEM surface raster. Orange circles are the rest of FC sites (image by the author).

Concerning the remaining new sites, they generate a visibility spectrum projected towards the inner Tavoliere and the Gargano valleys with respect to their position. So, the new placement reflects a trend encircling an area embracing the whole Plain between San Severo and Poggio Imperiale. This tendency could indicate the attitude to create a sort of site network that was able to control the

main communication ways (like the watercourses, the main valleys and the coastline) which allowed the connection with the inner and outer regions. Likely, the presence of this characteristic trend is due to socio-economic dynamics that in this chronological phase resulted well-rooted (fig. 139).

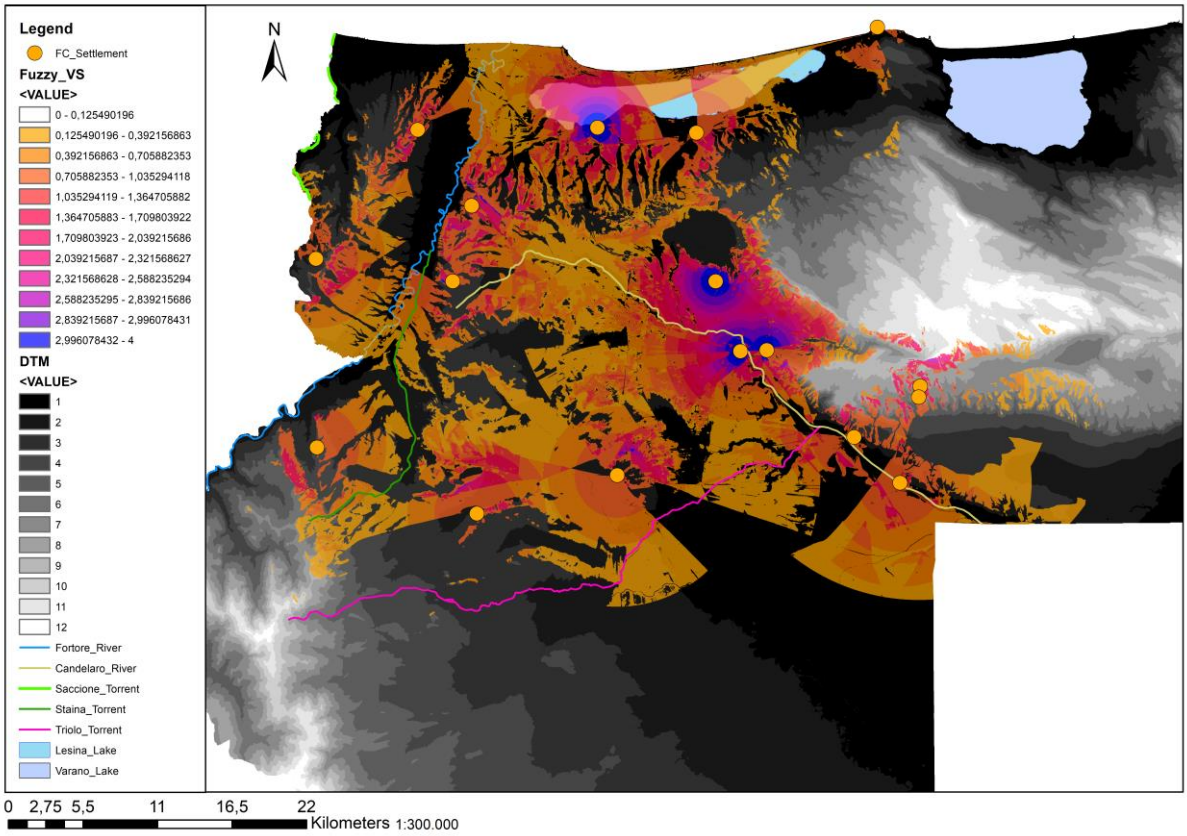


Fig.139 – Fuzzy Viewshed Analysis applied to all sites. The generated visibility spectrum is characterized by a trend to encircle and keep the inner region and the borders of the study area under sight control. The watercourses involved are: Fortore River (in blue), Candelaro River (in yellow), Saccione Torrent (in light green), Staina Torrent (in dark green) and Triolo Torrent (in pink) (image by the author).

4.2.6. Early Bronze Age

The beginning of the Bronze Age shows a new site organization; it seems that the placement gravitates more towards the watercourses and other strategic areas. Because of this aspect, the villages are clustered in four groups, with just one "outsider" alone on the south-western corner of the study area (Masseria Iacovelli, id6). Therefore, the groups are:

- Molise border;
- Fortore Valley;
- Gargano foothills and inner valleys;
- Tavoliere Plain.

From the relationship of site-location to point of view, it is possible to observe that there is variety in the continued use of some locations or the reconsideration of areas which were abandoned during the Copper Age. To this revaluation phenomenon belongs the Tavoliere Plain that returns to be populated by three villages which were already exploited during the Early and Final Neolithic (fig. 140):

- Località Guadone (id2, see also EN);
- Oliveto Torre dei Giunchi (id16, see also EN);
- Portata Casone (id17, see also FN).

Thus, we could summarize the continuum phenomenon in the table below:

ID	Site Name	Period	Position
1	Colle di Creta	EN, MN, FN, EMC, FC, EB	SP
2	Località Guadone	EN, EB	SP
3	Monte Granata	EB	SP
4	Chiancata La Civita	FC, EB	SP
5	Cantalupo-Tre Ponti	EB	SP
6	Masseria Iacovelli	EB	SP
7	Colle Arsano	EMC, FC, EB	SP
8	Piani di Lauria	EN, FN, EMC, FC, EB	SA
9	Chiarappa	MN, FN, EMC, EB	SP
10	Brancia Km10-Volta Pianezza	EMC, FC, EB	SP
11	Ciccalento	EN, MN, FN, EMC, FC, EB	SP

12	Casino Crisetti	FC, EB	SP
13	Masseria Mezzanella di Brancia	EN, FN, FC, EB	SP
14	Località Brecciara	EB	SP
15	Mezzana della Quercia	EN, FN, EMC, FC, EB	SP
16	Oliveto Torre dei Giunchi	EN, EB	SA
17	Portata Casone	EN, FN, EB	SP

The periods are expressed by acronyms, i.e. for instance EN stands for Early Neolithic, EMC for Early-Middle Copper Age and so on; the position indicates if the site was occupied diachronically at the same location/point (SP) or if it shifted slightly but can still be found in the same area (SA).
Nine[5] out of 17 sites present a continuum embracing, more or less, the whole chronological range. On the other hand, two sites show a large gap: they were first settled during the EN and then again only during the EB (i.e. Località Guadone and Oliveto Torre dei Giunchi). Three settlements demonstrate a link with the Copper Age, even though with some hiatuses; in detail, Chiancata la Civica and Casino Crisetti indicate the presence of FC and EB, while only Brancia km 10 – Volta Pianezza was occupied from the EMC to the EB. Ultimately, only three sites appear as new foundations: Monte Granata, Masseria Iacovelli and Località Brecciara.

[5] Refering to: Colle Creta, Colle Arsano, Piani di Lauria, Chiarappa, Ciccalento, Masseria Mezzanella di Brancia and Portata Casone.

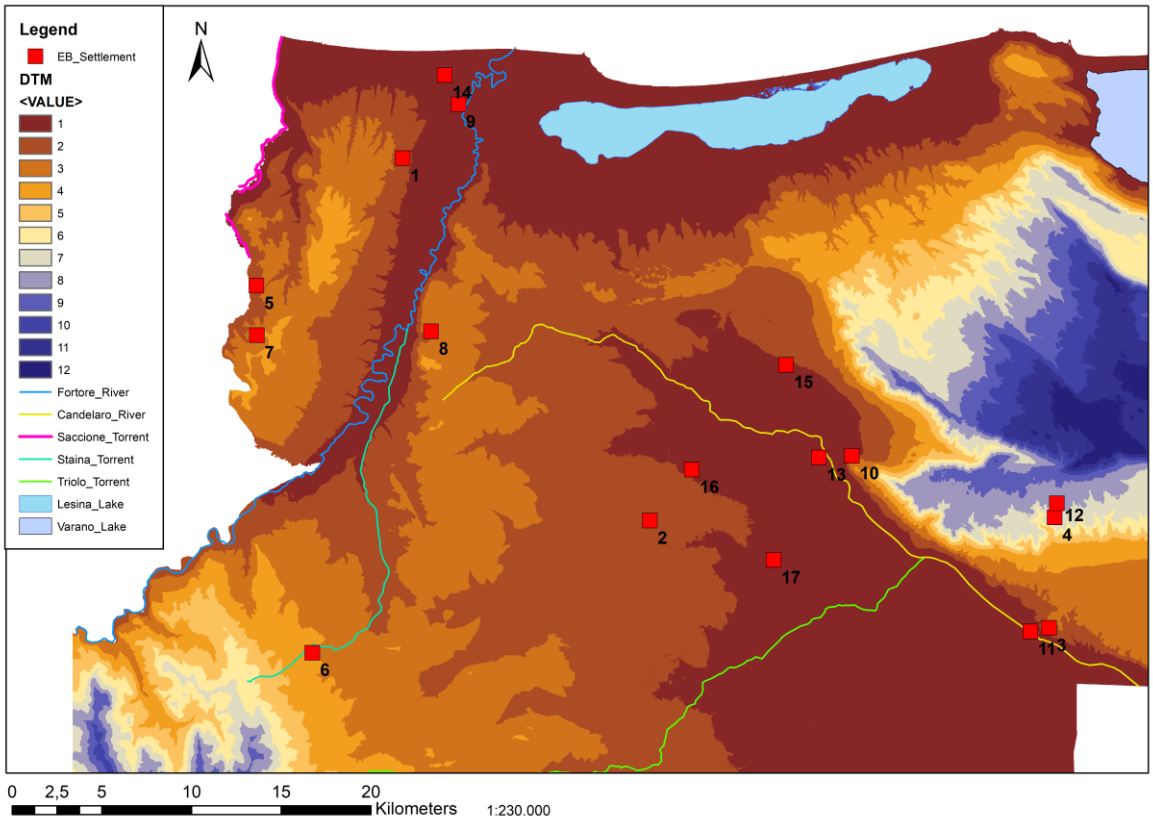


Fig. 140 – Site Distribution map of the Early Bronze Age. See the table above for the site list and site diachronology (image by author).

If during the Final Copper Age the analysis revealed a sort of visibility frame in which the whole bulk of sites was related to each other, now this kind of "common control" of the landscape is lost in favour of selected areas. Specifically, the sites generate a visibility spectrum almost strictly spread over the whole area, with rare overlappings recorded just between the last sight values of Piani di Lauria and the spectra generated from the Gargano sites Brancia km 10-Volta Pianezza, Masseria Mezzanella di Brancia, Mezzana della Quercia and Oliveto Torre dei Giunchi. Because the analysis reflects the site clustering mentioned above, we could speculate about the formation of diverse site networks in view connection and able to control a certain portion of the territory. This assumption would be enforced by the fact that the settlements demonstrate to keep the main watercourses under sight control, i.e. the Fortore and Candelaro rivers and the Saccione, Staina and Triolo torrents (fig.141). This constitutes important information because it would mean that likely these communication ways had to play an important role for the in- and outgoing flows that crossed northern Daunia.

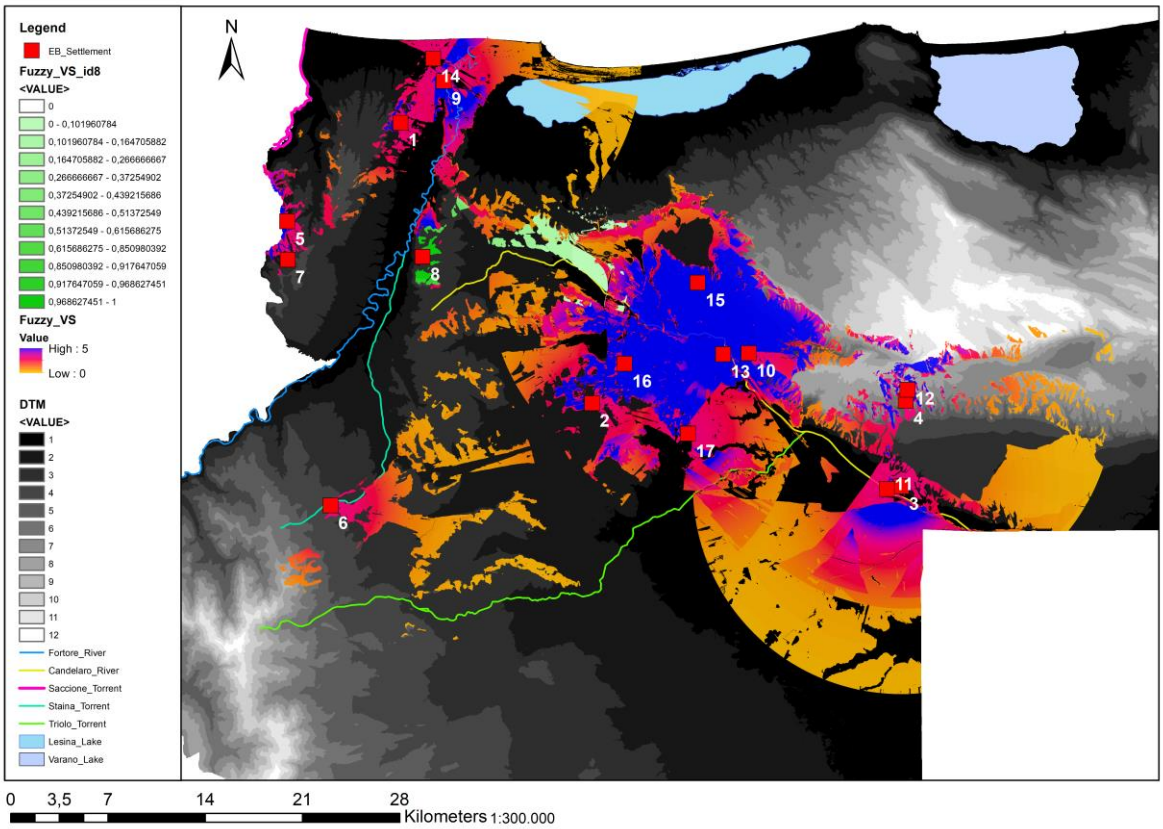


Fig. 141 – Fuzzy Viewshed Analysis applied to all sites. In green is the drop-off in clarity of Piani di Lauria that overlaps the above-mentioned spectra where the green becomes lighter (image by the author).

Even for this period, visibility information for the sites located at the Molise border was enhanced by using the same process previously described. The analysis, run on the base of the DEM, reveals a similar result for Colle Arsano as in the EMC estimation, while the new site Cantalupo–Tre Ponti shows a spectrum similar to Colle Arsano but less extended and with more lack in visibility. Nevertheless, the two calculations are in a certain way complementary since the sight ranges are overlapping, above all where they verify the visibility peak value likely due also to the similar position. In any case, the two sites were oriented surely towards the Molise border keeping the part of the border, the opposite landscape and the portion of the Saccione Torrent flowing from Molise to Apulia under sight control. These are the preconditions through which we could assume the villages had to play an important role as joining points between the two regions (fig. 142).

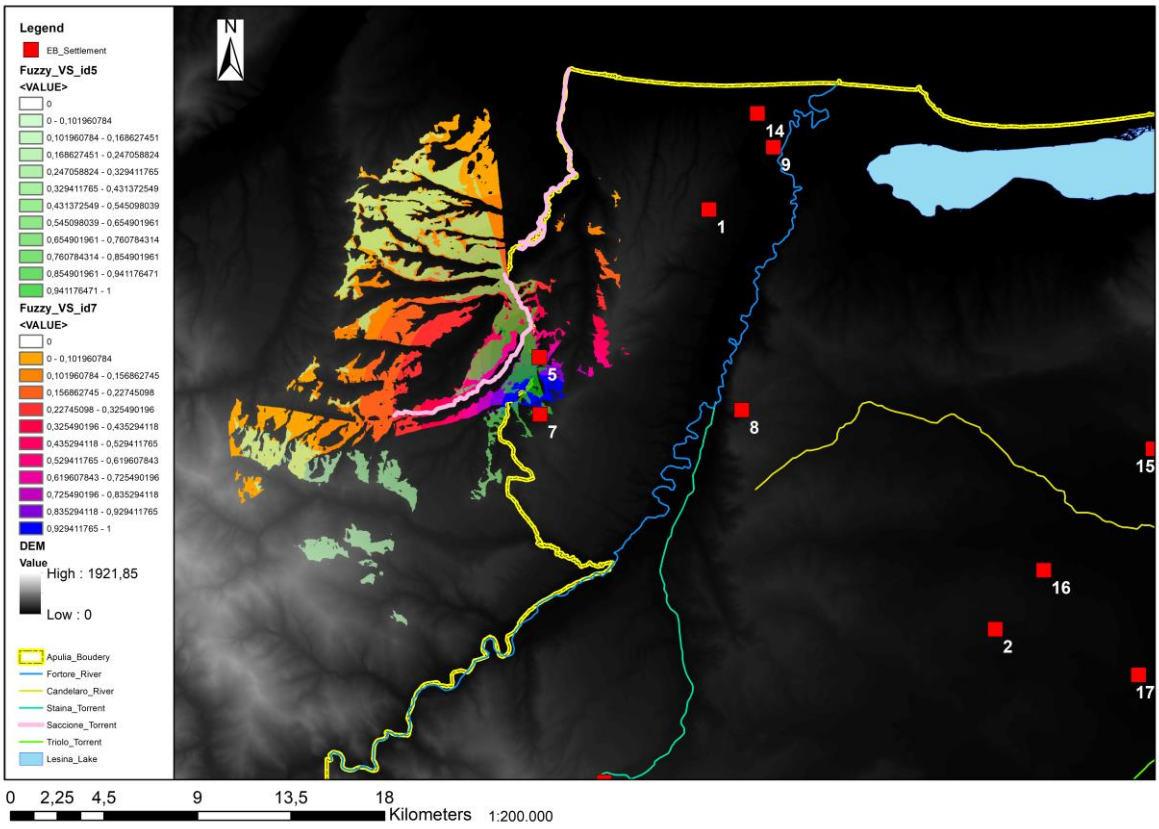


Fig. 142 – Fuzzy Viewshed Analysis applied to Cantalupo-Tre Ponti (id5) and Colle Arsano (id7). Id5 values are in green, the applied transparency marks the overlapping trend. In pink is the Saccione Torrent falling into the high visibility range of both sites (image by the author).

4.3. Field Investigation

To obtain a more complete frame of information, it was decided to add field investigation to the computerized analysis. Therefore, on the base of the LPCA and VA, specific areas were chosen to subject them to systematic survey activity[1]. Before beginning the activity, a data investigation process was conducted, including checking aerial and satellite images in order to find archaeological traces on the ground. In this way, it was possible to collect extra information on the considered sites such as the persistent presence of structures. Examples are evidence for ditches recognised at the villages of Casino Giuliani (San Severo district) and Piani di Lauria Bassa (San Paolo di Civitate district) (figs. 143a, b).



Fig. 143a - Satellite image from 2013 showing traces of the Casino Giuliani village ditch, Early Neolithic (Filloramo *et al.* 2020, 6).

[1] The survey activity was carried out entirely by Filloramo, sometimes assisted by Dr. Oione (person in charge from the Archaeological Department of the Superintendence of Foggia, responsible of the Serracapriola and San Severo areas)

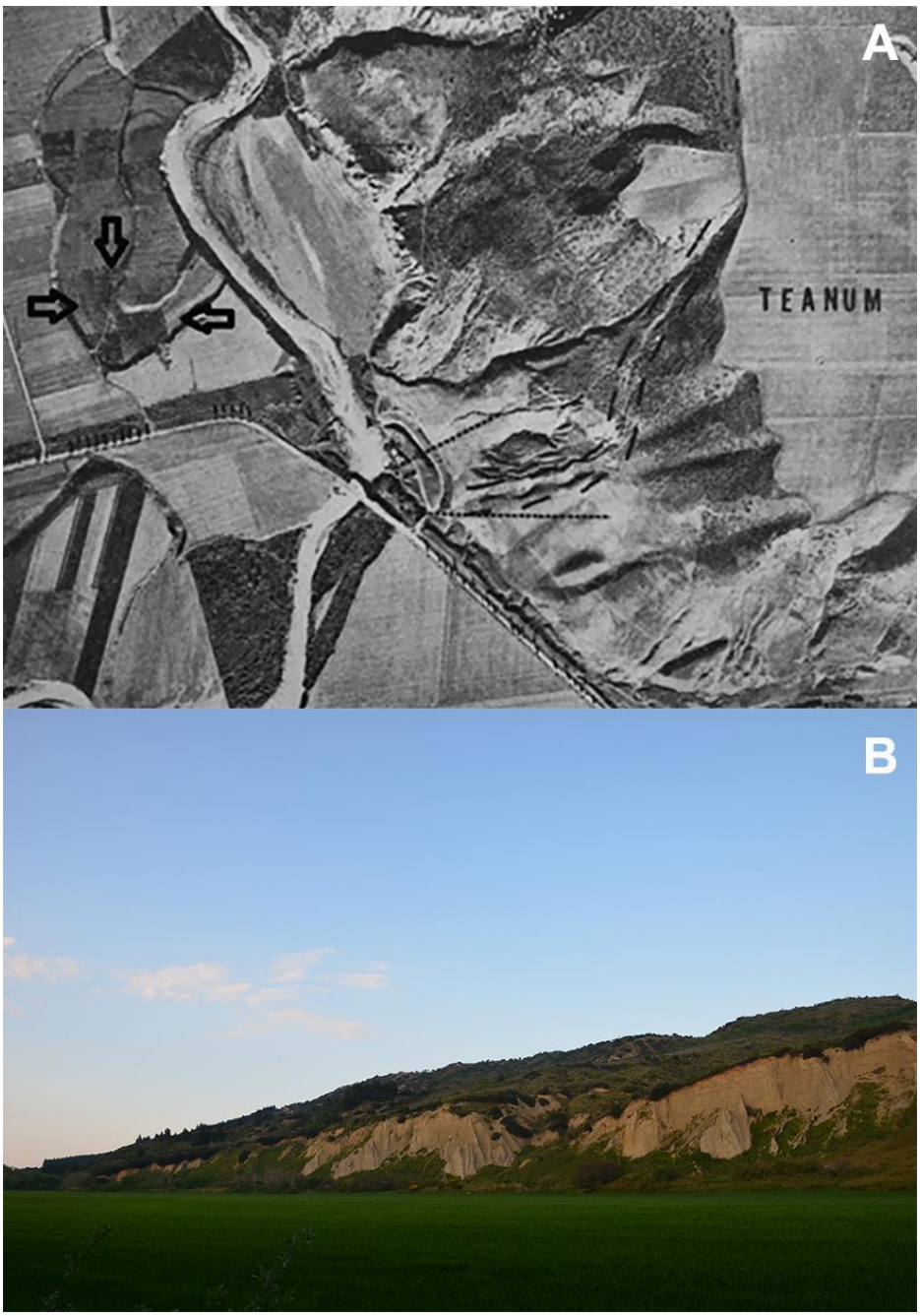


Fig. 143b – Piani di Lauria Bassa: A) Historical aerial photo showing traces of an ancient Neolithic village (image elaborated by the author from Alvisi 1970, fig. 25); B) landscape view (NW) of the site of Piani di Lauria Bassa (image by the author).

The work on field was conducted in five macro-areas falling into diverse municipalities representing diverse types of landscape like plains, rivers ands valleys, promontory foothills and lakeshores. It is remarkable that the chosen areas were settled in all periods considered and therefore allowed diachronic feedback.

Within the macro-areas, subzones were chosen in order to gather the most detailed information from the survey, increasing the number of the survey spots to seven (fig. 144). Within these seven survey spots, 64 archaeological sites were

visited, and for each one a dedicated form was produced, as expressed in the methodology chapter. This was necessary to record the current status of the archaeological data and the site condition in order to plan further activity. Furthermore, due to the time period the surveys were conducted – between the 15th of April and the 13th of May 2019 –, some spots were still covered by spontaneous vegetation and crops, limiting the possibility to explore the zone. Nevertheless, the activity produced meaningful results able to confirm and enhance the archaeological information.

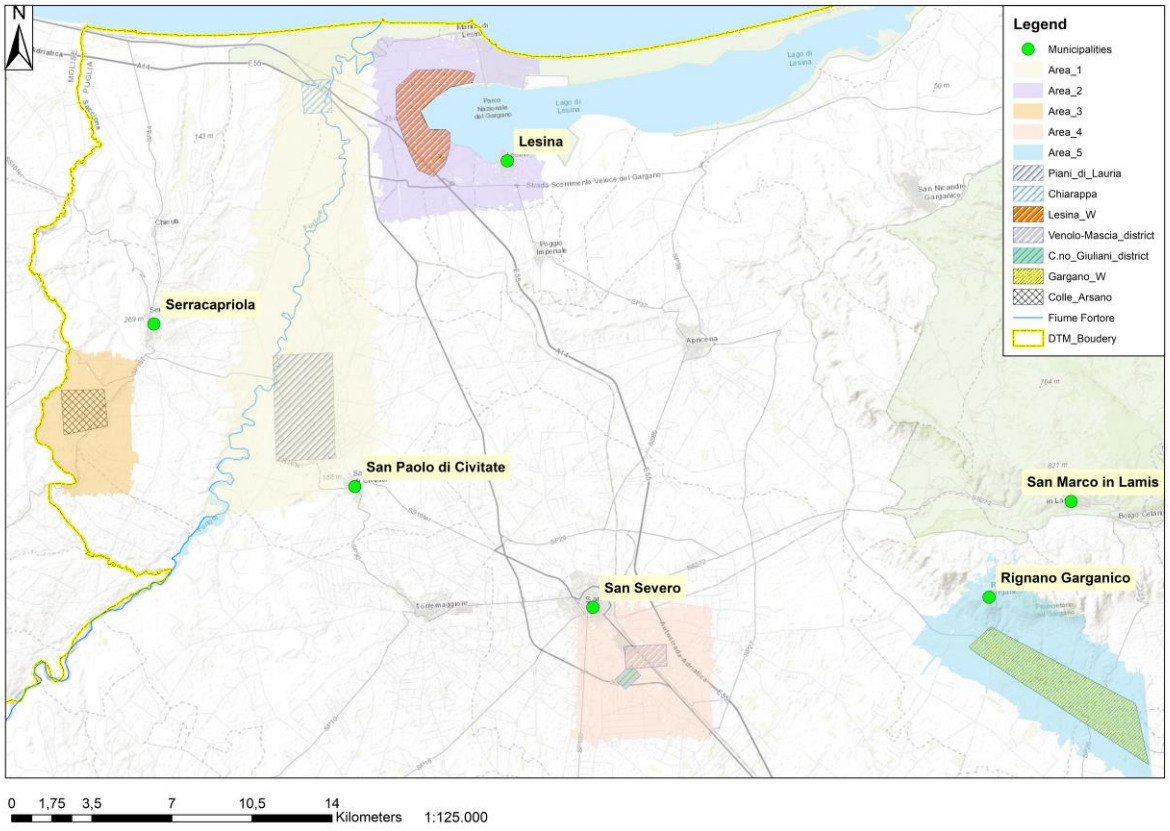


Fig. 144 – Distribution map of the survey areas. Coloured areas from 1 to 5 constitute the macro-areas, while the polygons with dashed lines are the sub-zones where the surveys took place. The green circles represent the municipalities (image by the author).

4.3.1. Area 1

The area corresponds to the Fortore River valley, and the settlements considered are Chiarappa (municipality of Serracapriola) and Piani di Lauria (municipality of San Paolo di Civitate). The area was chosen because the sites were settled diachronically, most likely due to the strategic position as a crossroad of communication routes towards the inner Italian inner regions, such as Molise or Abruzzo, and those beyond the Tavoliere Plain.

Chiarappa is located on a flat area in proximity of the river. Currently it is used for agricultural purposes (wheat and vegetables) (fig. 145). Archaeologically, the site presents a long life range, being inhabited from the Middle Neolithic to the Early Bronze Age. This would lead to assume that the village played a hub role in the communication network. Remarkable is that, together with Colle di Creta and San Matteo-Chiantinelle, the site had to be part of a system controlling the Fortore valley with respect to trading and transhumance routes towards Molise and vice versa. This phenomenon emerged during the Middle Copper Age and continued in the following periods (Gravina A. 1999a, pg. 94).



Fig. 145 – Landscape view (NE) from the site of Chiarappa (image by the author).

Situated north of San Paolo di Civitate, Piani di Lauria is located on a hilltop dominating the related valley portion up to the modern-day city of Serracapriola (under good weather conditions). Currently, the area is alternately used for agriculture (crops and vegetables) and livestock (fig. 146).
A diachronic occupation was observed, however, not in the same exact spot; rather, the settlement moved into the area with respect to the time period. During the Early Neolithic, two villages were located to the east (Piani di Lauria III) and south (Piani di Lauria I, IV) with respect to the current Masseria. The Middle Neolithic is attested just in Piani di Lauria IV (Gravina 1995, 12).
During the Copper Age and Bronze Age, the settlement was placed close to the western ridges of the plateau, likely due to the development of the new economic dynamics.



Fig.146 – Landscape view (NW) from the site of Piani di Lauria (image by the author).

4.3.2. Area 2

In area 2, the investigation was focused on the western lakeshore which today is used for agricultural purposes (wheat and vegetable) and in part covered by spontaneous vegetation.
Settlements can be observed since the Early Neolithic, even though the recorded sites are marked as "sporadic find areas" because of the scarcity of archaeological confirmation. Therefore, Località Zurrone, Località Chiancata-Conelle, Località Le Cannelle, Masseria Giovanditti e Masseria Pontone can be attributed to this phase. Località Conella, however, can be referred to the Final Neolithic.
The Copper Age is attested by settlements such as Località Cannelle al Muro, Località Fischino, Località Pontone and Palude San Lorenzo (fig. 147).



Fig. 147 – Landscape view (N) from the site of Fischino (image by the author).

The lack of clearly confirmed Neolithic settlements could be due to landscape changes that occurred during this time. We have to keep in mind that during the Early Neolithic the coastline was completely different from the Middle Neolithic (see the chapter about the geomorphological background); hence it is not easy and clear to consider some evidence as a settlement site *sensu strictu*. For example, Gravina supposed that some "sporadic find areas", like Località Zurrone (fig. 148), could be interpreted as weak attestations of a probable village (Gravina

1979, 77; id. 2004, 9). During the Copper Age, however, the more stable landscape conditions permitted to populate the area with the possibility to exploit the lake resources and keep local trading under control.

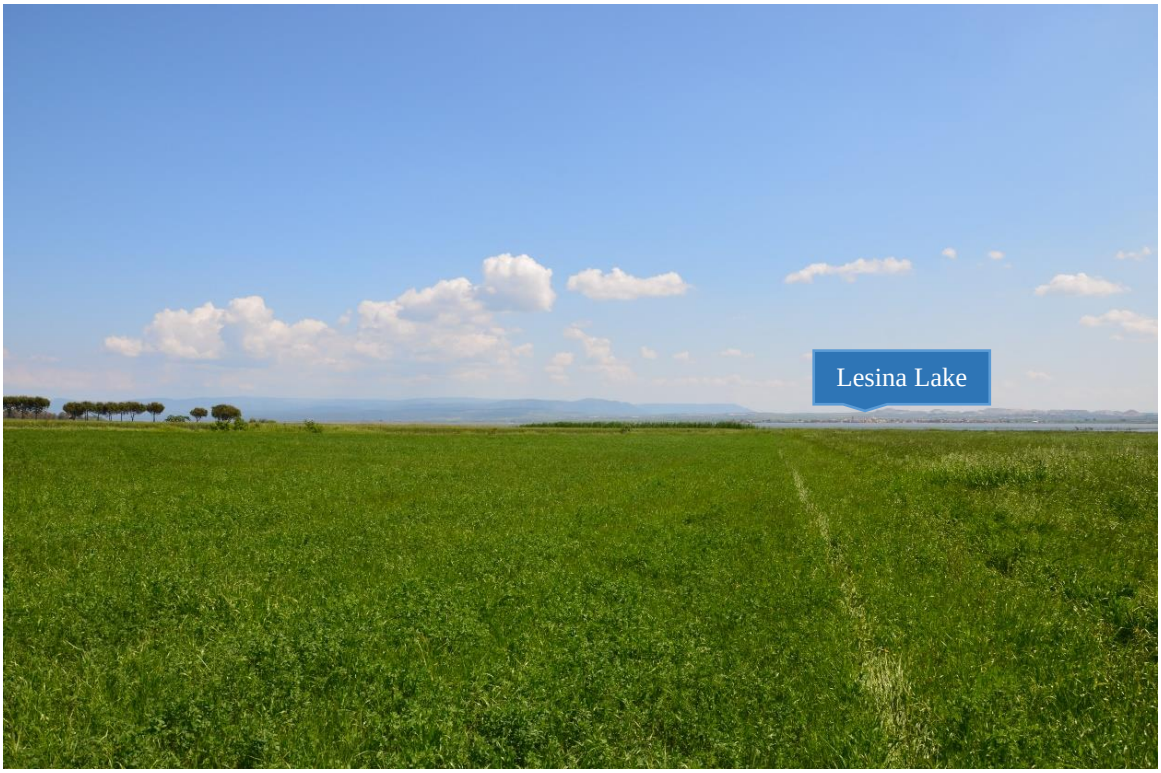


Fig.148 – Landscape view (SE) from the site Località Zurrone (image by the author).

4.3.3. Area 3

Located close to the Molise border, the area includes Colle Arsano (municipality of Serracapriola) where the village was founded on top of the hill; it was used from the Copper Age to the Middle Bronze Age (fig. 149). Currently, the area is designed for wheat cultivation.
The area was chosen because it is characterized by a a high interconnection potential between the regions of Molise and Apulia, dominating the main valley passages. Moreover, the top position allowed to have good visibility on the territories between the two regions.



Fig.149 – Landscape view (NW) from the site of Colle Arsano (image by the author).

4.3.4. Area 4

The area corresponds to the southern periphery of the municipality of San Severo, currently exploited for wheat, olive and grapevine cultivation. The Early Neolithic sites of Casa Mascia, Località Mascia-Venolo, Località Venolo and Casino Giuliani are ascribed to this region.
The settlements were part of a dense settlement network populating this portion of the Tavoliere Plain, characterised by fertile soil and easy access to raw materials; prerequisites that allowed the blooming of a huge number of villages often at a close distance from each other (fig. 150).



Fig.150 – Landscape view (NW) from the site of Località Venolo (image by the author).

4.3.5. Area 5

The area encompasses the south-western Gargano foothills immediately south of the city of Rignano Garganico until the bridge of Ciccalento. The sites checked during the survey are the Final Eneolithic village of Cicerale (municipality of Rignano Garganico) and the necropolis of Località Tagliavia (municipality of San Marco in Lamis) that is dated between the Early Copper Age and the Bronze Age (Gravina 2014, 170).
The area was chosen due to the placement of sites into a communication network linking the Tavoliere-northern Daunia with southern Apulia.



Fig.151 – Landscape view (SW) from the site of Località Tagliavia (image by the author).

4.3.6. Neolithic

Unfortunately, the anthropogenic action and the agricultural activity changed, partially or totally, the landscape structure. An example is the Fischino district (western shore of Lake Lesina) which during the ’70s was exploited for its sandy soil mainly for building material. Afterwards, the dugout zones were filled with new soil, hence constituting a problem for the archaeological research. Apart from these few disturbed areas, the investigation demonstrated the presence of archaeological remains in areas 1, 2 and 4.

Concerning flint, a moderate quantity was found at Località Chiancata-Conelle (fig. 152), Località Cannelle (both in the lake district, area 2) and Località Venolo (San Severo district, area 4). Scarce evidence originates from Casino San Giuliano, always area 4.



Fig. 152 – Landscape view (SE) from the site of Località Chiancata-Conelle (image by the author).

The evidence consists of cores and parts of artefacts, such as blades, that could be ascribed to the first phases of the Neolithic; while a singular sample of an arrowhead comes from Località Venolo and seems to refer to the Final Neolithic, a phase not considered for this site until now. If this hypothesis is true, it could shed new light on the chronological sequence of the area; further investigations could be useful for an in-depth comprehension of the site (fig. 153).



Fig. 153 – Example of flint evidence: A) cores from Località Chiancata-Conelle; B) arrowhead from Località Venolo; C) fragments of blades from Località Venolo (image by the author).

Regarding the pottery, the archaeological record is represented by a moderate number of finds attested in the same sites mentioned above and consists of rough sherds. However, the evidence is characterized by wall fragments made from coarse or medium-coarse clay from Località Chiancata-Conelle and Piani di Lauria; just one sample of *figulina* pottery was found at Piani di Lauria (fig. 154).



Fig.154 – Example of Neolithic pottery: A) sherd of wall in coarse pottery from Località Chiancata-Conelle; B) fragment of wall in *figulina* pottery from Piani di Lauria (imagine by the author).

Remarkable is the discovery of two fragments of hut plaster from the site of Casino Giuliani (San Severo district) that would confirm the presence of the Early Neolithic village whose ditch trace is still visible on the ground. The field data in combination with the satellite image analysis allowed to reconstruct the complete perimeter of the village ditch estimating an area of ca. 419292 m^2; of these, ca. 54000 m^2 distributed in seven zones were screened. It is necessary to point out that the surveyed areas were only those free from cultivation or spontaneous grass. During this survey, rare flint evidence and pottery was found, belonging to diverse chronological periods, like the Neolithic but also historical periods (fig. 155).

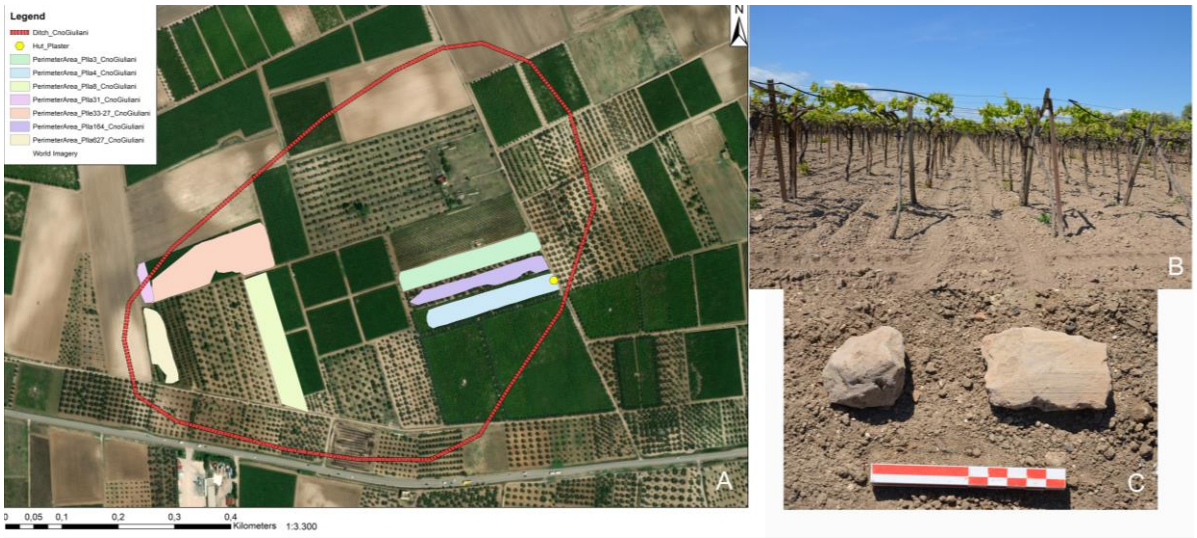


Fig.155 – Example of survey data referred to Casino San Giuliani: A) Satellite image of the site with the reconstruction of the ditch (in red) and in colours the surveyed zones. Yellow point is the hut plaster finding point; B) zone view (SW) where the hut plaster fragment was found (corresponding to the light blue area in A); C) fragment of hut plaster (image by the author).

4.3.7. Copper Age

Because of the season of the early spring, a certain number of parcels was impossible to survey since they were already covered by wheat cultivation or spontaneous grass, like in the cases of Cicerale, Cannelle al Muro, Palude San Lorenzo and Località Pontone. Still, the survey proceeded at the EMC sites of Chiarappa, Fischino, Colle Arsano, Piani di Lauria and at the FC site of Cicerale.

As far as flint is concerned, the record is scarce and consisted of a small blade fragment from Chiarappa that can hardly be dated because of the long life of the settlement. From Cicerale came a core and two tranchets that could be ascribed to the FC, according to the pottery found in the settlement (fig. 156).



Fig.156 – Example of survey activity: A) landscape view (E) from the site of Chiarappa; A1) blade fragment from Chiarappa; B) landscape view (SE) from the site of Cicerale; B1) nucleus from Cicerale; B2) tranchet from Cicerale (image by the author)

Concerning the pottery, an important concentration of archaeological artefacts was found in Piani di Lauria, additionally constituting the highest number of finds for this period. The material is composed of wall, rim and bottom fragments with polished surfaces and a medium coarse clay.

The archaeological pottery record from Cicerale is constituted by a moderate number of fragments made from medium coarse clay and with scarce presence of diagnostic elements. Remarkable is the identification of fragments of hut plaster that would confirm the presence of the Copper Age village ascribable to the *facies* Laterza, i.e. the final phase of this period, together with other settlements placed along the Gargano foothills like Brancia km 10-Volta Pianezza, Casale Crisetti and Chiancata la Civita (Gravina 1999a, 92) (fig. 157).



Fig.157 – Example of survey activity: A) landscape view (NE) from the site of Piani di Lauria; A1) EMC pottery fragments; B) landscape view (SE) from the site of Cicerale; B1) hut plaster sample (image by the author).

4.3.8. Early Bronze Age

The investigation was focused on the settlements of Piani di Lauria, Colle Arsano, Chiarappa and Località Tagliavia. Evidence was found at all sites except the necropolis because of the spontaneous grass that covered the ground homogenously.
The survey was conducted in two rounds and revealed a really modest presence of pottery fragments in Chiarappa, while in Piani di Lauria the highest percentage of finds was detected. The archaeological record is composed of small and medium vessel walls with rare diagnostic sherds like rims or bottoms. At first glance, the pottery displayed a medium and coarse clay with carbonate or quartz temper, while the shapes could be probably ascribable to open vessels such as bowls as well as transport vases, which is in accordance with the thickness of the walls. Moreover, also rare traces of flint artefacts and a moderate number of historical pottery fragments were recorded (Filloramo *et al.* 2020, 10) (fig. 158).



Fig.158 – Example of survey activity: A) landscape view (S) from the site of Piani di Lauria; A1) sample of Bronze Age pottery fragment from Piani di Lauria; B) Bronze Age and historical period pottery from Piani di Lauria; C) Bronze Age pottery fragments from Piani di Lauria (image by the author).

Again from Piani di Lauria, precociously from the top plateau area that locals call Piani di Lauria Alta, came a noteworthy find consisting of fragmentary blades, an arrowhead, a spearhead and a single bronze earring. The flint artefacts, for their typology and quality of execution, seemed to refer to the Bronze Age; they were made of local flint. The metal artefact is a simple round earring that probably should be linked to a close burial destroyed by atmospheric agent; its presence is held as a rumour in the local community (fig. 159).

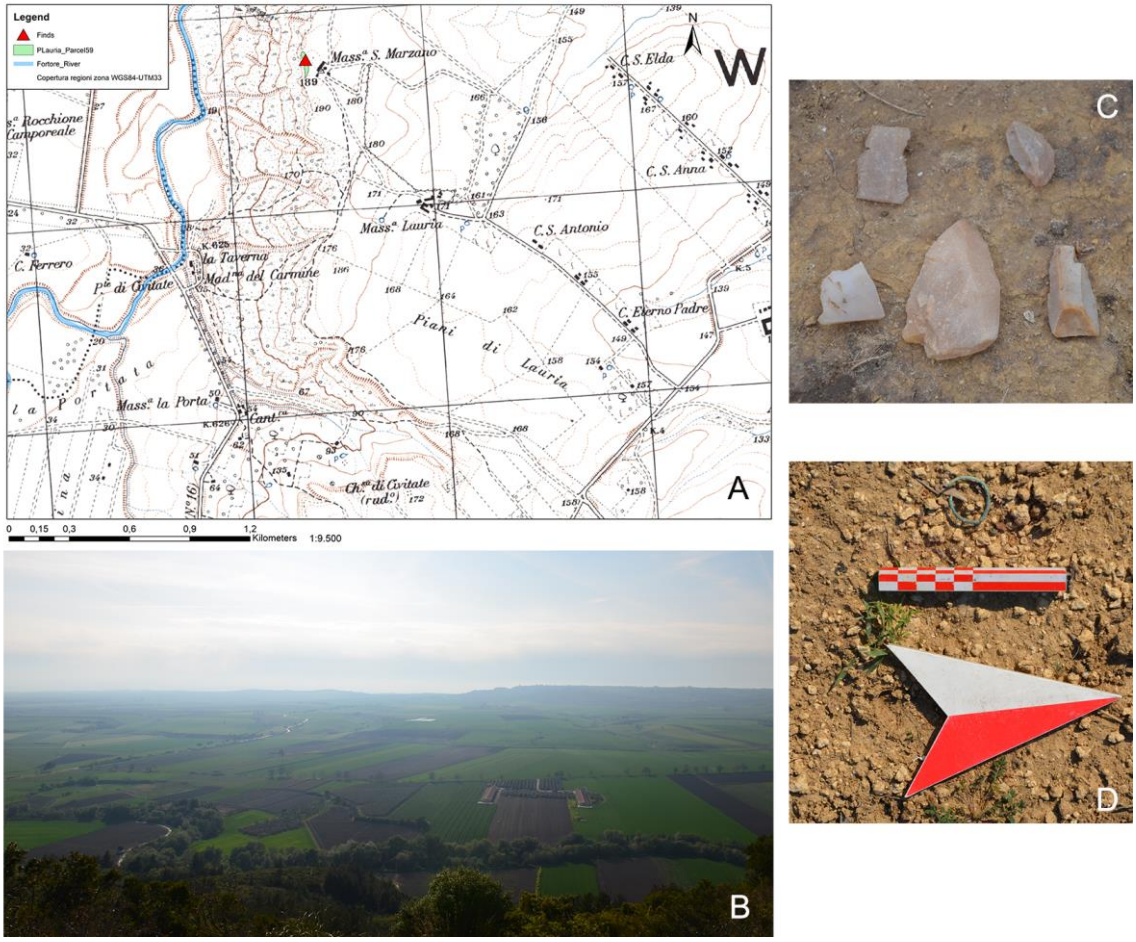


Fig.159 – Example of survey activity: A) IMG map of Piani di Lauria (out of scale). In green the area of Piani di Lauria Alta that was surveyed; the red triangle is the find spot of flint and metal artefacts; B) landscape view (W) from the site of Piani di Lauria Alta; C) flint artefacts from A (fragmentary blades, arrow head and spearhead); D) round bronze earring from A (image by the author).

The investigation on Colle Arsano did not bring any artefacts to light because of the wheat cultivation, but along the hill side, nearby the top, the presence of a broad layer was observed in profile. It was constituted of small and medium pebbles packed together by sandy soil. It is noticeably that these two elements appeared to be completely different from the context because the stones are similar to river pebbles and soil did not match the surrounding earth. The layer

seemed to extend alontg the whole circumference of the top hill, with a height between ca. 1 and 2 meters. These characteristics allowed to speculate that the layer was a sort of containment structure related to the village that occupied the area since the Copper Age. Because of the nature of the layer texture, the possibility of a defensive, or offensive, structure was excluded, at least until now; in any case, further in-depth investigation should occur in this area (fig. 160a-c).

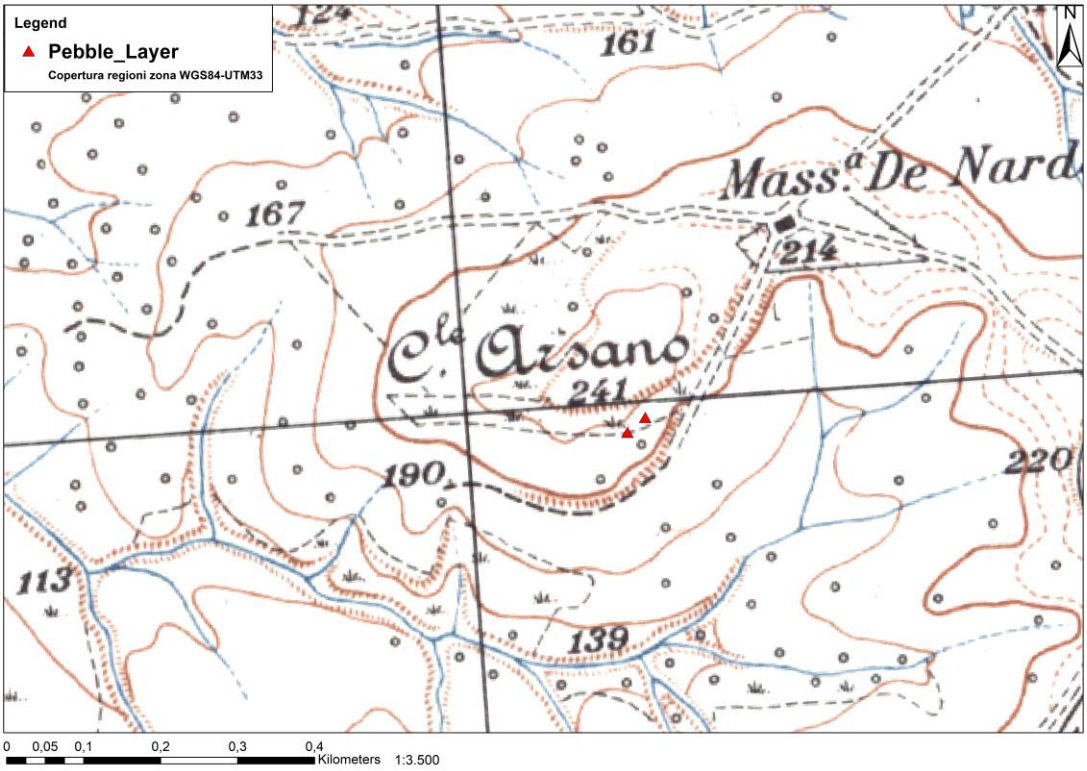


Fig.160a – IGM map of Colle Arsano (out of scale). Red triangles are the point from which the photo of the layer was taken (image by the author).

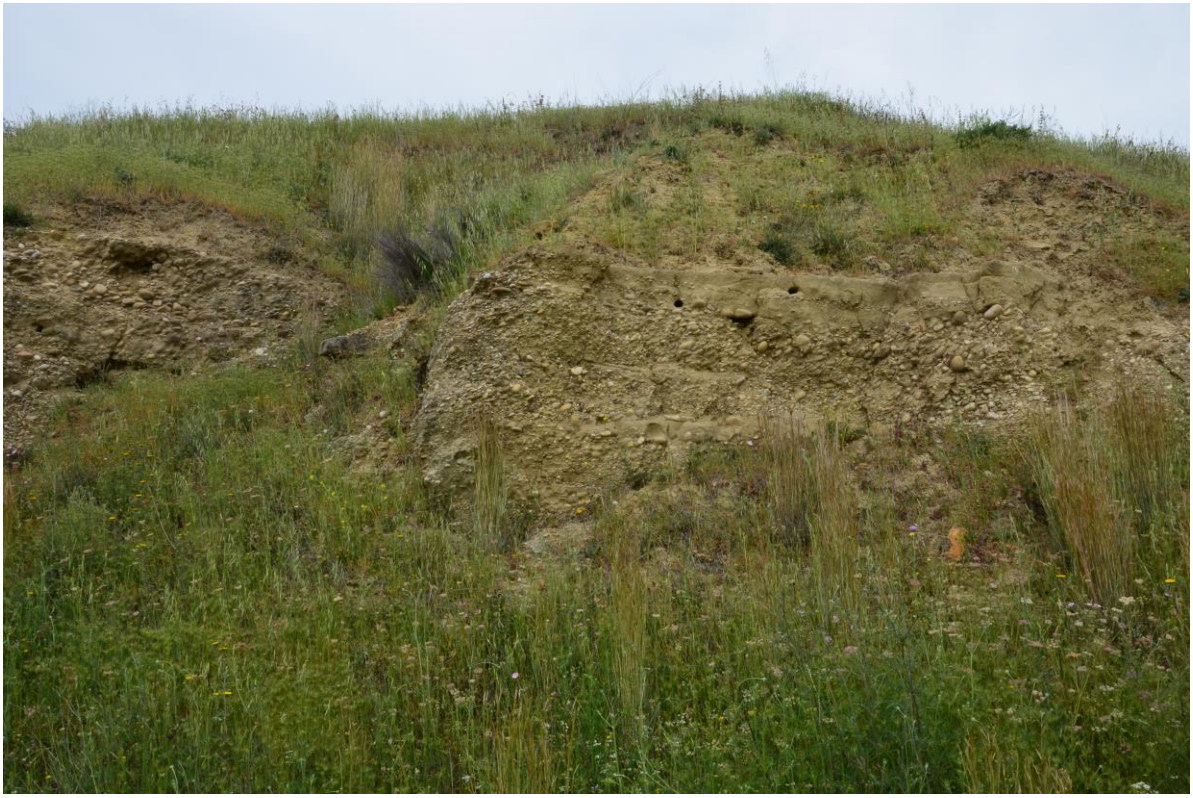


Fig.160b – Colle Arsano, pebble layer (image by the author).



Fig.160c – Colle Arsano, detail of the pebble layer (image by the author).

5. Conclusion

In summary, the collected data offers and defines new perspectives on both the life of prehistoric communities and changes that succession during the considered chronological sequence.
A complex framework was underlined in which the reasons for picking a spot for a settlement change according to aspects linked to the landscape and economical developments. The analysis permitted to comprehend that aspects like visibility and proximity to communication corridors were decisive in the choice of the place where to set the village. Therefore, the perception of the landscape ceased to be a mere understanding where to carry on subsistence activities in favour of an always more calculated placement to exploit the environmental potential in the best way possible.

The LCPA demonstrated that the sites were connected, thus furnishing important insights regarding the assumable ways covered by the groups. The result was a dense and complex network of links estimated by the calculation. Despite the development of new routes traced in relation to sites changing places, it was noted that the main watercourse system played a role as a corridor to reach the sites.
Specifically, the analysis revealed the exploitation of the Staina and Triolo torrents for the movement into the low Tavoliere Plain and likely from the southern area edge to the north. In contrast, the Candelaro River was used to connect the upper Tavoliere Plain and the southern areas with northern Daunia. That was determining for the passage through the Gargano foothills.
Ultimately, the Fortore River and the Saccione Torrent had to work as joint points between the inner Italian regions and northern Daunia (figs. 161a-f).

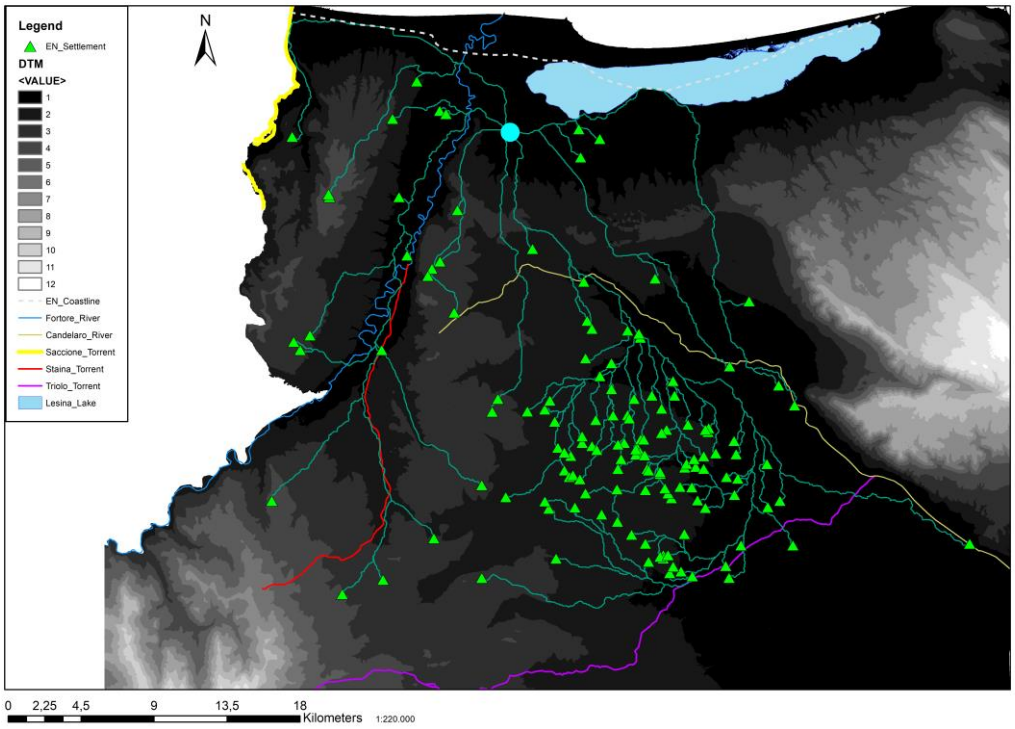


Fig. 161a – Use of the watercourse corridors during the EN. LPCA applied to the site of Masseria Anita-Canimpiso (in light blue). The path network generated tends to follow the corridors developed by rivers and torrents (coloured lines, see the legend) (image by the author).

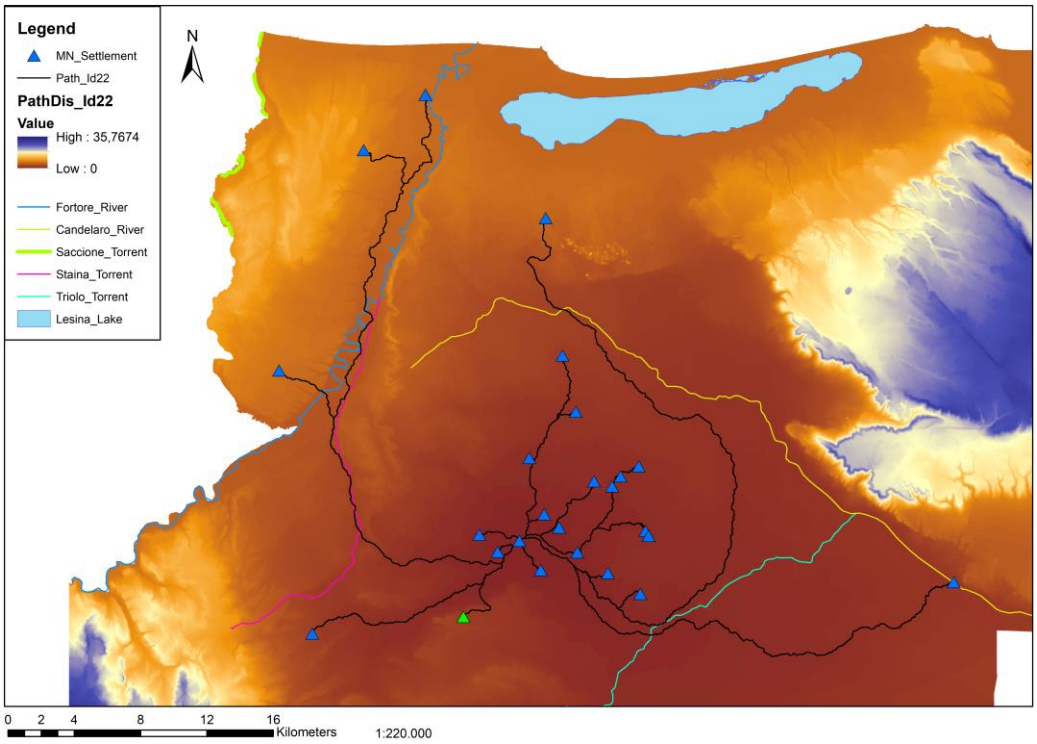


Fig. 161b – Use of the watercourse corridors during the MN. LPCA applied to the site of Castellana (in light green). The path network generated tents to follow partially the corridors developed by rivers and torrents (coloured lines, see the legend) (image by the author)

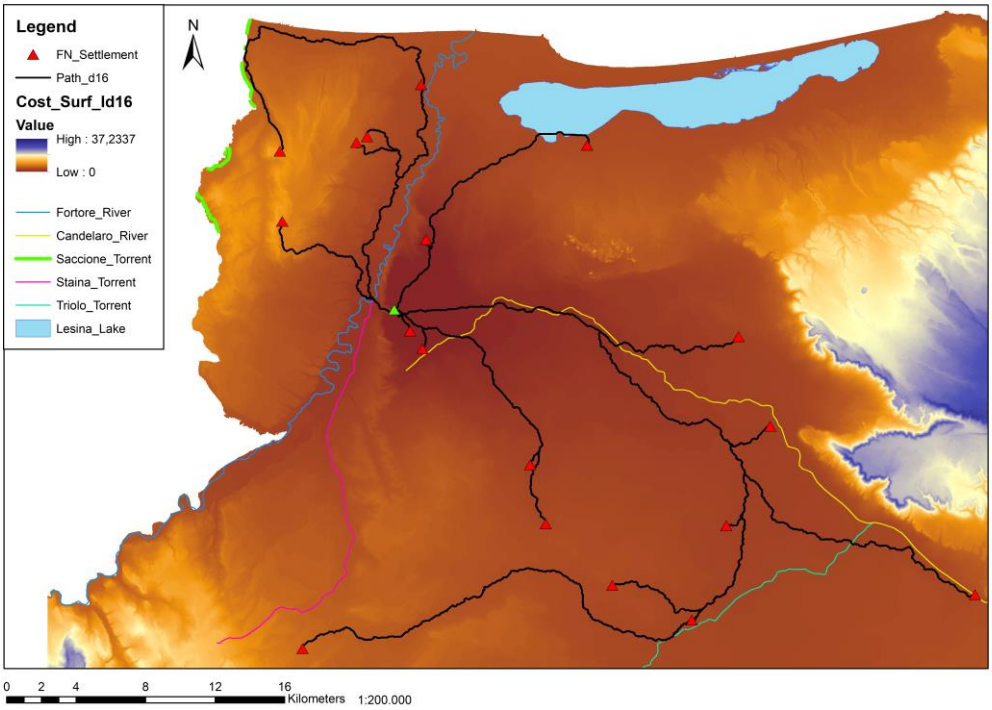


Fig. 161c – Use of the watercourse corridors during the FN. LPCA applied to the site of Piani di Lauria (in light green). The path network generated tends to follow the corridors developed by rivers and torrents (coloured lines, see the legend) (image by the author).

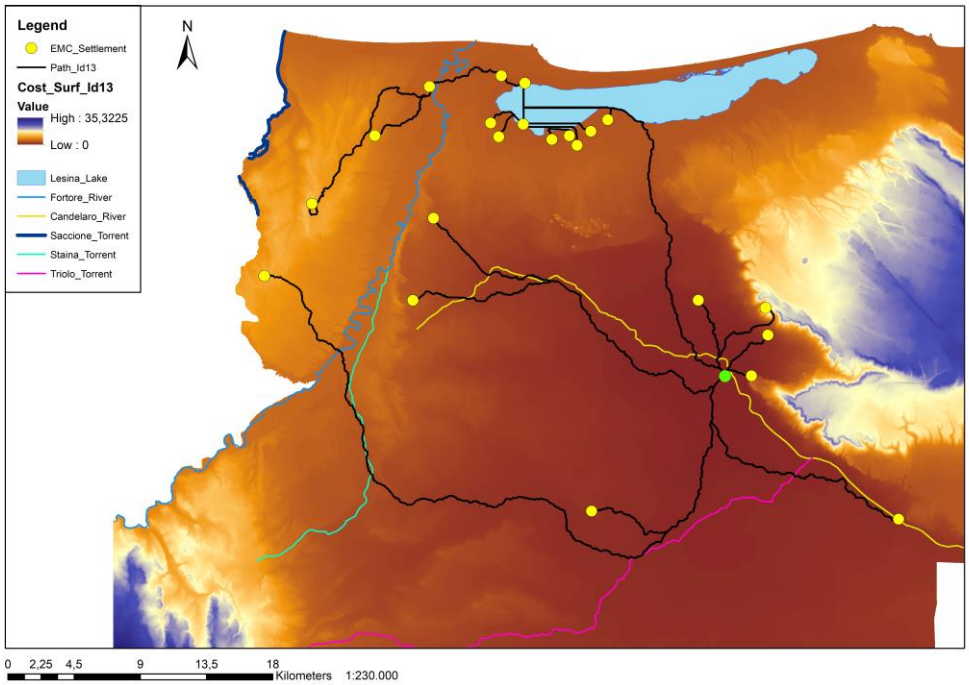


Fig. 161d – Use of the watercourse corridors during the EMC. LPCA applied to the site of Mezzanella di Braccia (in light green). The path network generated tends to follow the corridors developed by rivers and torrents (coloured lines, see the legend) (image by the author).

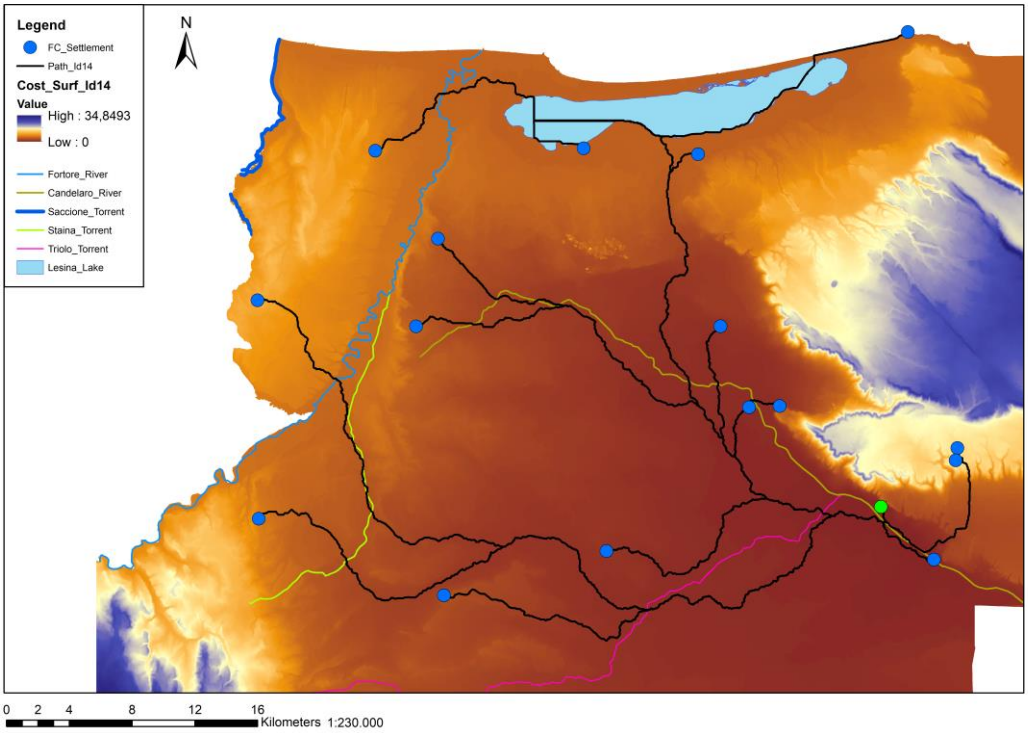


Fig. 161e – Use of the watercourse corridors during the FC. LPCA applied to the site of Cicerale (in light green). The path network generated tends to follow the corridors developed by rivers and torrents (coloured lines, see the legend) (image by the author).

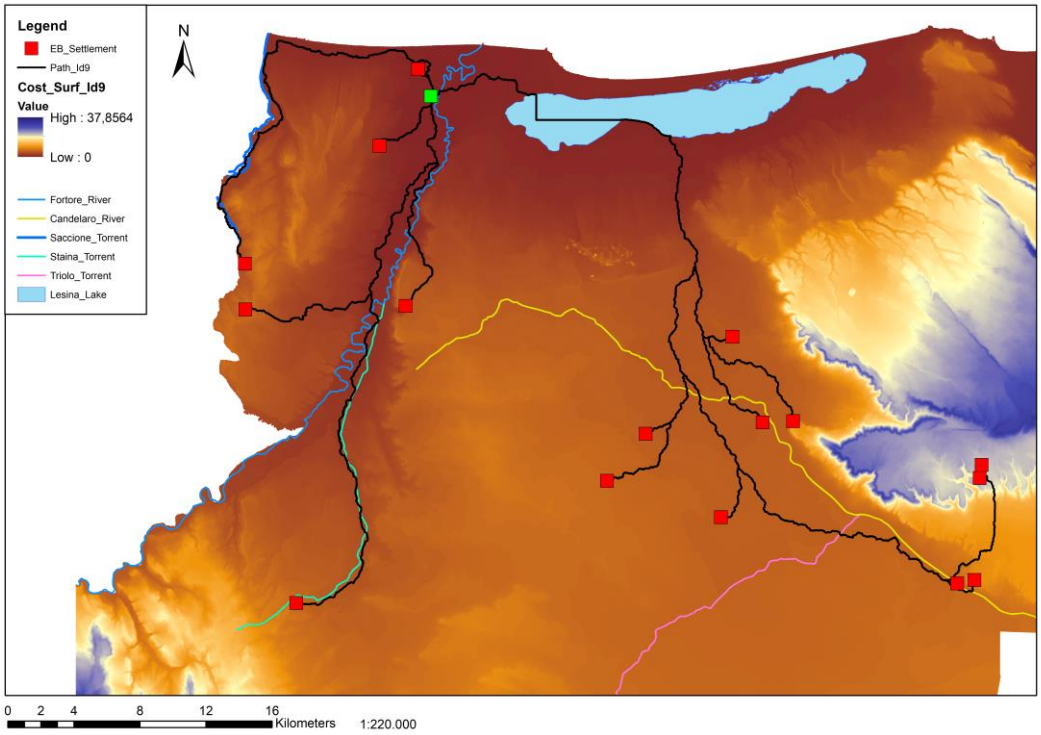


Fig. 161f – Use of the watercourse corridors during the EB. LPCA applied to the site of Chiarappa (in light green). The path network generated tends to follow the corridors developed by rivers and torrents (coloured lines, see the legend) (image by the author).

The images above display how the use of the river course valley was possible, and in addition the calculation seems to mark how the movement could be facilitated properly by these natural routes, above all to reach specific areas. If this assumption is possible to apply all the generated networks in general, the Middle Neolithic seems to be almost a case apart. Figure 161 b shows a placement focused on the centre of the study area, generating paths that use largely just the Staina Torrent and the Fortore River; while the watercourse on the right side is merely crossed.

In general, the watercourse crossing points were several, hence attesting that the rivers were assumable as "aware" viability, meaning the capability of prehistoric individuals to perceive and comprehend the space around them.
Moreover, it could be speculated that this awareness was enhanced more and more in the course of time as displayed in the estimated LCPA; indeed, this aspect is enforced by the overlapping of the path network, diachronically and synchronically. As highlighted in the LCPA chapter, within the same period the tendency to have overlapping segments of paths, long network pieces or whole networks (in some cases) was observed, indicating continuous use of those trajectories. This assumption could be applied also diachronically where the sites with a medium- or long-life term exhibit a repeated use of the same paths (fig. 162).

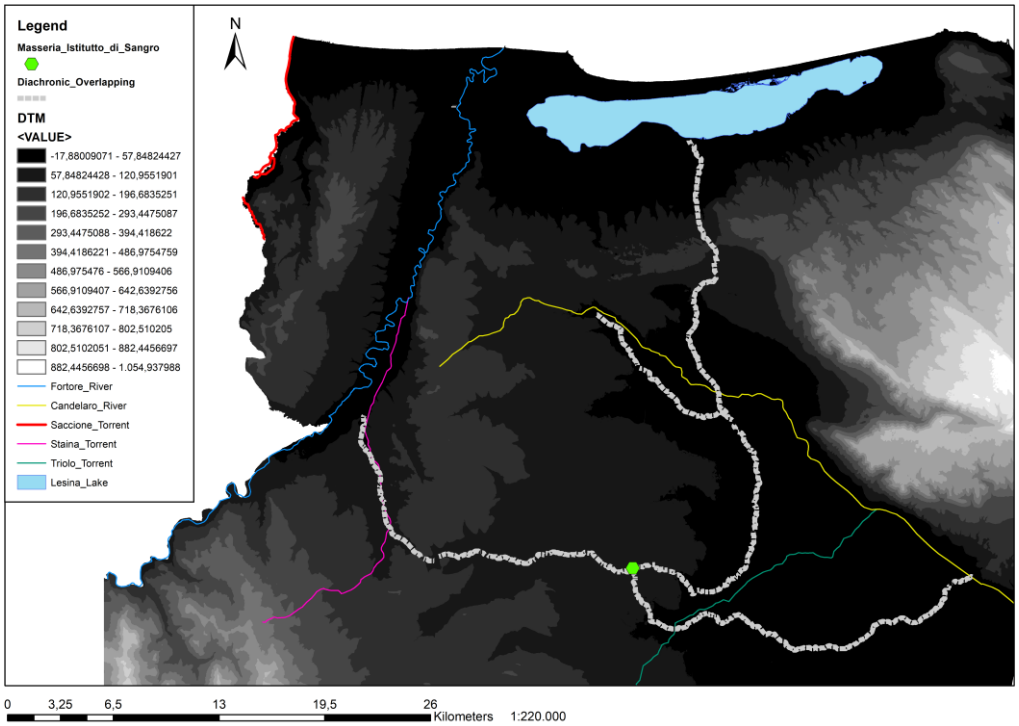


Fig.162 – Diachronic intersect between the path networks of the site of Masseria Istituto di Sangro (white dashed line). The settlement lived through the periods EN, MN, FN, EMC and FC. To preserve the clarity of the image, it was avoided to display all the sites linked to the above-mentioned period (image of the author).

Fig. 162 shows an example of continuous use of specific path segments using the network of the site Masseria Istituto di Sangro. Analysing all the trajectories of this settlement through the ArcGIS tool “Intersect”, it was possible to mark which were the overlapping routes. Therefore, it would bring us to think that knowledge of the landscape was a process definable as *in fieri* since the acquired information on the territory is transmitted to the following period. Indeed, it would be interesting to analyse in-depth with further analysis how much of this information survived until the modern time, above all in environments linked to livestock-herding where the breeder is used to follow also uncommon inland paths. For this aspect, the comparison analysis made between the pre- and protohistoric networks and the transhumance system could work as a trigger to bring new insights and open new perspectives on the use and perception of the territory.

At this point of the research, it was justified to analyse also how mobility worked towards the region of Molise. For this reason, two examples of path networks were generated in order to give feedback, at least in general, about possible routes.
Therefore, on the base of the DEM (10 metres resolution), an area of ca. 318000 m^2 corresponding to the Molisean landscape portion including the low valley of the Biferno River, the coast, the regional border and an area just north of the municipality of Larino was considered.
This territory was chosen because, archaeologically, the Biferno Valley was subject to dense populating phenomena from the Neolithic onwards. Therefore, trying to figure out possible mobility in several directions, it was decided to generate 30 random points set in a distance of 5 meters to each other in order to cover the area homogenously.
The calculation took into consideration the sites of Brecciara and Colle Arsano as starting points of the networks, because of their closeness to the border and thus a possible relation with the neighbouring territory. In addition, the choice was made in consideration of the kind of mobility developed during the Early Bronze Age. The random points were used as destinations (figs. 163a-b).

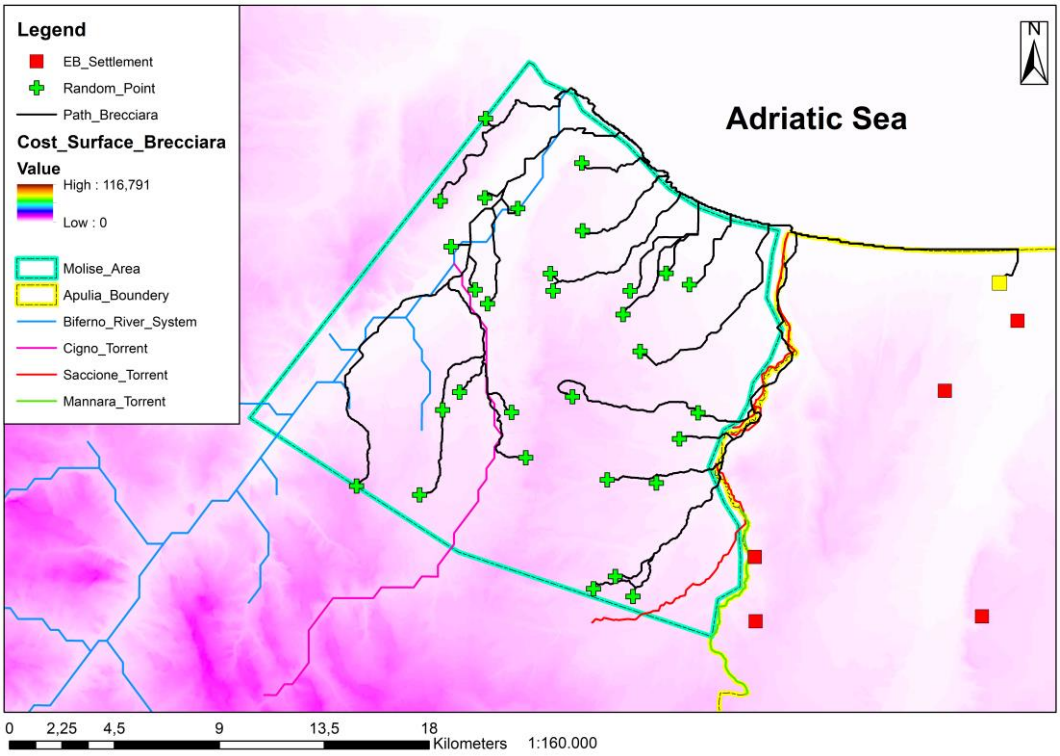


Fig.163a – Example of LCPA applied to Brecciara (yellow square) towards the territory of Molise. The Molise area polygon is the considered sample zone. The Green crosses are the random points. The main rivers and torrents involved in the path network are marked in colours (image by the author).

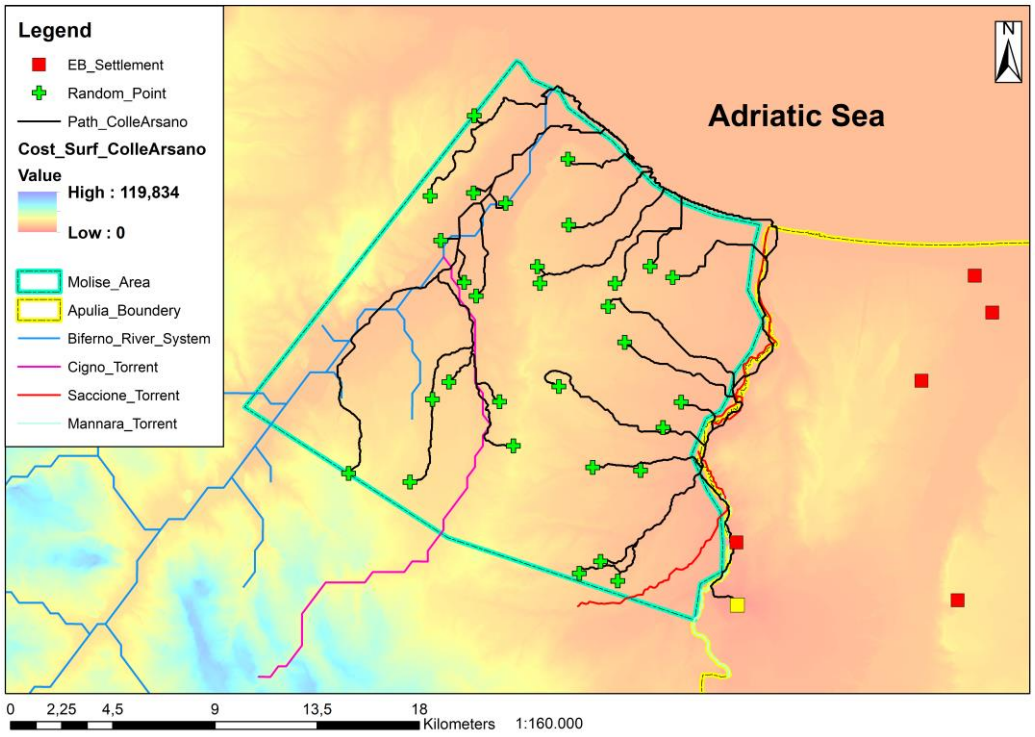


Fig.163b – Example of LCPA applied to Colle Arsano (yellow square) towards the territory of Molise. The Molise area polygon is the considered sample zone. The green crosses are the random points. The main rivers and torrents involved in the path network are marked in colours (image by the author).

The sample analysis demonstrated mobility from a northern source point (Brecciara) and from a southern one (Colle Arsano). In both cases it is clear how moving people use the torrents to go from Apulia to Molise, i.e. the Saccione Torrent (fig. 163a, red torrent) starting from the north and the Mannara and Saccione Torrents (fig. 163b, red and aquamarine torrents) from the south.
Once entered into the neighbouring region, the mobility pattern seems to follow specific trajectories to reach the various targets exploiting mainly the coastline, the Biferno River valley and the Cigno Torrent (tributary of the Biferno).
According to the calculation, it is assumable that the hydrological systems had to play an important role as communication ways able to direct the flow towards the inner or outer regions. Therefore, the Biferno River was surely involved in mobility centred towards the northern and central regions of the Peninsula, while the Saccione and Mannara Torrents facilitated the access into the area of Daunia and consequently through the Fortore River towards the inner Tavoliere and the southern regions.
Moreover, the coastline proves to be another main route in reaching the Biferno valley and vice versa; hence it could be assumed that this corridor had to work as a bridge between the two zones.
Therefore, it appears clear that during the Early Bronze Age a continuous exchange phenomenon had to exist between the regions that should result in a modification of site placements. Specifically, it could be speculated that settlements like Colle Arsano, Cantalupo-Tre Ponti, Colle di Creta, Chiarappa and Brecciara constituted a sort of controlling site network of the main access routes (Gravina 1979, 92). Indeed, the villages were situated just at the brink of the ridges that worked as natural barriers between the two regions and only after passing them, real access to the rest of the territory, i.e. the Fortore River, was possible (fig. 164).

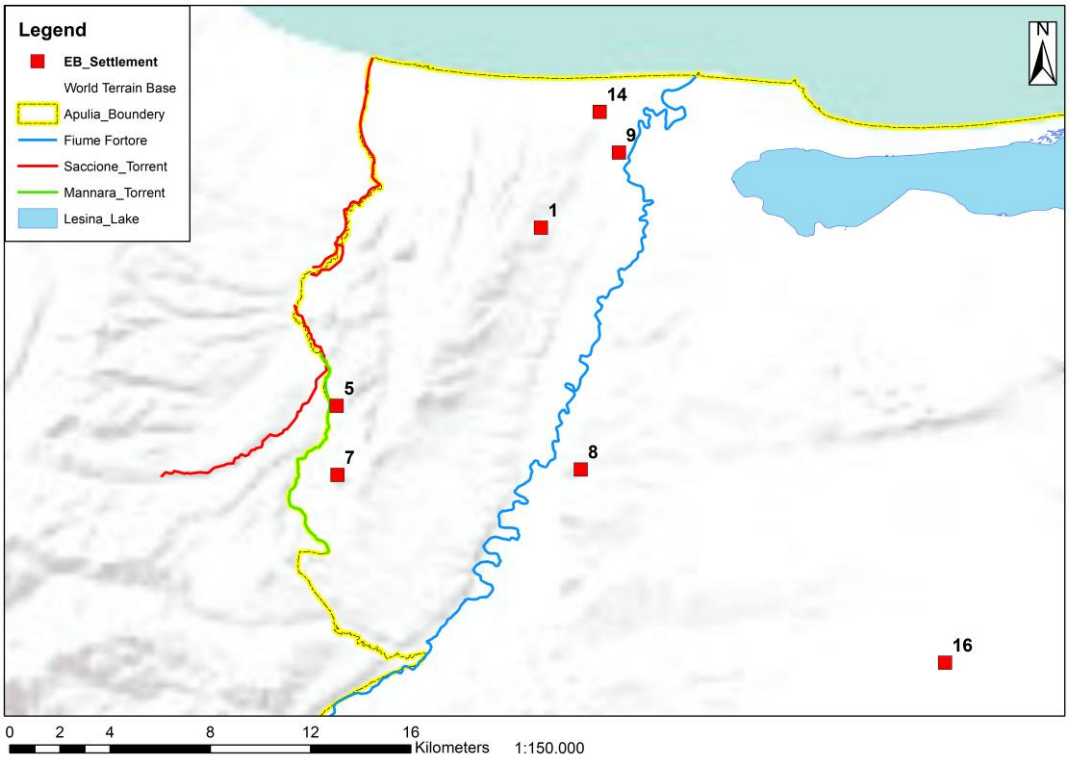


Fig.164 – Terrain map with highlighted geographical features. The "border sites" mentioned in the text: Colle Arsano (id7), Cantalupo-Tre Ponti (id5), Colle di Creta (id1), Chiarappa (id9) and Brecciara (id14) (image by the author).

The aforesaid assumption is addressed mainly to the Bronze Age because it is this period in which the dynamics of landscape control for economic reasons appear and stabilize. Analysing the other periods, the results show that the Neolithic was not focused on this kind of economy but more prone to subsistence activity, hence the landscape was mainly seen as a proper resource from which to benefit. Therefore, the estimated networks indicate probably more cooperative relationships, especially for those sites located at small distances to each other. The Copper Age seems to have a double way to use the landscape, according to the respective phase. In detail, the Early-Medium phase displays a placement addressed to specific areas, i.e. the Fortore Valley, Lake Lesina and the Gargano foothills. This kind of arrangement would presume that likely a control of certain territory arose, but strongly focused on the aforementioned zones. Therefore, relationships with outer groups had to be verified, and indeed the archaeological record attests the presence of the cultural aspects of Macchia a Mare and Piano Conte. These two phenomena were spread in southern Italy, above all the second which was defined as a cultural phenomenon accepted and implemented by different southern communities. The main presence of these aspects leads us to speculate on a kind of relationship turned mostly to the Peninsula (fig. 165).

The mobility analysis demonstrated that the sites had to be at the heart of a network through with groups were able to travel from the south to north and vice versa. In this perspective, the sites of Colle Arsano, Località Piano Navuccio, Chiantinelle and Chiarappa would constitute the first control network for all who entered or exited northern Daunia from the west. Similarly, for the Gargano area Ciccalento had to play a main connection role because of its placement at the Candelaro valley. In a second step, the other sites on the inner area and the foothills of the promontory had to cover the same function.
On the other hand, Piani di Lauria and Coppe di Rose had to work as control "stations" of the Fortore valley fords and as sorting hubs for a direct crossing of the Tavoliere Plain. Likely, the lake area could work similarly as a sort of "communication bridge" for connections around northern Daunia.

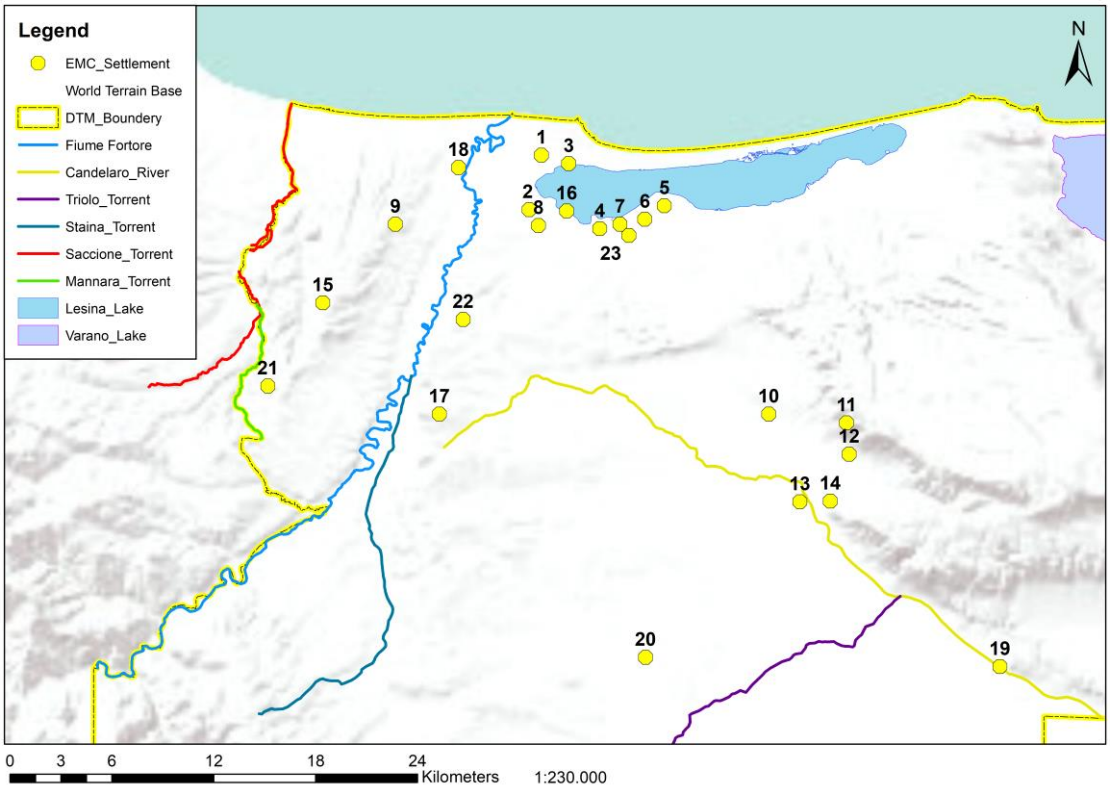


Fig.165 – Terrain map with EMC site distribution. The mentioned sites: Colle Arsano (id21), Località Piano Navuccio (id15), Chiantinelle (id9), Chiarappa (id18), Coppe di Rose (id22), Piani di Lauria (id17) and Ciccalento (19) (image by the author).

The final phase of the Copper Age displayed, as previously described, a placement which was more spread out and seems to enlarge the control of the territory by the settlements. Likely, it could be interpreted as a prelude to the socio-economic dynamics that strengthened especially from the Early Bronze Age on.
Specifically, it is possible to observe that the sites gravitate towards the Gargano area and the southern edge of the study area, ignoring the Molise and Lake Lesina areas. This arrangement could reflect the new connections established during that phase; indeed, the archaeological record shows evidence of the Laterza and Četina *facies* (see chapter of archaeological background) that could use routes passing through the areas estimated by the LCPA calculations. In detail, the Laterza aspect would spread through the southern regions; instead, the Četina *facies* came from the Balkans, hence along the eastern Apulian coast, and would move across the region's trajectories to reach different locations.
Therefore, the villages in the Gargano and edge areas had to play the main part as first contact points for new cultural flows, allowing the diffusion and circulation of the cultural aspects. In this perspective, the use of the valleys of the Candelaro, Triolo and Staina as main corridors to reach northern Apulia and afterwards the neighbouring regions could be considered.
On the other hand, the Fortore valley, Lake Lesina and the Molise border had to work as sorting hubs to allow the passage from one region to the other, hence facilitating the mobility into and the crossing of northern Daunia (fig. 166).

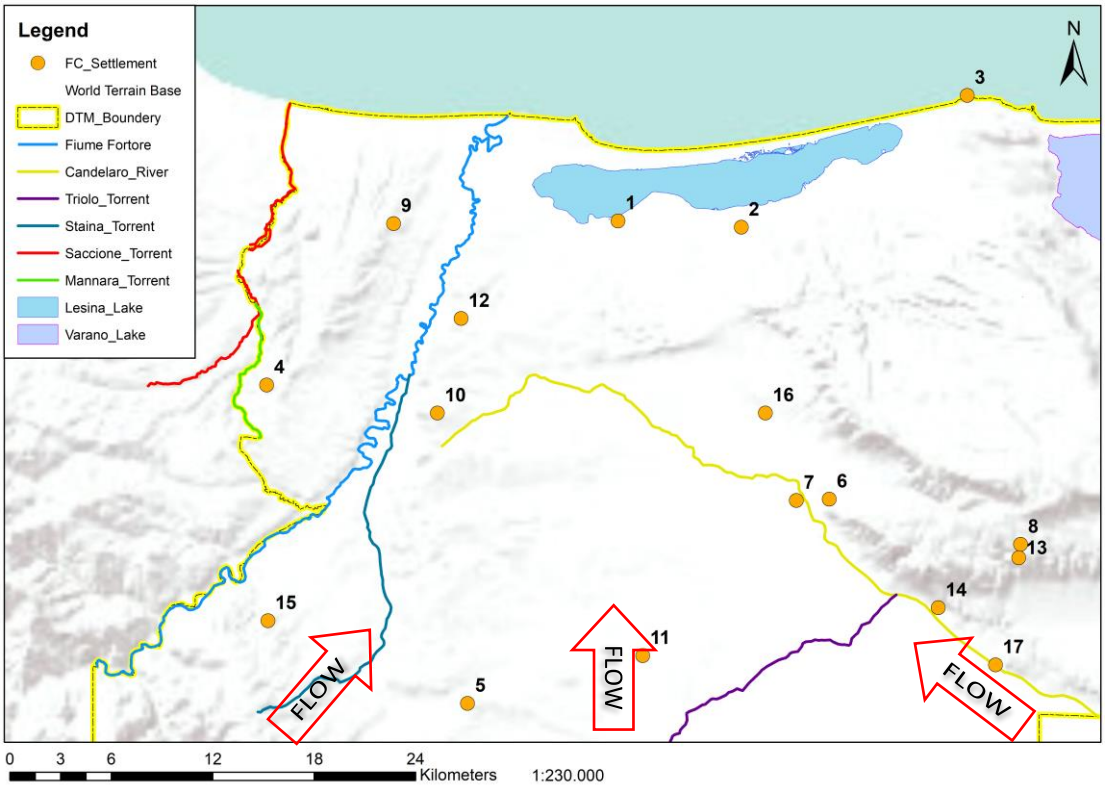


Fig.166 – Terrain map with site distribution. Edge area sites: Colle d'Armi (id15), Torre Fiorentina (id5), Masseria Istituto di Sangro (id11). Gargano area sites: Ciccalento (id17), Cicerale (id14), Chiancata La Civita (id13), Casale Crisetti (id8), Vola Pianezza (id6), Mezzanella di Brancia (id7), Mezzana della Quercia (id16) (image by the author).

The assumptions regarding Daunian mobility are supported by the visibility analysis that enhances the comprehension of the perception of the prehistoric landscape and the reasons behind settlement choices. Indeed, the Fuzzy Viewshed Analysis demonstrated a straight correlation between site placement, mobility and socio-economic dynamics developed during the different periods.
If for the Neolithic the estimation displays attention turned towards the inner area, from the Copper Age on an opening towards the outside begins to appear. As mentioned before, during the Early-Middle Copper Age northern Daunia starts to be crossed by flows coming from the southern and western areas. Moreover, the settlements situated along the study area edges display the attitude to keep the surroundings outside the area borders under control, hence towards Molise, the Adriatic Sea, the inner Gargano and the southern Tavoliere (fig. 167).

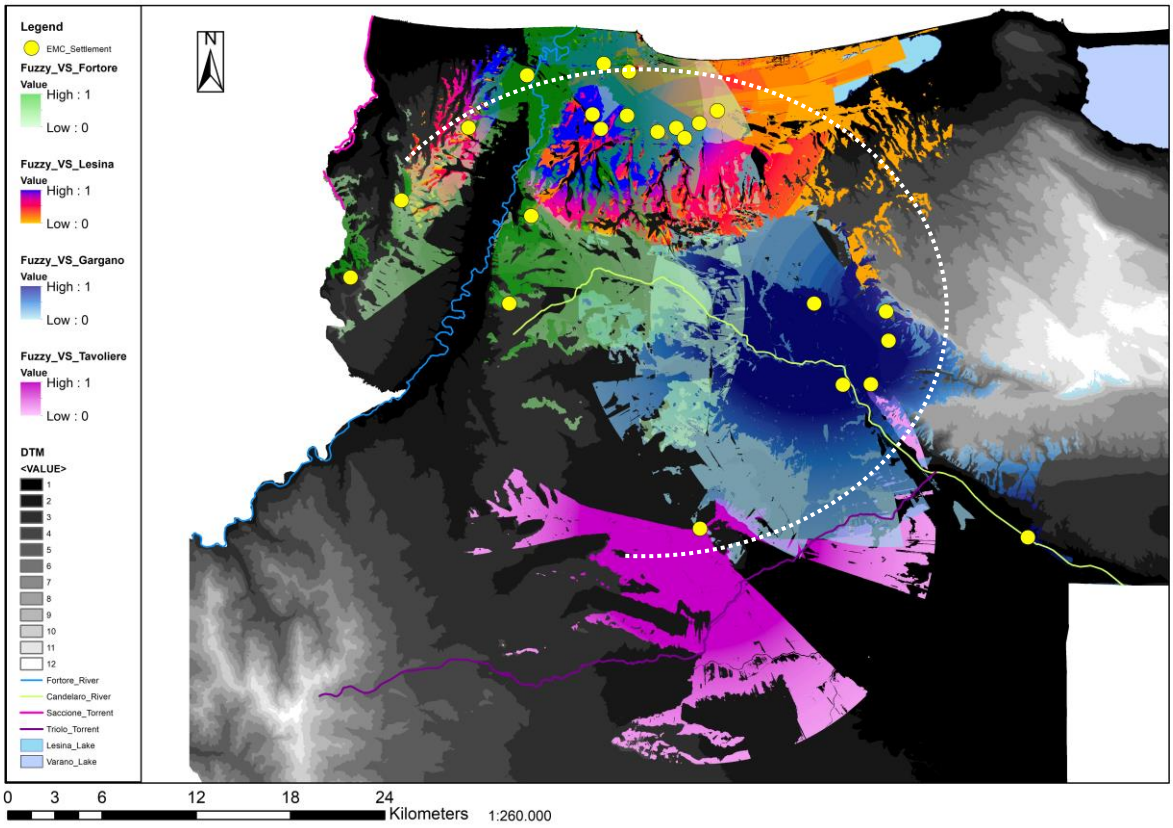


Fig.167 – Example of Fuzzy Viewshed applied to the EMC settlements. The sites were grouped in accordance with their location, hence the different VA per zones are in colour: Fortore in green, Lesina in orange-blue ramp, Gargano in blue and Tavoliere in purple. The dashed line is the likely circular sight network between the sites (image by the author).

Fig. 167 shows how the several visibility spectra are articulated, showing a specific affiliation to the observer point area. As expressed in the VA chapter and previously here, new placements along the borders are emphasized by spectra that enlarge their horizons towards the neighbour regions, hence supporting the assumption about the rise of new communication networks.
In addition, the division of the spectra could help to understand how the site relationships worked. In detail, each colour represents the respective area but, above all, a specific sight network formed by the placement that is characterized by clusters.
If we think of northern Daunia as a possible whole site-group with a structure able to guarantee the circulation and the communication, we could assume that the visibility played an important role and allowed to keep in sight contact with each site. Moreover, it has to be considered that this system had a circular trend starting from the Molise border and ending in the Tavoliere area and vice versa. In this way, the whole group was likely continuously updated on landscape events.

The mentioned hypothesis could have effected also the Final Copper Age, but with some variation maybe foreshadows the changes of the Early Bronze Age. Therefore, in this new phase, the presence of cultural influences from external regions and a likely reflection of this opening also with respect to site placement was recorded, since sites are now spread more broadly all over northern Daunia. The VA revealed similarities with the EMC where the sites clustered per zones seem to generate a sight network but a more complete one, from the coverage point of view. If it was true, we could suppose that the reasons for settlement choice were turned to keep the territory under control by the sites constituting a sort of integral group, at least for this phase. Therefore, the settlements still denoted attention to the whole territory of northern Daunia (fig. 168).

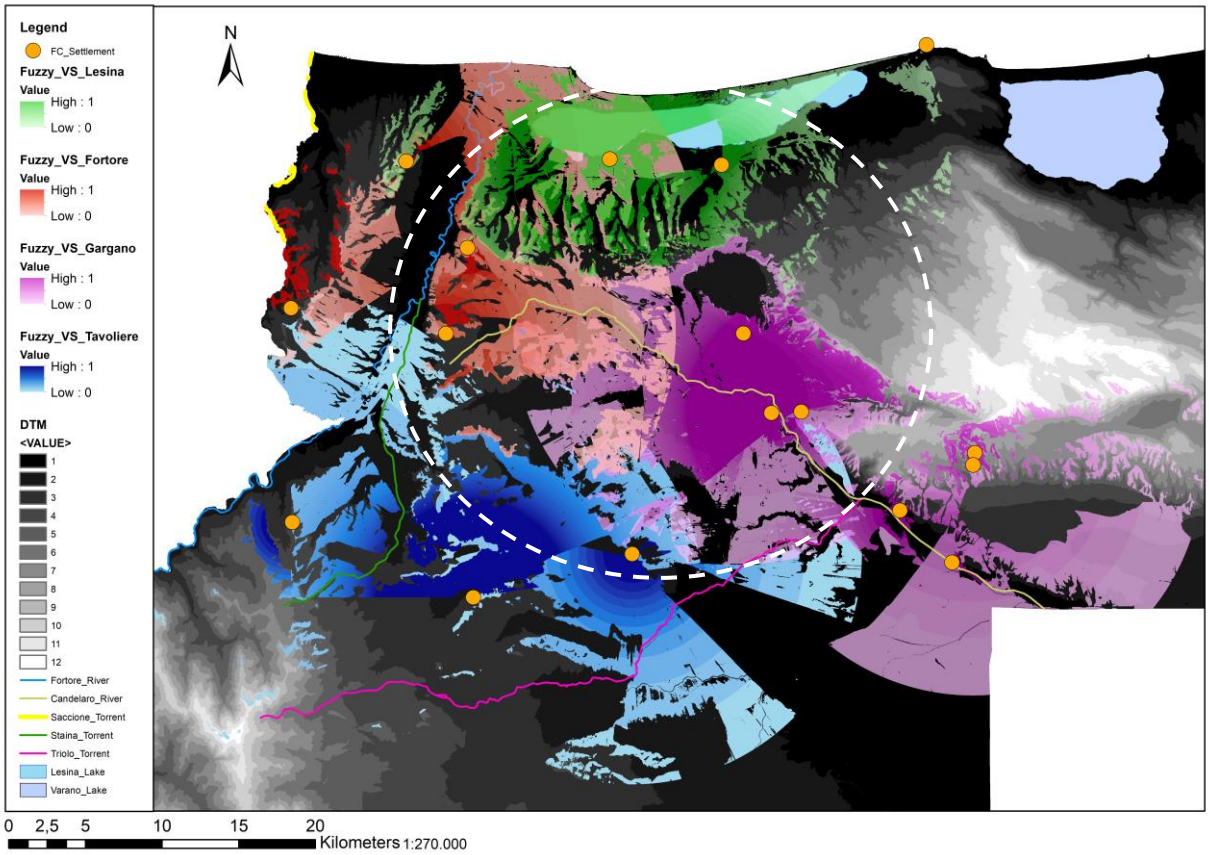


Fig. 168 – Example of Fuzzy Viewshed applied to the FC settlements. The sites were grouped in accordance with location, hence the different VA per zones are in different colours: Fortore in red, Lesina in green, Gargano in purple and Tavoliere in blue. The dashed line is the possible circular sight network between the sites (image by the author).

Diversely, the Early Bronze Age seems to leave the consideration of the whole territory in favour of only a portion of it. The site placement reflects the preference of specific areas because their control guaranteed strategic advantages and direct connections with the main communication ways.
To confirm this assumption, we could consider the change as a “selfish” choice of single villages that tried to stand out in the newly rising socio-economic dynamics.
The VA emphasizes this aspect where the several generated spectra result in a focus on a specific area and connected only with neighbour sites (fig. 169).

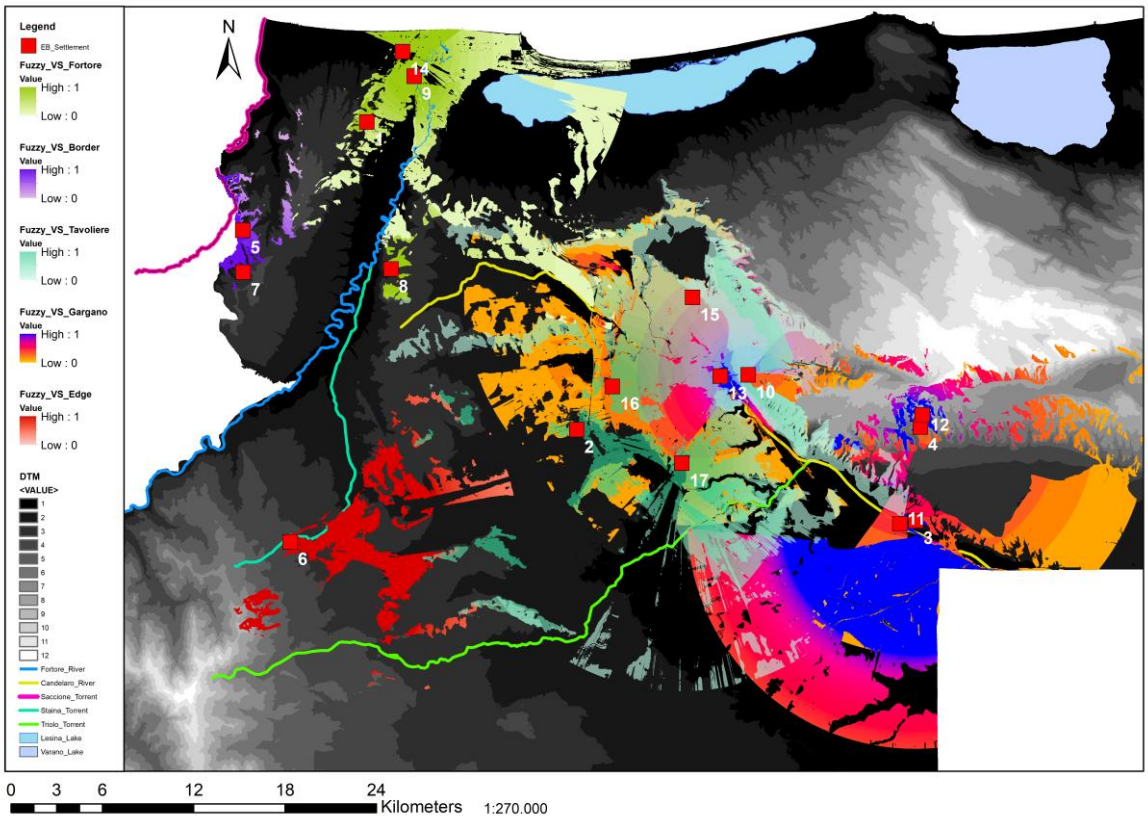


Fig.168 – Example of Fuzzy Viewshed applied to the EB settlements. The sites were grouped in accordance with location, hence the different VA per zones are in colour: Molise border in purple, Fortore in green, Gargano in orange-blue ramp, Tavoliere in aquamarine and study area southern edge in red (image by the author).

Fig. 168 clearly shows the difference to the previous analysis because of the lack of the circular sight network. It is possible to cluster sites in accordance with the location but the spectra colours reveal that the groups are isolated entities controlling their likewise territory. The only exception that it is possible to recognize is the relation between the villages situated on the Tavoliere and Gargano area. The two groups seem to have a sight connection. Therefore we could assume that they constituted a sort of system connected by sight and able to dominate the Candelaro valley and the proximity of the related Tavoliere and Gargano foothills.

In summary, the RPCM Apulia project shed new light on the communities' perception of the landscape and how the groups were integrated into a context linked to external influences.
For the first time for northern Daunia, an analysis aimed to comprehend how the communities could exploit the territory was run, giving supplementary information on the reasons for settlement placement. The GIS investigations in combination with an evaluation of finds and features can offer important insights into the lifestyle of the prehistoric communities.

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APPENDIX

CHRONOLOGICAL TIMELINE

Table A – Neolithic Timeline

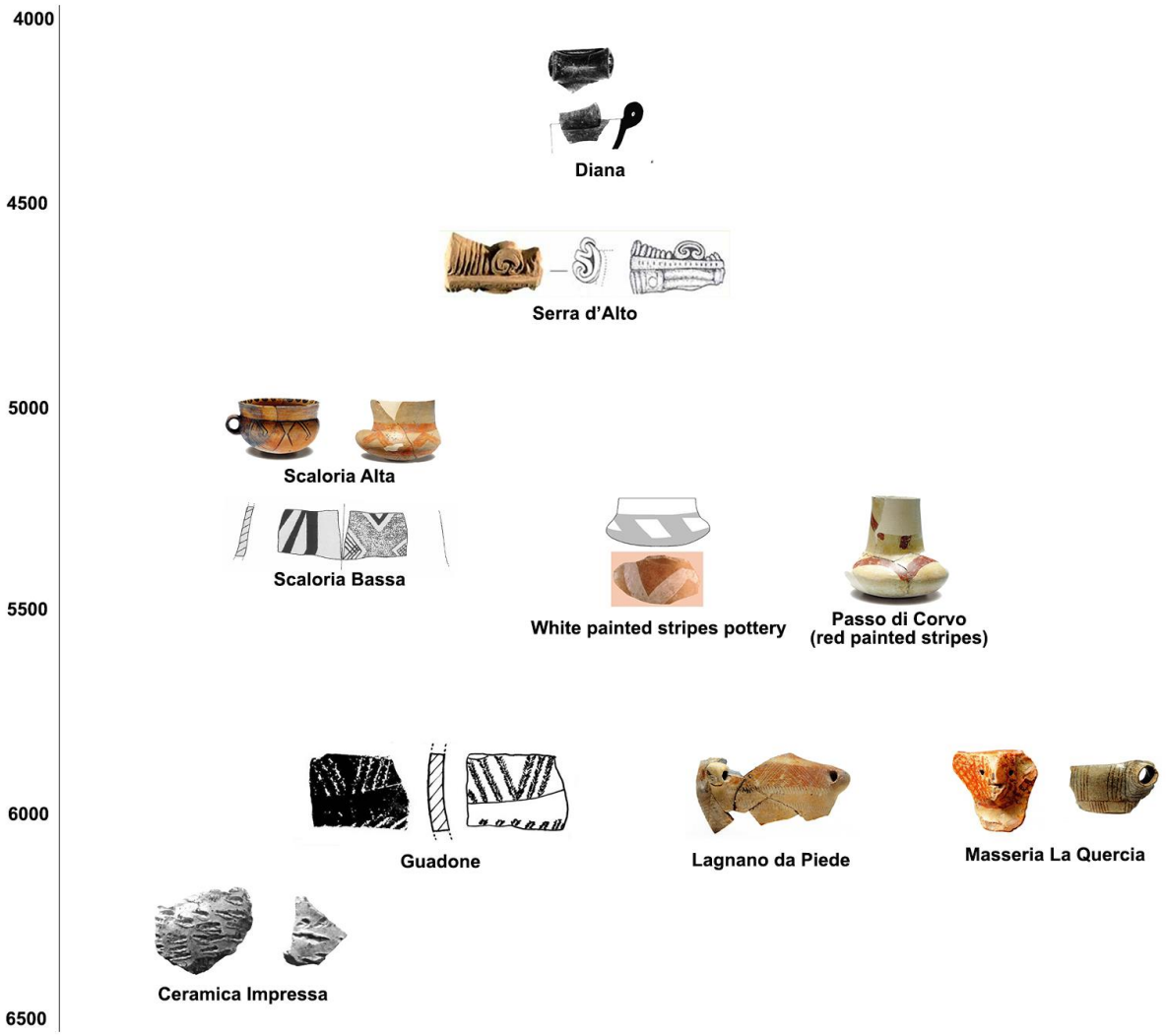


Table B – Copper Age-Early Bronze Age Timeline

2000



Early Bronze Age

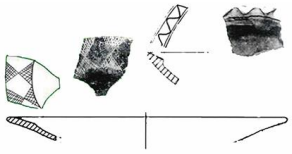
2500



Laterza



Cellino San Marco

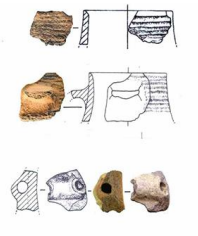


Laterza-Četina

3000



Gaudo



Piano Conte

3500

4000



Macchia a Mare

4500

SURFACE DATA

Table 1 – Northern Daunia DTM

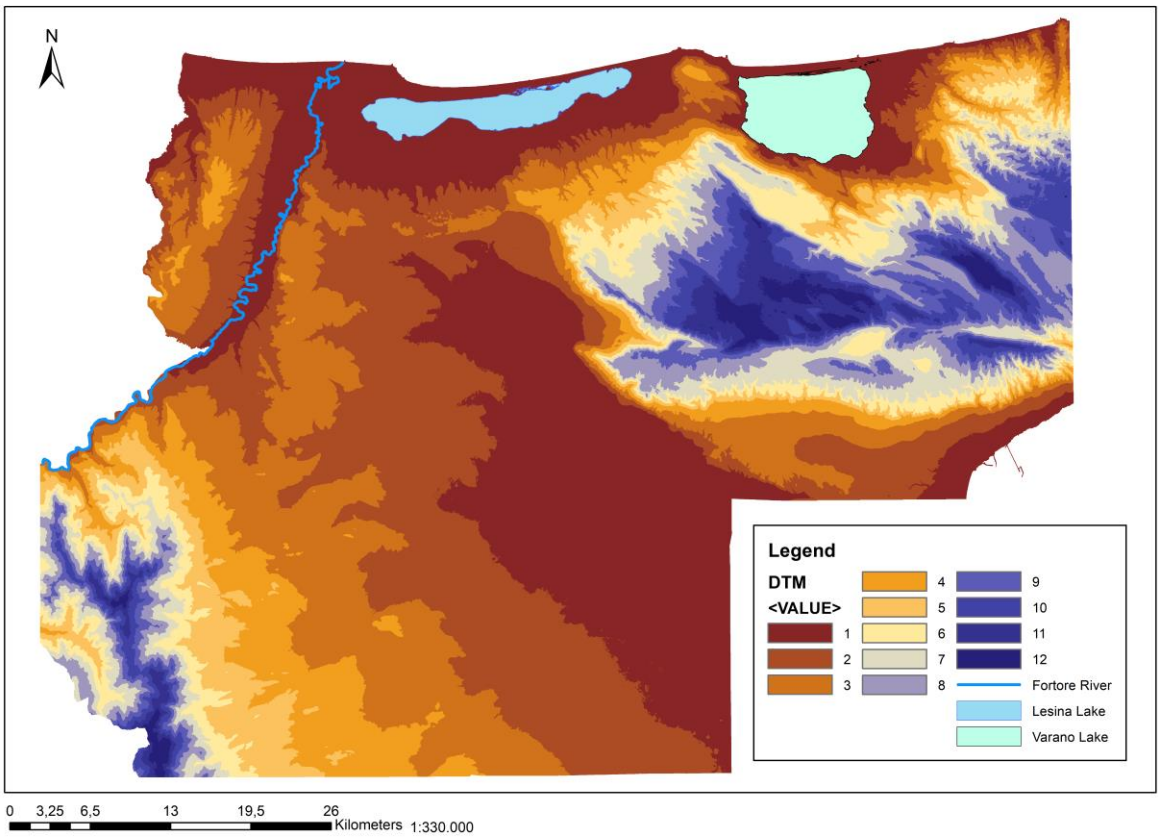
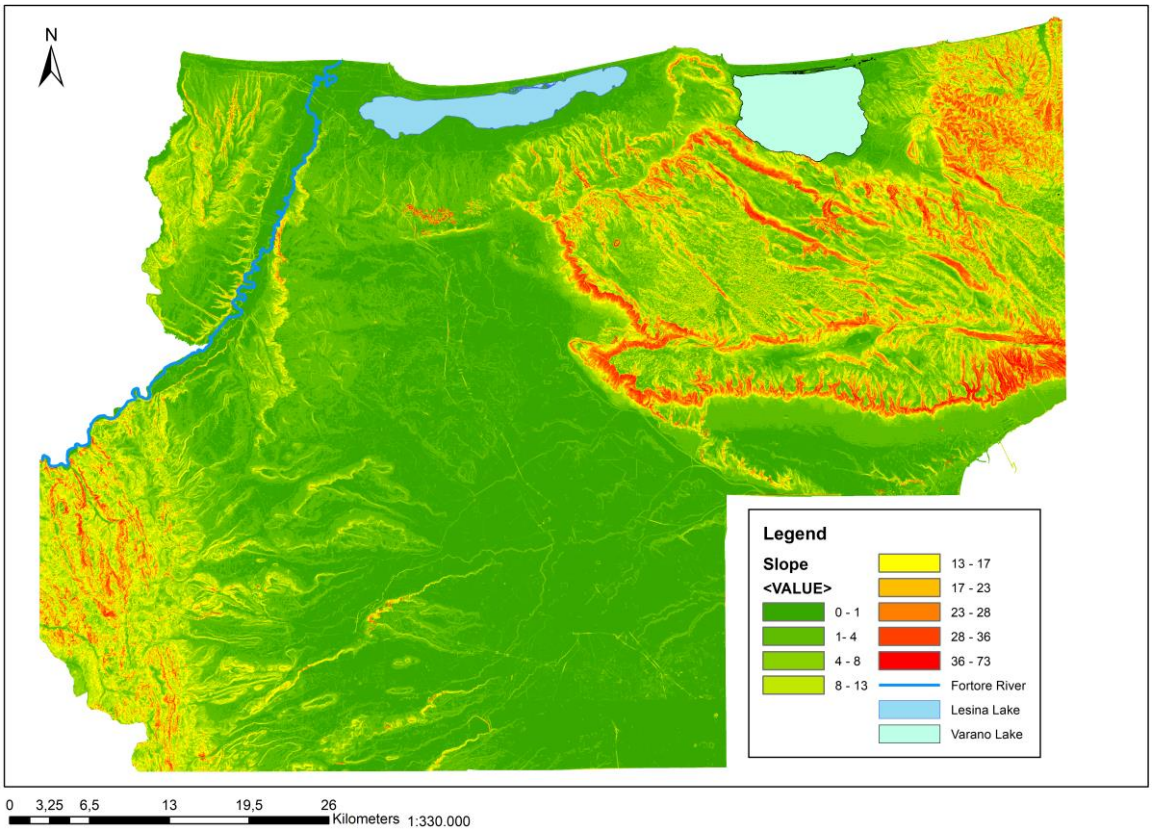


Table 2 – Northern Daunia Slope



EARLY NEOLITHIC

Table 3 – Distribution Settlement Map

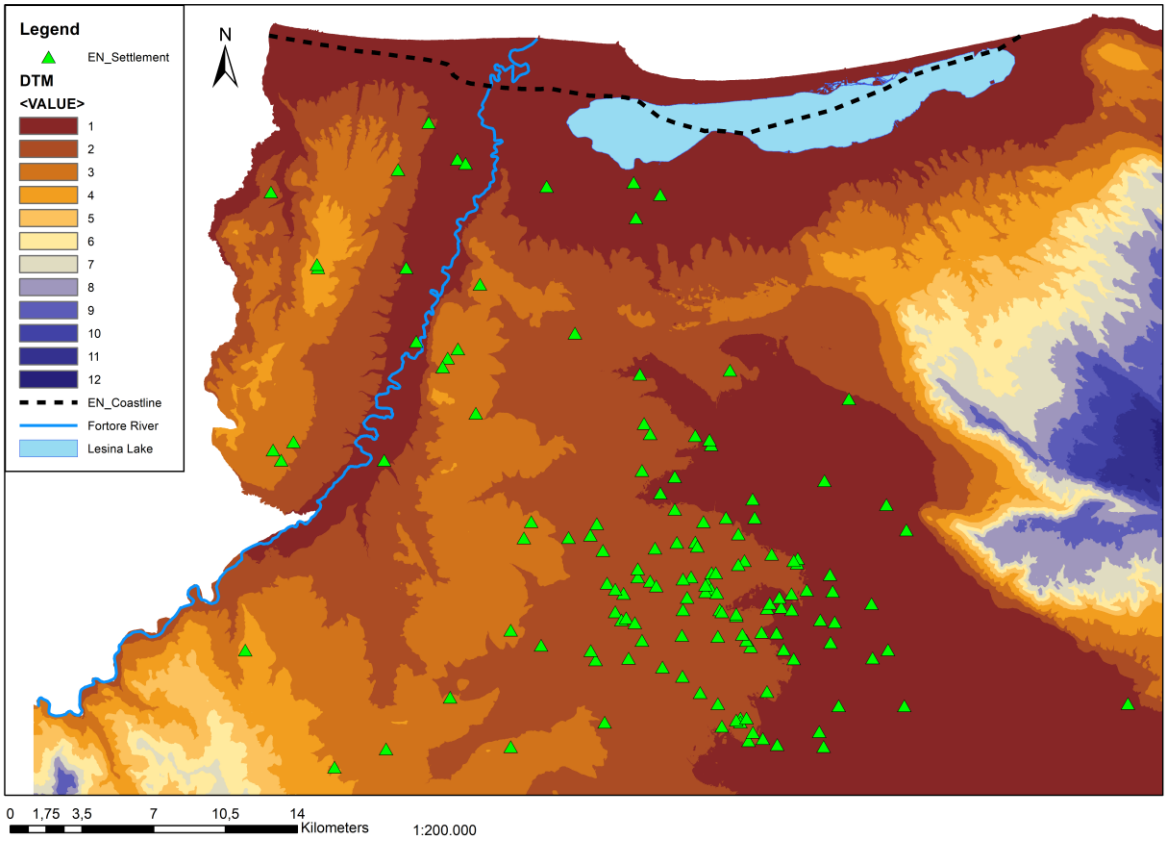


Table 4 – Distribution Settlement Detail Map

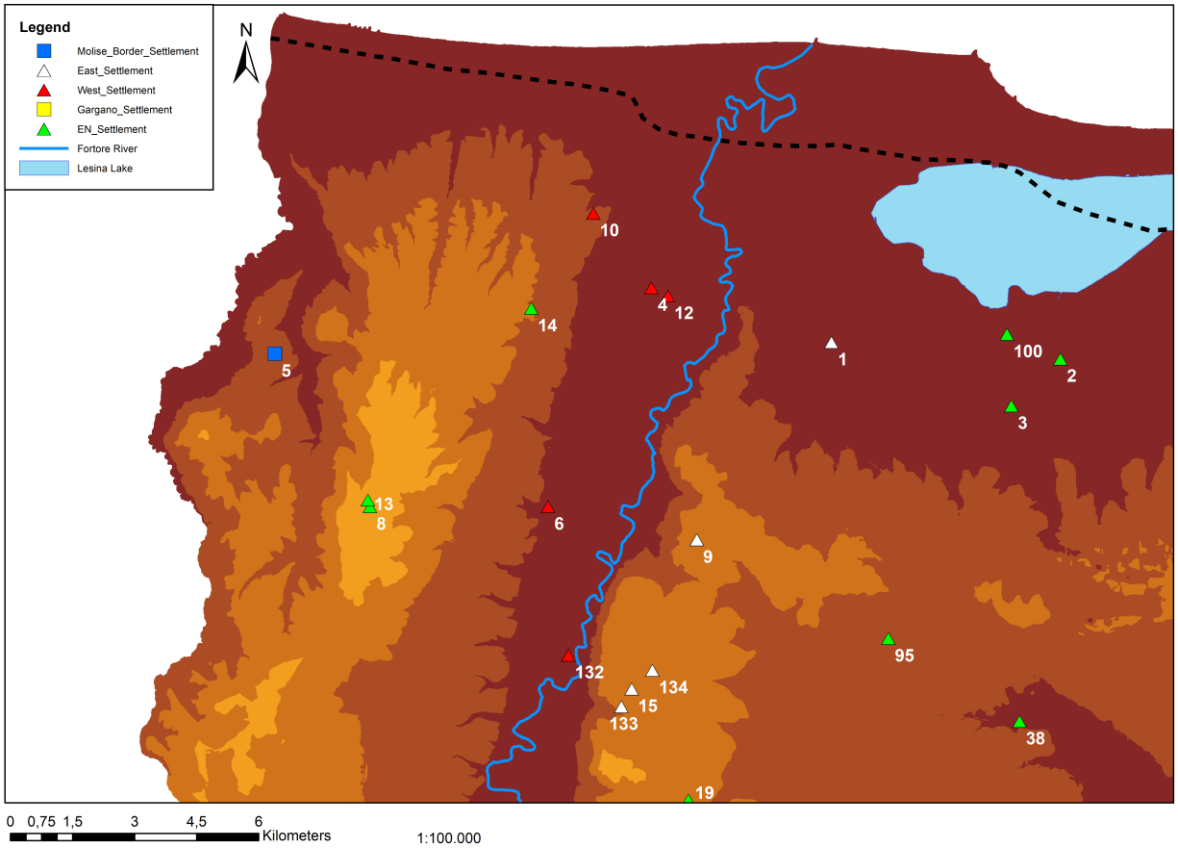


Table 5 – Distribution Settlement Detail Map

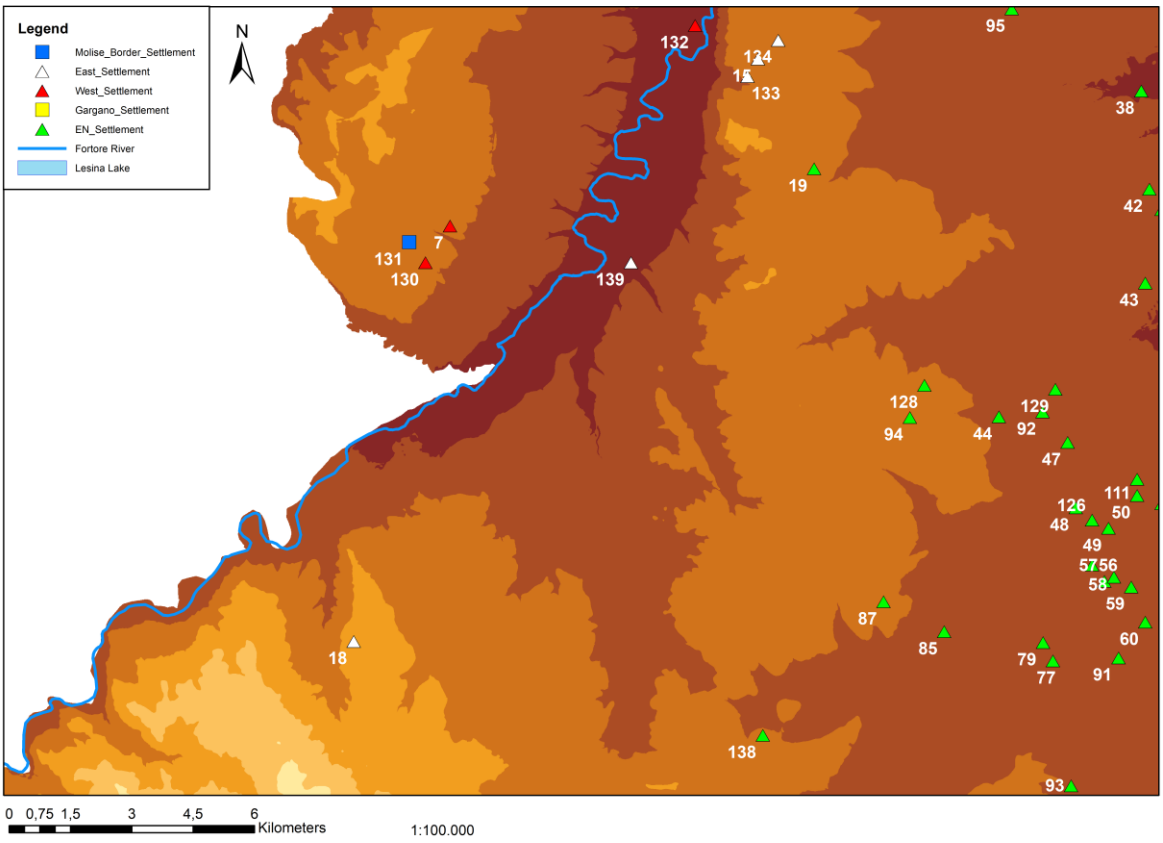


Table 6 – Distribution Settlement Detail Map

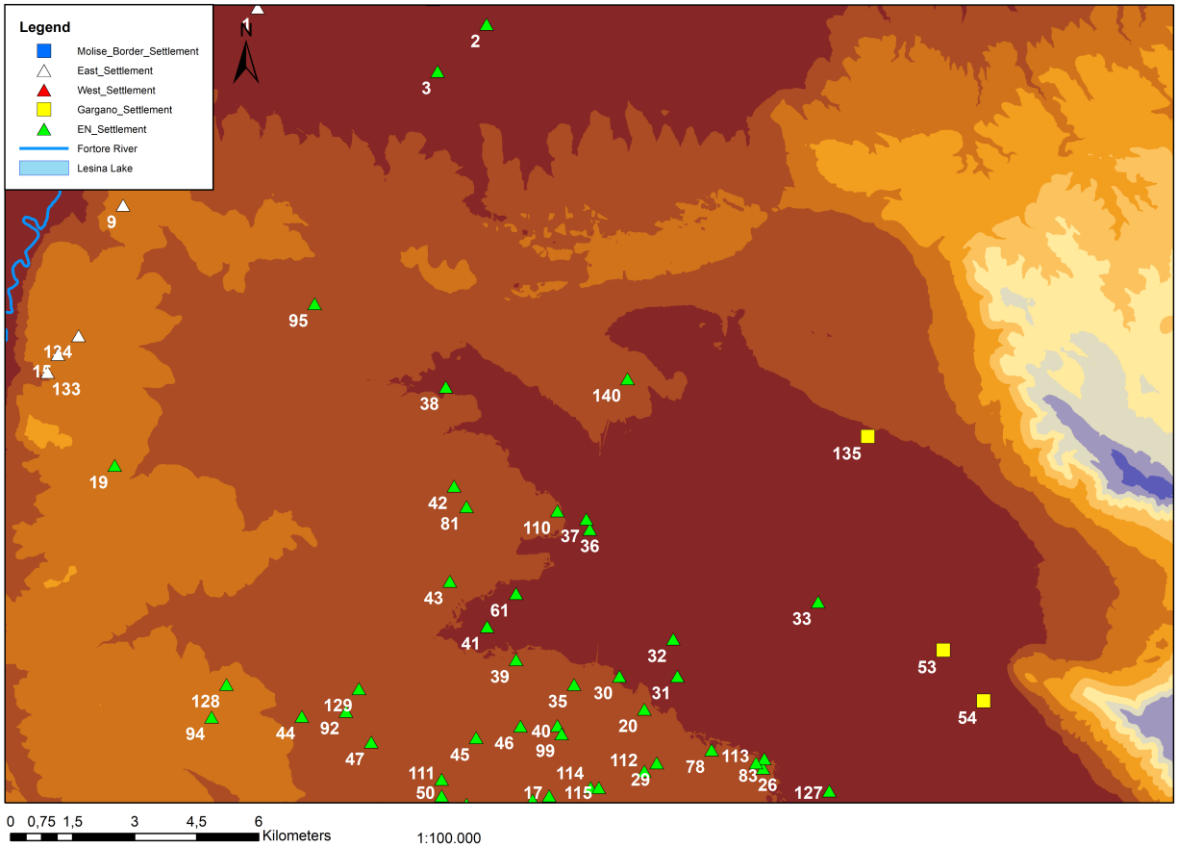


Table 7 – Distribution Settlement Detail Map

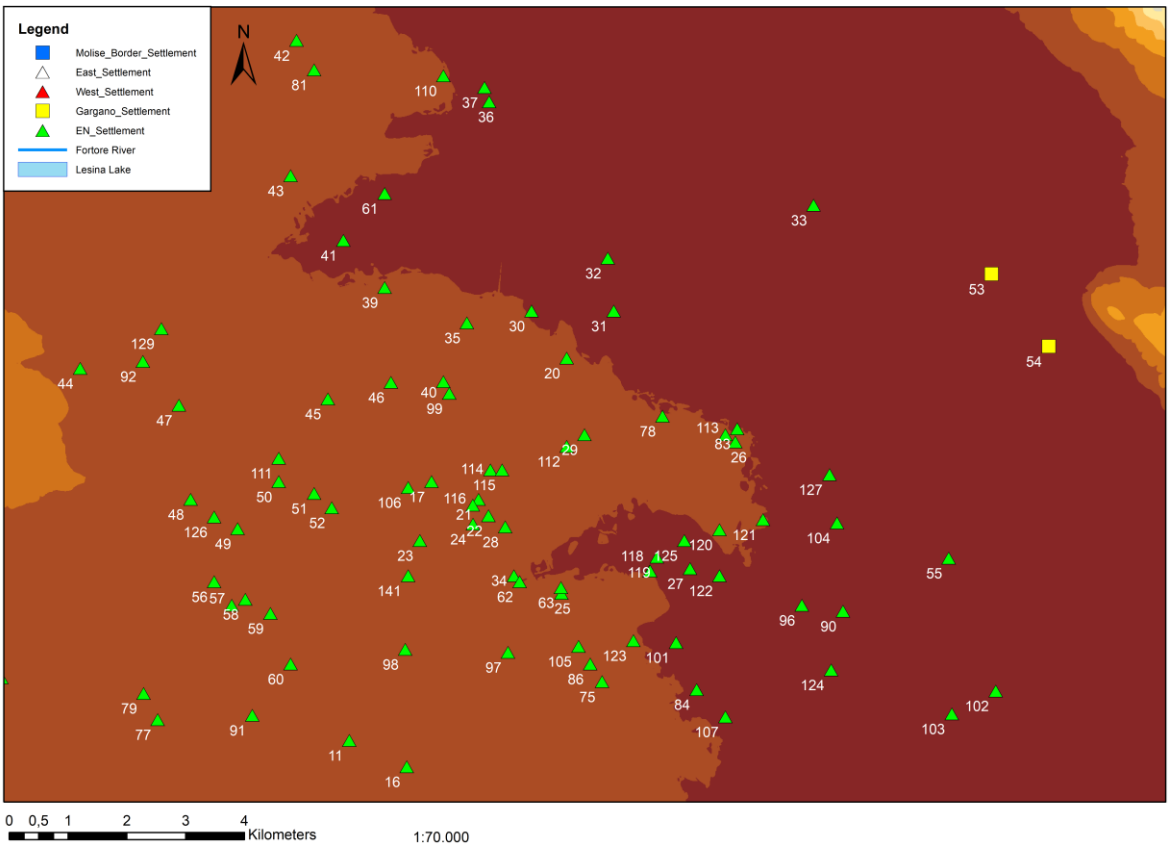


Table 8 – Distribution Settlement Detail Map

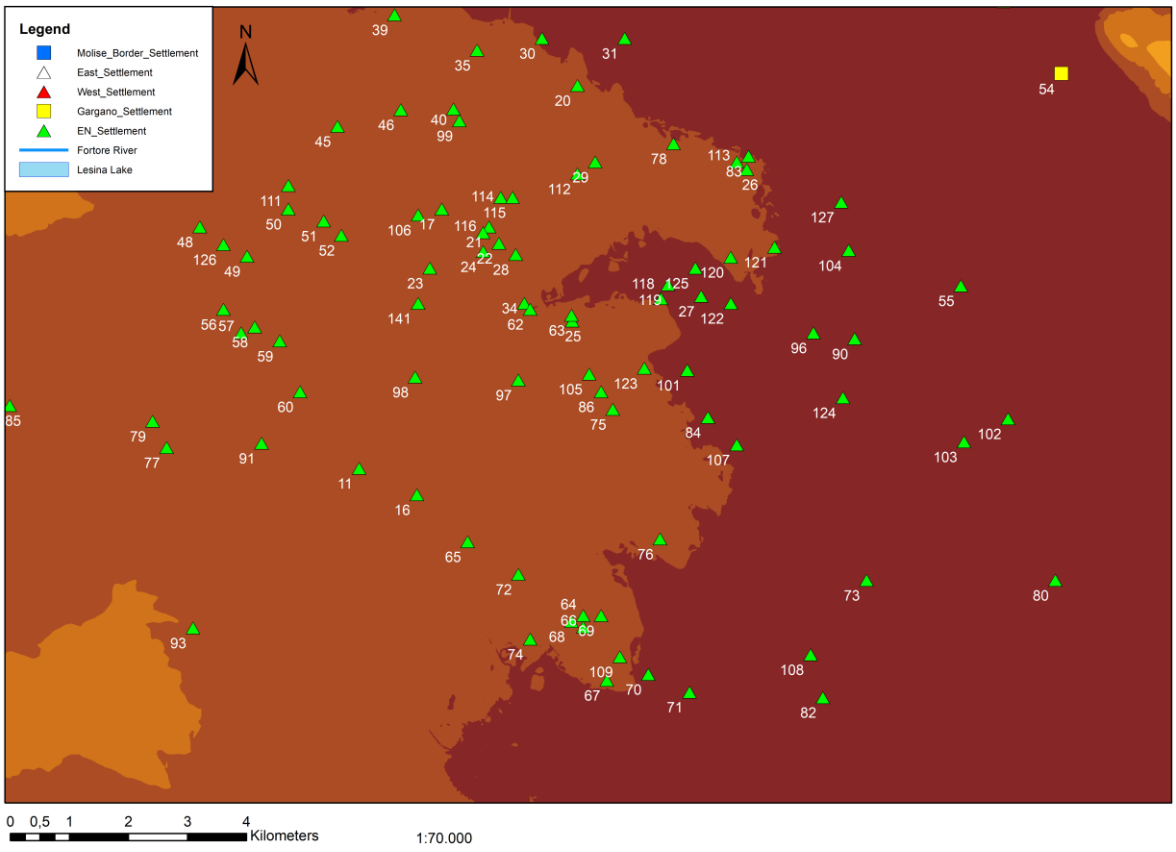


Table 9 – Distribution Settlement Detail Map

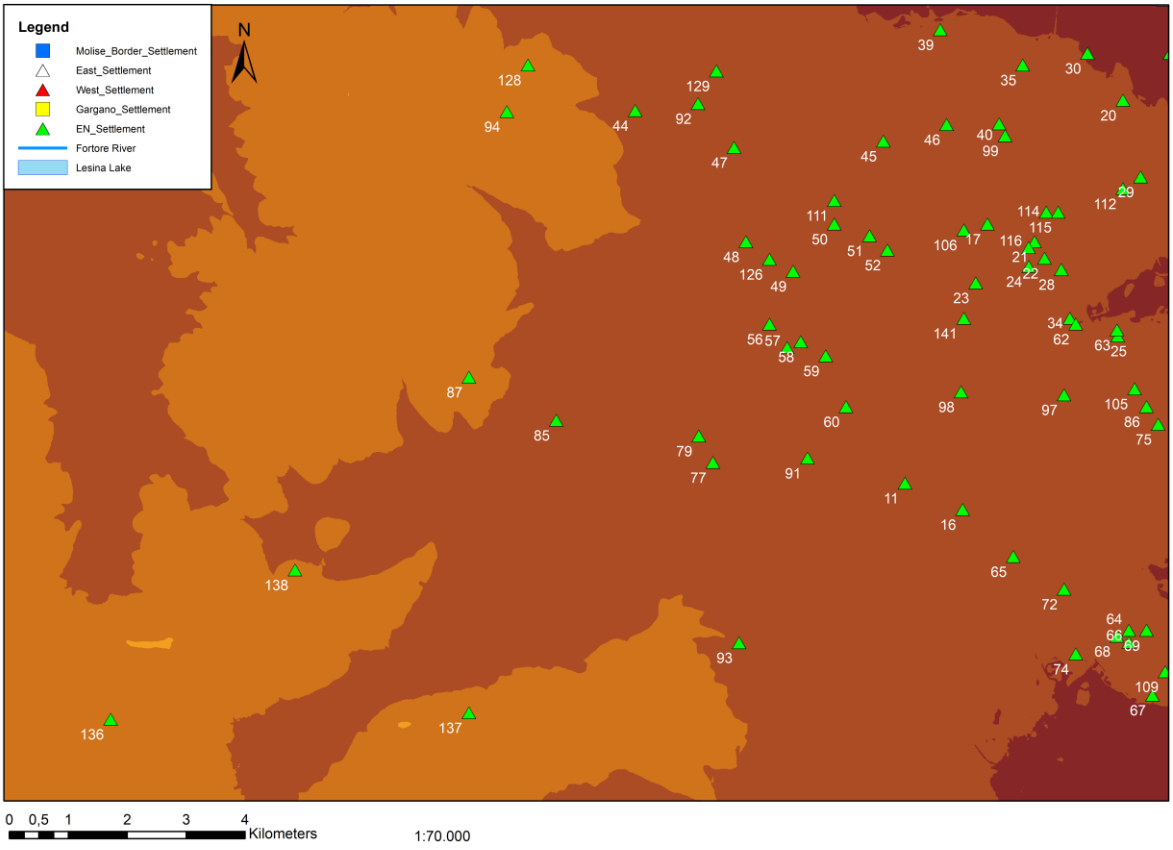


Table 10 – Settlements List

Id	Name	Typology	Elevation mt a.s.l.
1	Masseria Anita-Canimpiso	Settlement	28
2	Coppa Faccio Olivo	Settlement	11
3	Località Colonella	Settlement	23
4	Vastaioli	Settlement	25
5	Masseria Bivento	Settlement	104
6	Masseria dell'Ischia	Settlement	34
7	Masseria Settimo di Grotte	Settlement	133
8	Macello di Serracapriola	Settlement	258
9	Coppe di Rose	Settlement	158,
10	Località Sant'Agata	Settlement	71
11	Coppa Pocci	Settlement	69
12	Cesine Inferiore	Settlement	12
13	Pressi Mattatoio-Covento Cappuccini	Settlement	257
14	Casino San Matteo	Settlement	123
15	Piani di Lauria I	Settlement	163
16	Masseria Santa Giusta	Settlement	83
17	Località Guadone	Settlement	82
18	Colle d'Armi	Settlement	256
19	Coppa dell'Olmo	Settlement	143
20	Località Serpente	Settlement	64
21	Liceo Classico San Severo	Settlement	74
22	Macello di San Severo	Settlement	69
23	Località Stazzano	Settlement	72
24	Località San Biagio	Settlement	69
25	Località Venolo	Settlement	65
26	Località San Ricciardo-Demanio	Settlement	61
27	Masseria Stellatella del Casone	Settlement	54
28	Località Macello-Pescatore	Settlement	65
29	Località Sant'Elia-Orsello	Settlement	70
30	Masseria Tabanaro	Settlement	57
31	Masseria Torre dei Giunchi	Settlement	48
32	Tenimento Torre dei Giunchi	Settlement	43
33	Località Irene	Settlement	30
34	Località Schiavetta-Venolo	Settlement	61
35	Località Zuccaro	Settlement	73
36	Masseria D'Alfonso	Settlement	54
37	Masseria Ricciardelli	Settlement	54
38	Masseria Filiasi	Settlement	55
39	Masseria Cicero Bianco	Settlement	62
40	Masseria D'Alfonso-Cappuccini	Settlement	86
41	Località Boschetto	Settlement	54
42	Località Franceschiello	Settlement	79

43	Località Coppa d'Oro	Settlement	66
44	Località Reinella	Settlement	106
45	Località Mascia-Contatore	Settlement	94
46	Località Carobba	Settlement	89
47	Masseria Pagliari	Settlement	91
48	Località Cisterna-Monsignore	Settlement	102
49	Località Monsignore	Settlement	101
50	Pozzo delle Capre	Settlement	94
51	Località Mezzana della Terra	Settlement	95
52	Mezzana della Terra-San Rocco	Settlement	92
53	Mezzanella di Brancia	Settlement	30
54	Località Piro di Brancia	Settlement	25
55	Masseria Piro	Settlement	36
56	Coppa Pallante-Monsignore	Settlement	103
57	Coppa Pallante	Settlement	93
58	Vigna Boccola	Settlement	98
59	Masseria Pallante	Settlement	91
60	Masseria Parisi	Settlement	85
61	Santa Giusta	Settlement	53
62	Casa Mascia	Settlement	59
63	Località Mascia-Venolo	Settlement	63
64	Masseria Casalorda	Settlement	74
65	Masseri Istituto di Sangro	Settlement	80
66	Casalorda-Motta del Lupo	Settlement	74
67	Motta del Lupo-Podere San Severo	Settlement	64
68	Podere Santa Rosa	Settlement	71
69	q.68 Est Podere S. Arcangelo	Settlement	71
70	Località Motta del Lupo	Settlement	55
71	Masseria Motta del Lupo	Settlement	52
72	Masseria Solimanti	Settlement	74
73	Comprensorio Masseria Torretta	Settlement	44
74	Masseria Pezza Nera	Settlement	59
75	Torretta Sant'Andrea	Settlement	70
76	Masseria Ratino	Settlement	66
77	Masseria Florio	Settlement	82
78	Masseria Del Sordo	Settlement	60
79	Località Florio-Ricci	Settlement	83
80	Predicatella-La Camera	Settlement	41
81	Località Sant'Antonio-Franceschiello	Settlement	79
82	Masseria Perastri	Settlement	49
83	Deamnio San Ricciardo	Settlement	59
84	Località Vignali	Settlement	54
85	Oliveto Masselli	Settlement	106
86	Li Gatti	Settlement	69
87	Masseria Matarese	Settlement	134
88	Pian Devoto	Settlement	189
89	Ciccalento	Settlement	18
90	Portata Casone	Settlement	43

91	Masseria Padula	Settlement	72
92	Contrada Tatozzo	Settlement	94
93	Masseria Coppa Castello	Settlement	120
94	Masseria Mortella	Settlement	165
95	Località Pozzilli Alti	Settlement	94
96	Il Casone	Settlement	50
97	Casino Giuliani	Settlement	74
98	Madonna dell'Oliveto	Settlement	68
99	Villette d'Aries	Settlement	86
100	Tratturo dei Greci	Settlement	7
101	Masseria Cupola I	Settlement	50
102	Masseria Miniscetti I	Settlement	35
103	Masseria Miniscetti II	Settlement	38
104	Masseria Scoppa	Settlement	48
105	Sant'Andrea	Settlement	70
106	San Rocco	Settlement	86
107	Casale Imperati	Settlement	49
108	Km 656 (SS Adriatica FG-SSevero)	Settlement	48
109	Contrada Motta del Lupo	Settlement	64
110	Sant'Antonino da Piede	Settlement	59
111	Contrada Quadroni San Giovanni	Settlement	101
112	Località Orsello	Settlement	74
113	Demanio II	Settlement	62
114	Contrada Spirito Santo	Settlement	77
115	Coppa d'Ovidio	Settlement	74
116	Coppa Porci	Settlement	73
117	Masseria Stellatella I	Settlement	60
118	Masseria Stellatella II	Settlement	60
119	Masseria Stellatella III	Settlement	52
120	Masseria Masselli I	Settlement	61
121	Masseria Masselli II	Settlement	59
122	Stellatella	Settlement	52
123	Masseria Cupola II	Settlement	61
124	Il Torrione (Casone)	Settlement	42
125	Località Stellatella	Settlement	54
126	Grotta Pallante	Settlement	104
127	Pezza della Fontana	Settlement	47
128	Casino Marinello	Settlement	144
129	Casino Iuso	Settlement	94
130	Canale Carpano I	Settlement	135
131	Canale Carpano II	Settlement	151
132	Piani Lauria Bassa	Settlement	24
133	Piani di Lauria IV	Settlement	169
134	Piani di Lauria III	Settlement	169
135	Mezzana della Quercia	Settlement	54
136	Località Carmessola	Settlement	143
137	La Castellana	Settlement	183
138	Masseria De Pasquale	Settlement	131

139	Msseria Fara Sentinella	Settlement	41
140	Località San Trifonte	Settlement	66
141	Le Fornaci	Settlement	72

Table 11 – Distribution Sporadic Finding Area Map

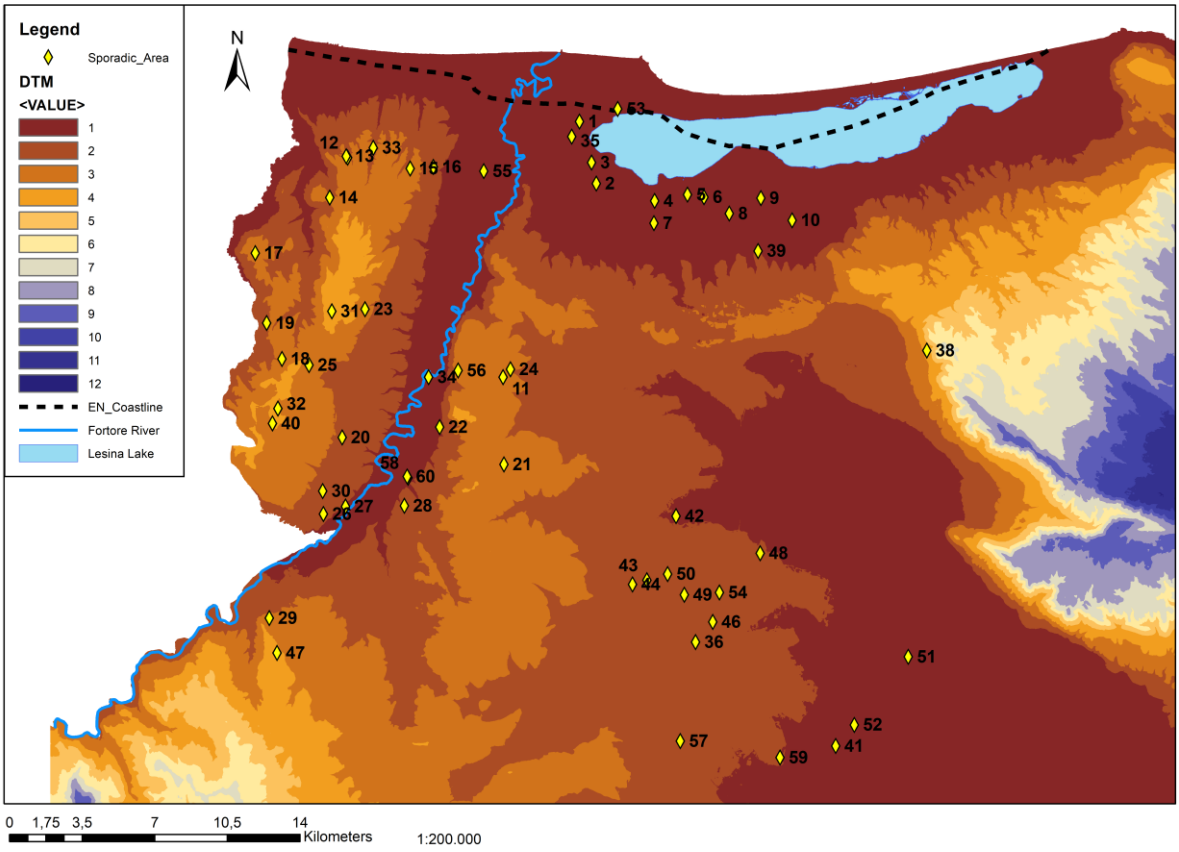


Table 12 – Sporadic Finding Area List

Id	Name	Typology	Elevation mt a.s.l.
1	Località Chiancata-Conelle	Sporadic Area	7
2	Masseria Pontone	Sporadic Area	13
3	Masseria Giovanditti	Sporadic Area	4
4	Masseria de Cesare	Sporadic Area	7
5	Cammarata	Sporadic Area	7
6	Contrada Chirò	Sporadic Area	7
7	Contrada del Medico	Sporadic Area	15
8	Tra Masseria Nisi e Rivolo Frà Matteo	Sporadic Area	13
9	Tra Masseria Campiglia e Contrada Caniglia	Sporadic Area	10
10	Sgrascina Amorusi	Sporadic Area	19
11	Masseria Difensola	Sporadic Area	140
12	Viarelle	Sporadic Area	135
13	Casa Capanna	Sporadic Area	130
14	Masseria Palmieri	Sporadic Area	123
15	Località Terra Vecchia	Sporadic Area	127
16	Cesine Superiore	Sporadic Area	79
17	Località Montesecco	Sporadic Area	193
18	Ferrantoni	Sporadic Area	162
19	Monte Stincione-Località Tre Ponti	Sporadic Area	135
20	Tronco Sud	Sporadic Area	112
21	Pozzo Basso	Sporadic Area	187
22	Inverse Tristi	Sporadic Area	53
23	La Difesa	Sporadic Area	151
24	Marana della Difensola	Sporadic Area	128
25	Località Fontana Salotto	Sporadic Area	154
26	Località Masseria Grottavecchia	Sporadic Area	89
27	Località C. di Caccia	Sporadic Area	50
28	Masseria Mezzana delle Ferole	Sporadic Area	70
29	Masseria Dragonarella	Sporadic Area	175
30	Selva delle Grotte (Canale Carpano)	Sporadic Area	102
31	Km 5.5 Strada Prov. Serracapriola-Torremaggiore	Sporadic Area	265
32	Località Tre Pozzi	Sporadic Area	192
33	Terra Vecchia	Sporadic Area	96
34	Località Portata	Sporadic Area	25
35	Località Le Cannelle	Sporadic Area	9
36	Casino Mortore	Sporadic Area	77
38	Grotta Manganaturo	Sporadic Area	225
39	Località Santo Spirito	Sporadic Area	57
40	Colle della Pila	Sporadic Area	200
41	Località Torretta	Sporadic Area	49

42	Boschetto	Sporadic Area	55
43	Quadroni di San Giovanni-Cisterna	Sporadic Area	93
44	Località De Vito	Sporadic Area	90
46	Località Cuculicchio	Sporadic Area	70
47	Masseria Sculgola	Sporadic Area	206
48	Serpente-Santa Monica	Sporadic Area	64
49	Località Mezzana della Terra Sud	Sporadic Area	96
50	Località Lo Stinco	Sporadic Area	98
51	Masseria Villa Diacetto	Sporadic Area	36
52	Masseria Zannotti	Sporadic Area	45
53	Zurrone	Sporadic Area	3
54	Contrada Santo Spirito	Sporadic Area	79
55	Vastaioli	Sporadic Area	18
56	Piani di Lauria II	Sporadic Area	180
57	Località Ponte di Santa Maria	Sporadic Area	64
58	Masseria Ciaccia (Località Mezzana delle Ferole)	Sporadic Area	41
59	Podere Sant'Anna I	Sporadic Area	62
60	Località Mezzana delle Ferole	Sporadic Area	41

MIDDLE NEOLITHIC

Table 13 – Distribution Settlement Map

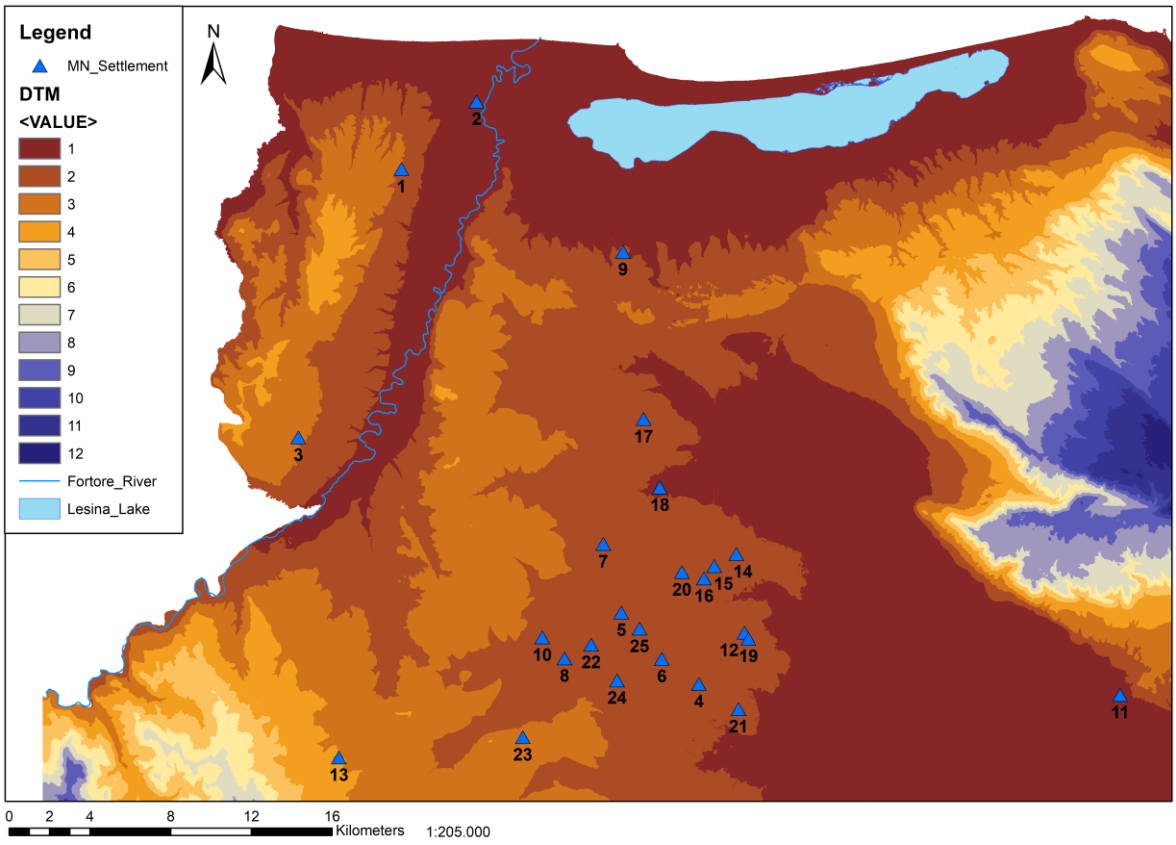


Table 14 – Settlement List

Id	Name	Typology	Elevation mt a.s.l.
1	Casino San Matteo-Chiantinelle	Settlement	123
2	Chiarappa	Settlement	10
3	Masseria Settimo di Grotte	Settlement	133
4	Masseria Istituto di Sagro	Settlement	80
5	Coppa Pallante	Settlement	93
6	Coppa Pocci	Settlement	69
7	Masseria Pagliari	Settlement	91
8	Masseria Li Gatti	Settlement	83
9	La Torretta	Settlement	69
10	Oliveto Masselli	Settlement	106
11	Ciccalento	Settlement	18
12	Li Gatti	Settlement	69
13	Pian Devoto	Settlement	189
14	Località Orsello	Settlement	73
15	Coppa d'Ovidio	Settlement	74
16	Coppa Porci	Settlement	73
17	Località Franceschiello	Settlement	79
18	Località Boschetto	Settlement	54
19	Torretta Sant'Andrea	Settlement	70
20	San Rocco	Settlement	86
21	Masseria Casalorda	Settlement	74
22	Località Florio-Ricci	Settlement	83
23	Castellana	Settlement	177
24	Località S. Maria	Settlement	74
25	Masseria Parisi	Settlement	84

Table 15 – Distribution Sporadic Finding Area Map

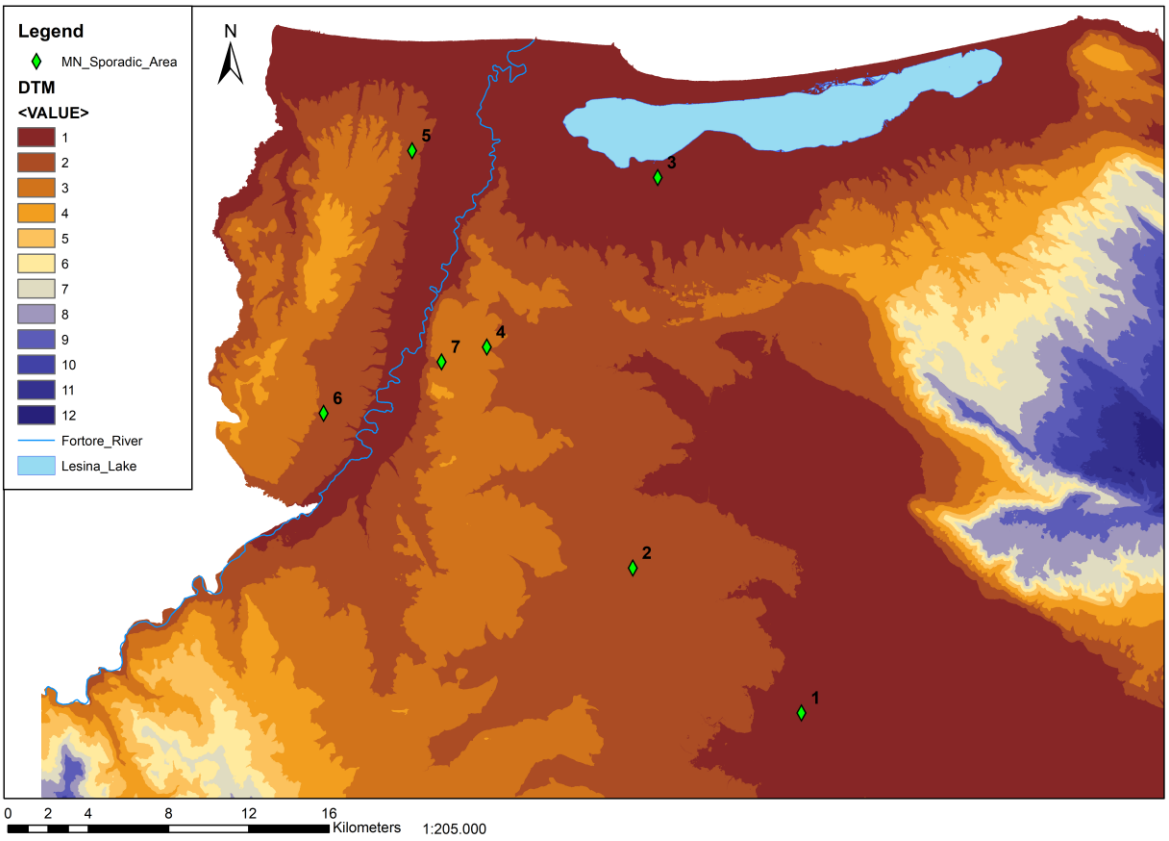


Table 16 –Sporadic Finding Area List

Id	Name	Typology	Elevation mt a.s.l.
1	Località Torretta	Sporadic Area	49
2	Pozzo delle Capre	Sporadic Area	94
3	Località Cammarata	Sporadic Area	7
4	Marana della Difensola	Sporadic Area	128
5	Cesine Superiore	Sporadic Area	79
6	Tronco Sud	Sporadic Area	113
7	Piani di Lauria	Sporadic Area	169

Table 17 – Distribution Necropolis Map

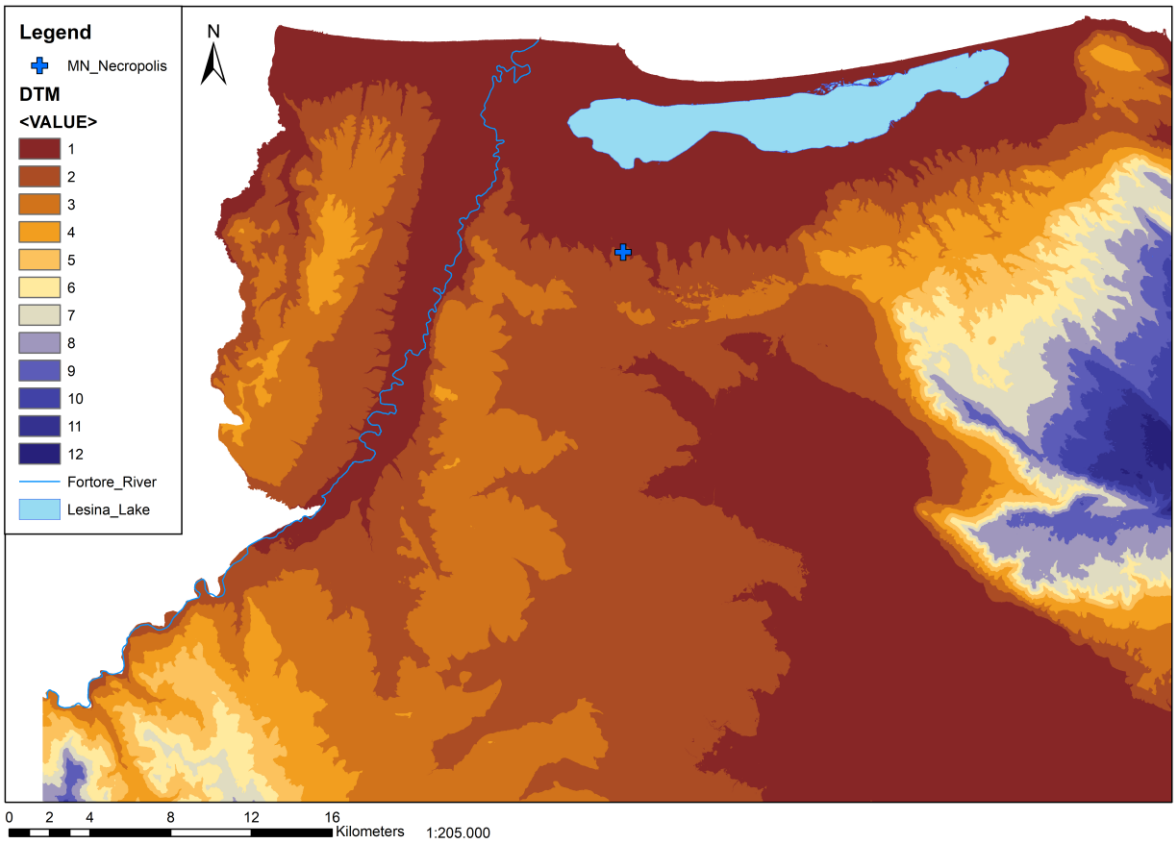


Table 18 – Necropolis List

Id	Name	Typology	Elevation mt a.s.l.
1	La Torretta	Necropolis	69

FINAL NEOLITHIC

Table 19 – Distribution Settlement Map

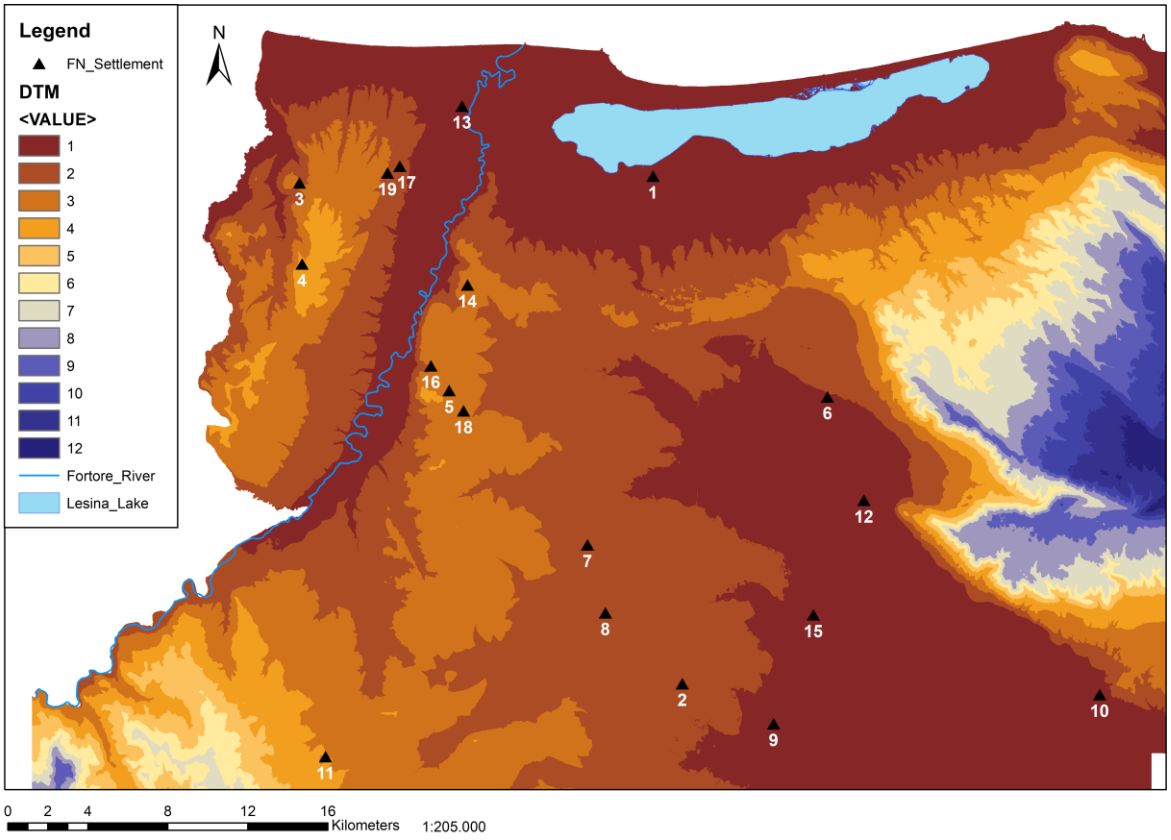


Table 20 – Settlement List

Id	Name	Typology	Elevation mt a.s.l.
1	Cammarata	Settlement	6
2	Masseria Istituto di Sagro	Settlement	80
3	Malchieuti	Settlement	114
4	Località Piano Navuccio	Settlement	229
5	Piani di Lauria	Settlement	174
6	Mezzana della Quercia	Settlement	54
7	Masseria Pagliari	Settlement	91
8	Coppa Pallante	Settlement	93
9	Masseria Torretta	Settlement	51
10	Ciccalento	Settlement	18
11	Pian Devoto	Settlement	189
12	Mezzanella di Brancia	Settlement	30
13	Chiarappa	Settlement	10
14	Coppe di Rose	Settlement	158
15	Portata Casone	Settlement	43
16	Piani di Lauria	Settlement	169
17	Colle di Creta	Settlement	93
18	Coppa dell'Olmo	Settlement	143
19	San Matteo-Chiantinelle	Settlement	123

Table 21 – Distribution Sporadic Finding Area Map

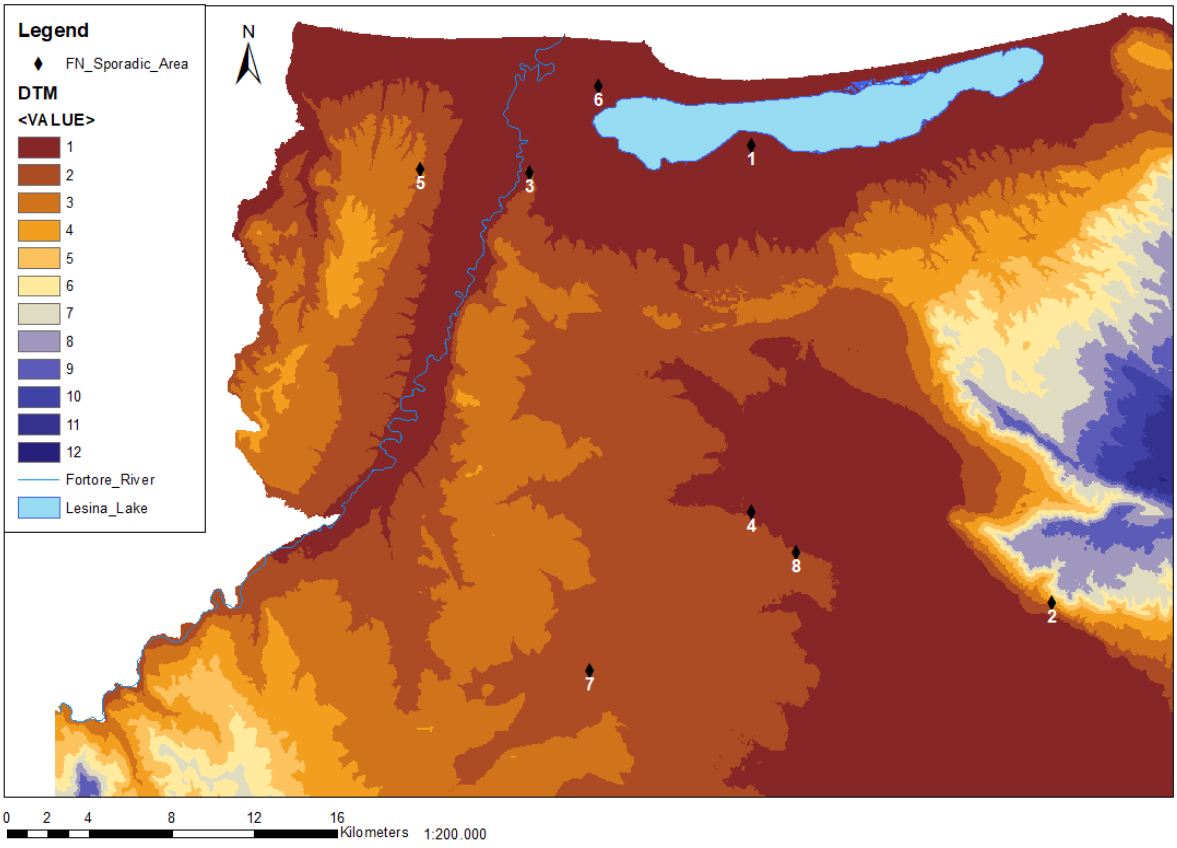


Table 22 – Sporadic Finding Area List

Id	Name	Typology	Elevation mt a.s.l.
1	Palude Grande	Sporadic Area	1
2	Grotta Trappedo	Sporadic Area	197
3	Ripalta	Sporadic Area	62
4	Località Tabarano	Sporadic Area	54
5	Casino San Matteo-Chiantinelle	Sporadic Area	128
6	Conella	Sporadic Area	3
7	Masseria Li Gatti	Sporadic Area	83
8	Località San Lorenzo	Sporadic Area	58

EARLY AND MIDDLE COPPER AGE

Table 23 – Distribution Settlement Map

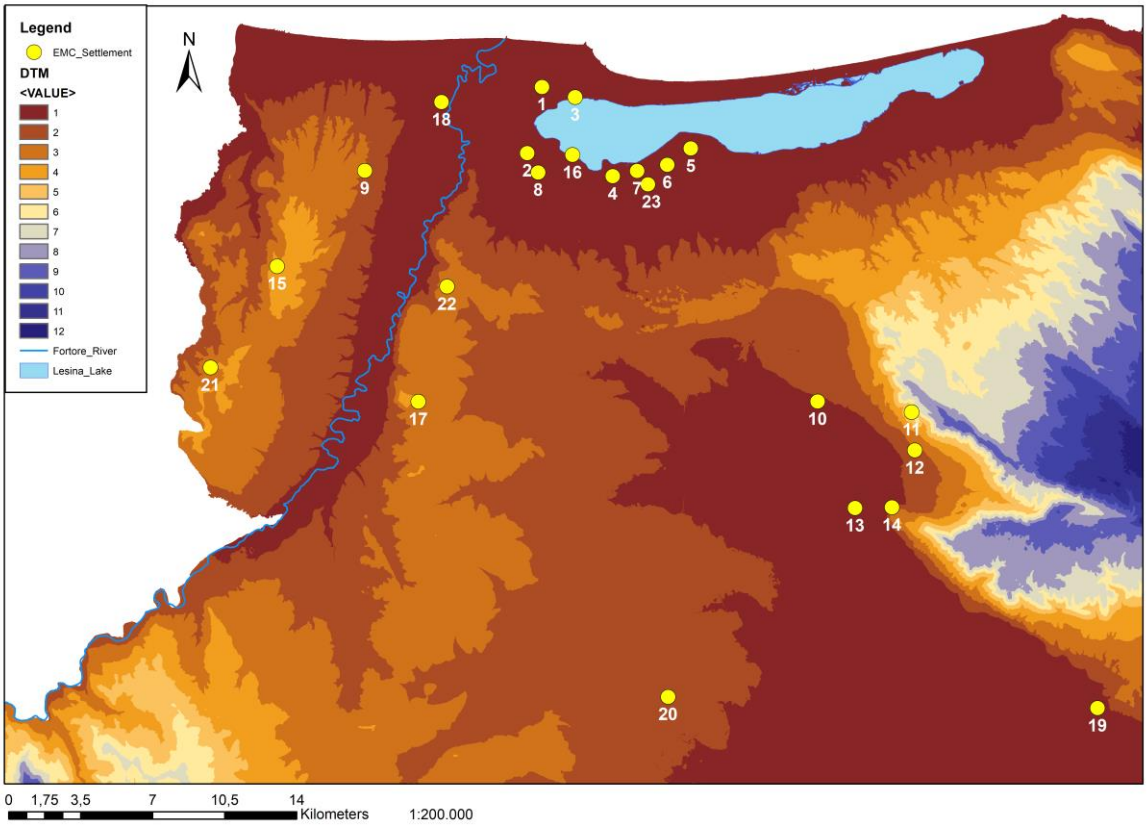


Table 24 – Settlement List

Id	Name	Typology	Elevation mt a.s.l.
1	Fischino	Settlement	3
2	Pontone	Settlement	8
3	Cannella al Muro	Settlement	2
4	Posta Corfiati (a.k.a. Colonella)	Settlement	5
5	Palude Grande	Settlement	1
6	Palude Caroppi	Settlement	2
7	Cammarata	Settlement	4
8	Palude San Lorenzo	Settlement	14
9	Chiantinelle	Settlement	123
10	Mezzana della Quercia	Settlement	54
11	Castelpagano	Settlement	525
12	Località Castate	Settlement	102
13	Mezanella di Brancia	Settlement	30
14	Brancia Km10 - Volta Pianezza	Settlement	55
15	Località Piano Navuccio	Settlement	234
16	Salsolido	Settlement	2
17	Piani di Lauria	Settlement	200
18	Chiarappa	Settlement	10
19	Ciccalento	Settlement	18
20	Masseria Istituto di Sangro	Settlement	80
21	Colle Arsano	Settlement	201
22	Coppe di Rose	Settlement	158
23	Contrada Chirò	Settlement	8

Table 25 – Distribution Sporadic Finding Area Map

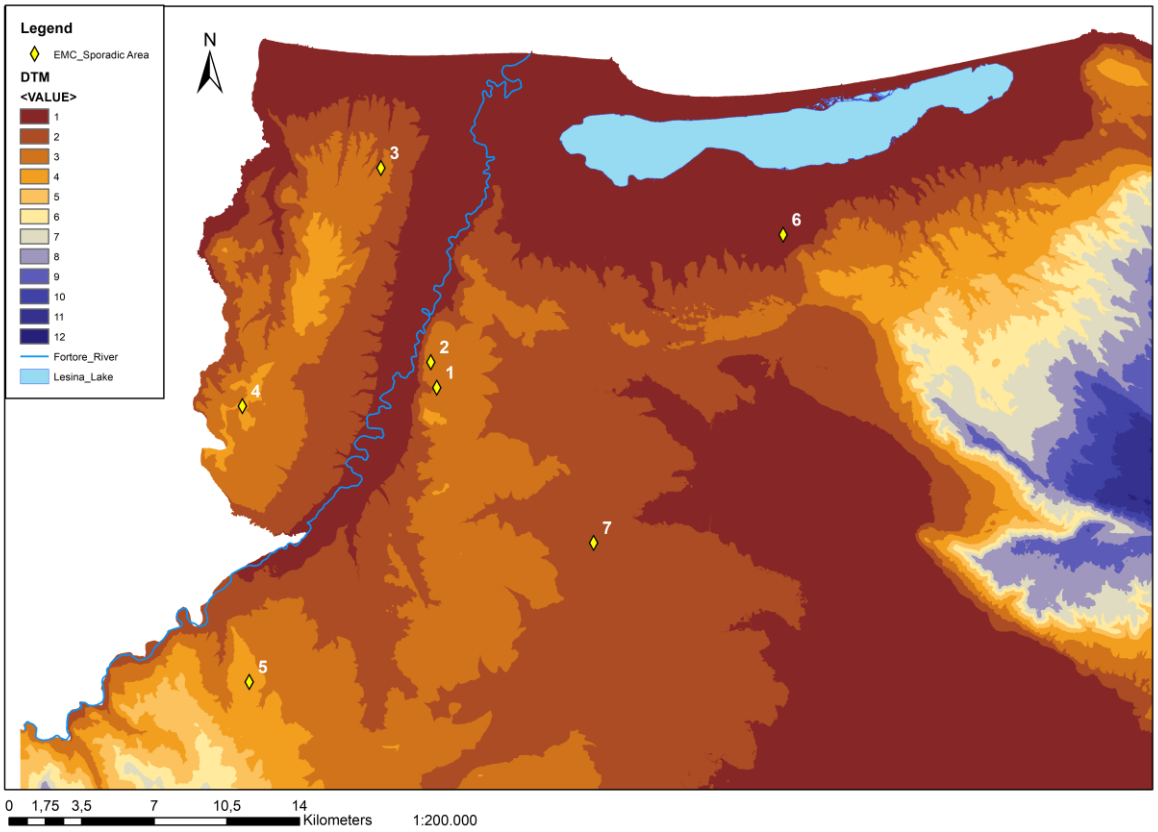


Table 26 – Sporadic Finding Area List

Id	Name	Typology	Elevation mt a.s.l.
1	Piani di Lauria I	Sporadic Area	169
2	Piani di Lauria III	Sporadic Area	178
3	Località Terra Vecchia	Sporadic Area	129
4	Tuppo della Guardiola	Sporadic Area	199
5	Convento Sculgola	Sporadic Area	237
6	Colle Tauro (Località Sgrascina)	Sporadic Area	25
7	Contrada Reinella	Sporadic Area	87

FINAL COPPER AGE

Table 27 – Distribution Settlement Map

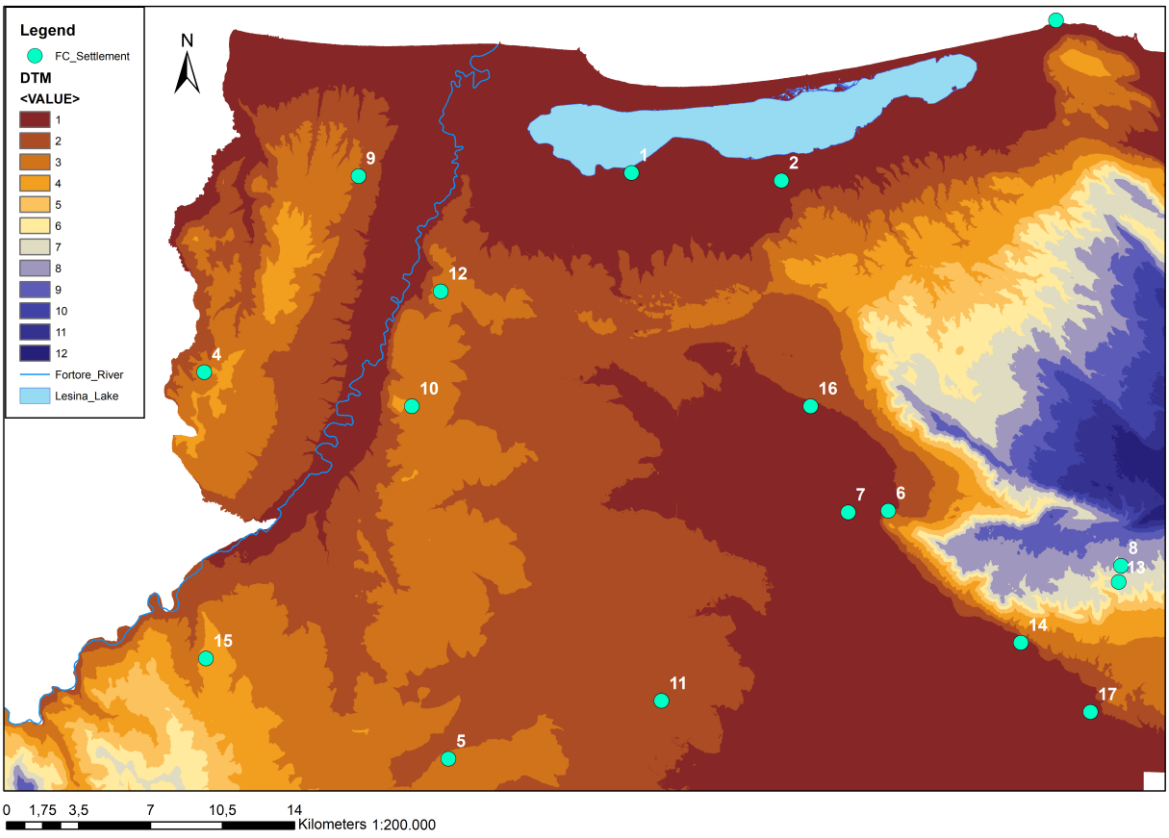


Table 28 – Settlement List

Id	Name	Typology	Elevation mt a.s.l.
1	Cammarata	Settlement	3
2	Mulino di Caldoli	Settlement	5
3	Torre Mileto	Settlement	2
4	Colle Arsano	Settlement	201
5	Torre Fiorentina	Settlement	199
6	Volta Pianezza	Settlement	61
7	Mezzanella di Brancia	Settlement	30
8	Casale Crisetti	Settlement	588
9	Colle di Creta-San Matteo Chiantinelle	Settlement	123
10	Piani di Lauria	Settlement	200
11	Masseria Istituto di Sangro	Settlement	80
12	Coppe di Rose	Settlement	158
13	Chiancata La Civita	Settlement	561
14	Cicerale	Settlement	21
15	Colle d'Armi	Settlement	255
16	Mezzana della Quercia	Settlement	54
17	Ciccalento	Settlement	18

Table 29 – Distribution Sporadic Finding Area Map

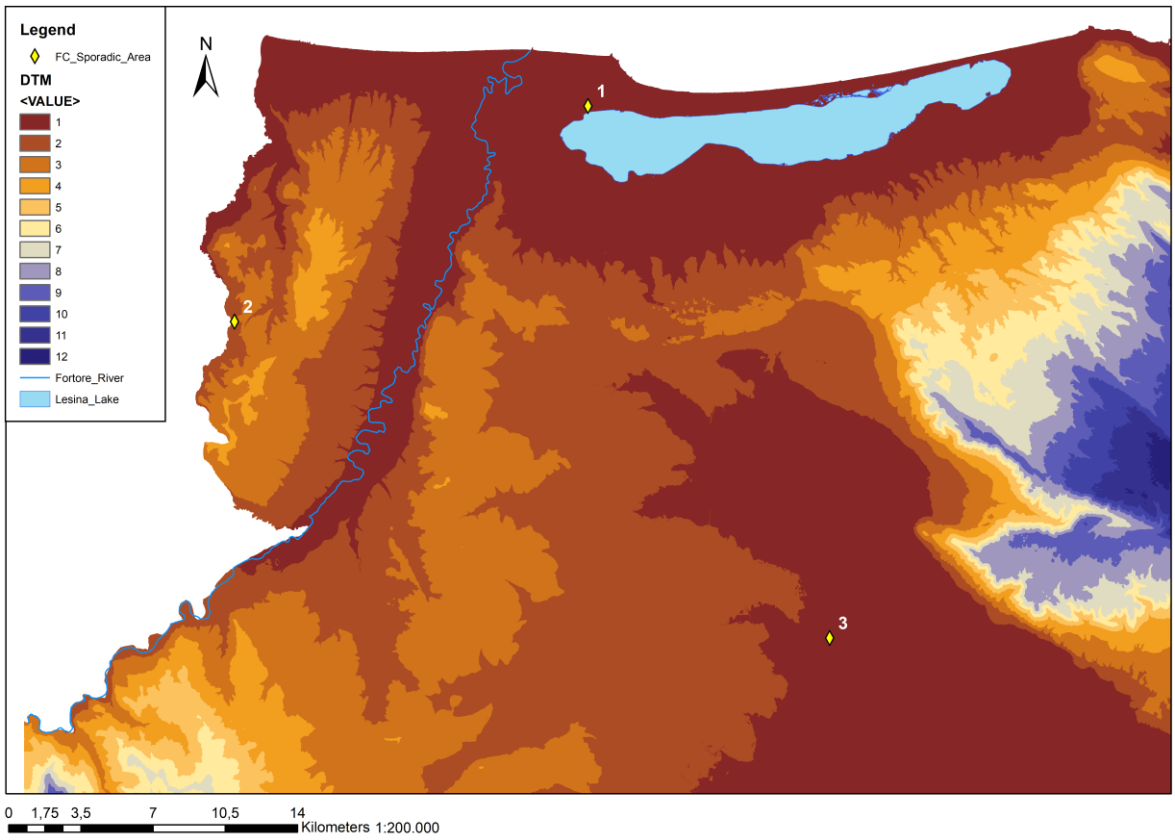


Table 30 – Sporadic Finding Area List

Id	Name	Typology	Elevation mt a.s.l.
1	Zurrone	Sporadic Area	3
2	Cantalupo-Tre Ponti	Sporadic Area	82
3	Portata Casone	Sporadic Area	43

Table 31 – Distribution Necropolis Map

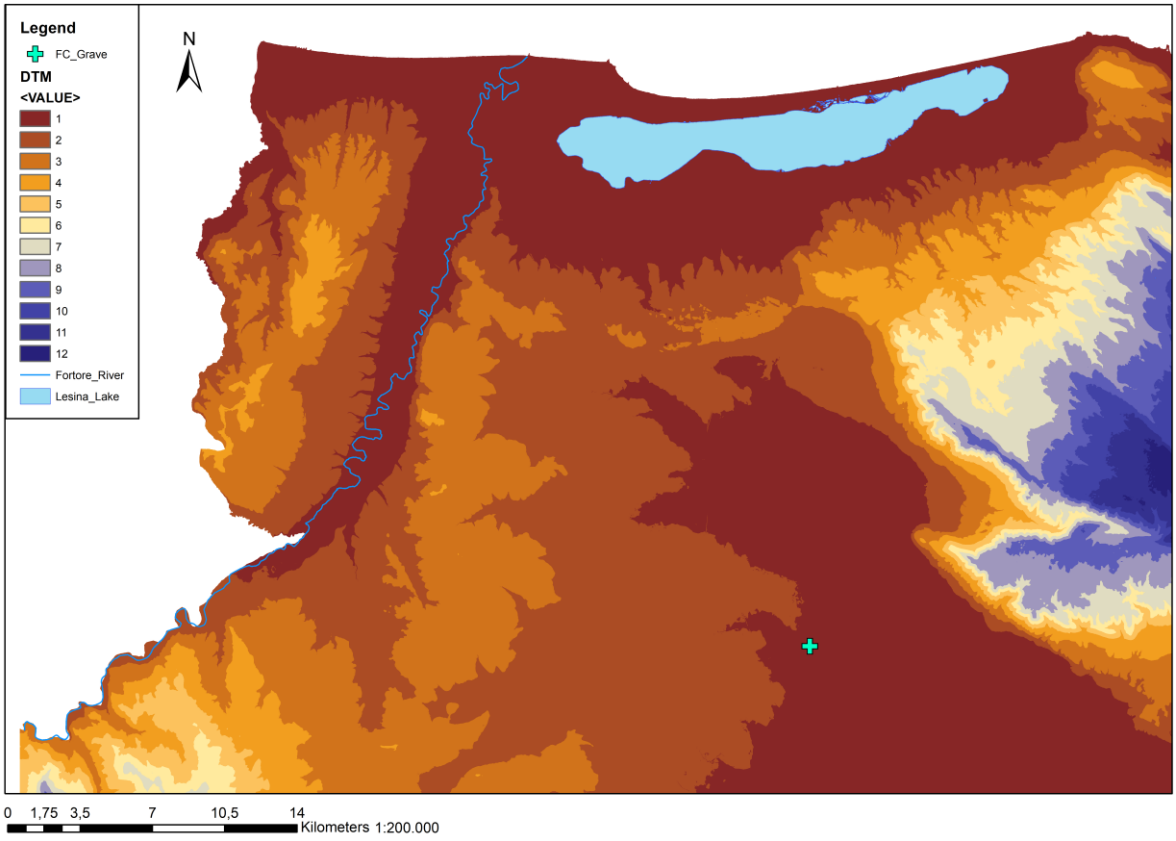


Table 32 – Necropolis List

Id	Name	Typology	Elevation mt a.s.l.
1	Il Casone	Necropolis	53

EARLY BRONZE AGE

Table 33 – Distribution Settlement Map

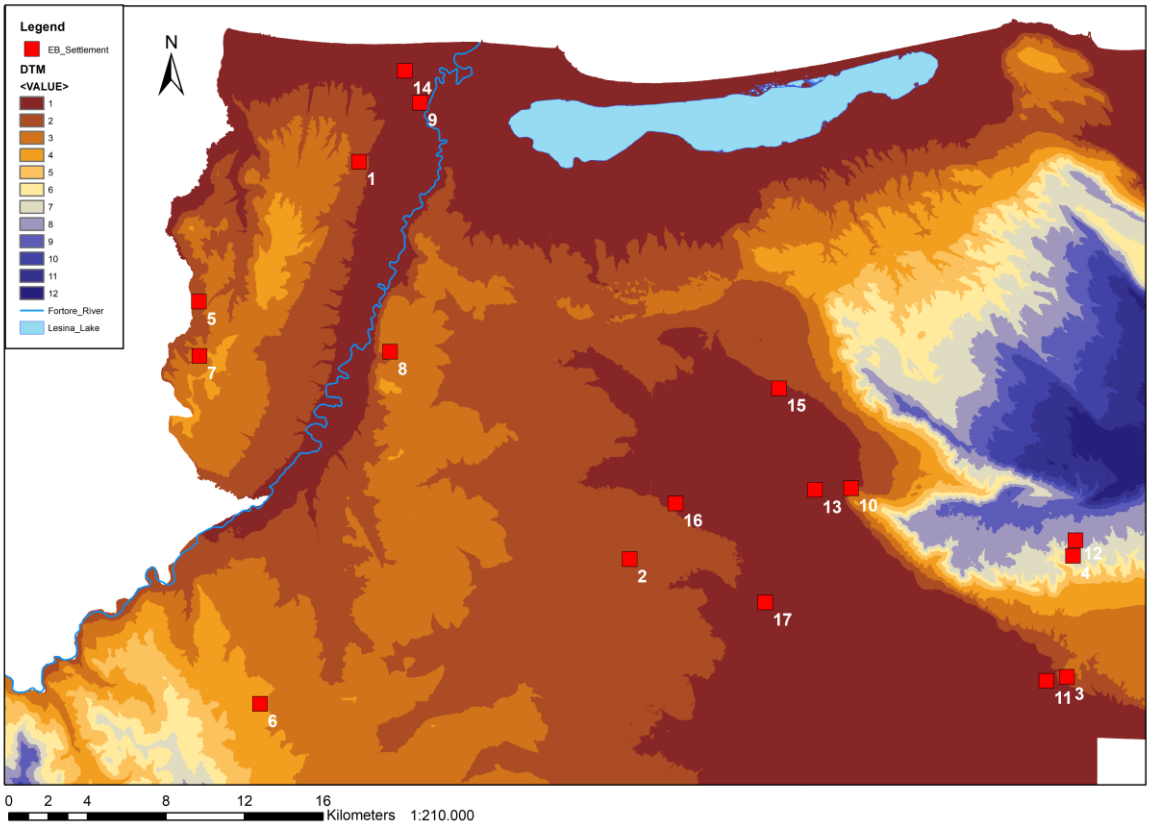


Table 34 – Settlement List

Id	Name	Typology	Elevation mt a.s.l.
1	Colle di Creta	Settlement	93
2	Località Guadone	Settlement	81
3	Monte Granata	Settlement	100
4	Chiancata La Civita	Settlement	562
5	Cantalupo-Tre Ponti	Settlement	86
6	Masseria Iacovelli	Settlement	207
7	Colle Arsano	Settlement	201
8	Piani di Lauria	Settlement	167
9	Chiarappa	Settlement	10
10	Brancia Km10-Volta Pianezza	Settlement	54
11	Ciccalento	Settlement	18
12	Casale Crisetti	Settlement	589
13	Masseria Mezzanella di Brancia	Settlement	30
14	Brecciara	Settlement	17
15	Mezzana della Quercia	Settlement	54
16	Oliveto Torre dei Giunchi	Settlement	54
17	Portata Casone	Settlement	43

Table 35 – Distribution Sporadic Finding Area Map

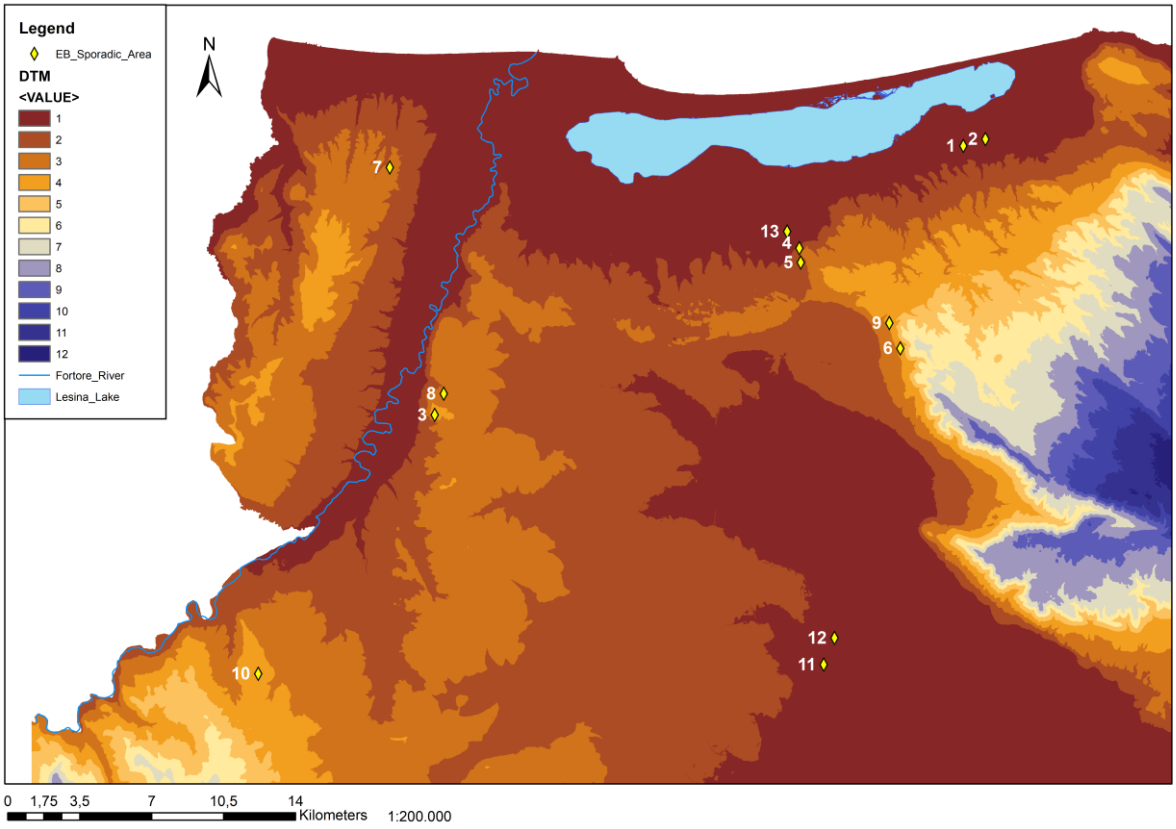


Table 36 – Sporadic Finding Area List

Id	Name	Typology	Elevation mt a.s.l.
1	Torre Lauro	Sporadic Area	7
2	Contrada Seggese	Sporadic Area	10
3	Coppa Mengoni	Sporadic Area	219
4	Campo di Pietra - Colle Castelluccia	Sporadic Area	67
5	Parco Morpina (a.k.a. Manfrina)	Sporadic Area	98
6	Grotta Manganaturo	Sporadic Area	225
7	Località Terra Vecchia	Sporadic Area	133
8	Località Chiesa di Civiate	Sporadic Area	169
9	Le Cave	Sporadic Area	220
10	Convento Sculgola	Sporadic Area	233
11	Il Torrione	Sporadic Area	45
12	Portata Casone	Sporadic Area	43
13	Colle Tauro (Località Sgrascina)	Sporadic Area	25

Table 37 – Distribution Necropolis Map

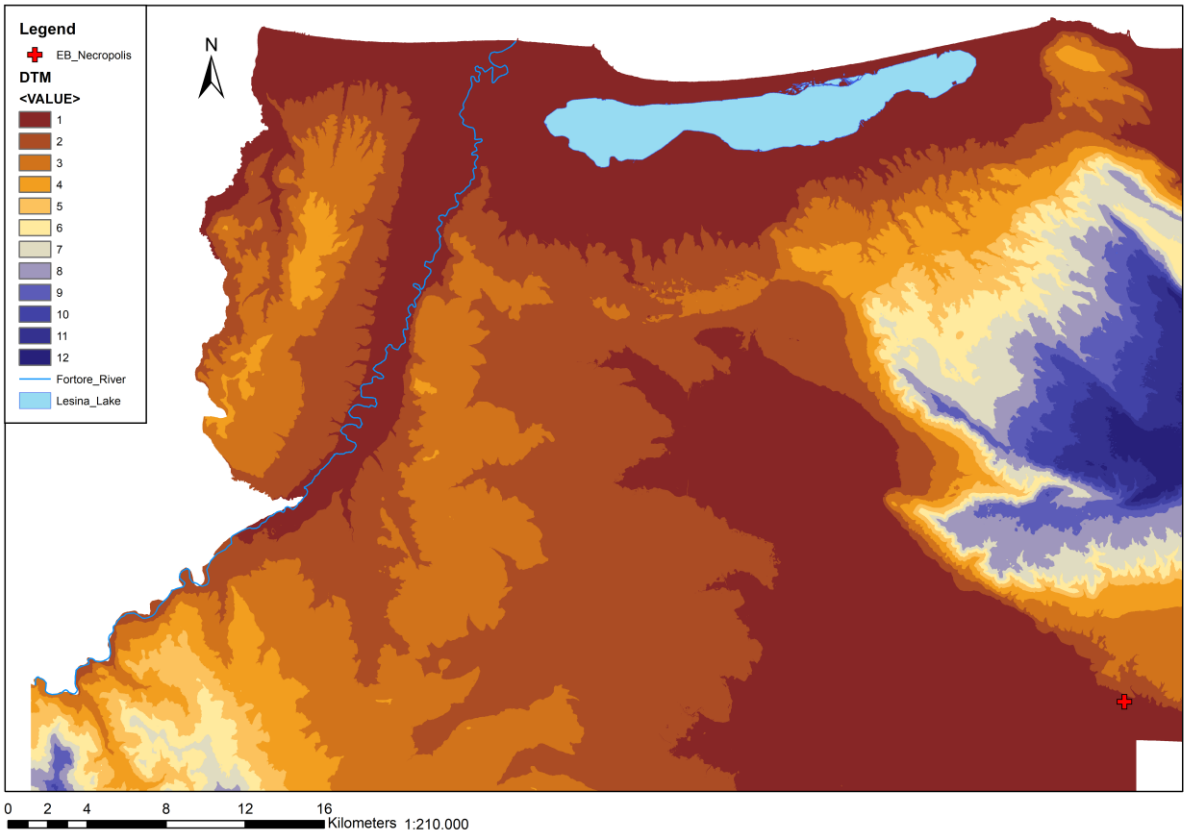


Table 38 – Necropolis List

Id	Name	Typology	Elevation mt a.s.l.
1	Tagliavia	Necropolis	15

LEAST COST PATH ANALYSIS

EARLY NEOLITHIC

FORTORE RIVER VALLEY

EASTERN SHORESIDE

Table 39 – LPCA applied to Masseria Anita-Canimpiso (id1)

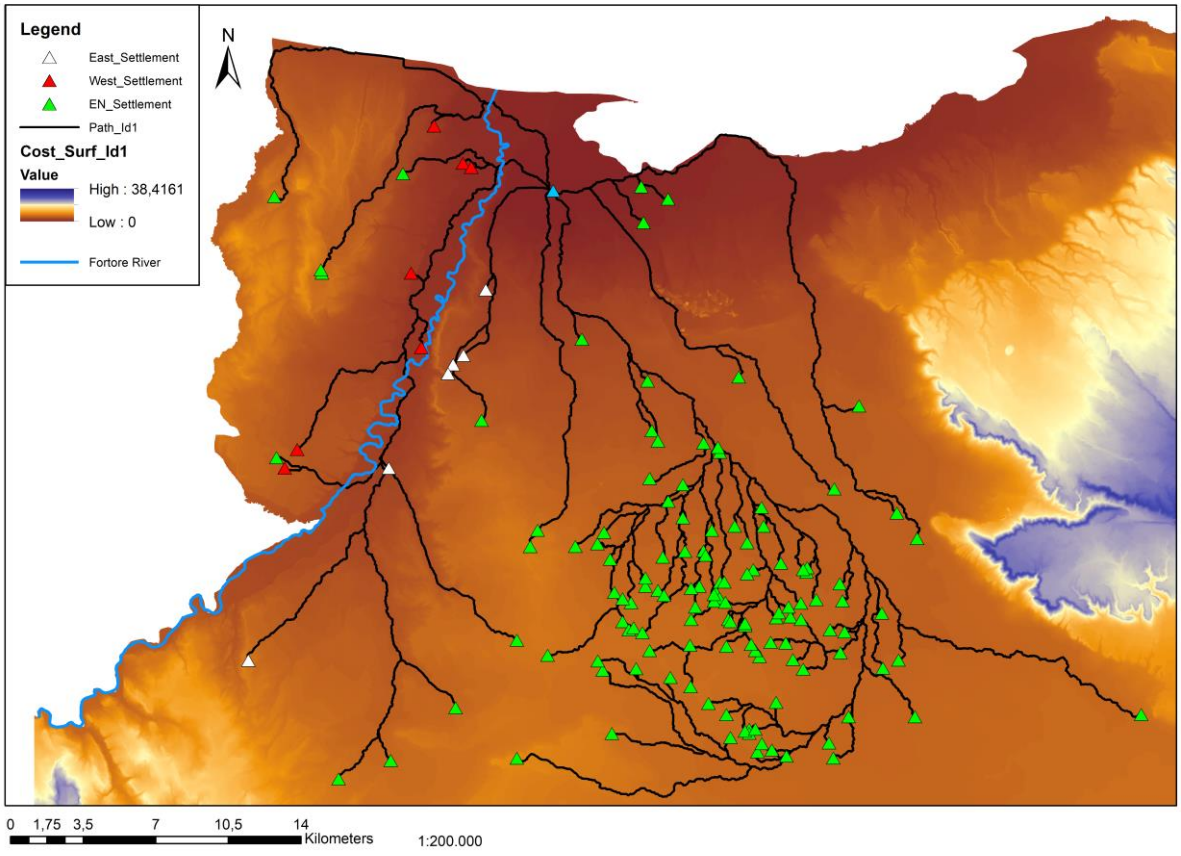


Table 40 – LPCA applied to Coppe di Rose (id9)

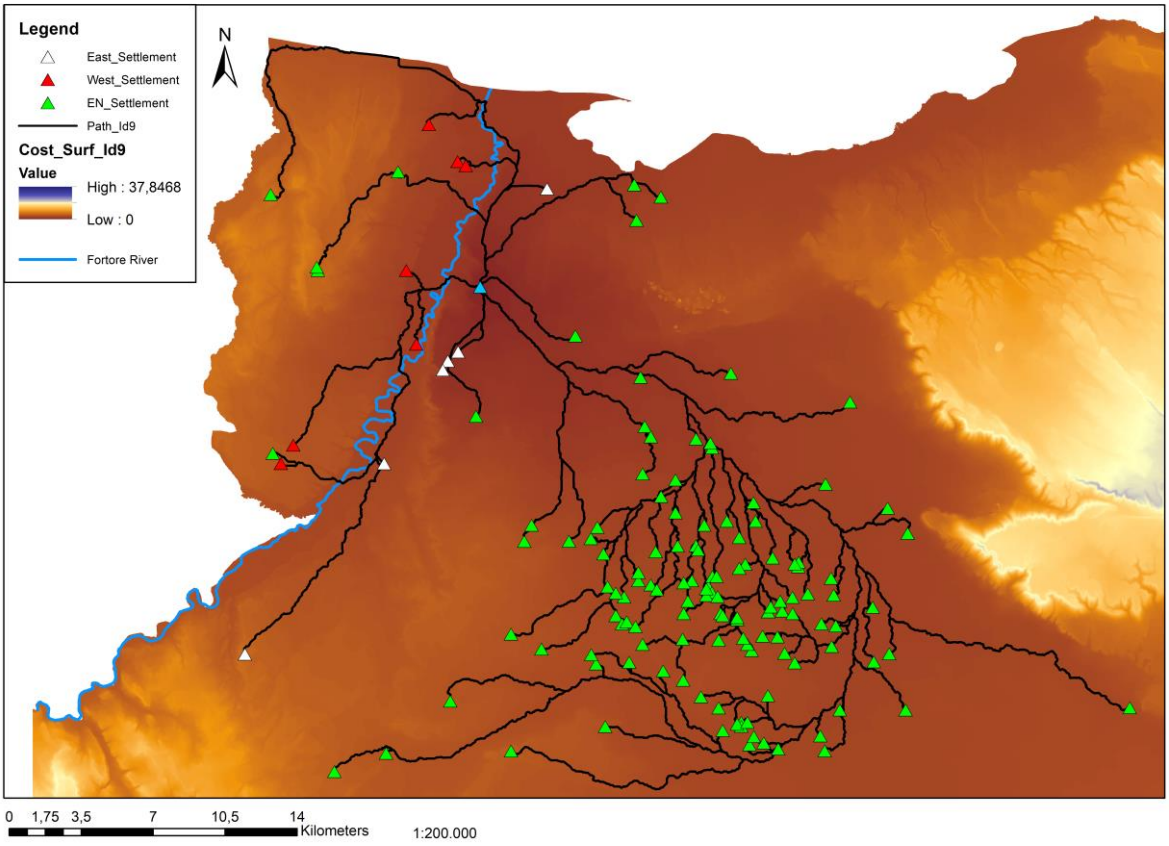


Table 41 – LPCA applied to Piani di Lauria I (id15)

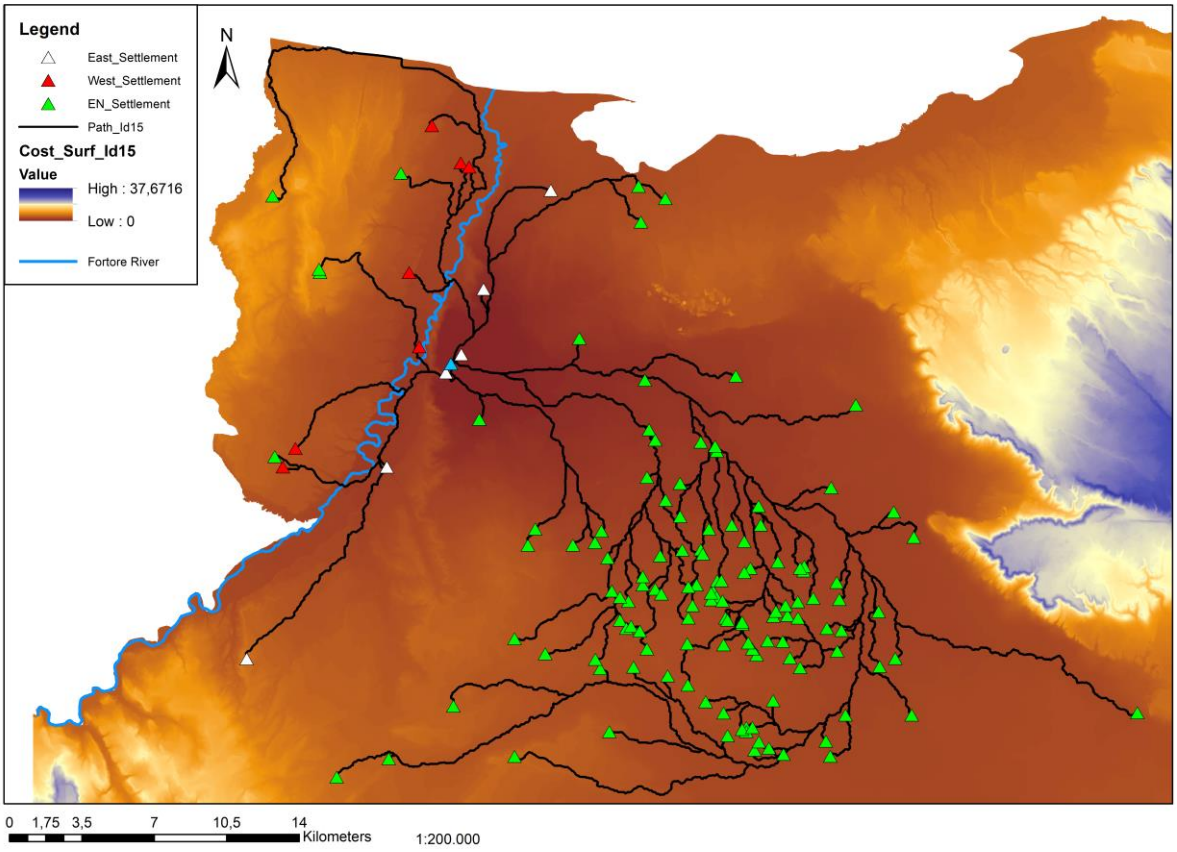


Table 42 – LPCA applied to Colle d'Armi (id18)

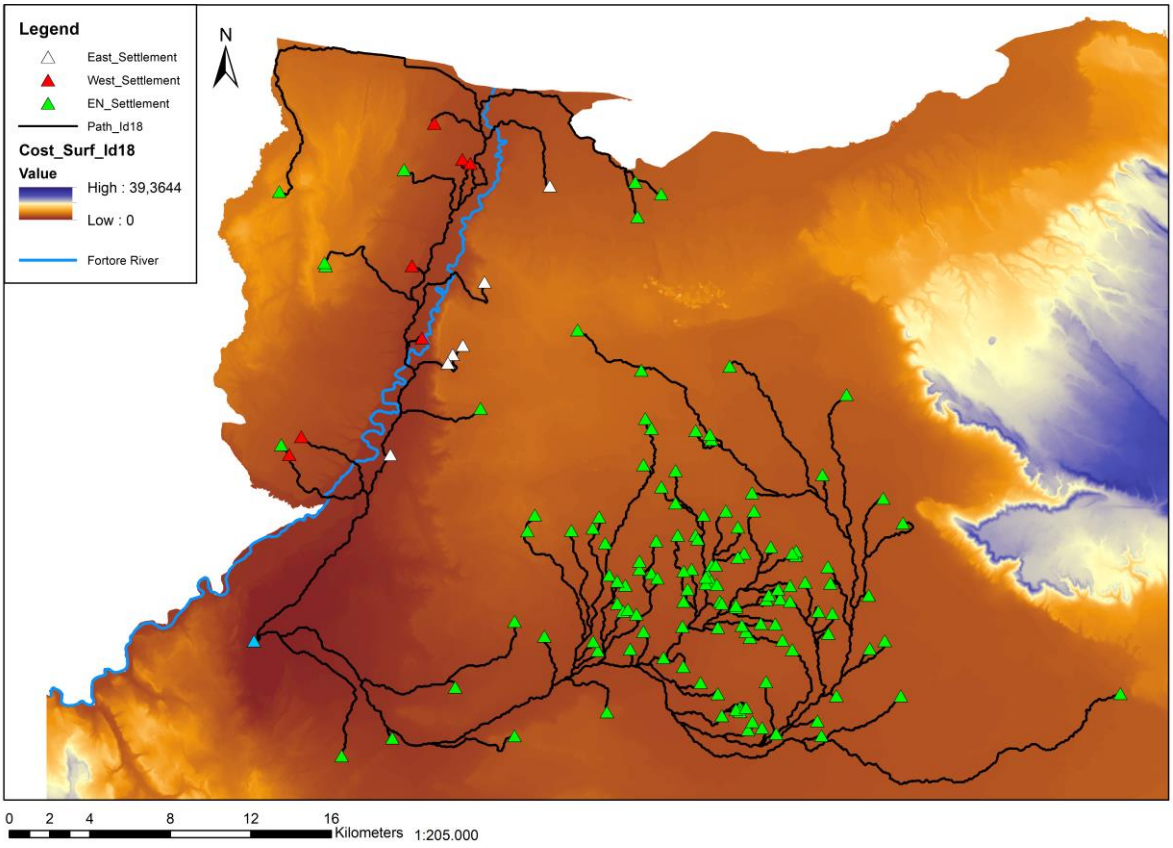


Table 43 – LPCA applied to Piani di Lauria IV (id133)

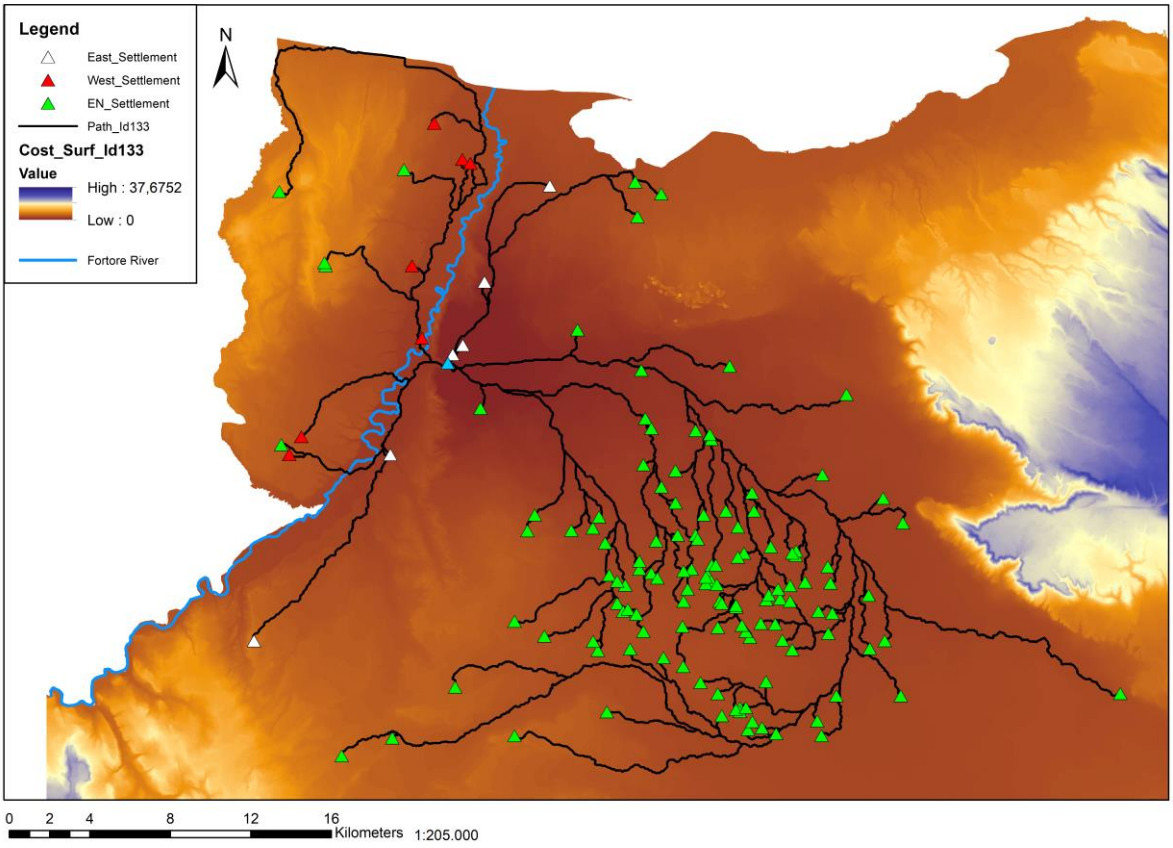


Table 44 – LPCA applied to Piani di Lauria III (id134)

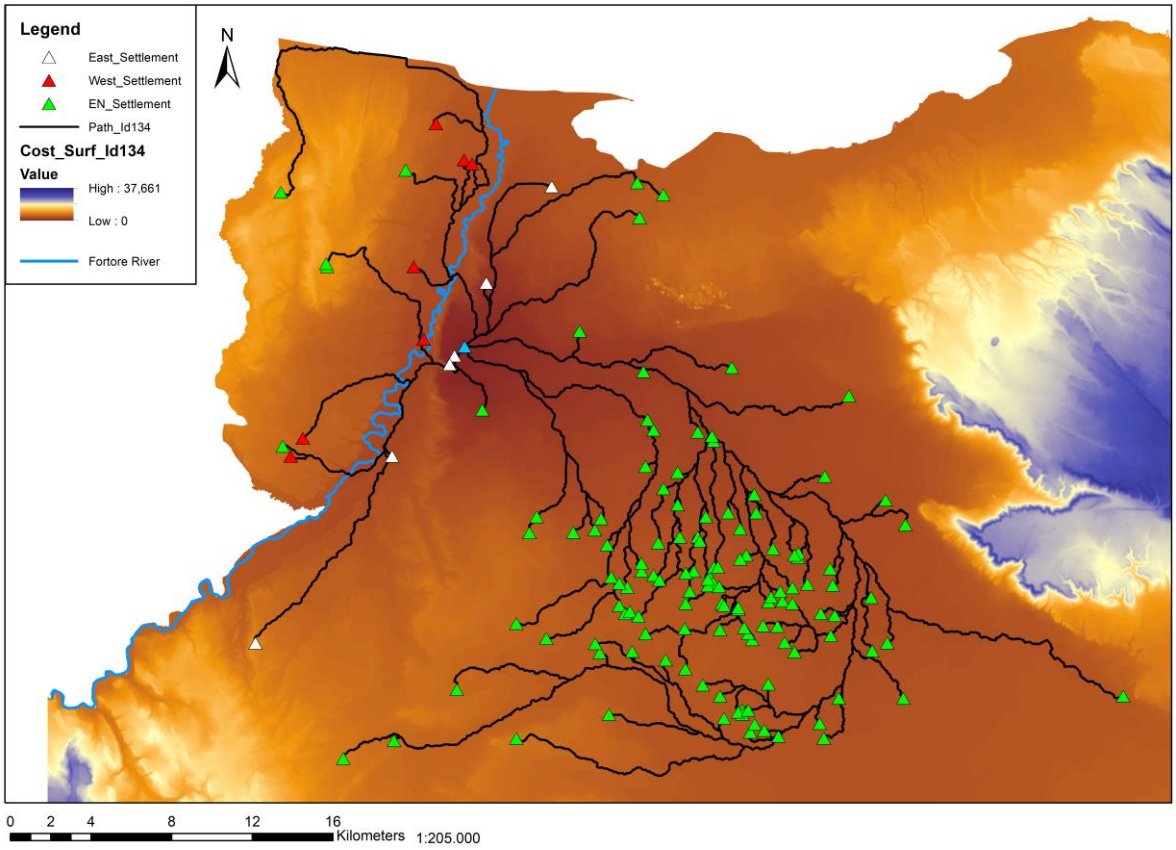
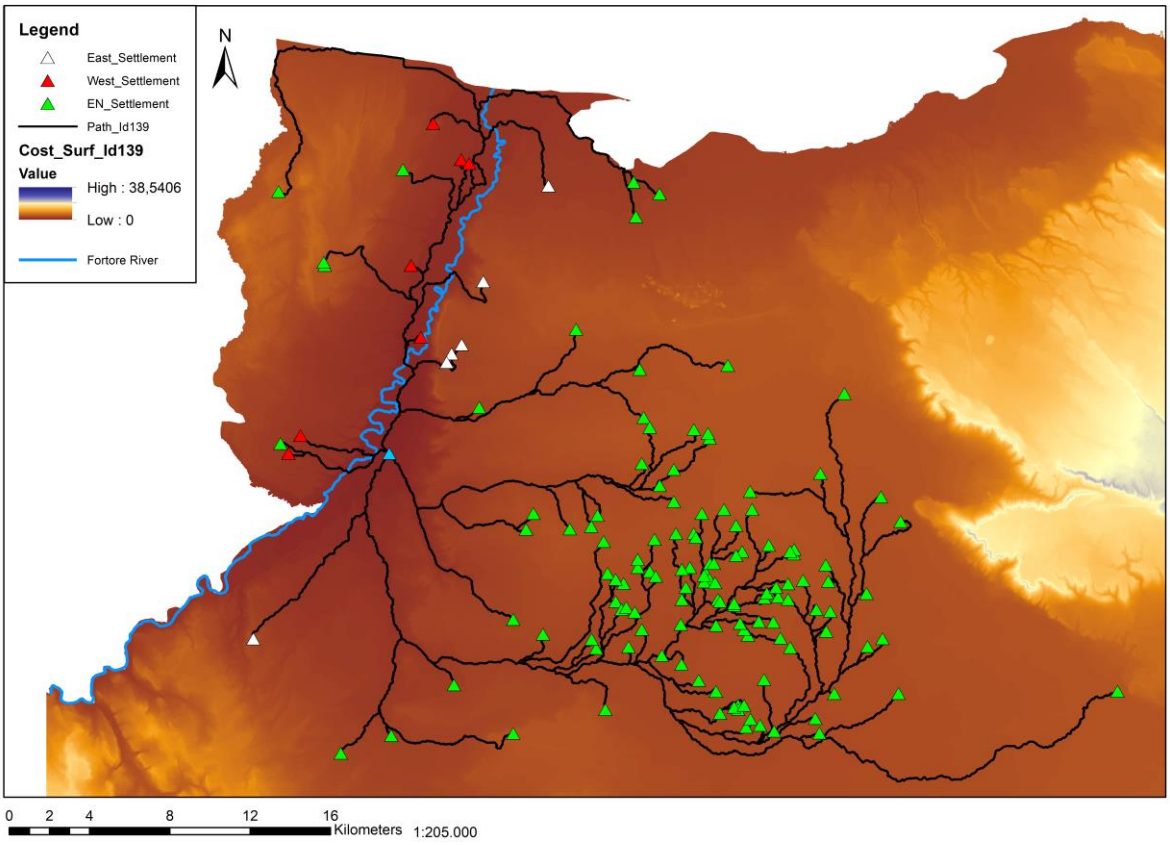


Table 45 – LPCA applied to Masseria Fara Sentinella (id139)



WESTERN SHORESIDE

Table 46 – LPCA applied to Vastaioli (id4)

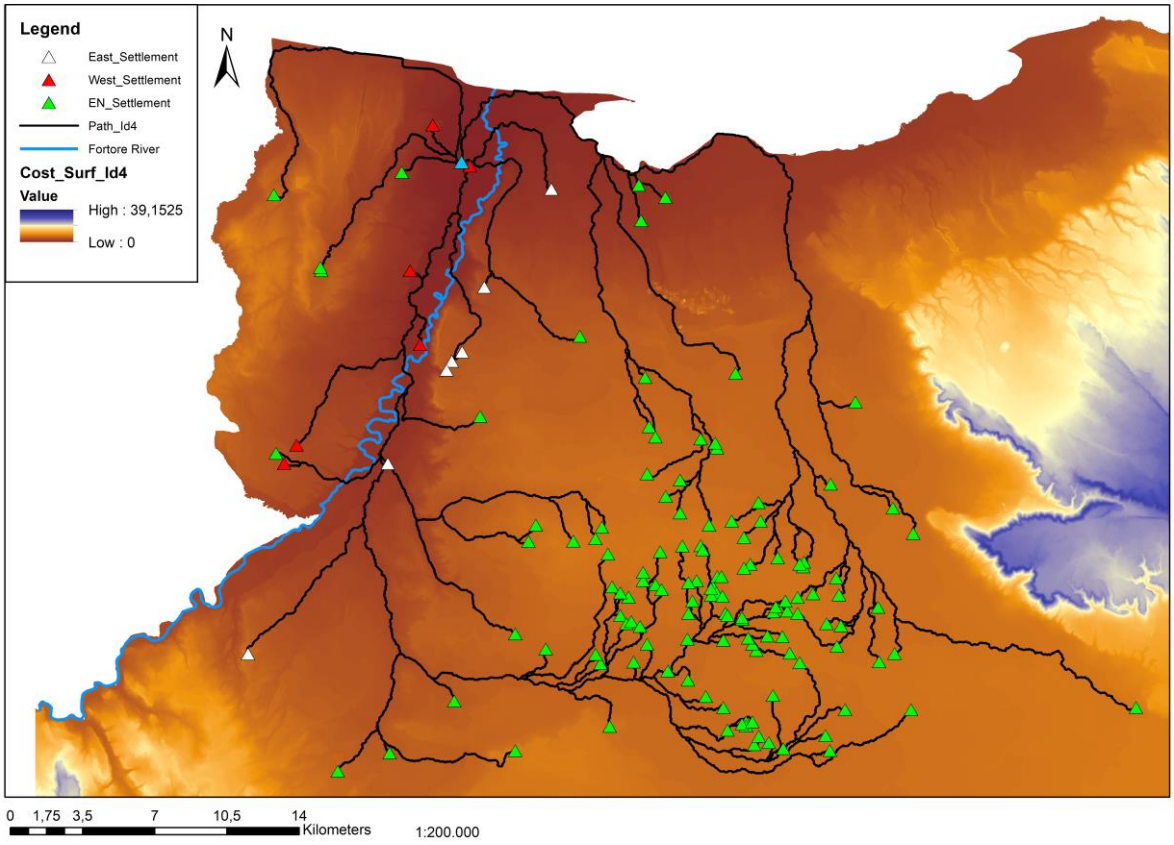


Table 47 – LPCA applied to Masseria dell'Ischia (id6)

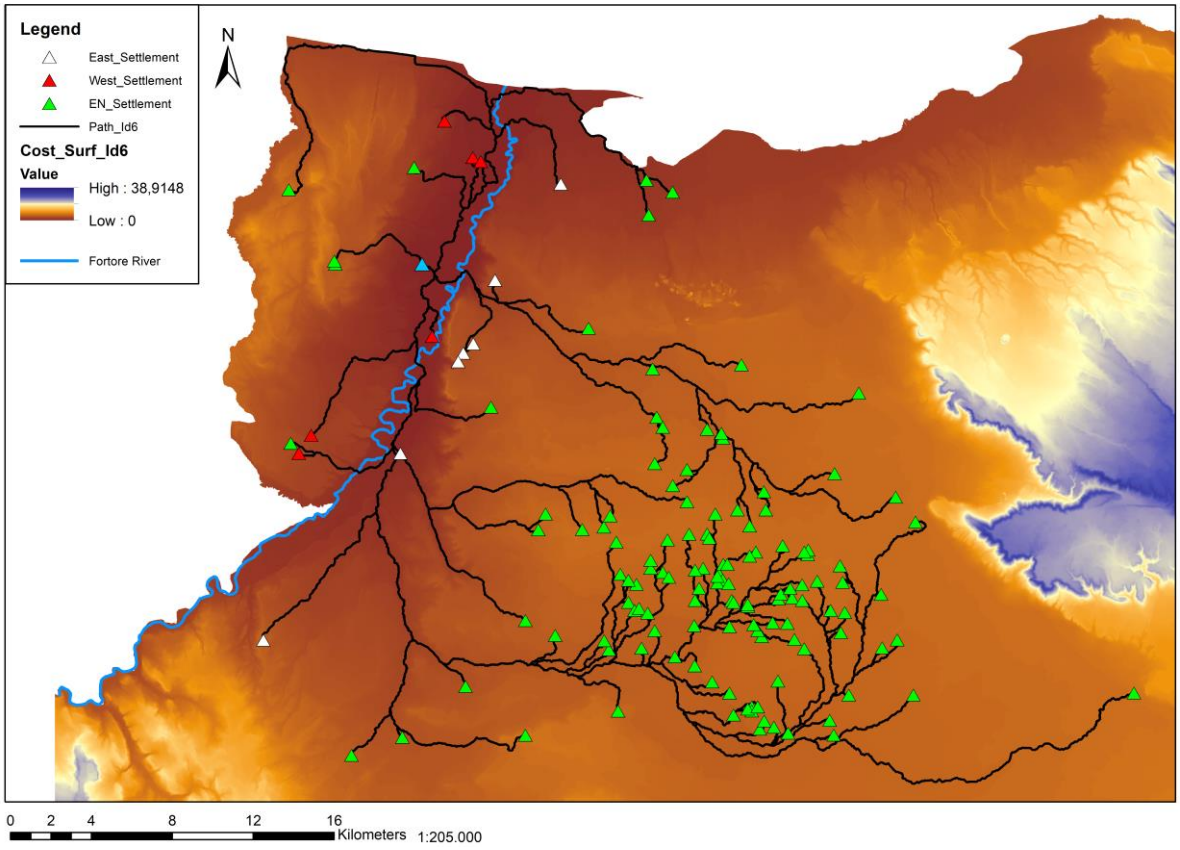


Table 48 – LPCA applied to Masseria Settimo Grotte (id7)

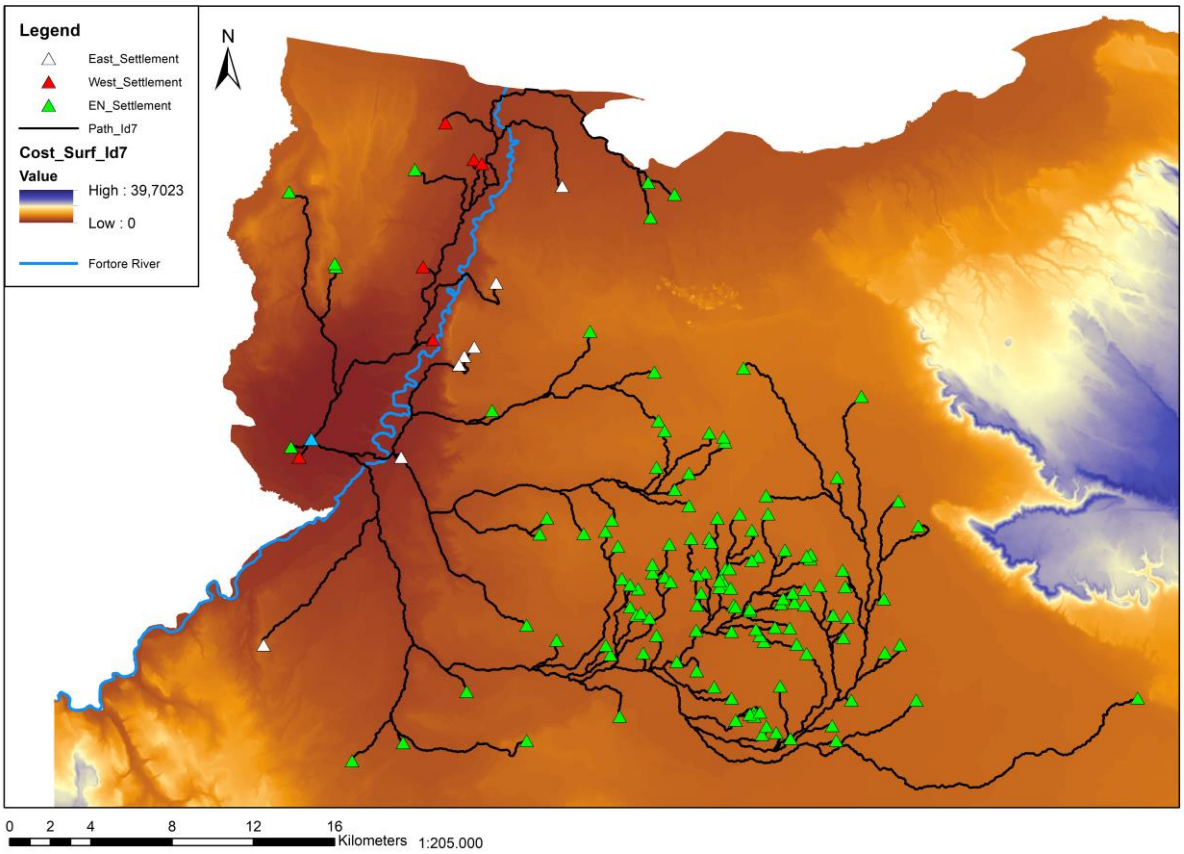


Table 49 – LPCA applied to Località Sant'Agata (id10)

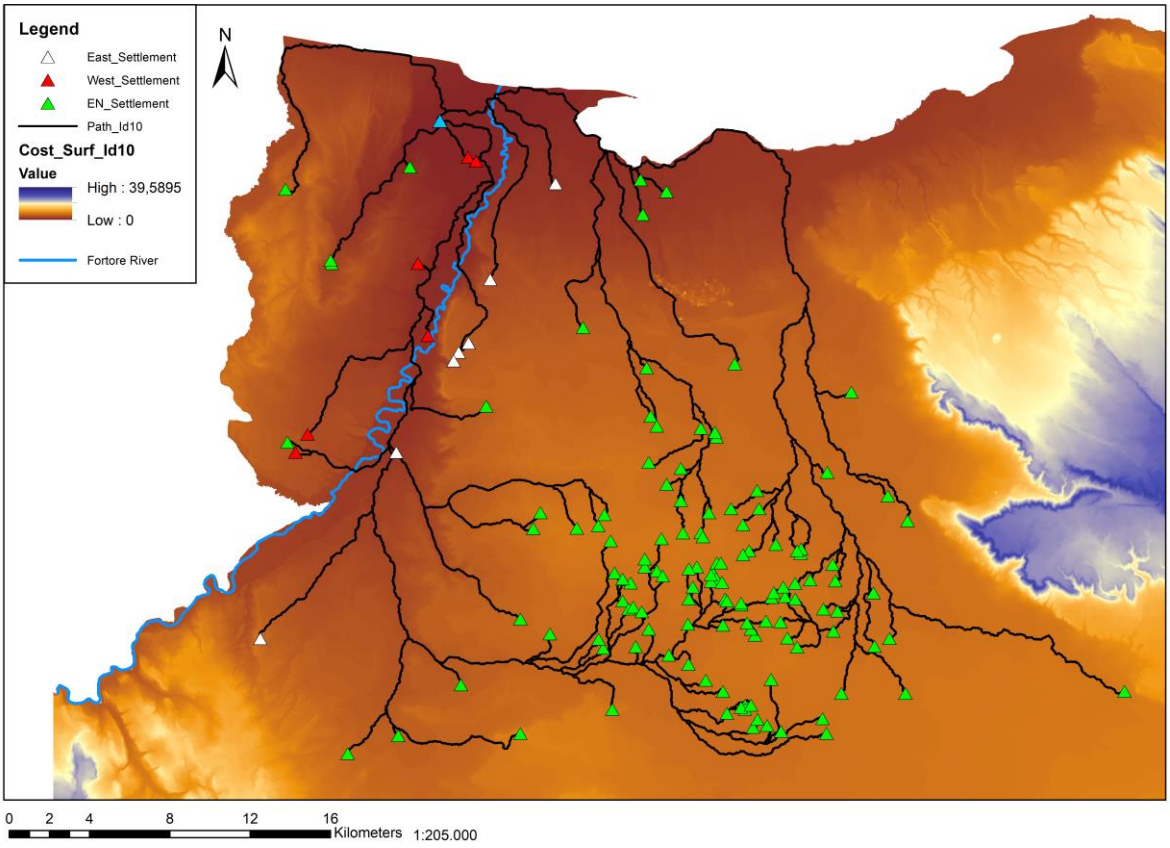


Table 50 – LPCA applied to Cesine Inferiore (id12)

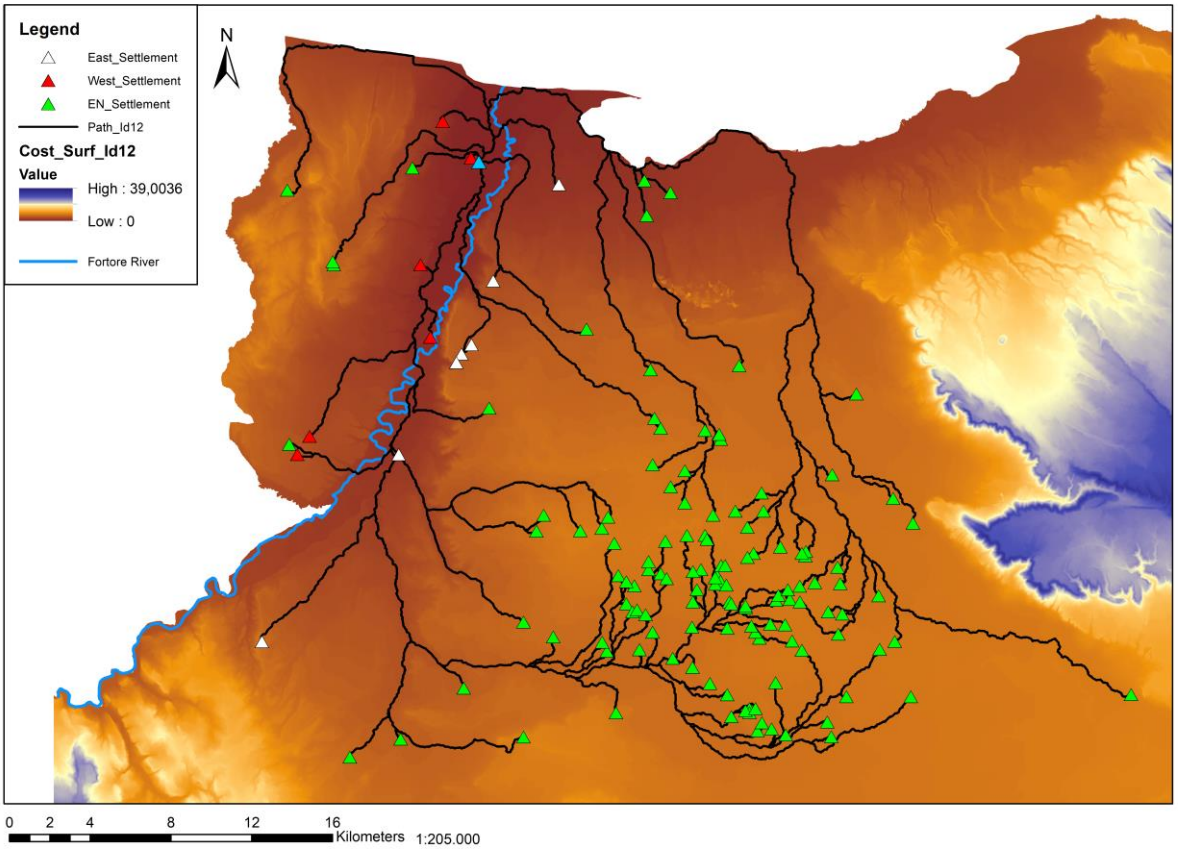


Table 51 – LPCA applied to Canale Carpano I (id130)

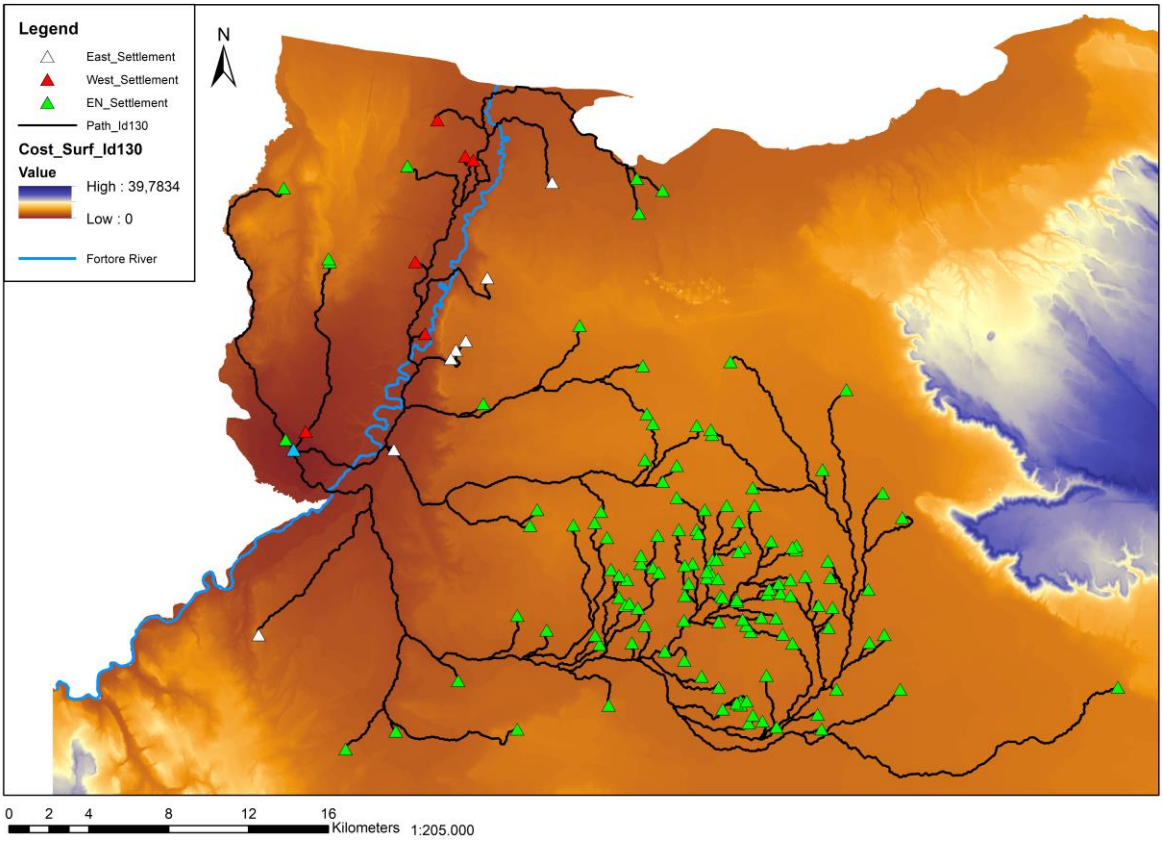
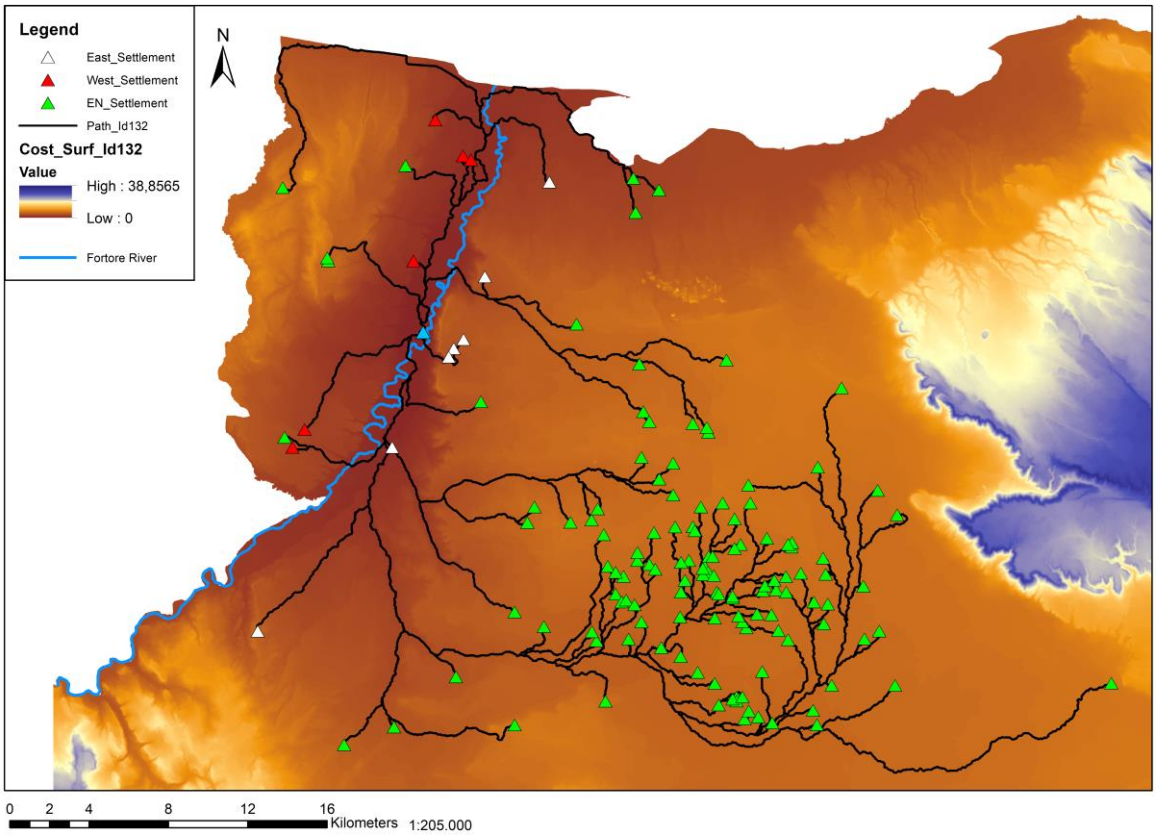


Table 52 – LPCA applied to Piani di Lauria bassa (id132)



GARGANO FOOTHILLS

Table 53 – LPCA applied to Mezzanella di Brancia (id53)

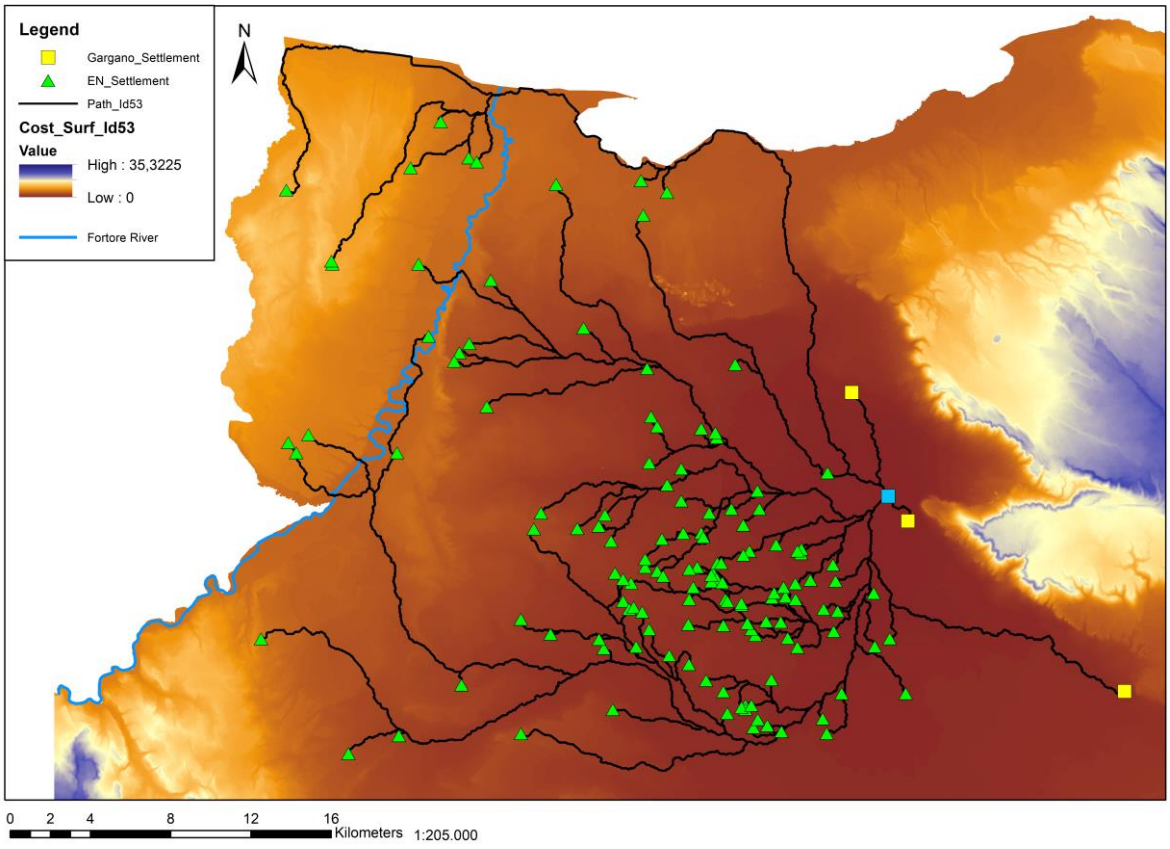


Table 54 – LPCA applied to Località Piro di Brancia (id54)

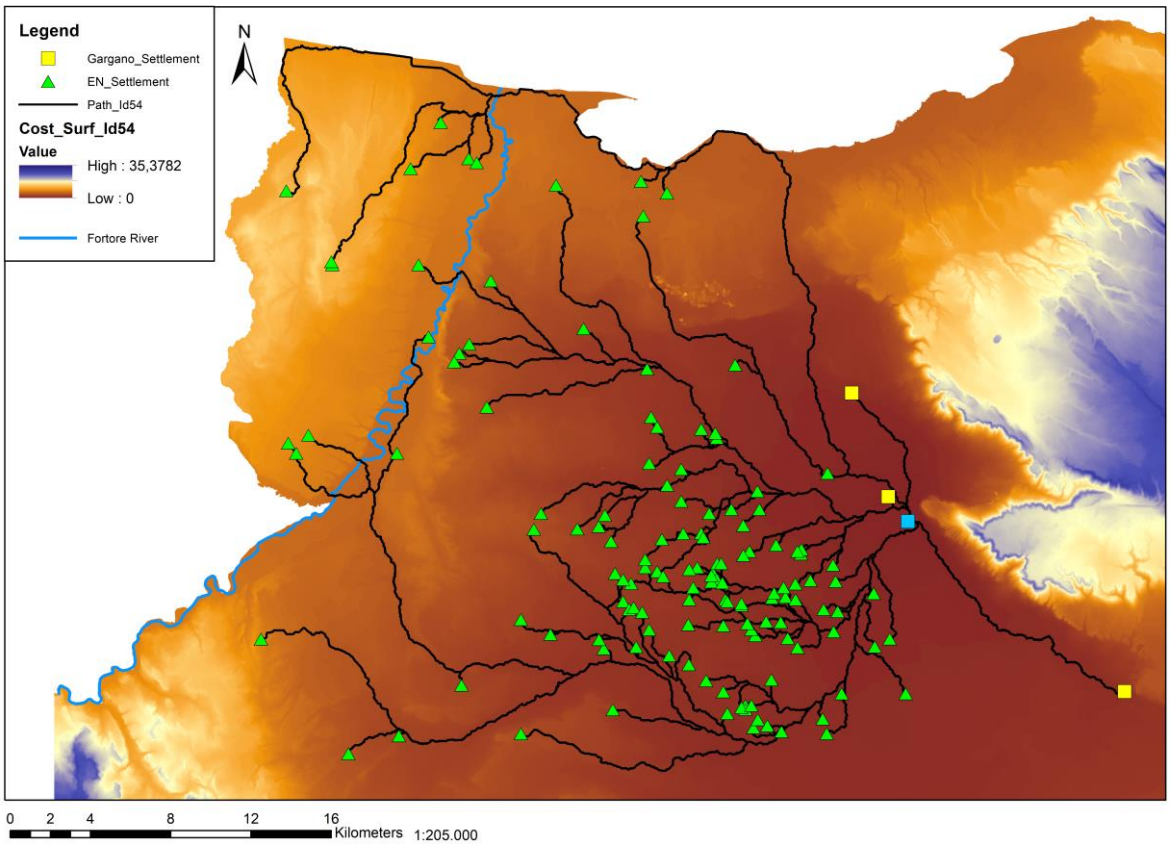


Table 55 – LPCA applied Ciccalento (id89)

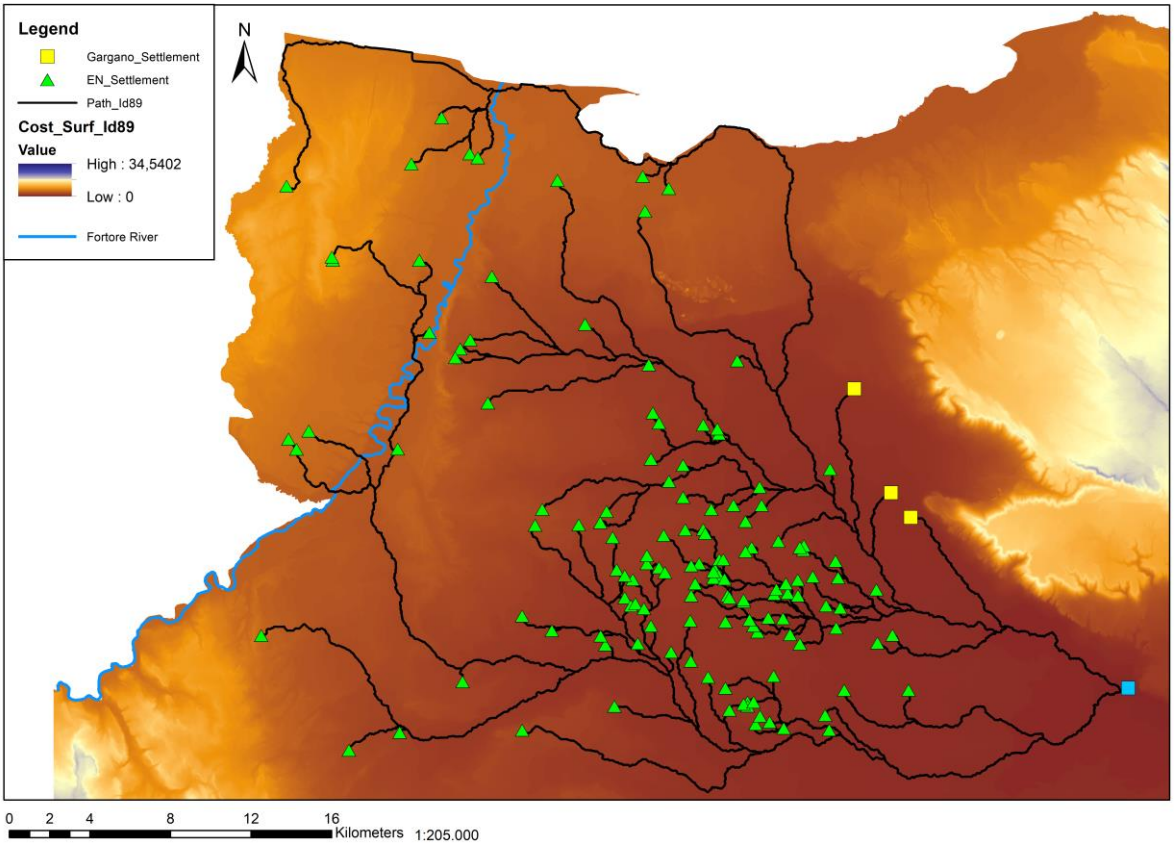
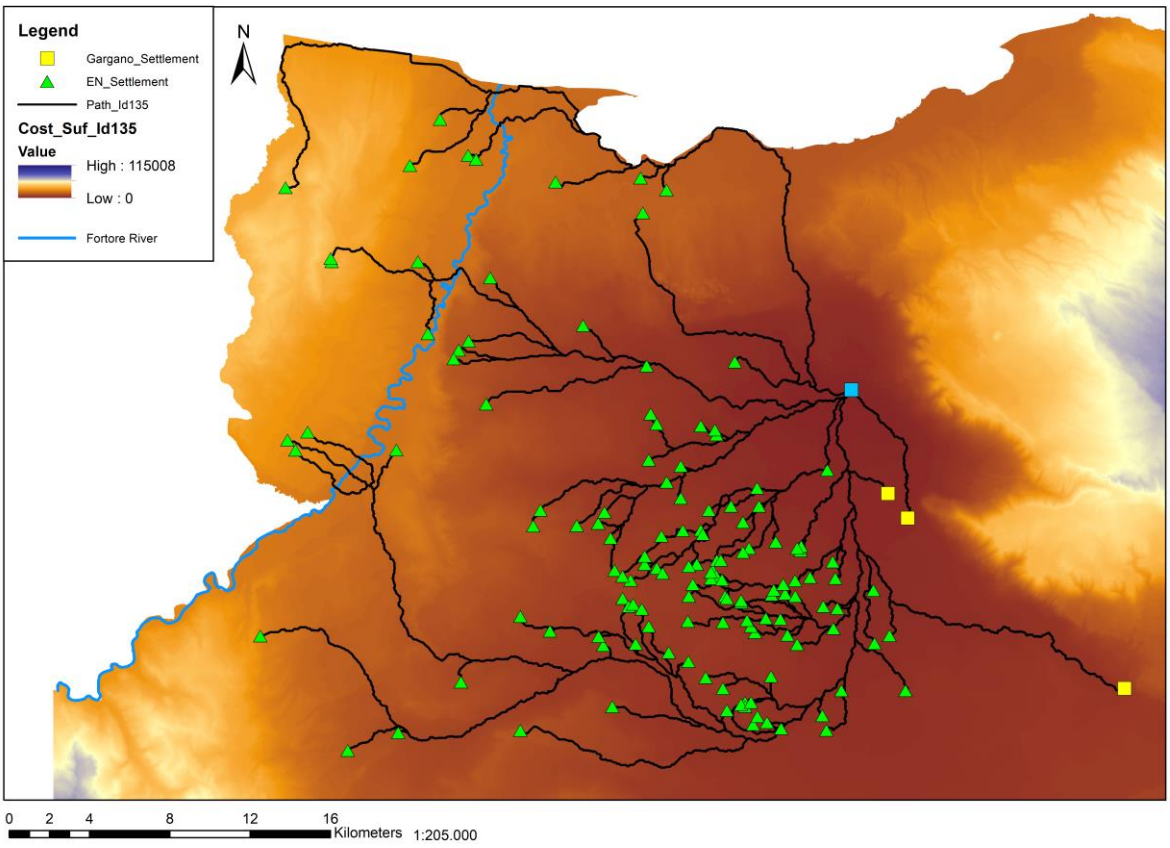


Table 56 – LPCA applied to Mezzana della Quercia (id135)



MOLISE BORDER

Table 57 – LPCA applied to Masseria Bivento (id5)

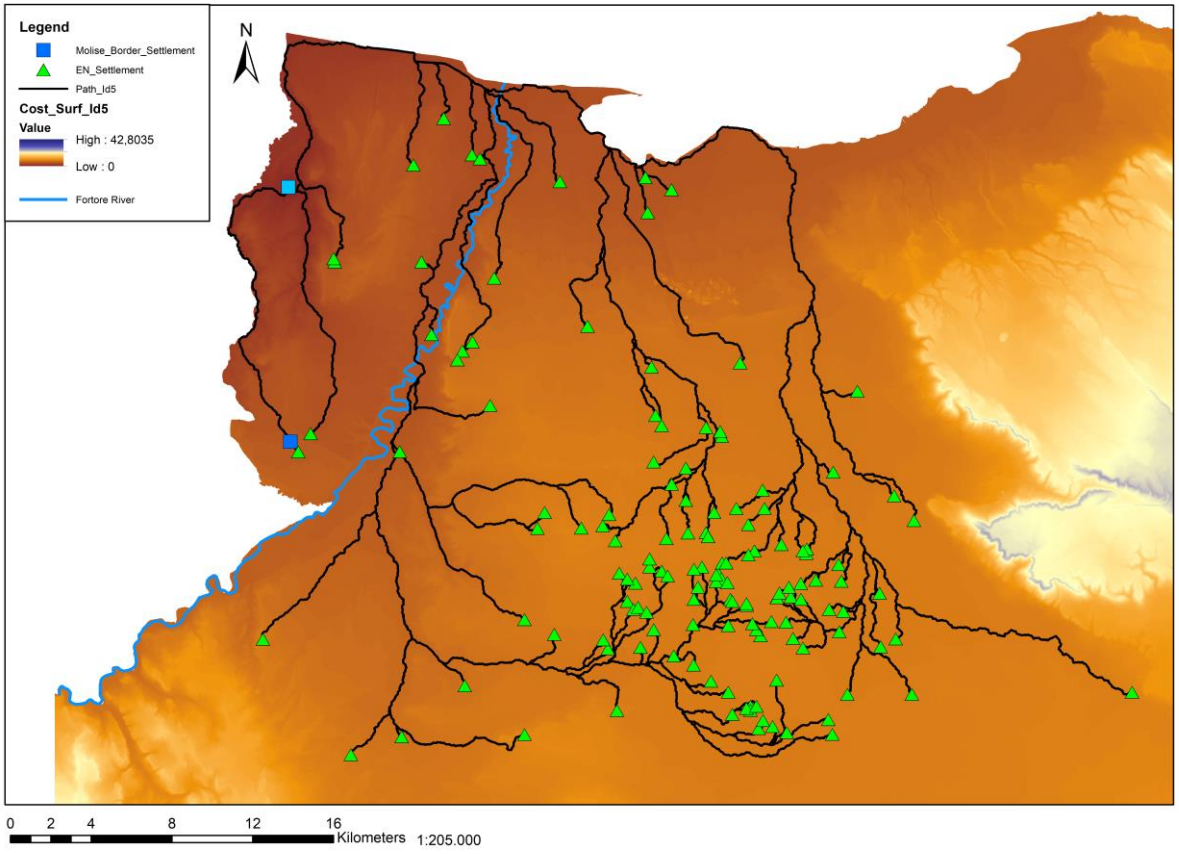
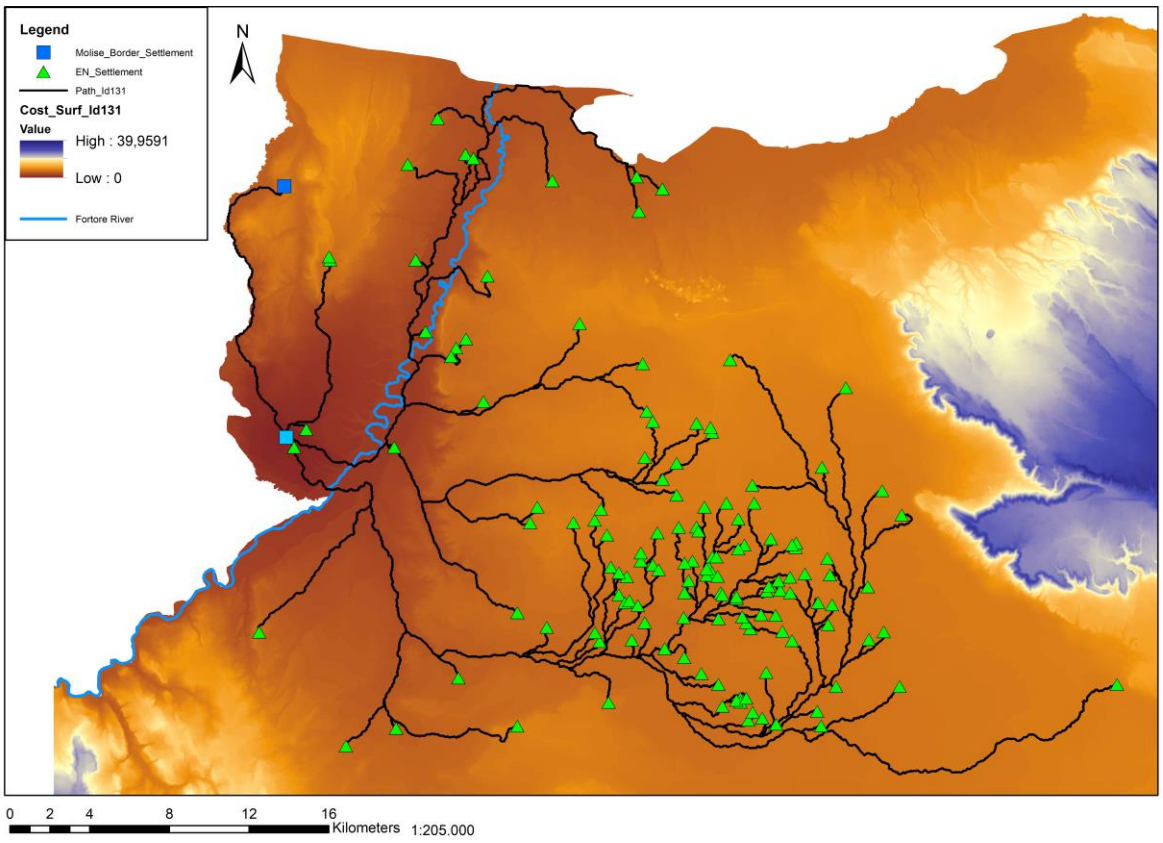


Table 58 – LPCA applied to Canale Carpano II (id131)



MIDDLE NEOLITHIC

Table 59 – LPCA applied to Casino San Matteo-Chiantinelle (id1)

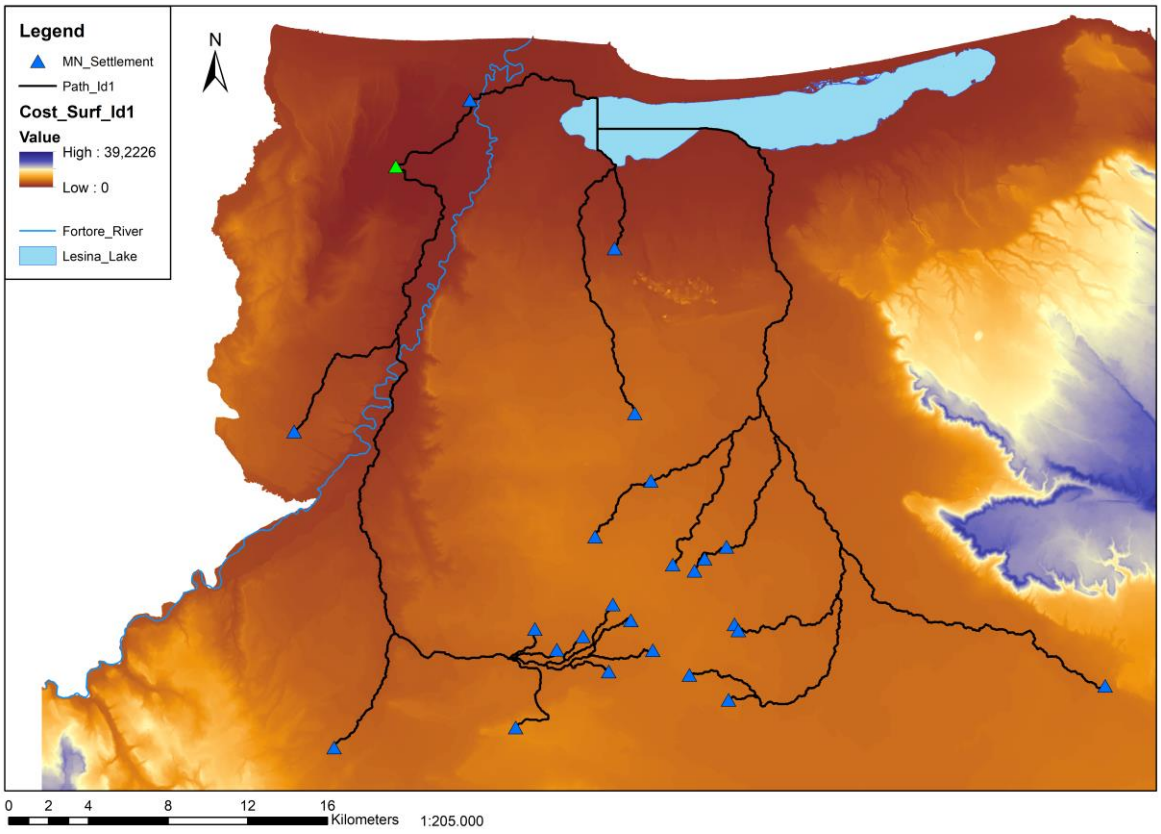


Table 60 – LPCA applied to Chiarappa (id2)

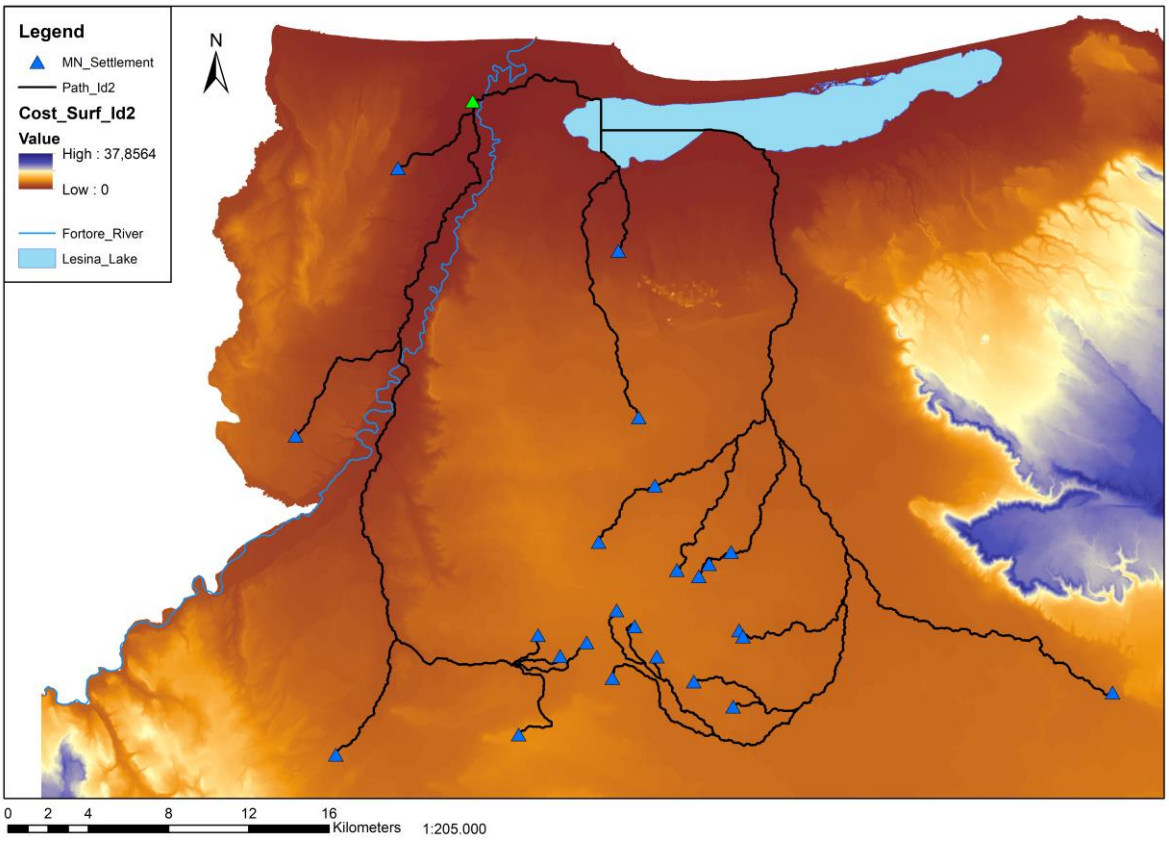


Table 61 – LPCA applied to Masseria Settimo di Grotte (id3)

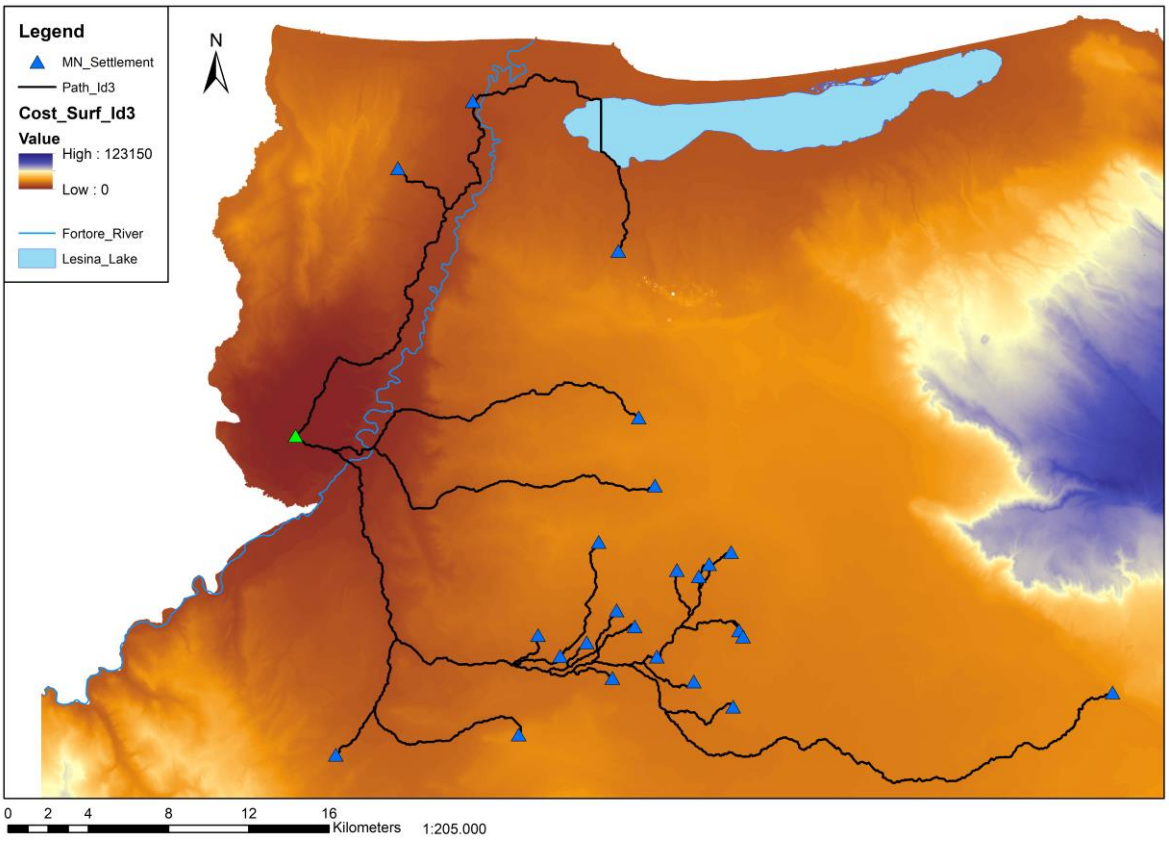


Table 62 – LPCA applied to Masseria Istituto di Sangro (id4)

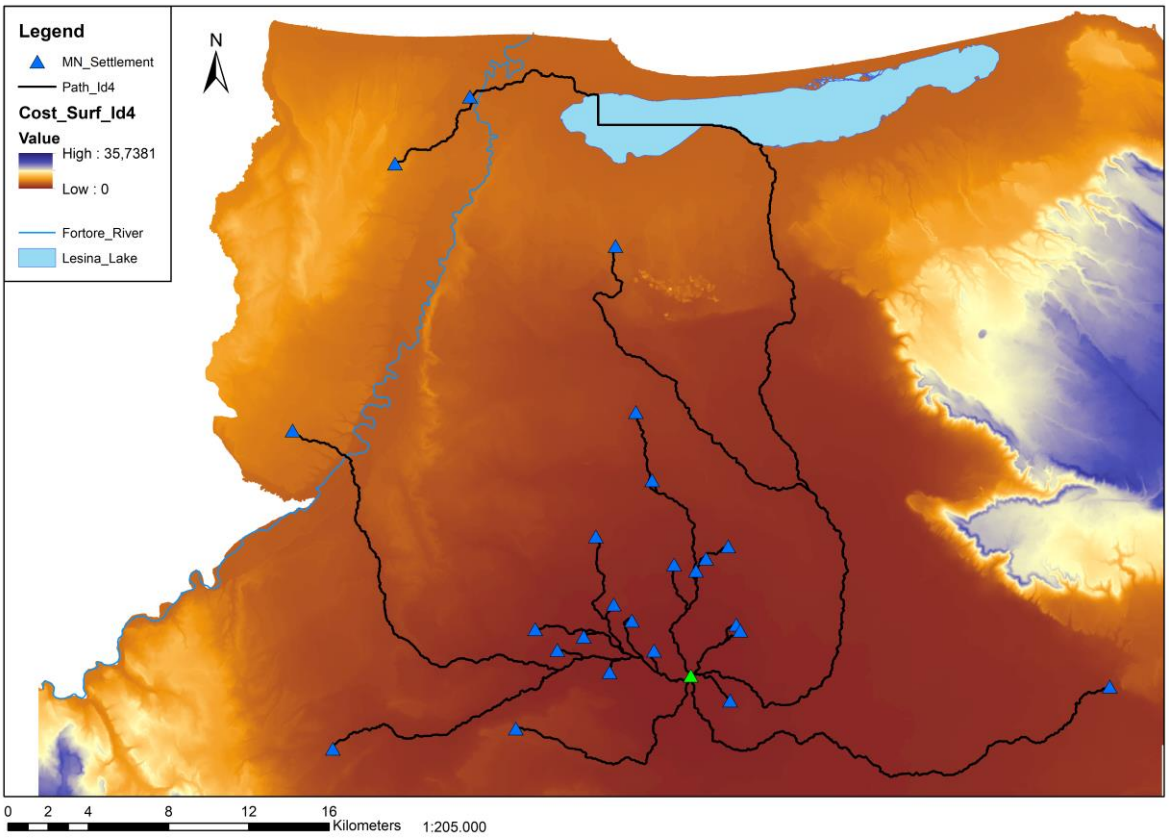


Table 63 – LPCA applied to Coppa Pallante (id5)

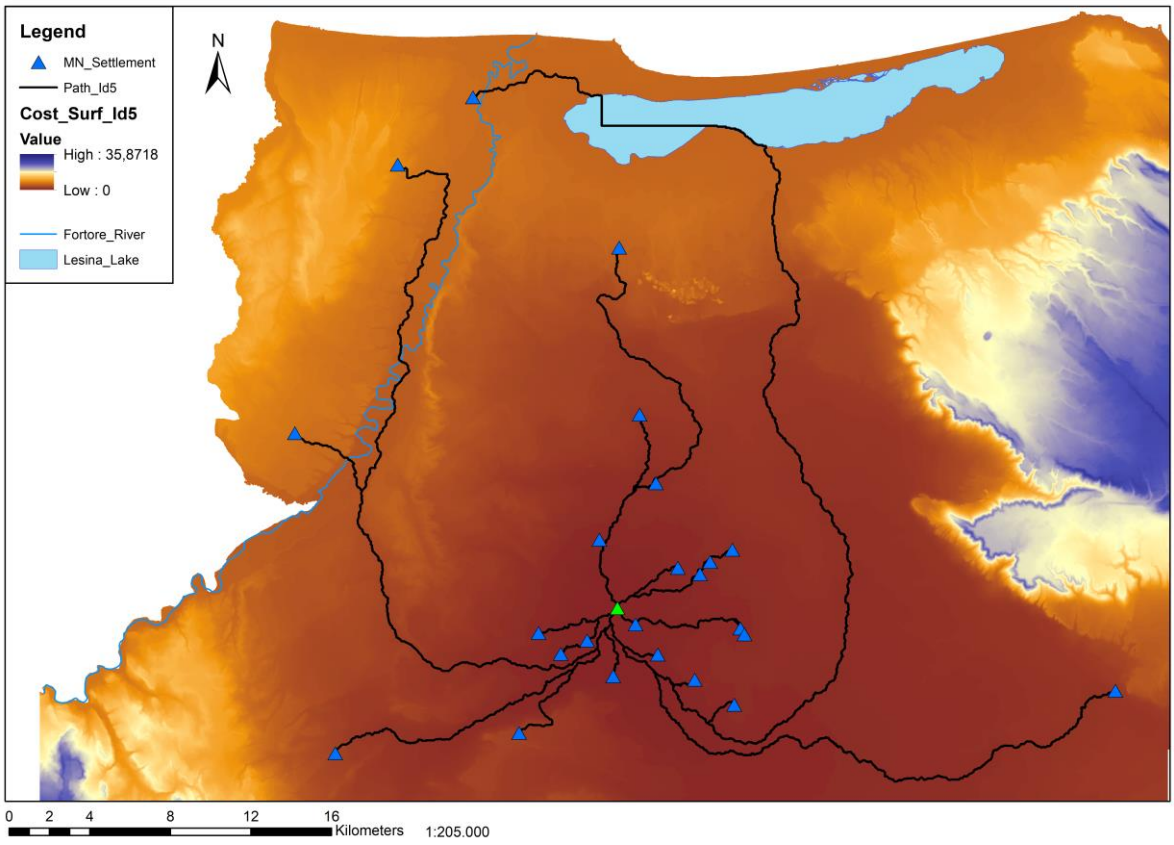


Table 64 – LPCA applied to Coppa Pocci (id6)

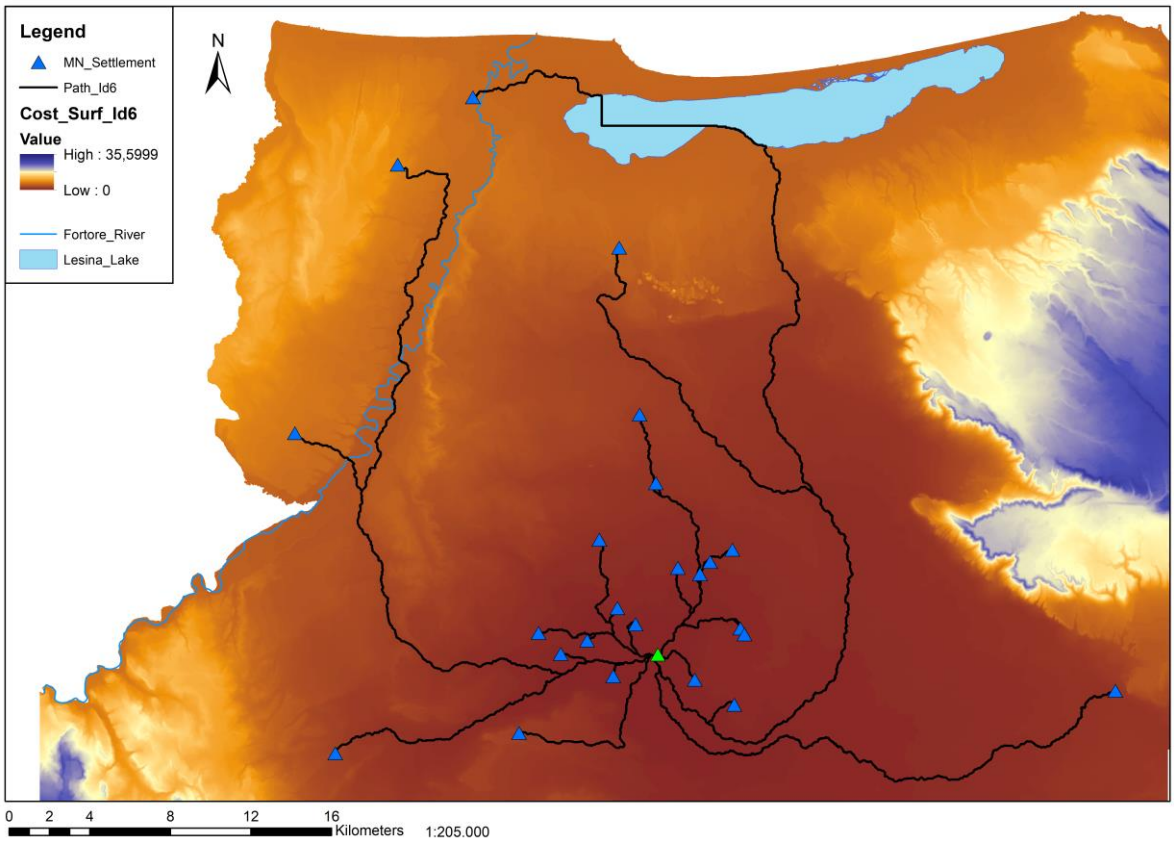


Table 65 – LPCA applied to Masseria Pagliari (id7)

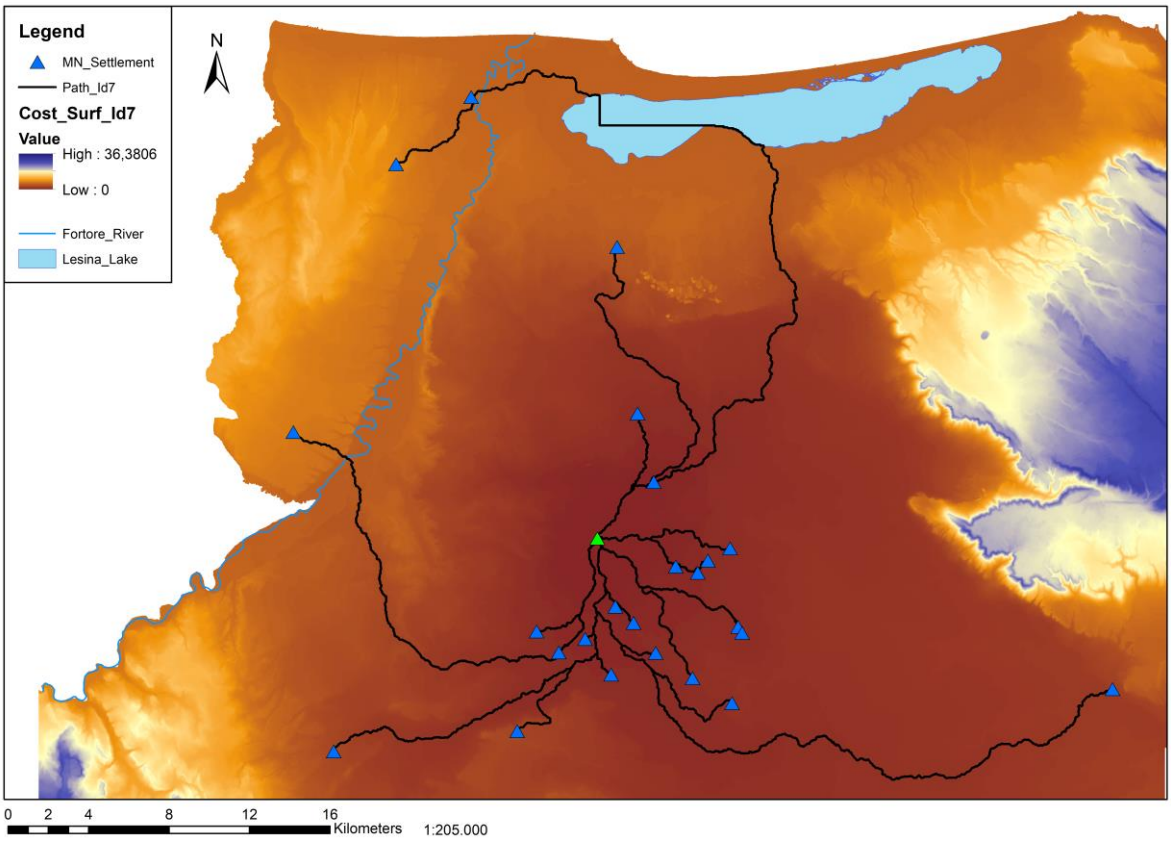


Table 66 – LPCA applied to Masseria Li Gatti (id8)

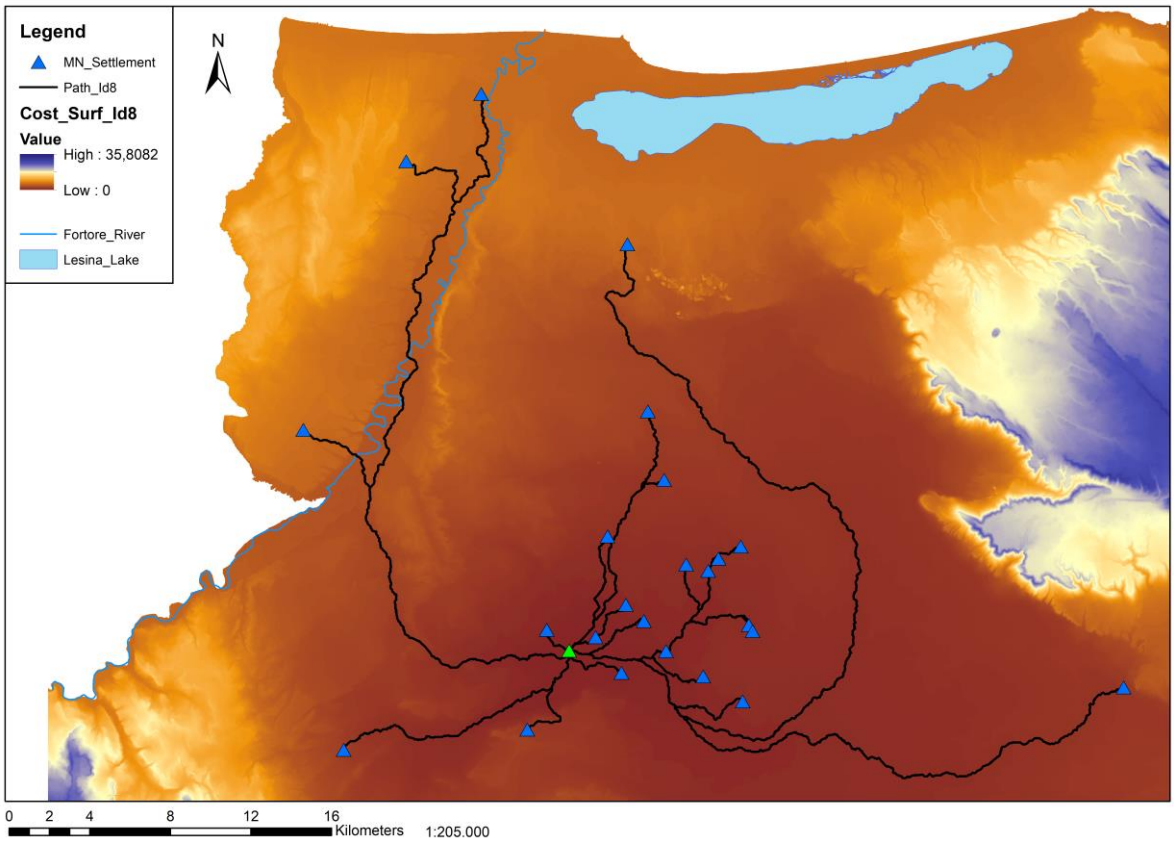


Table 67 – LPCA applied to La Torretta (id9)

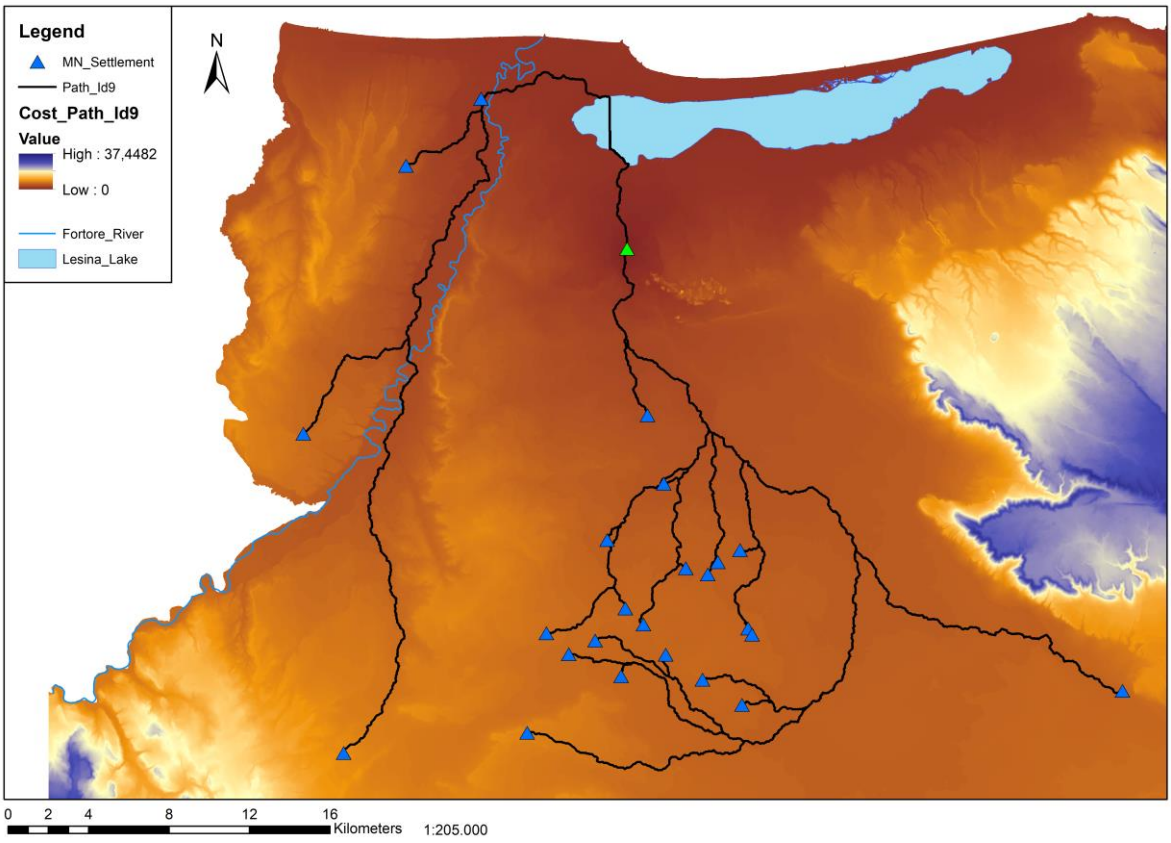


Table 68 – LPCA applied to Oliveto Masselli (id10)

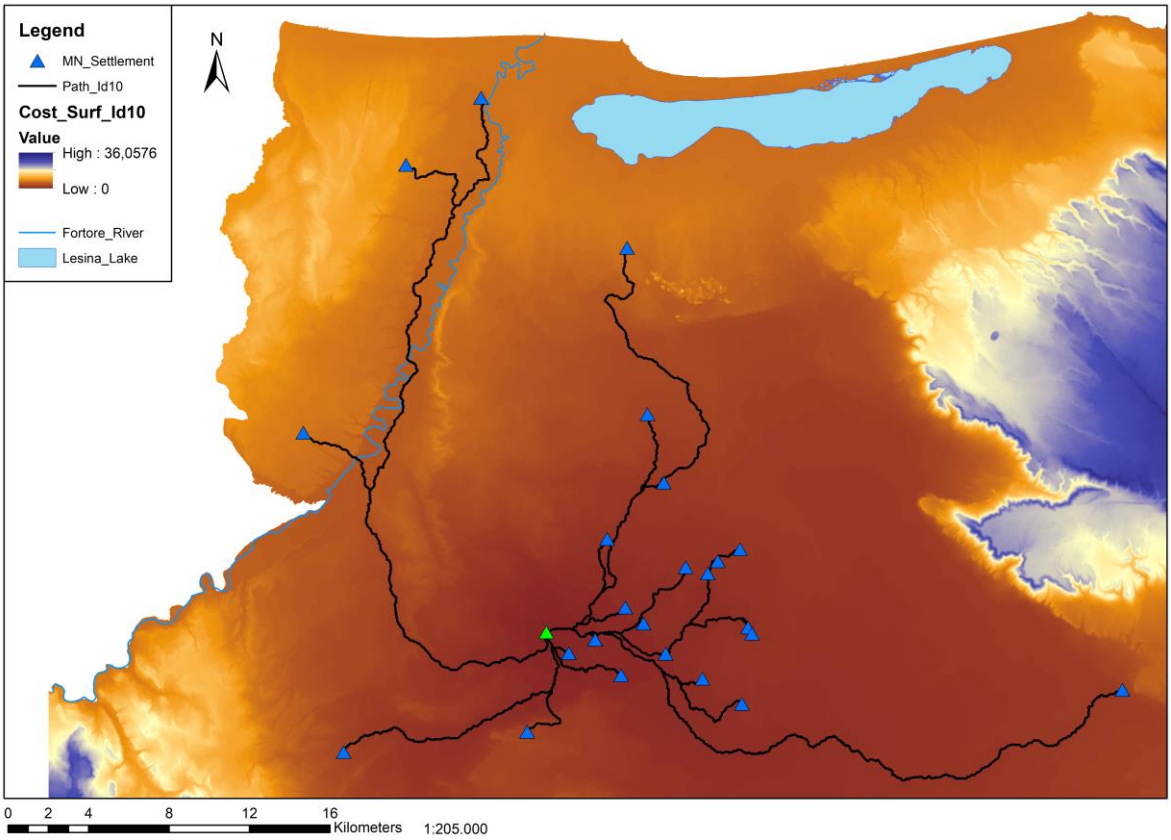


Table 69 – LPCA applied to Ciccalento (id11)

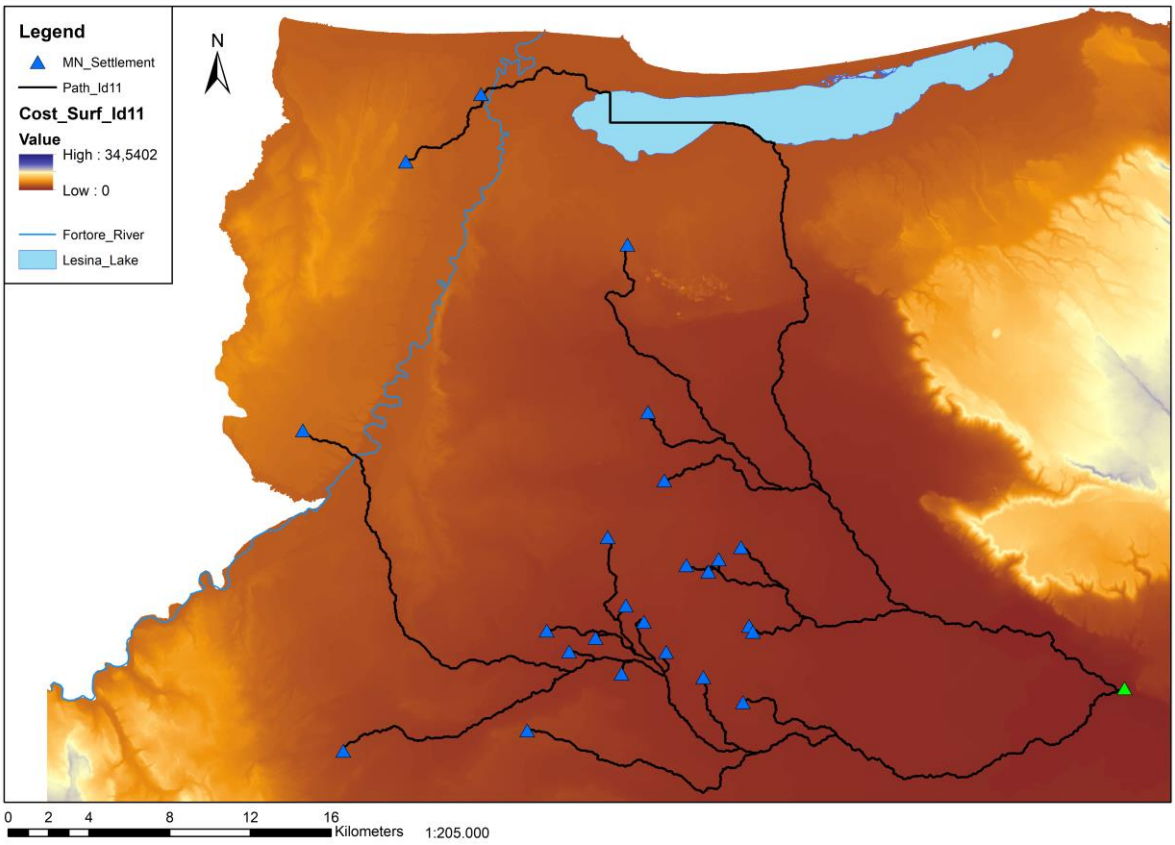


Table 70 – LPCA applied to Li Gatti (id12)

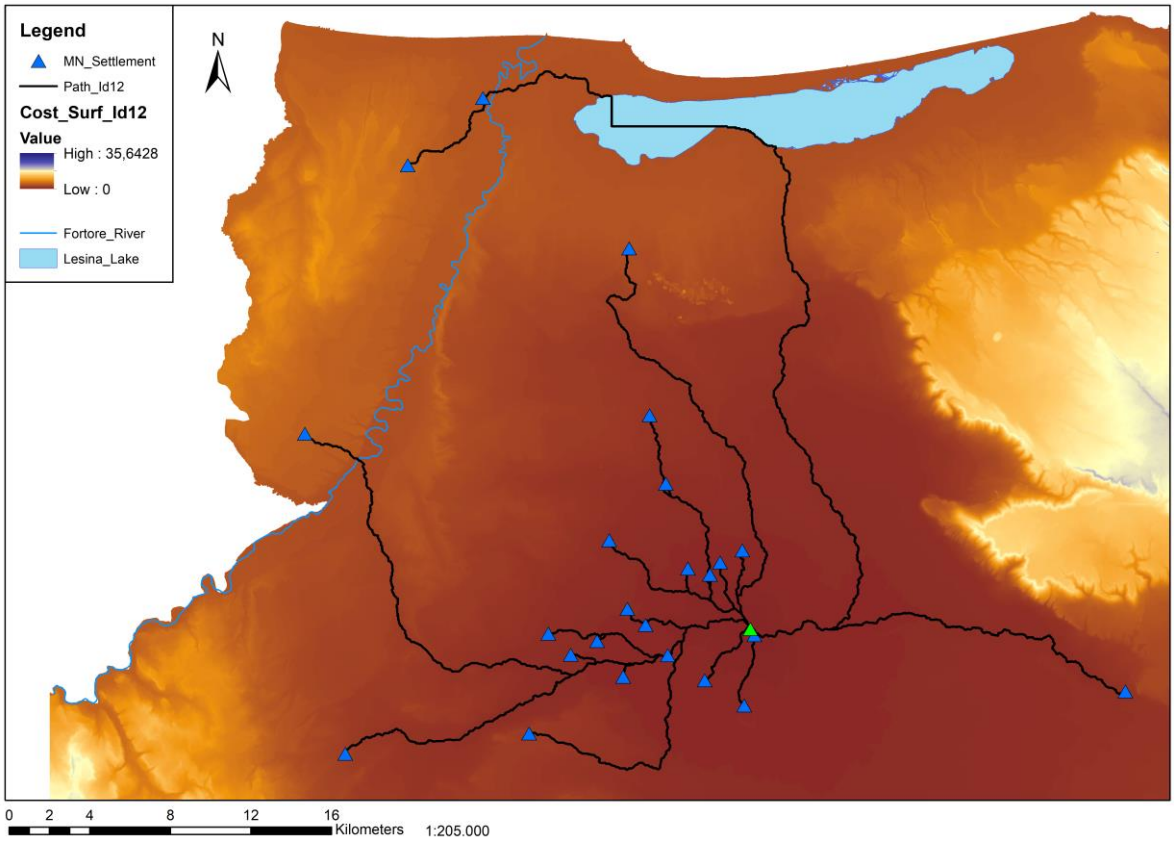


Table 71 – LPCA applied to Pian Devoto (id13)

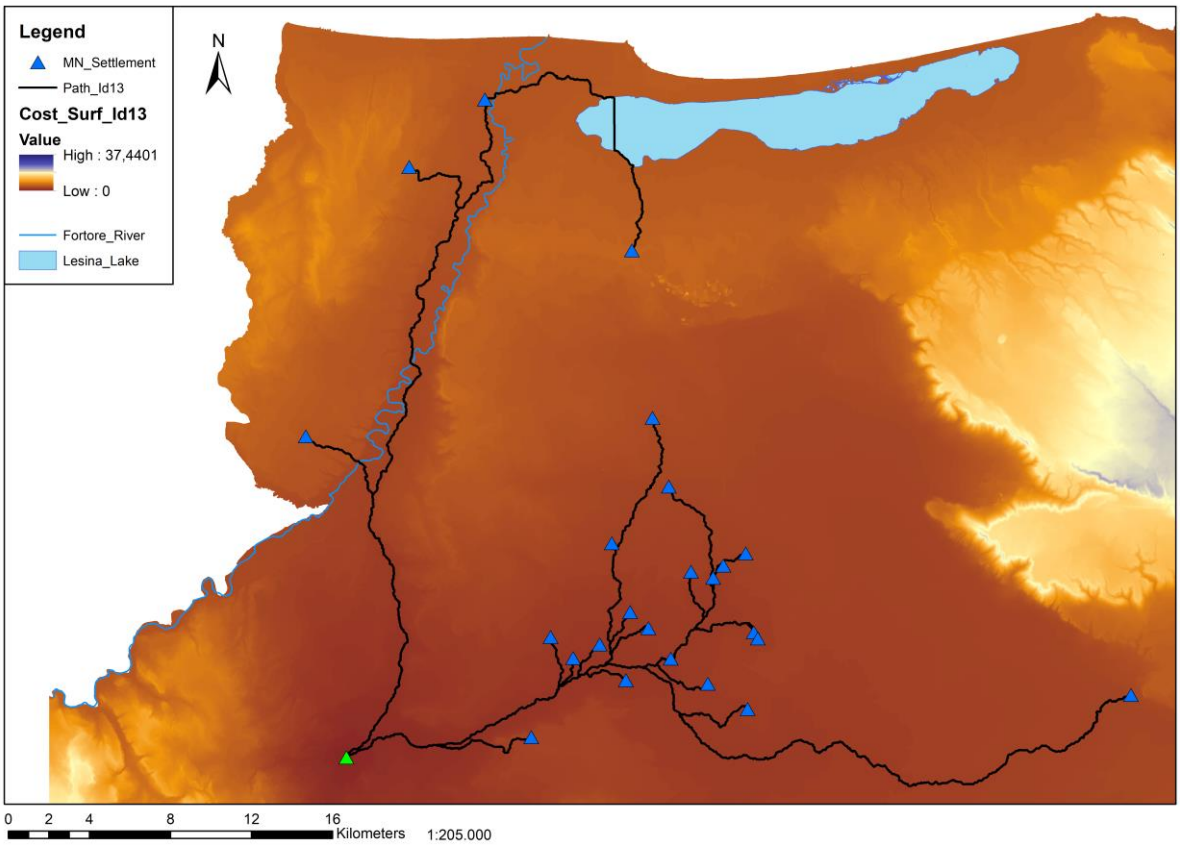


Table 72 – LPCA applied to Località Orsello (id14)

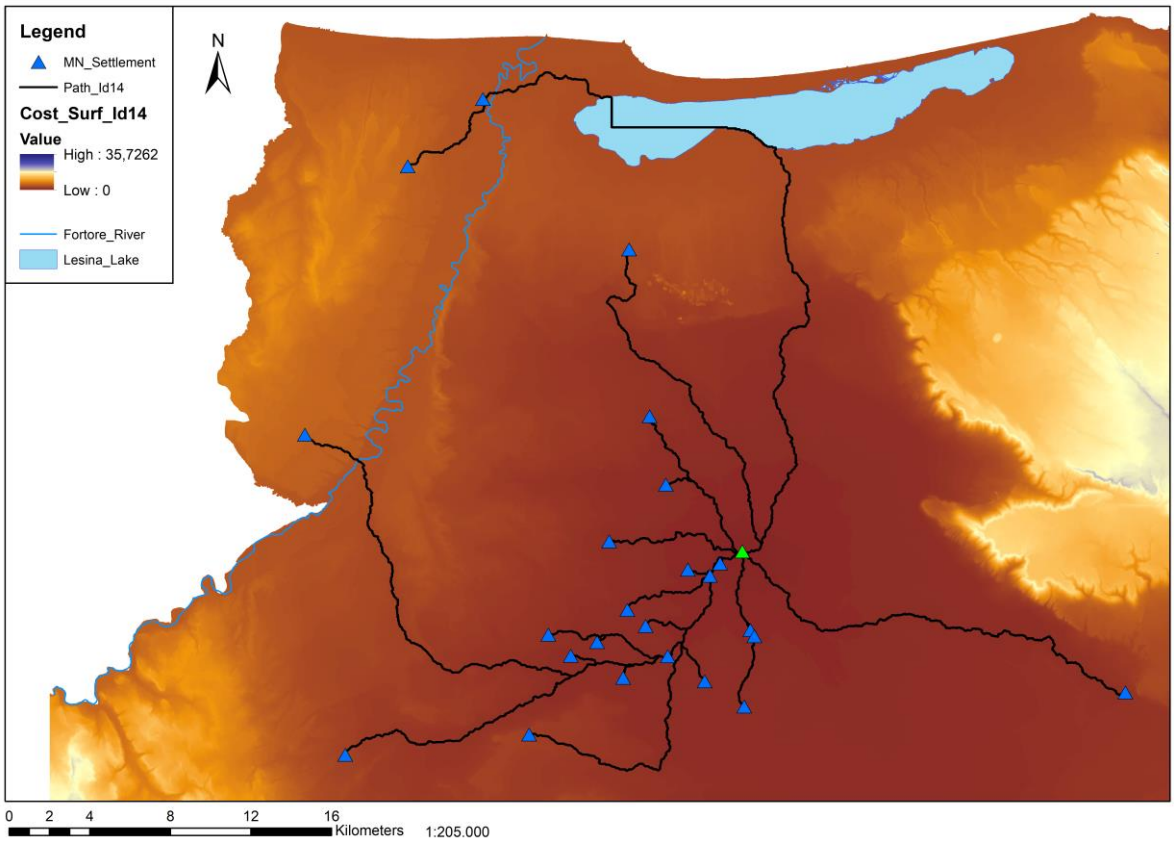


Table 73 – LPCA applied to Coppa d'Ovidio(id15)

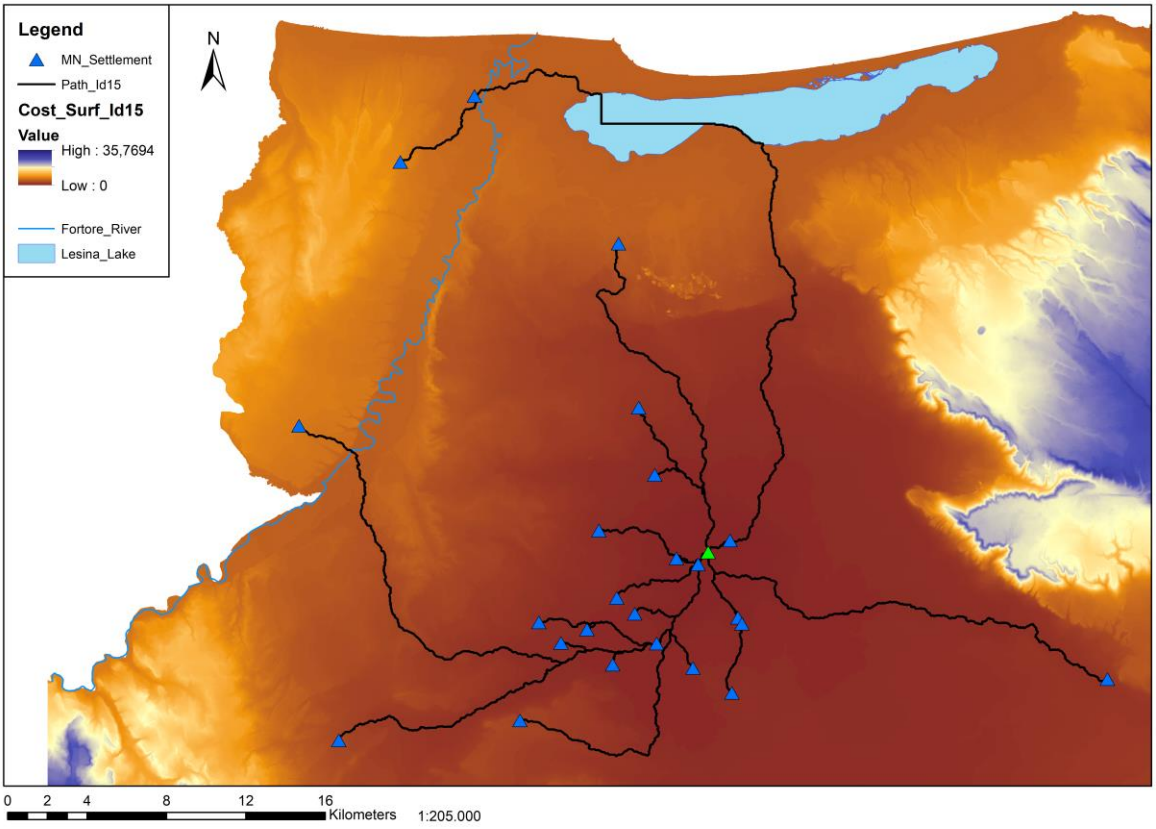


Table 74 – LPCA applied to Coppa Porci (id16)

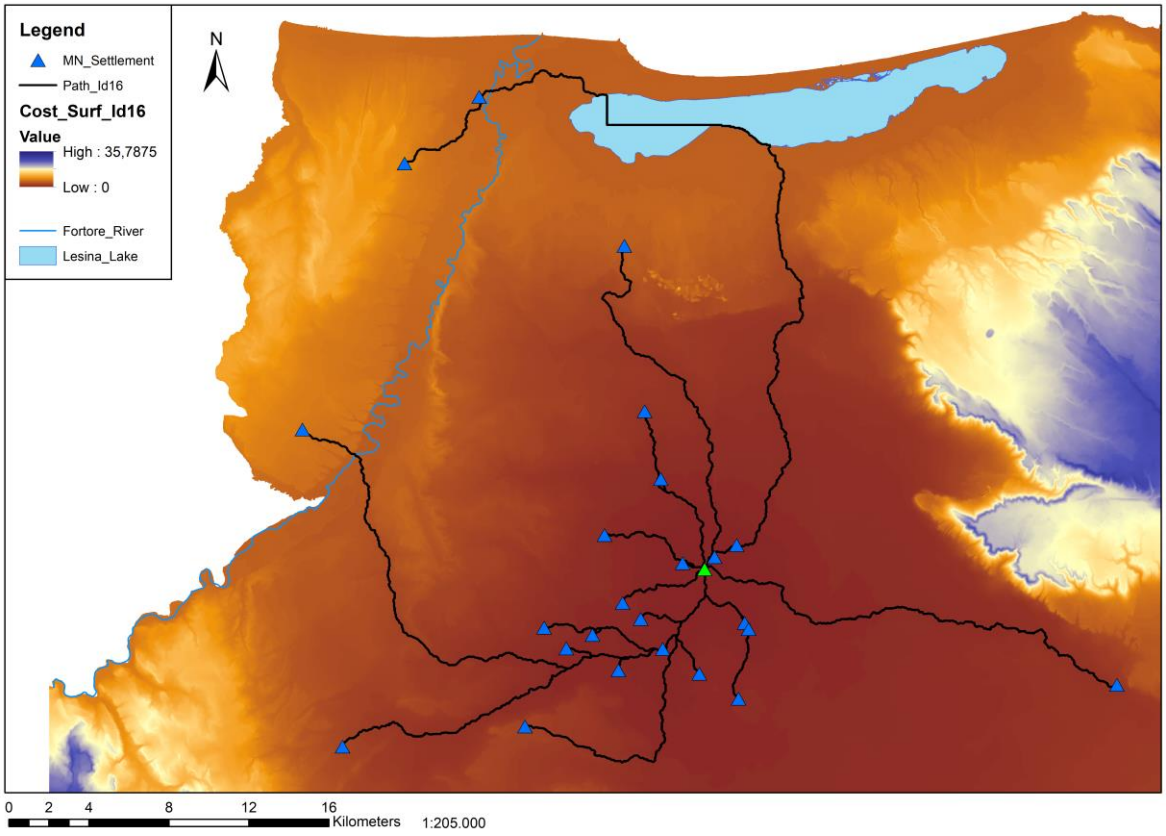


Table 75 – LPCA applied to Località Franceschiello (id17)

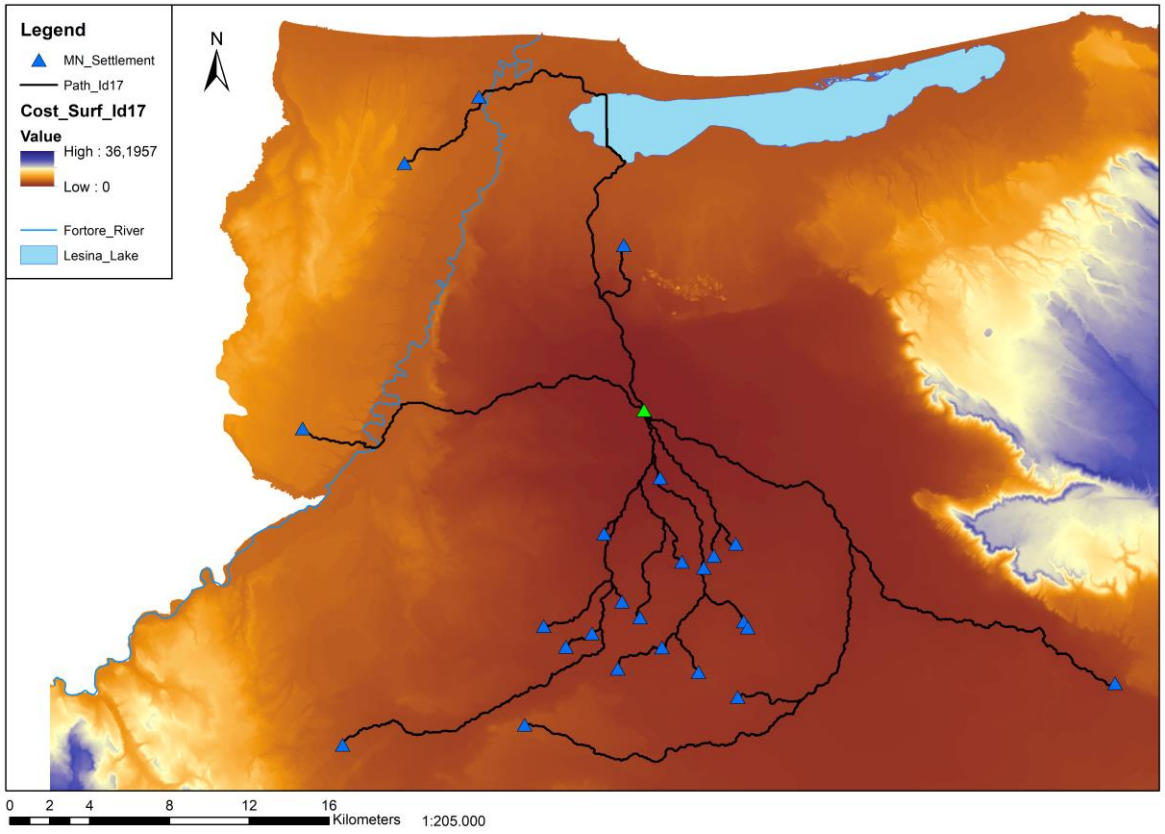


Table 76 – LPCA applied to Località Boschetto(id18)

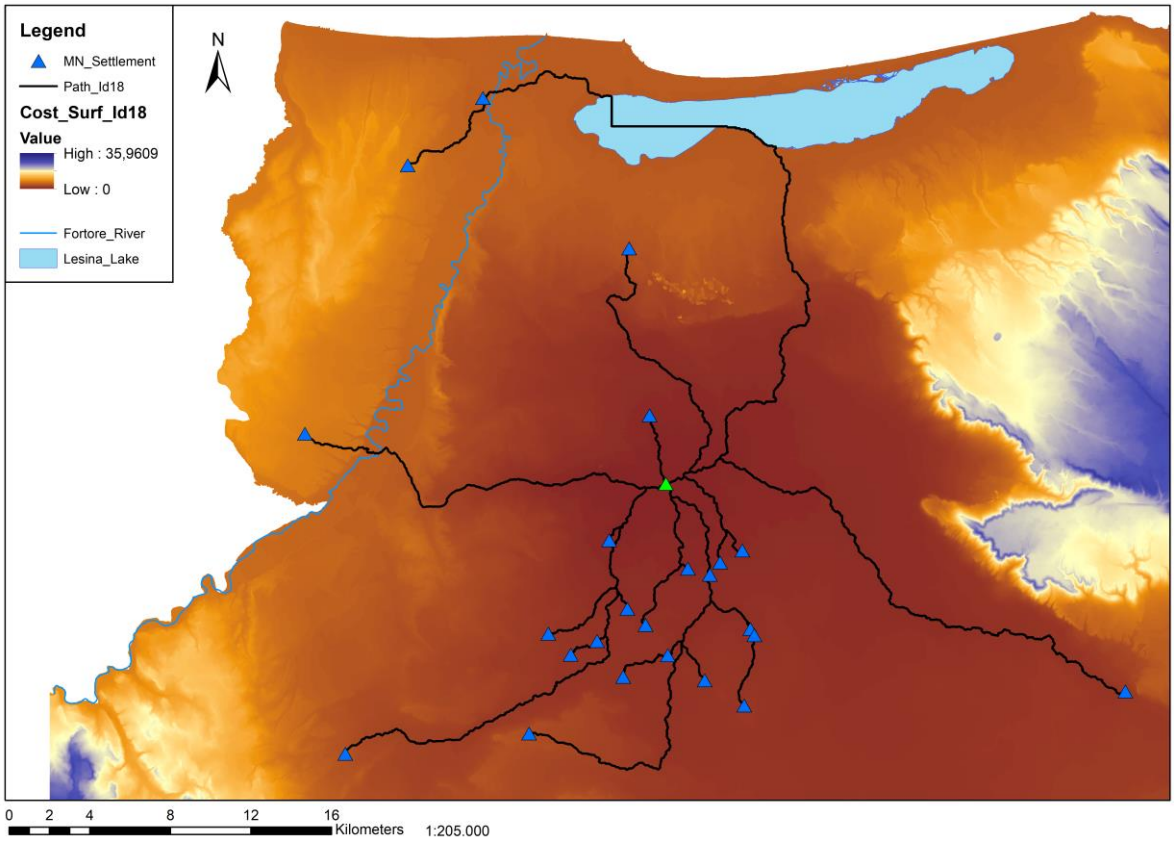


Table 77 – LPCA applied to Torretta Sant'Andrea (id19)

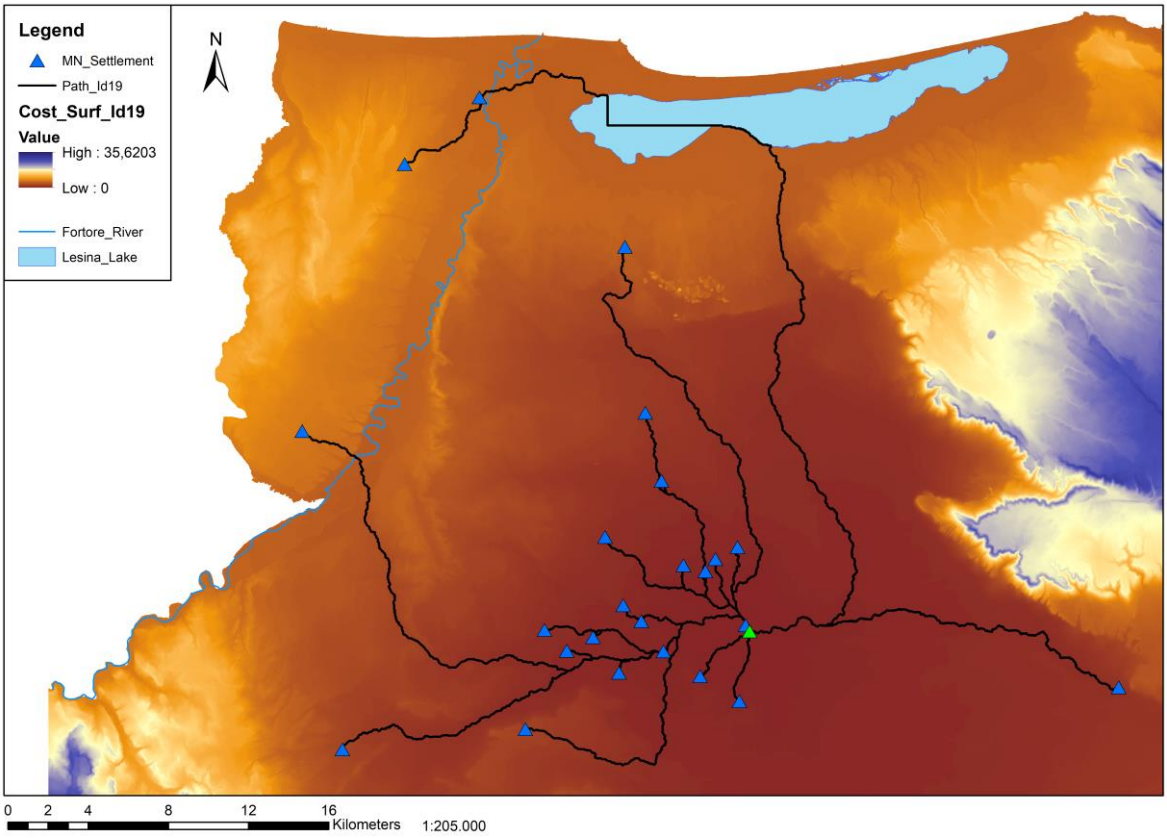


Table 78 – LPCA applied to San Rocco (id20)

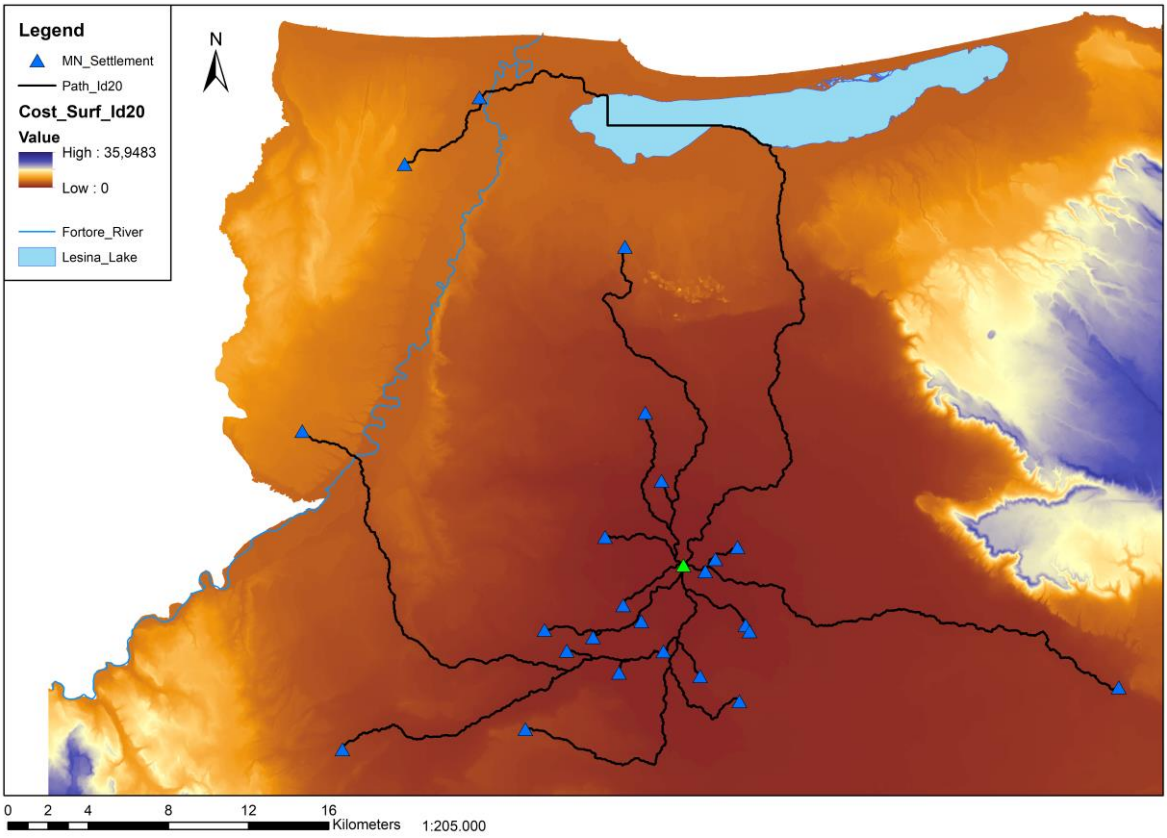


Table 79 – LPCA applied to Masseria Casalorda (id21)

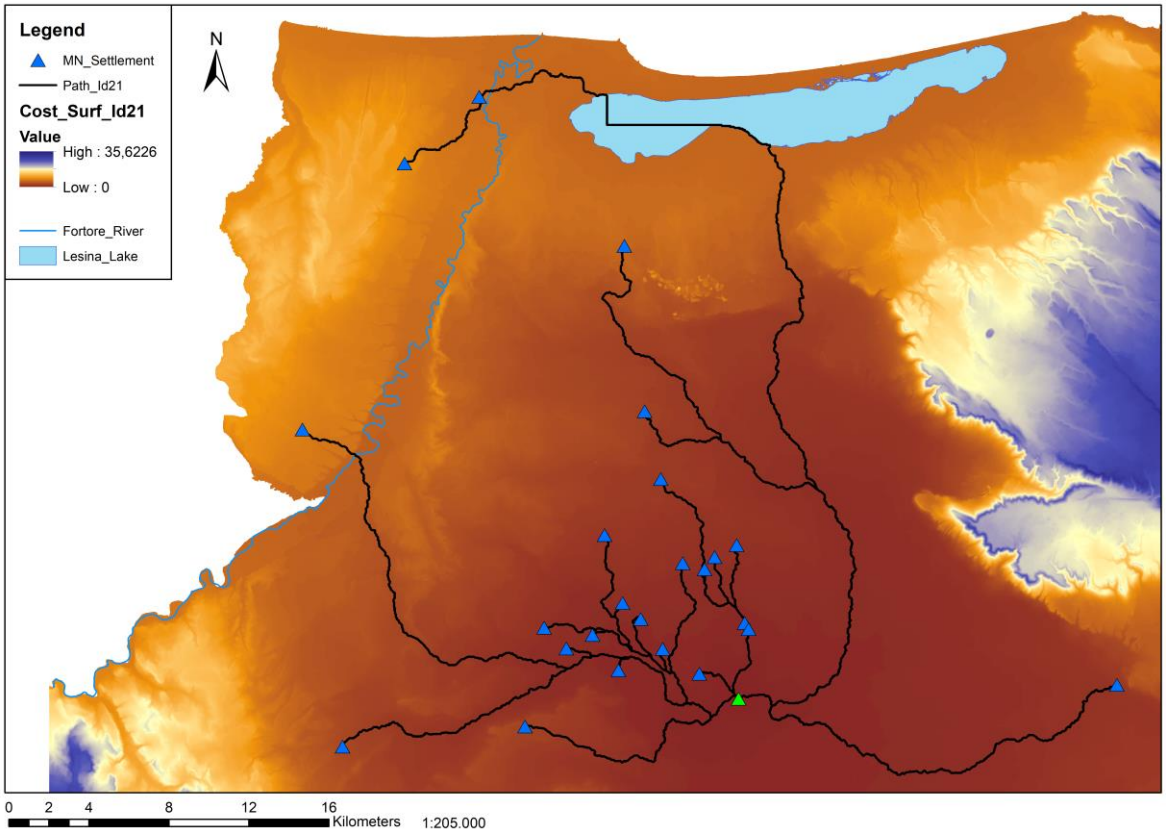


Table 80 – LPCA applied to Località Florio-Ricci (id22)

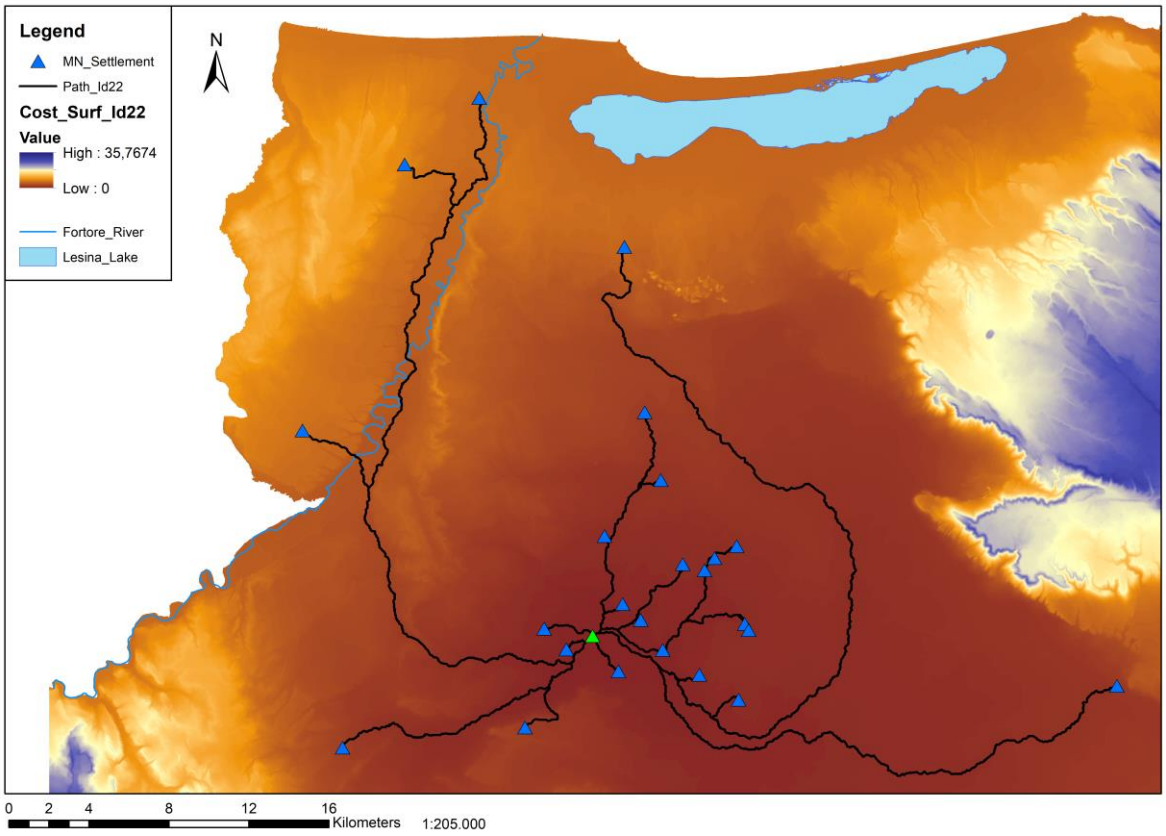


Table 81 – LPCA applied to Castellana (id23)

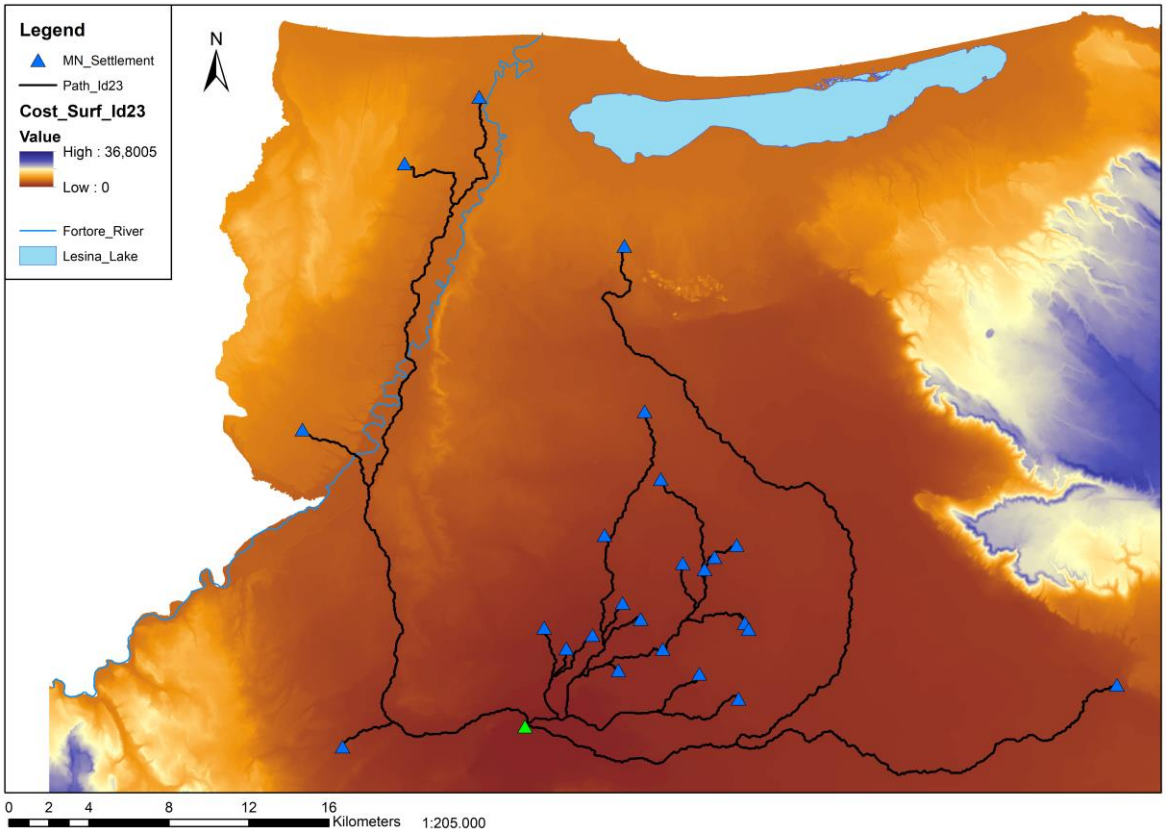


Table 82 – LPCA applied to Località Santa Maria (id24)

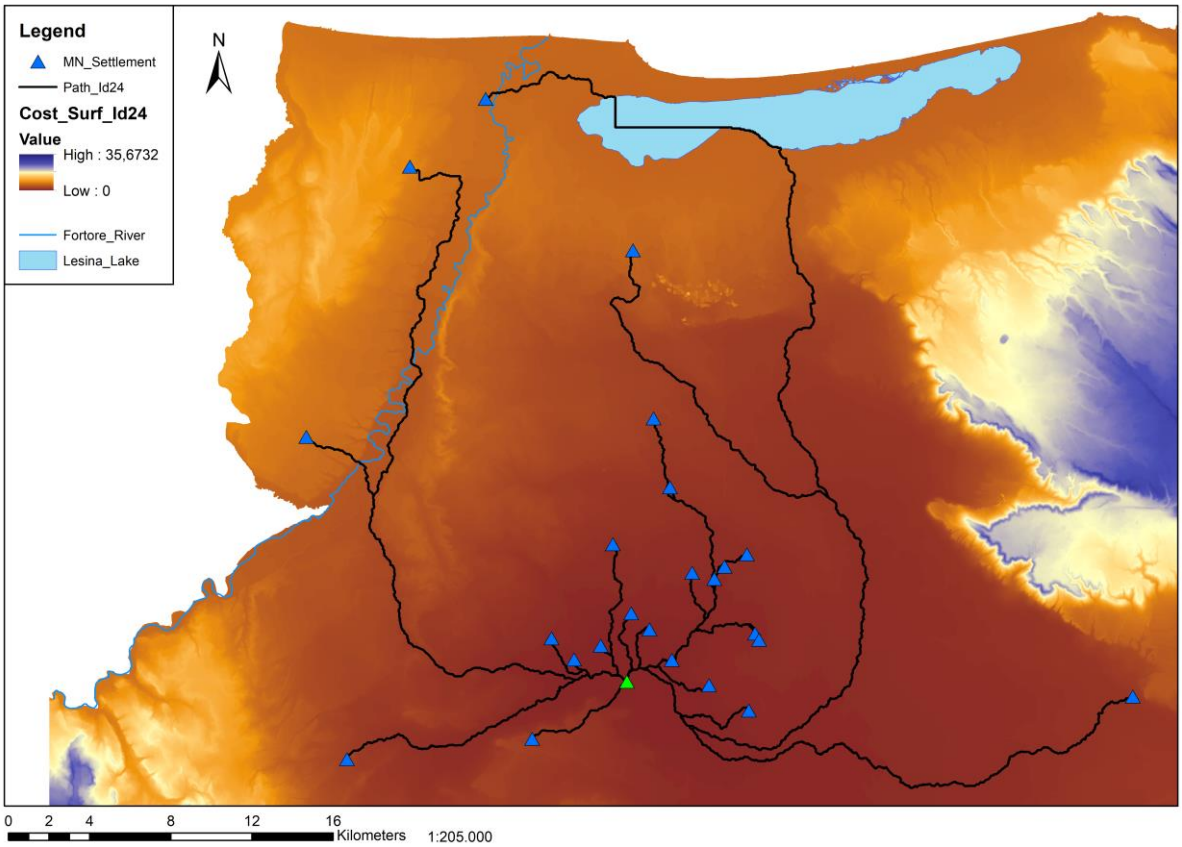
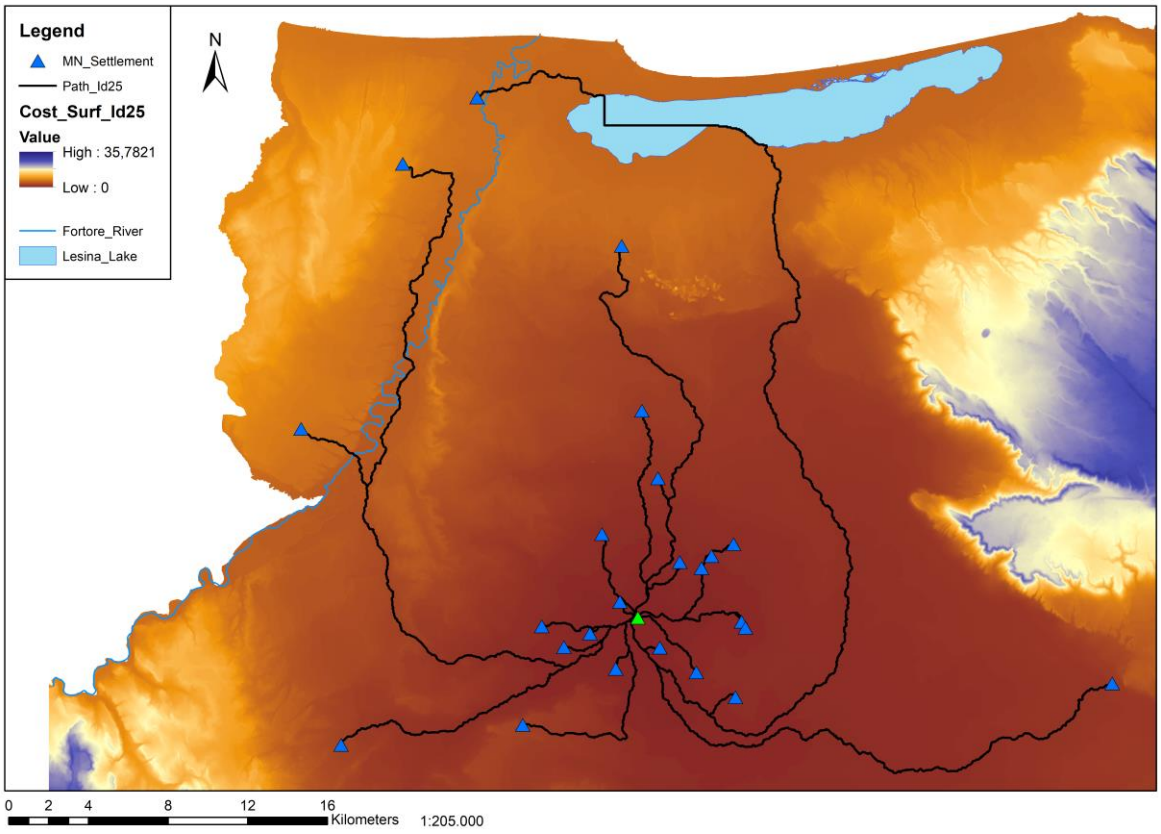


Table 83 – LPCA applied to Masseria Parisi (id25)



FINAL NEOLITHIC

Table 84 – LPCA applied to Cammarata (id1)

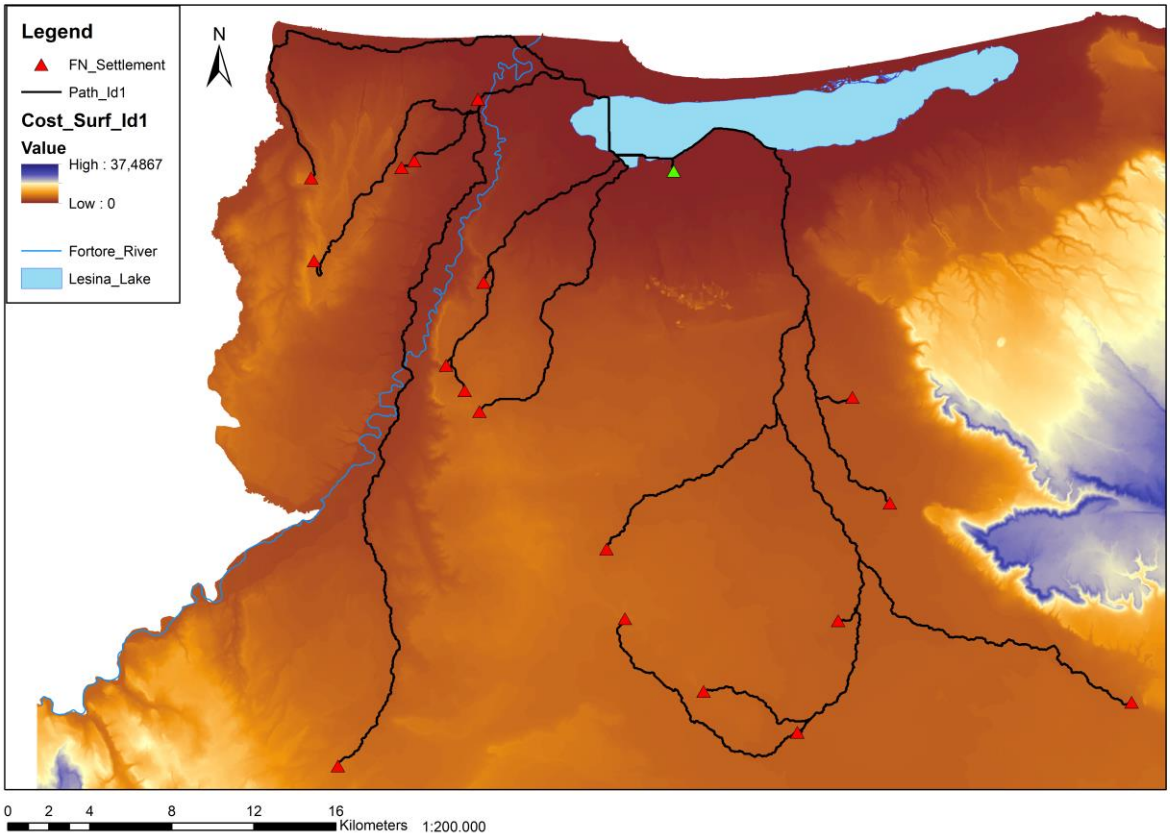


Table 85 – LPCA applied to Masseria Istituto di Sangro (id2)

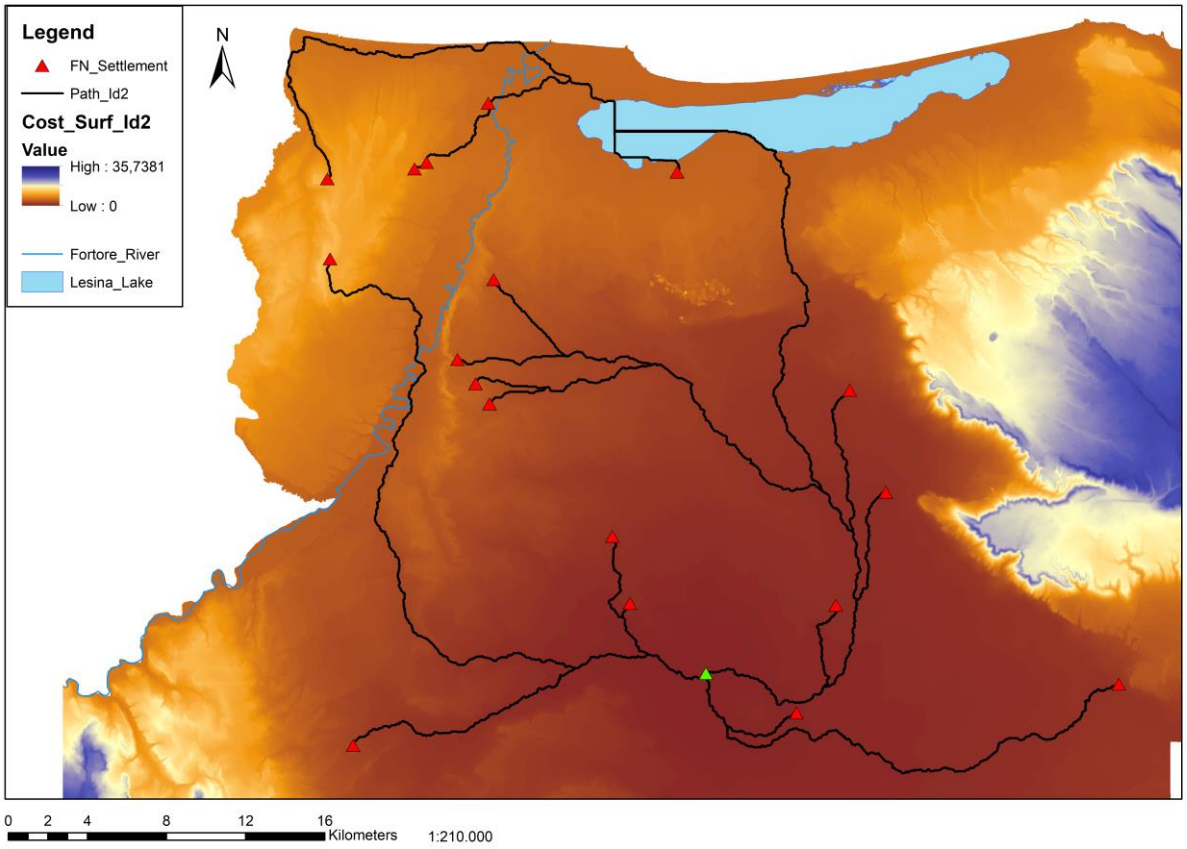


Table 86 – LPCA applied to Malchieuti (id3)

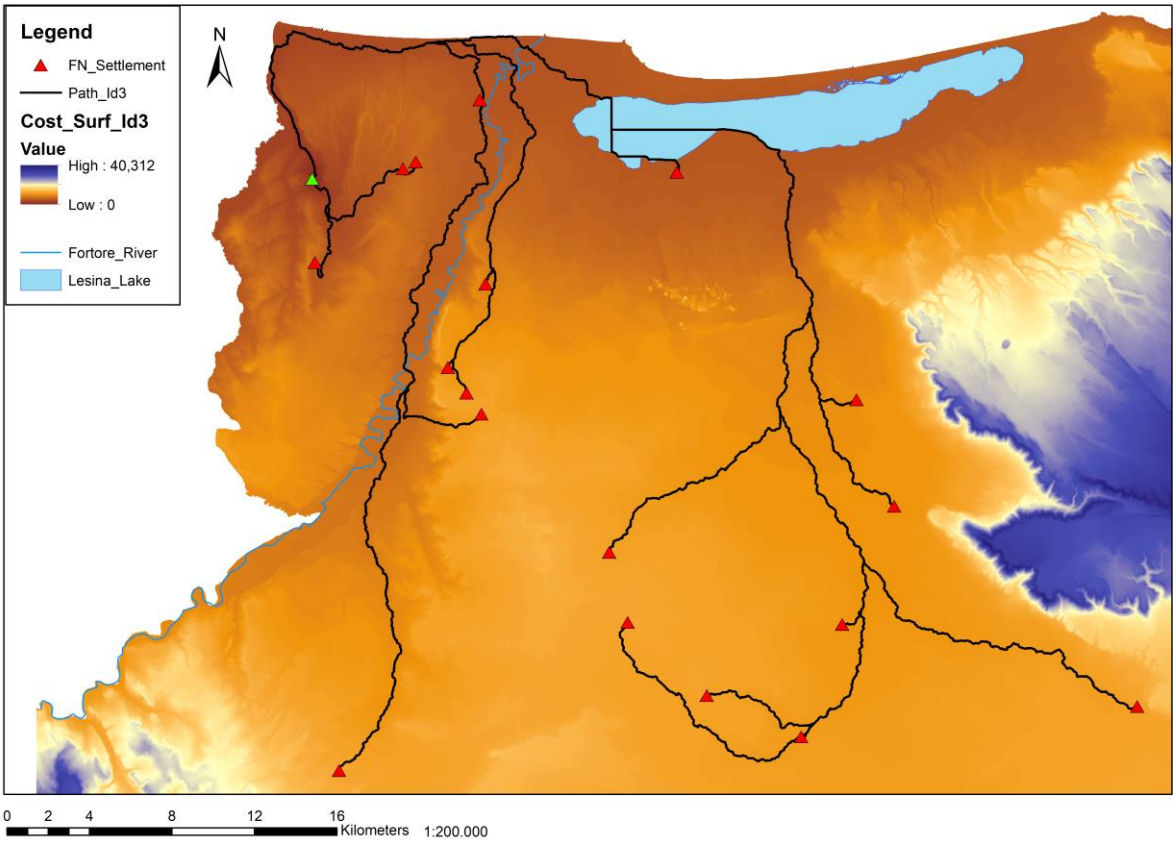


Table 87 – LPCA applied to Località Piano Navuccio (id4)

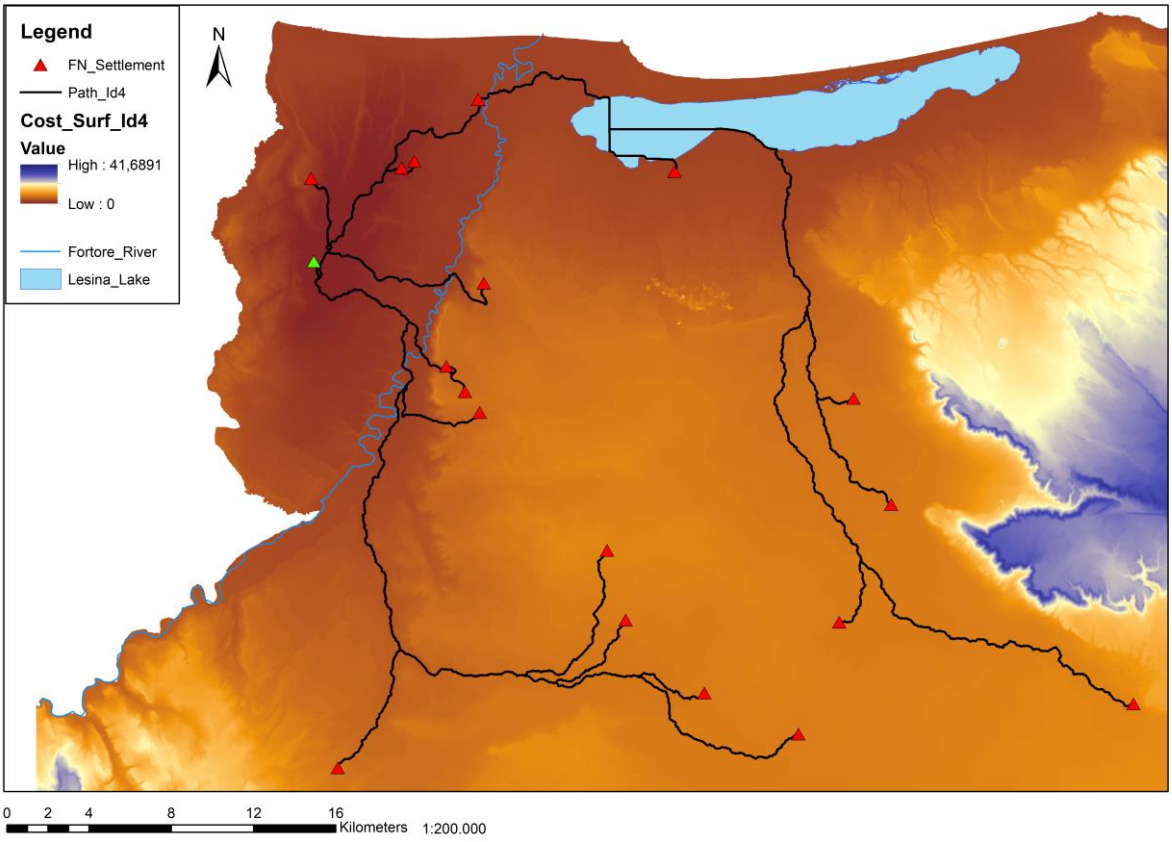


Table 88 – LPCA applied to Piani di Lauria (id5)

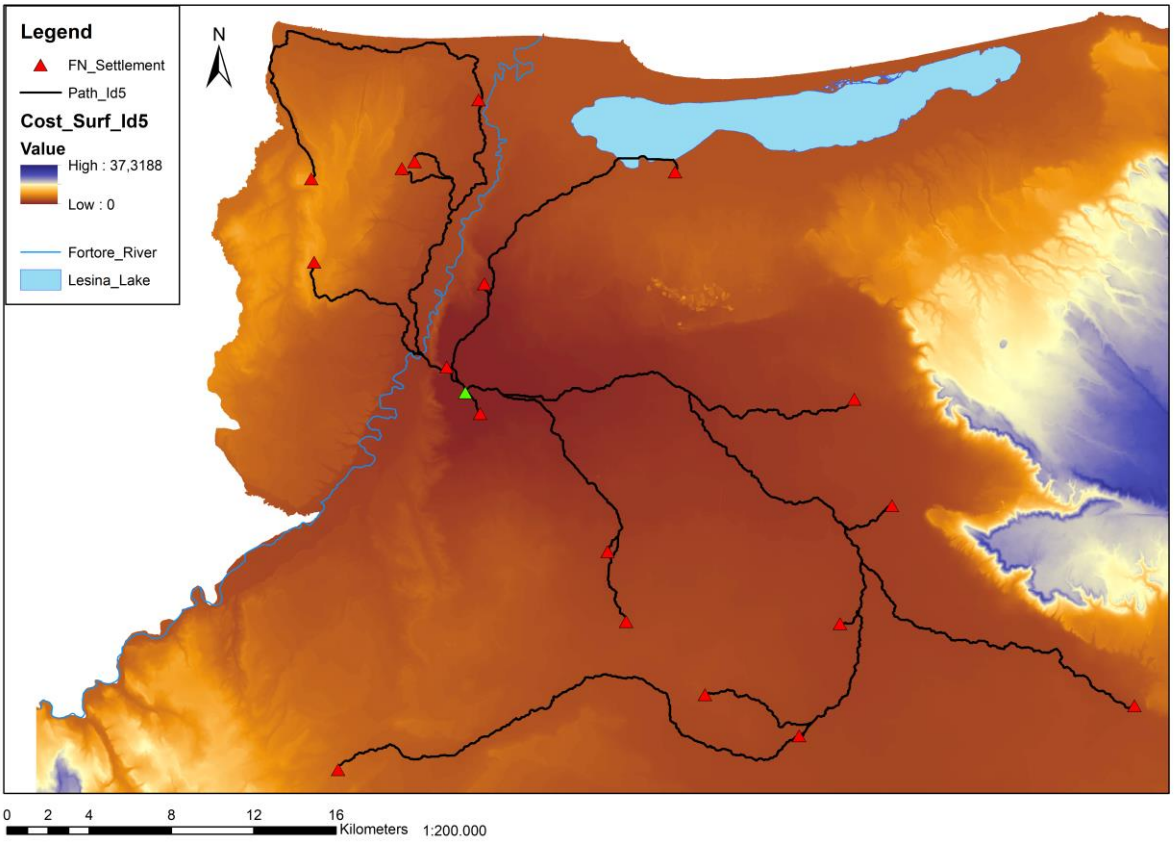


Table 89 – LPCA applied to Mezzana della Quercia (id6)

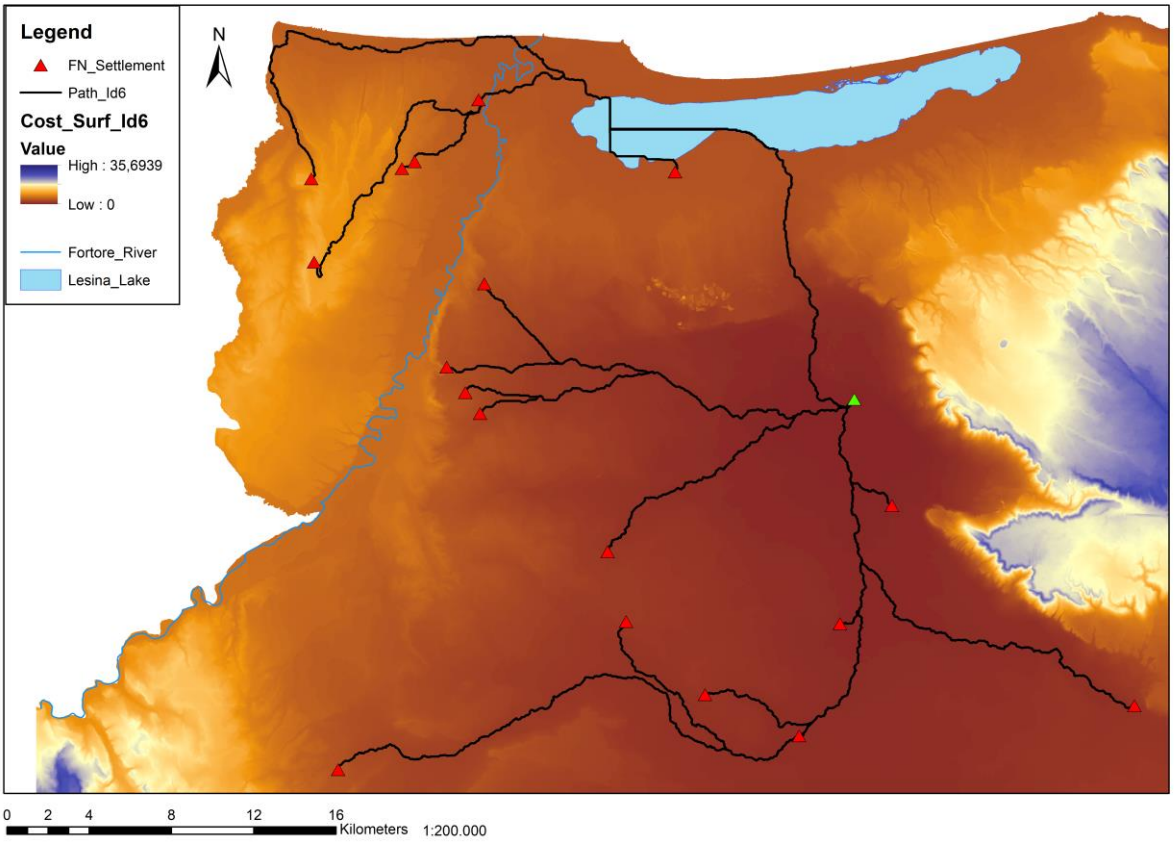


Table 90 – LPCA applied to Masseria Pagliari (id7)

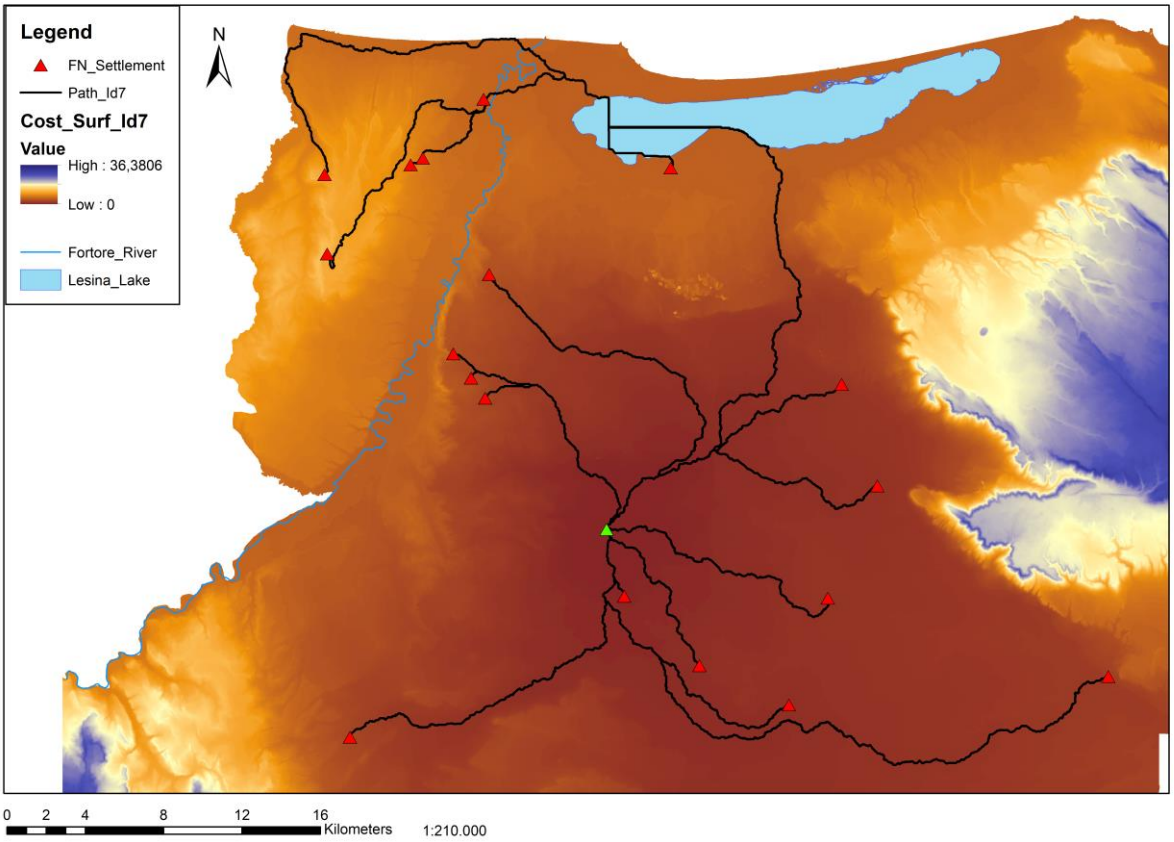


Table 91 – LPCA applied to Coppa Pallante (id8)

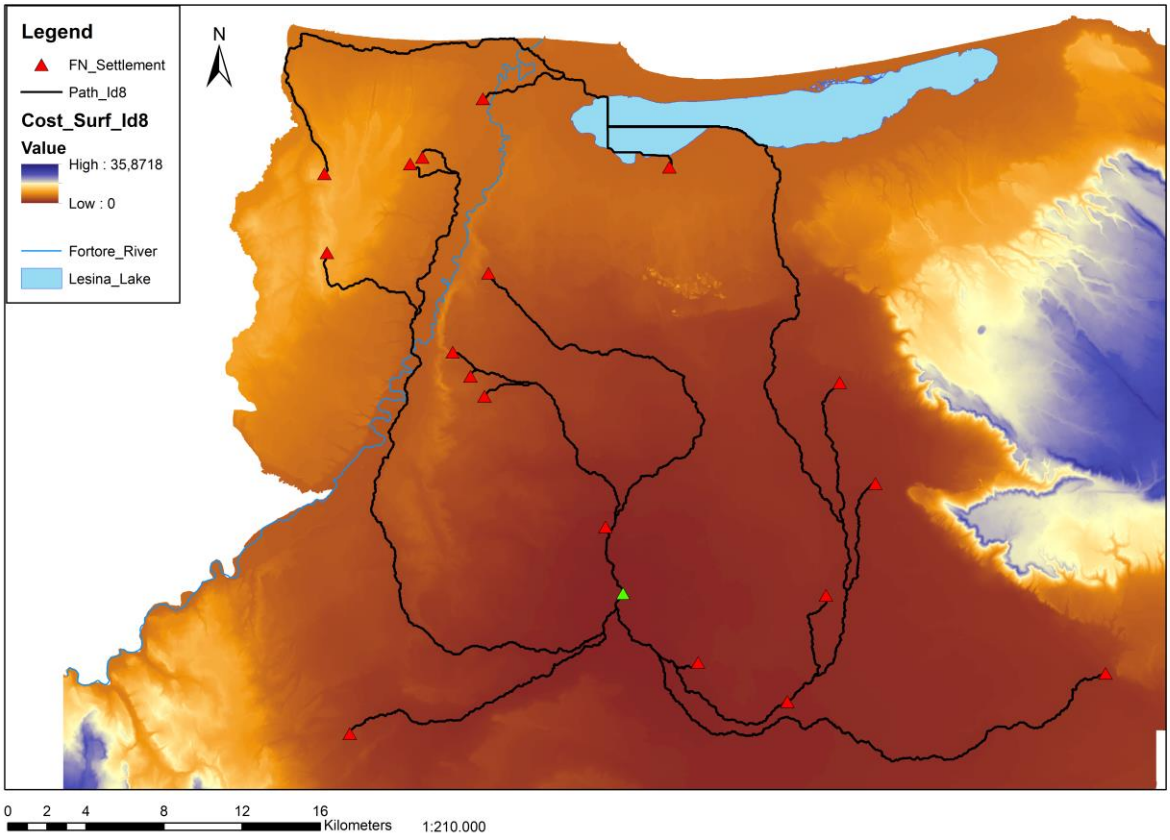


Table 92 – LPCA applied to Masseria Torretta (id9)

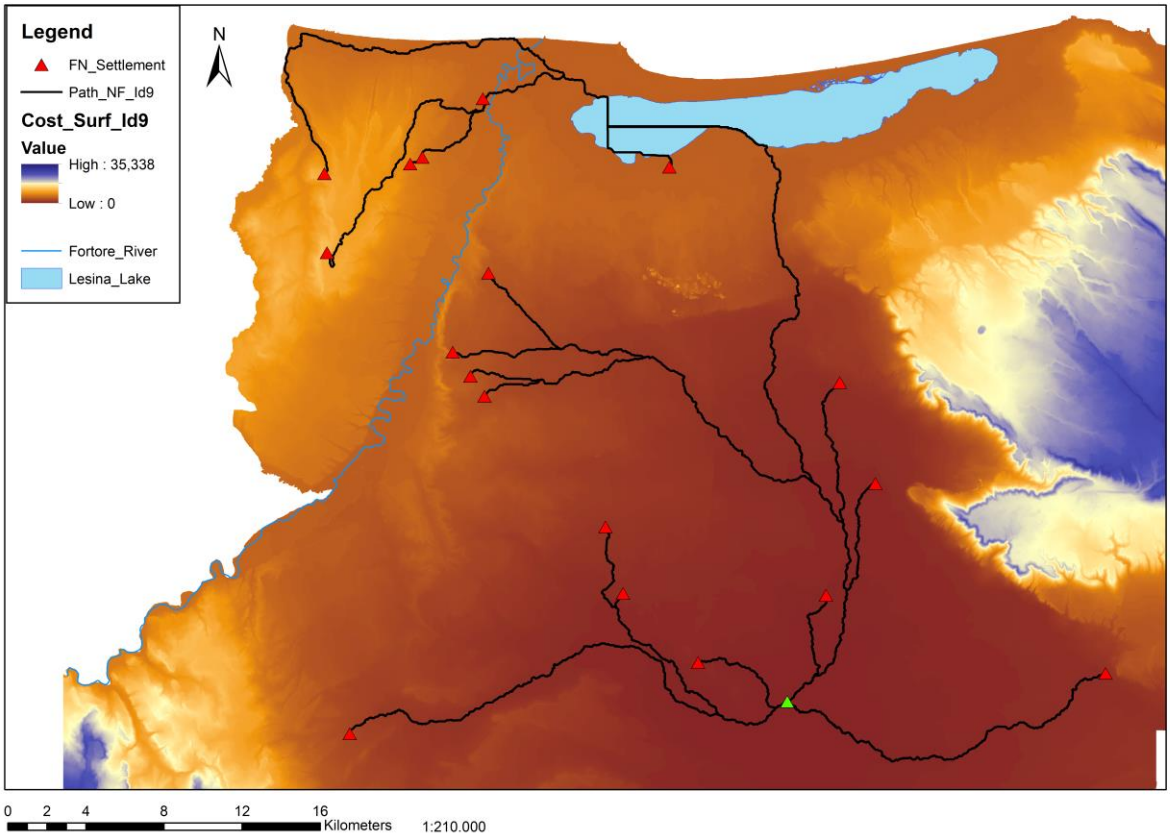


Table 93 – LPCA applied to Ciccalento (id10)

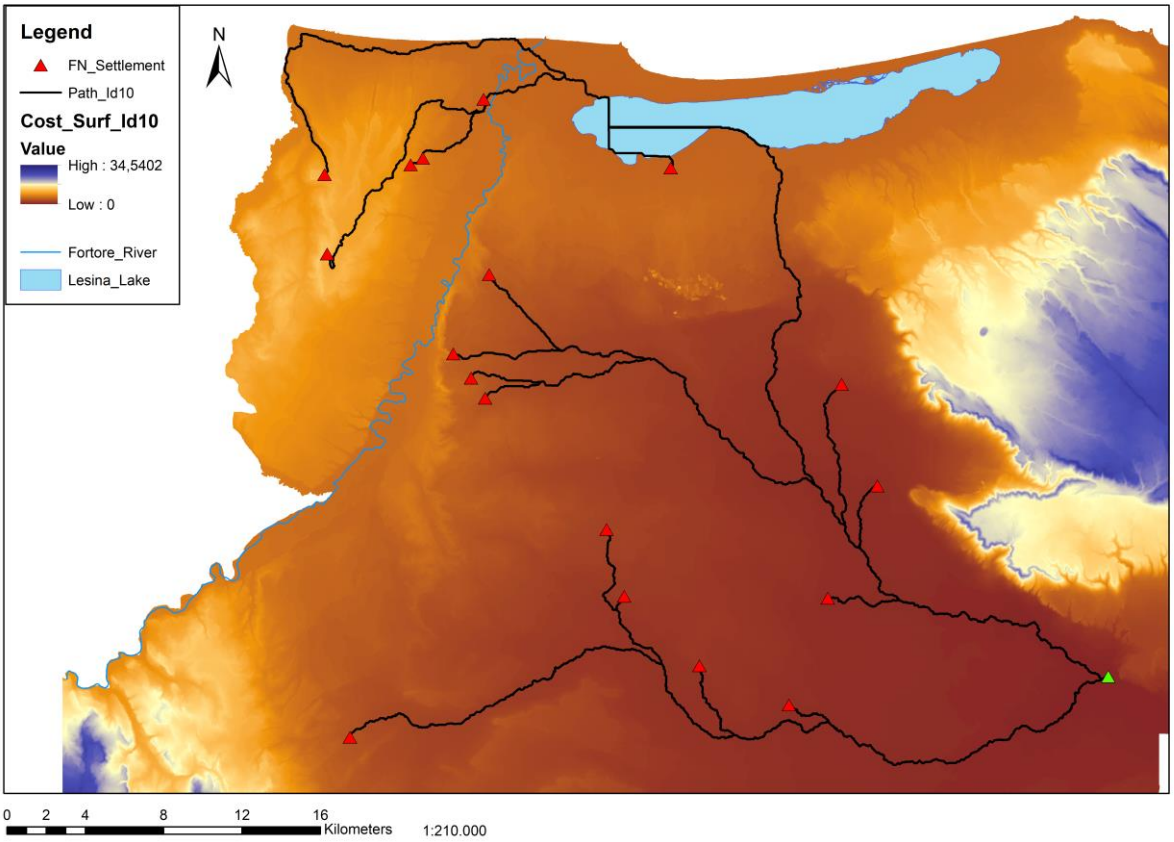


Table 94 – LPCA applied to Pian Devoto (id11)

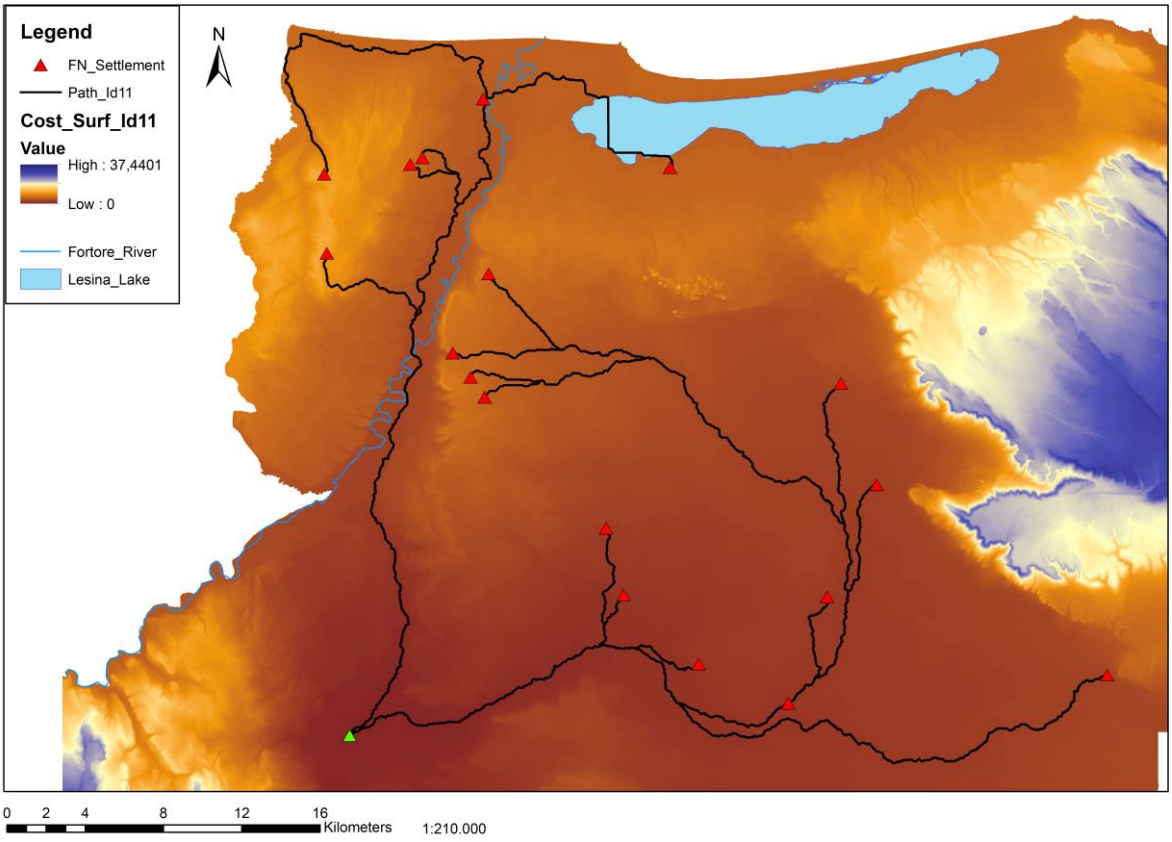


Table 95 – LPCA applied to Mezzanella di Brancia (id12)

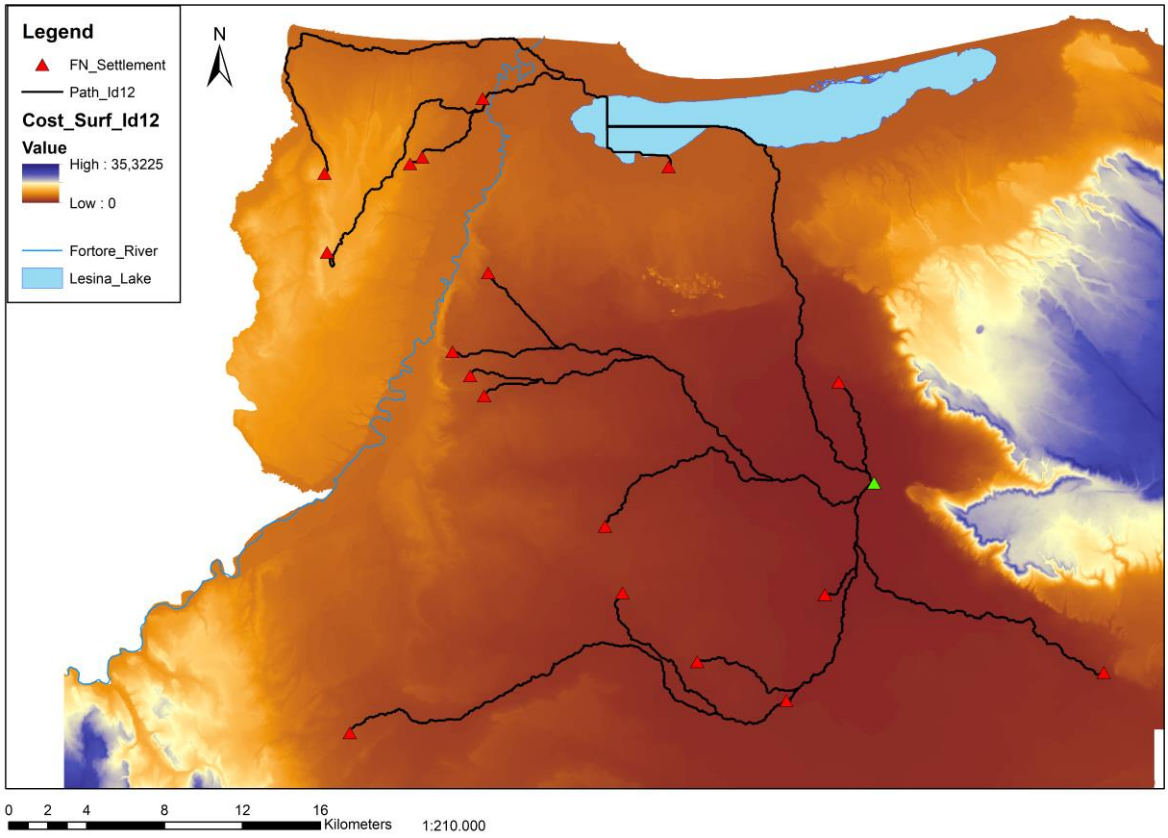


Table 96 – LPCA applied to Chiarappa (id13)

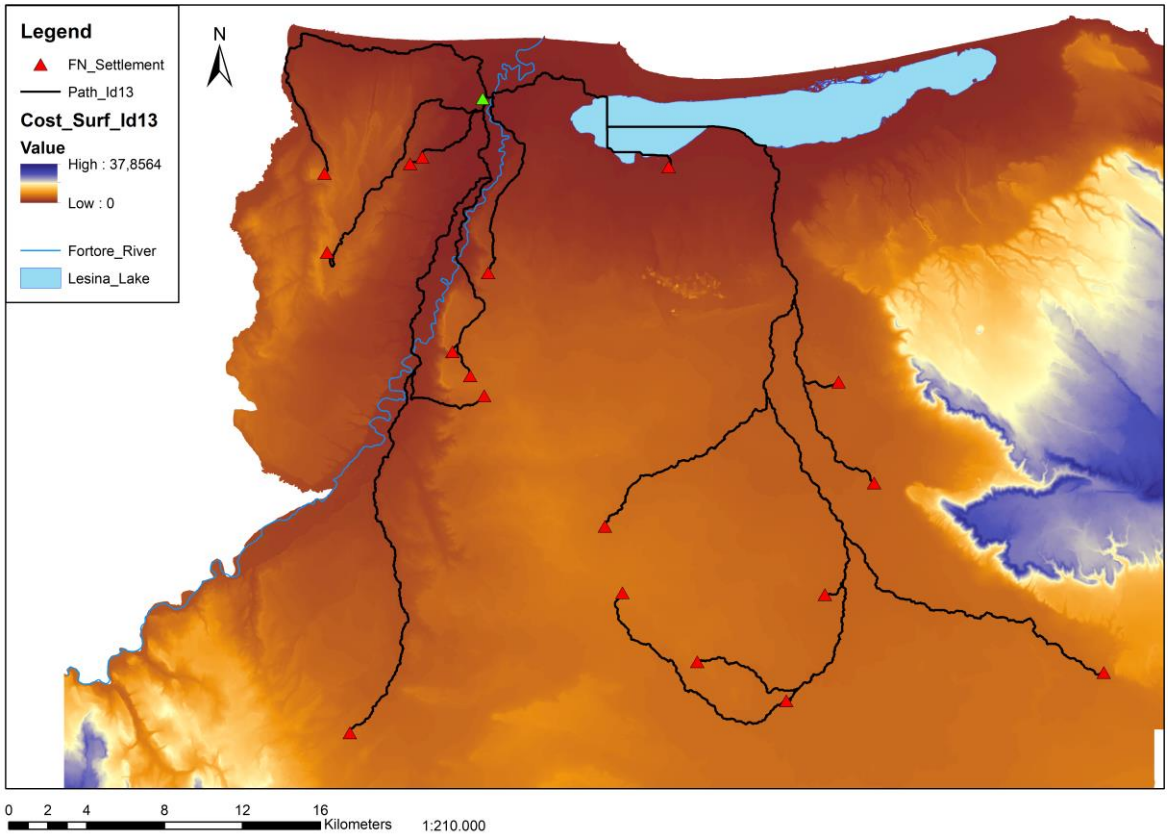


Table 97 – LPCA applied to Coppe di Rose (id14)

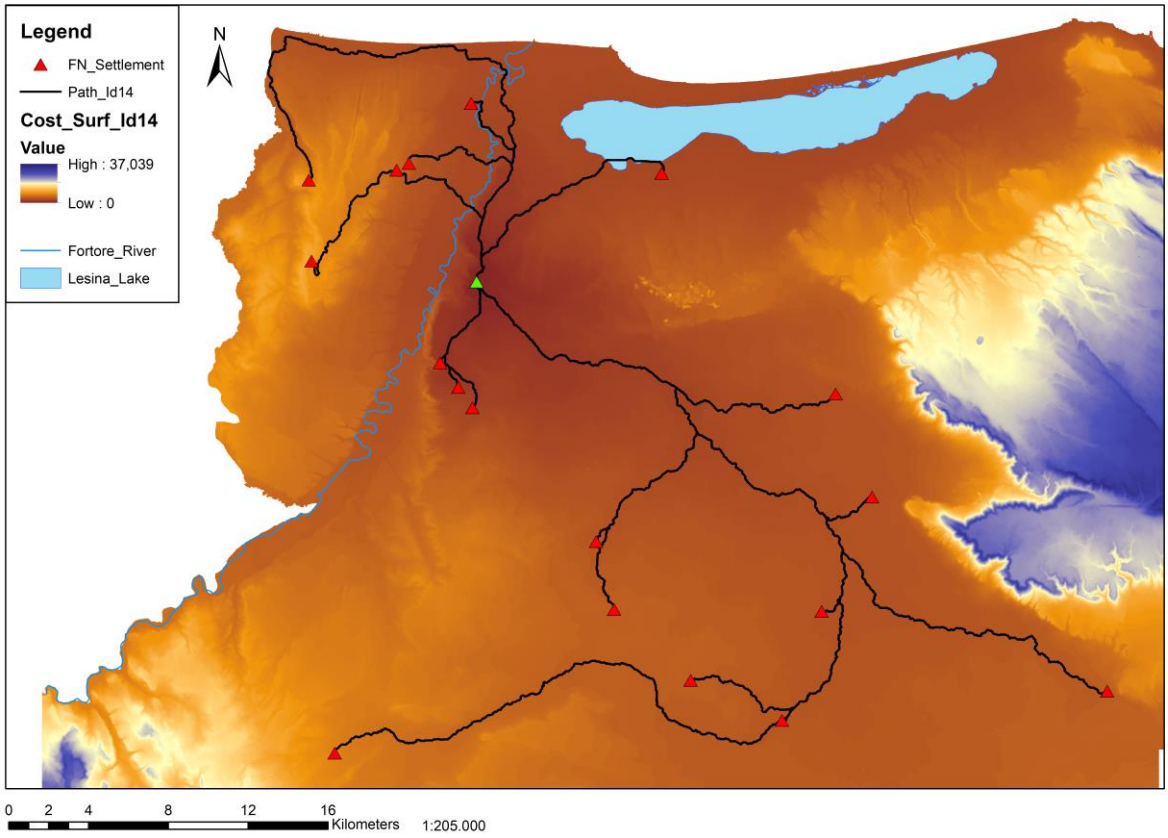


Table 98 – LPCA applied to Portata Casone (id15)

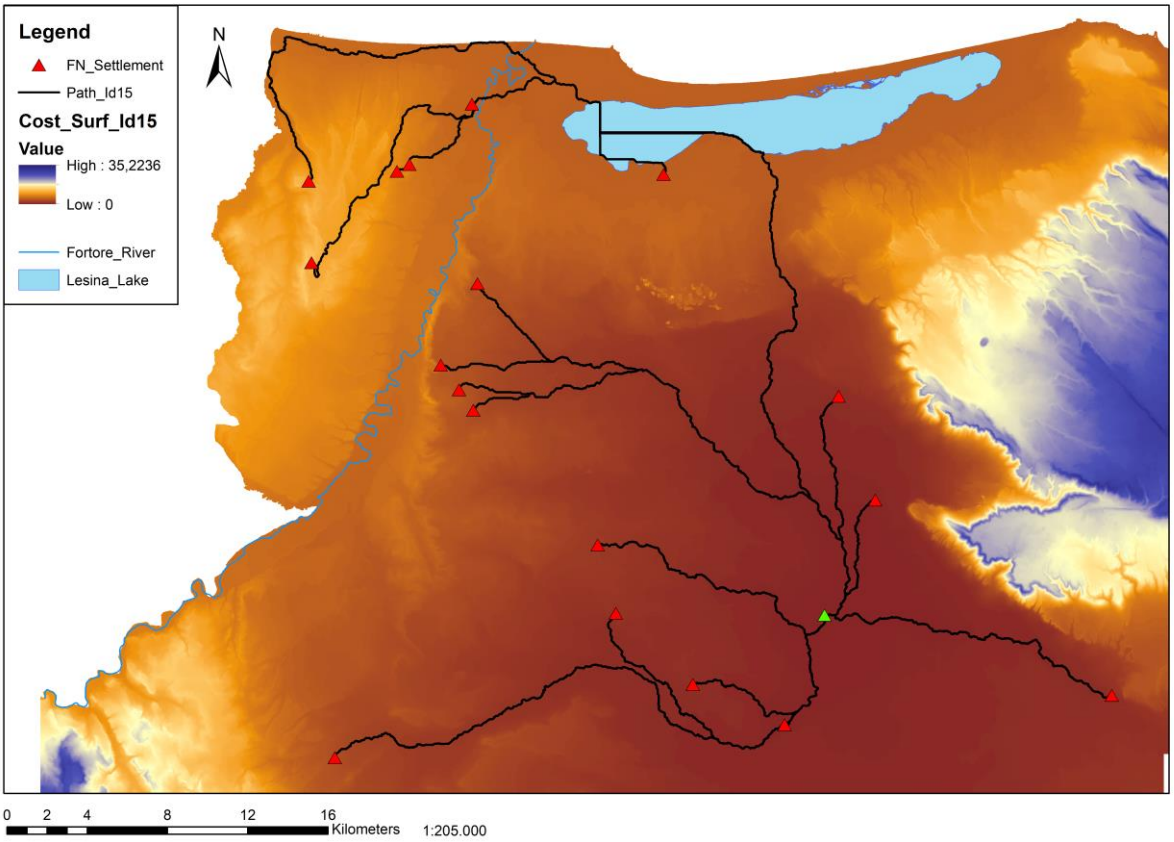


Table 99 – LPCA applied to Piani di Lauria (id16)

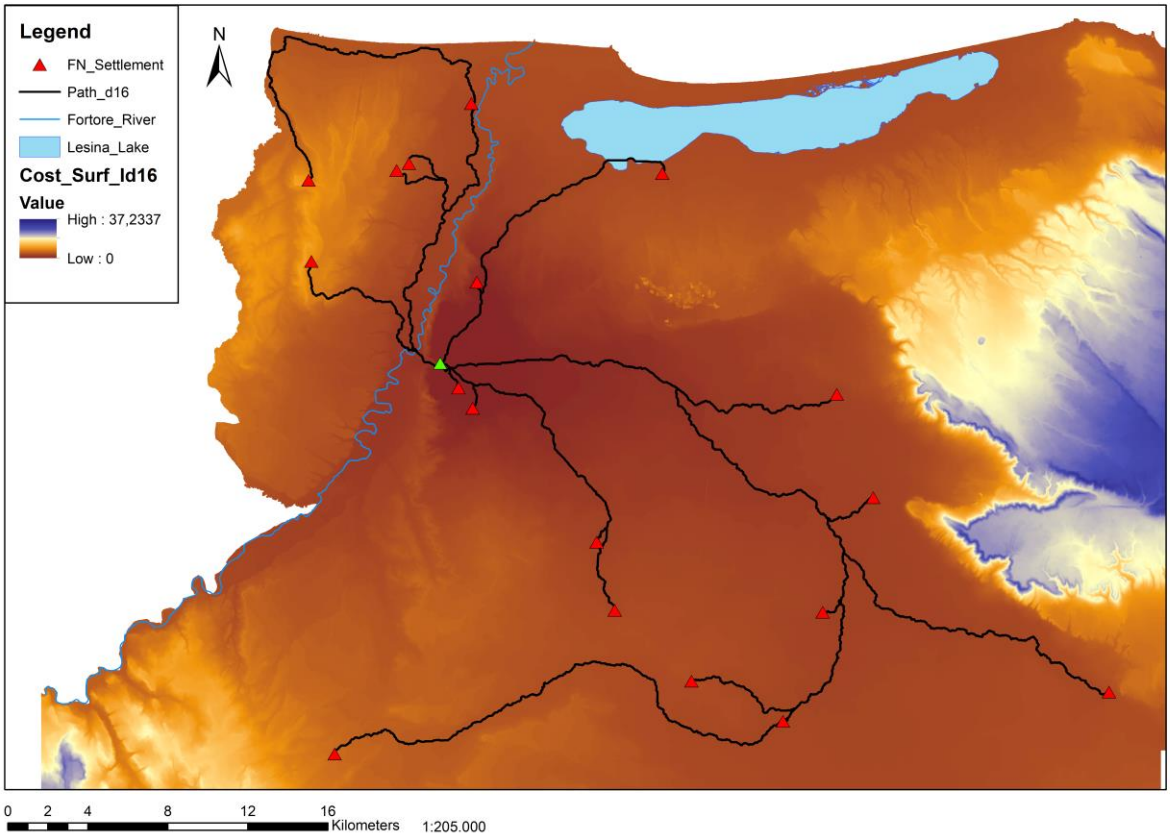


Table 100 – LPCA applied to Colle di Creta (id17)

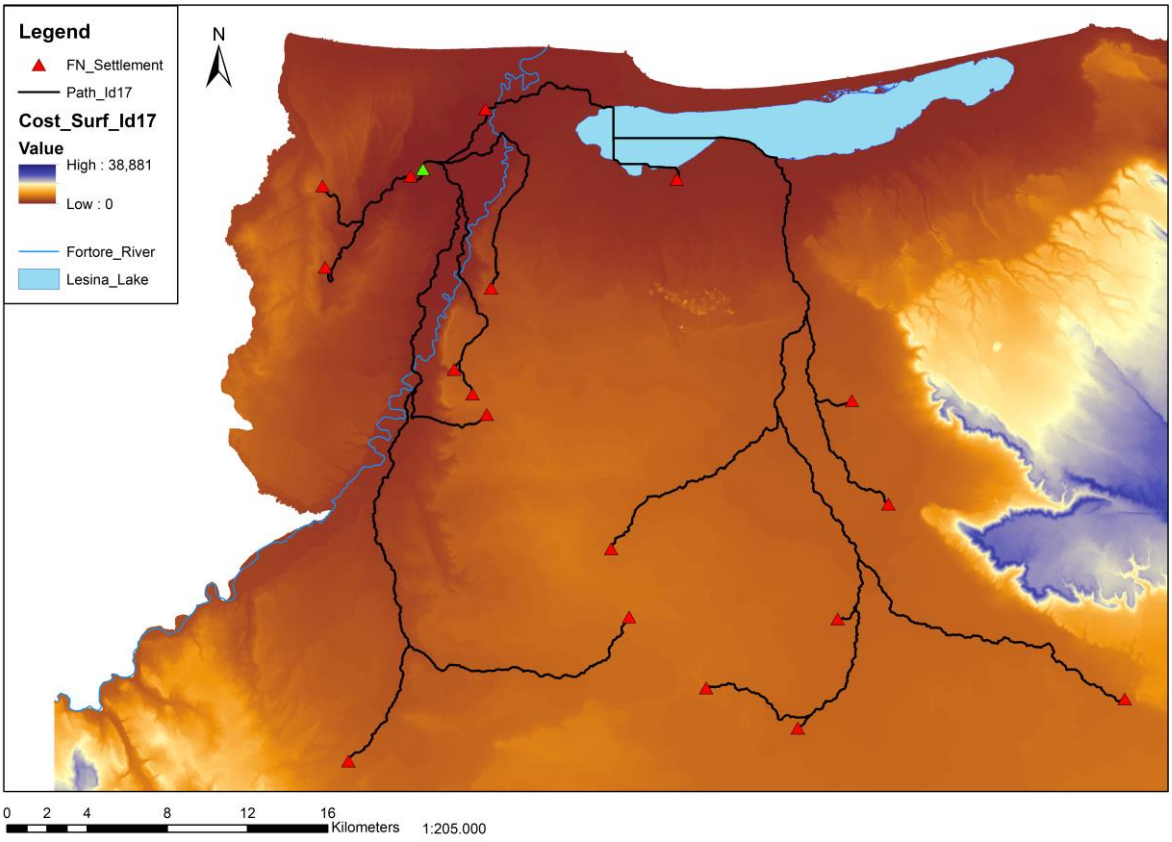


Table 101 – LPCA applied to Coppa dell'Olmo (id18)

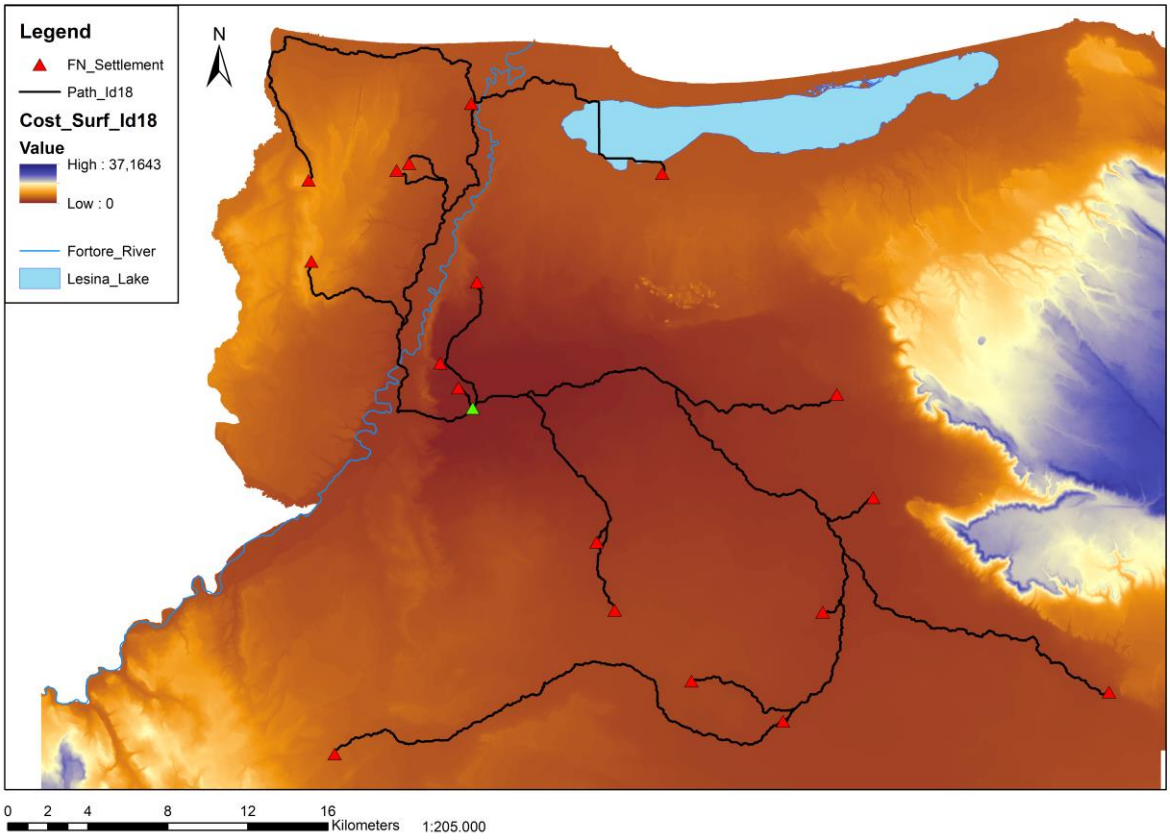
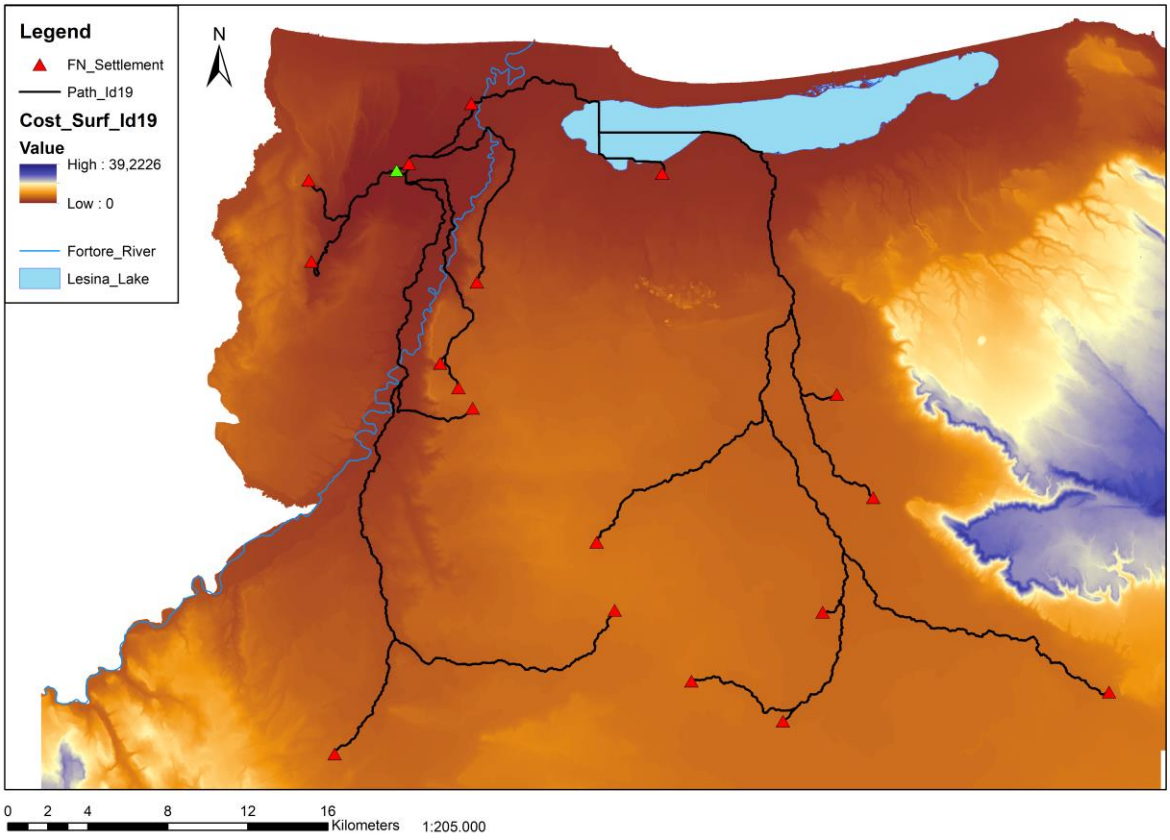


Table 102 – LPCA applied to San Matteo-Chiantinelle (id19)



EARLY AND MIDDLE COPPER AGE

Table 103 – LPCA applied to Fischino (id1)

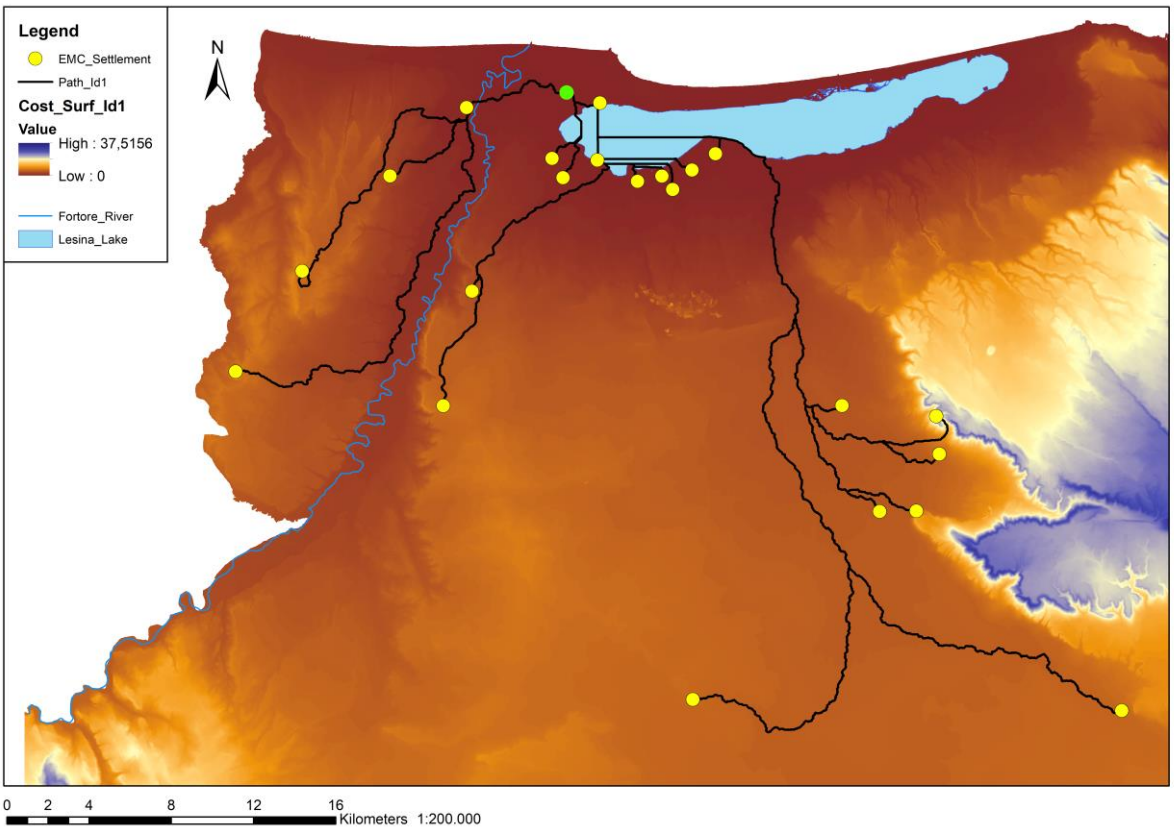


Table 104 – LPCA applied to Pontone (id2)

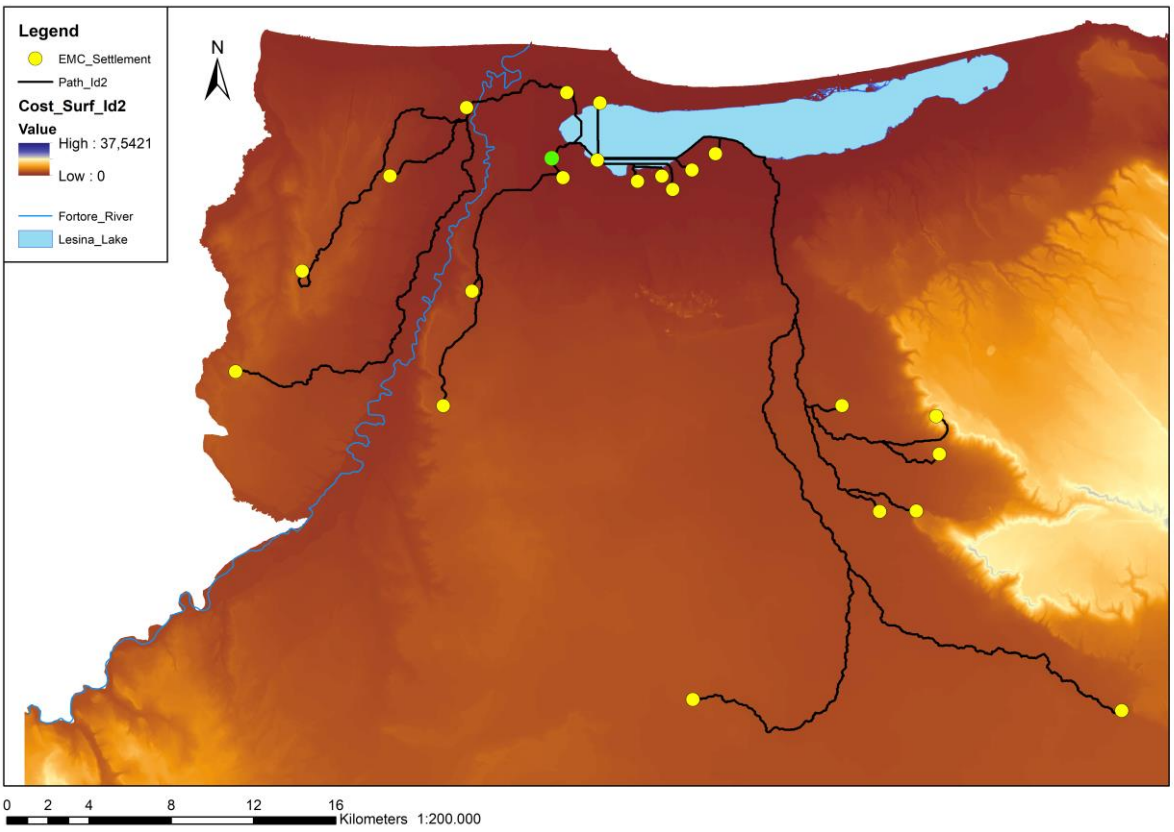


Table 105 – LPCA applied to Canelle al Muro (id3)

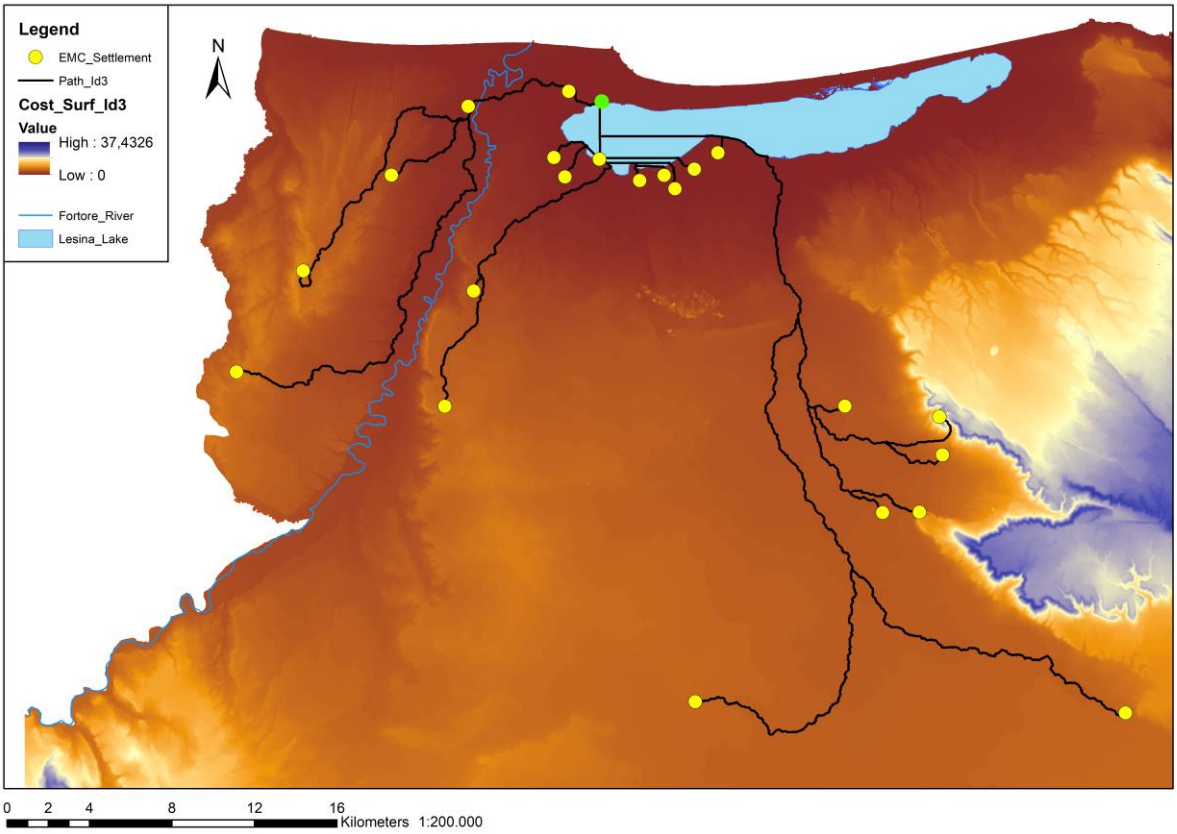


Table 106 – LPCA applied to Posta Corfiati (a.k.a. Colonnella) (id4)

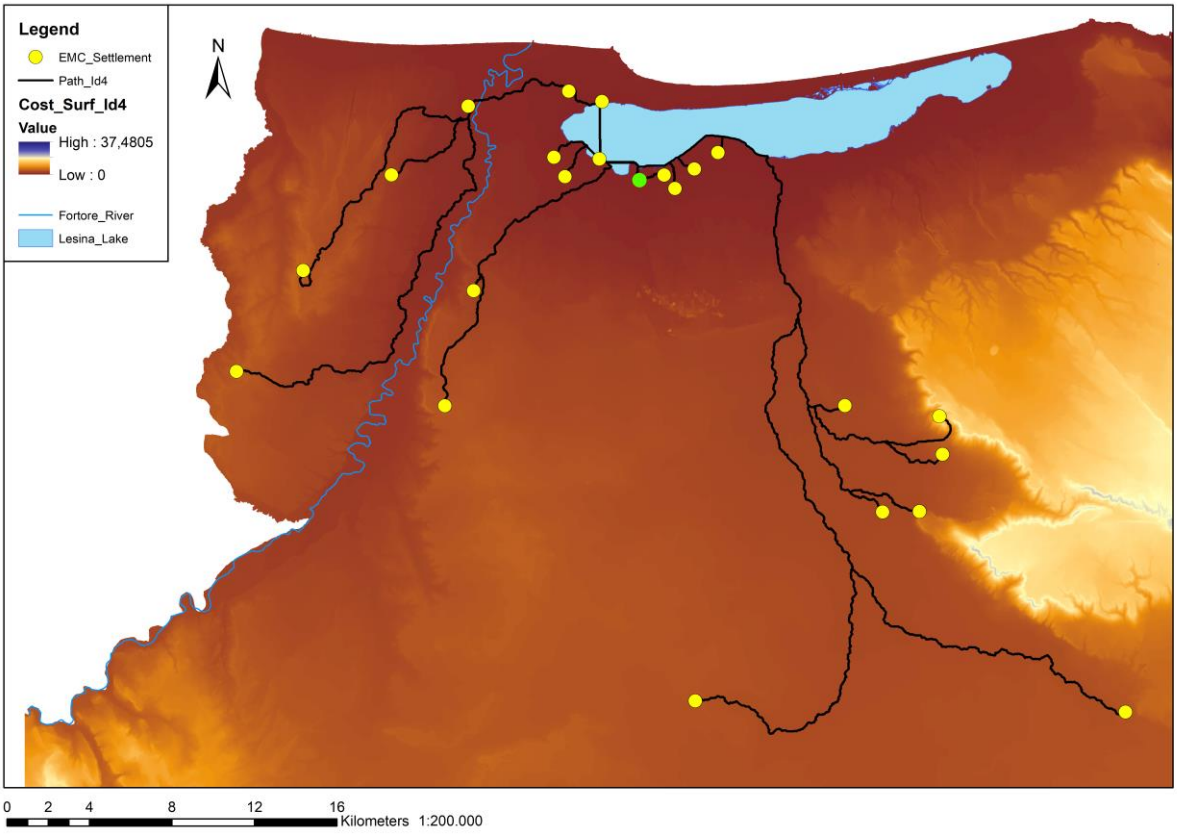


Table 107 – LPCA applied to Palude Grande (id5)

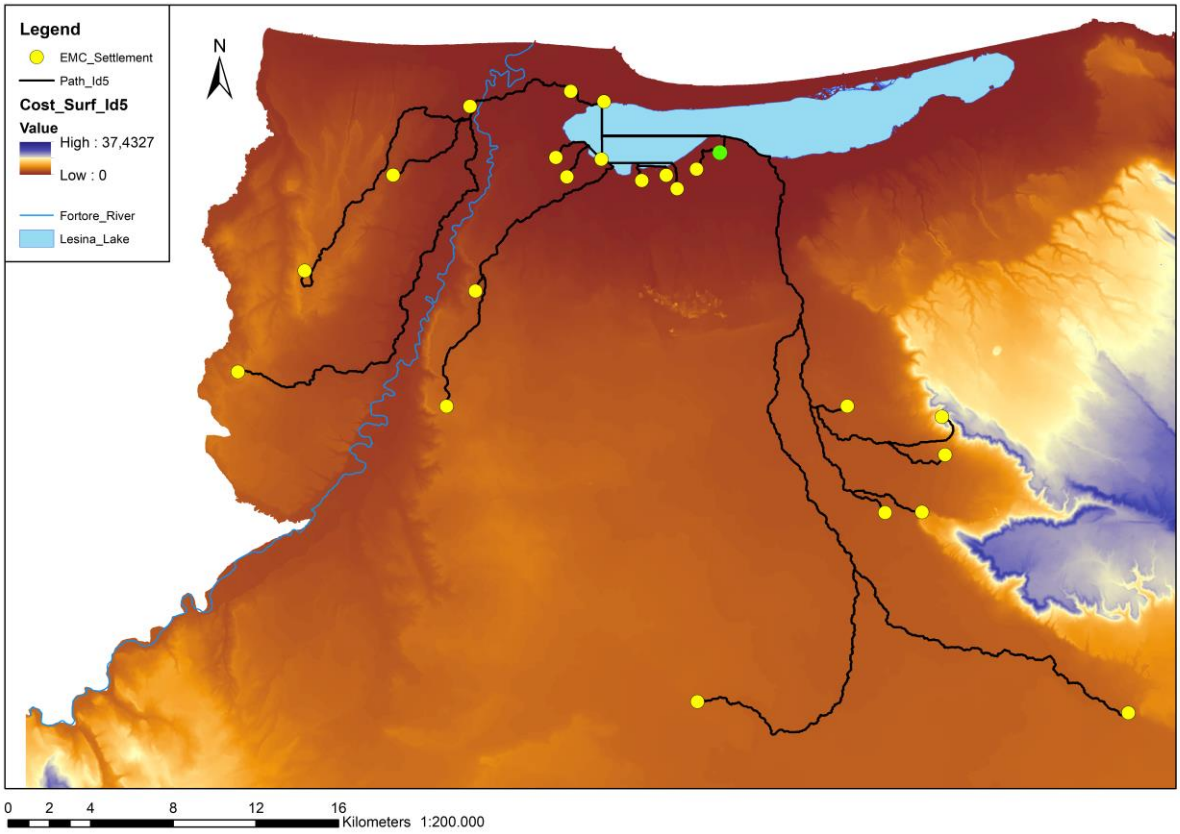


Table 108 – LPCA applied to Palude Caroppi (id6)

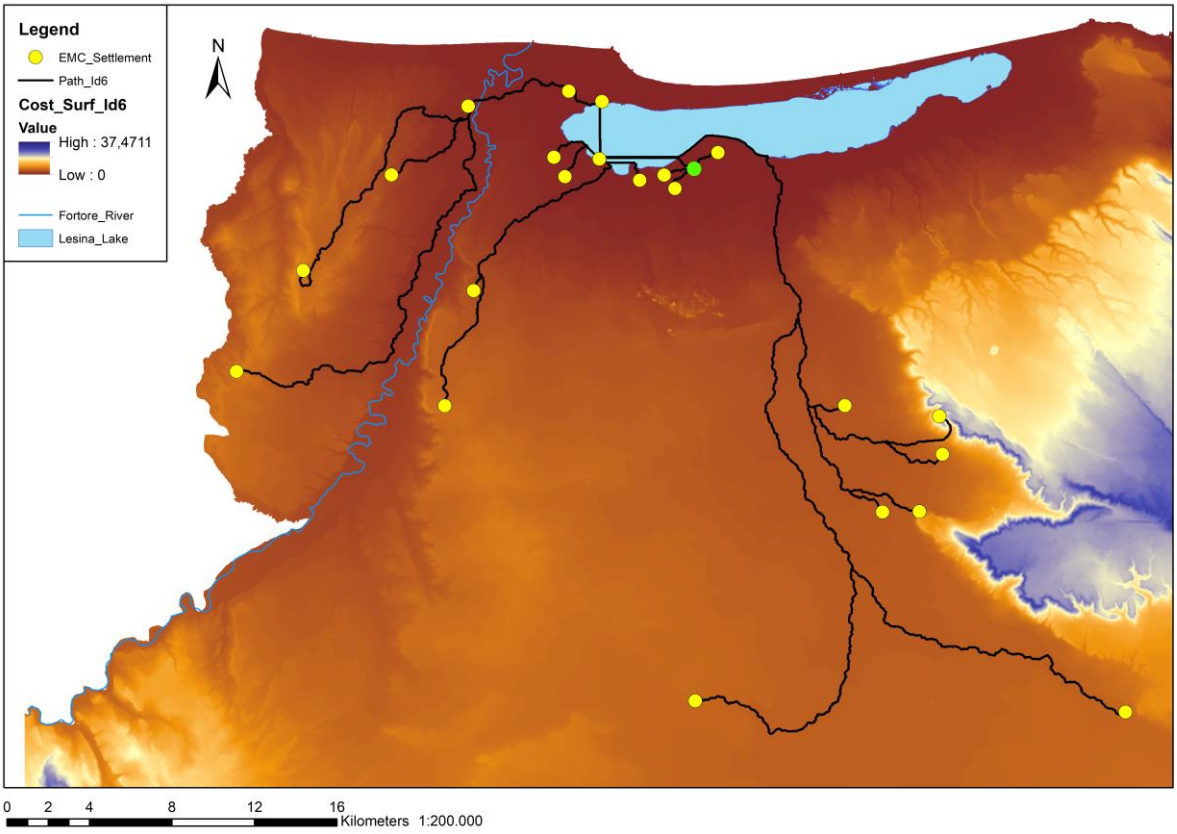


Table 109 – LPCA applied to Cammarata (id7)

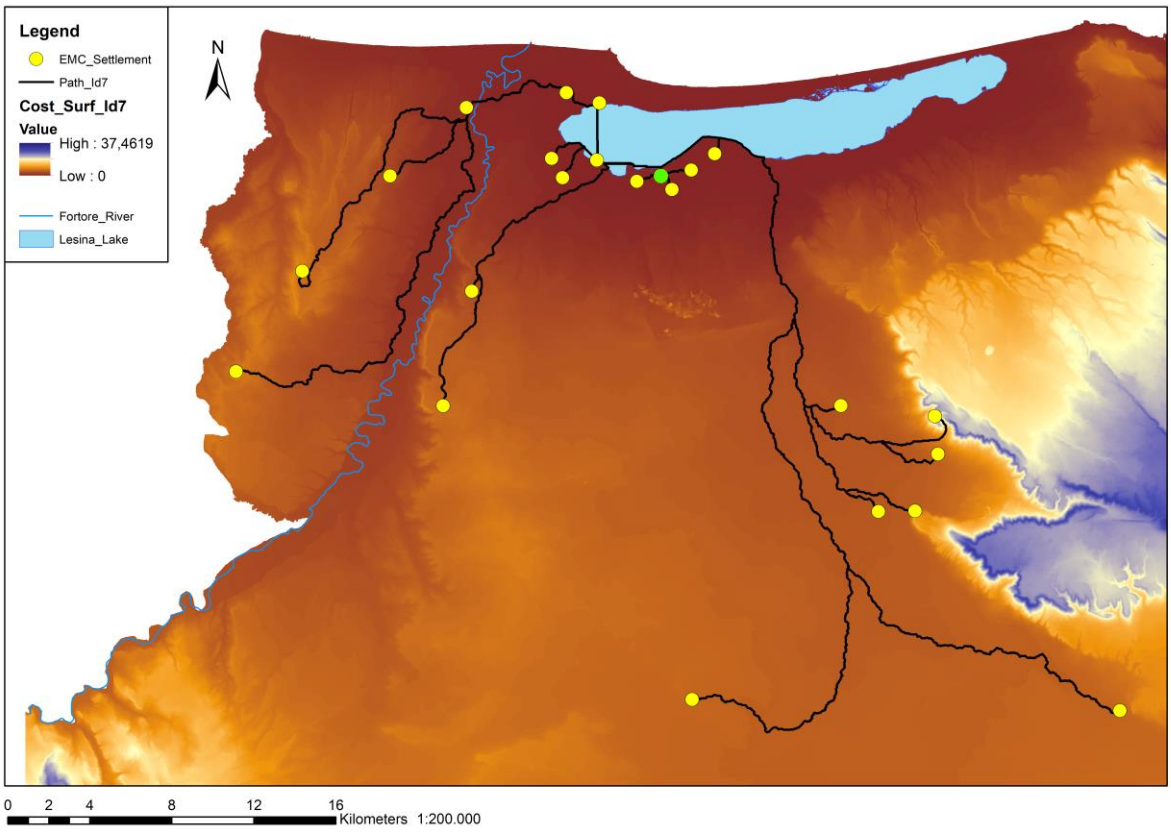


Table 110 – LPCA applied to Palude San Lorenzo (id8)

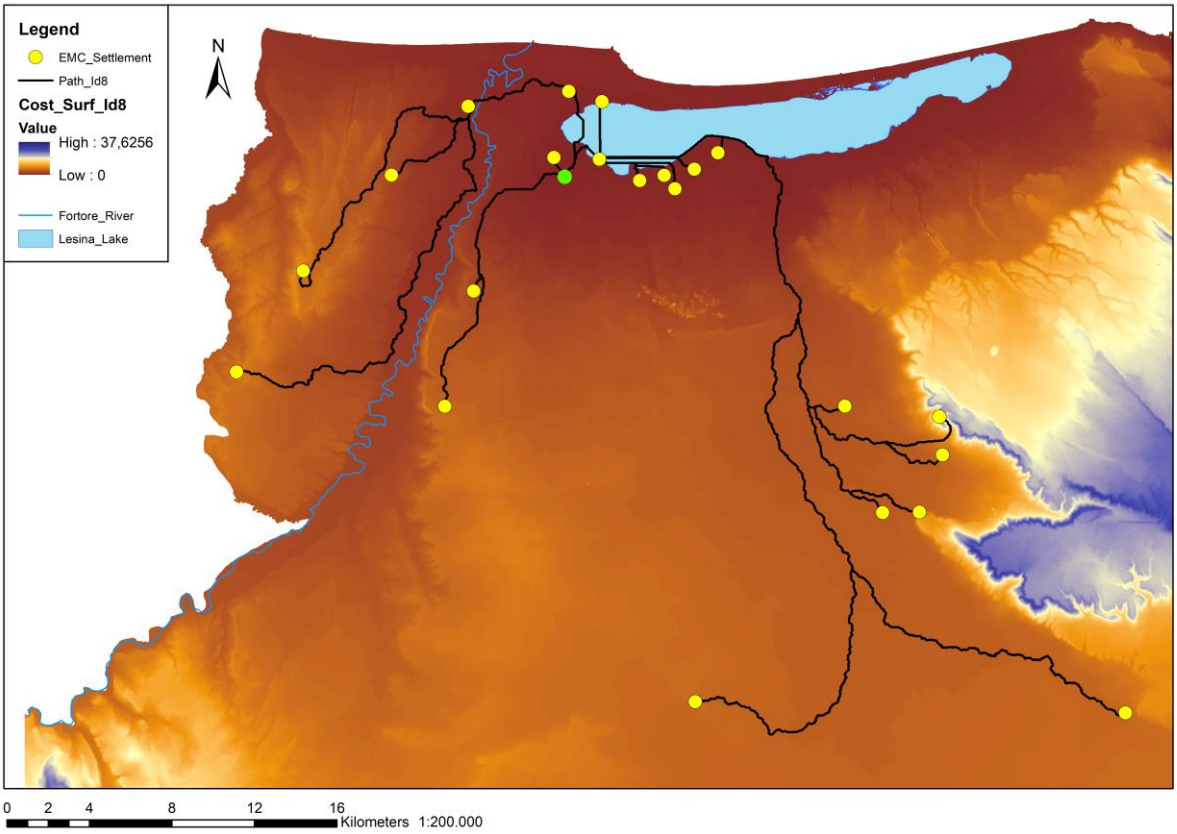


Table 111 – LPCA applied to Chiantinelle (id9)

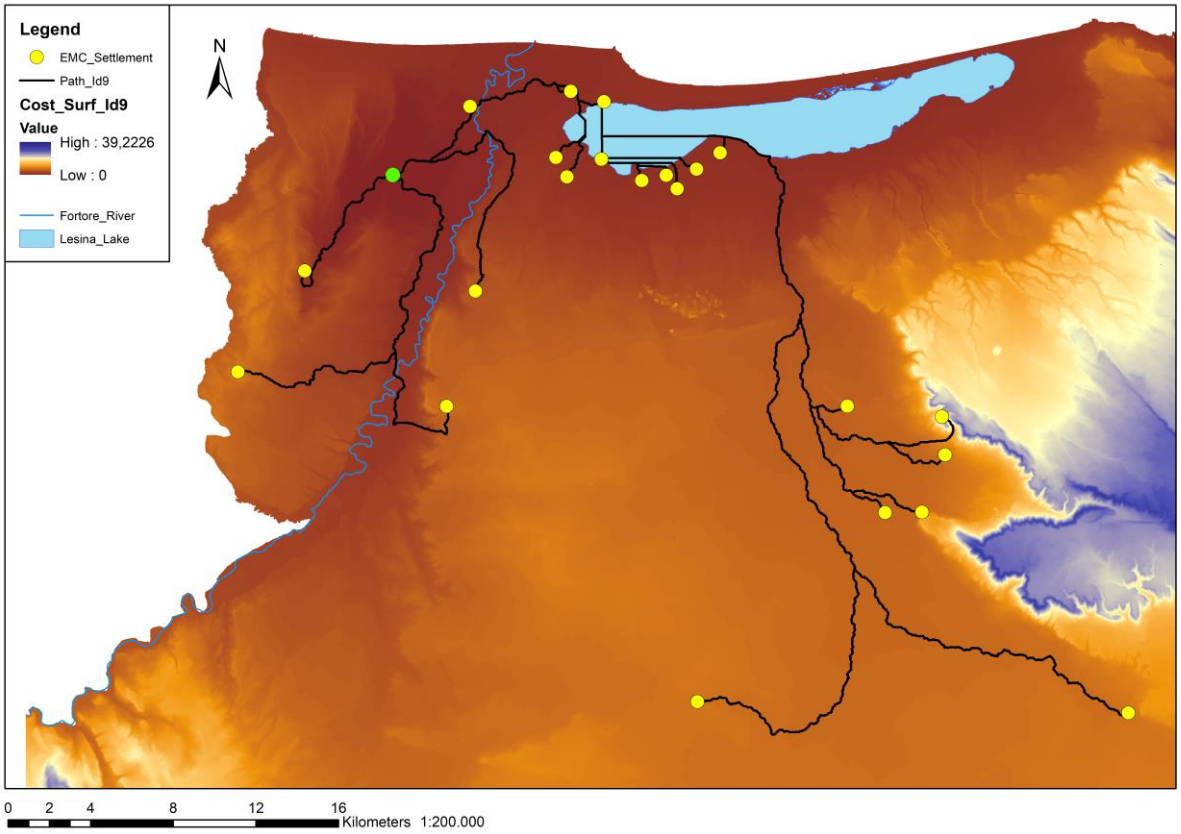


Table 112 – LPCA applied to Mezzana della Quercia (id10)

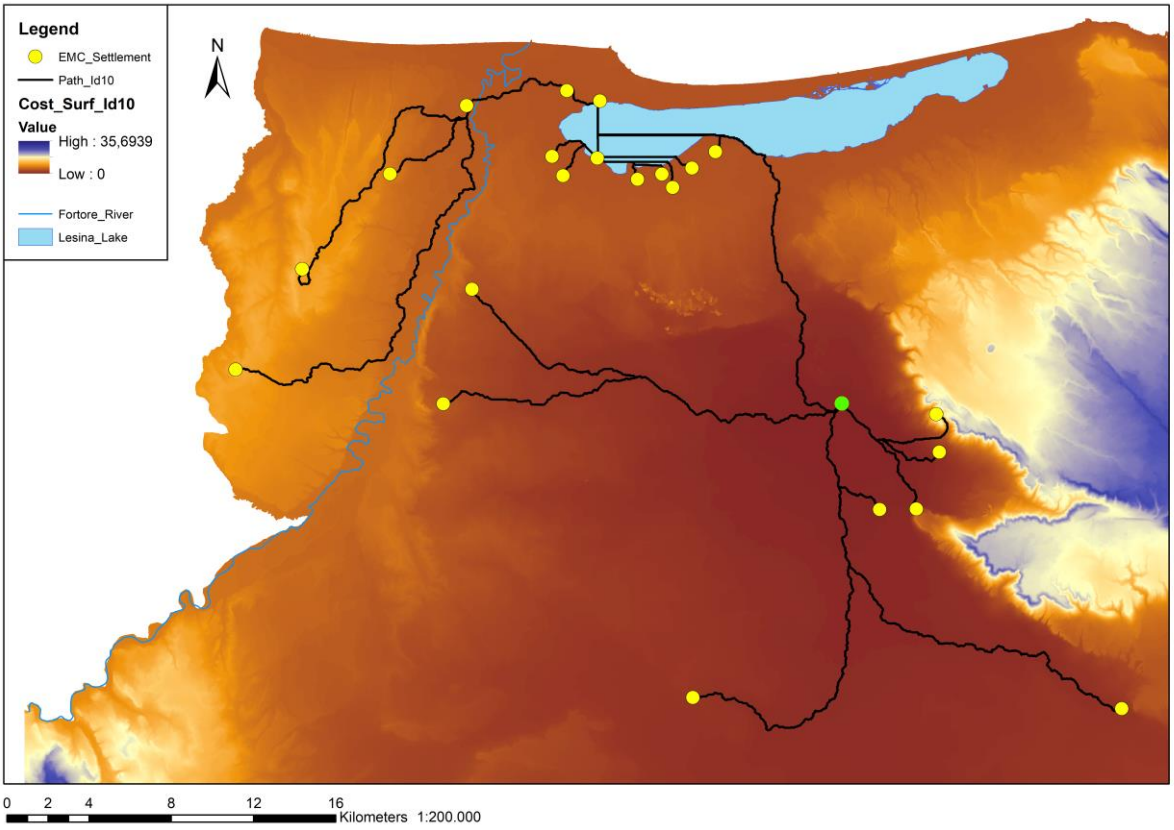


Table 113 – LPCA applied to Castelpagano (id11)

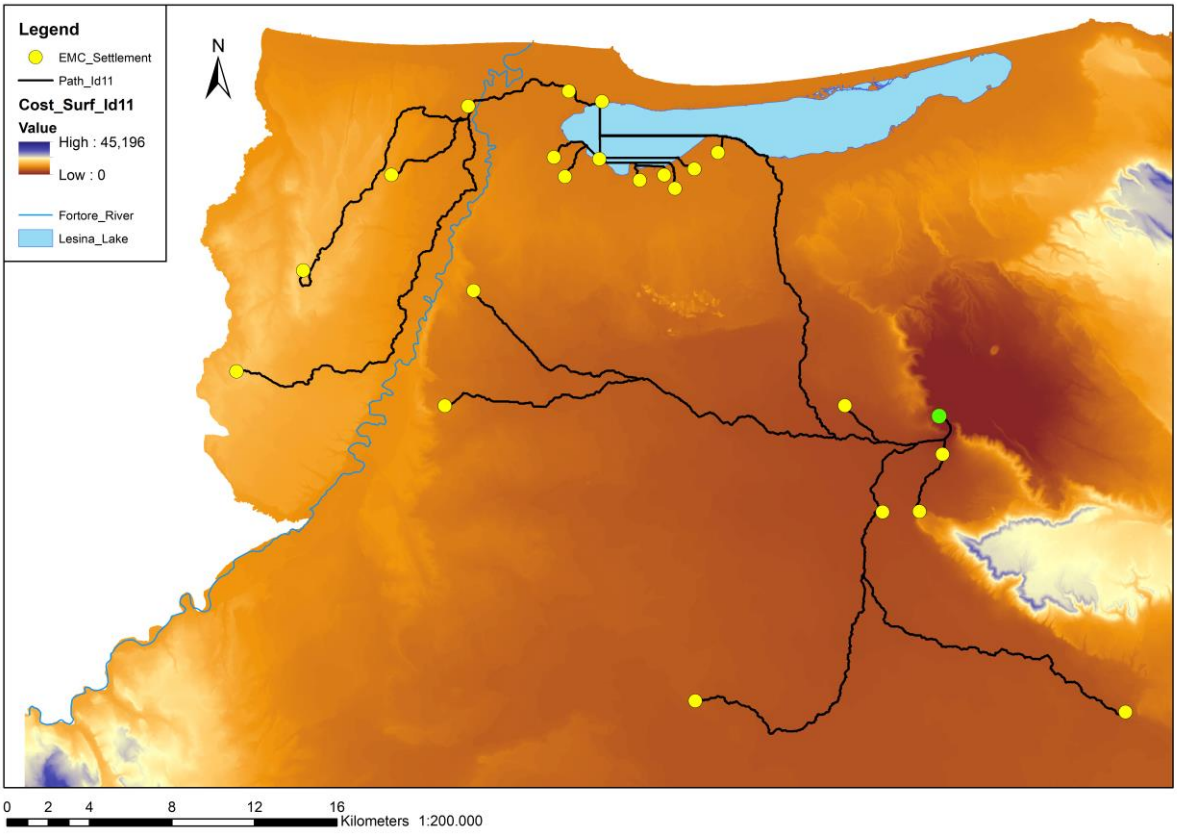


Table 114 – LPCA applied to Località Castate (id12)

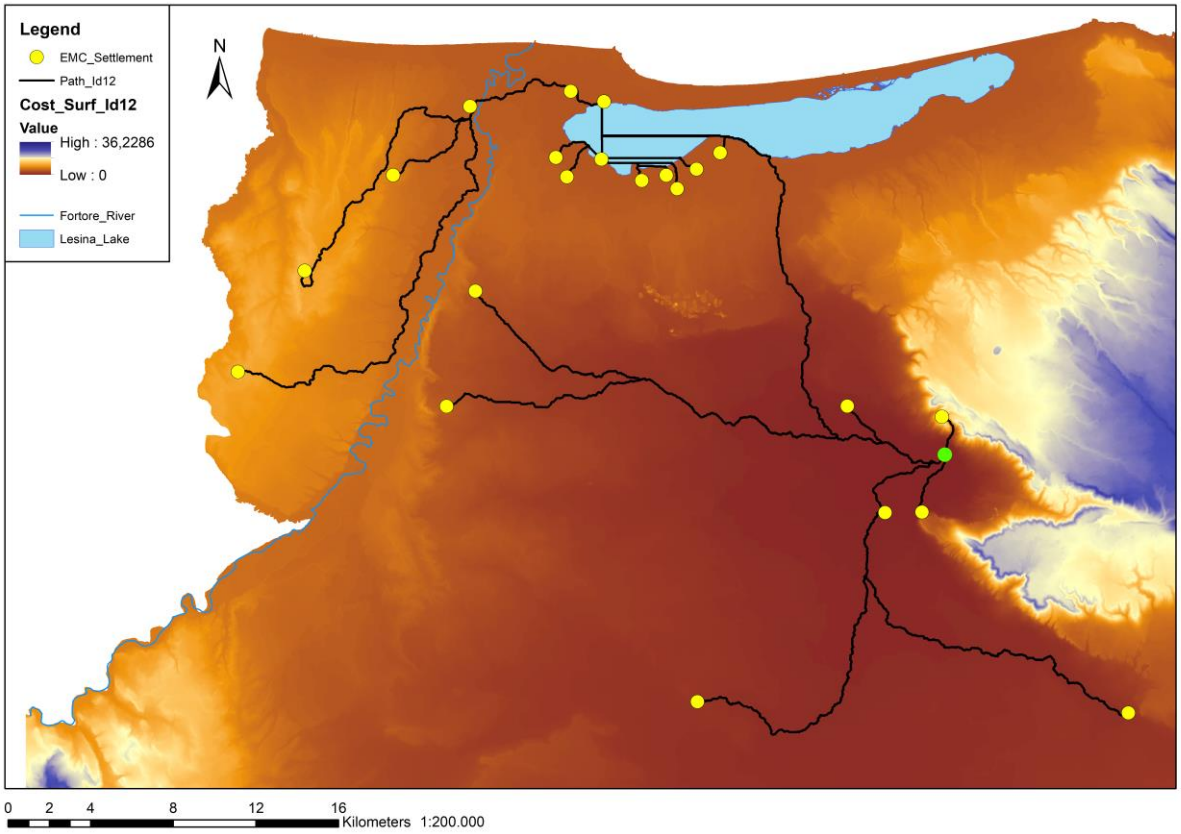


Table 115 – LPCA applied to Mezzanella di Brancia (id13)

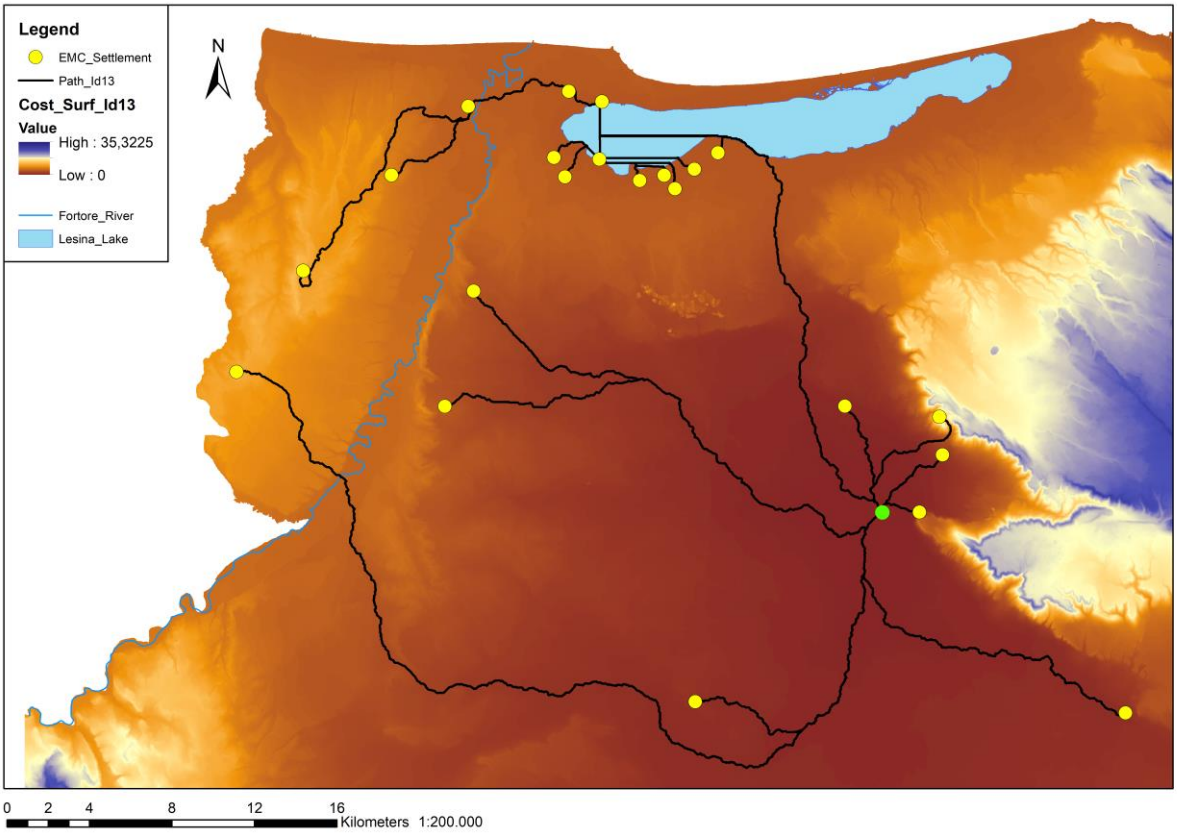


Table 116 – LPCA applied to Broncia km 10 – Volta Pianezza (id14)

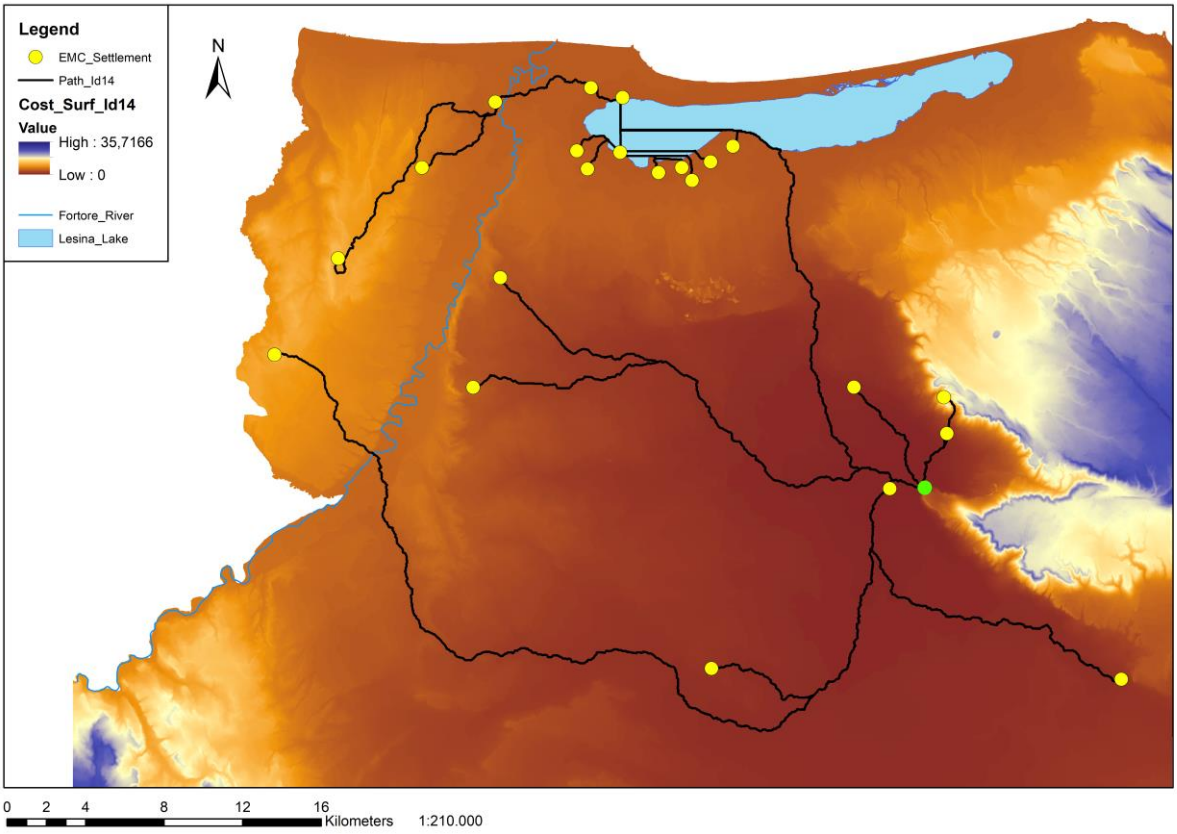


Table 117 – LPCA applied to Località Piano Navuccio (id15)

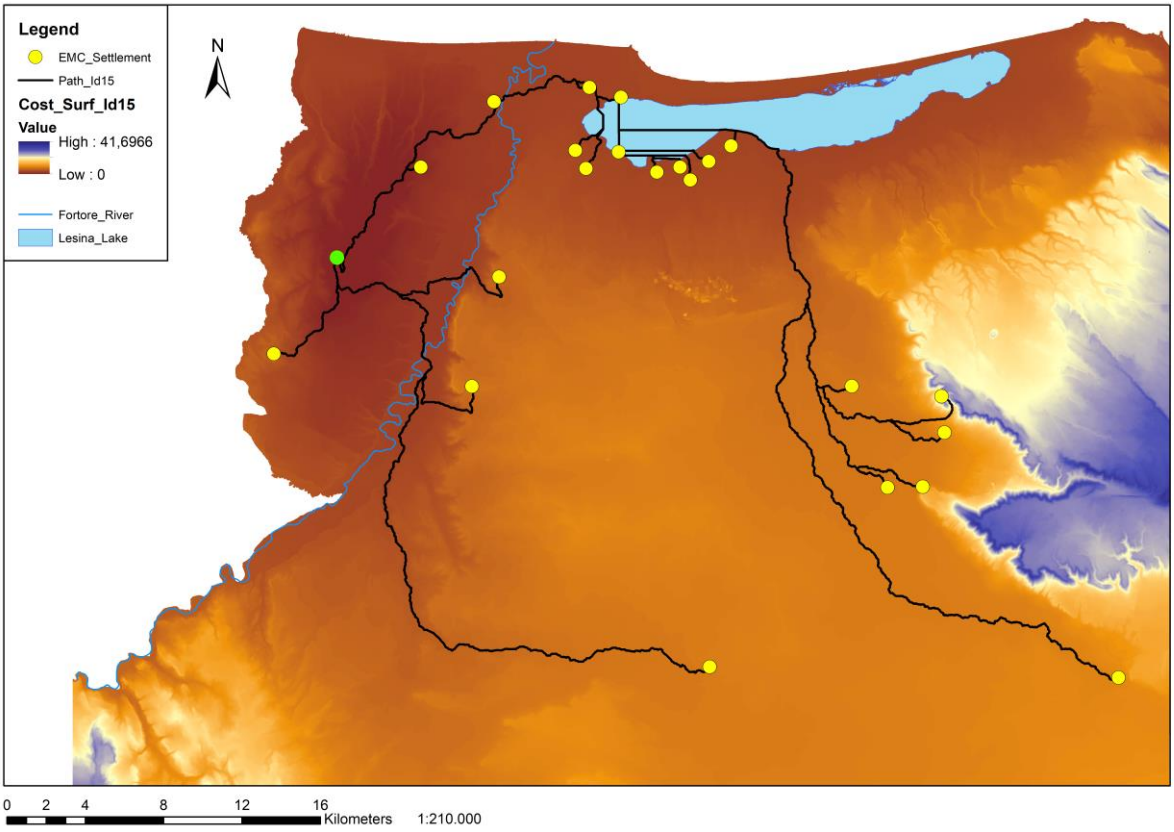


Table 117 – LPCA applied to Salsolido (id16)

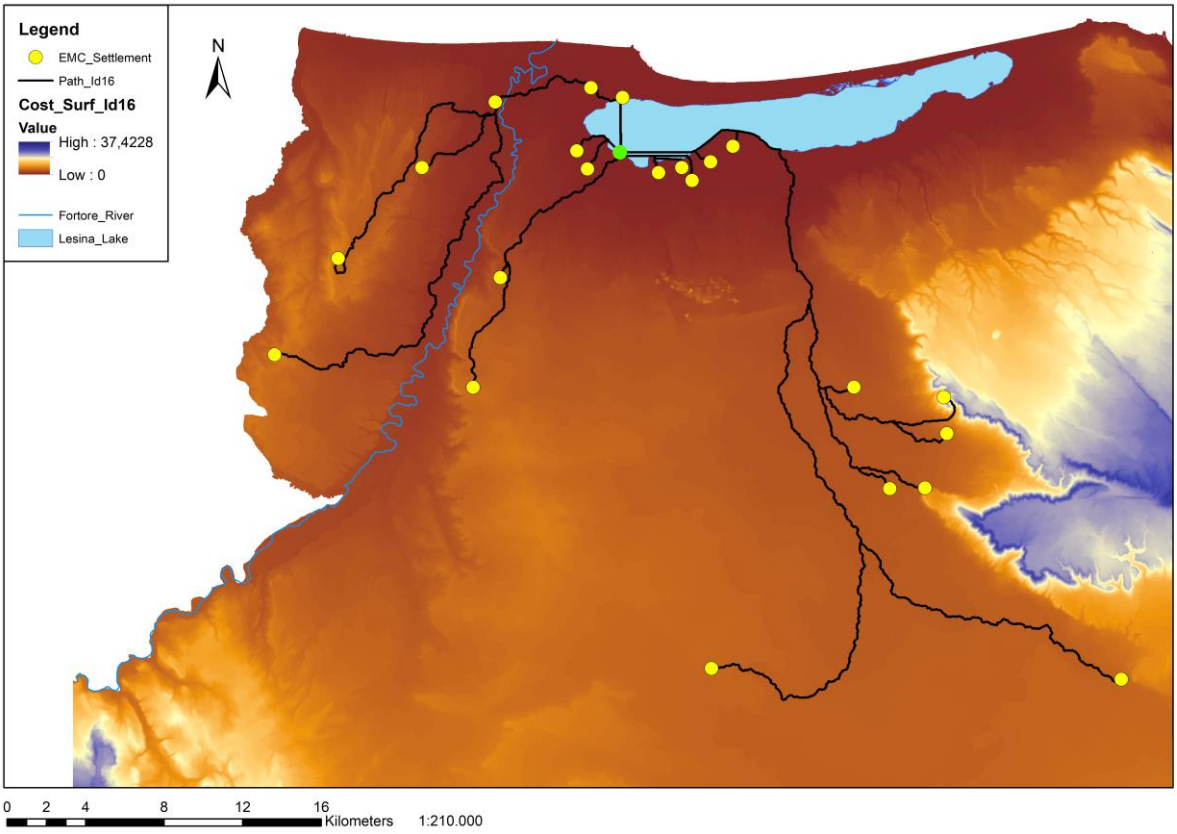


Table 118 – LPCA applied to Piani di Lauria (id17)

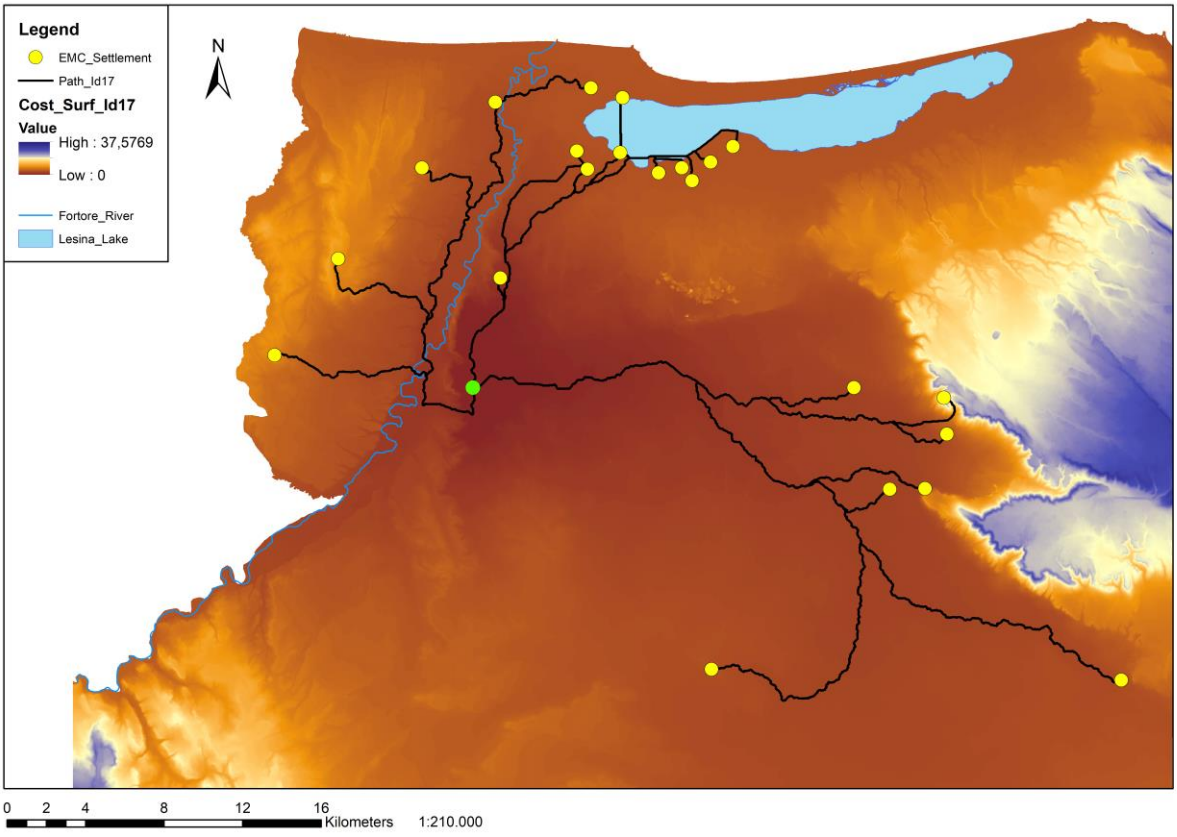


Table 119 – LPCA applied to Chiarappa (id18)

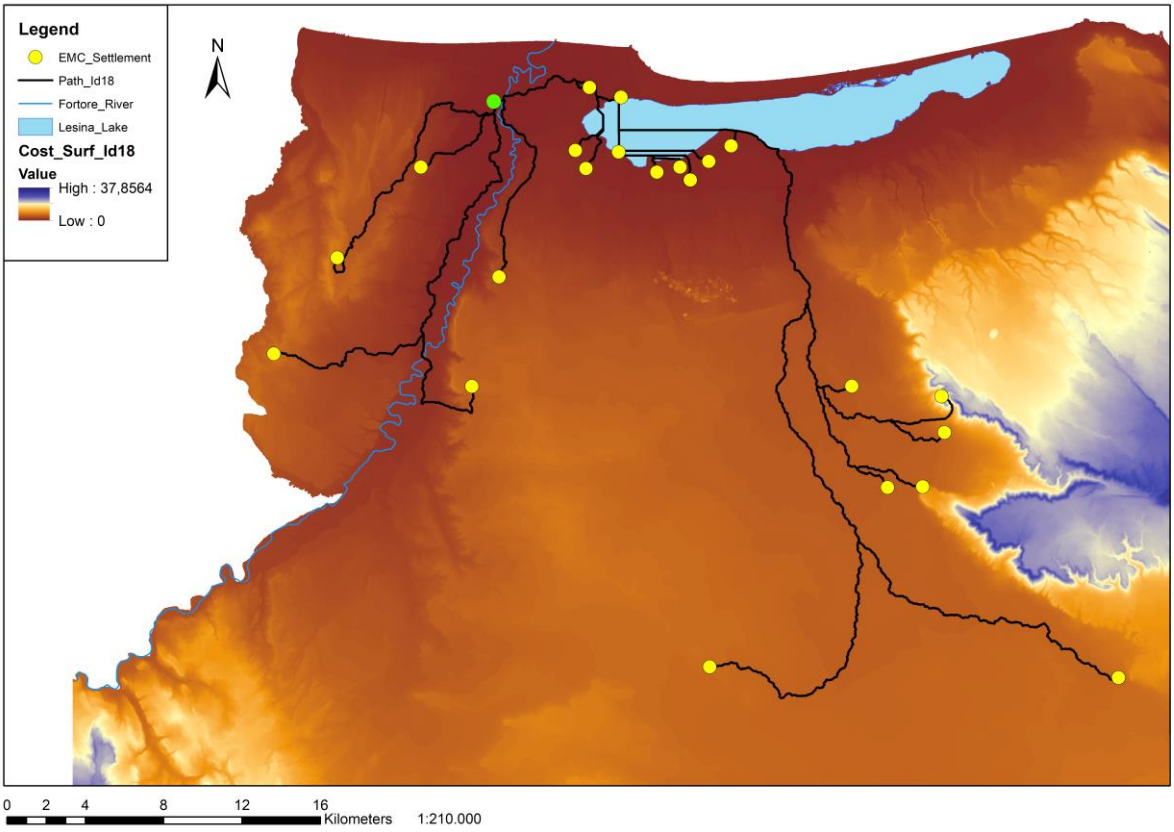


Table 120 – LPCA applied to Ciccalento (id19)

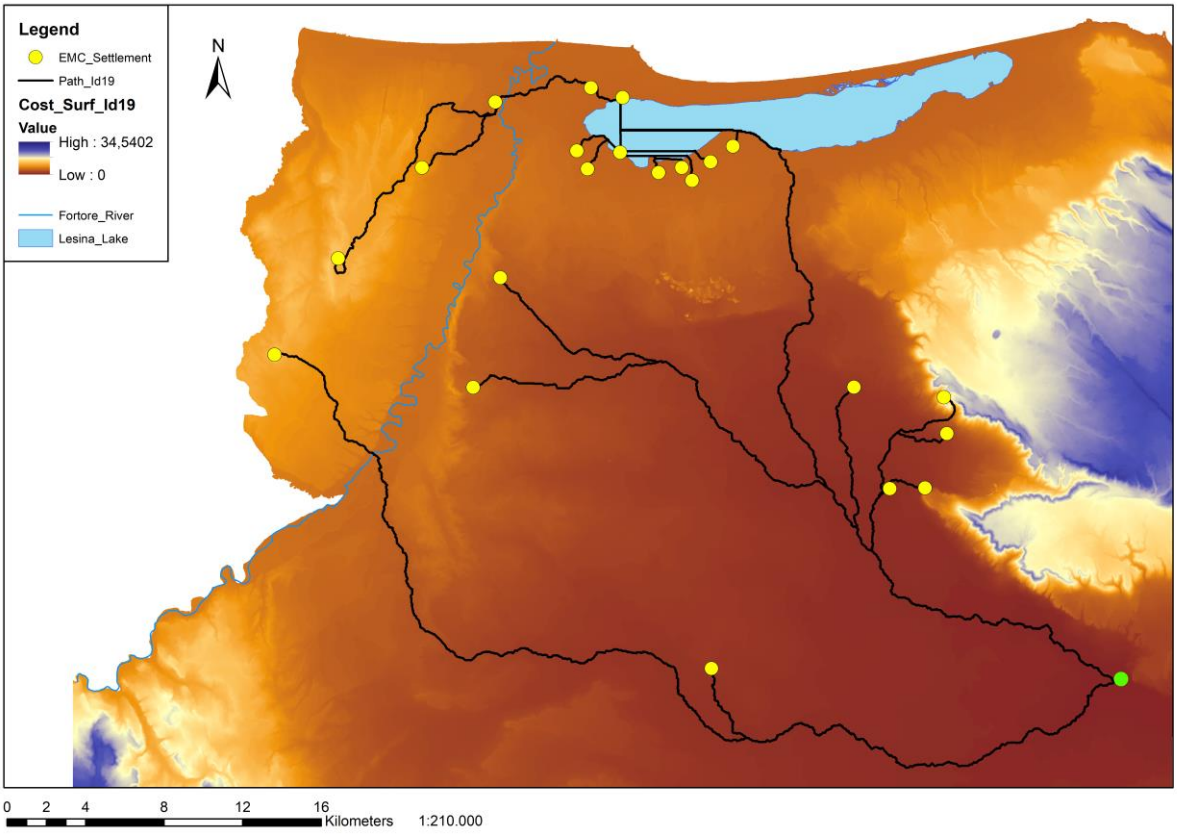


Table 121 – LPCA applied to Masseria Istituto di Sangro (id20)

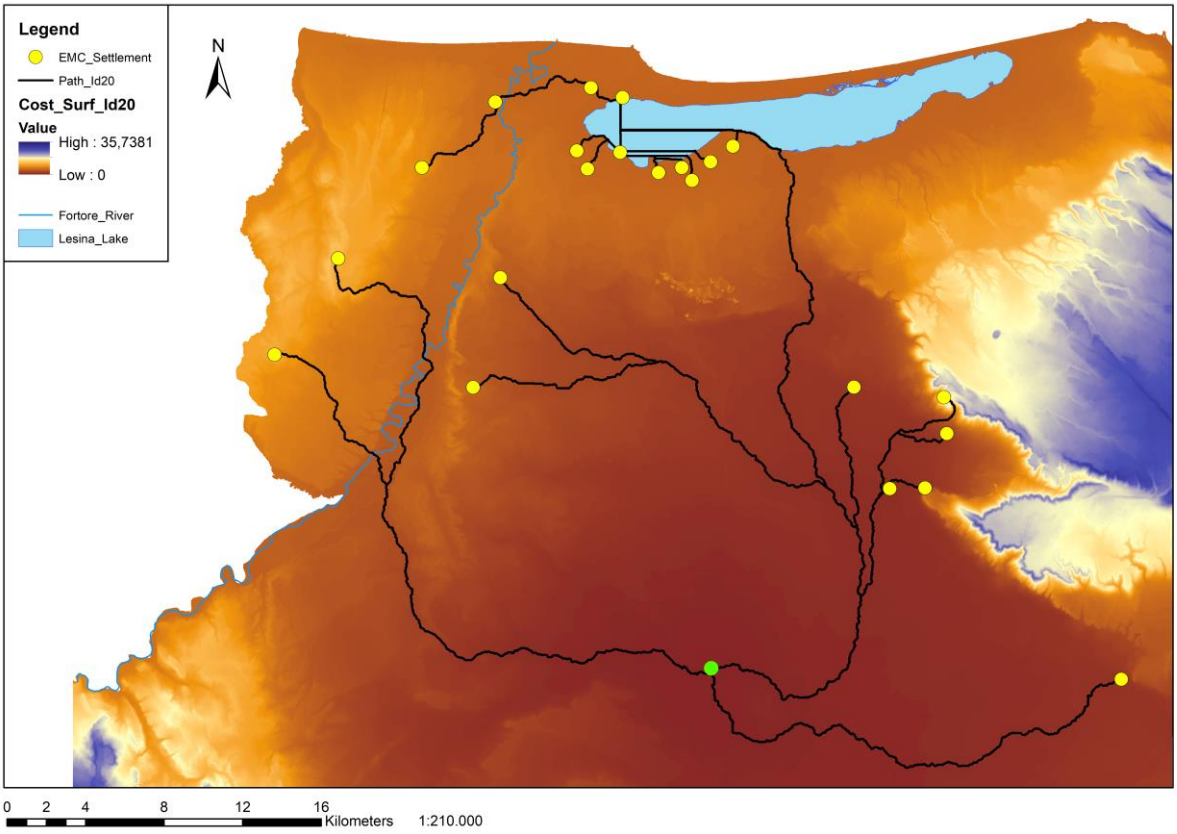


Table 122 – LPCA applied to Colle Arsano (id21)

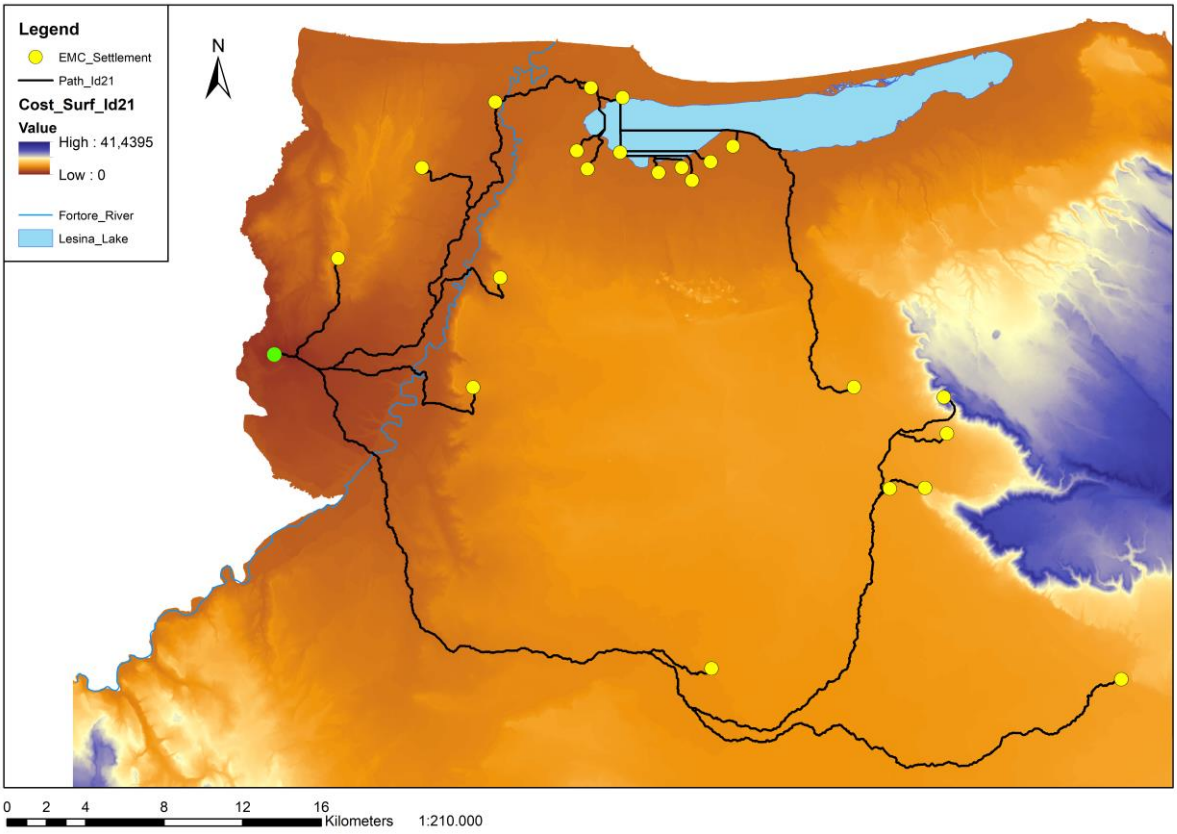


Table 123 – LPCA applied to Coppe di Rose (id22)

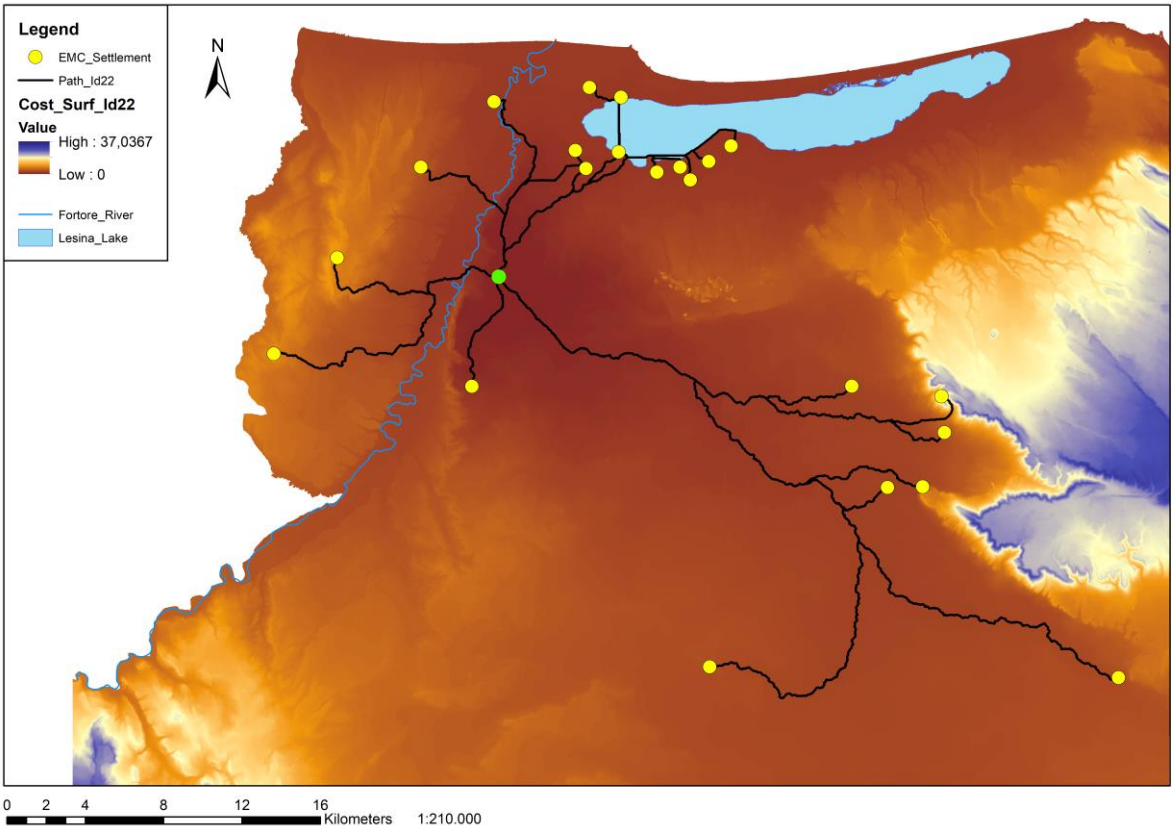
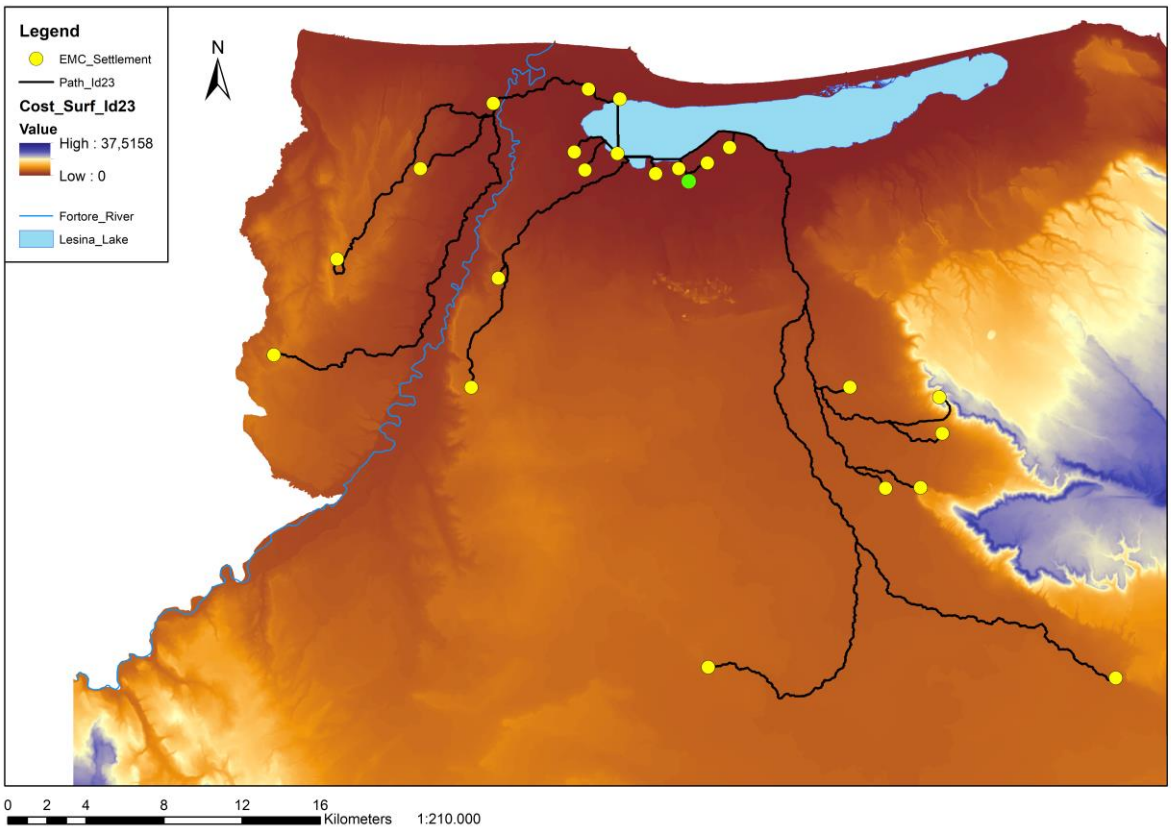


Table 124 – LPCA applied to Palude San Lorenzo (id23)



FINAL COPPER AGE

Table 125 – LPCA applied to Cammarata (id1)

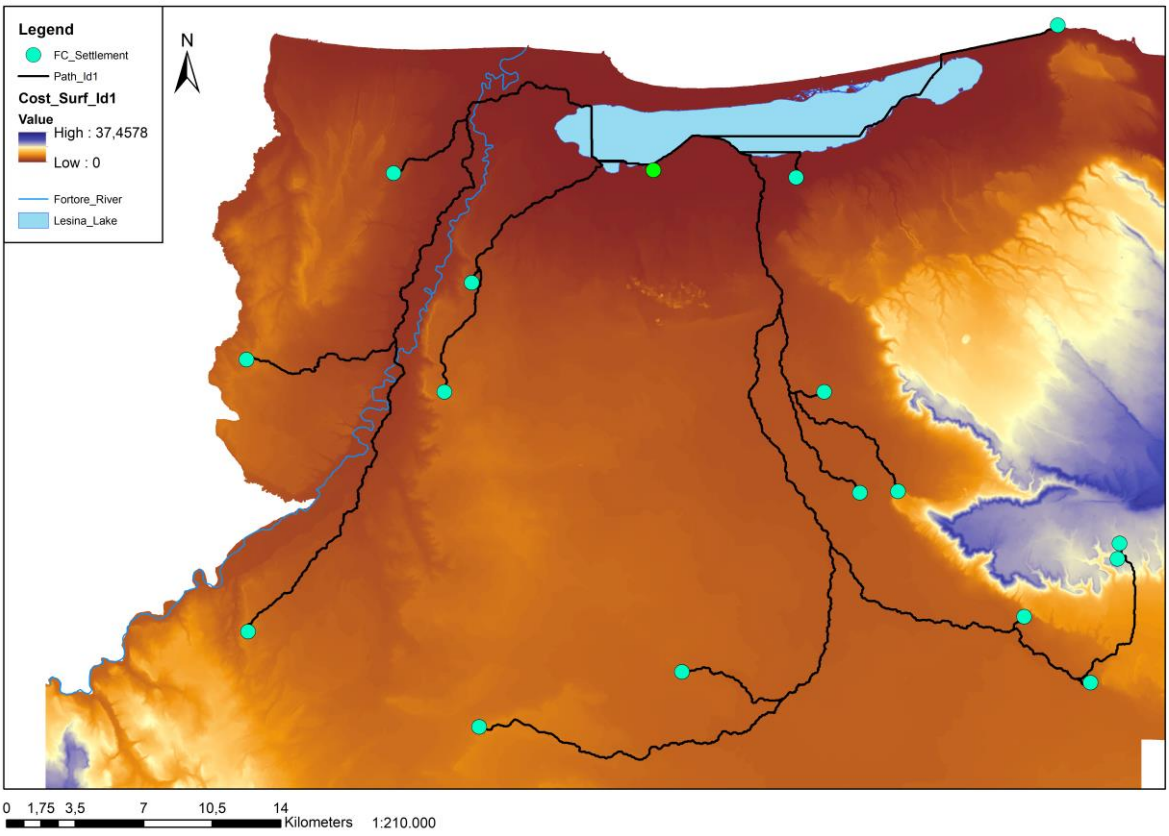


Table 126 – LPCA applied to Mulino di Caldoli (id2)

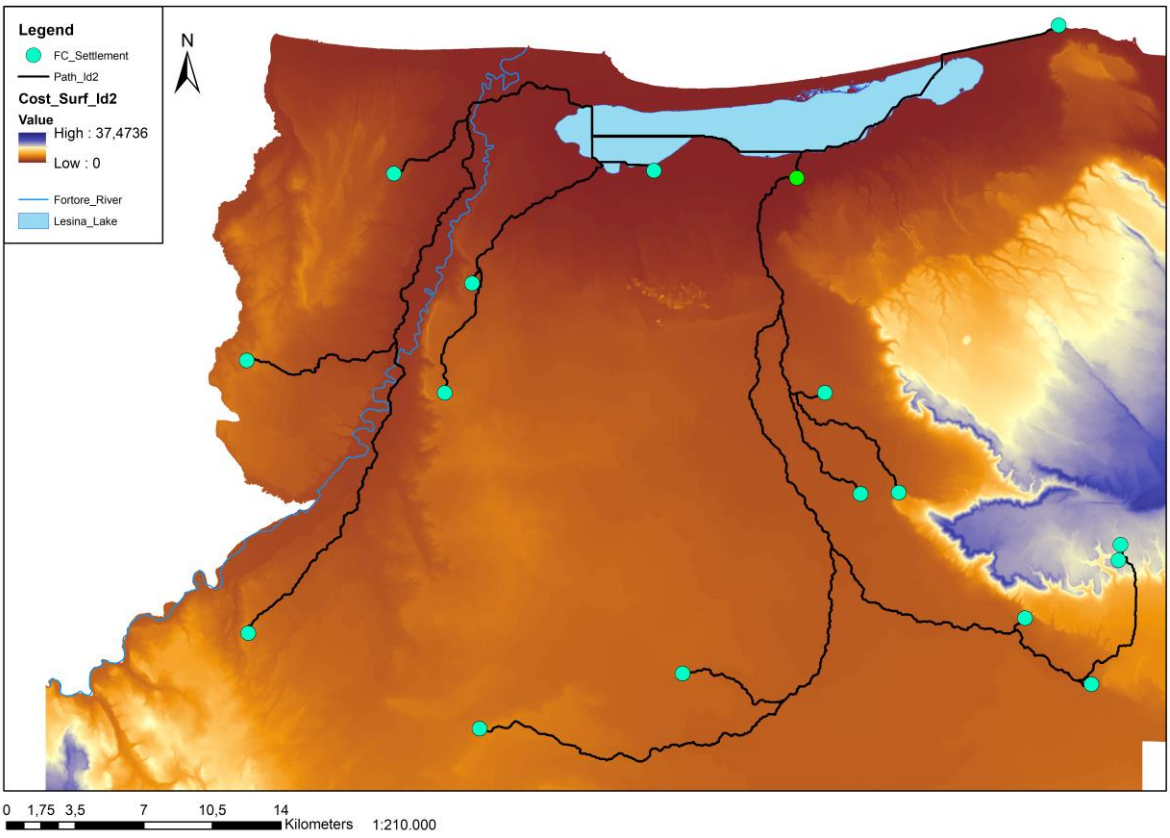


Table 127 – LPCA applied to Torre Mileto (id3)

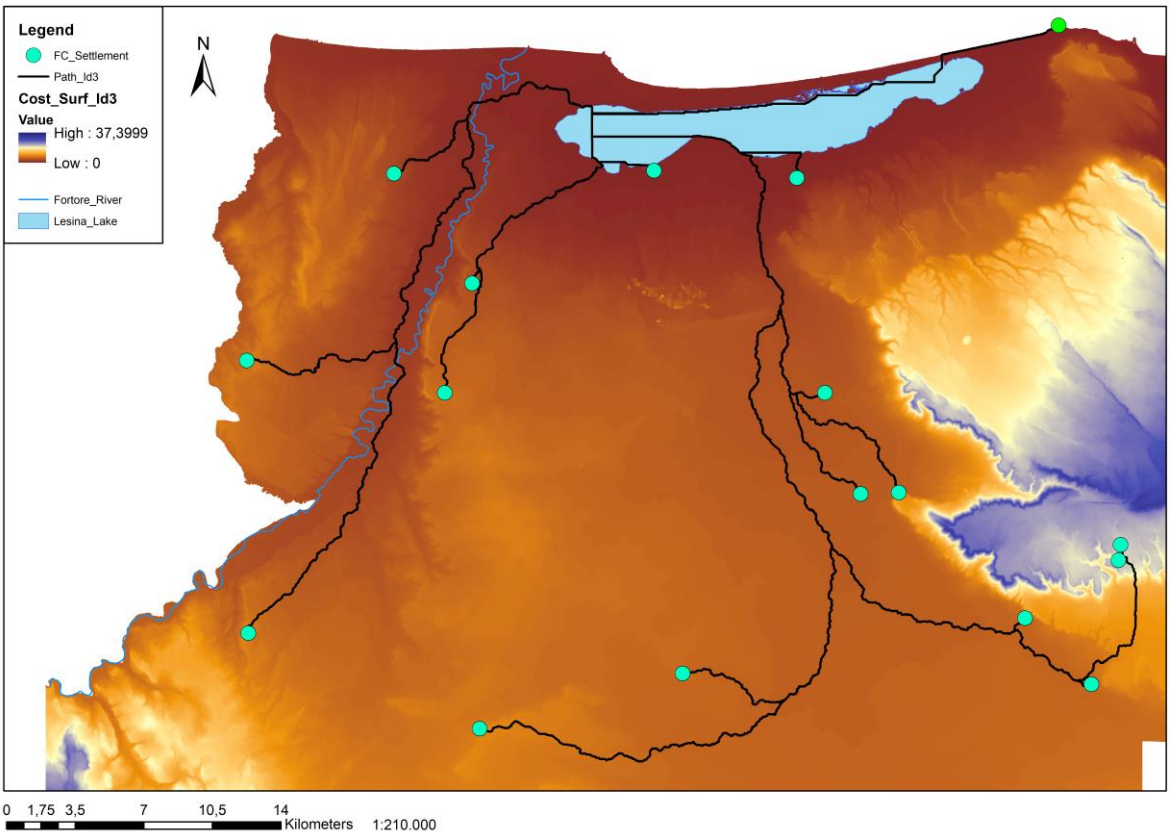


Table 127 – LPCA applied to Colle Arsano (id4)

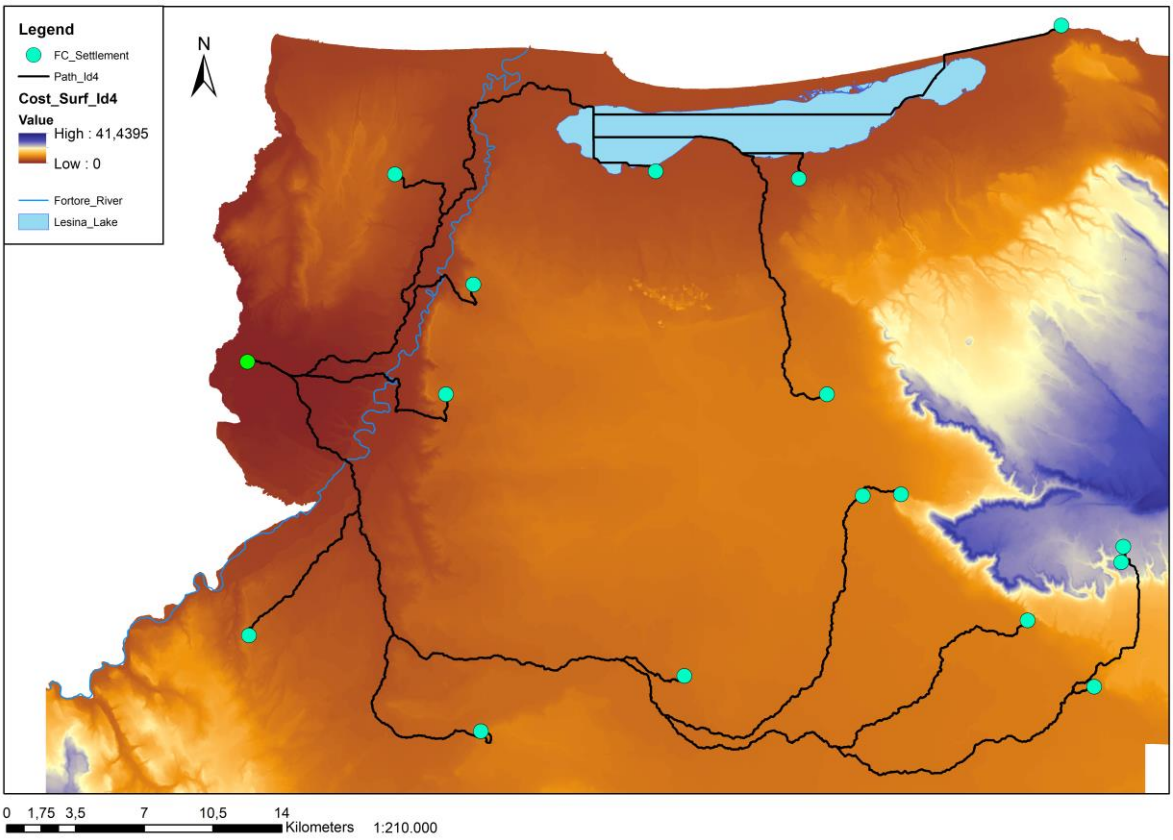


Table 128 – LPCA applied to Torre Fiorentina (id5)

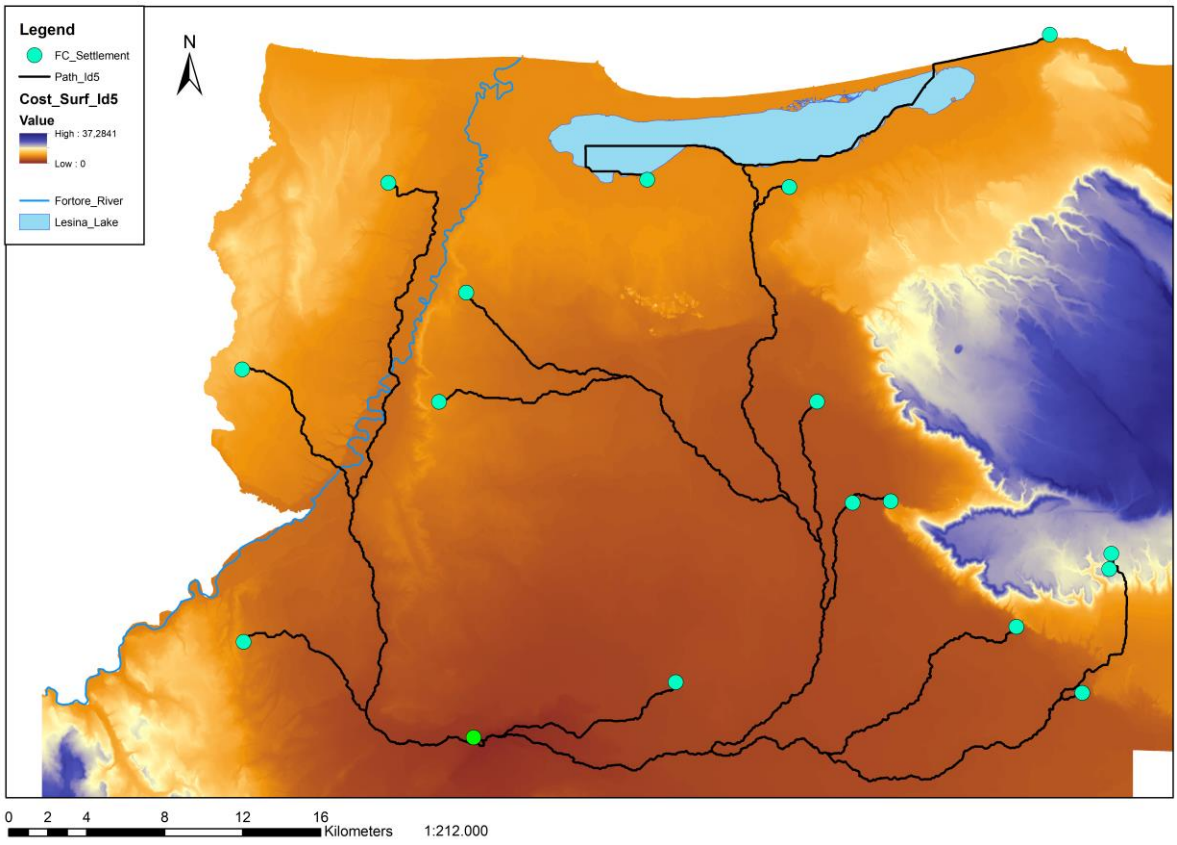


Table 129 – LPCA applied to Volta Pianezza (id6)

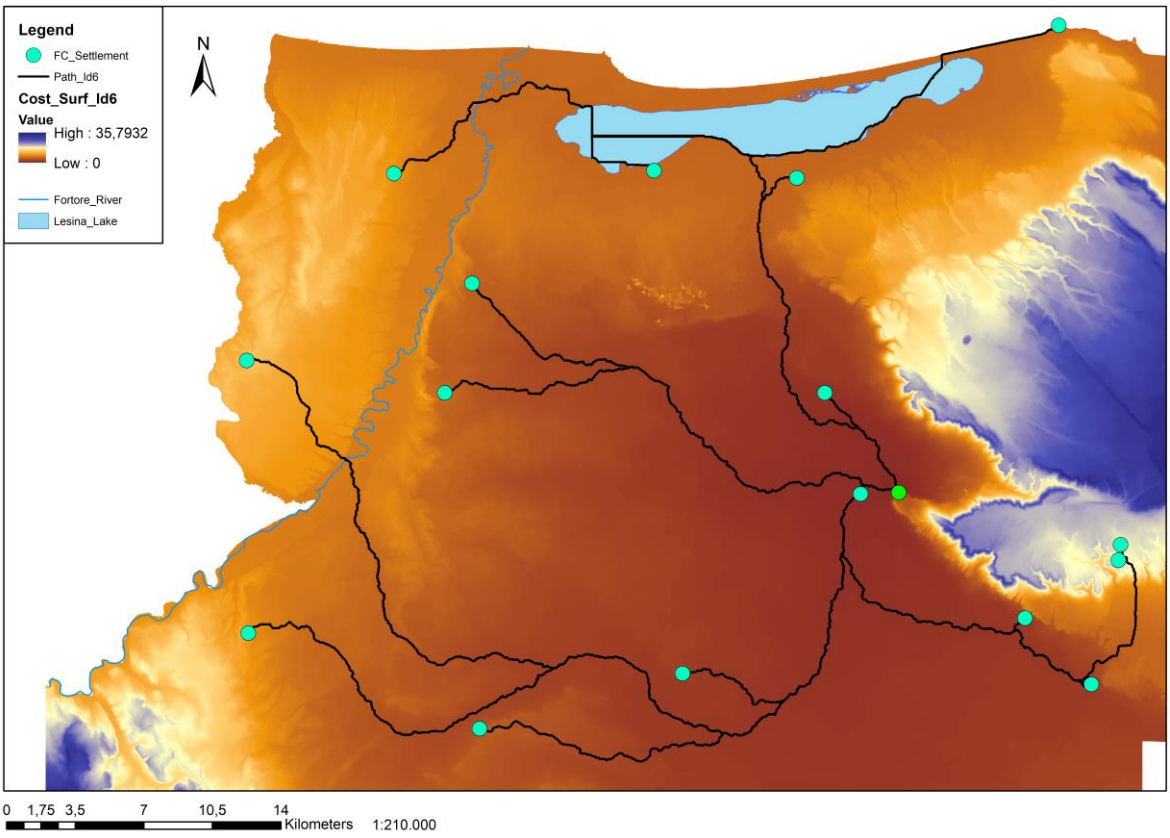


Table 130 – LPCA applied to Mezzanella di Brancia (id7)

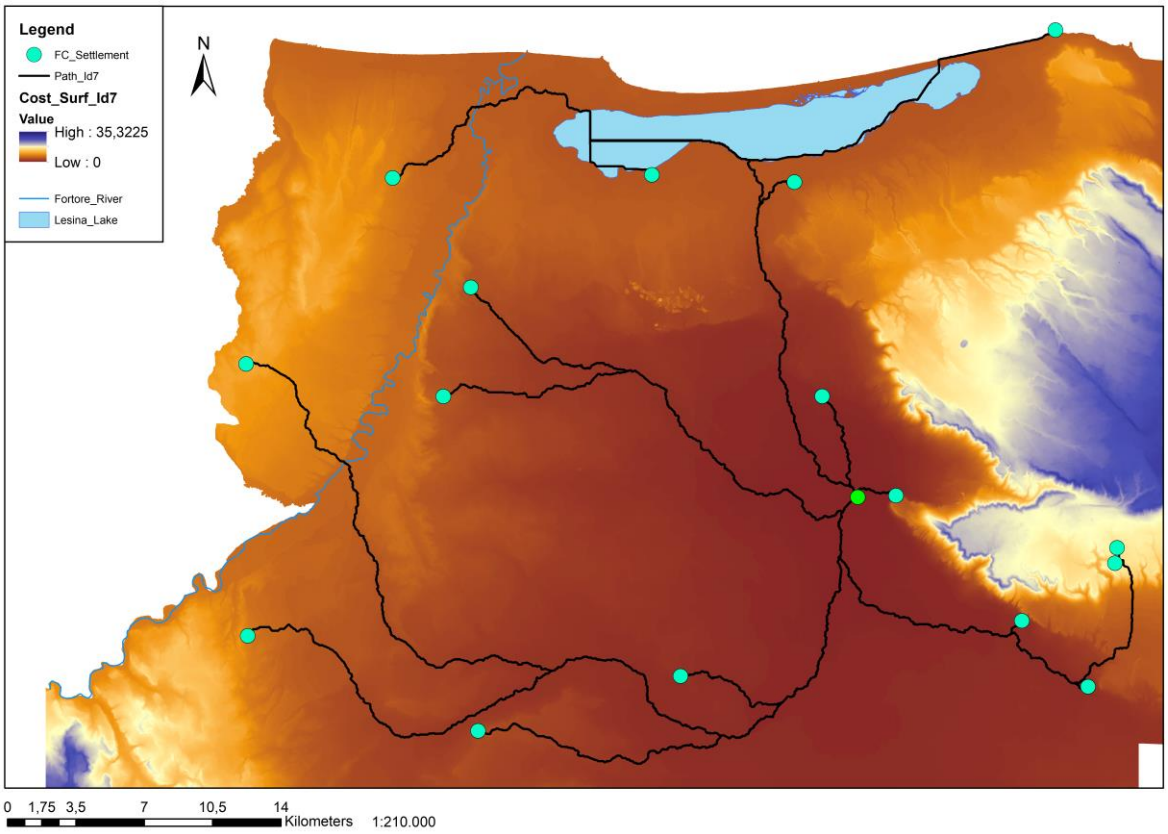


Table 131 – LPCA applied to Casale Crisetti (id8)

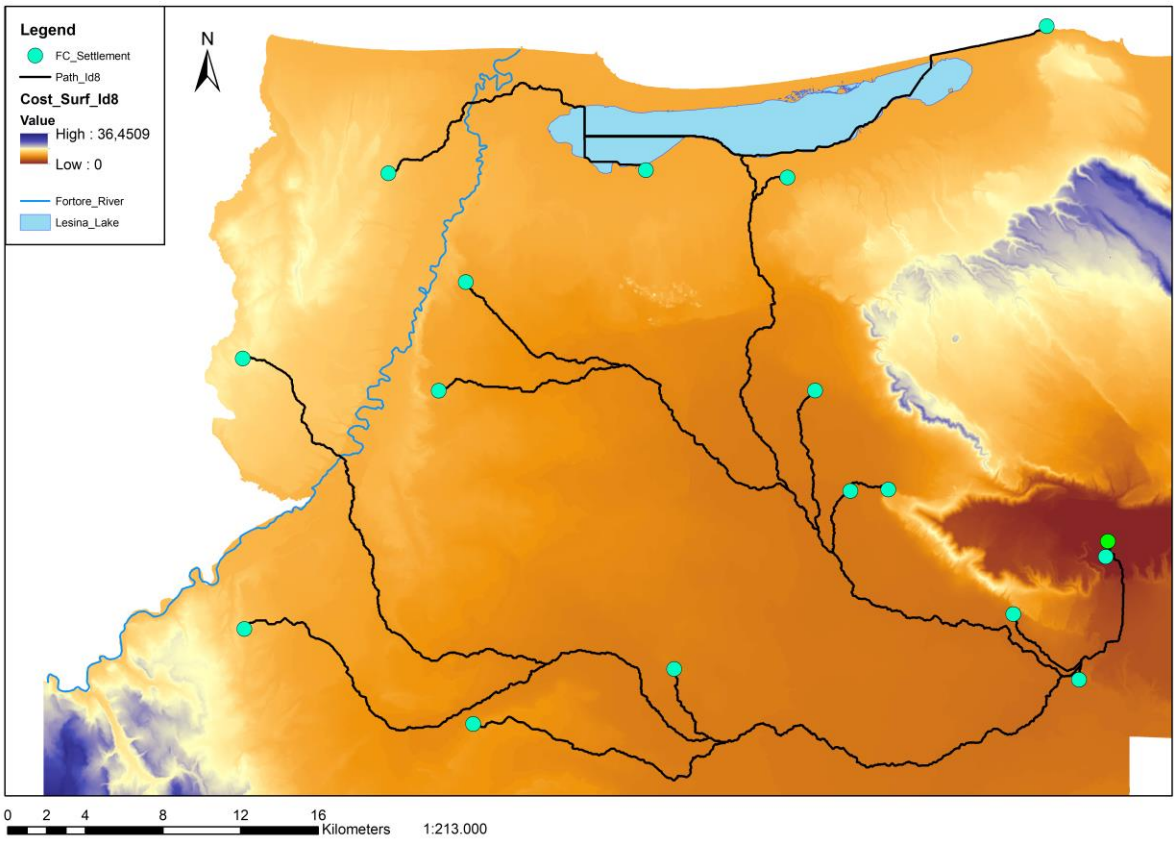


Table 132 – LPCA applied to Colle di Creta-San Matteo Chiantinelle (id9)

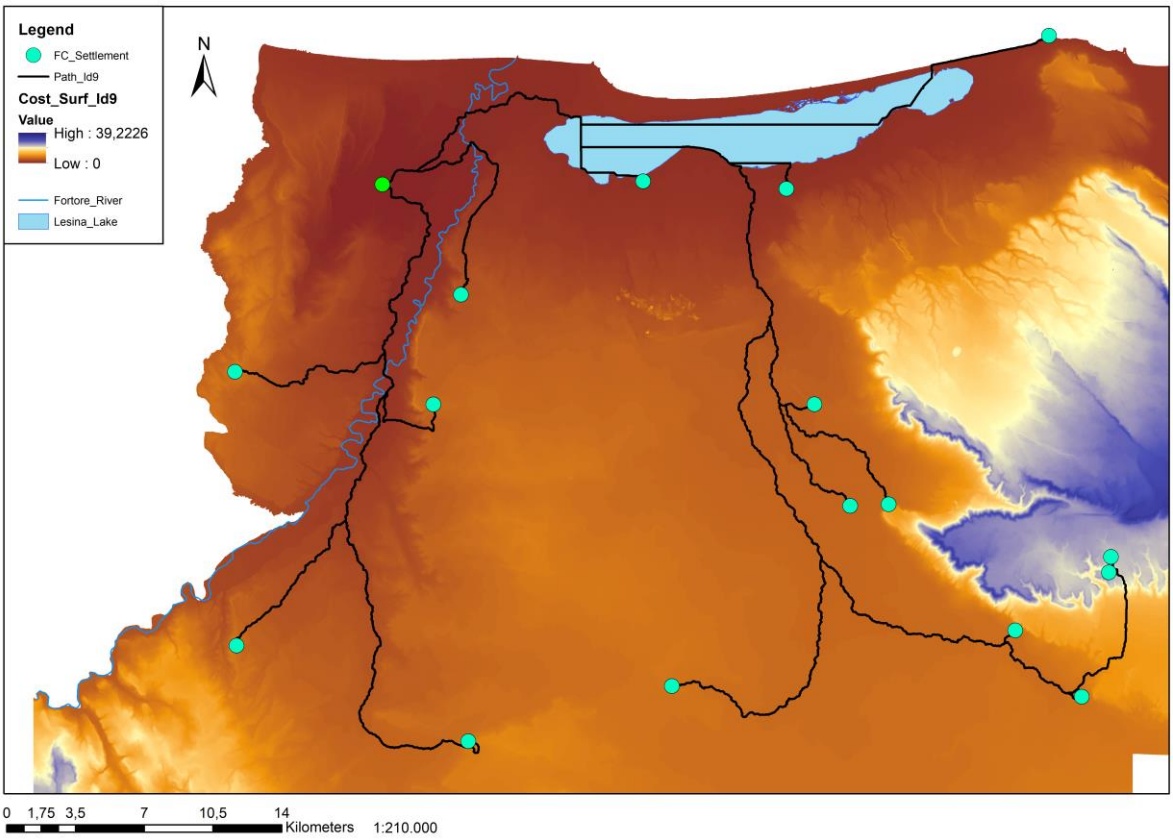


Table 133 – LPCA applied to Piani di Lauria (id10)

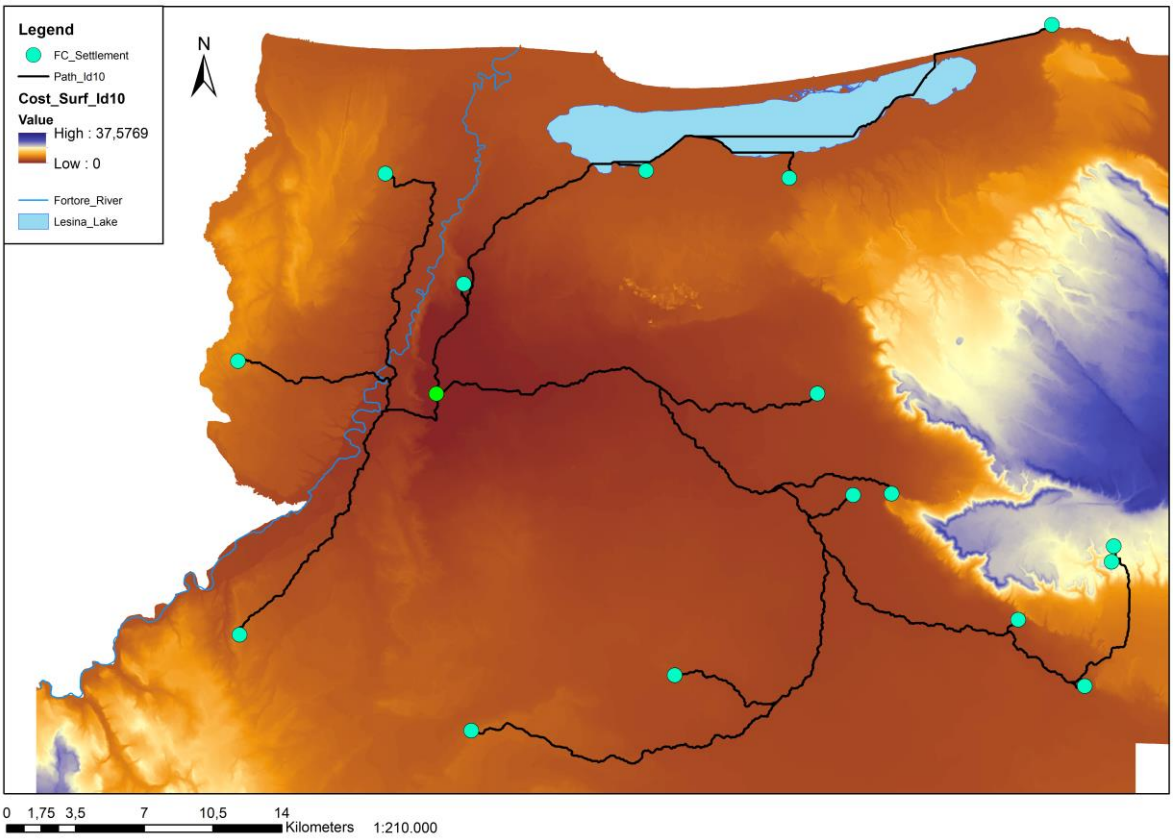


Table 134 – LPCA applied to Masseria Istituto di Sangro (id11)

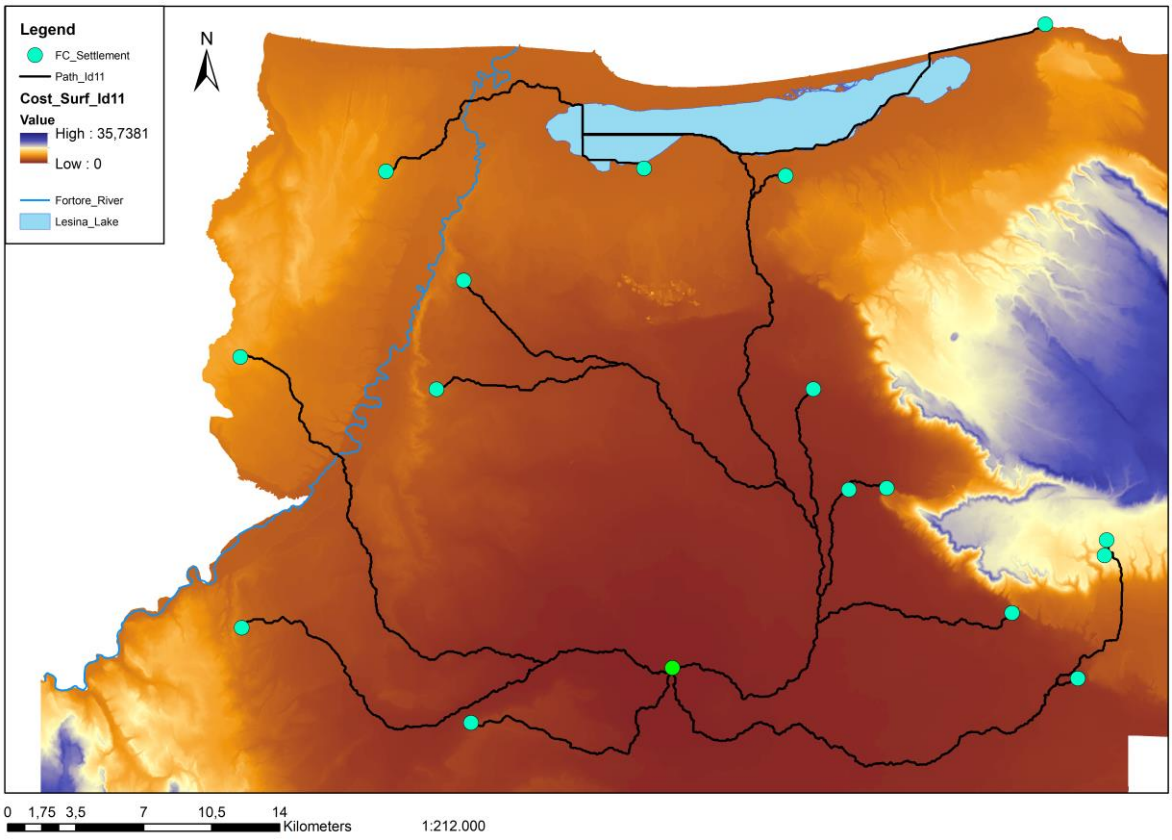


Table 135 – LPCA applied to Coppe di Rose (id12)

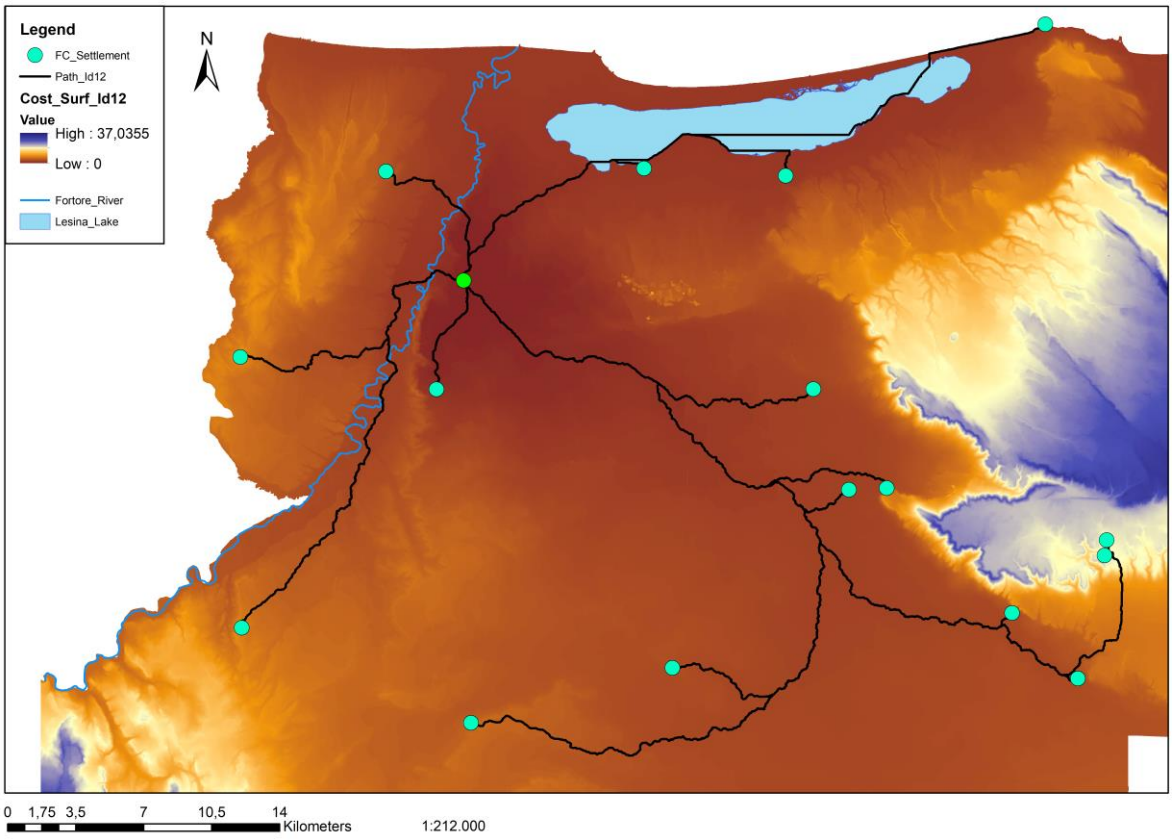


Table 136 – LPCA applied to Chiancata La Civita (id13)

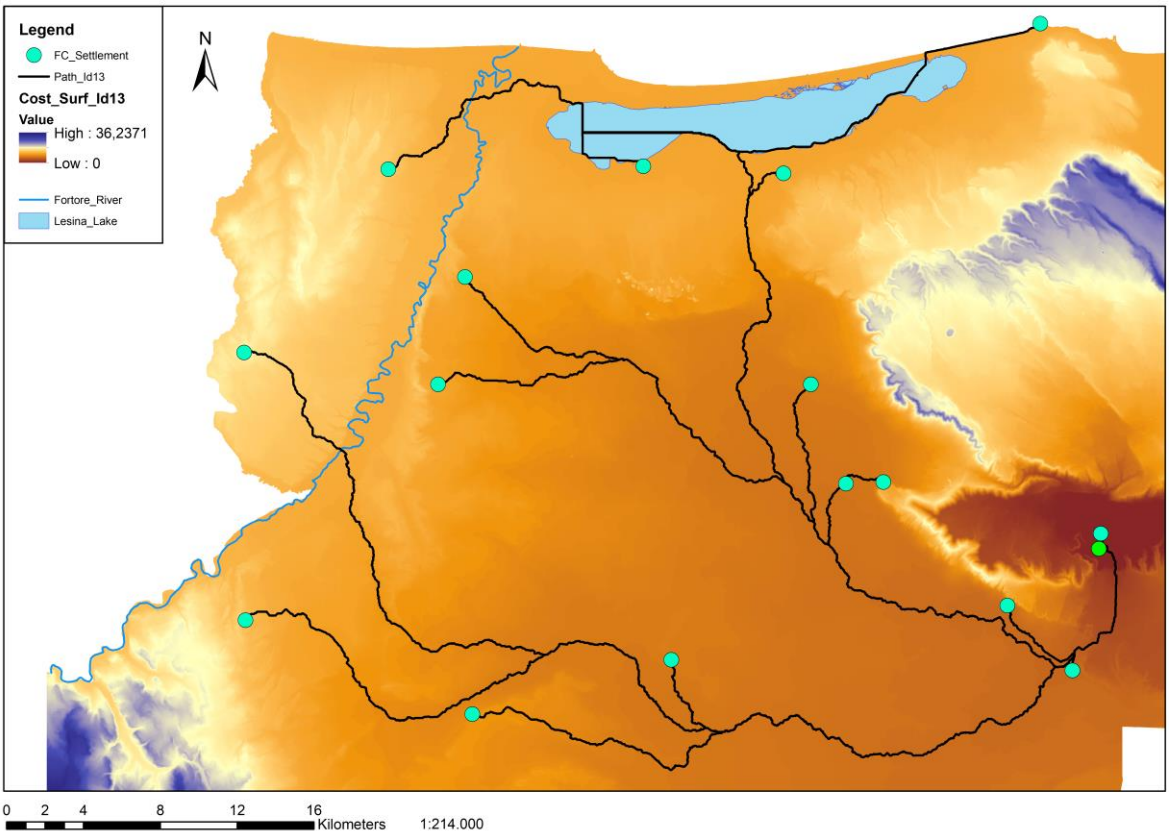


Table 137 – LPCA applied to Cicerale (id14)

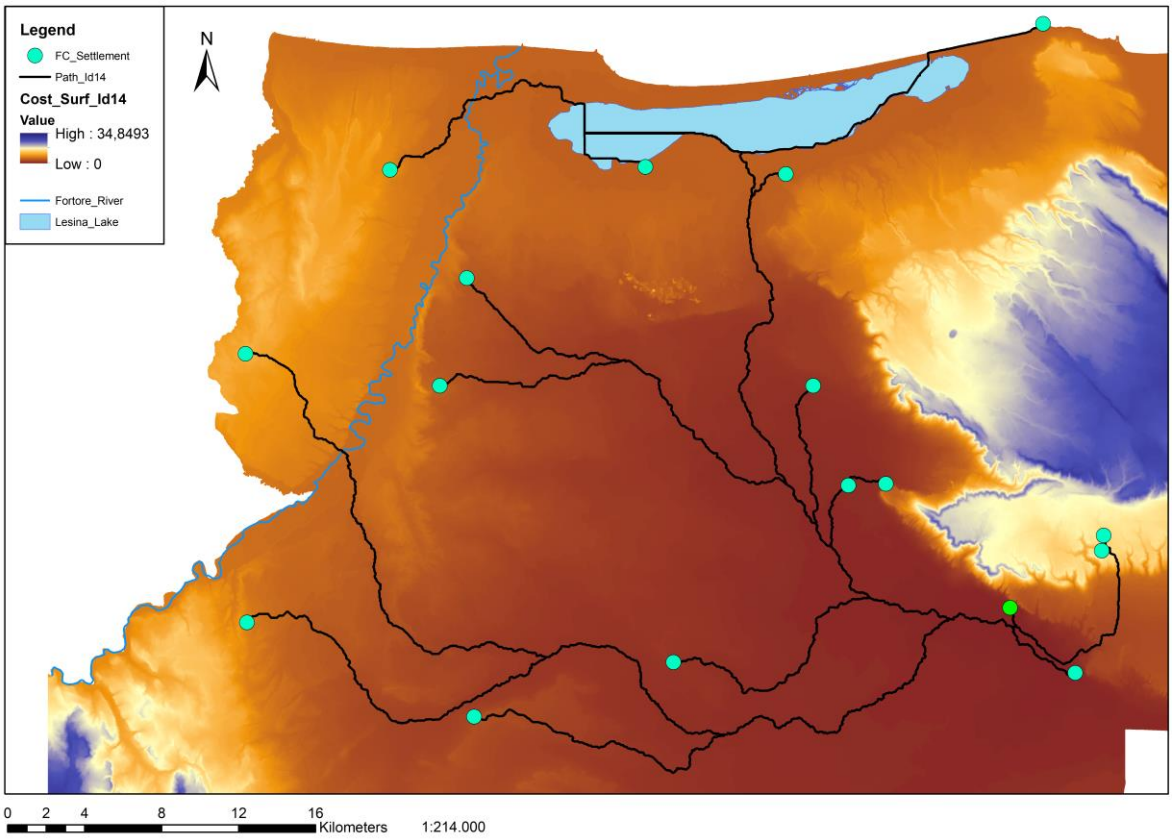


Table 138 – LPCA applied to Colle d'Armi (id15)

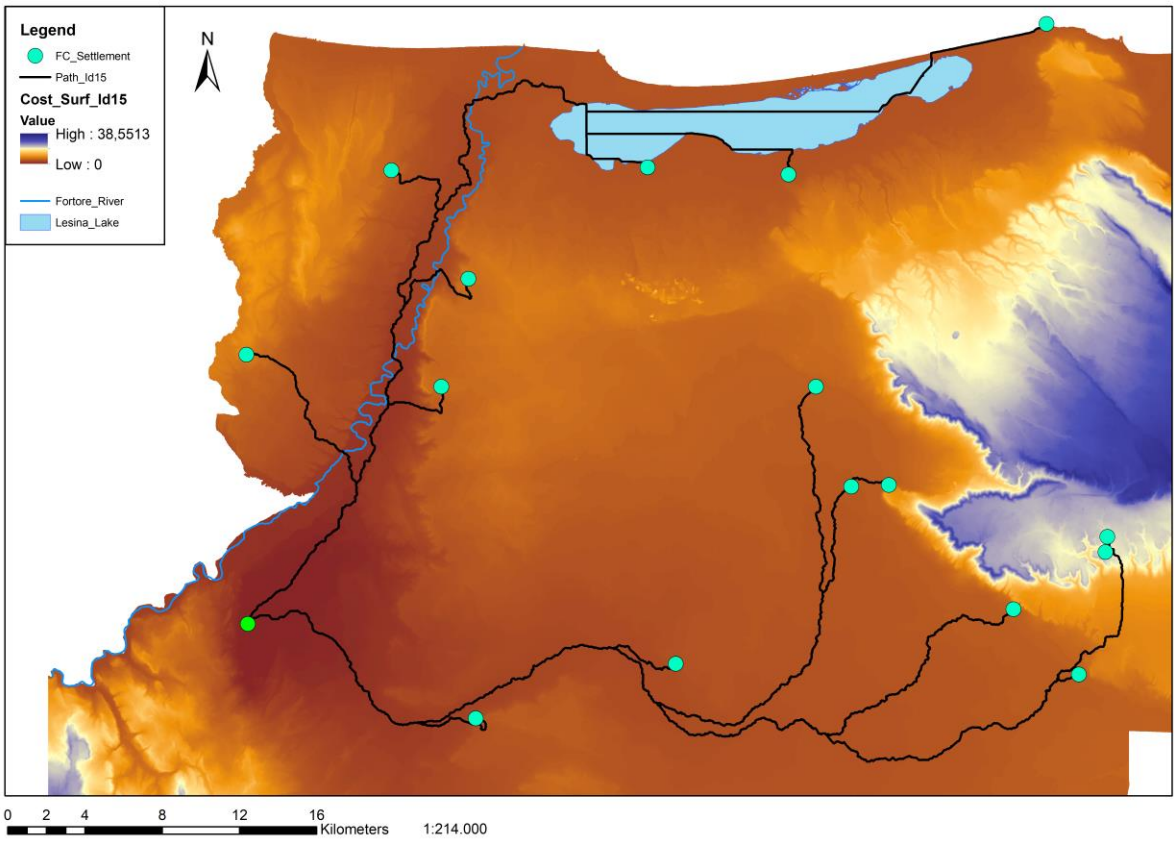


Table 139 – LPCA applied to Mezzana della Quercia (id16)

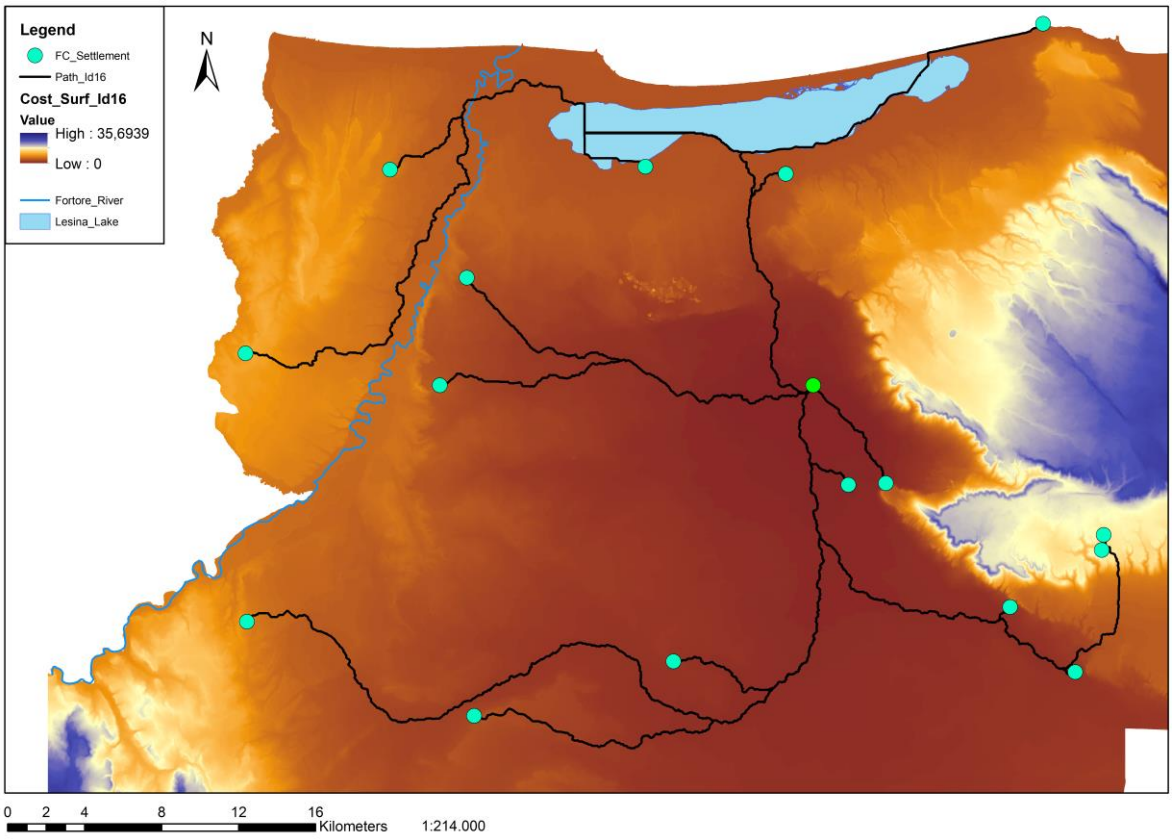
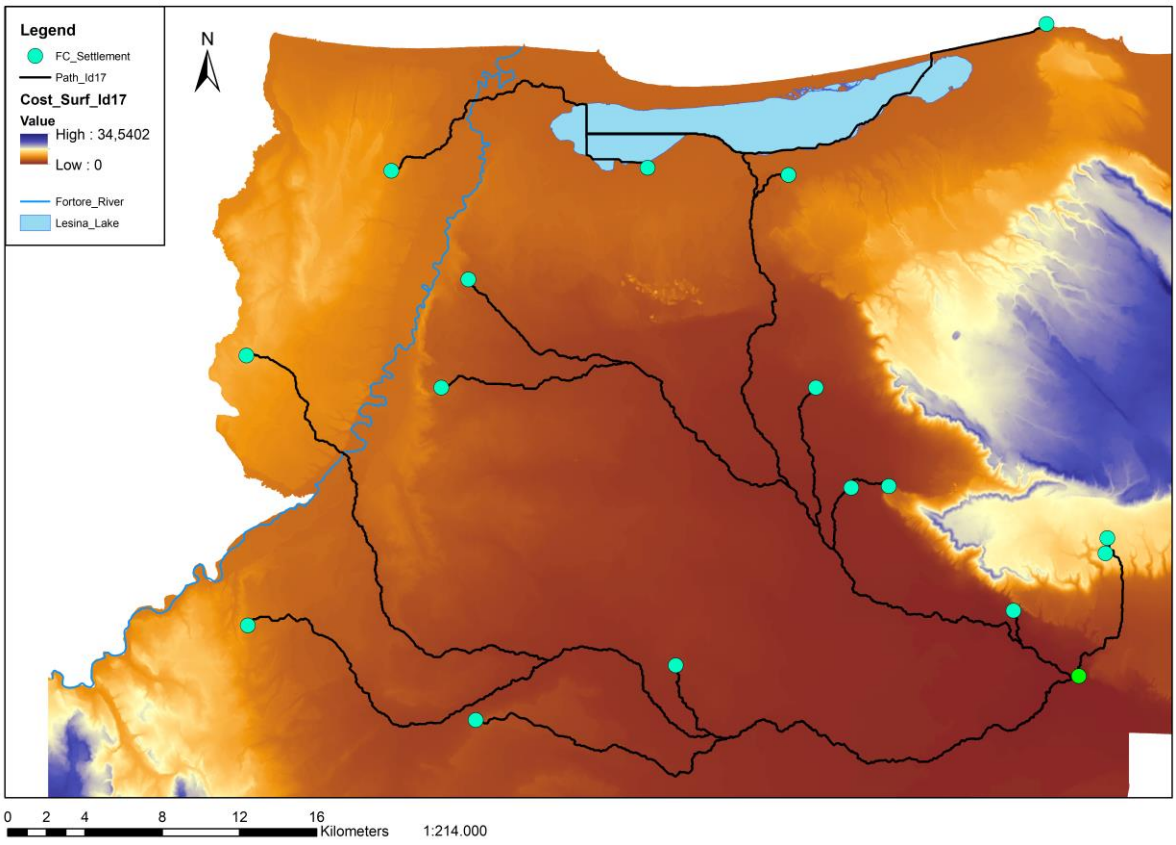


Table 140 – LPCA applied to Ciccalento (id17)



EARLY BRONZE AGE

Table 141 – LPCA applied to Colle di Creta (id1)

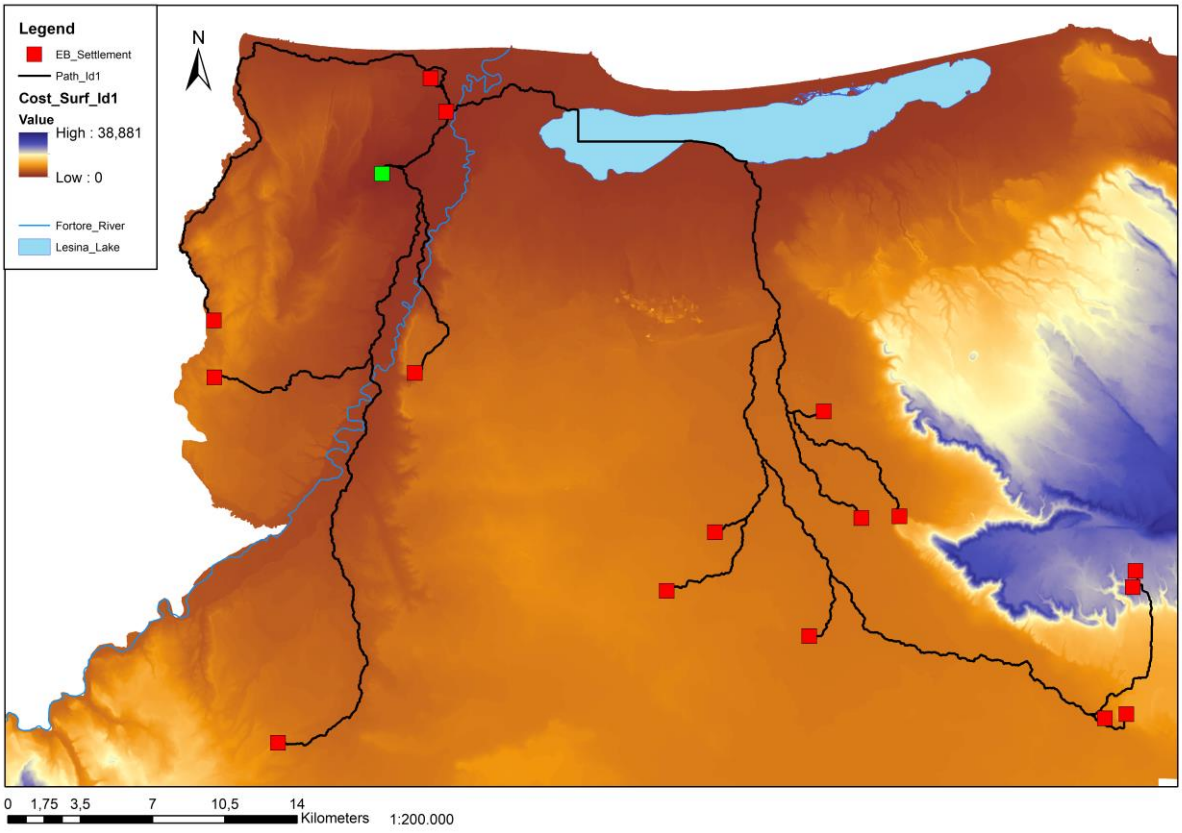


Table 142 – LPCA applied to Località Guadone (id2)

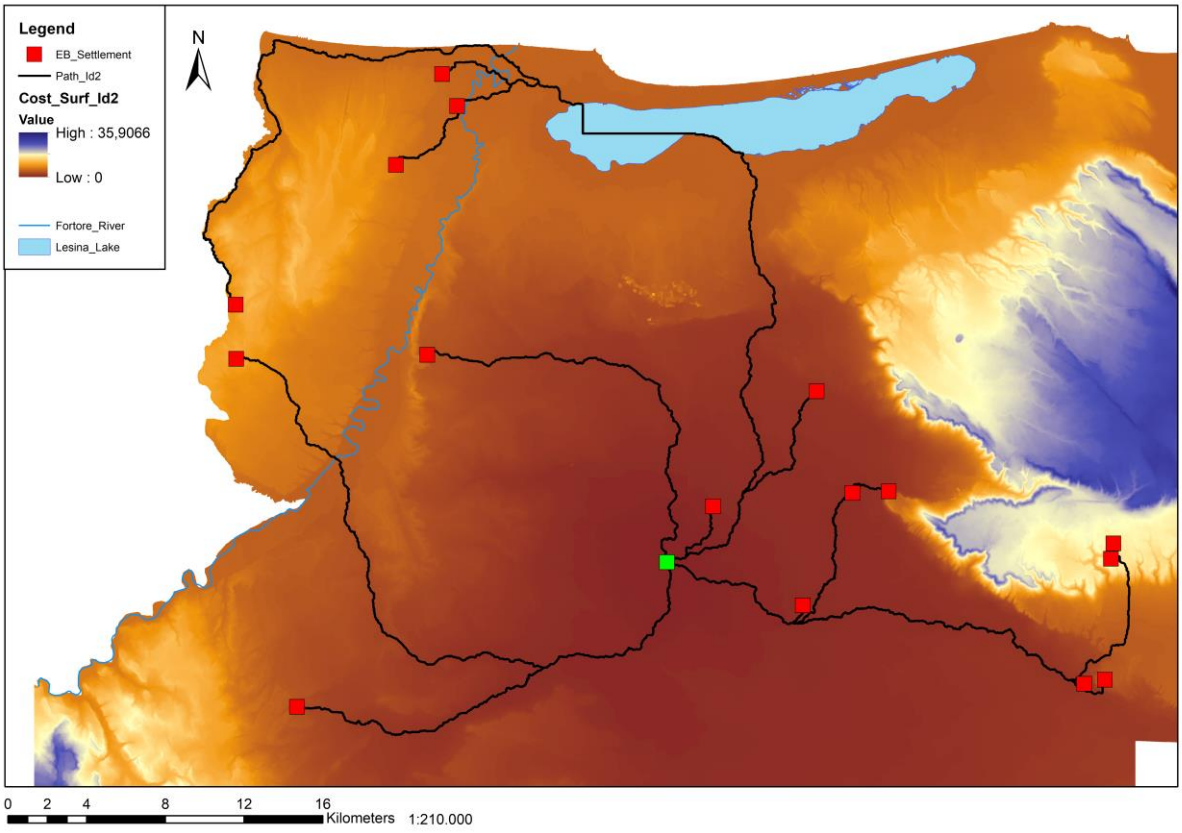


Table 143– LPCA applied to Monte Granata (id3)

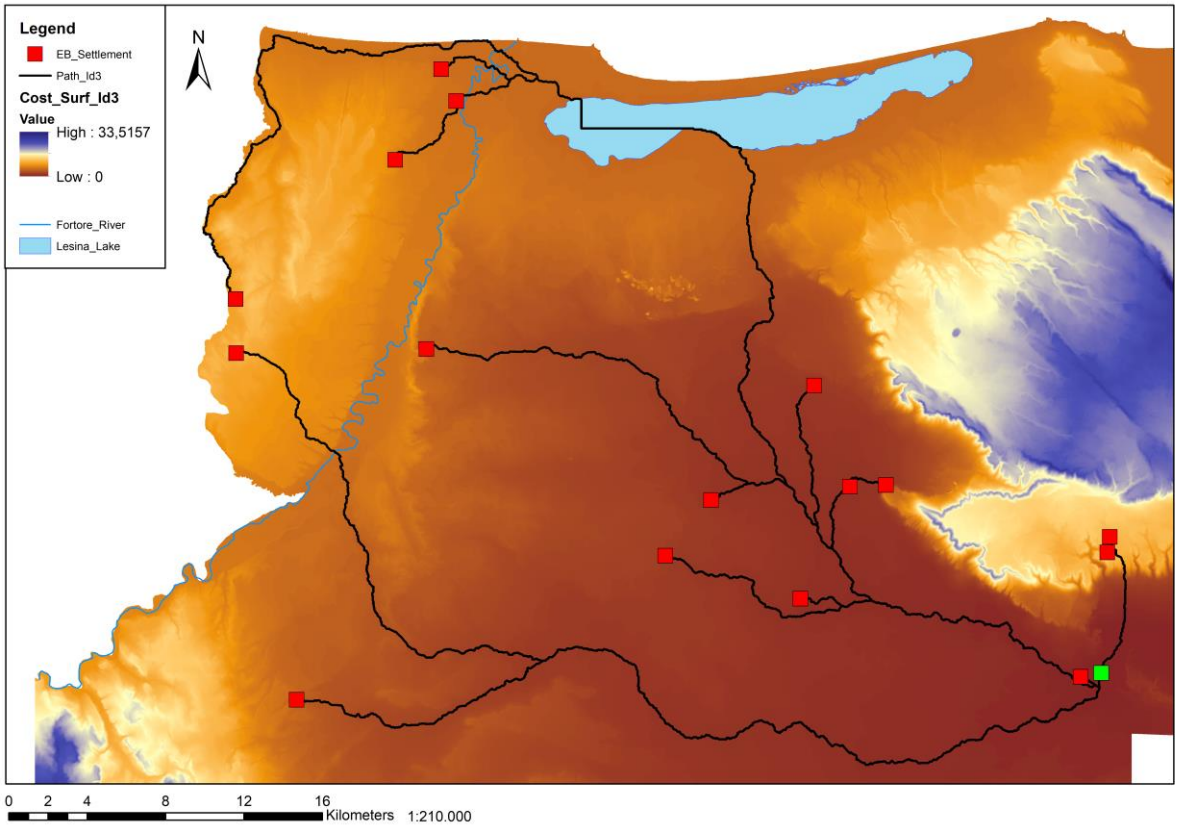


Table 144 – LPCA applied to Chiancata La Civita (id4)

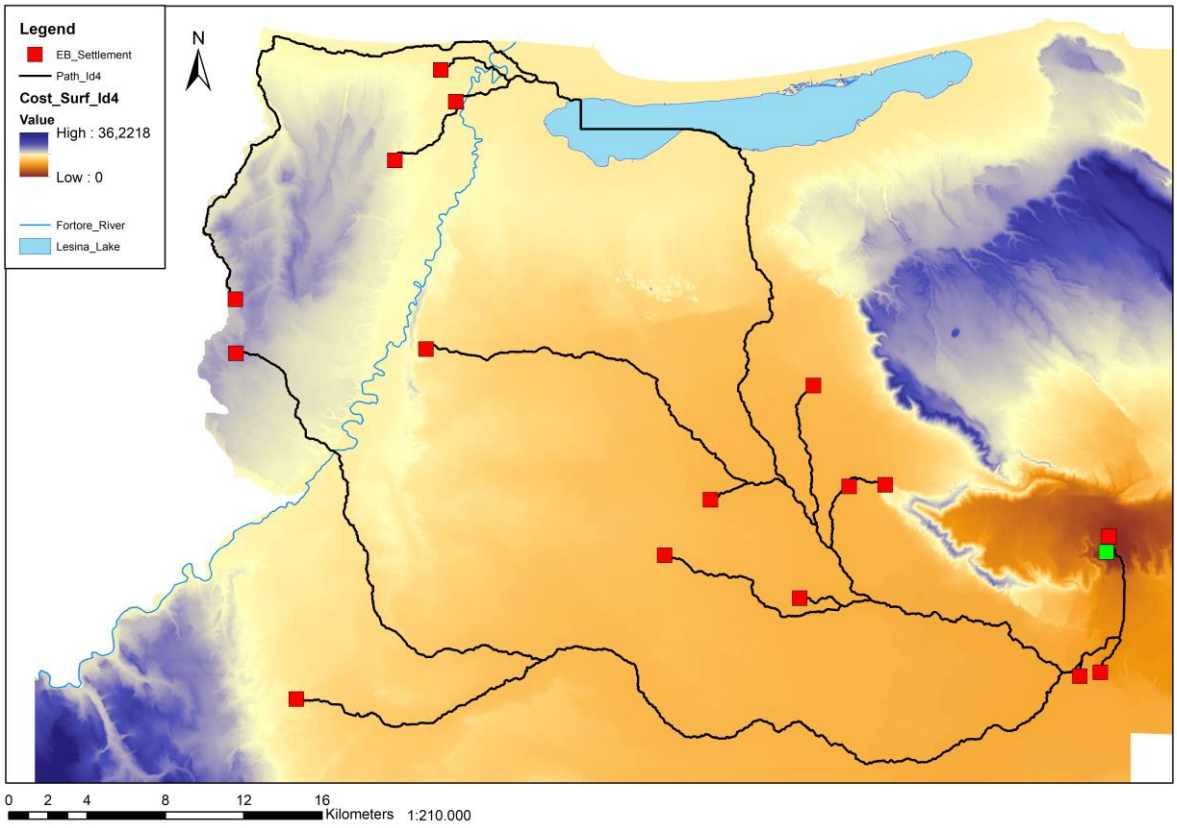


Table 145 – LPCA applied to Cantalupo-Tre Ponti (id5)

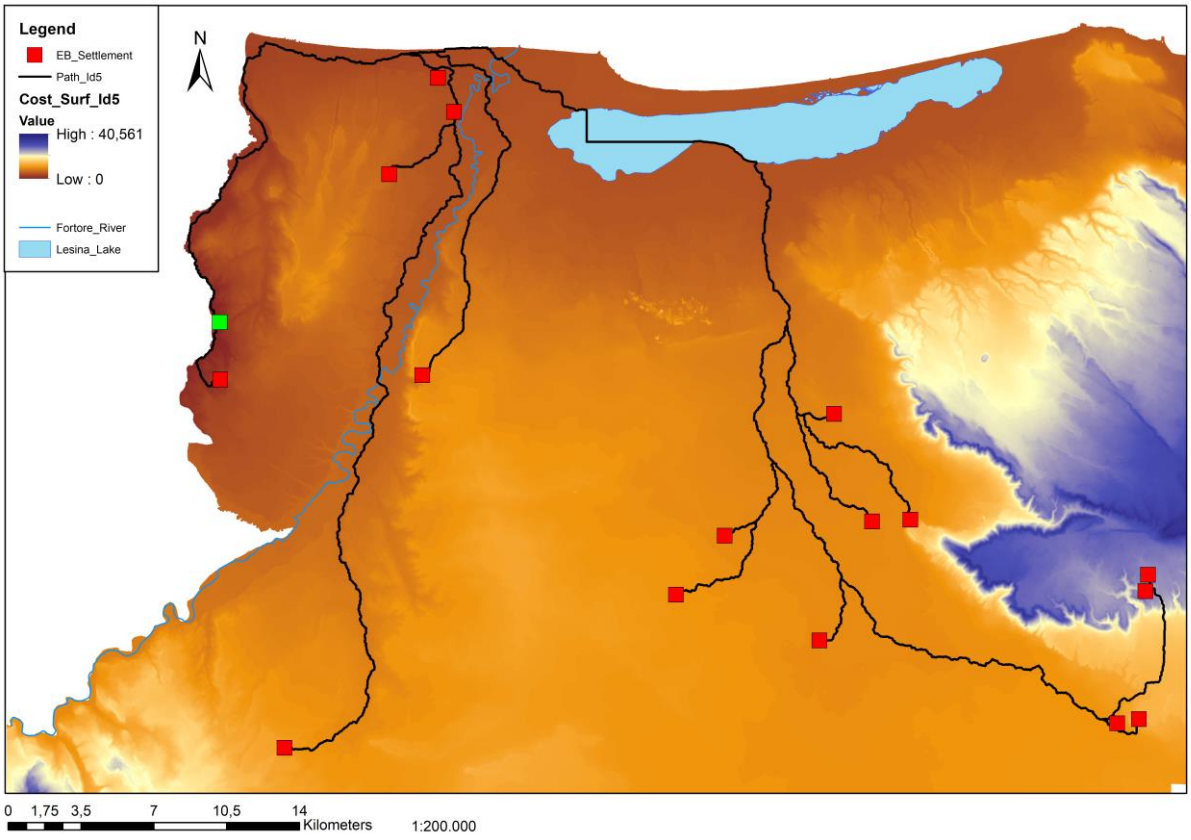


Table 146 – LPCA applied to Masseria Iacovelli (id6)

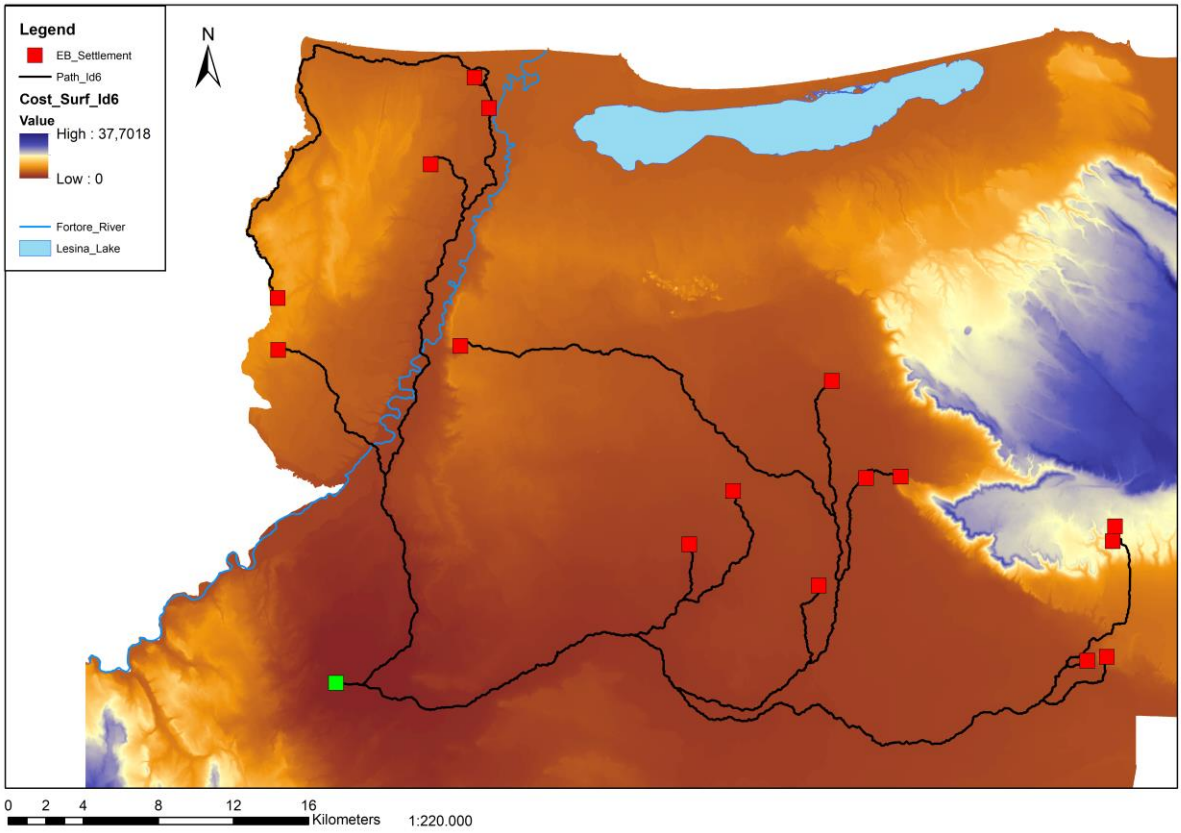


Table 147 – LPCA applied to Colle Arsano (id7)

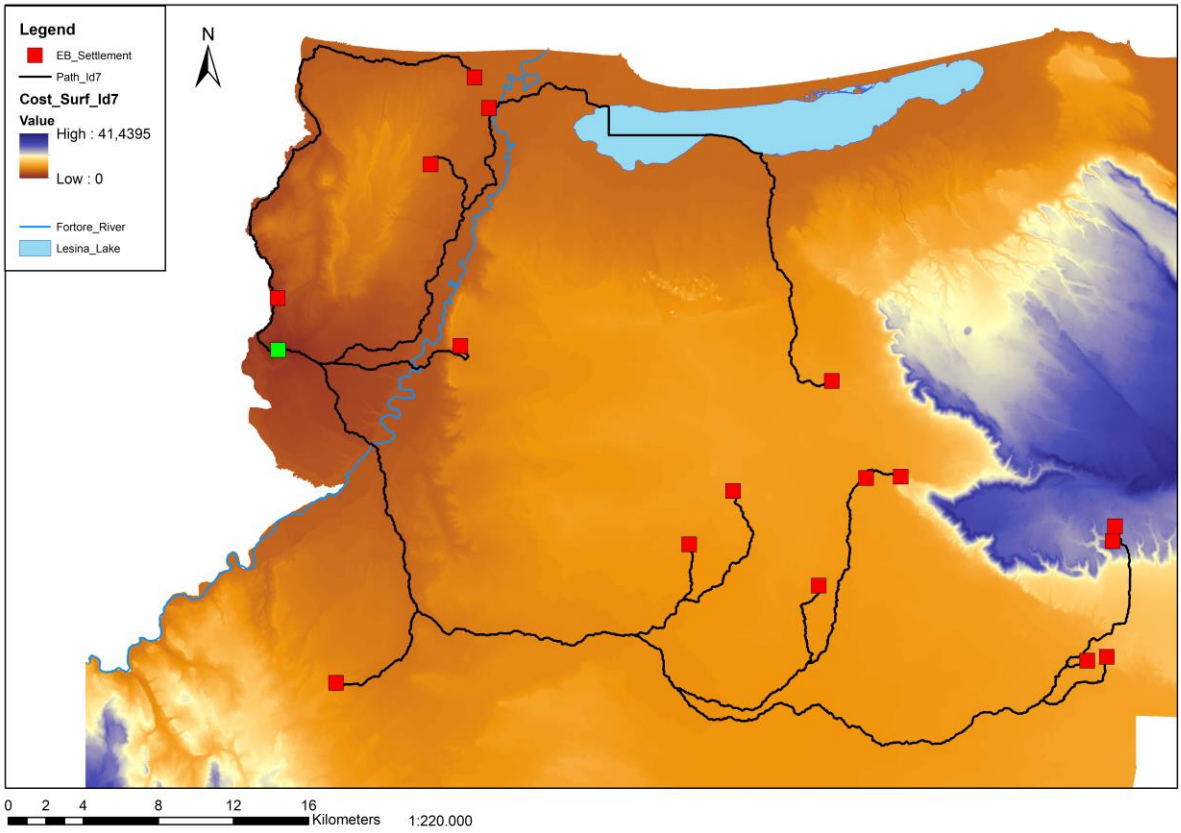


Table 148 – LPCA applied to Piani di Lauria (id8)

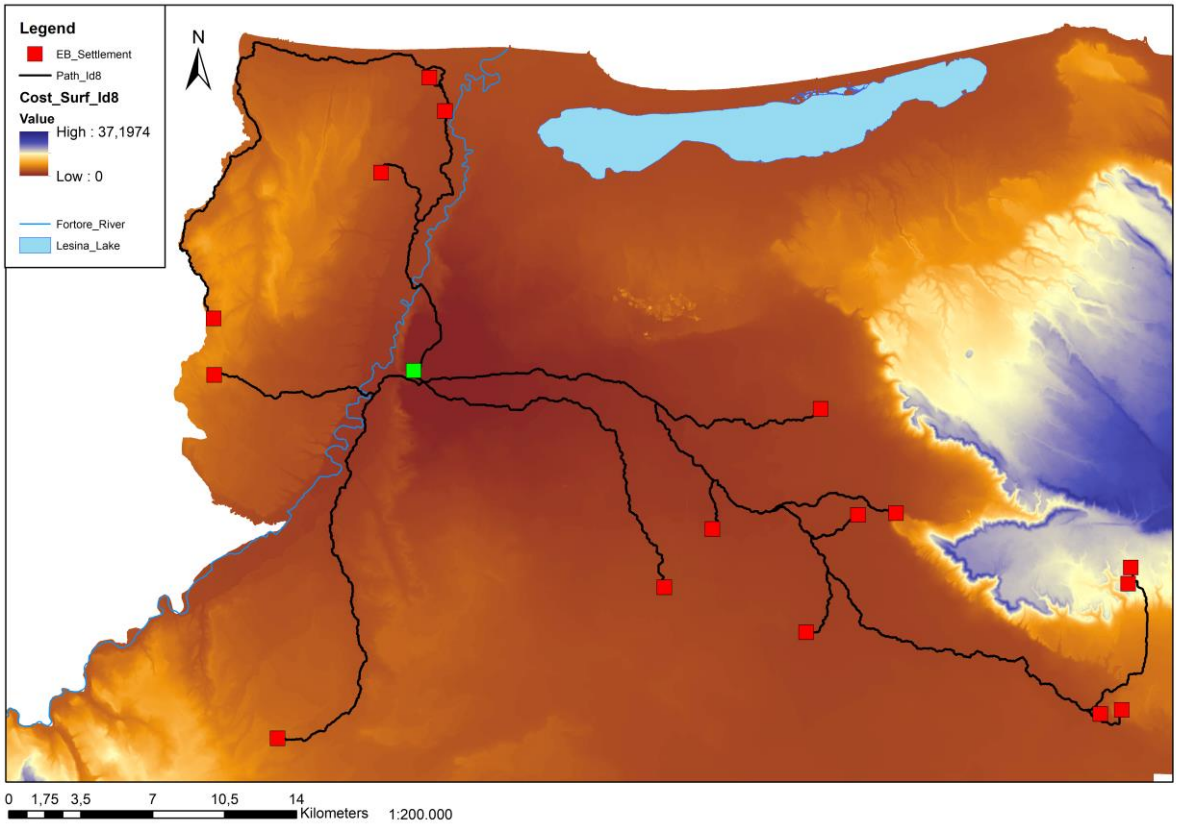


Table 149 – LPCA applied to Chiarappa (id9)

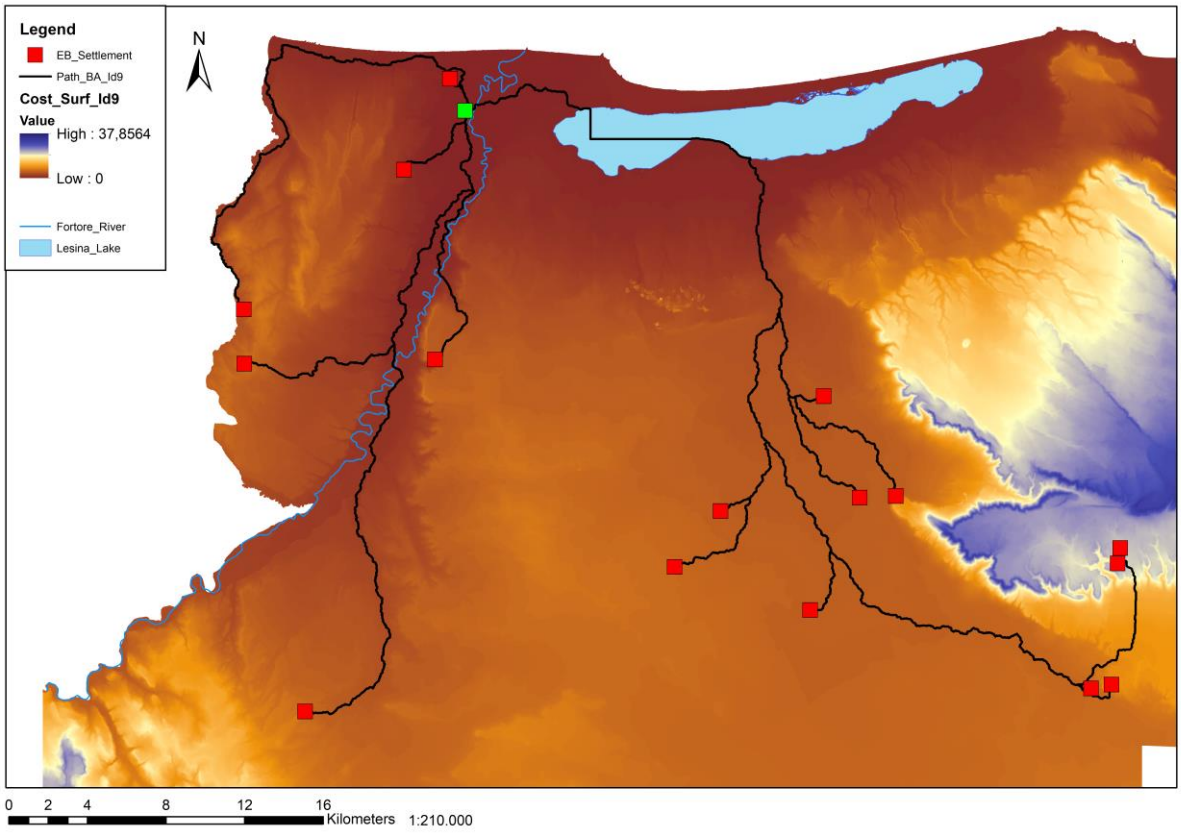


Table 150 – LPCA applied to Brancia km 10-Volta Pianezza (id10)

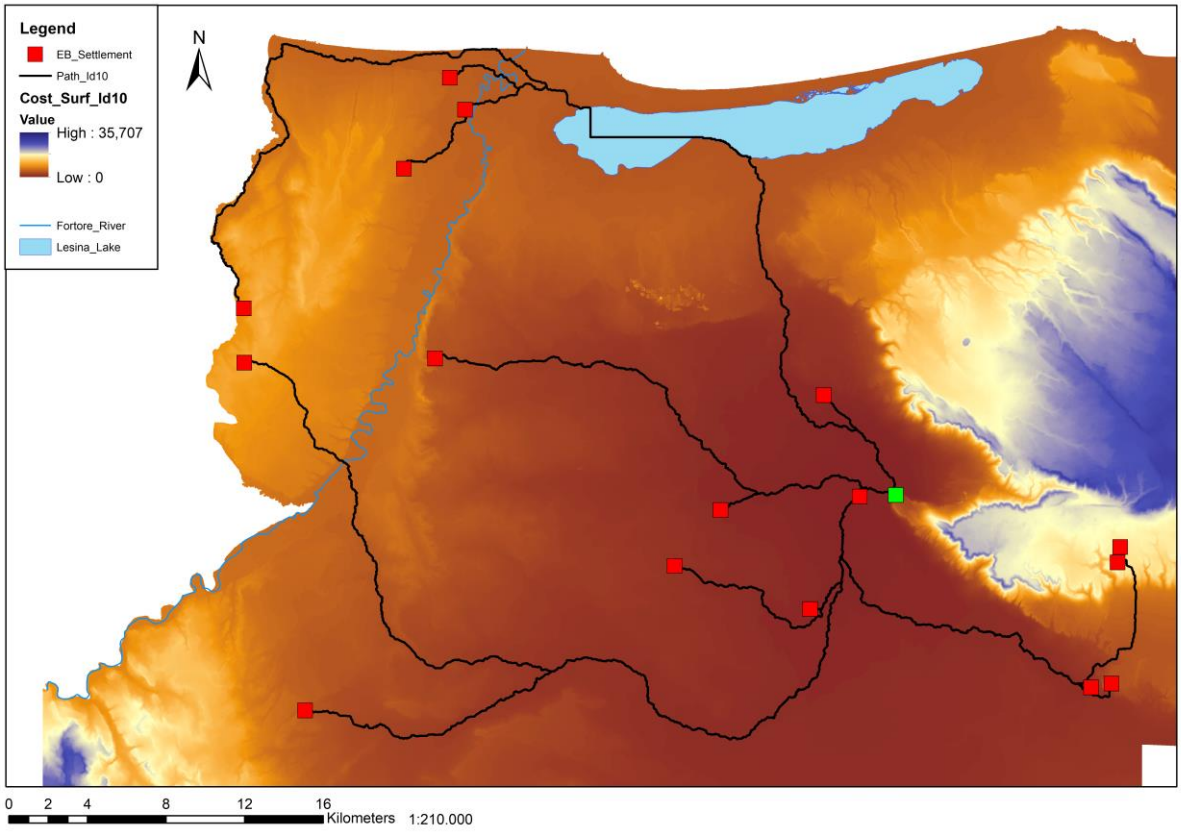


Table 151 – LPCA applied to Ciccalento (id11)

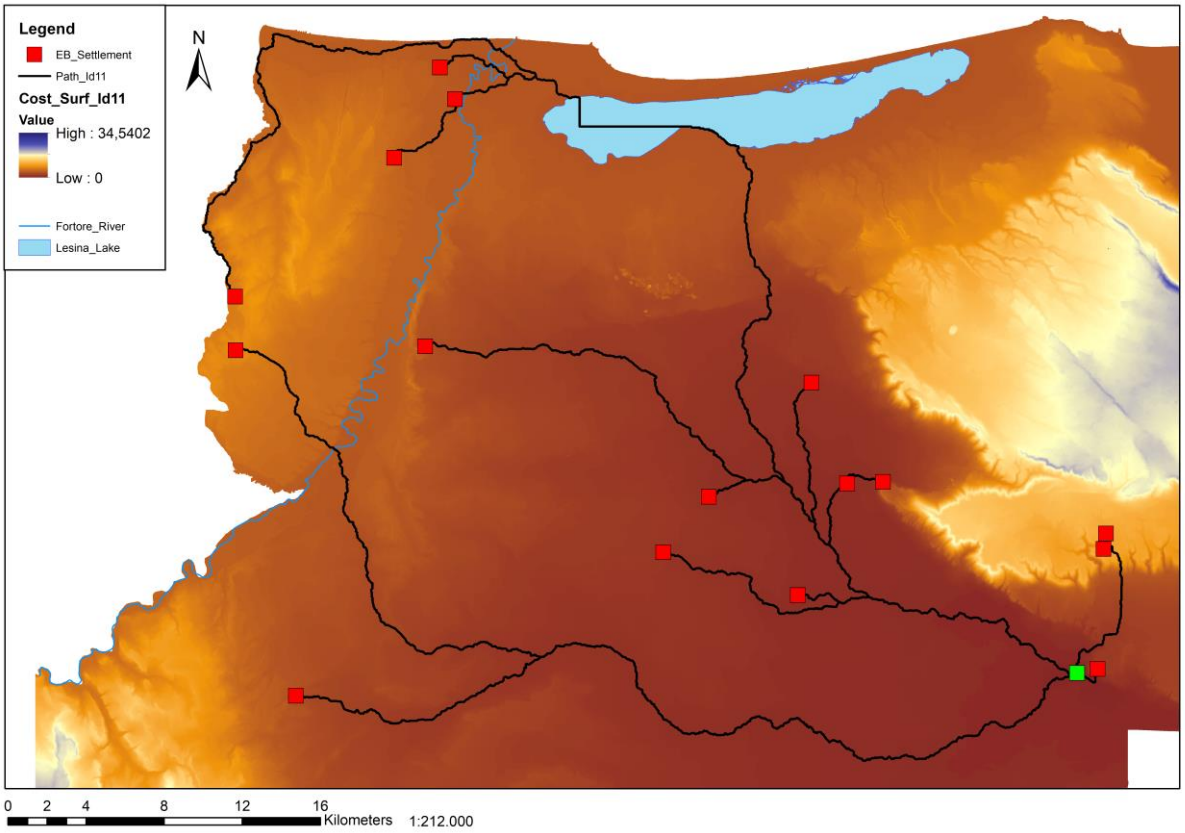


Table 152 – LPCA applied to Casale Crisetti (id12)

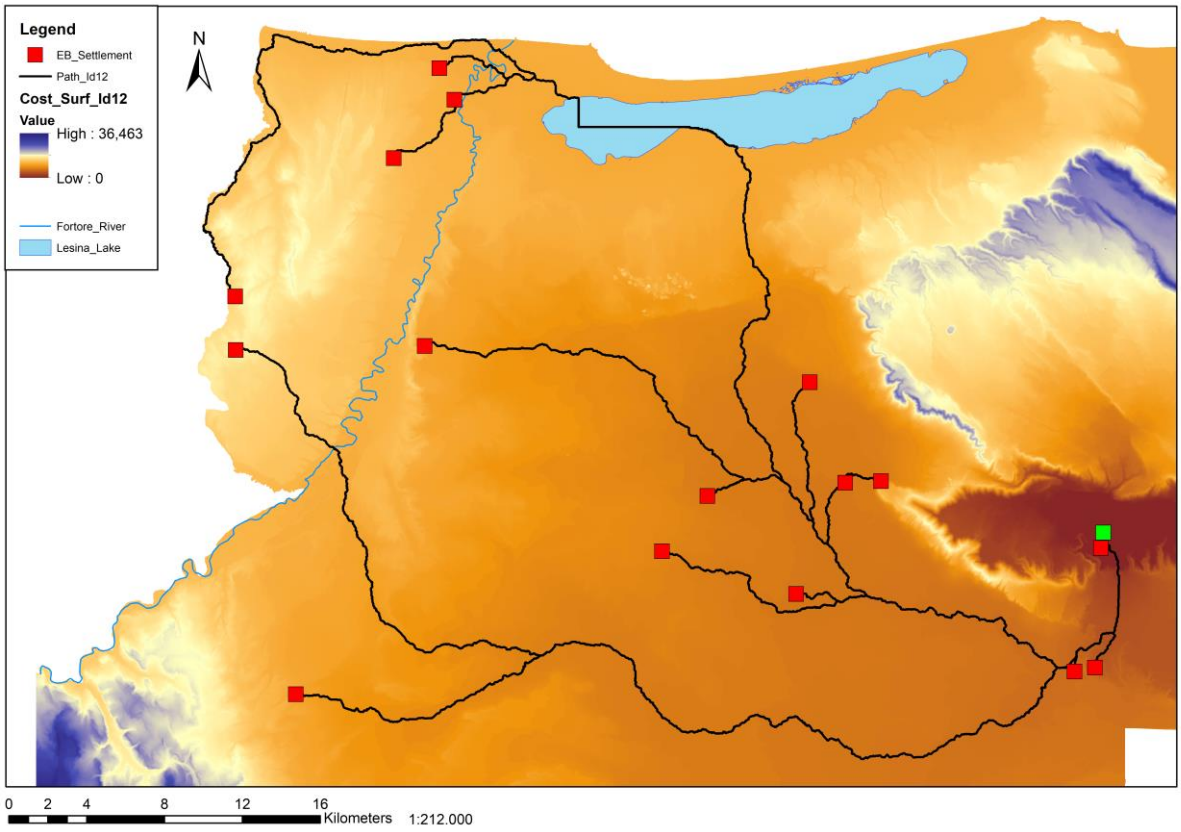


Table 153 – LPCA applied to Masseria Mezzanella di Brancia (id13)

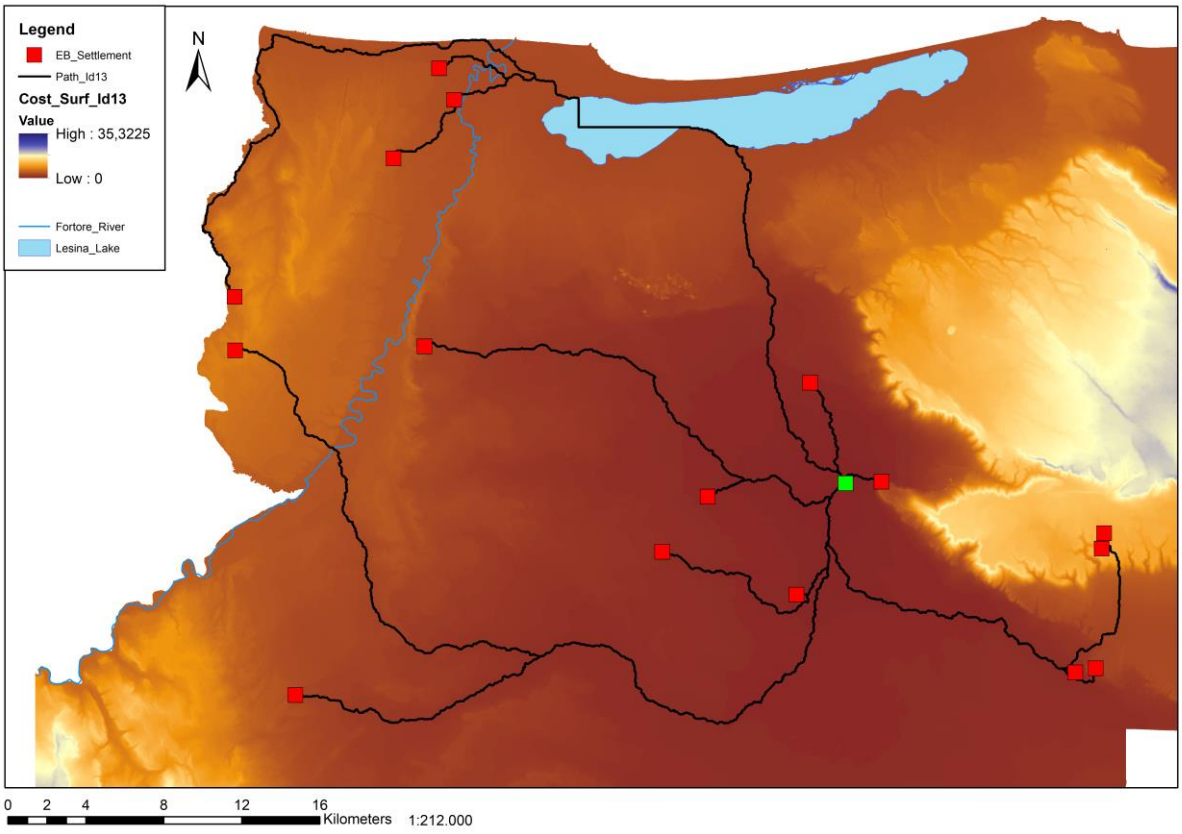


Table 154 – LPCA applied to Brecciara (id14)

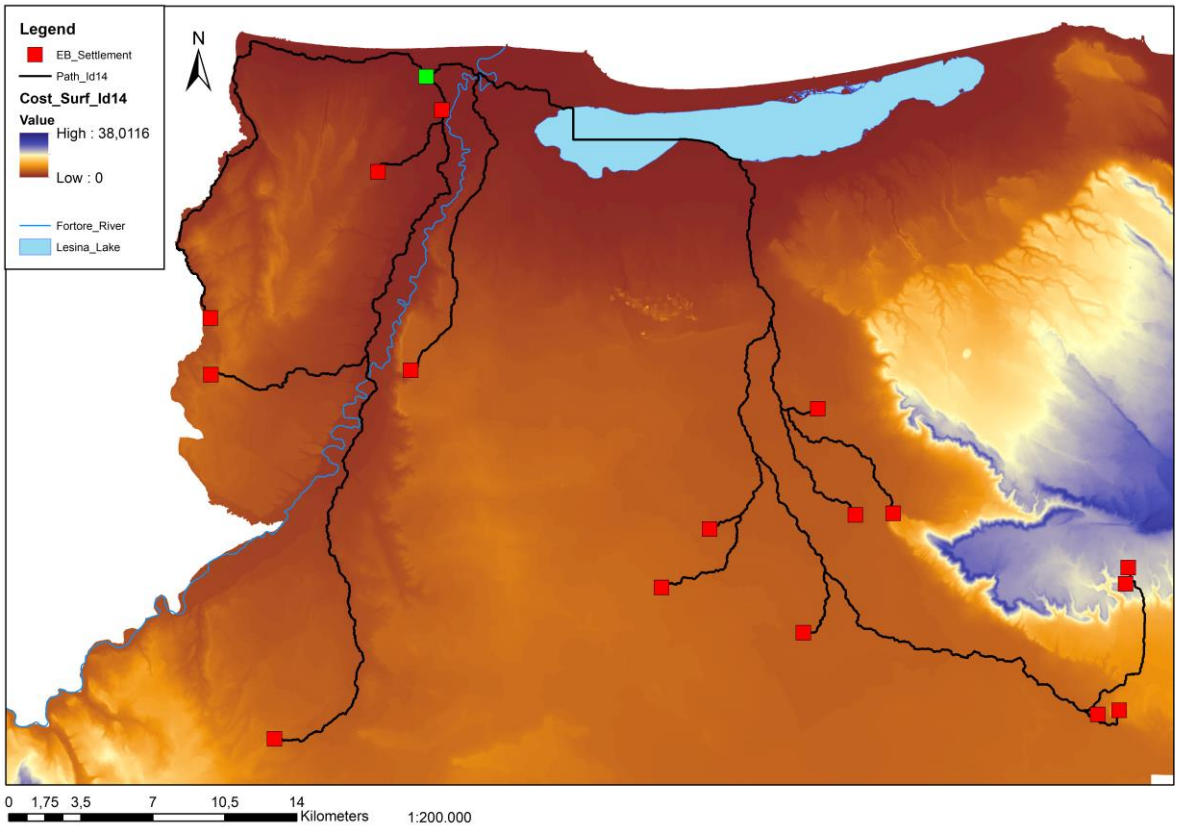


Table 155 – LPCA applied to Mezzana della Quercia (id15)

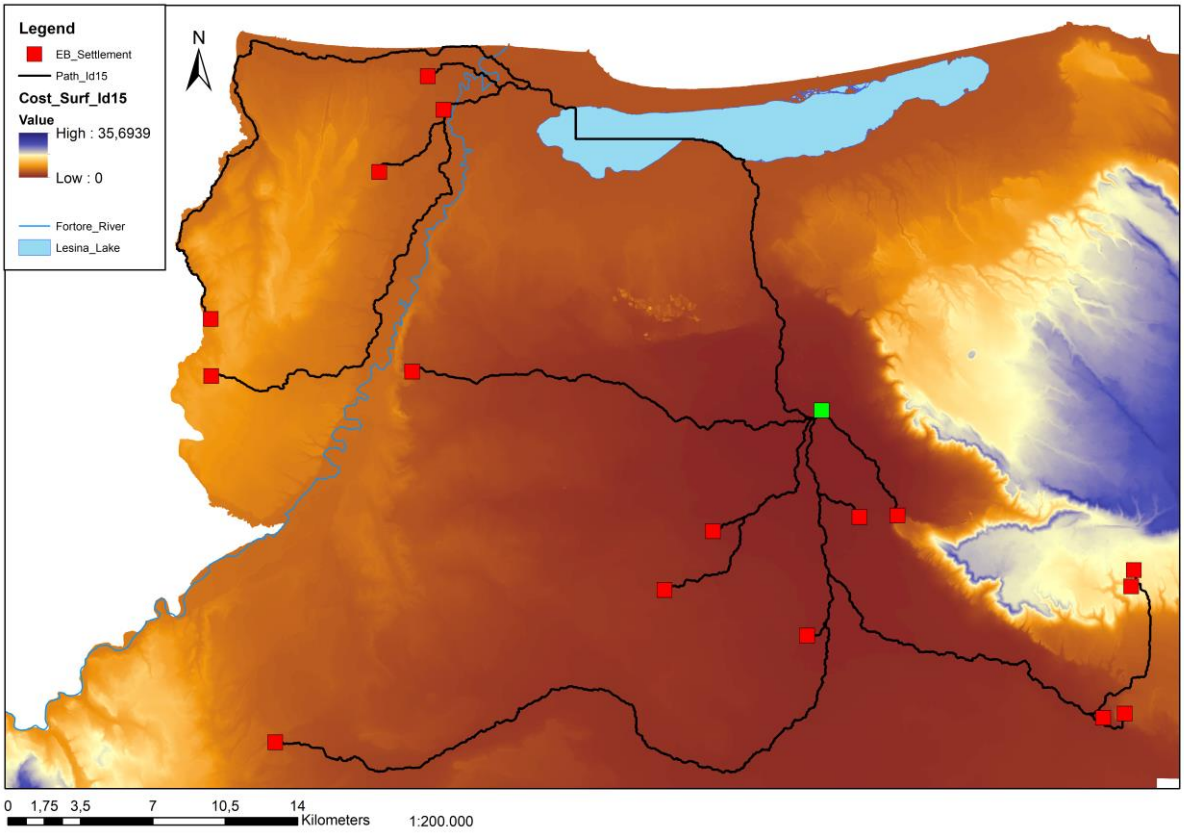


Table 156 – LPCA applied to Oliveto Torre dei Giunchi (id16)

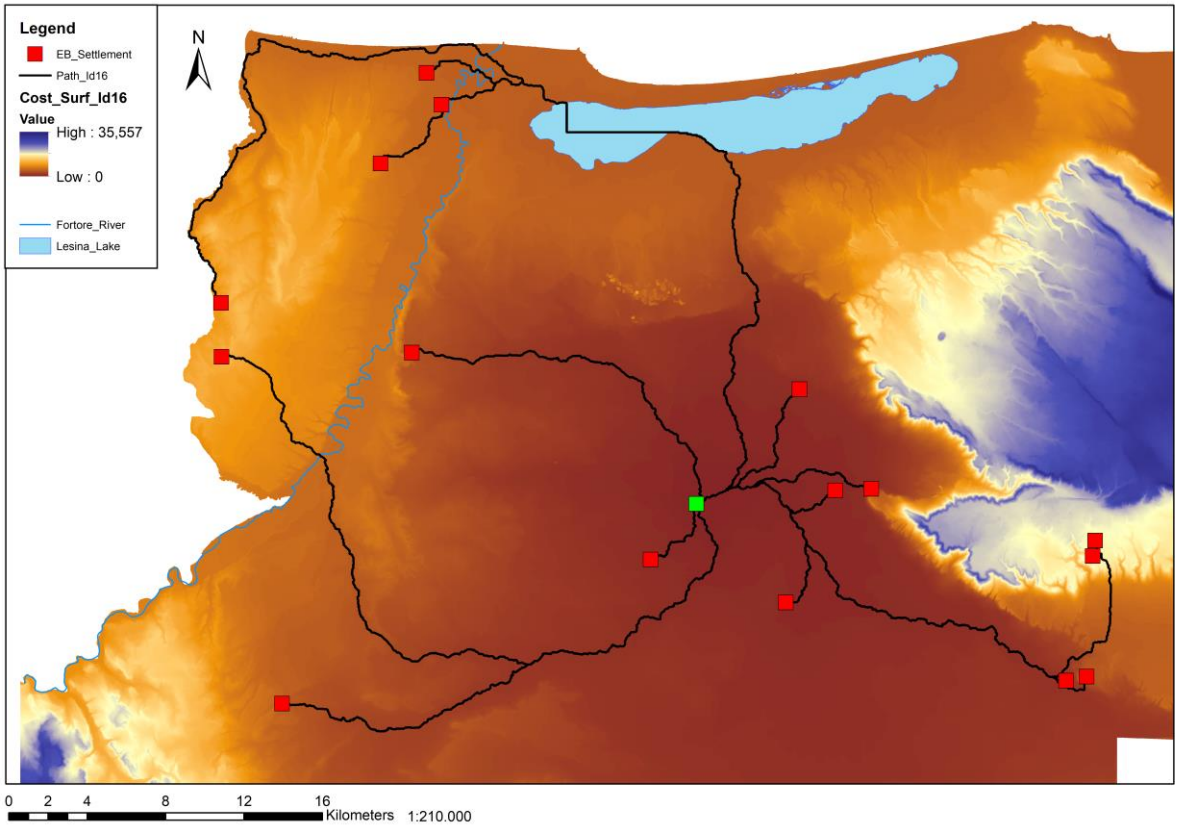
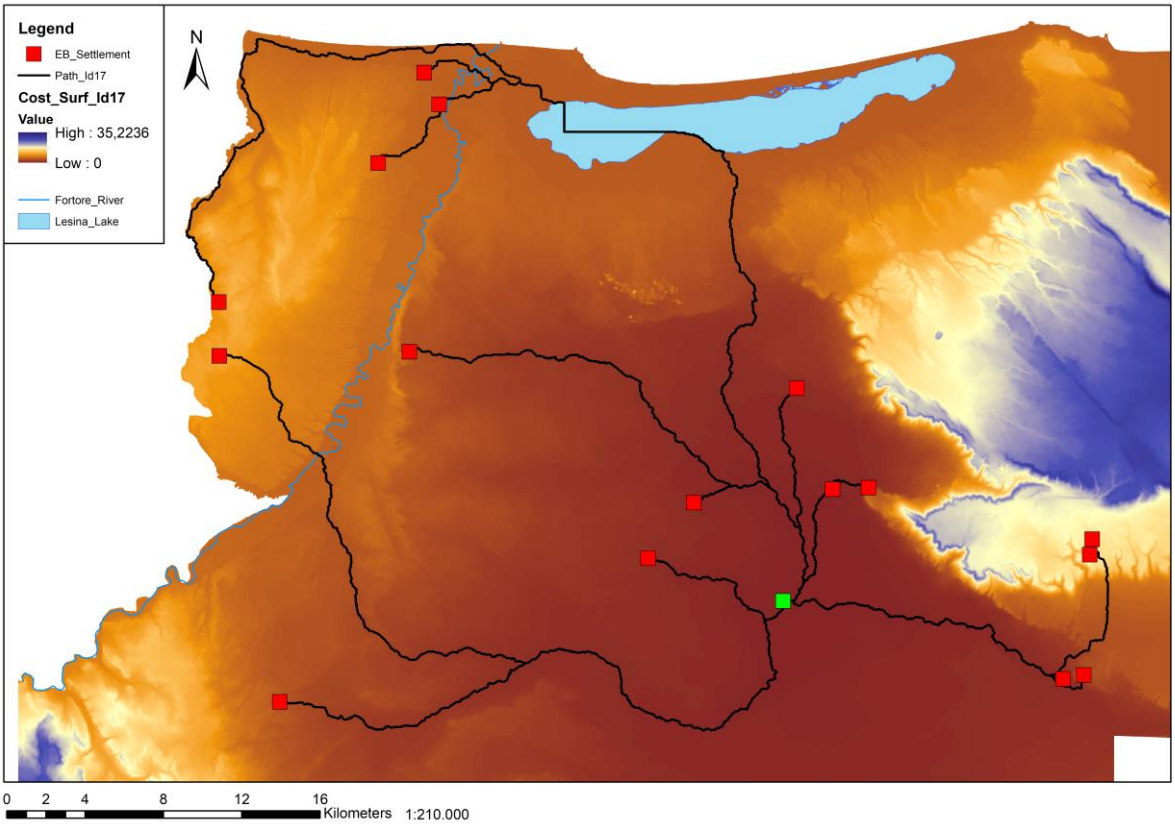


Table 157– LPCA applied to Portata Casane (id17)



FUZZY VIEWSHED ANALYSIS

EARLY NEOLITHIC

FORTORE RIVER VALLEY

EASTERN SHORESIDE

Table 158 – FVA applied to Masseria Anita-Canimpiso (id1)

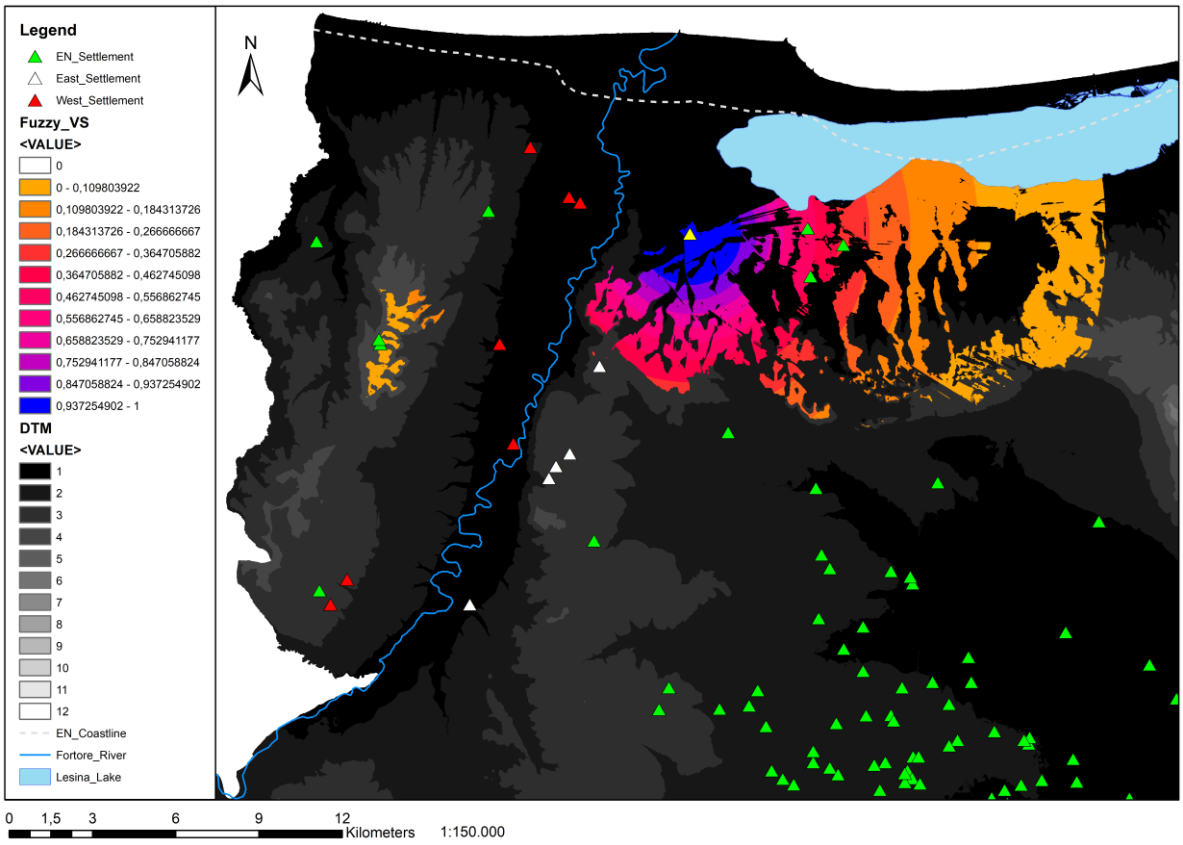


Table 159 – FVA applied to Coppe di Rose (id9)

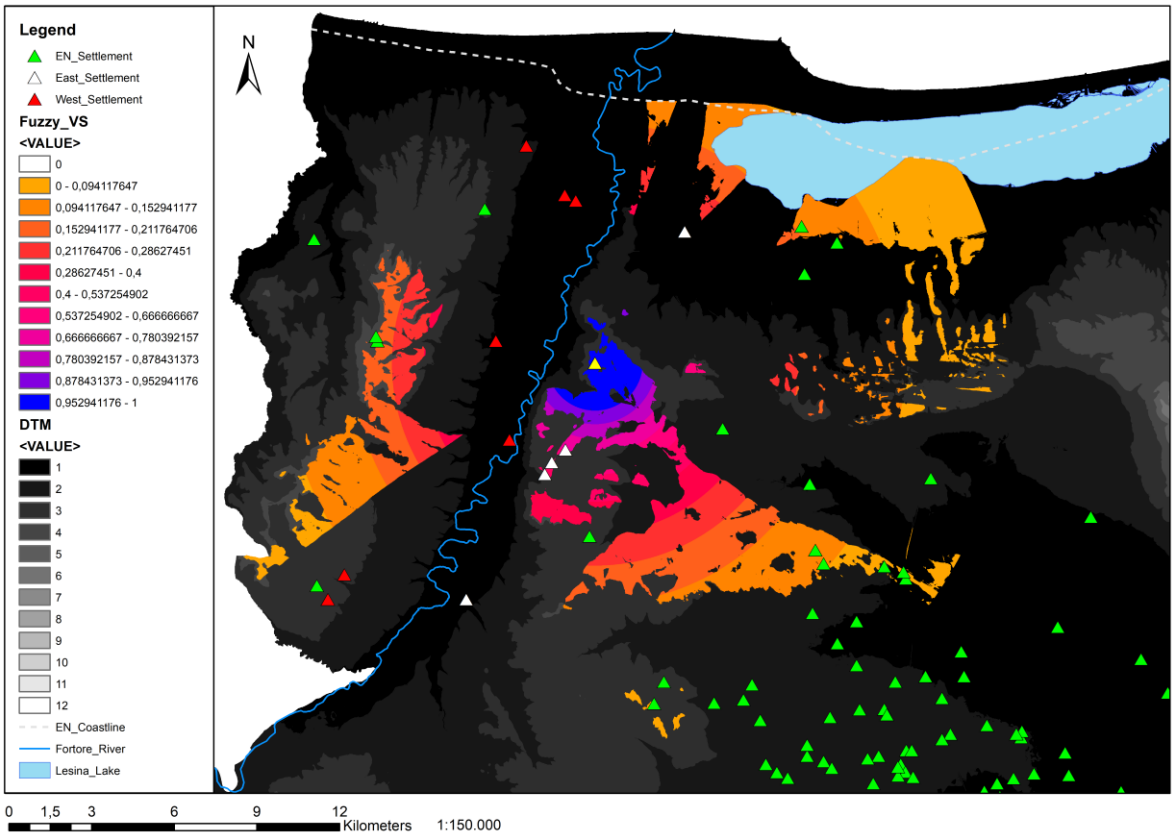


Table 160 – FVA applied to Piani di Lauria I (id15)

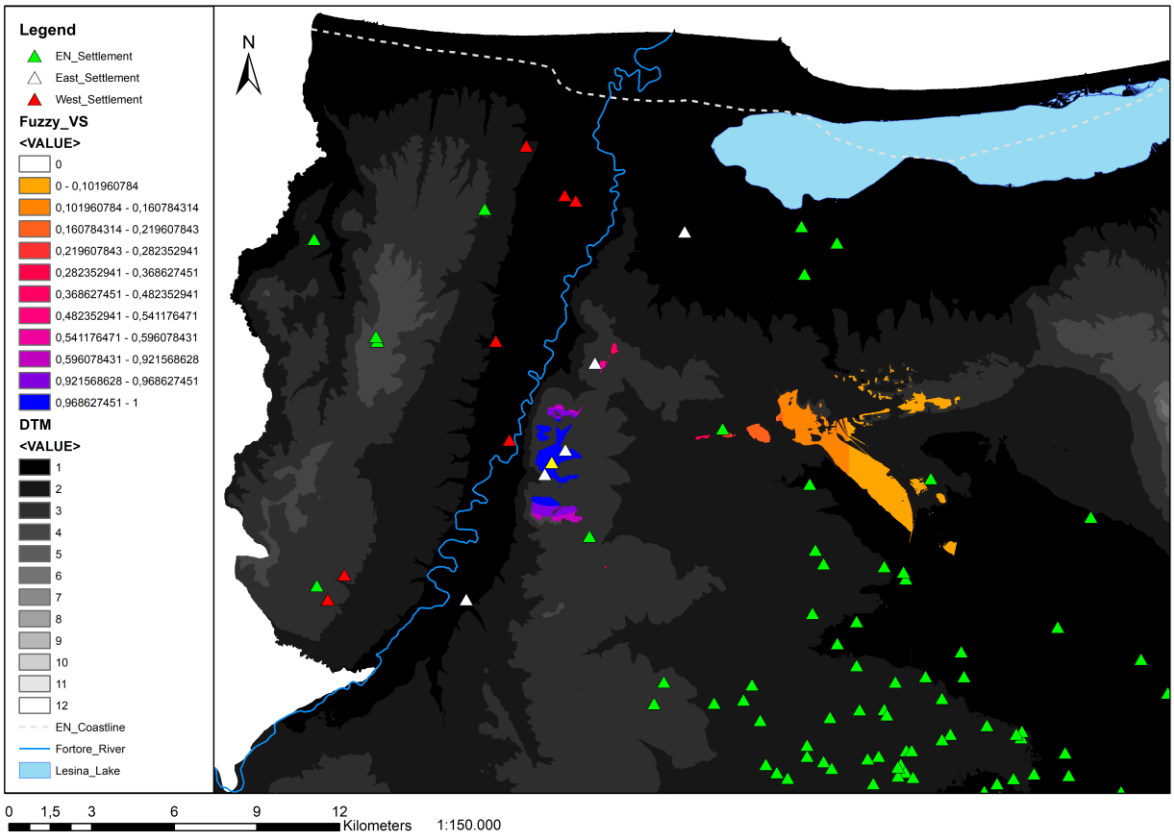


Table 161 – FVA applied to Colle d'Armi (id18)

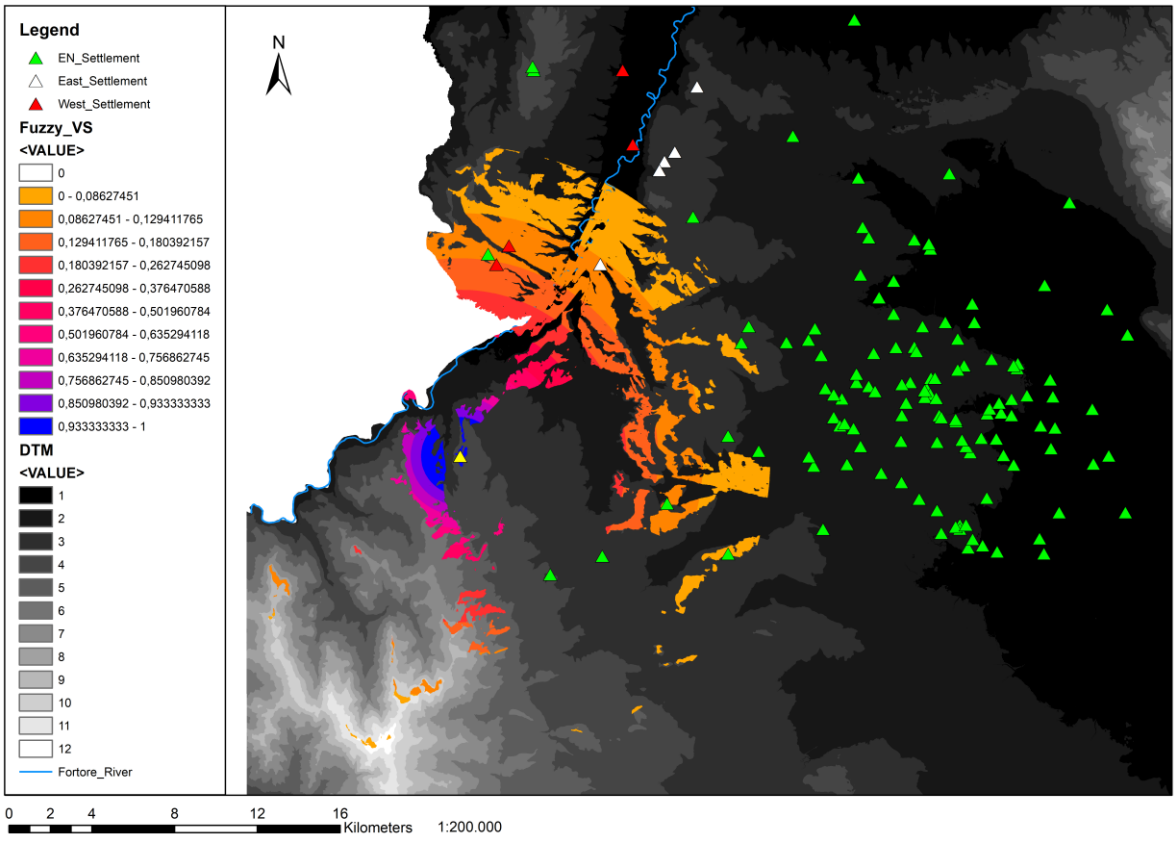


Table 162 – FVA applied to Piani di Lauria IV (id133)

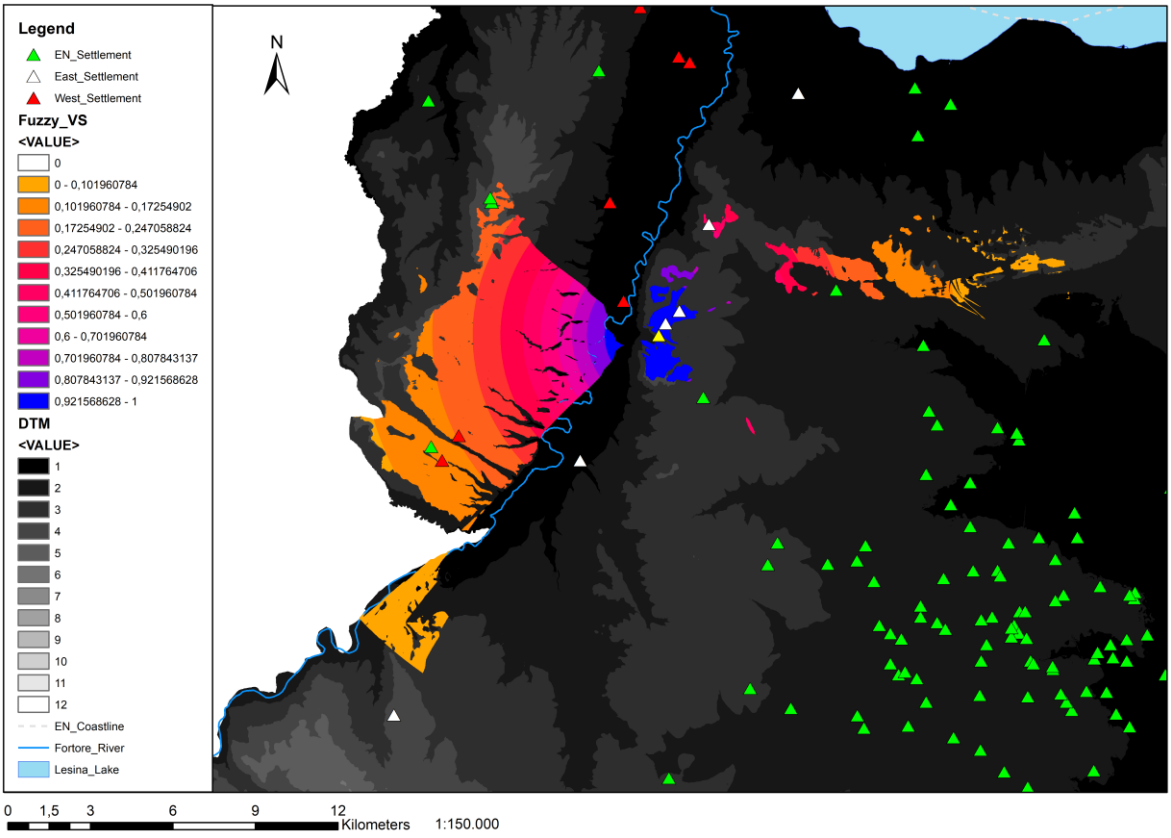


Table 163 – FVA applied to Piani di Lauria III (id134)

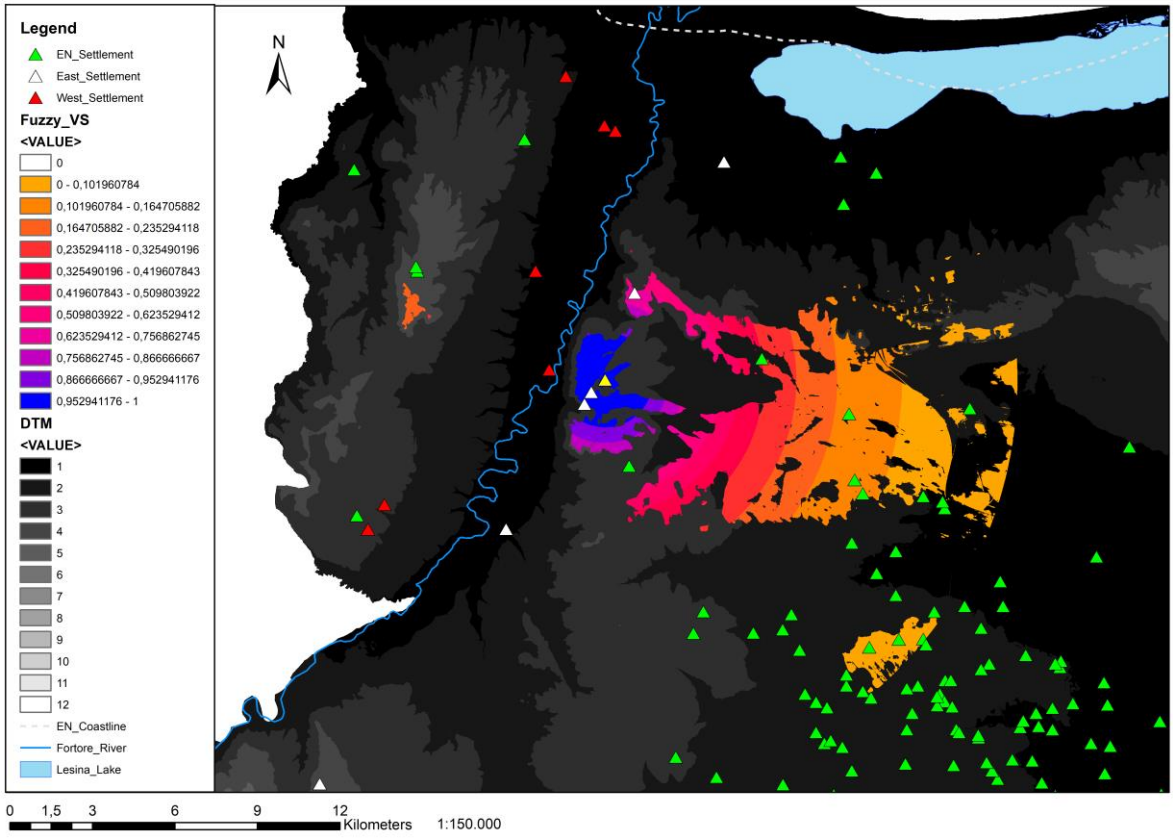
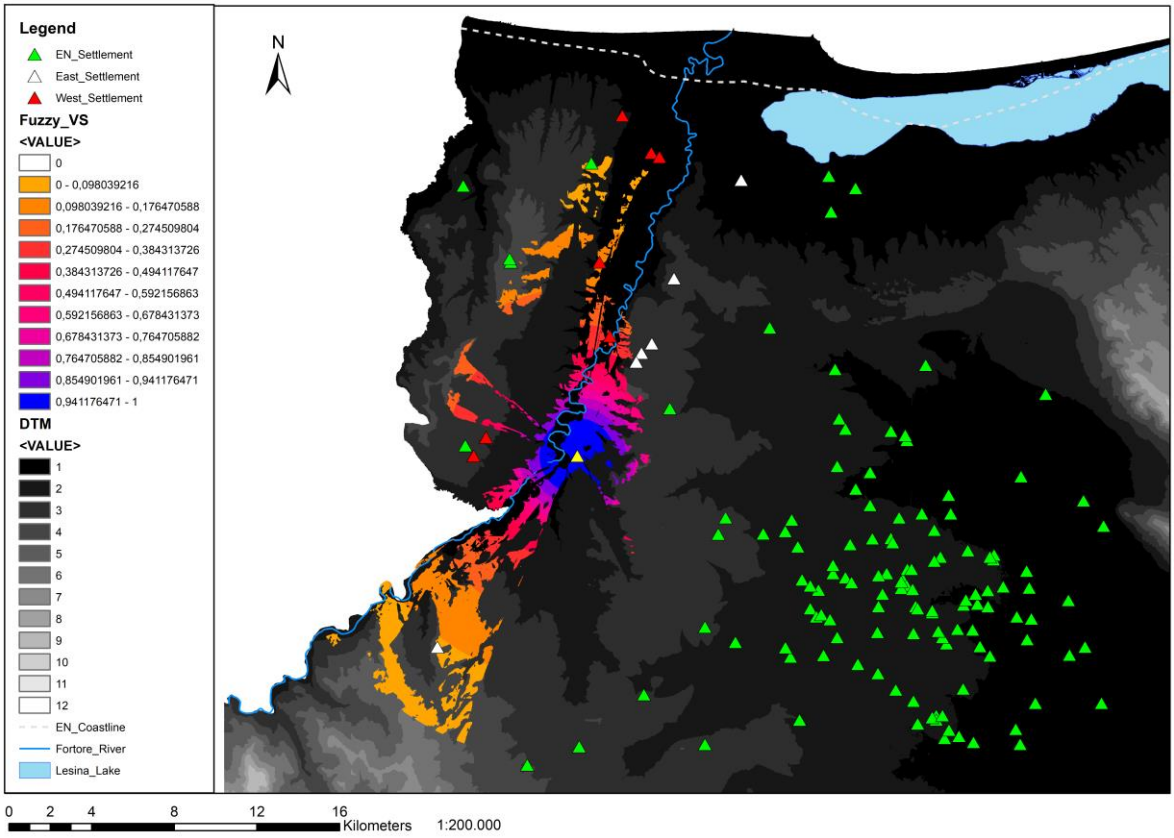


Table 164 – FVA applied to Masseria Fara Sentinella (id139)



WESTERN SHORESIDE

Table 165– FVA applied to Vastaioli (id4)

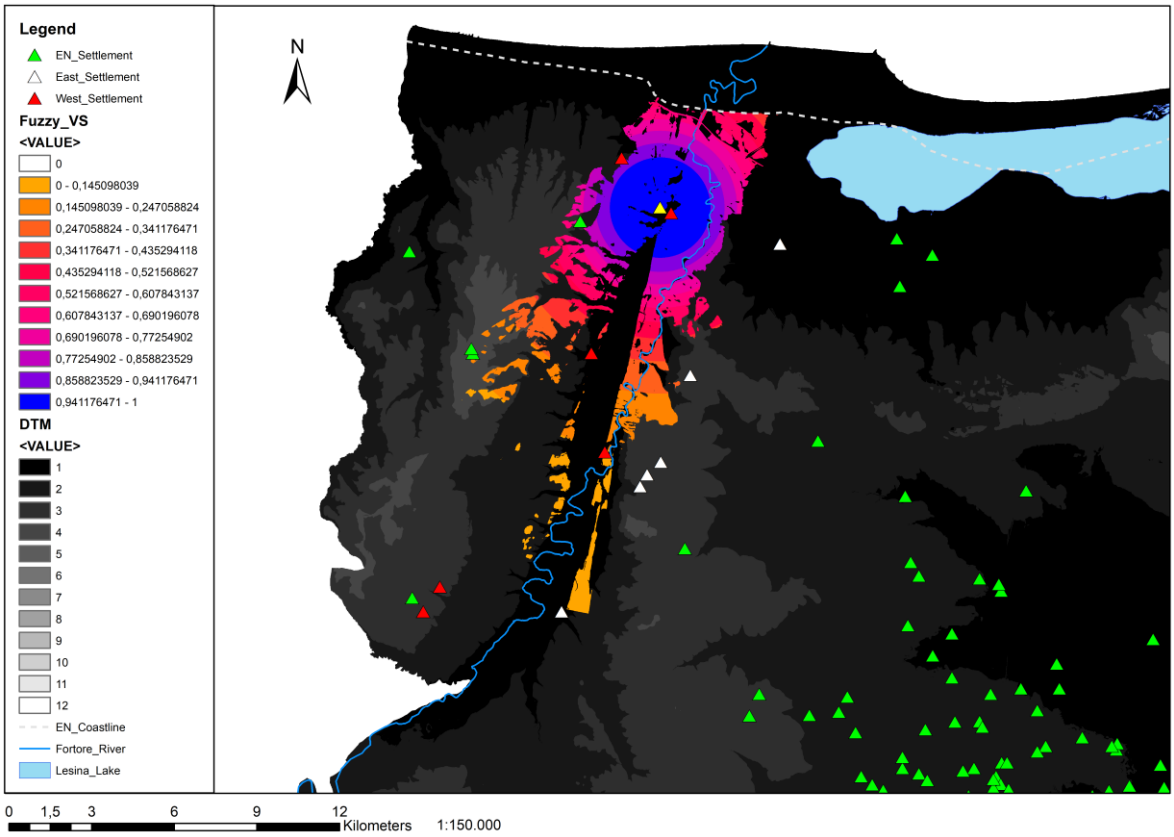


Table 166 – FVA applied to Masseria dell'Ischia (id6)

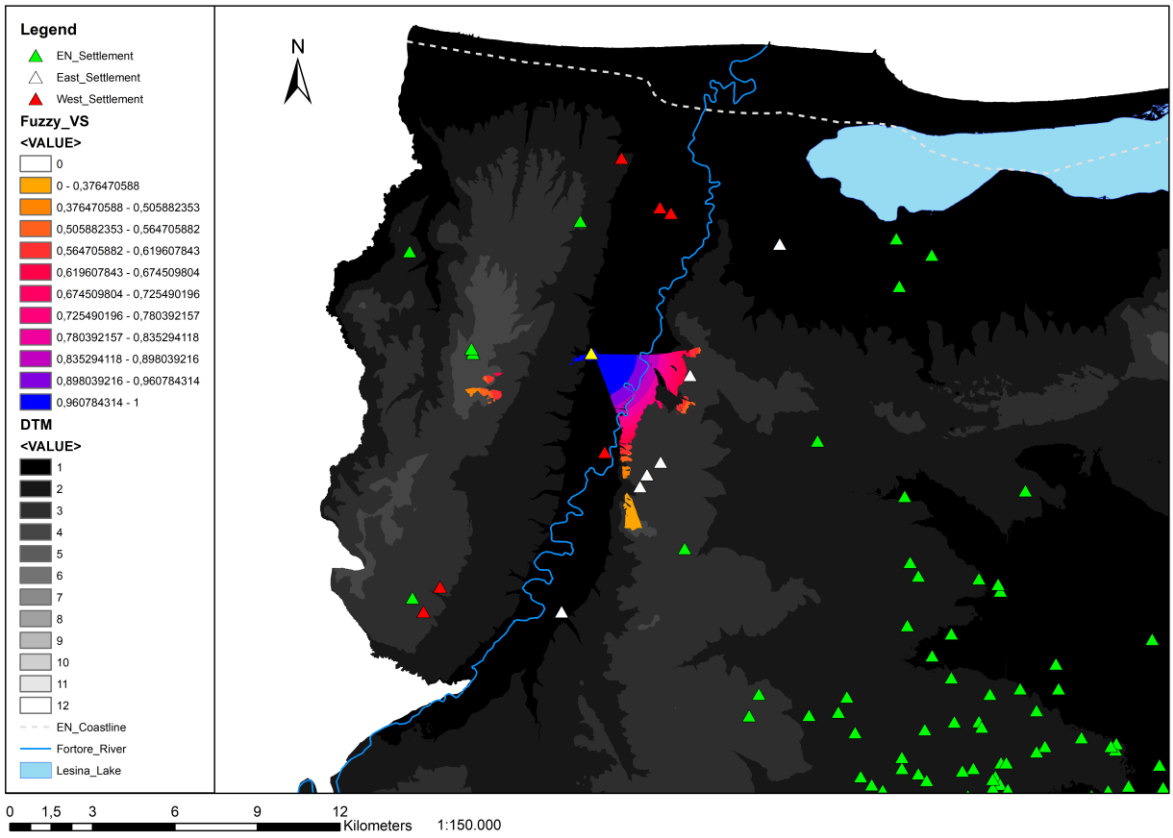


Table 167 – FVA applied to Masseria Settimo Grotte (id7)

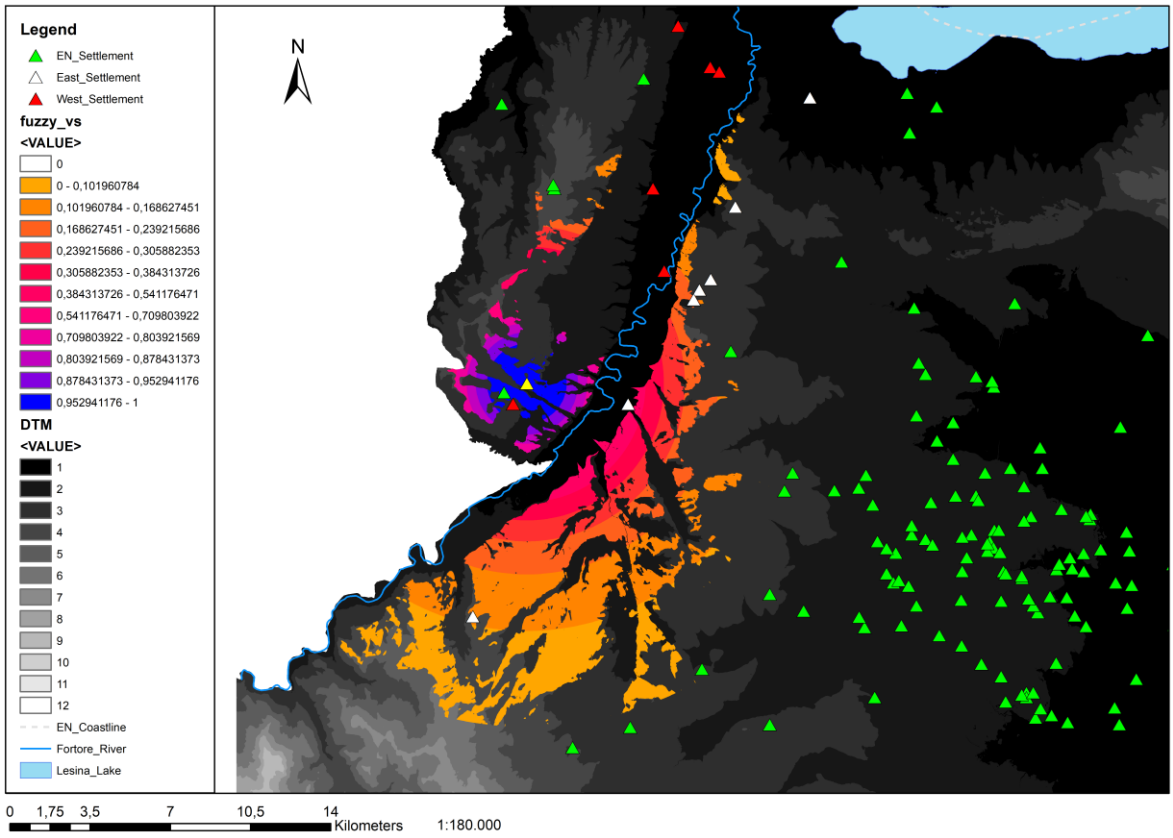


Table 168 – FVA applied to Canale Carpano I (id130)

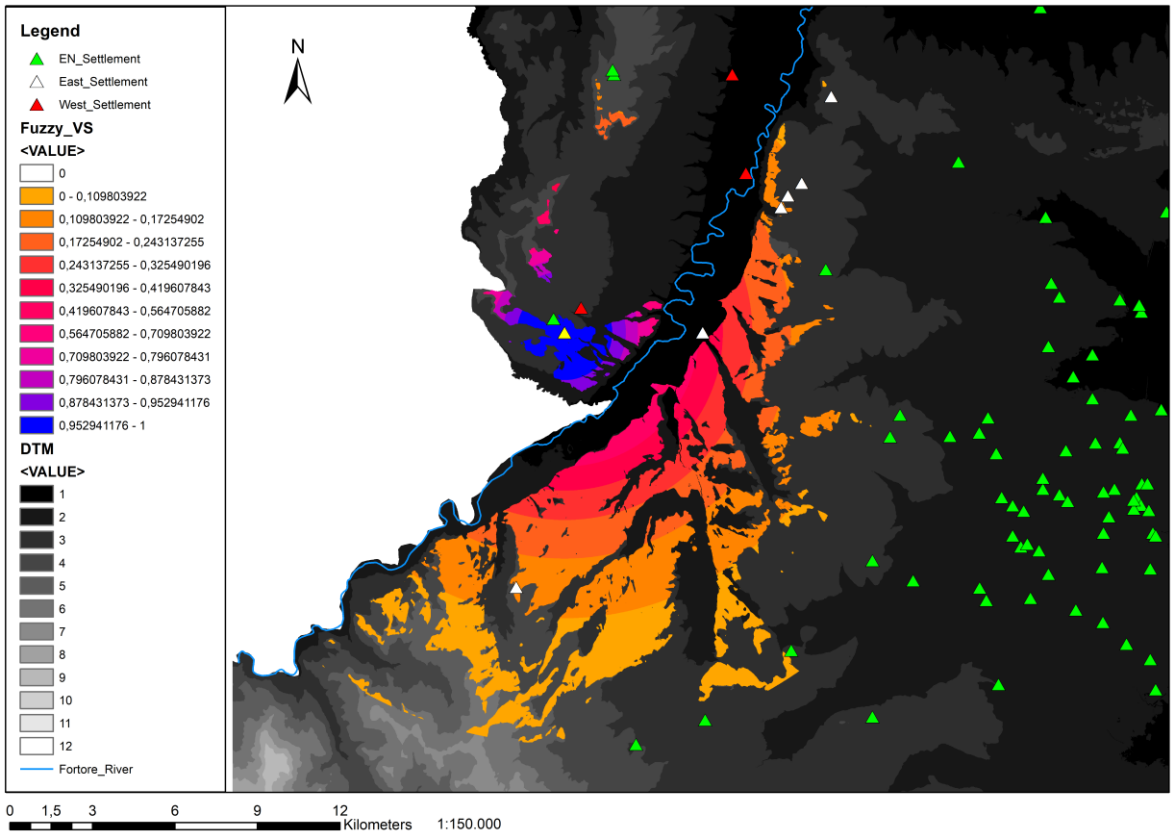
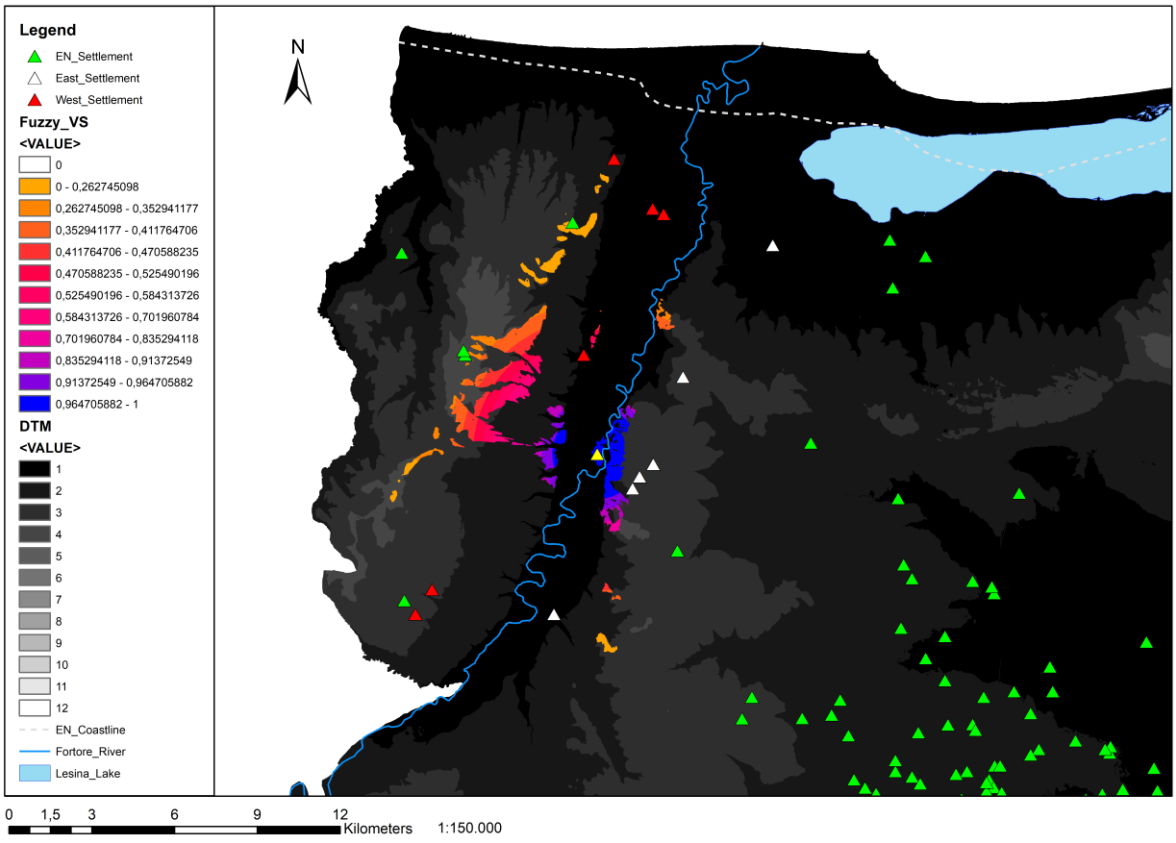


Table 169 – FVA applied to Piani di Lauria Bassa (id132)



GARGANO FOOTHILLS

Table 170 – FVA applied to Mezzanella di Brancia (id53)

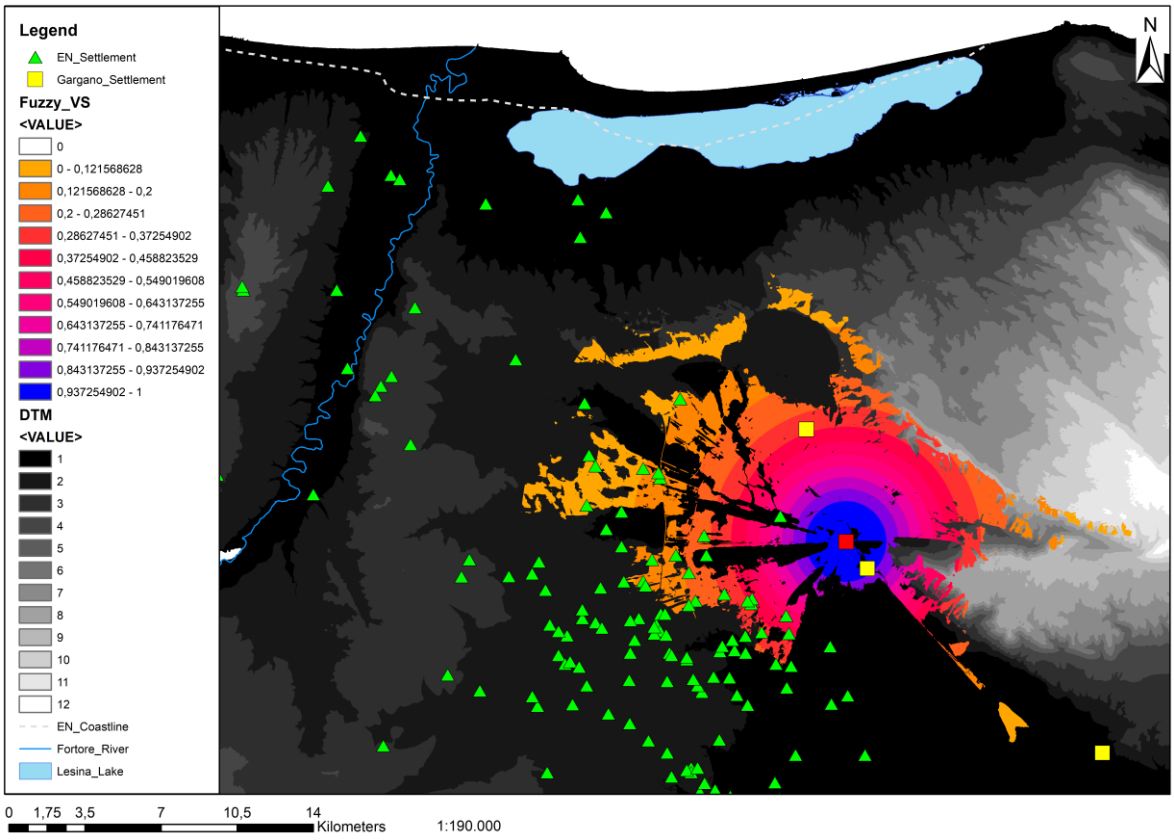


Table 171 – FVA applied to Località Piro di Brancia (id54)

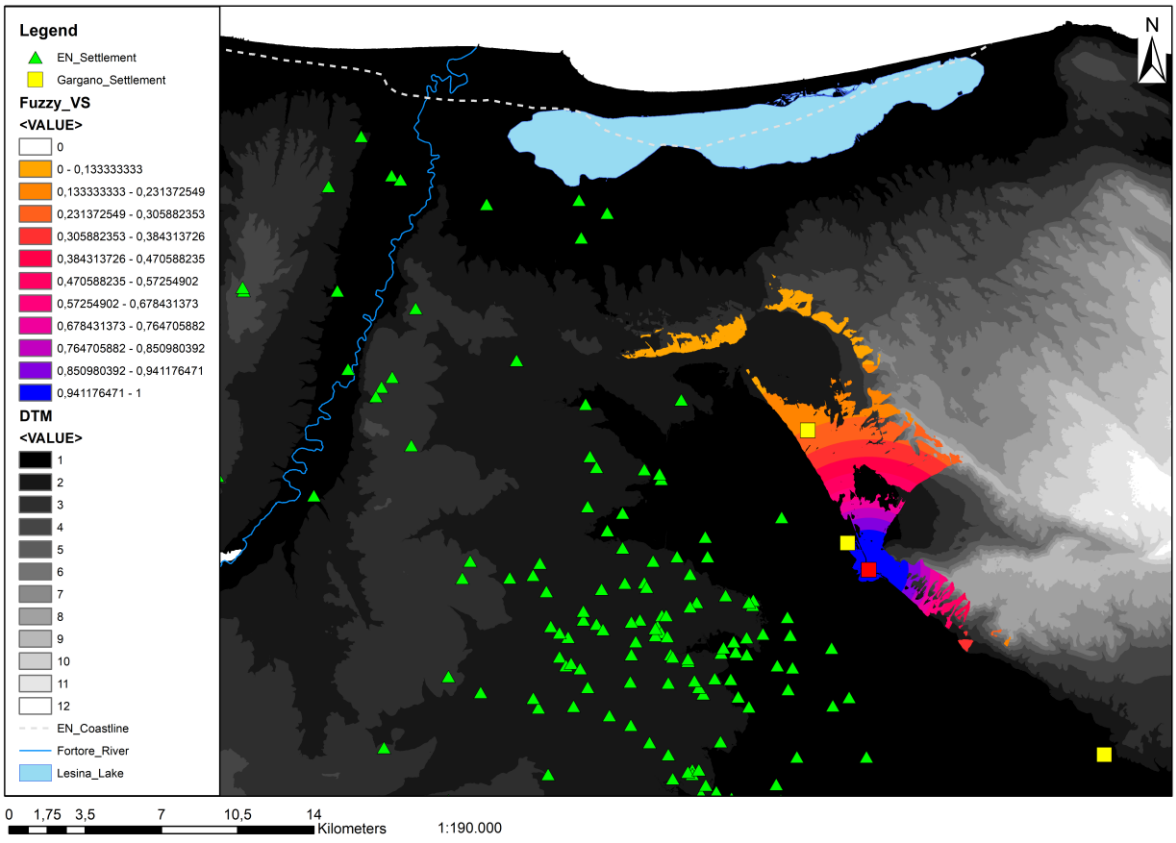


Table 172 – FVA applied to Ciccalento (id89)

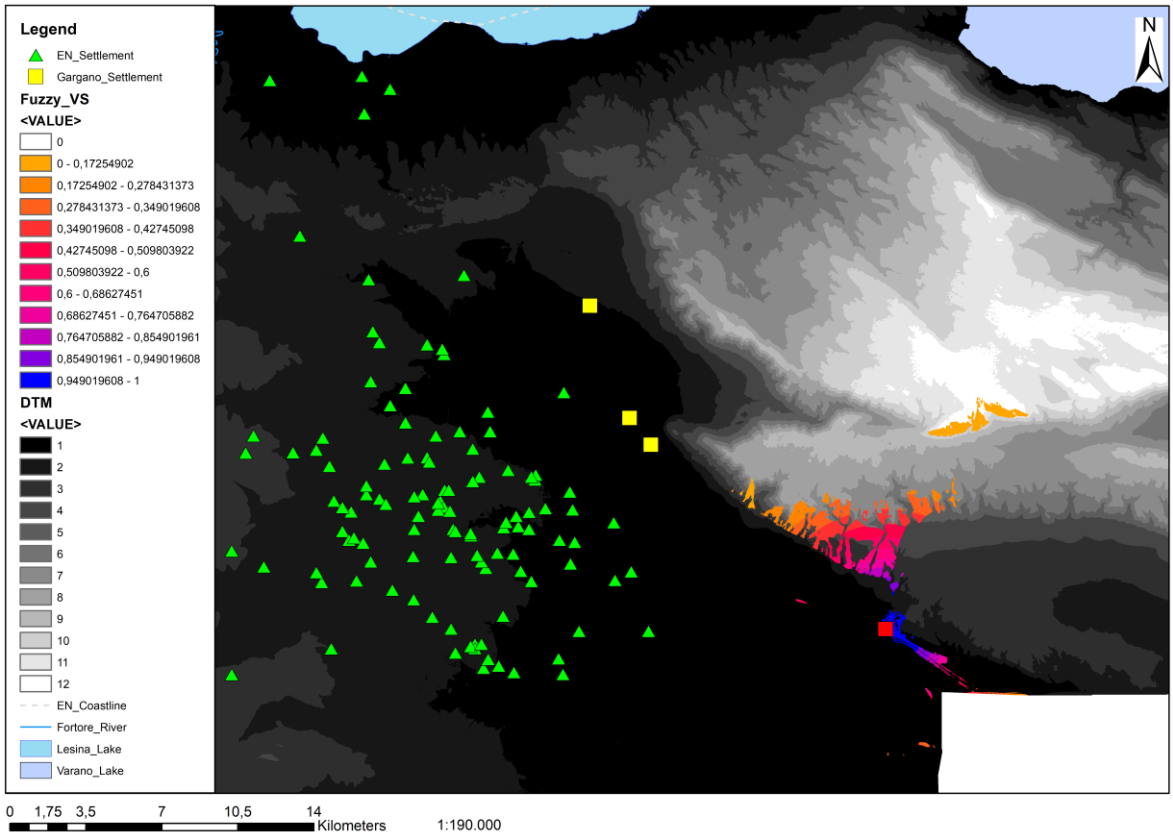
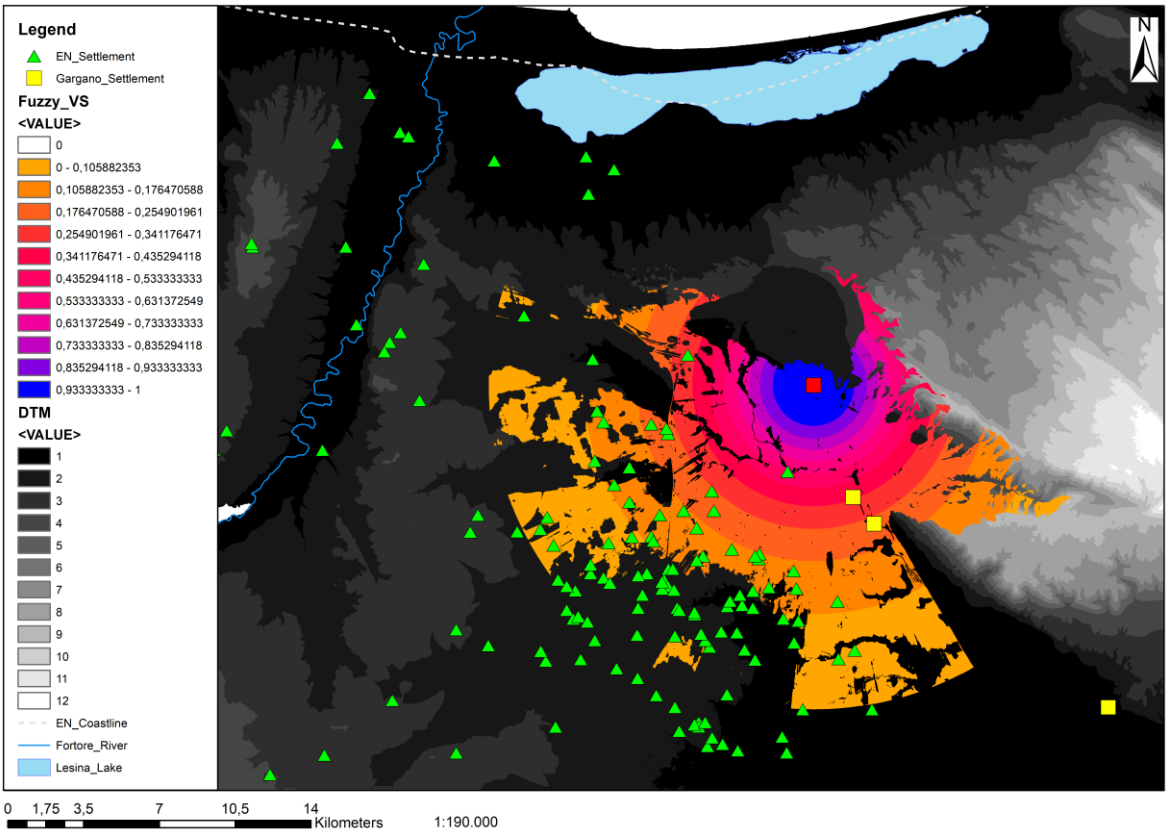


Table 173 – FVA applied to Mezzana della Quercia (id135)



MOLISE BORDER

Table 174 – FVA applied to Masseria Bivento (id5)

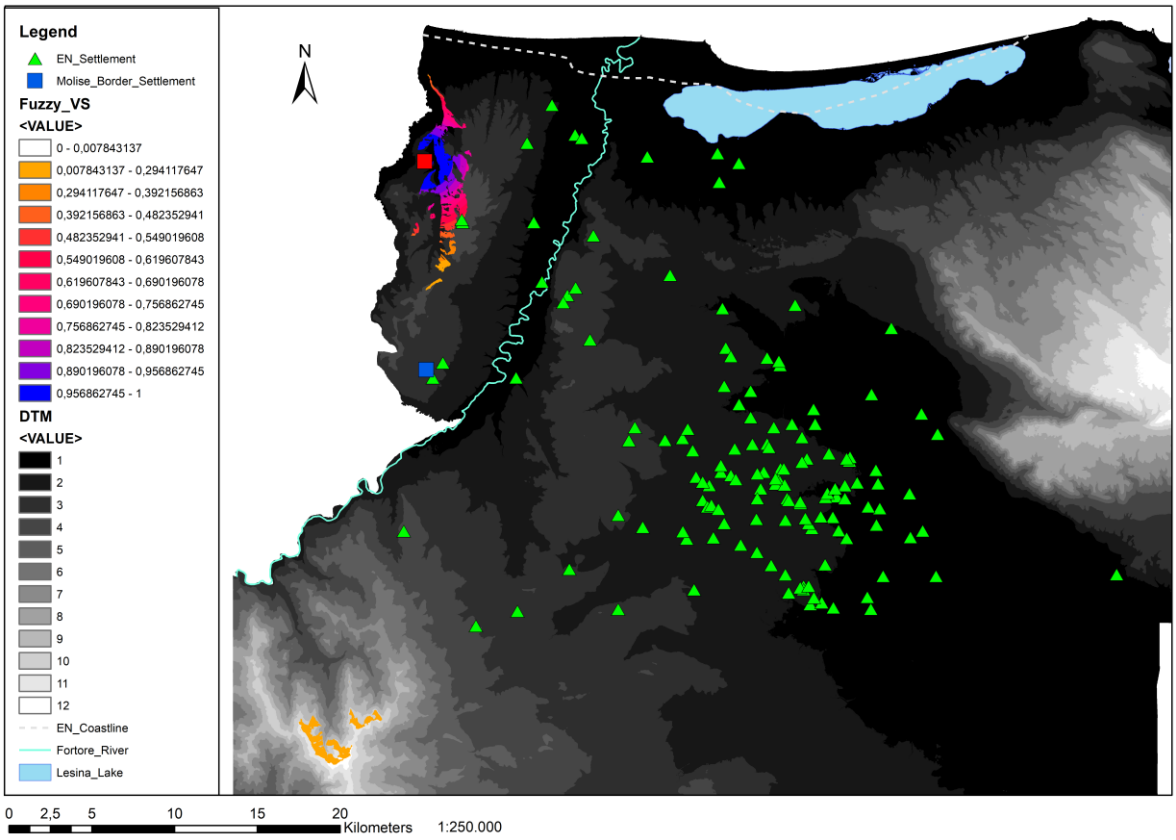
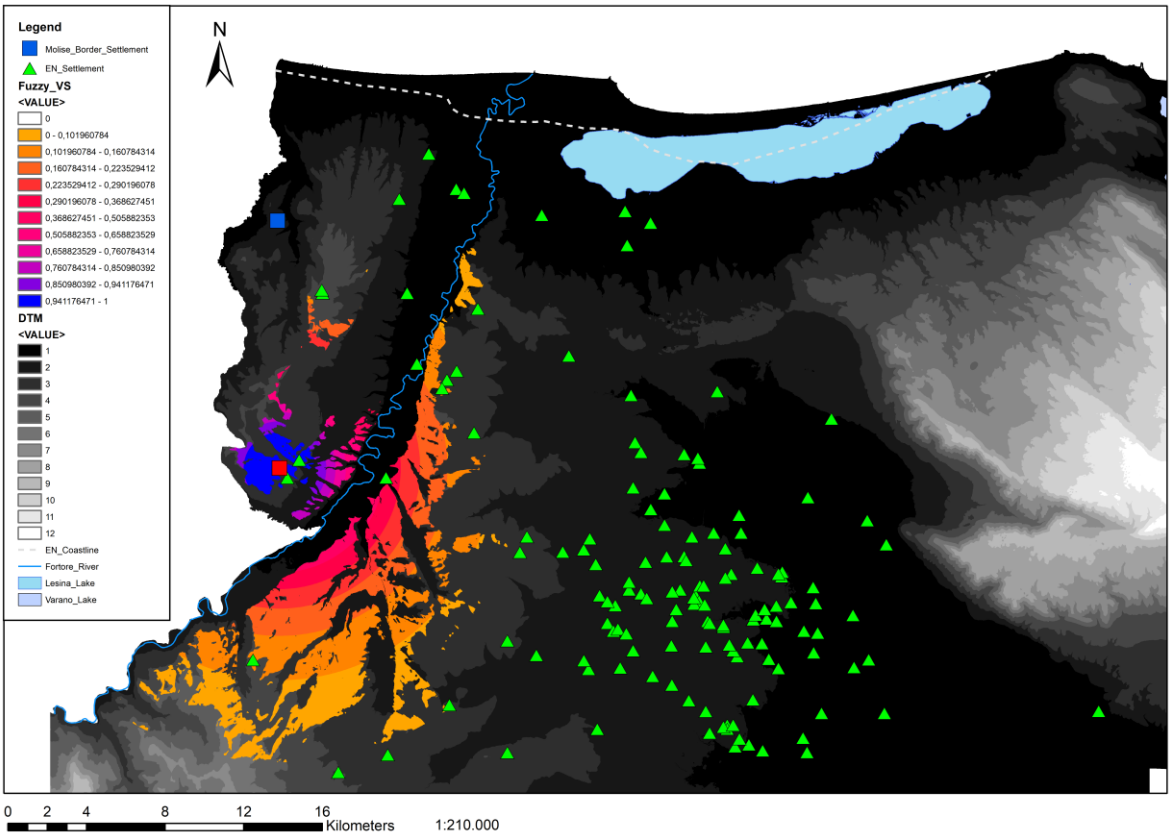


Table 175 – FVA applied to Masseria Canale Carpano II (id131)



MIDDLE NEOLITHIC

Table 176 – FVA applied to Casino San Matteo-Chiantinelle (id1)

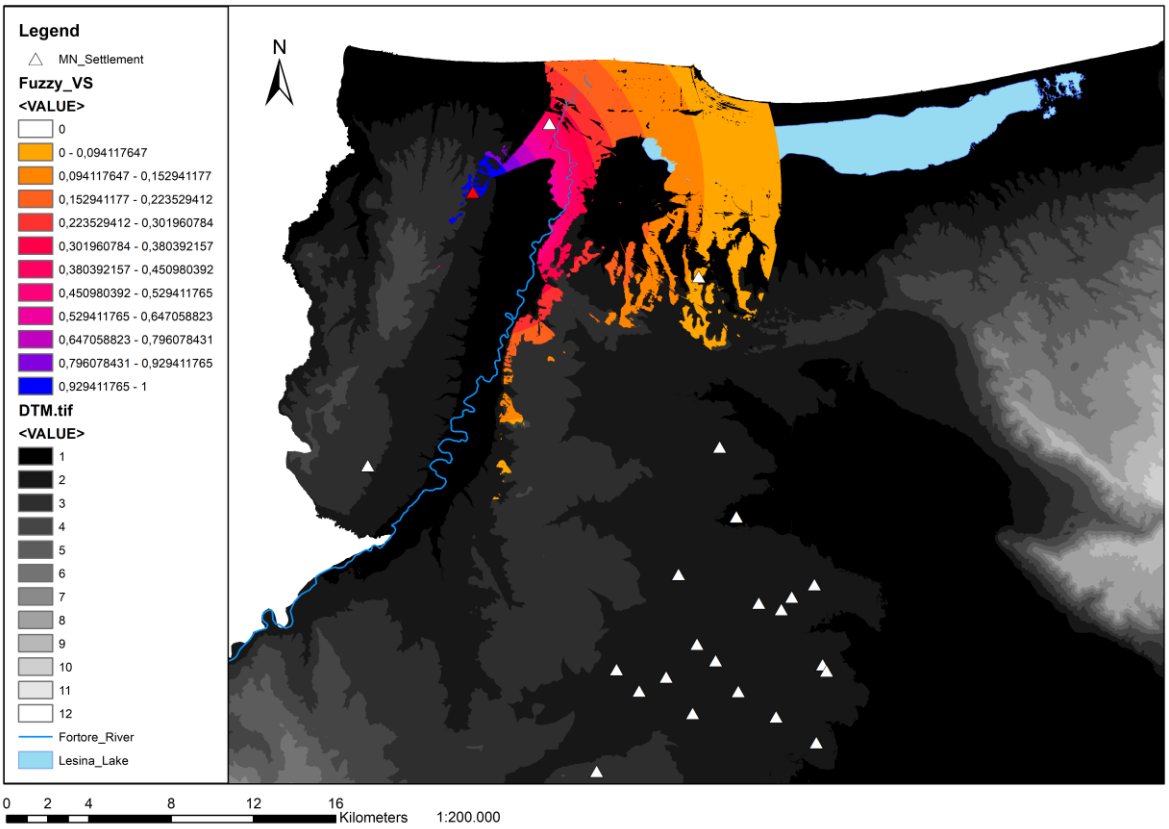


Table 177 – FVA applied to Chiarappa (id2)

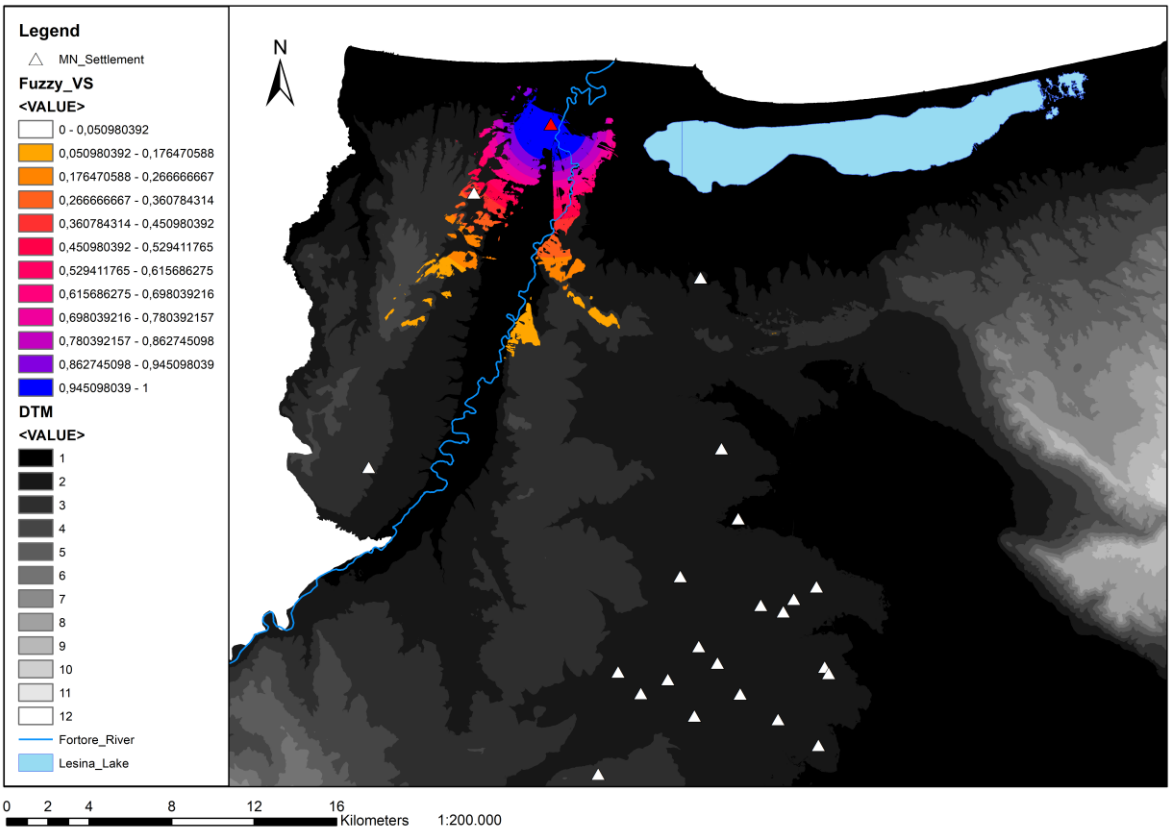


Table 178 – FVA applied to Masseria Settimo di Grotte (id3)

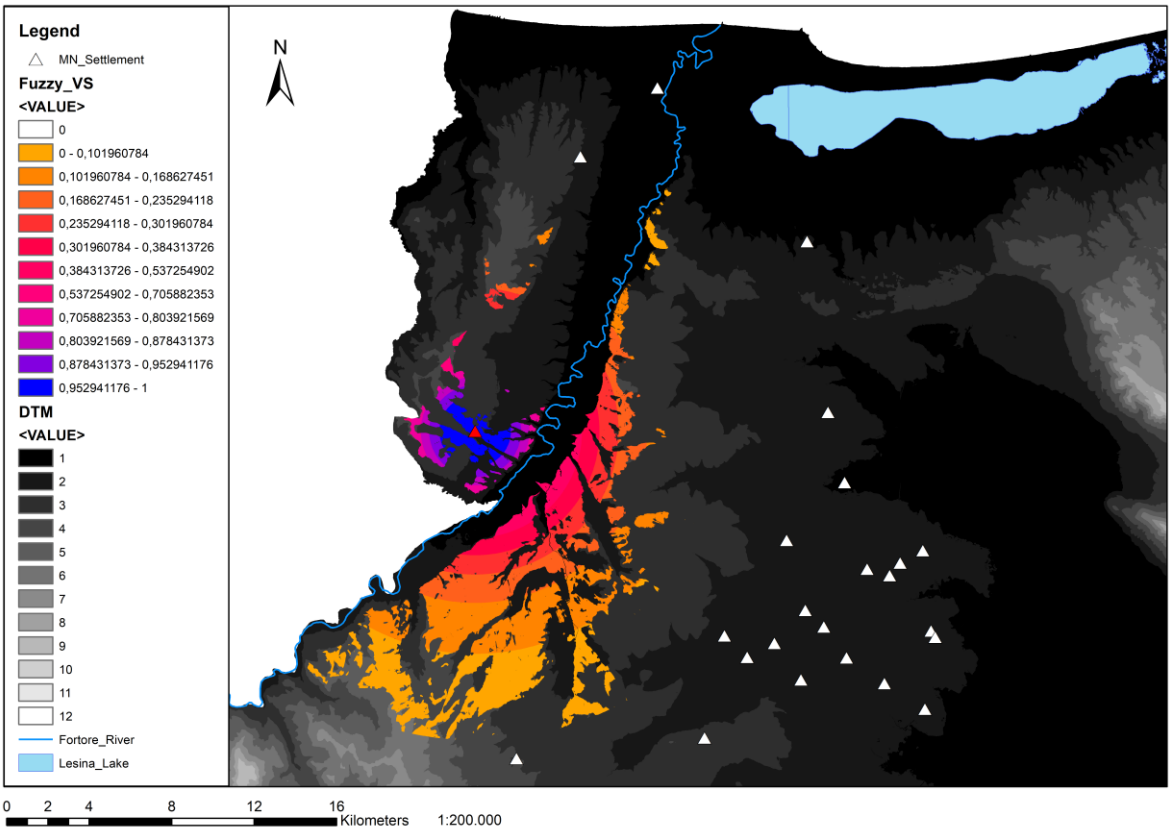


Table 179 – FVA applied to Masseria Istituto di Sagro (id4)

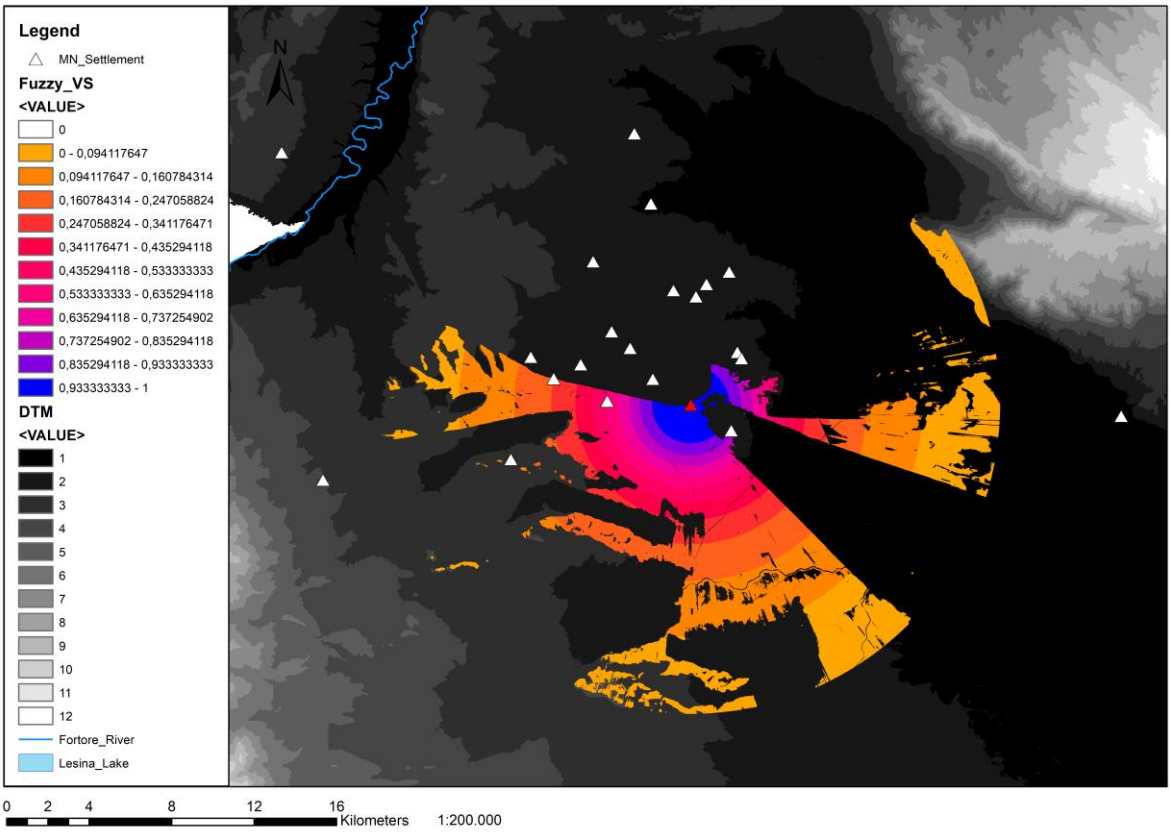


Table 180 – FVA applied to Coppa Pallante (id5)

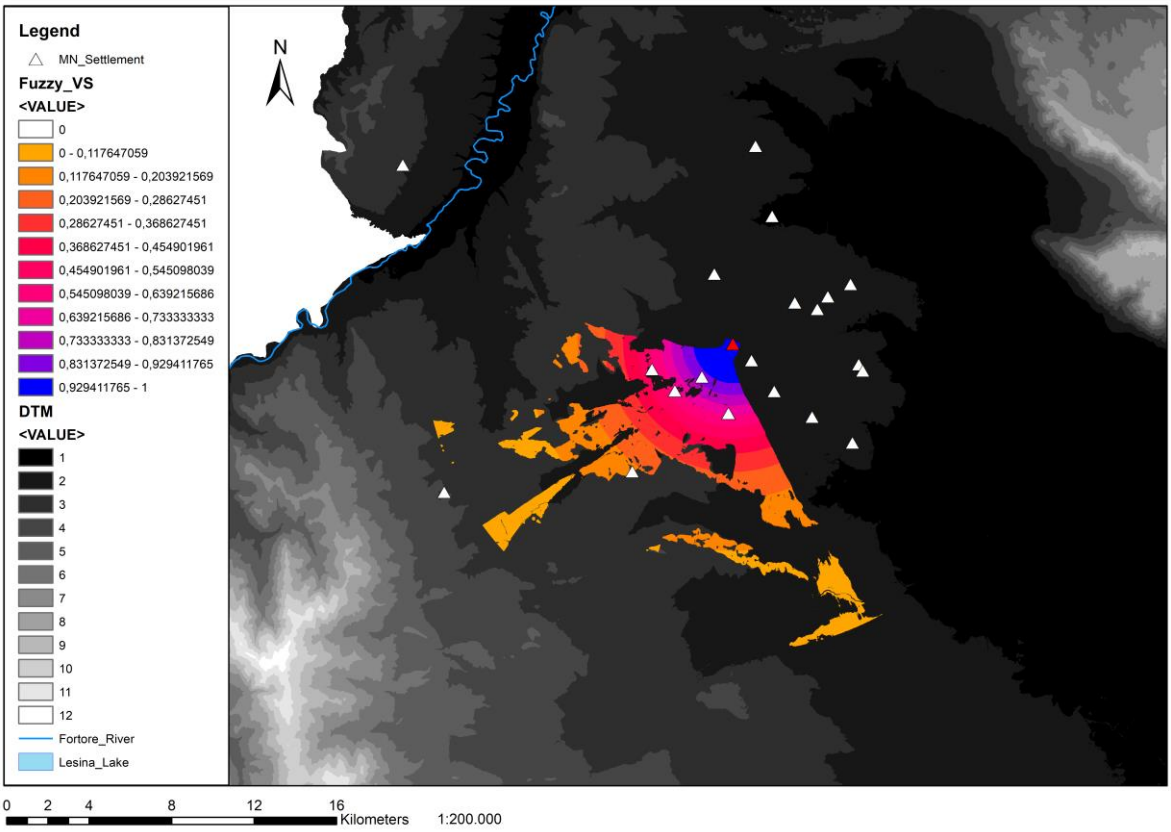


Table 181 – FVA applied to Coppa Pocci (id6)

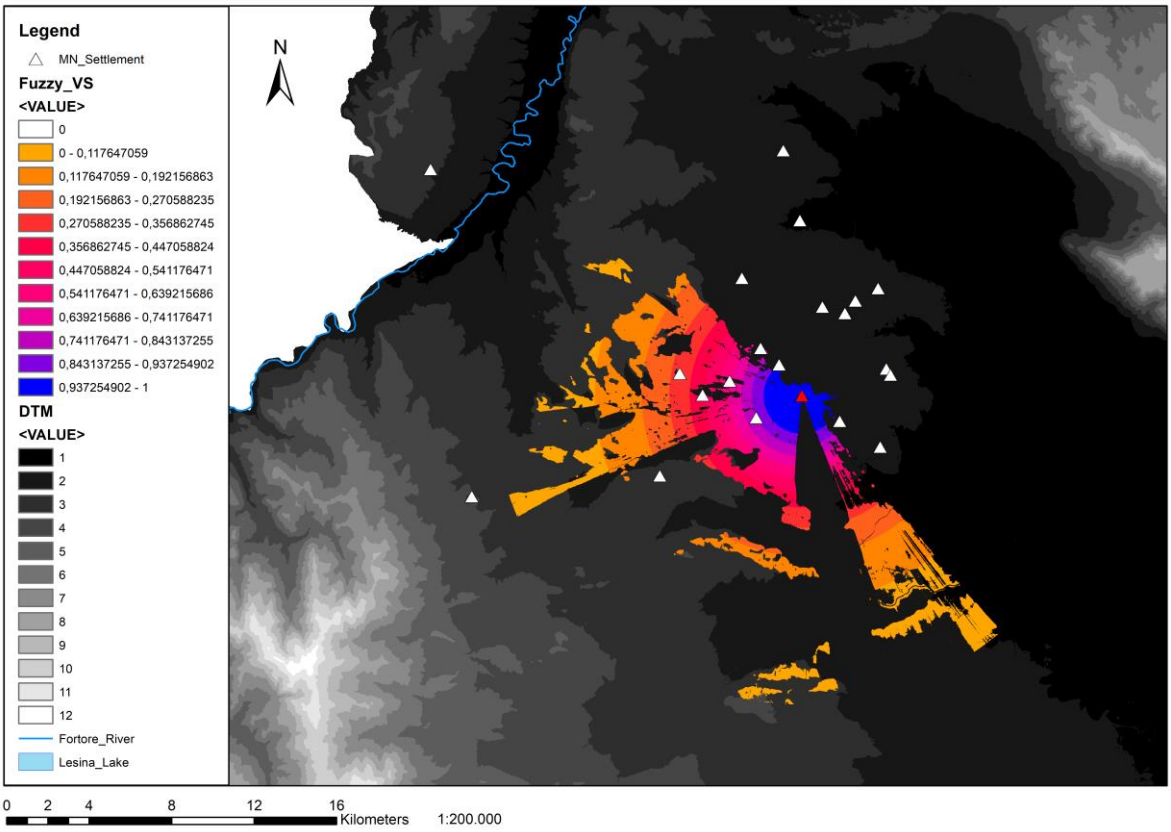


Table 182 – FVA applied to Masseria Pagliari (id7)

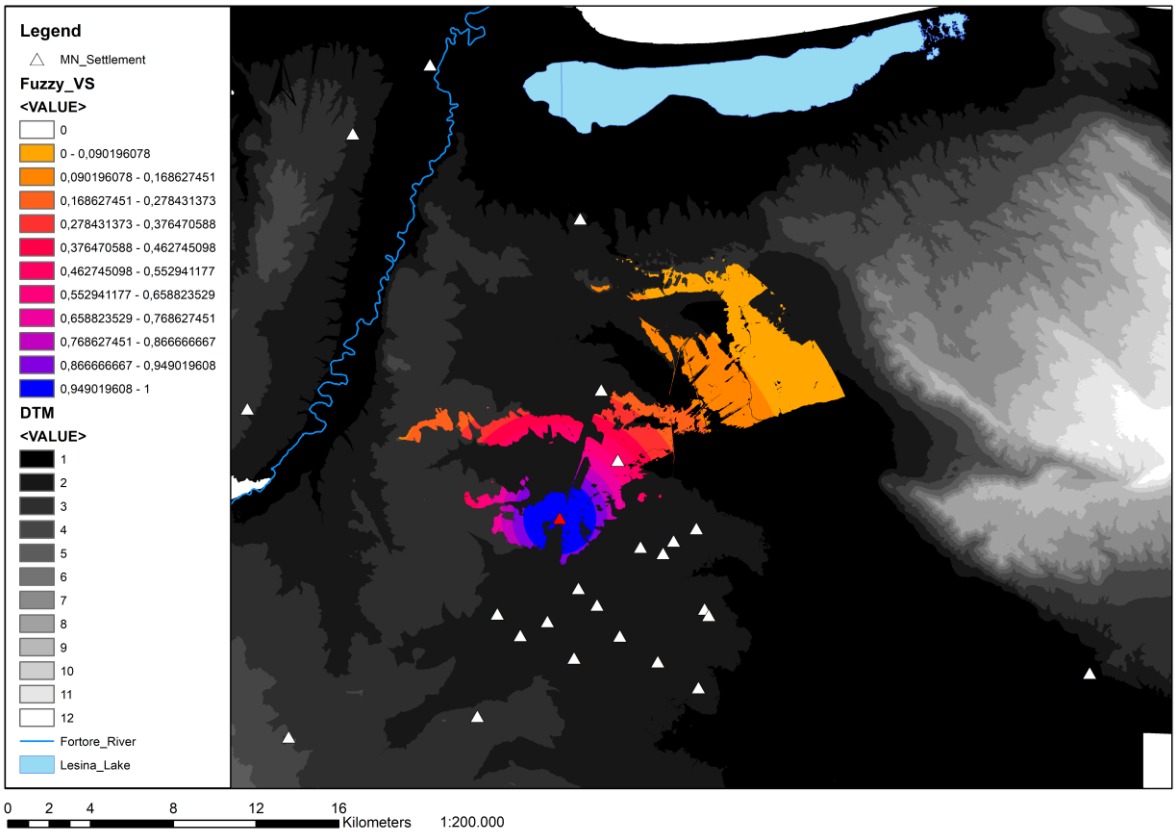


Table 183 – FVA applied to Masseria Li Gatti (id8)

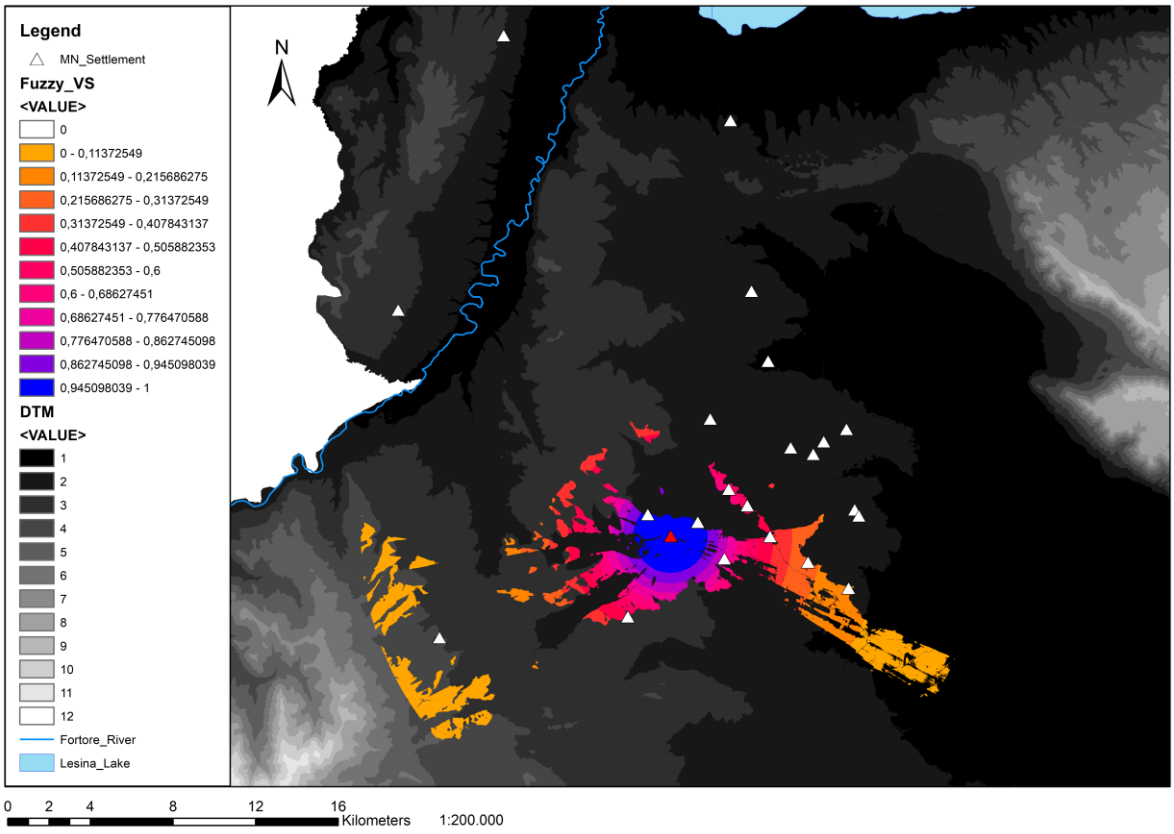


Table 184 – FVA applied to La Torretta (id9)

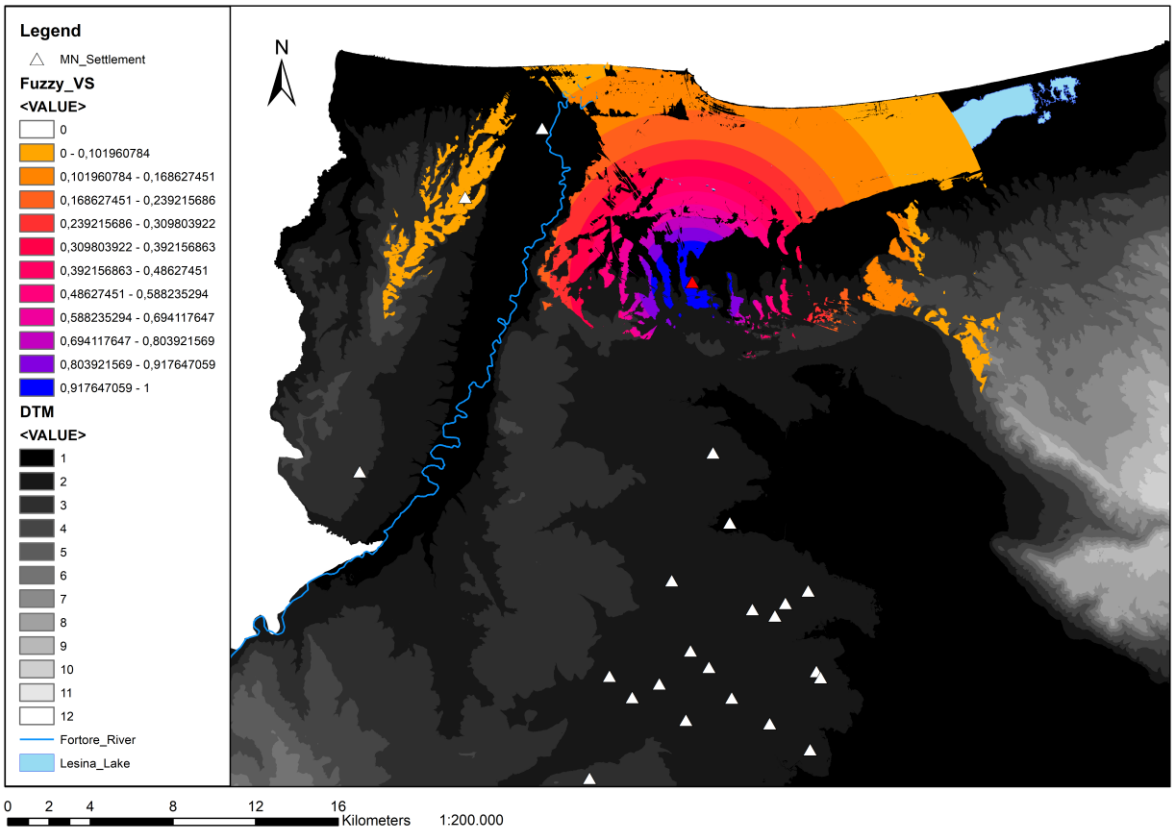


Table 185 – FVA applied to Oliveto Masselli (id10)

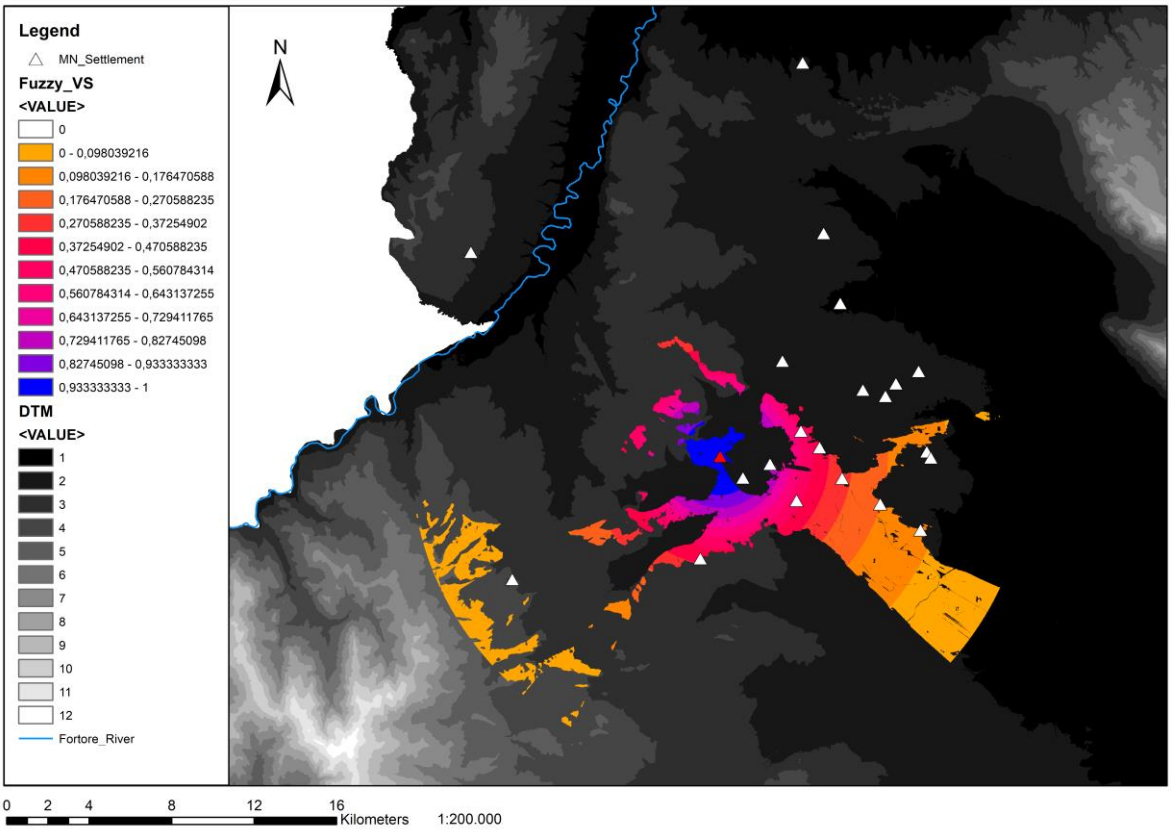


Table 186 – FVA applied to Ciccalento (id11)

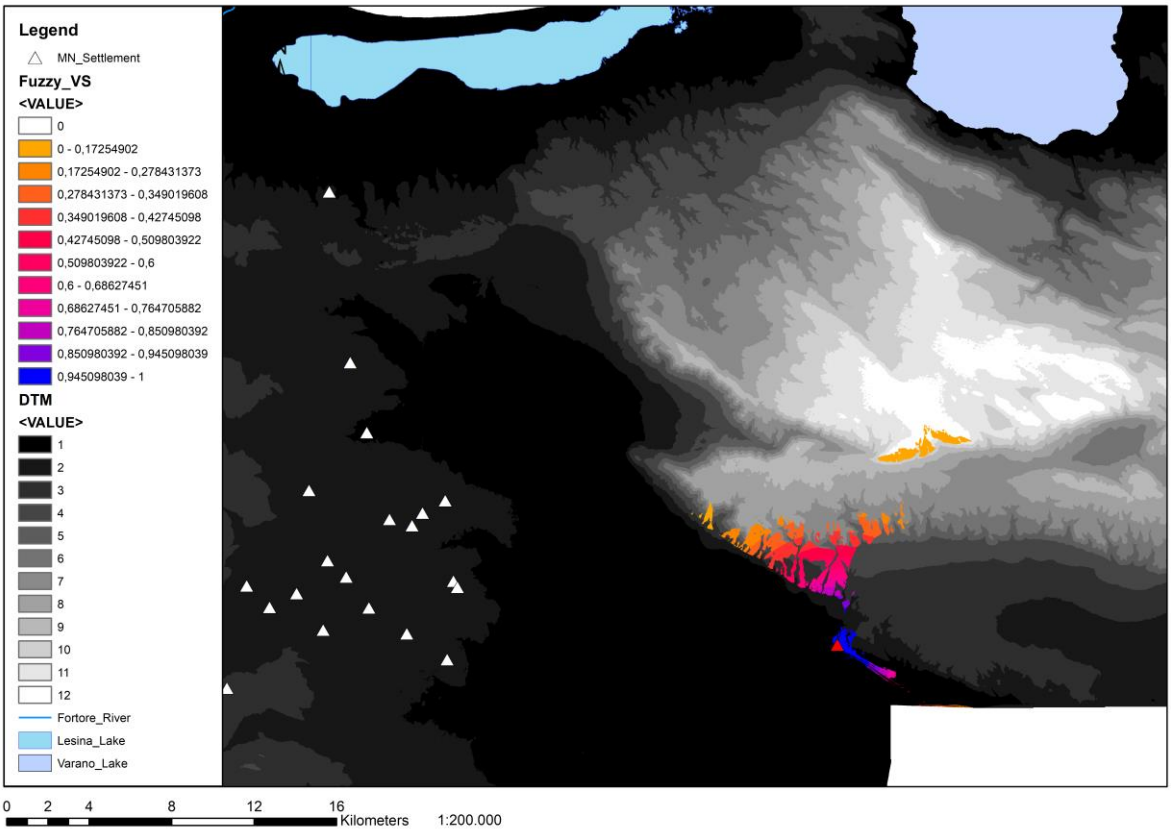


Table 187 – FVA applied to Li Gatti (id12)

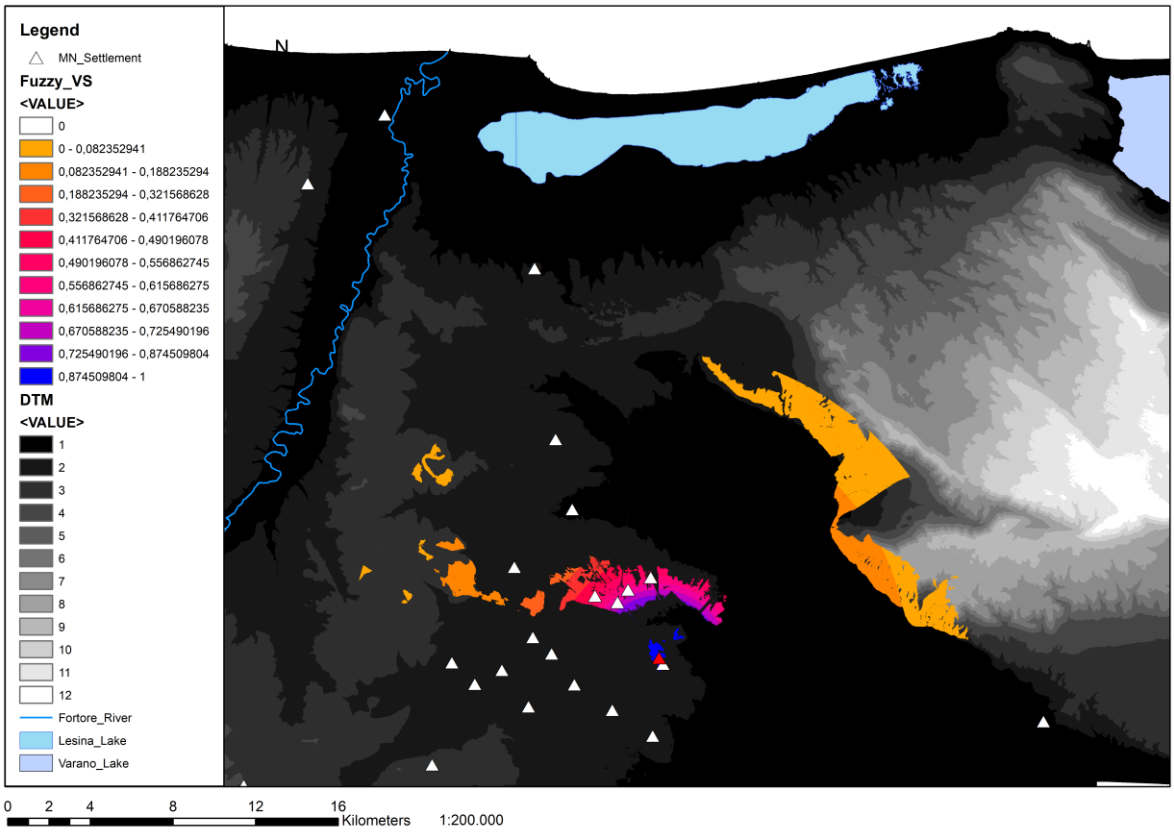


Table 188 – FVA applied to Pian Devoto (id13)

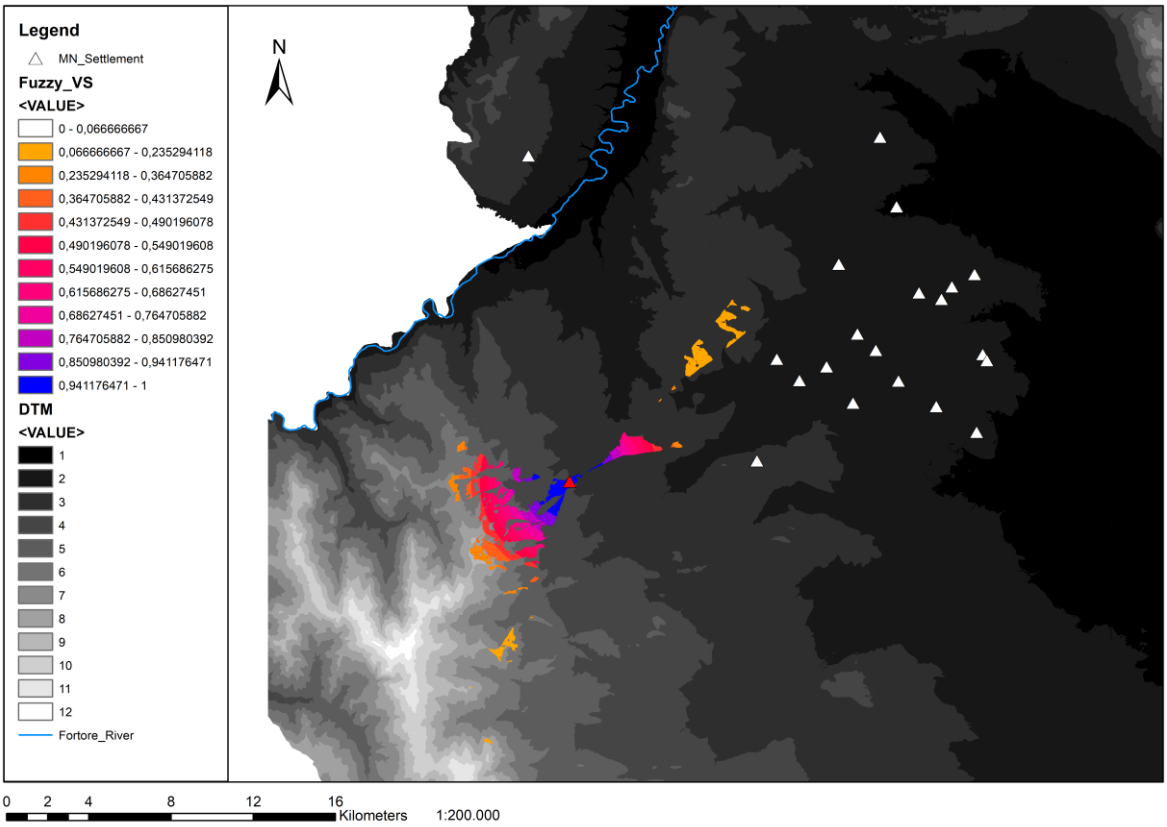


Table 189 – FVA applied to Località Orsello (id14)

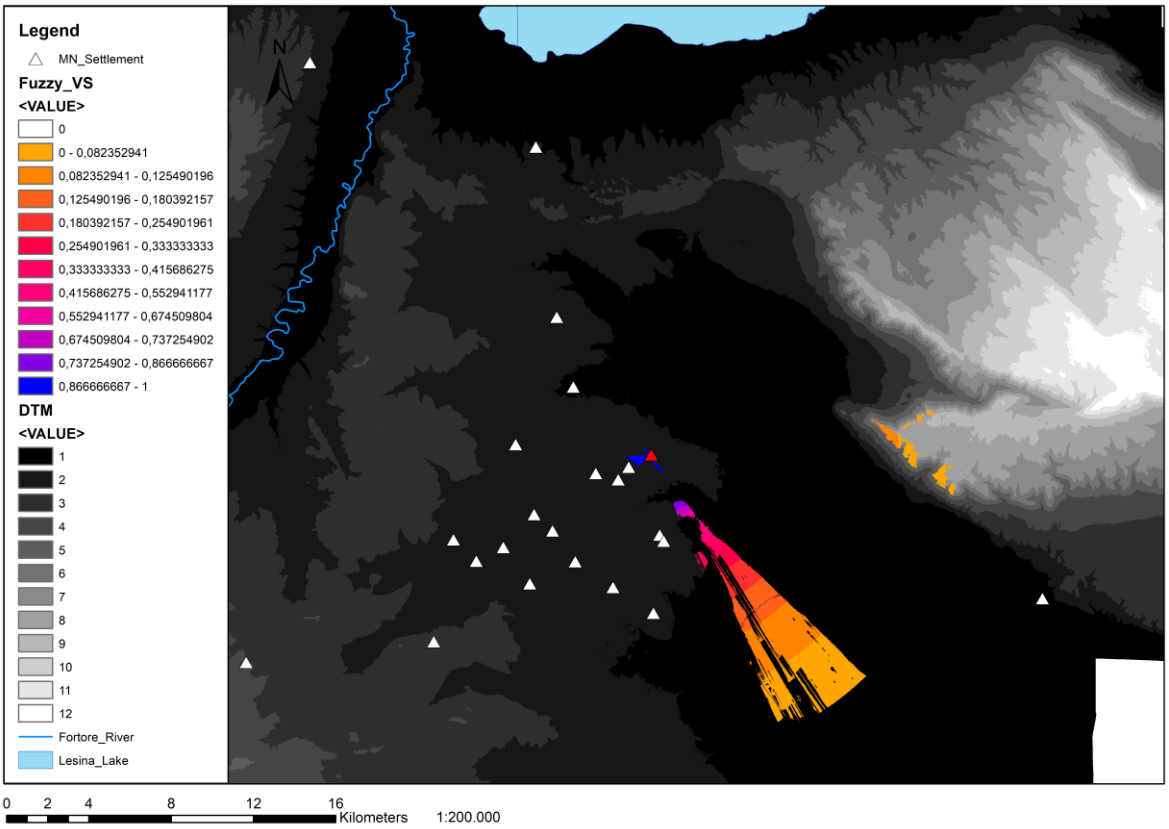


Table 190 – FVA applied to Coppa d'Ovidio (id15)

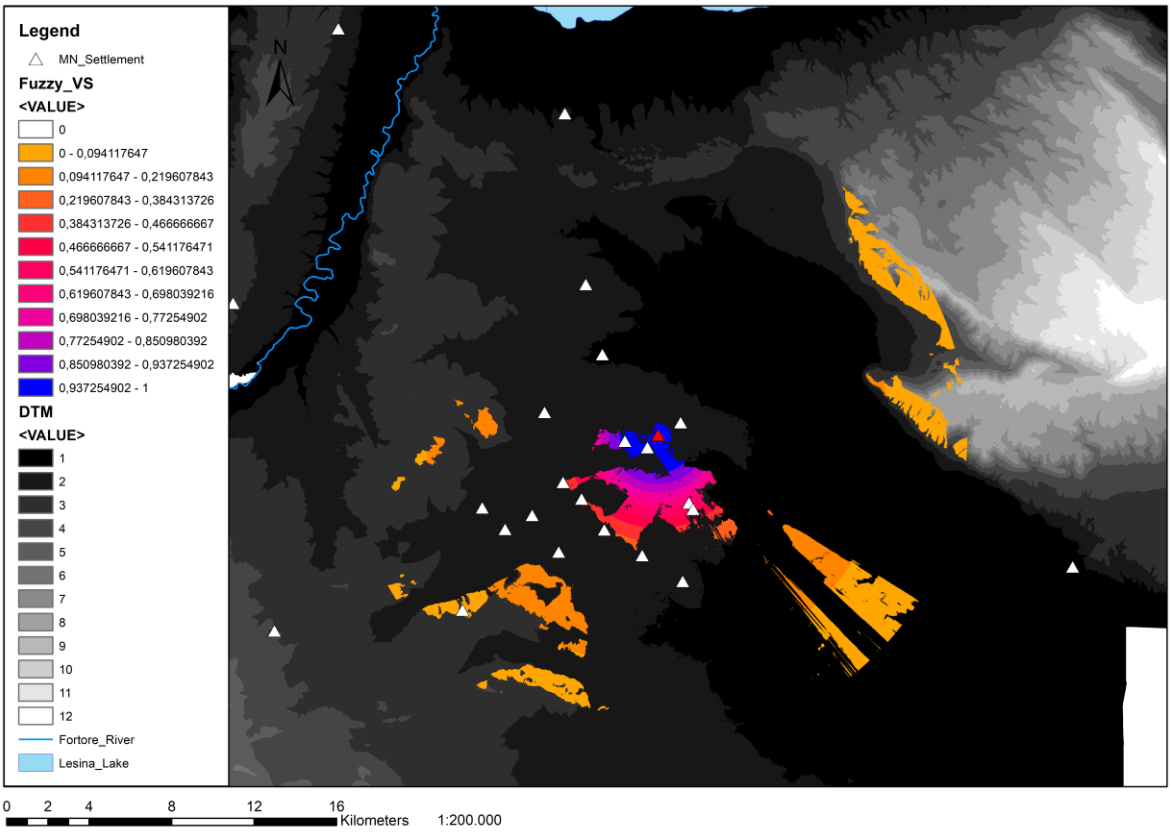


Table 191 – FVA applied to Coppa Pocci (id16)

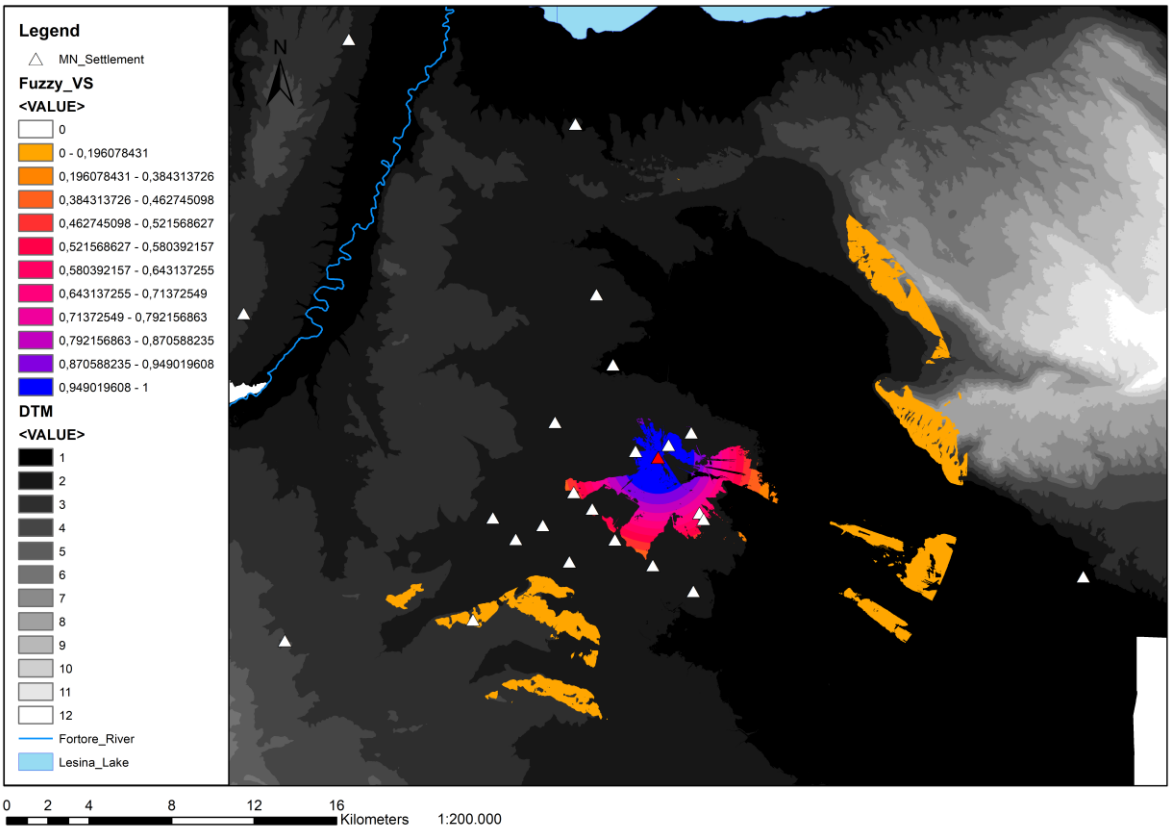


Table 192 – FVA applied to Località Franceschiello (id17)

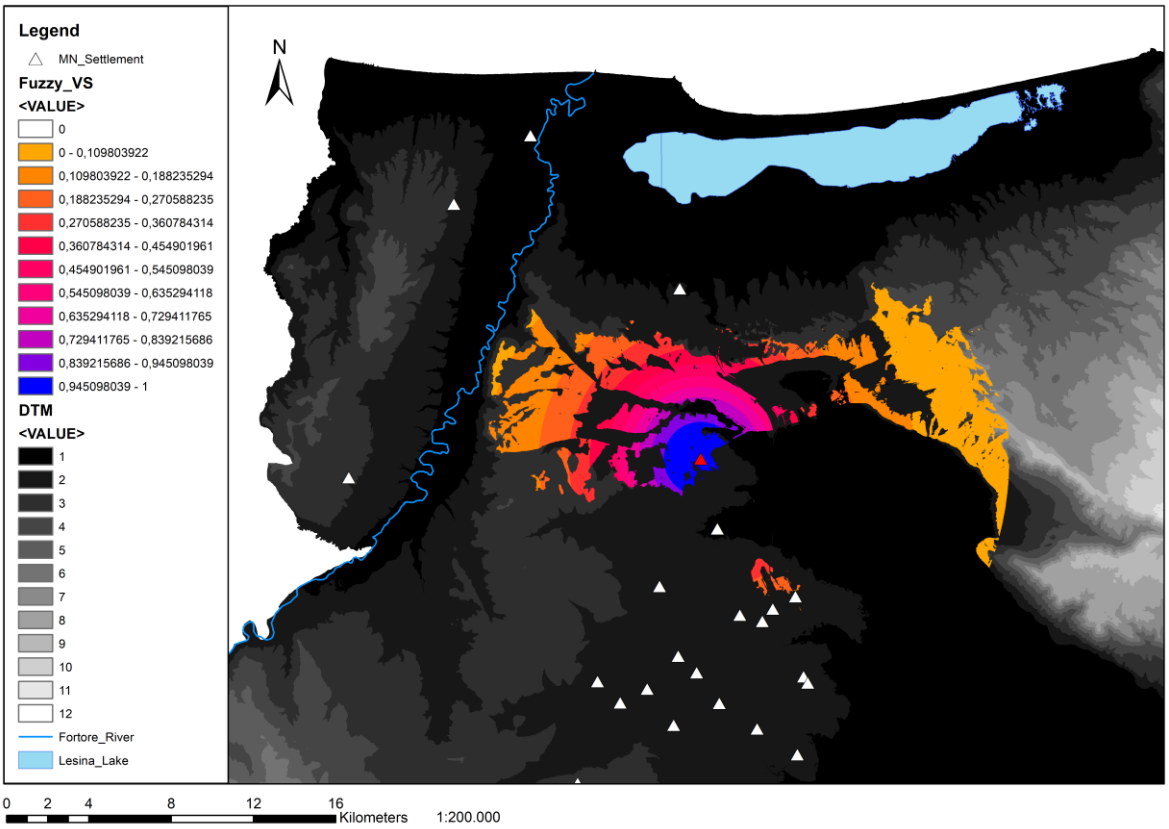


Table 193 – FVA applied to Località Boschetto (id18)

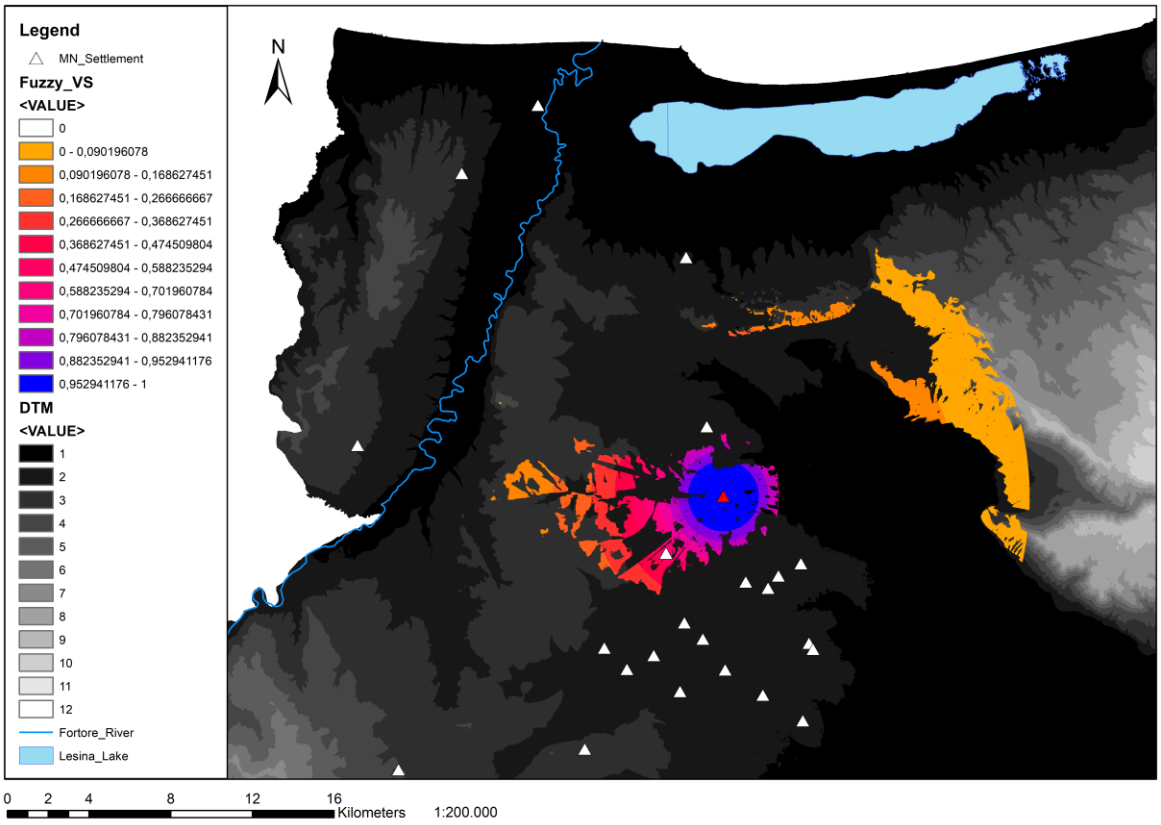


Table 194 – FVA applied to Torre Sant'Andrea (id19)

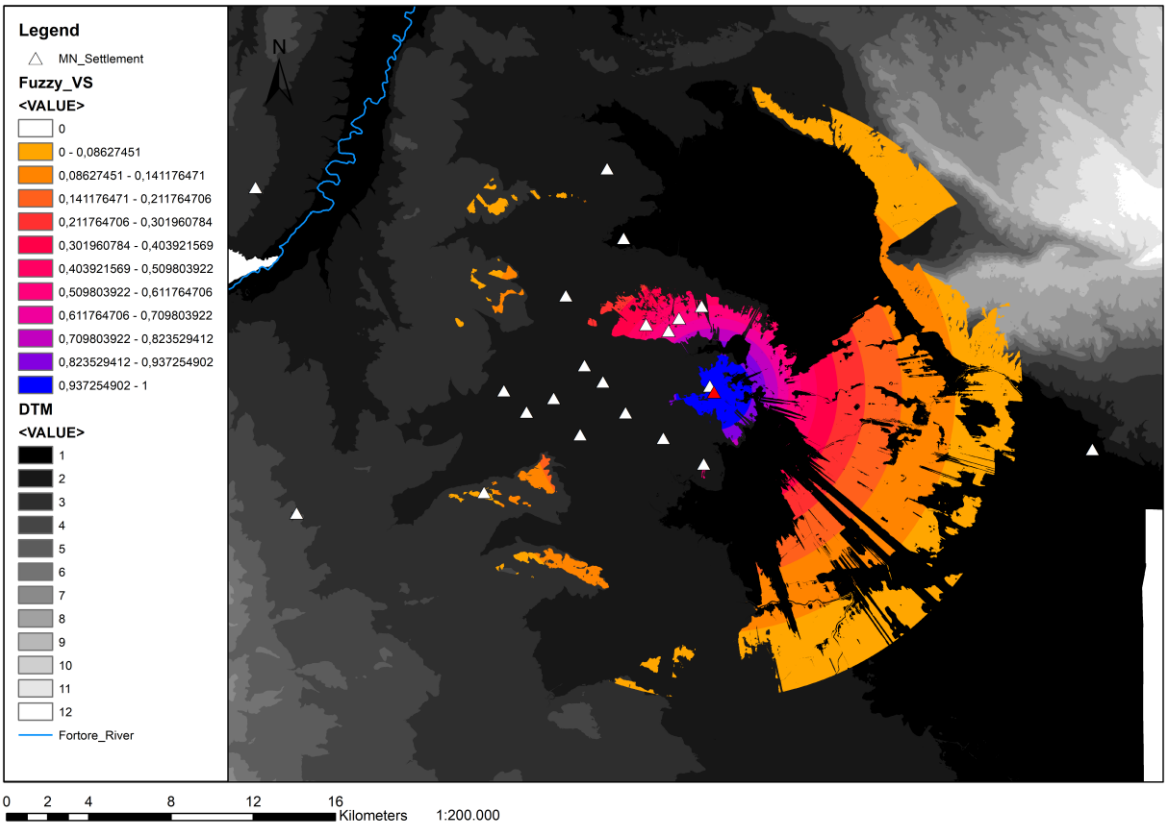


Table 195 – FVA applied to San Rocco (id20)

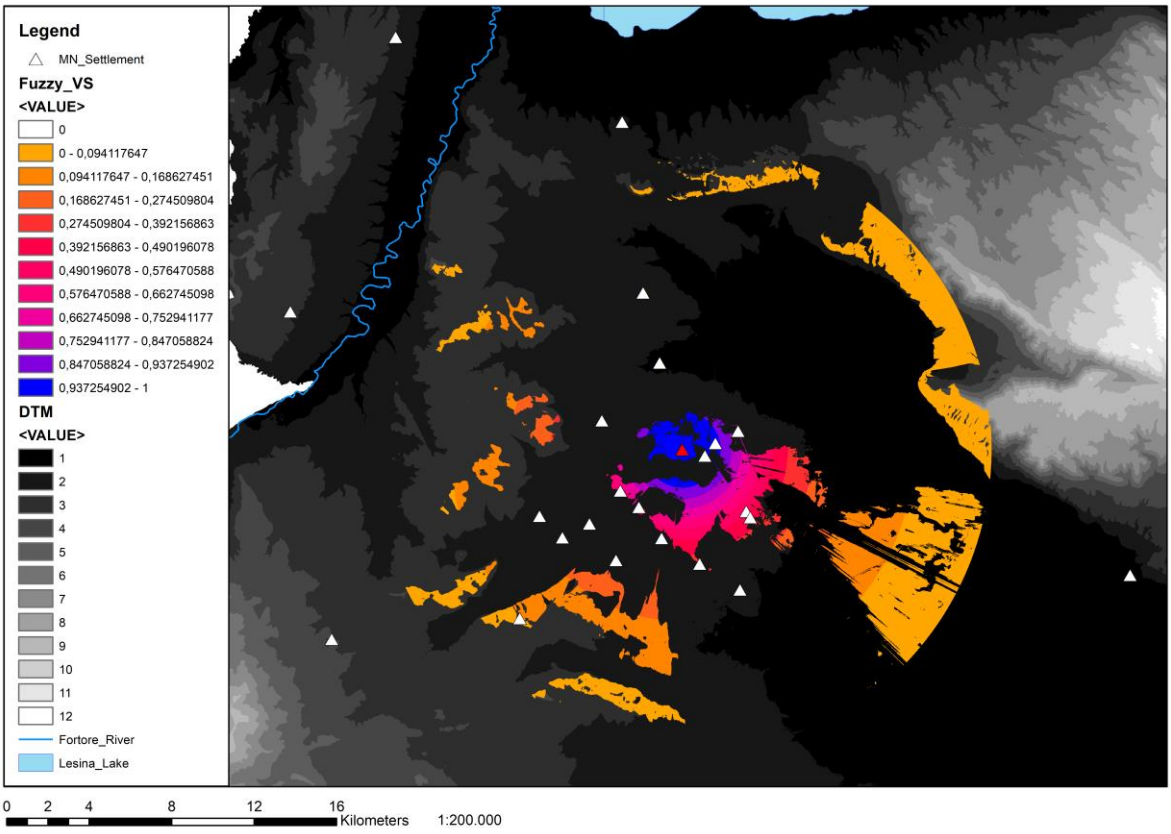


Table 196 – FVA applied to Masseria Casalorda (id21)

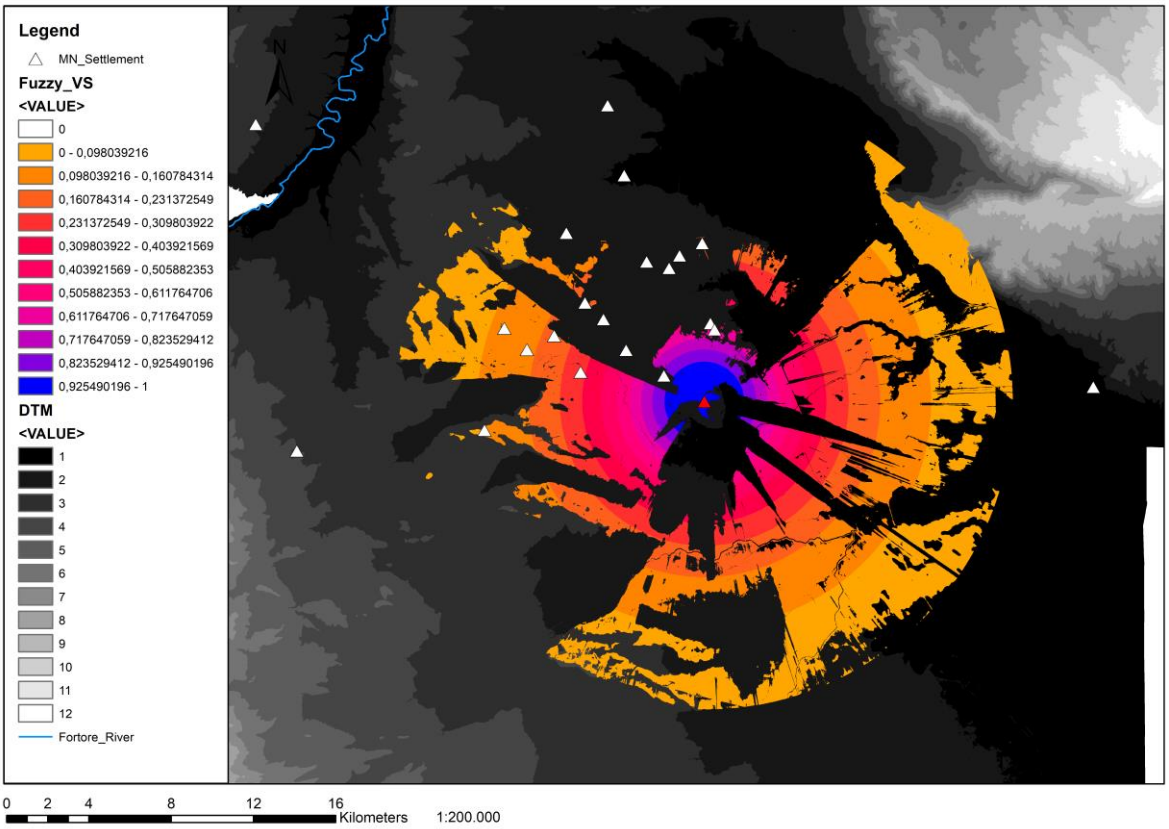


Table 197 – FVA applied to Località Florio-Ricci (id22)

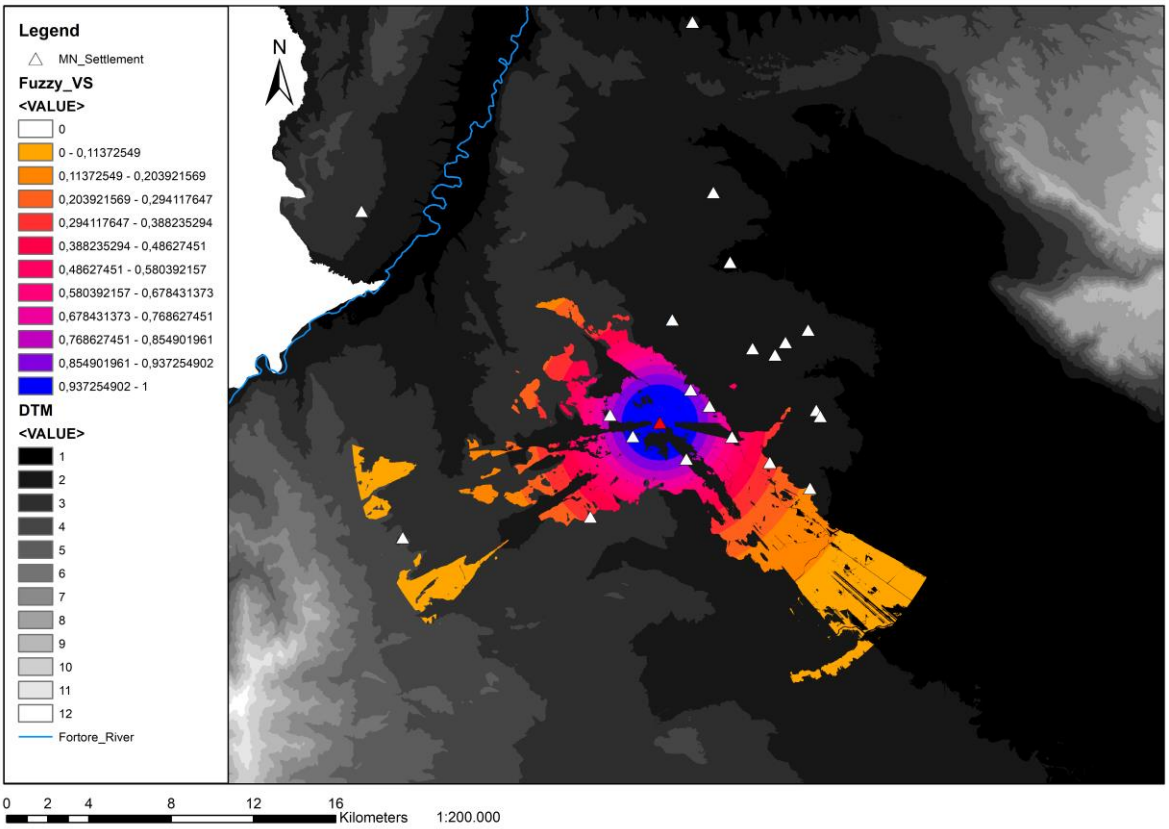


Table 198 – FVA applied to Castellana (id23)

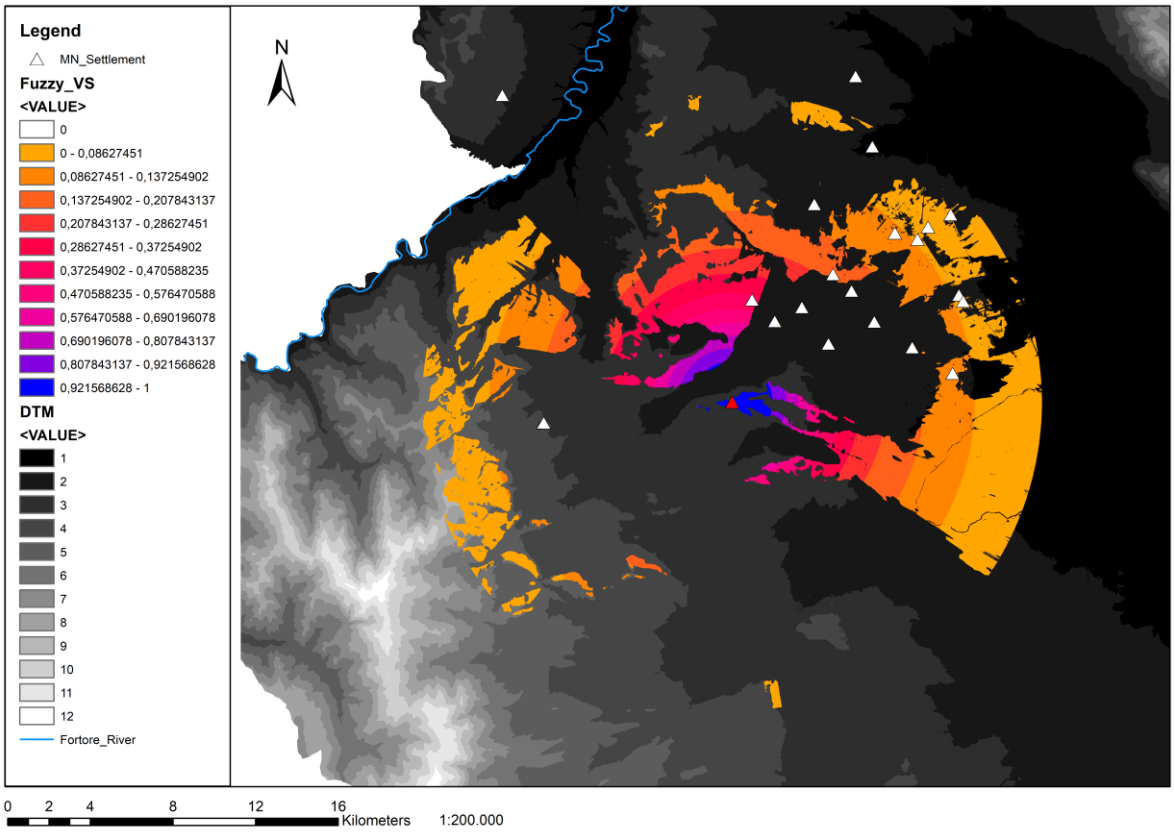


Table 199 – FVA applied to Località Santa Maria (id24)

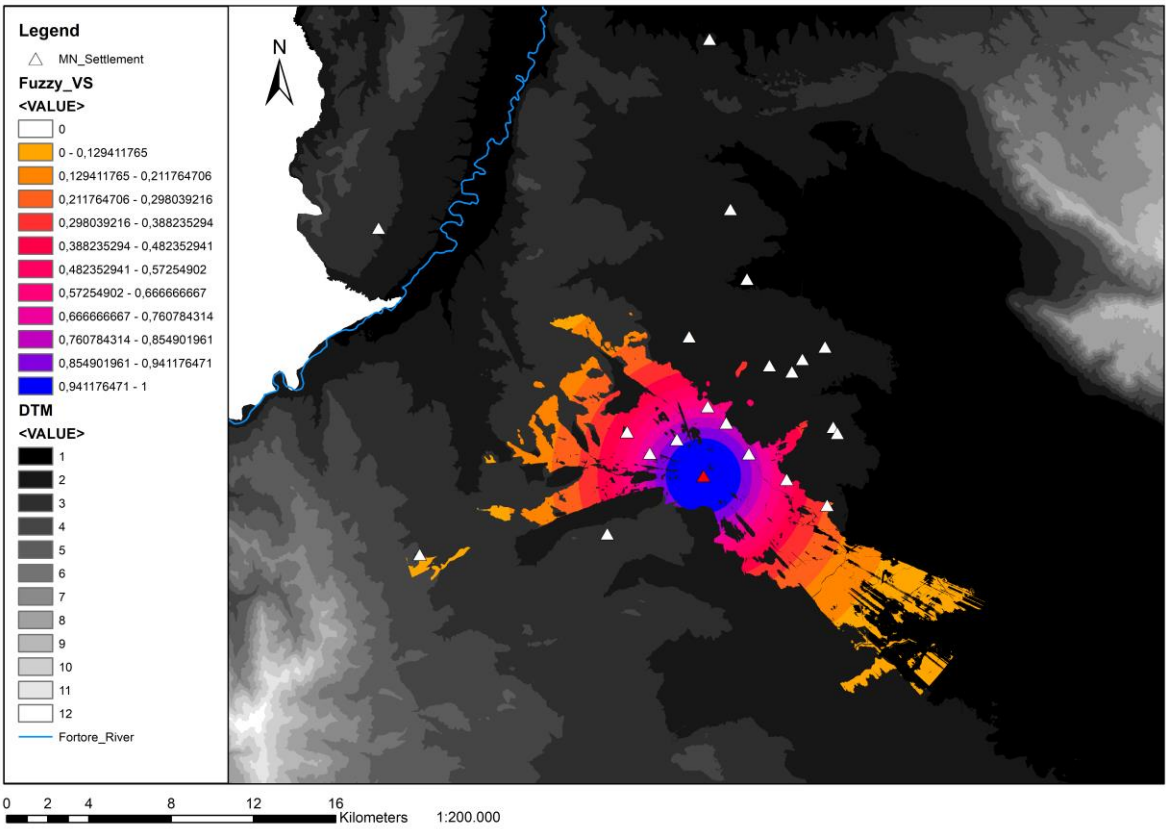
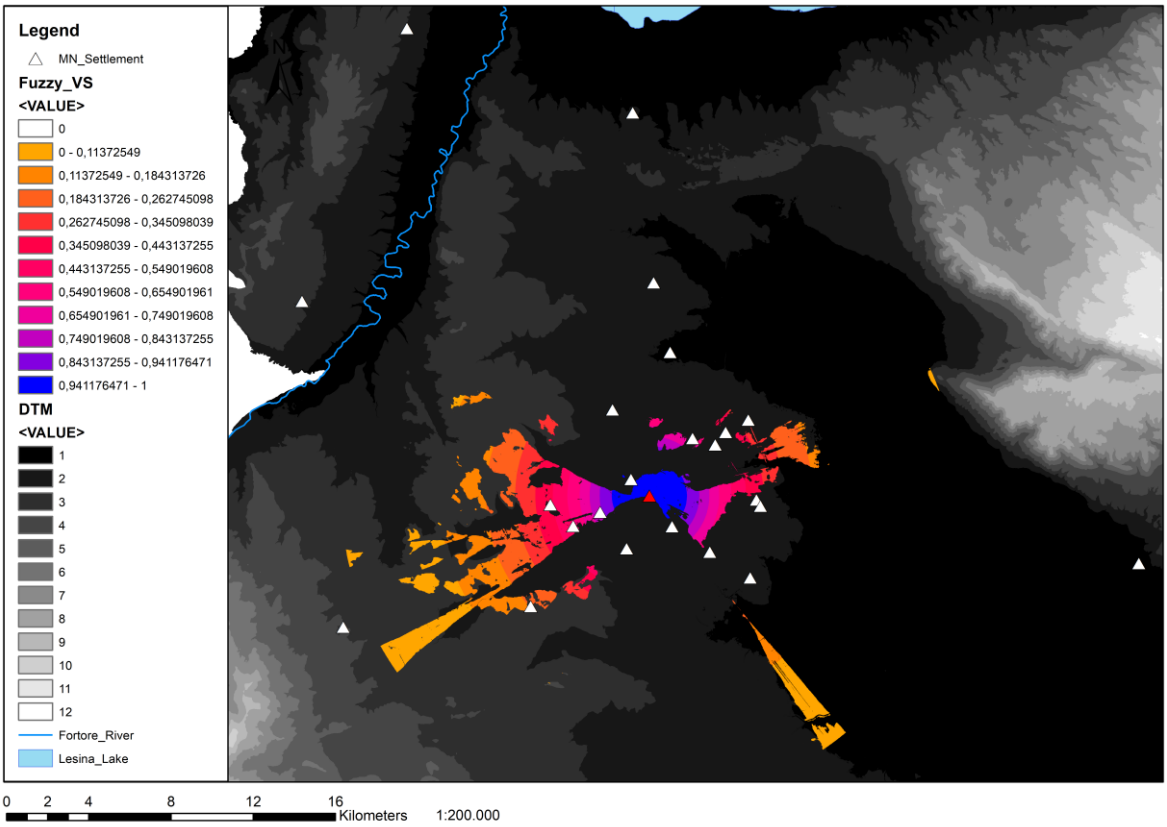


Table 200 – FVA applied to Masseria Parisi (id25)



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Table 201 – FVA applied to Cammarata (id1)

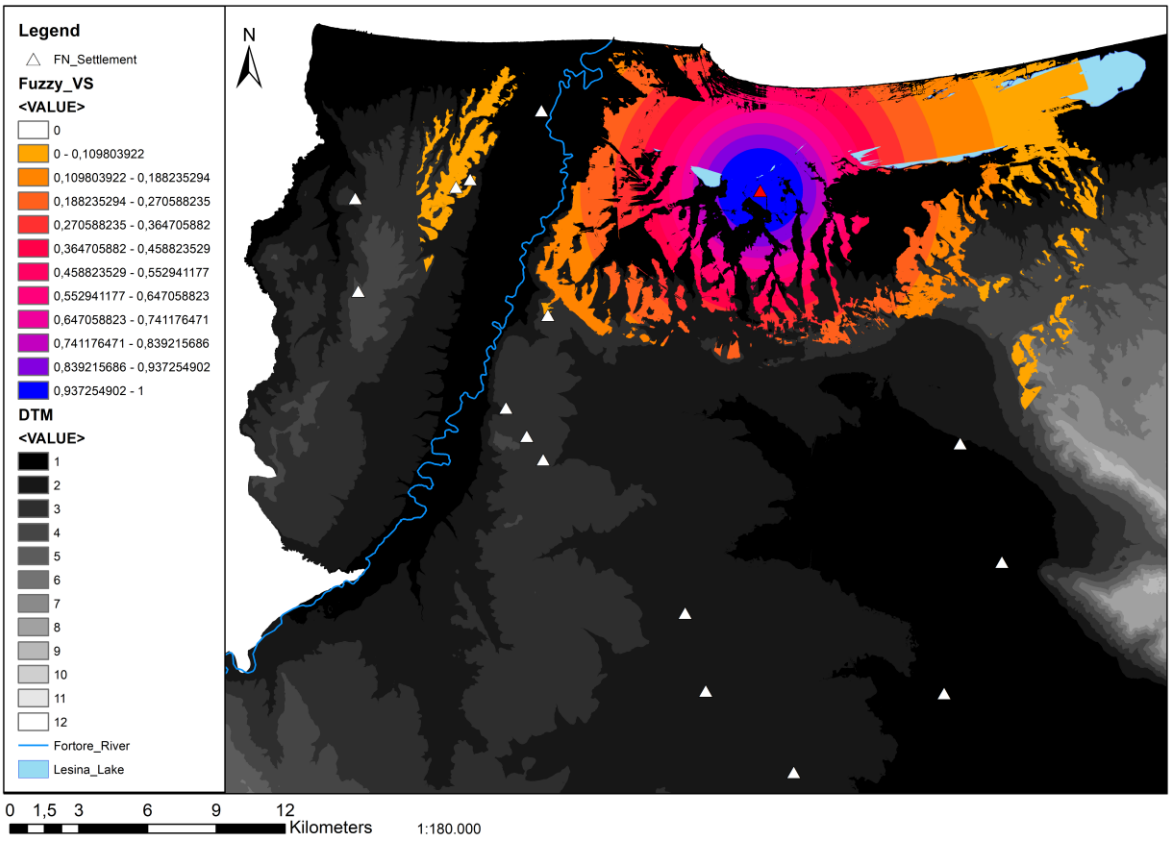


Table 202 – FVA applied to Masseria Istituto di Sangro (id2)

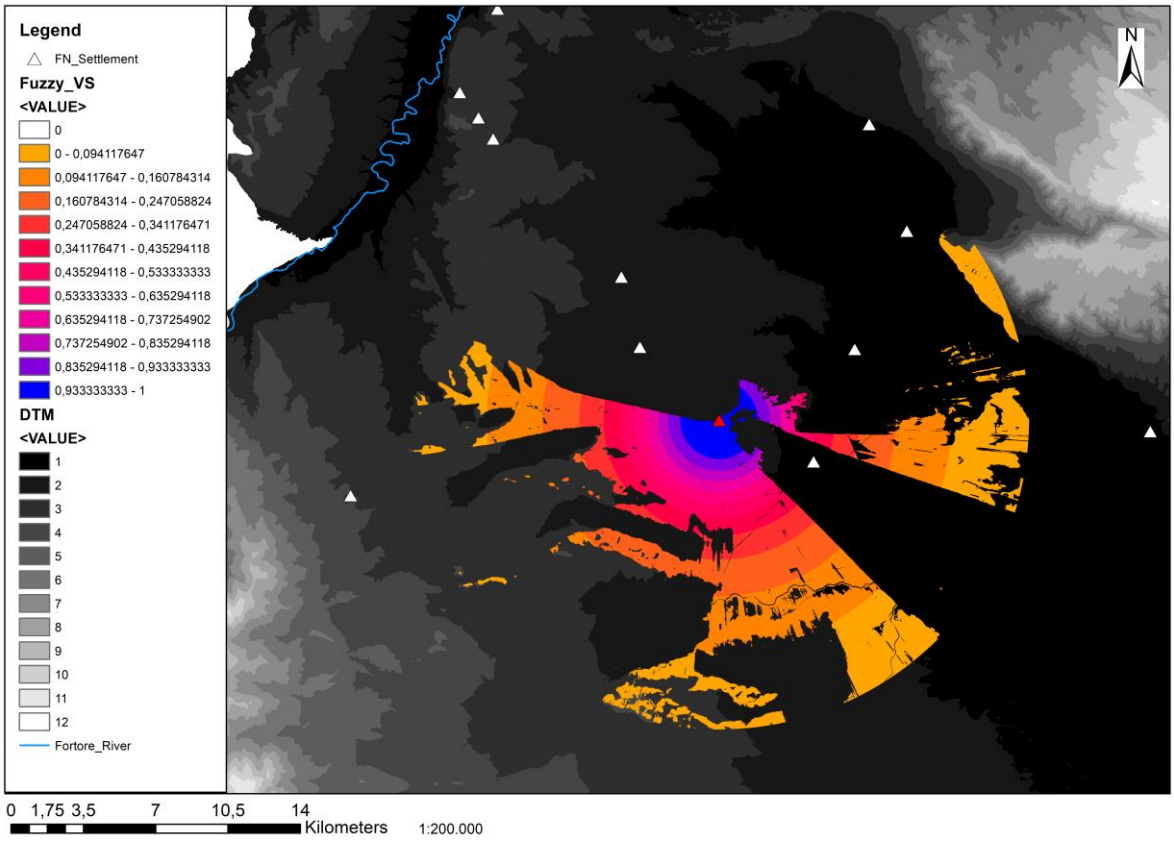


Table 203 – FVA applied to Malchieuti (id3)

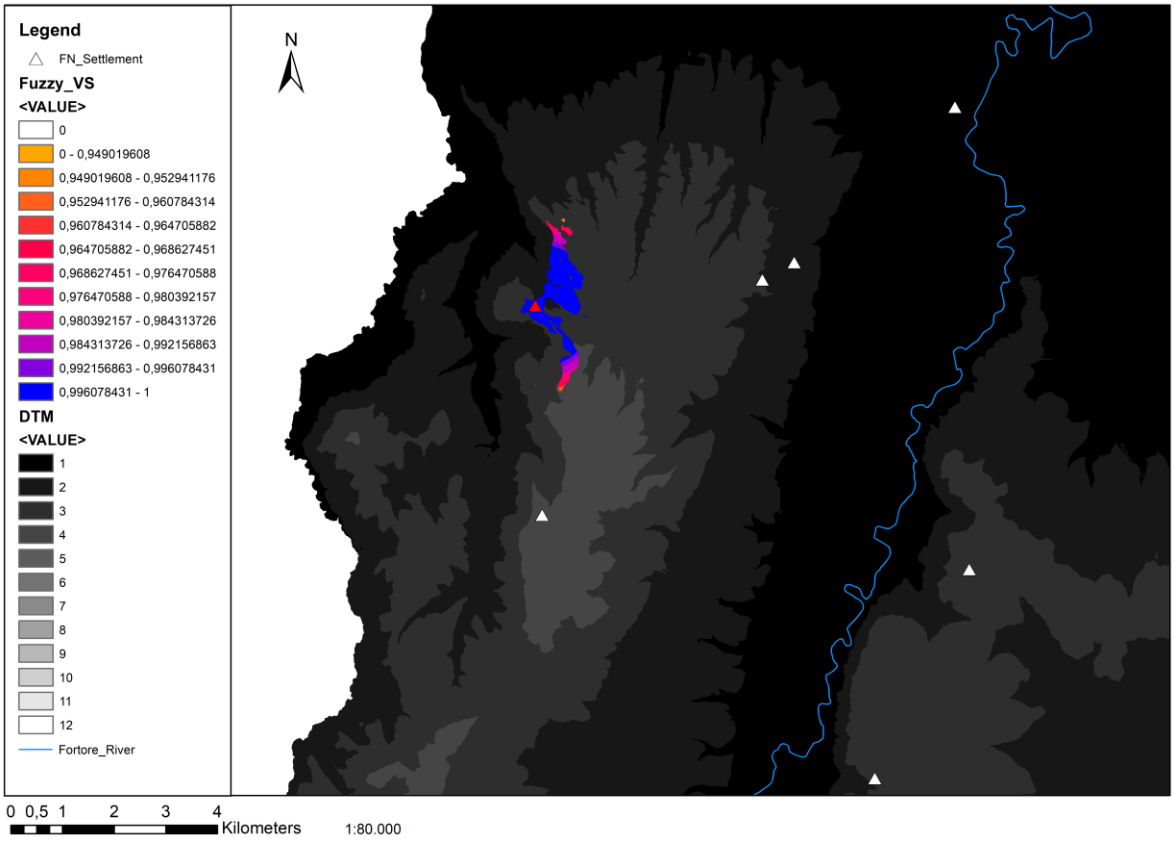


Table 204 – FVA applied to Località Piano Navuccio (id4)

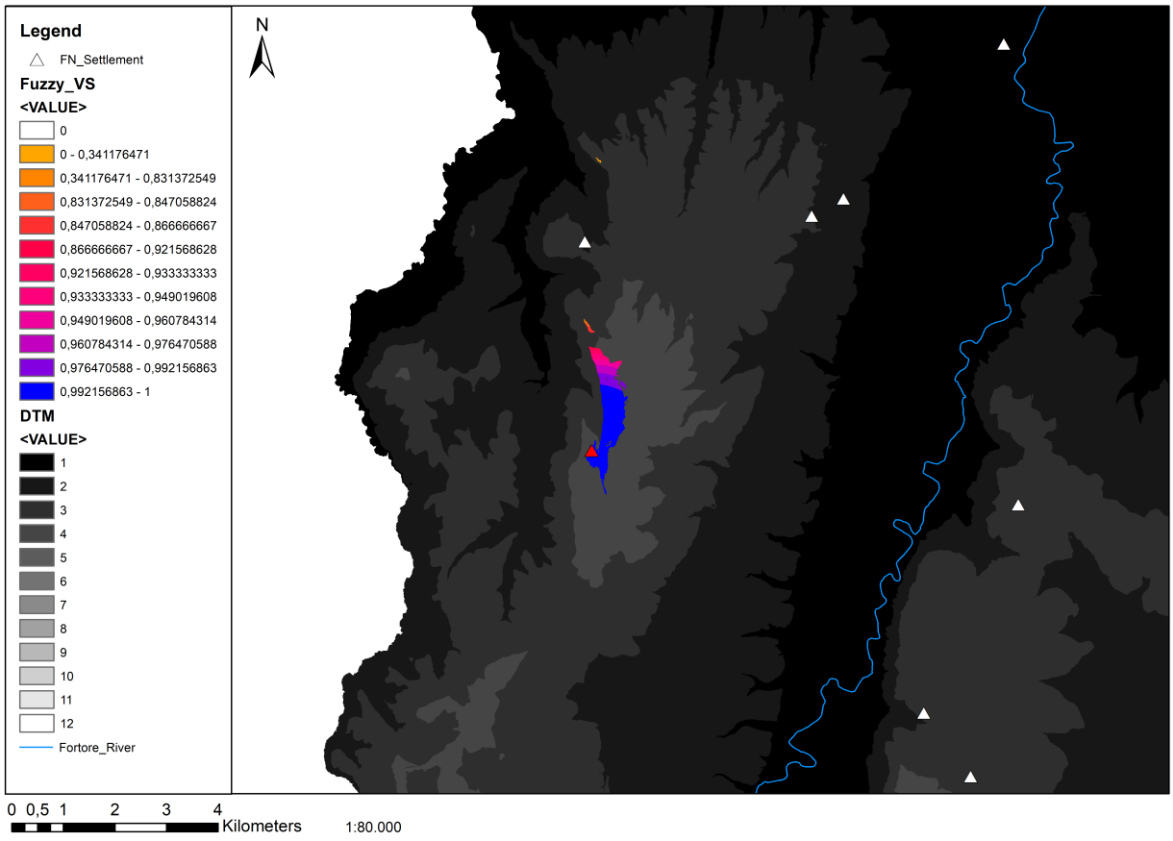


Table 205 – FVA applied to Piani di Lauria (id5)

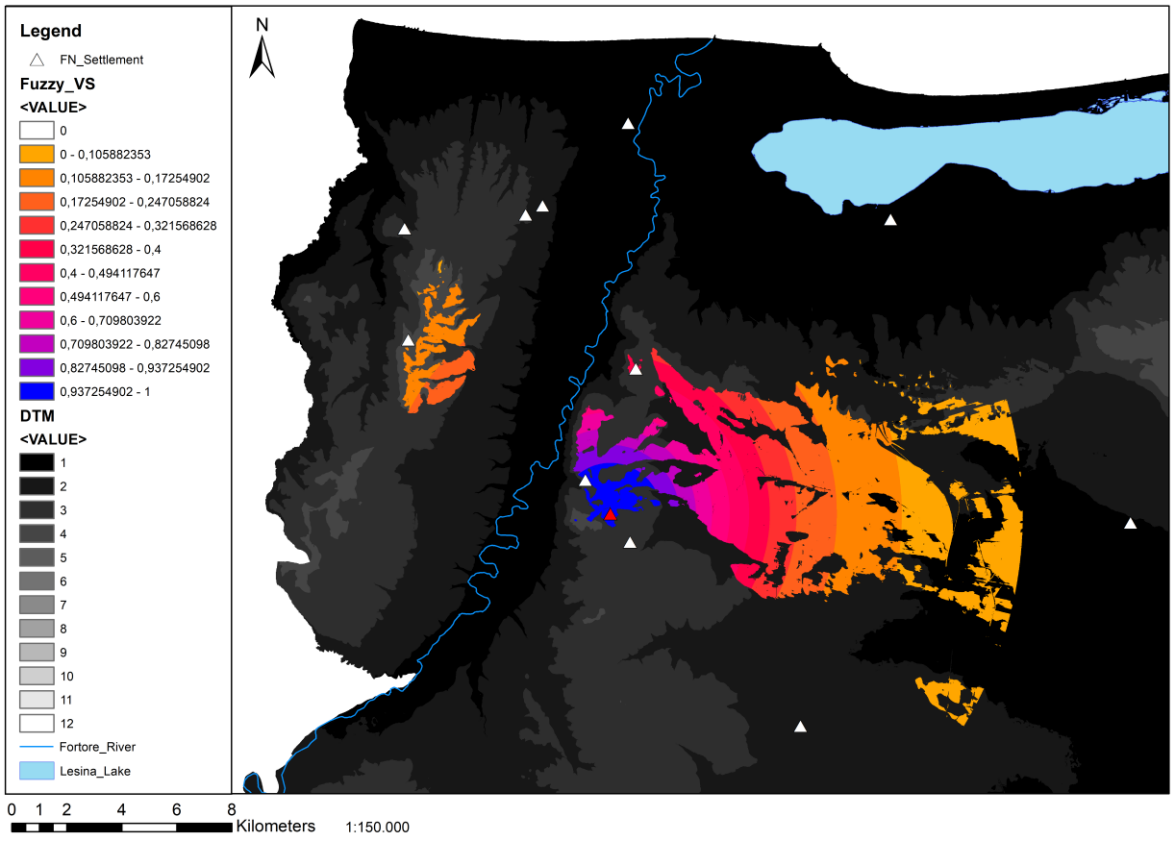


Table 206 – FVA applied to Mezzana della Quercia (id6)

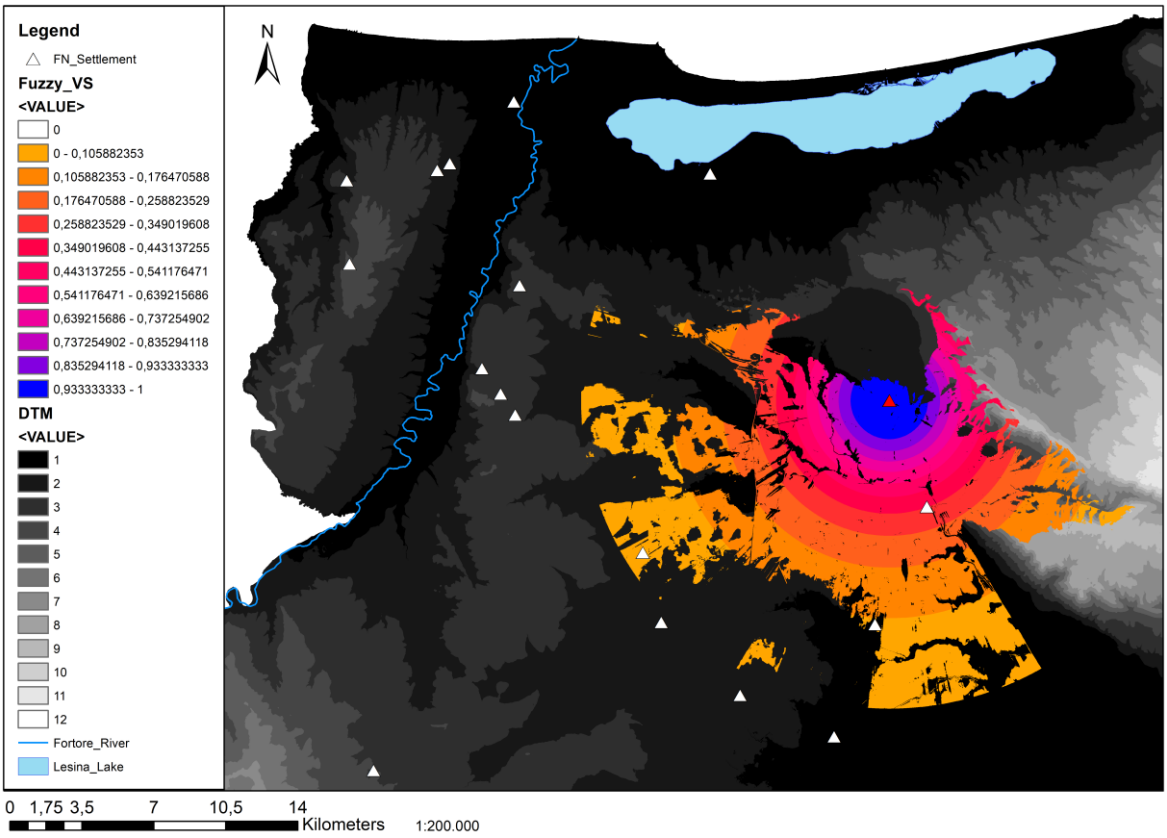


Table 208 – FVA applied to Coppa Pallante (id8)

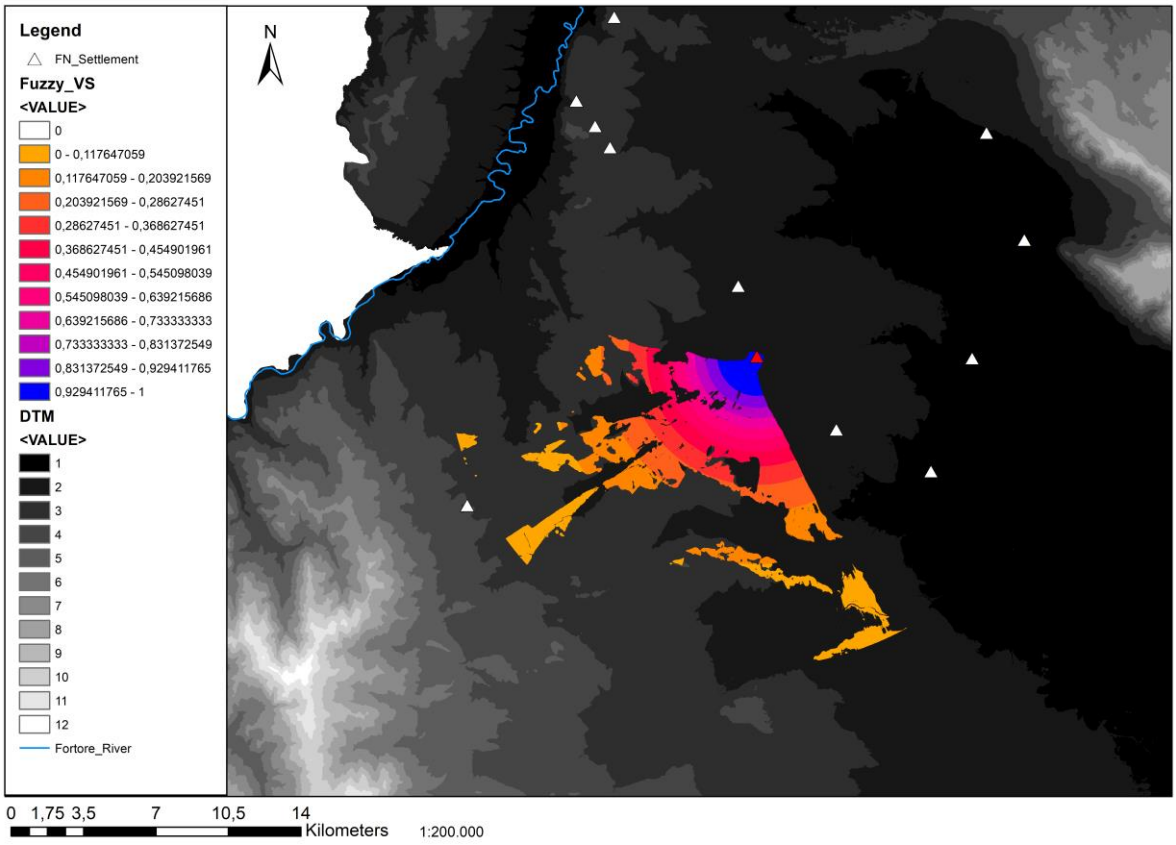


Table 209 – FVA applied to Masseria Torretta (id9)

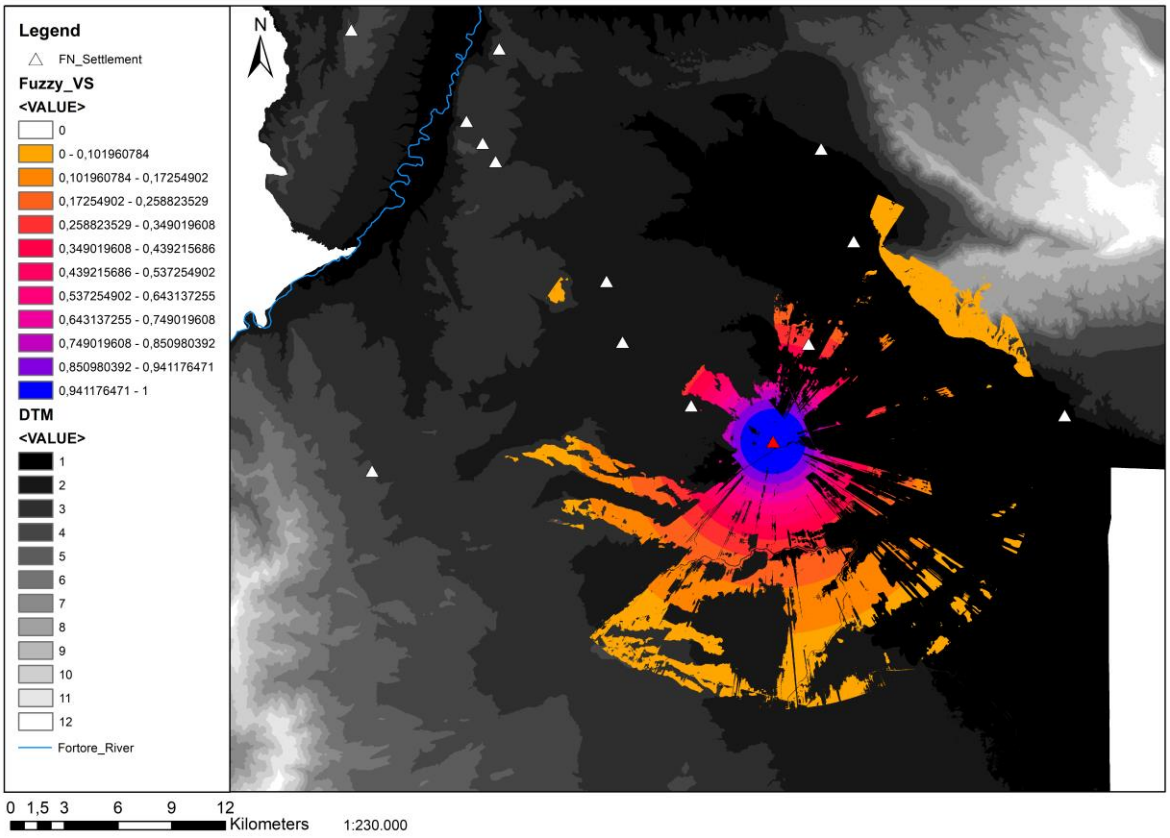


Table 210 – FVA applied to Ciccalento (id10)

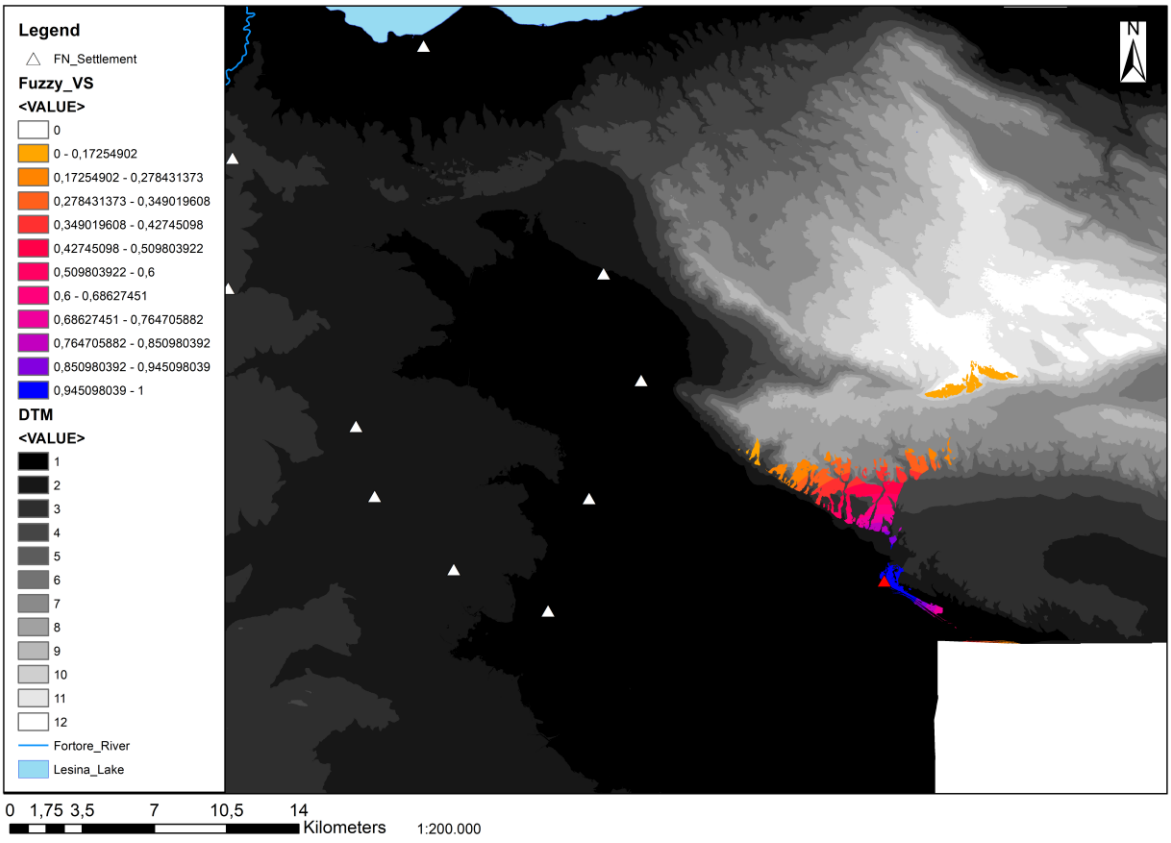


Table 211 – FVA applied to Pian Devoto (id11)

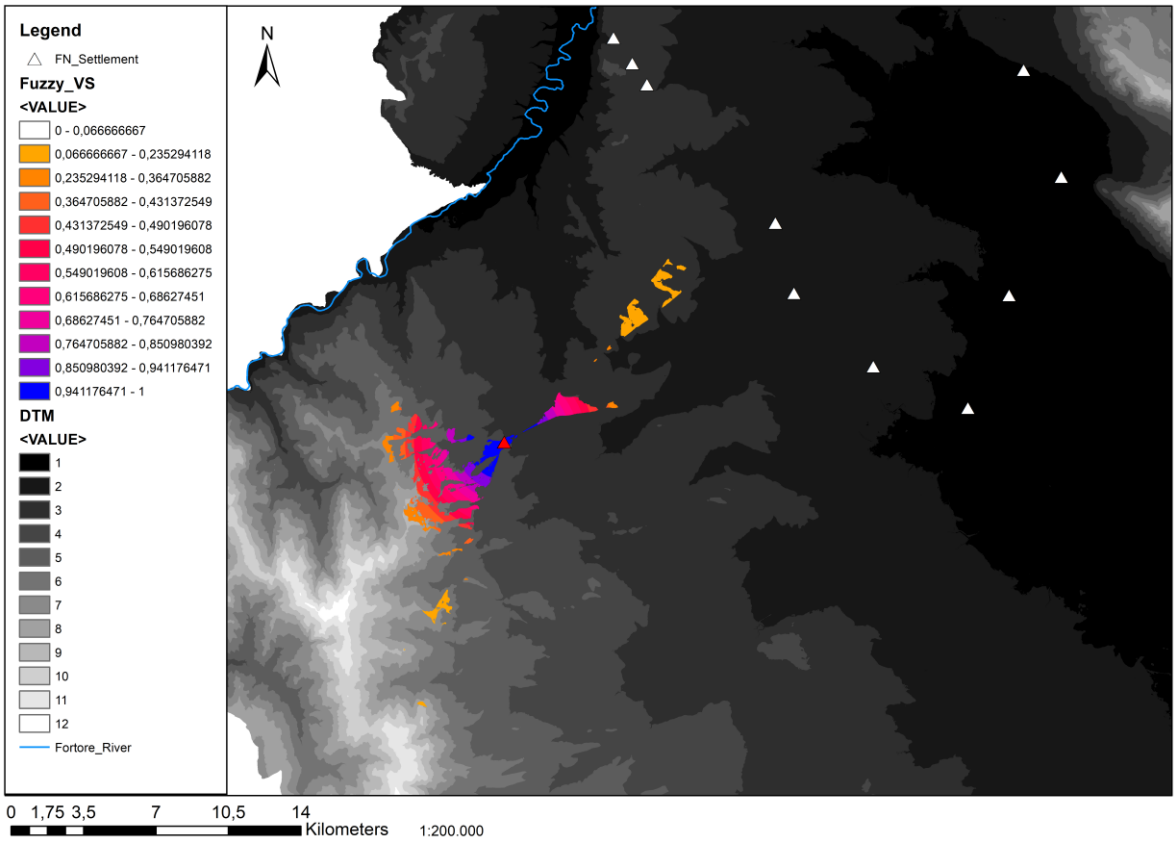


Table 212 – FVA applied to Mezzanella di Brancia (id12)

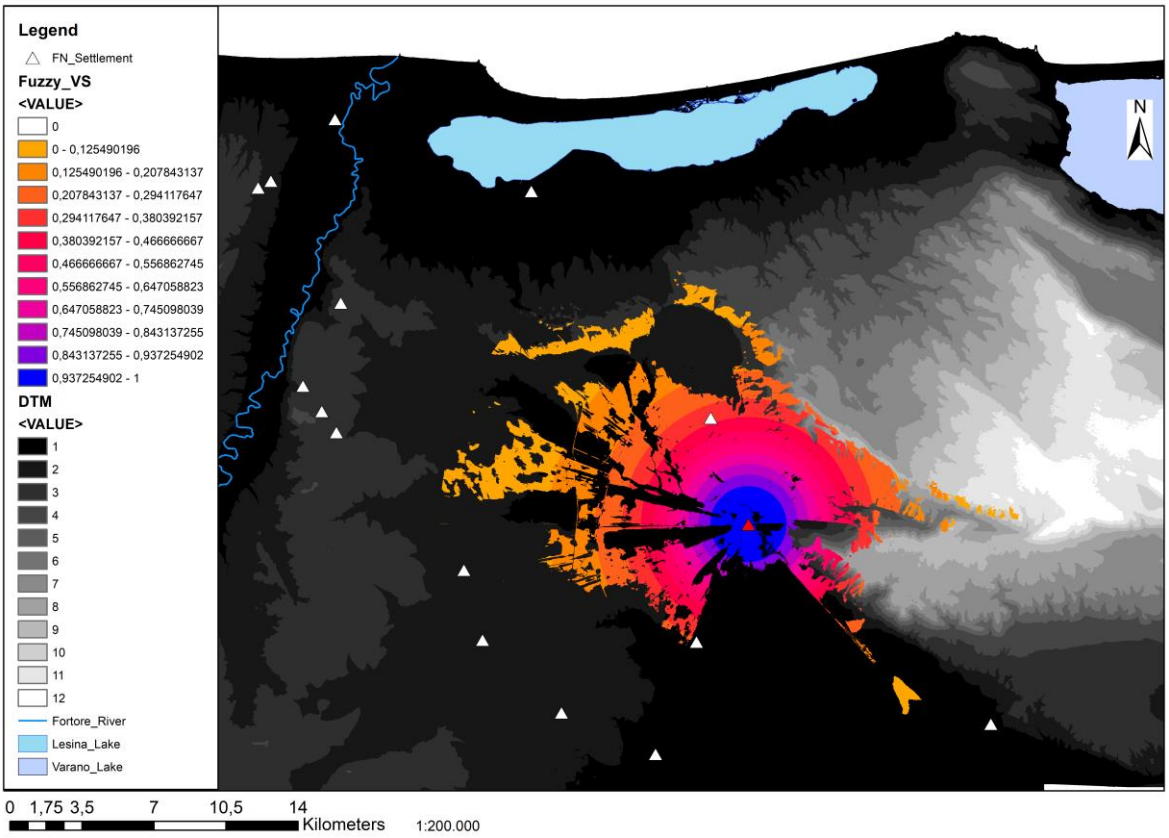


Table 213 – FVA applied to Chiarappa (id13)

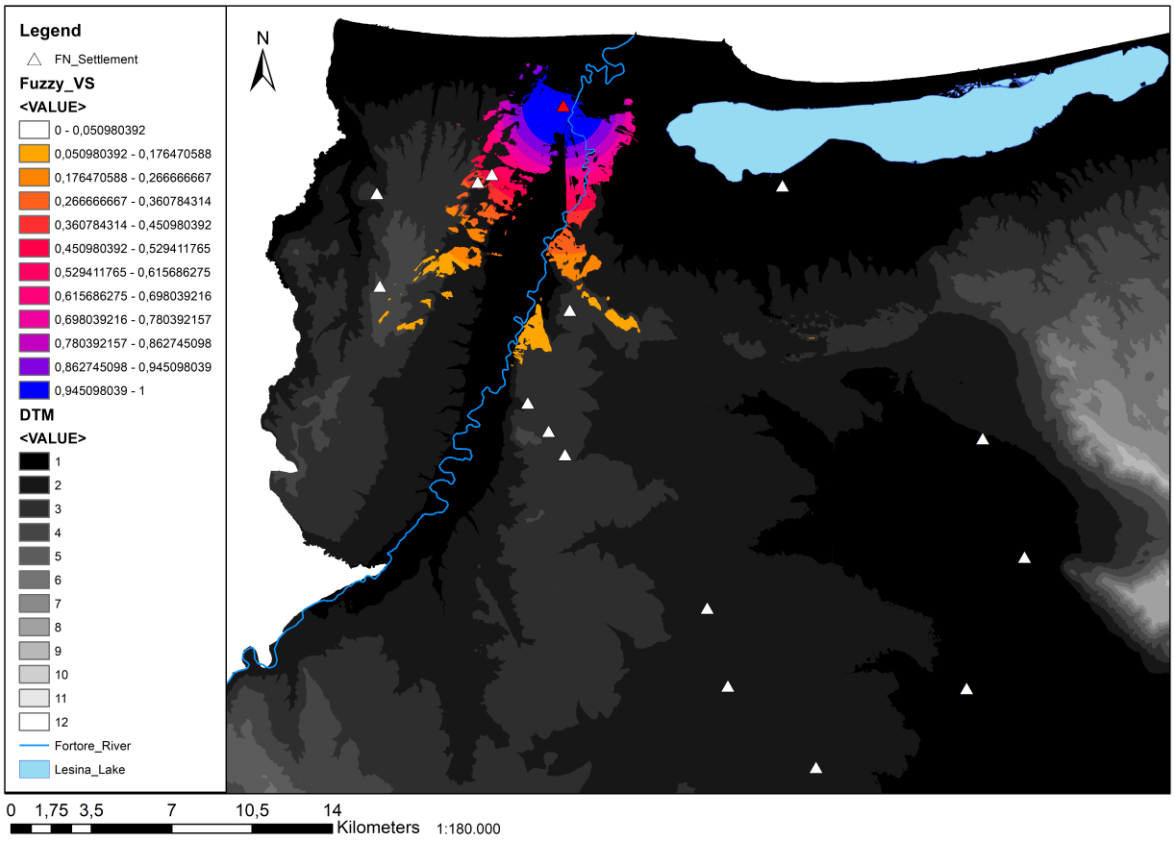


Table 214 – FVA applied to Coppa di Rose (id14)

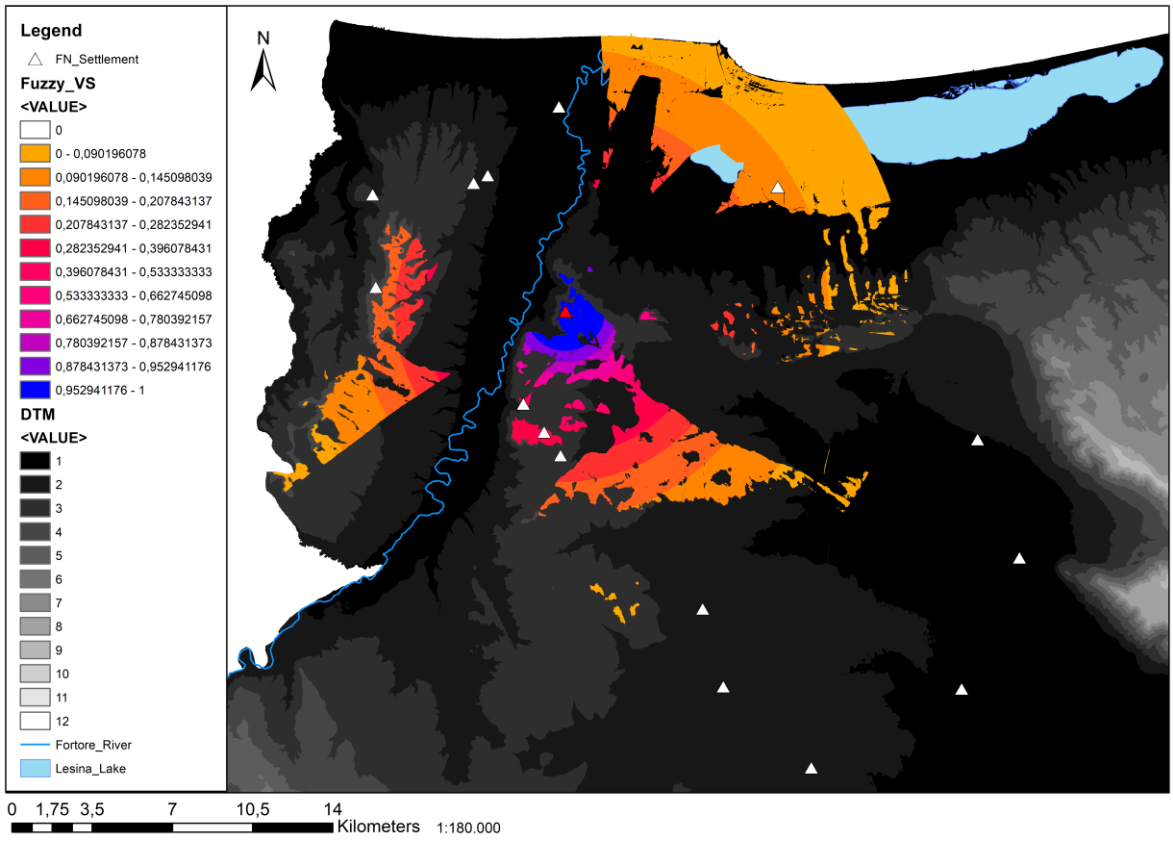


Table 215 – FVA applied to Portata Casone (id15)

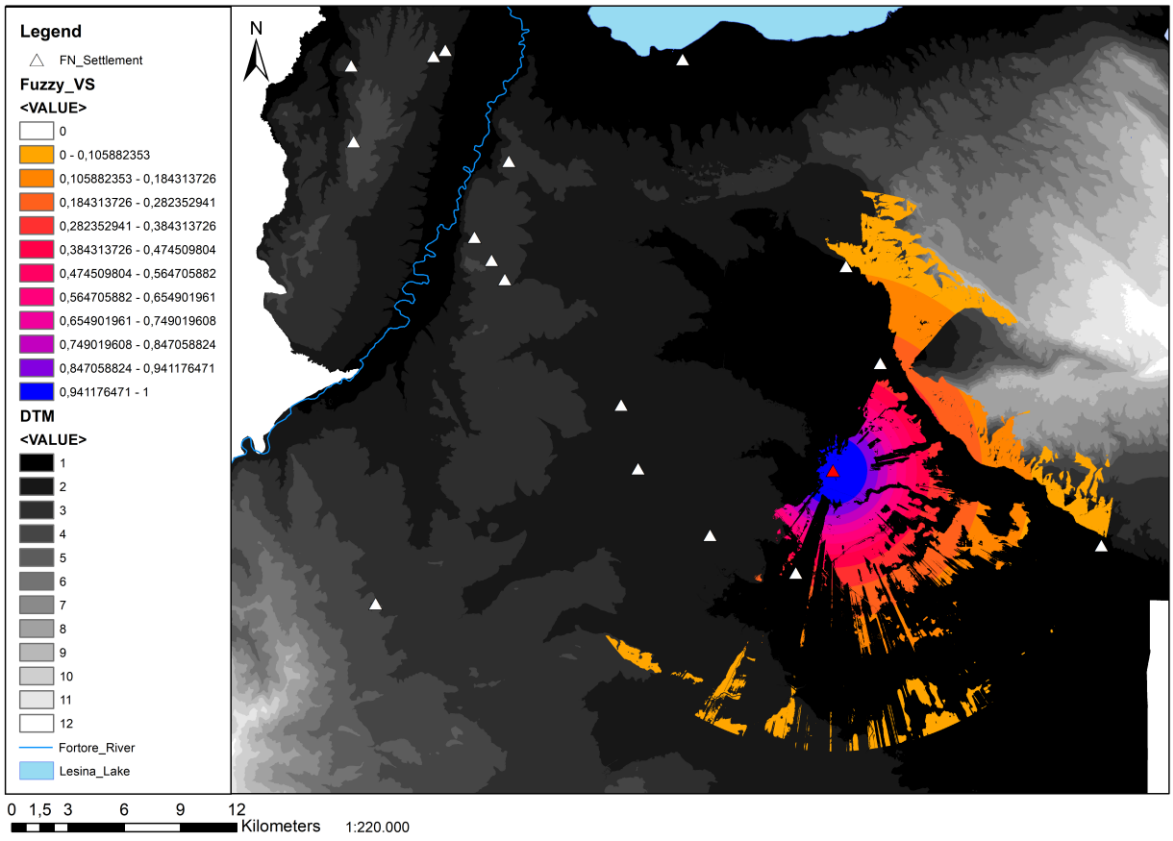


Table 216 – FVA applied to Piani di Laura (id16)

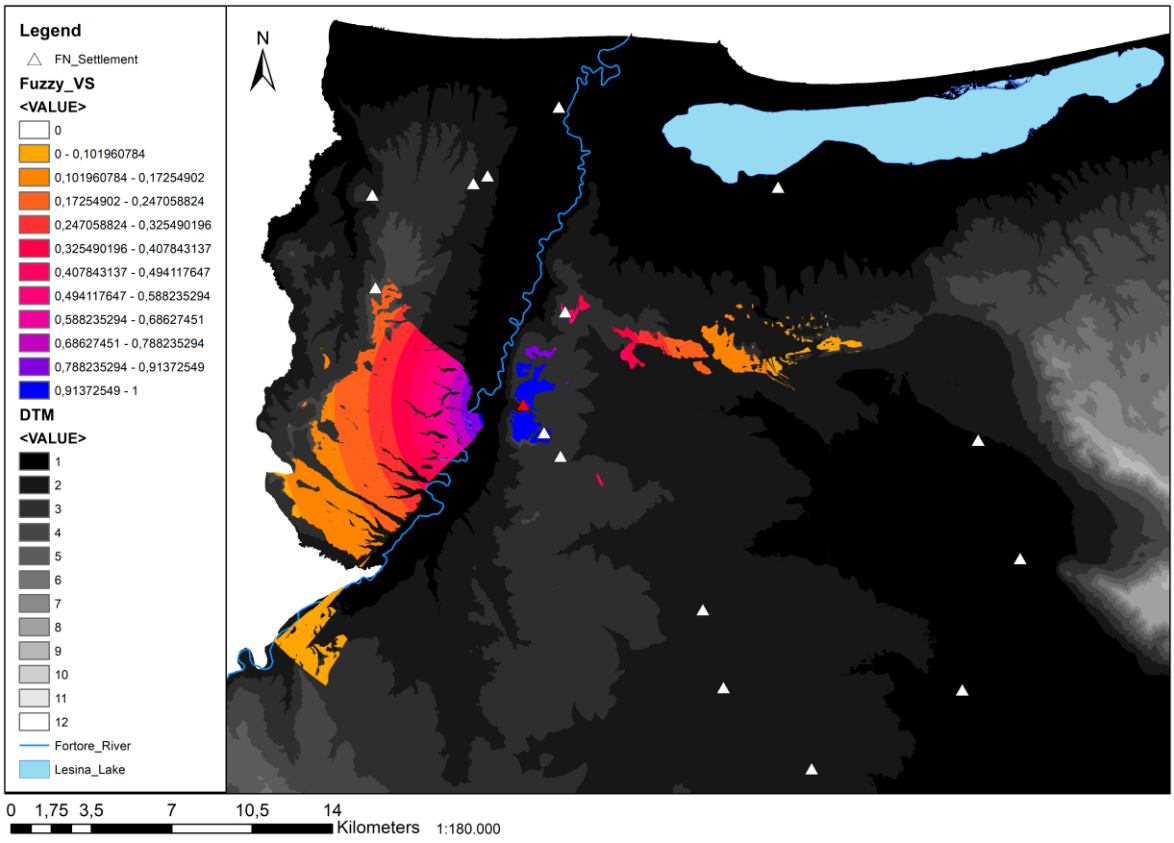


Table 217 – FVA applied to Colle di Creta (id17)

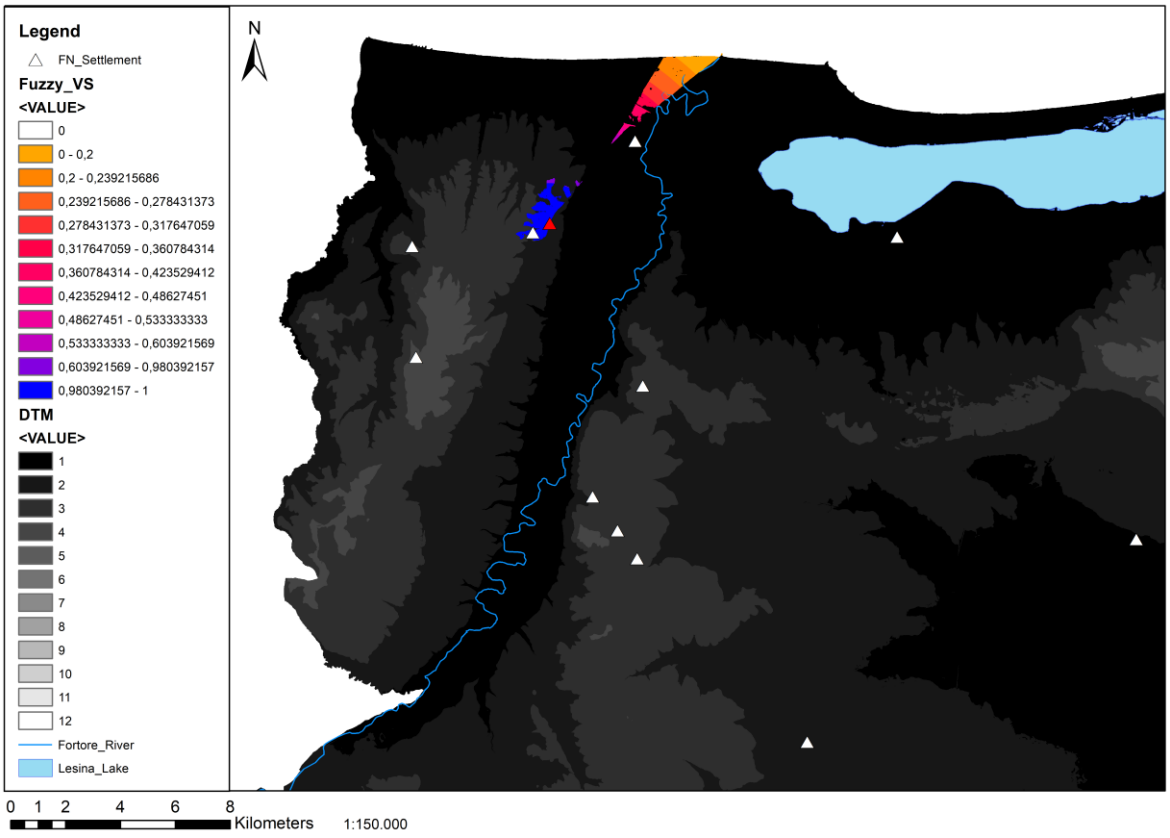


Table 218 – FVA applied to Coppa d'Olmo (id18)

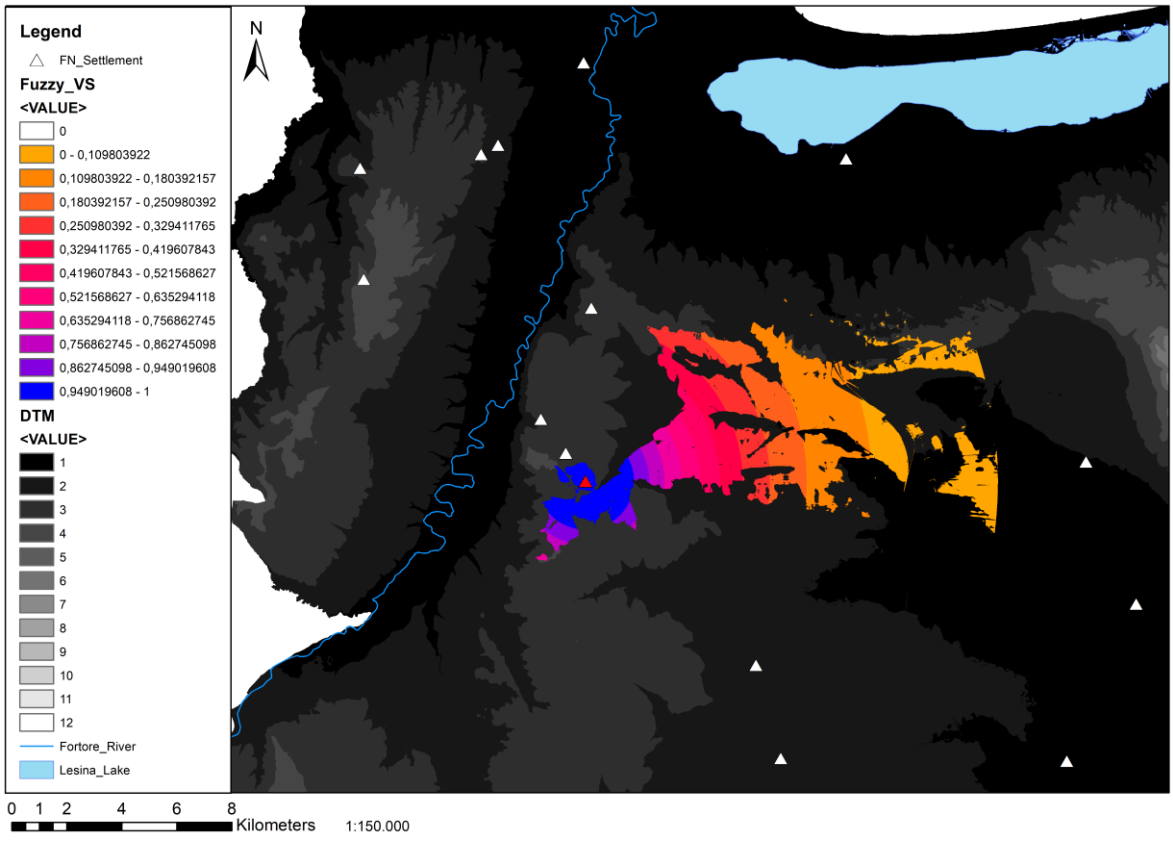
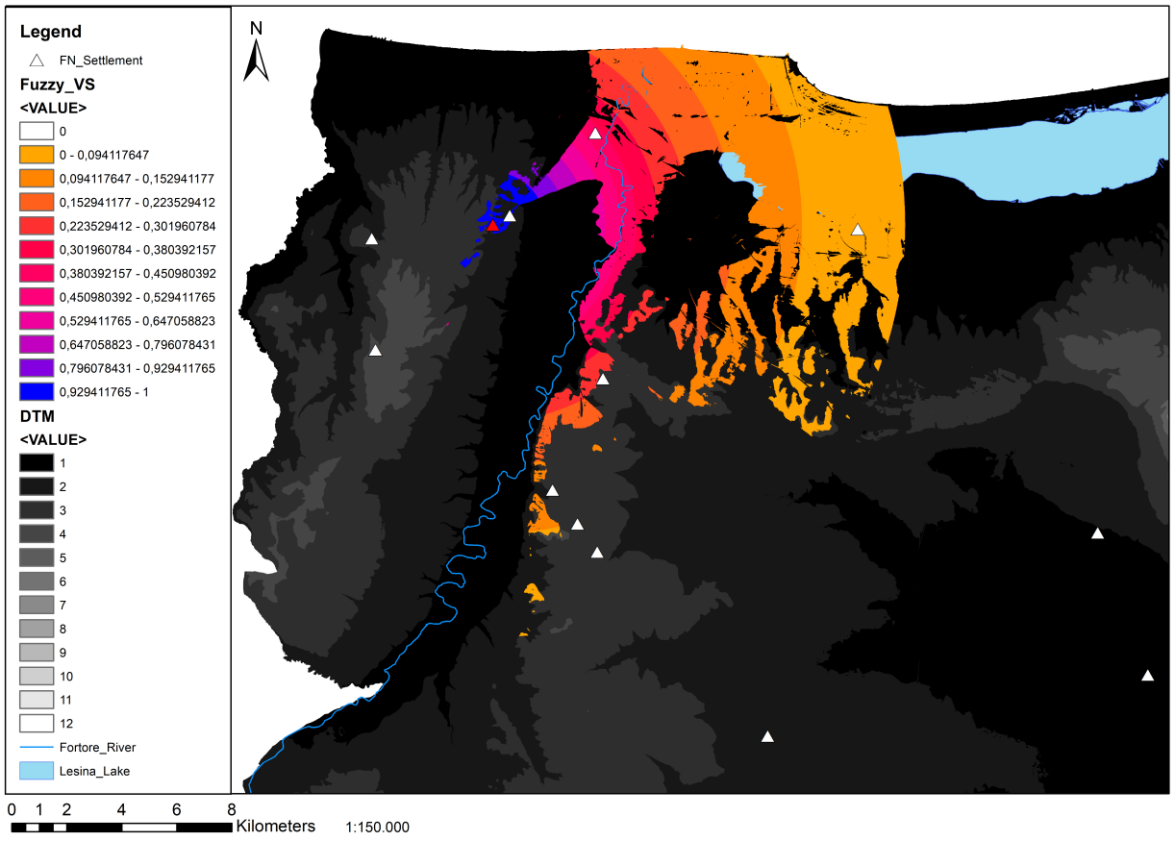


Table 219 – FVA applied to San Matteo-Chiantinelle (id19)



EARLY AND MIDDLE COPPER AGE

Table 220 – FVA applied to Fischino (id1)

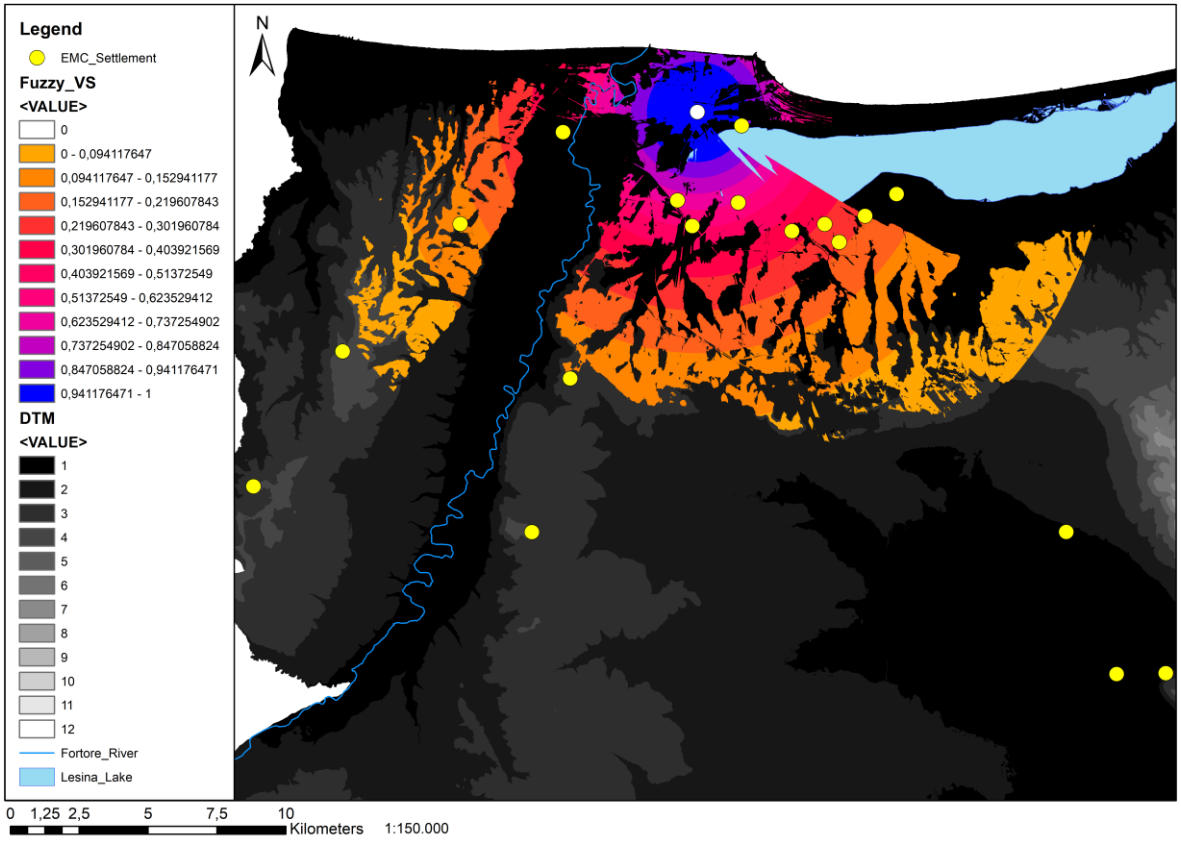


Table 221 – FVA applied to Pontone (id2)

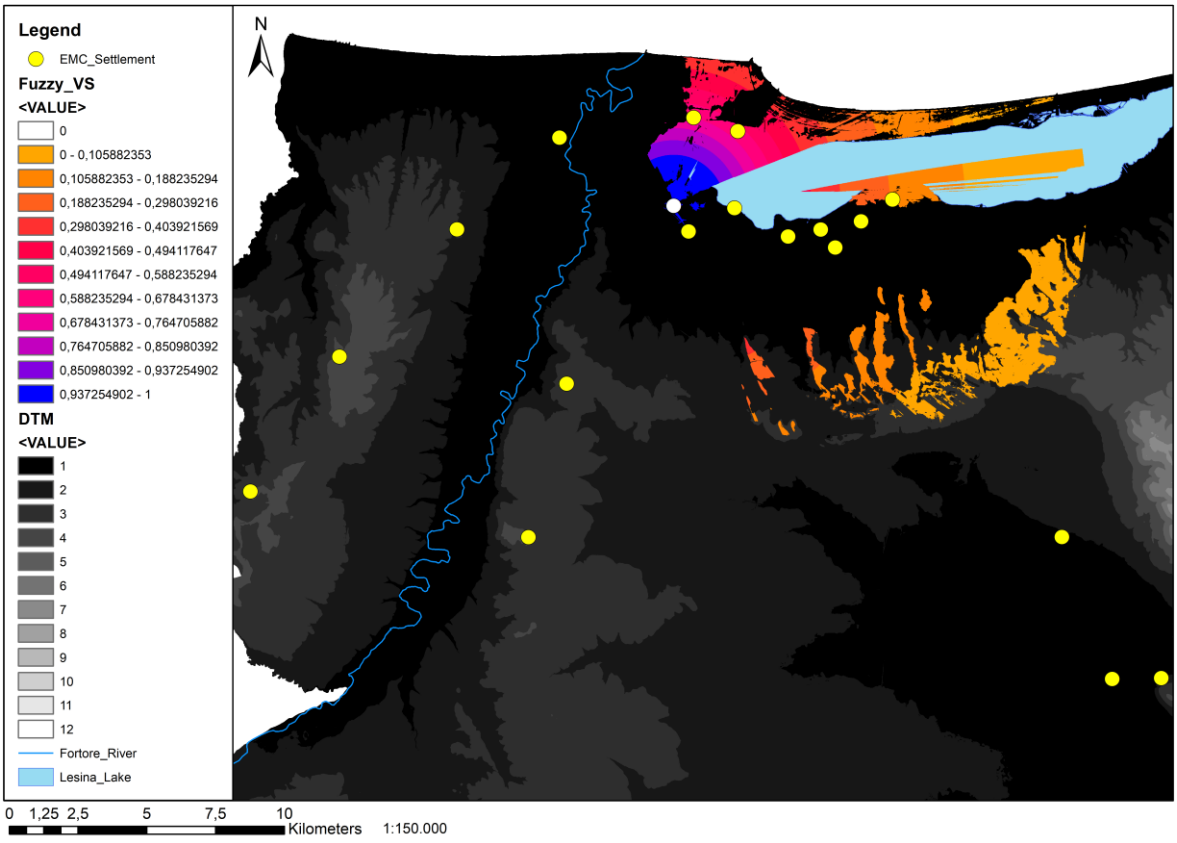


Table 222 – FVA applied to Cannella al Muro (id3)

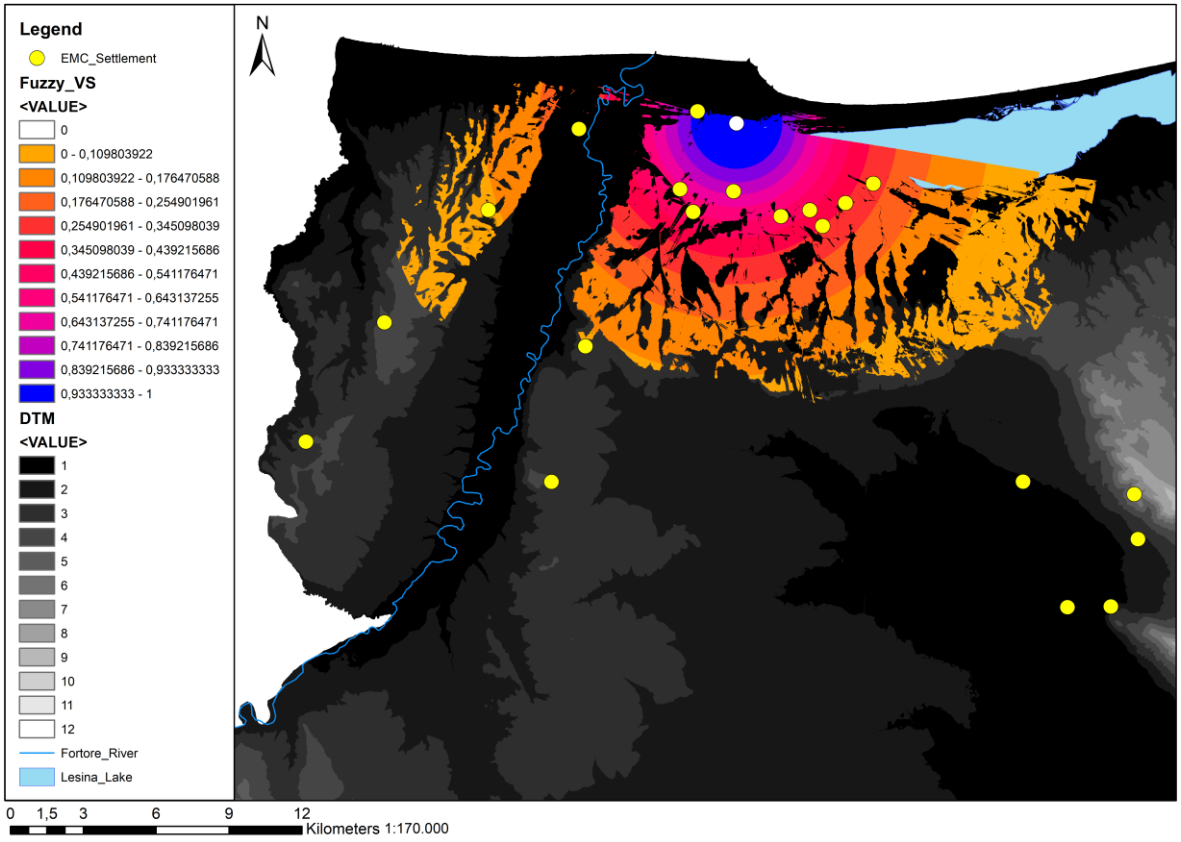


Table 223 – FVA applied to Posta Corfiati (a.k.a. Colonella) (id4)

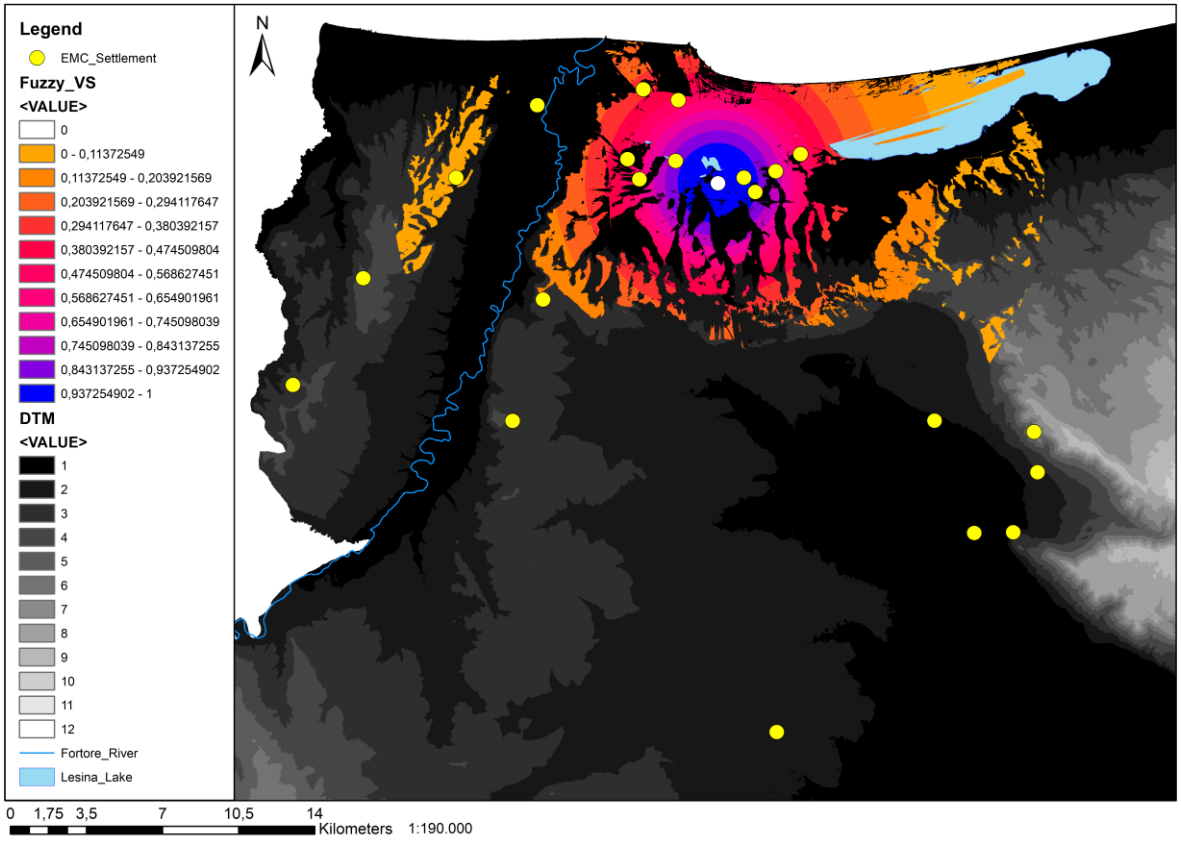


Table 224 – FVA applied to Palude Grande (id5)

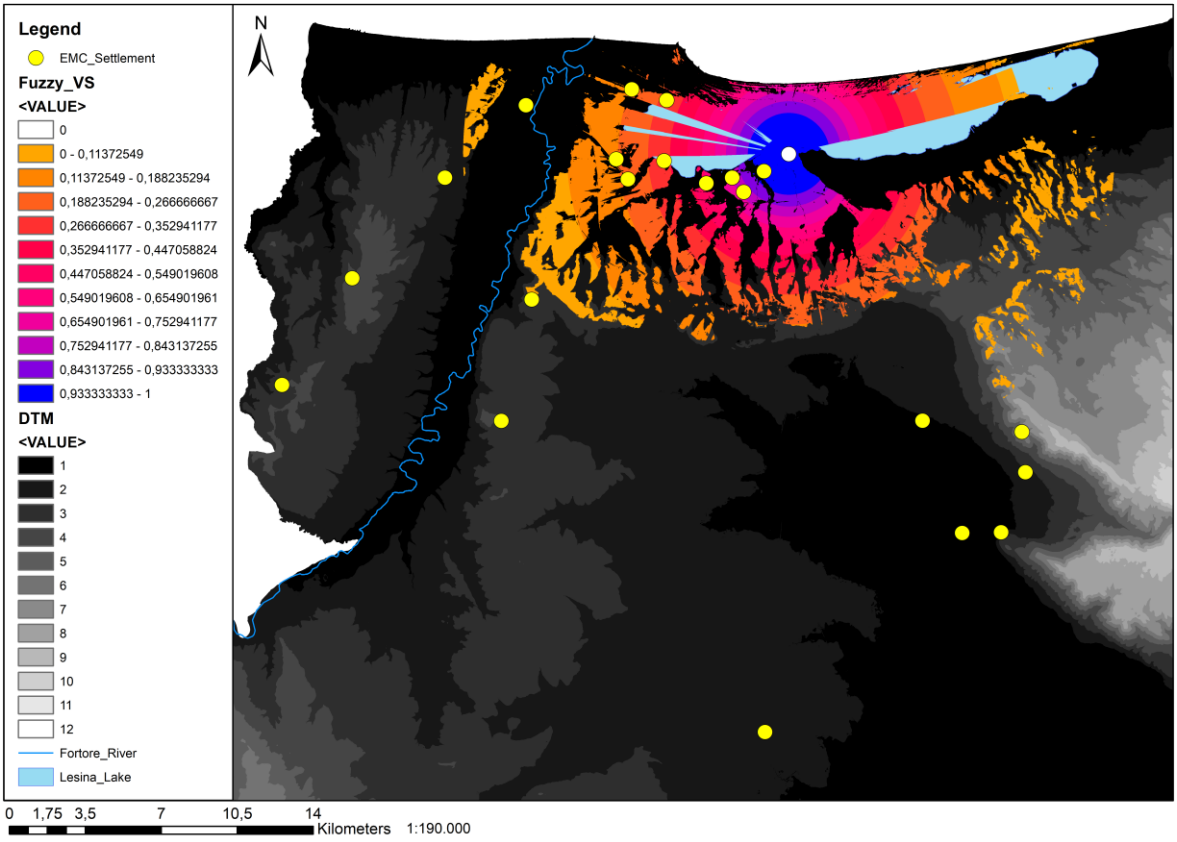


Table 225 – FVA applied to Palude Caroppi (id6)

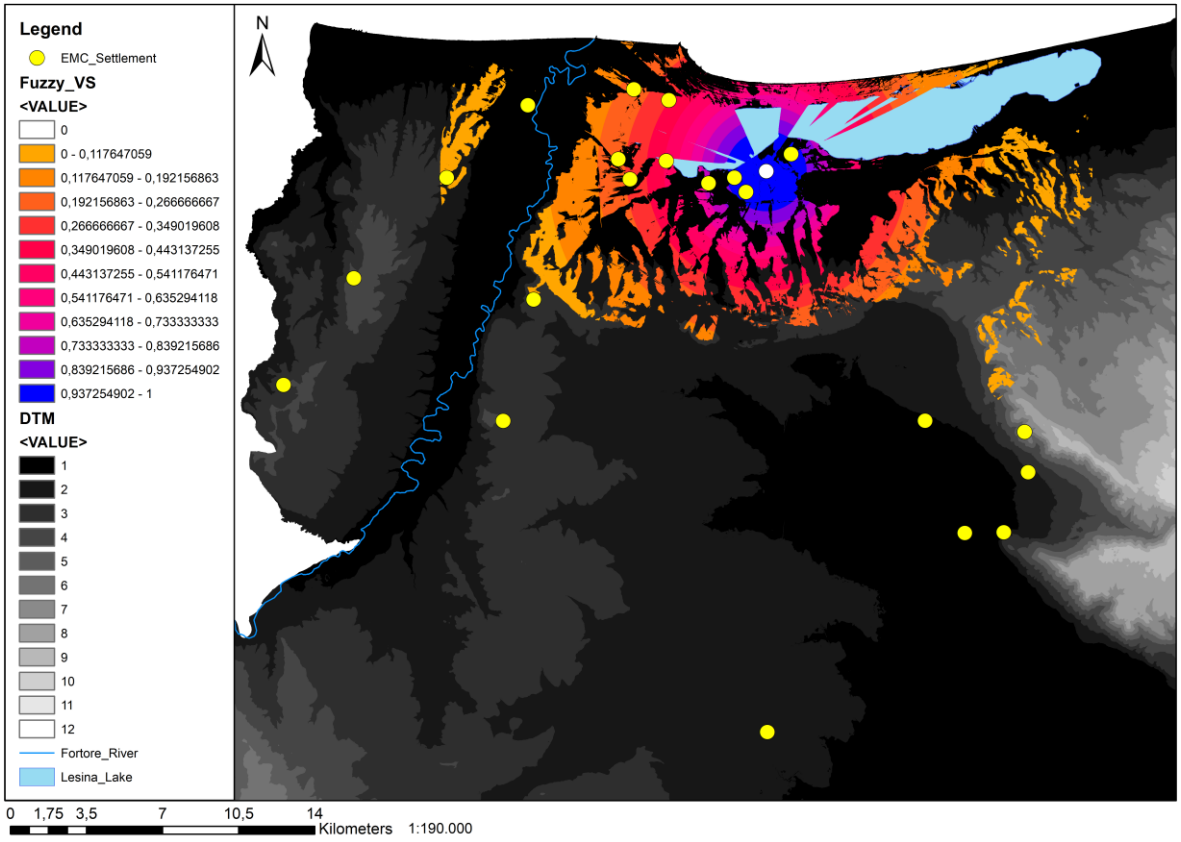


Table 226 – FVA applied to Cammarata (id7)

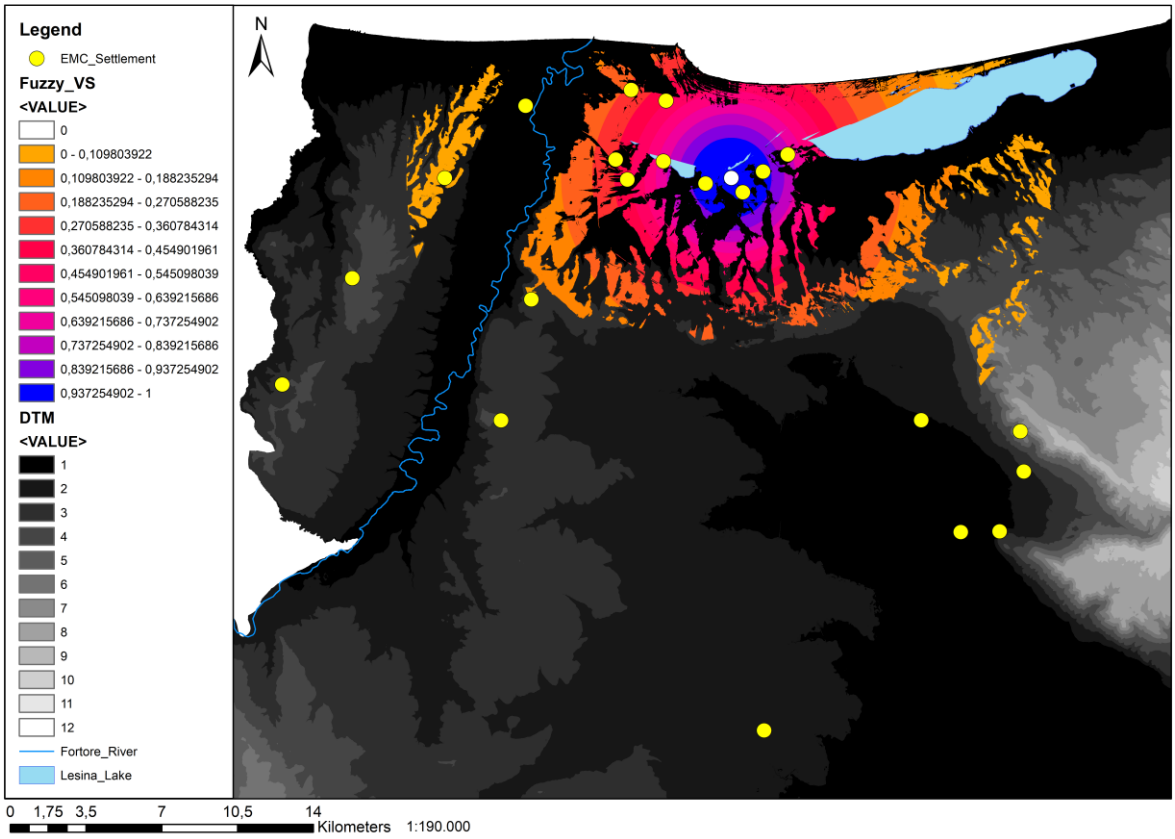


Table 227 – FVA applied to Palude San Lorenzo (id8)

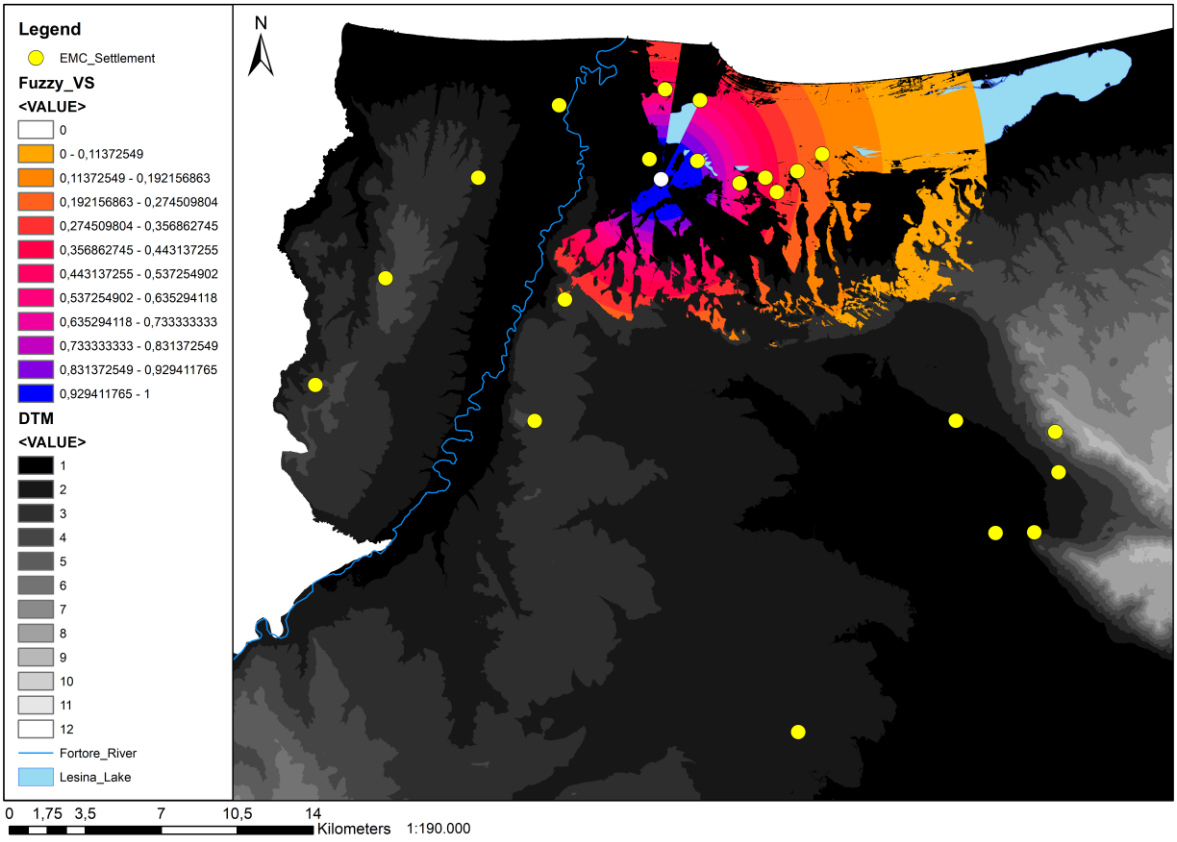


Table 228 – FVA applied to Chiantinelle (id9)

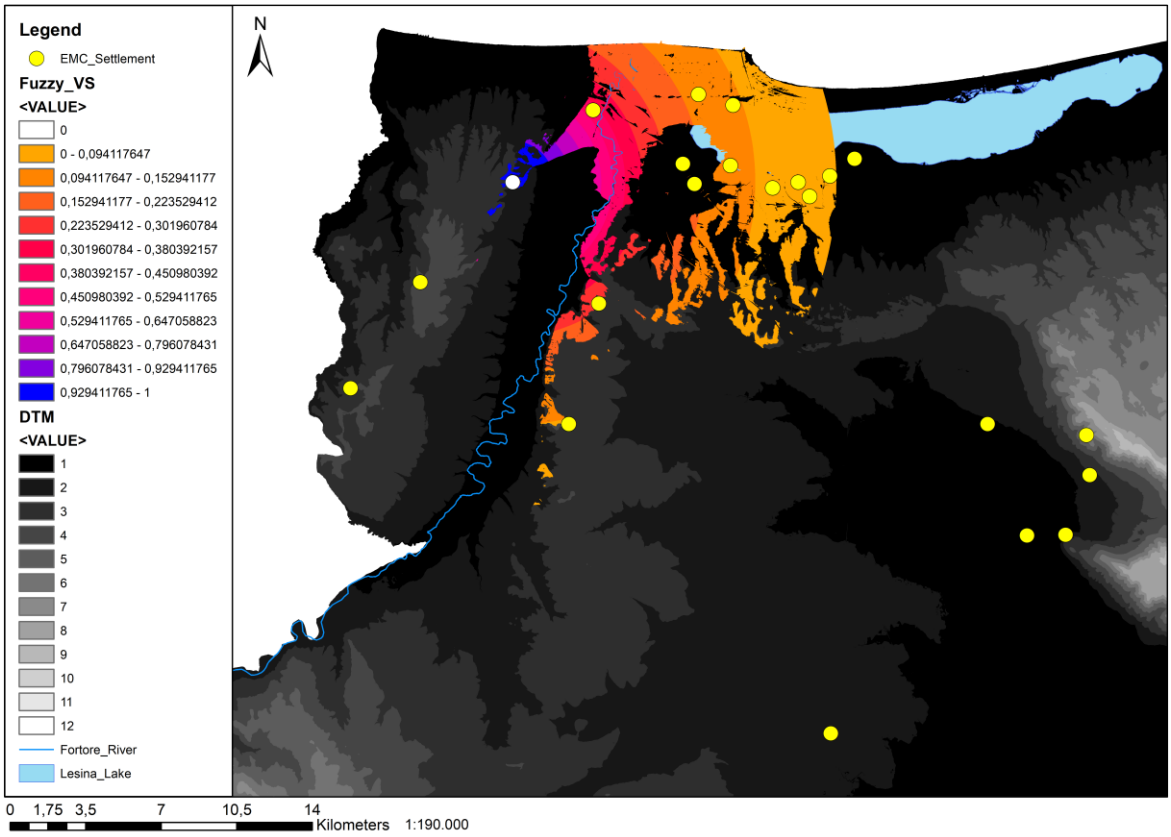


Table 229 – FVA applied to Mezzana della Quercia (id10)

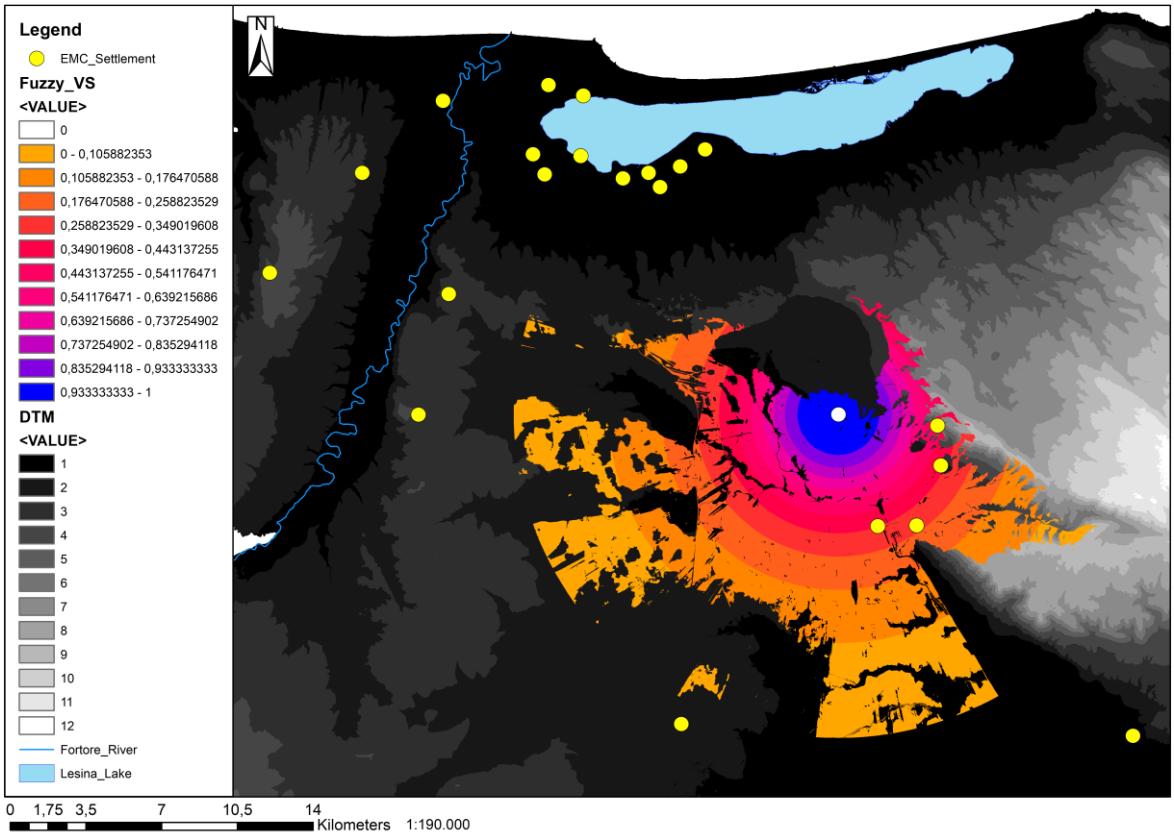


Table 230 – FVA applied to Castelpagano (id11)

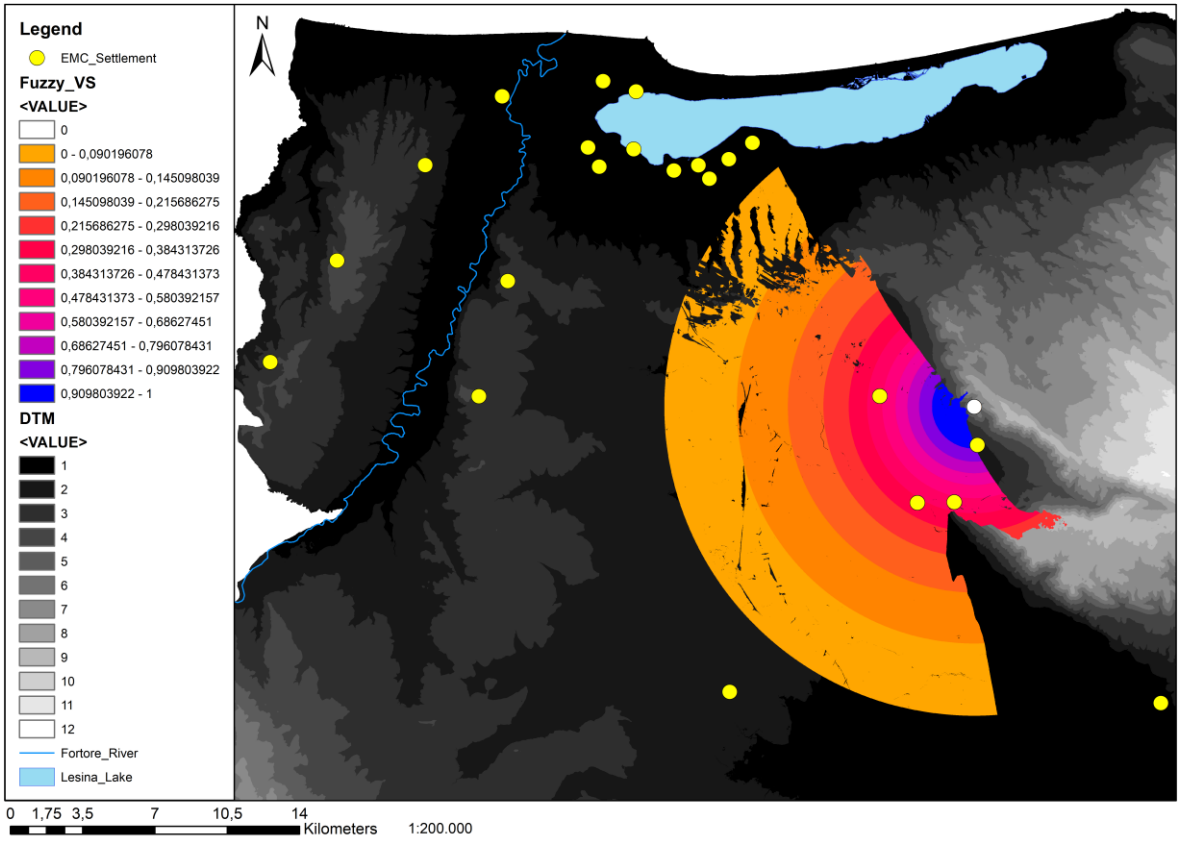


Table 231 – FVA applied to Località Castate (id12)

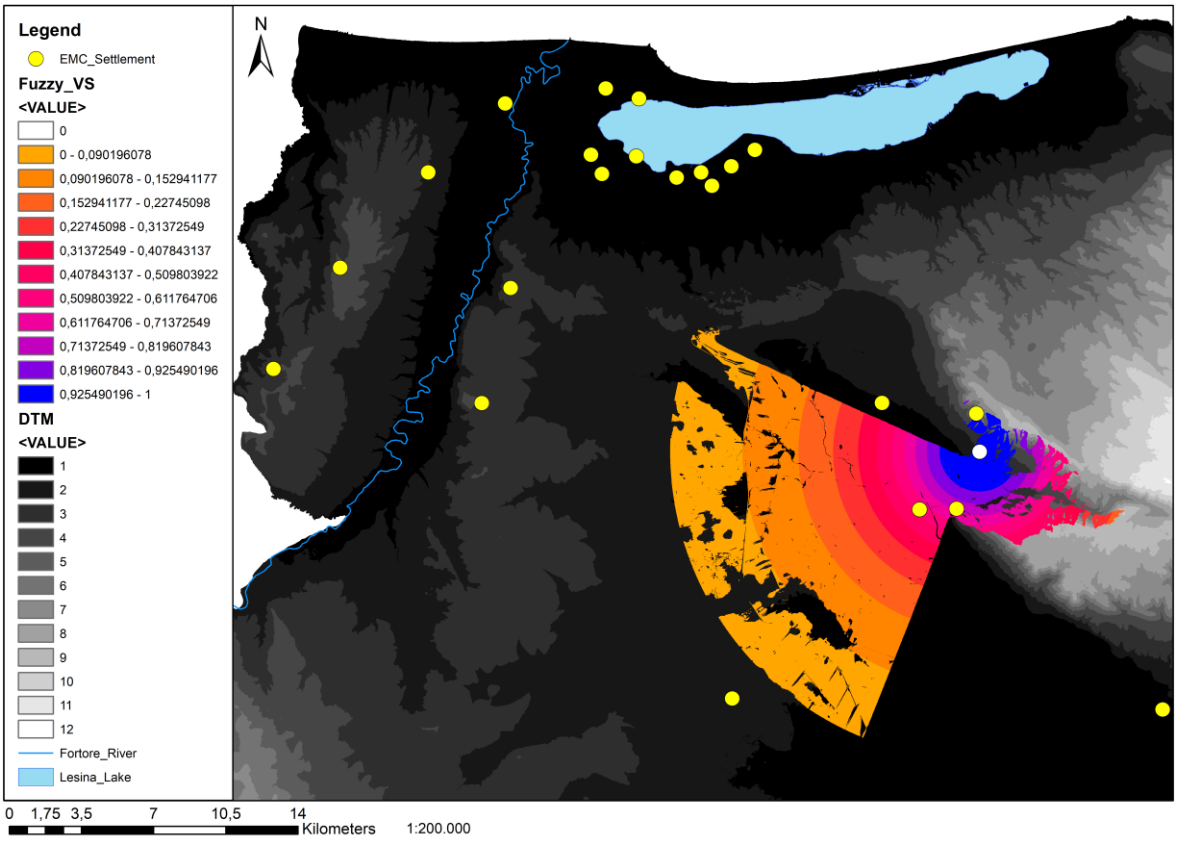


Table 232 – FVA applied to Mezzanella di Brancia (id13)

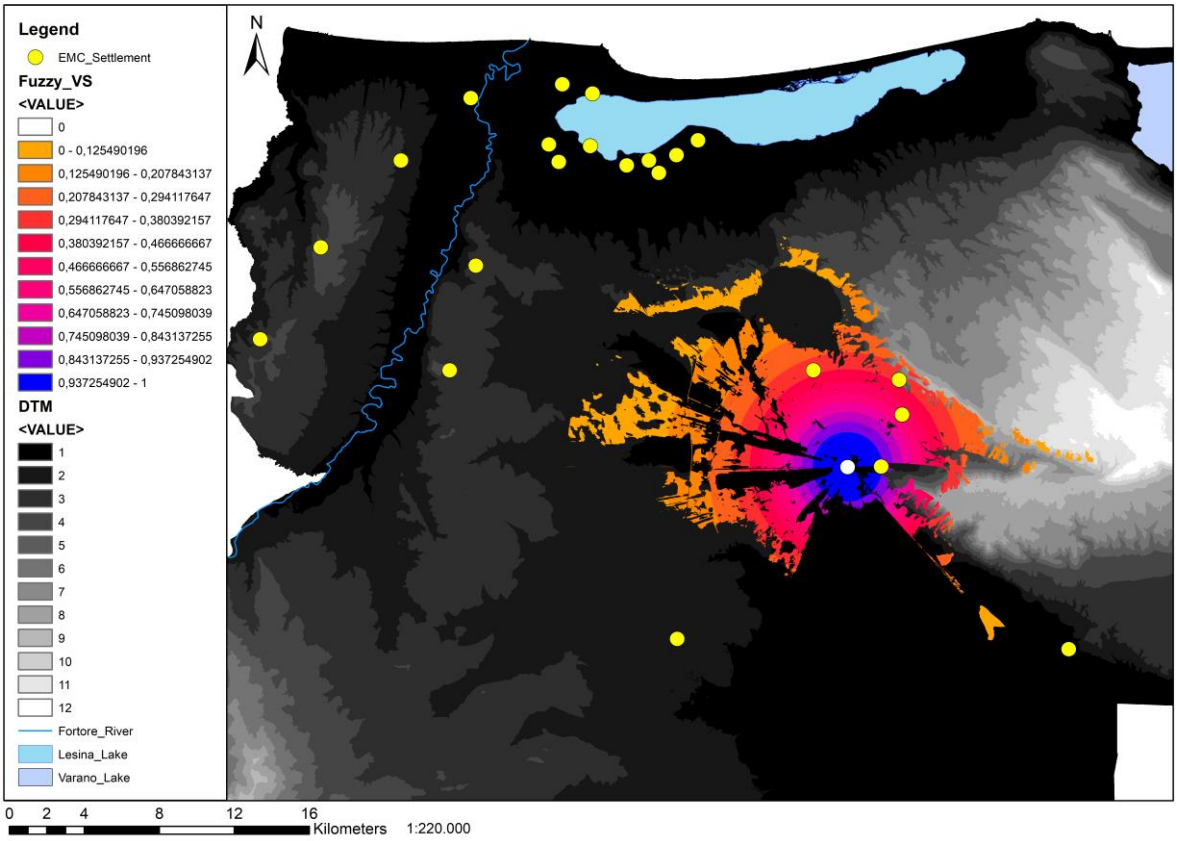


Table 233 – FVA applied to Località Brancia Km 10 – Volta Pianezza (id14)

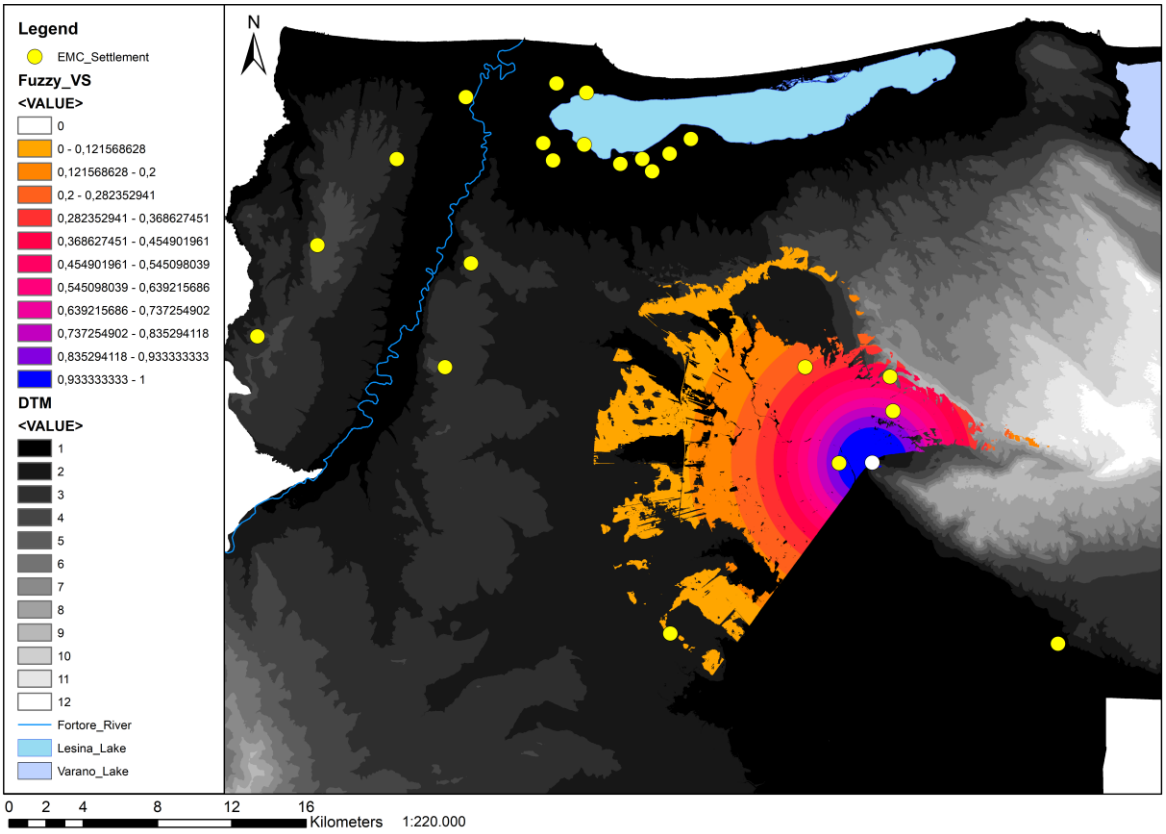


Table 234 – FVA applied to Località Piano Navuccio (id15)

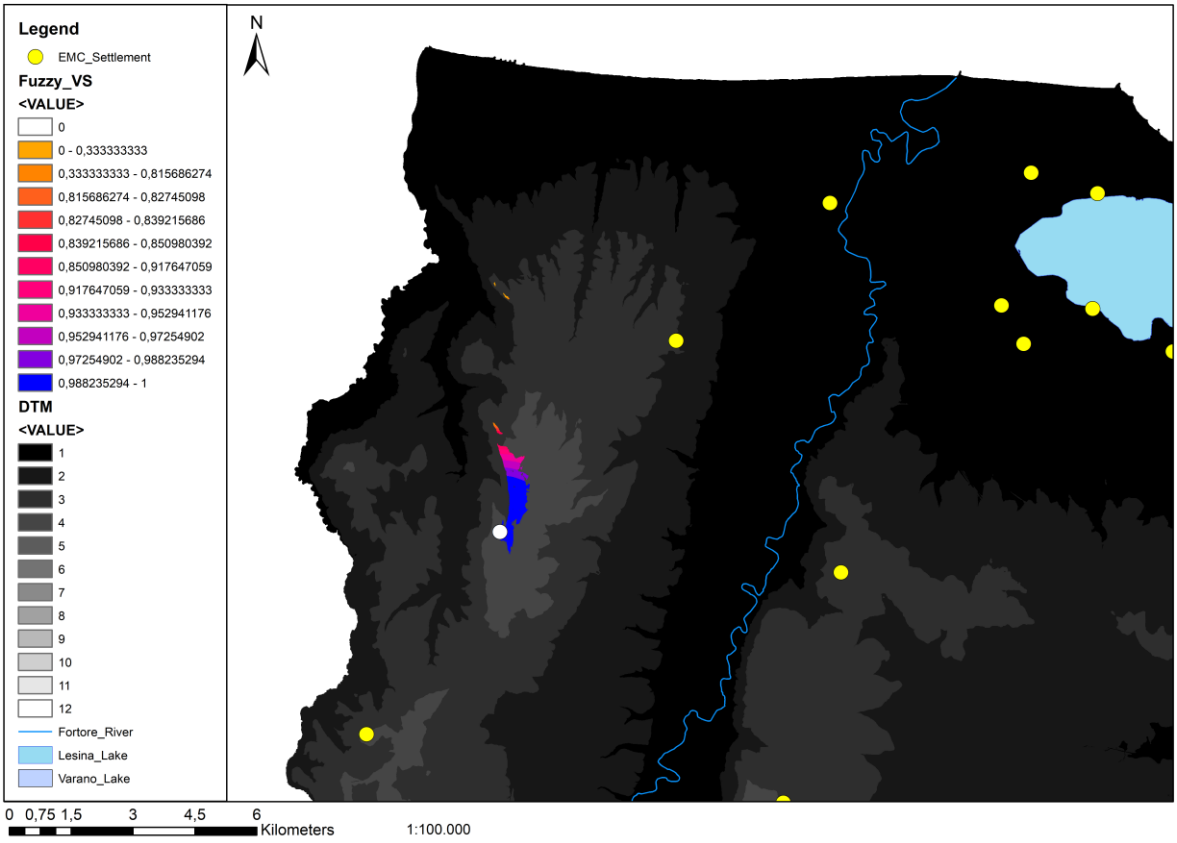


Table 235 – FVA applied to Salsolido (id16)

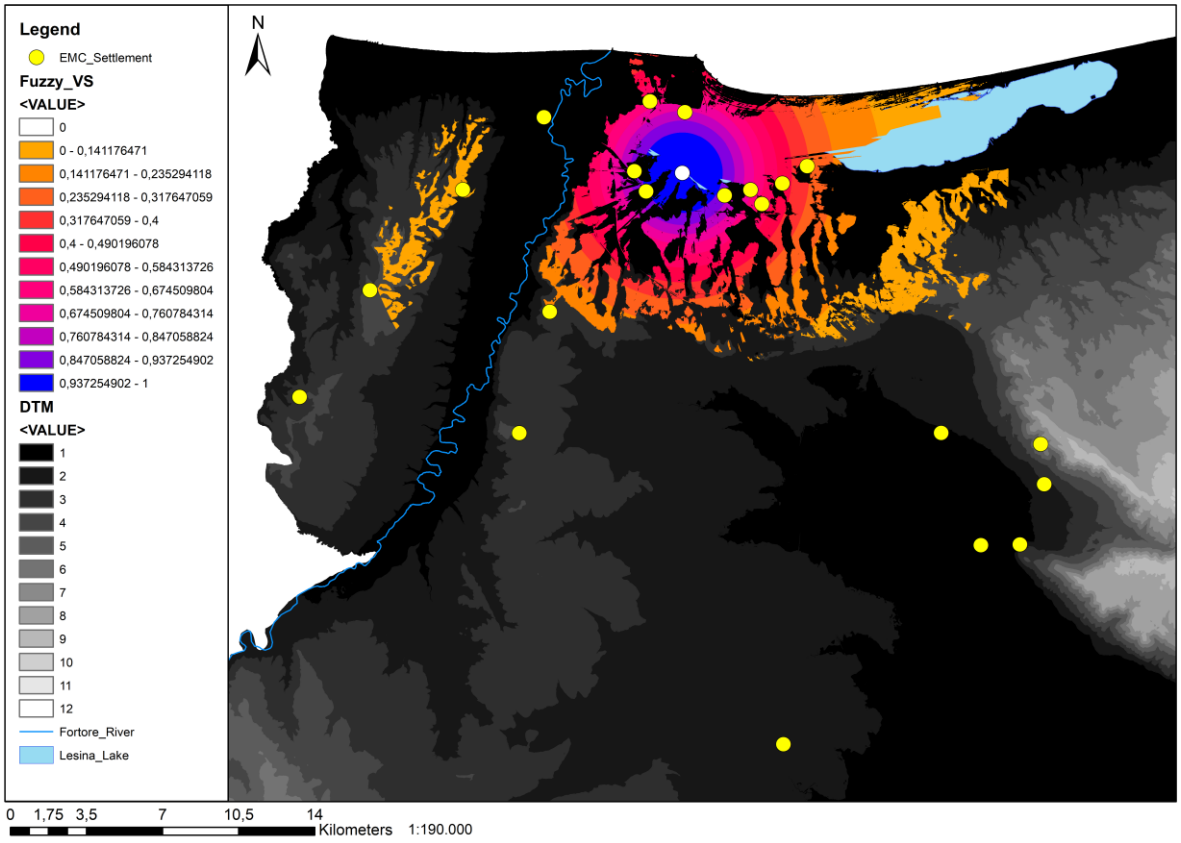


Table 236 – FVA applied to Piani di Lauria (id17)

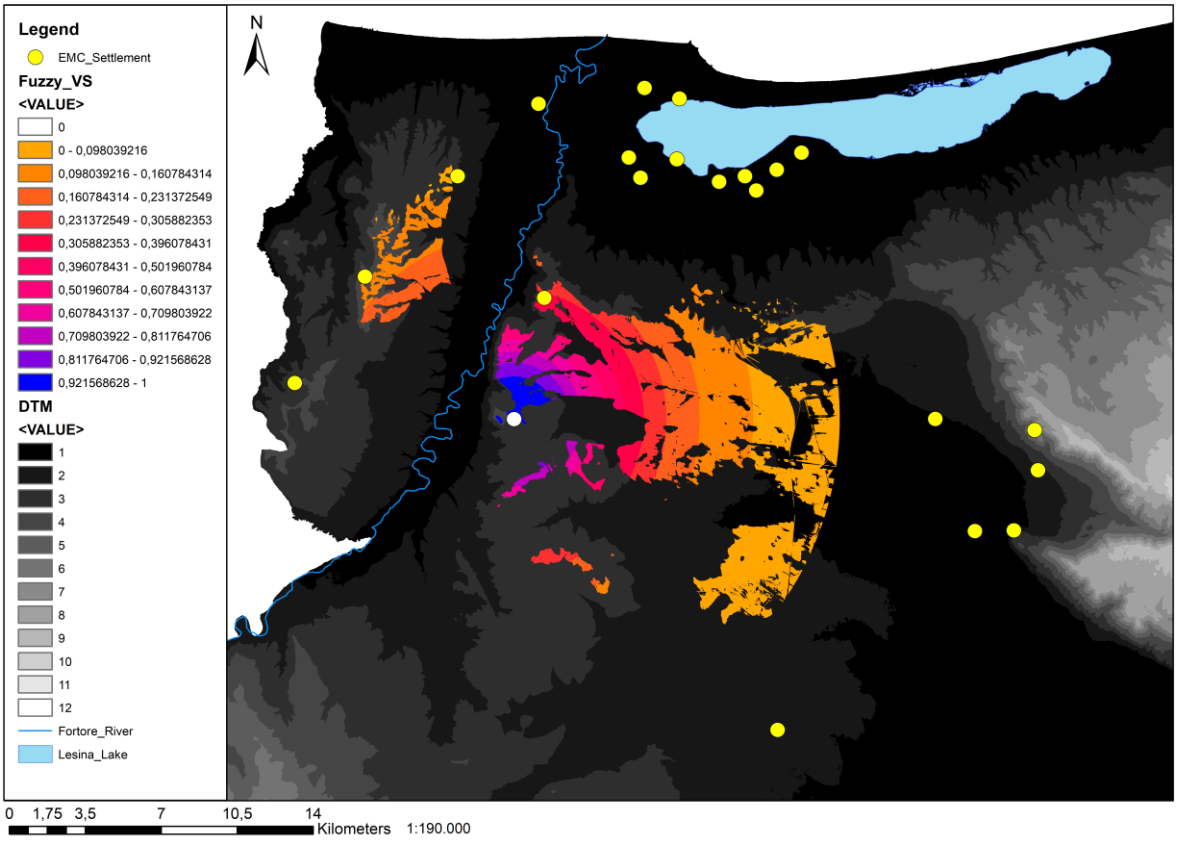


Table 237 – FVA applied to Chiarappa (id18)

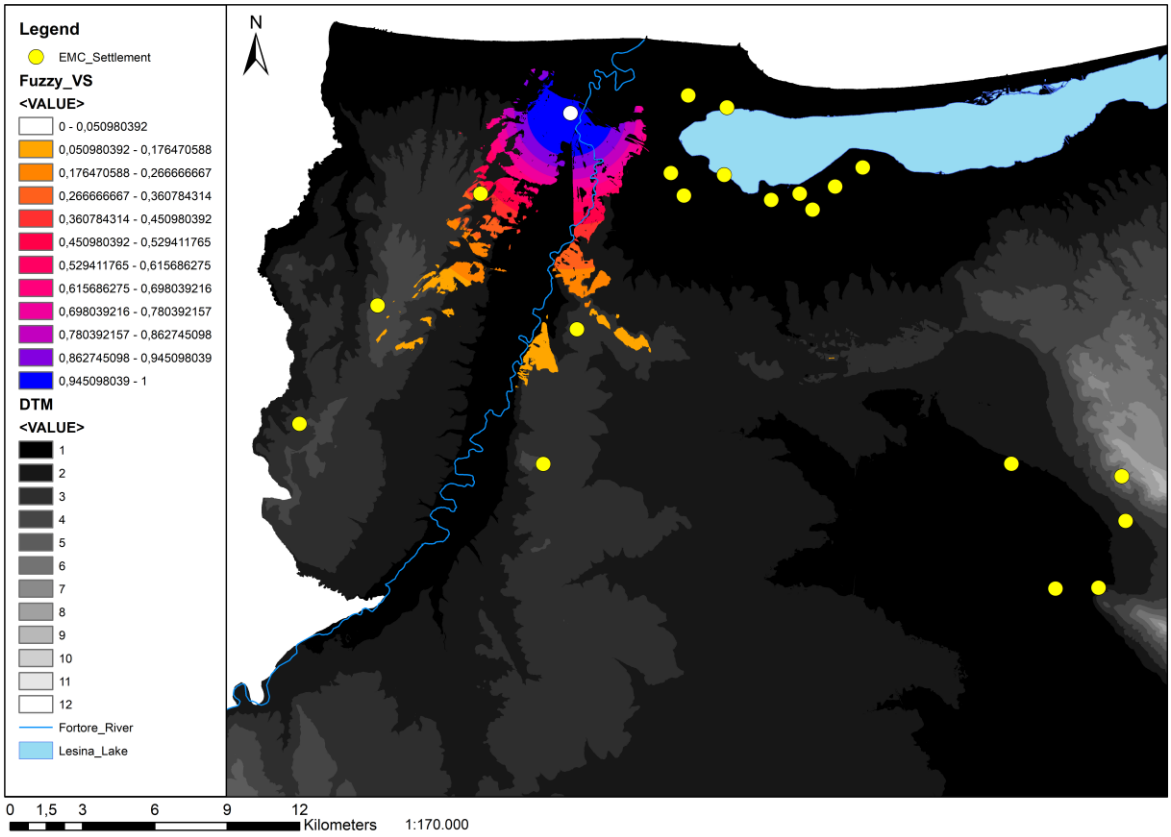


Table 238 – FVA applied to Ciccalento (id19)

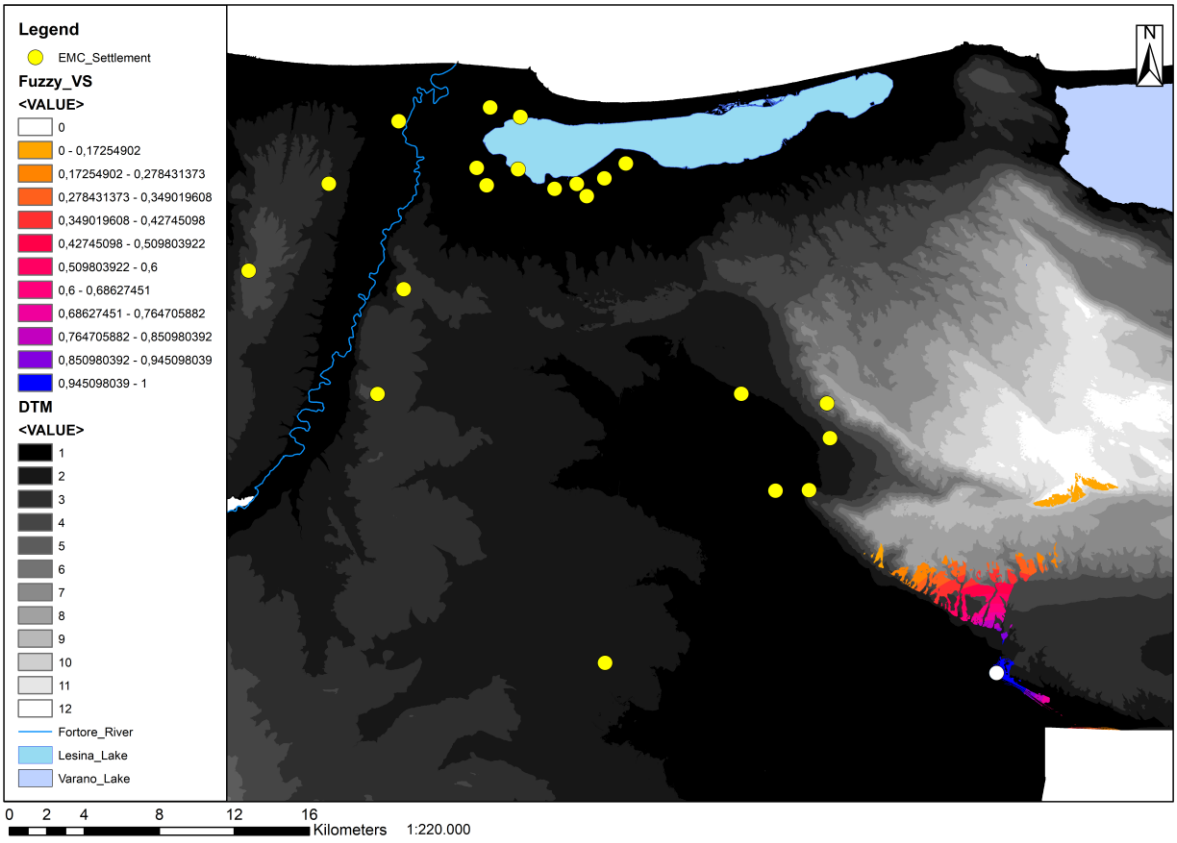


Table 239 – FVA applied to Masseria Istituto di Sangro (id20)

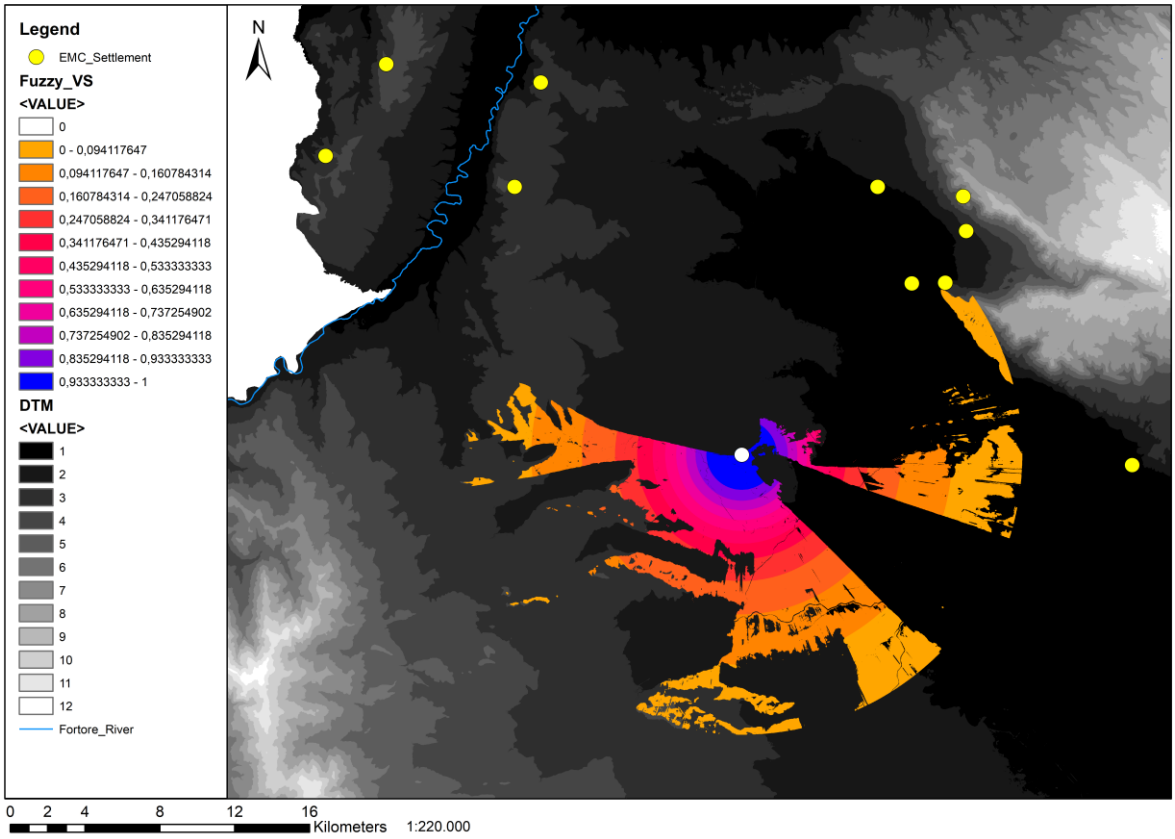


Table 240 – FVA applied to Colle Arsano (id21)

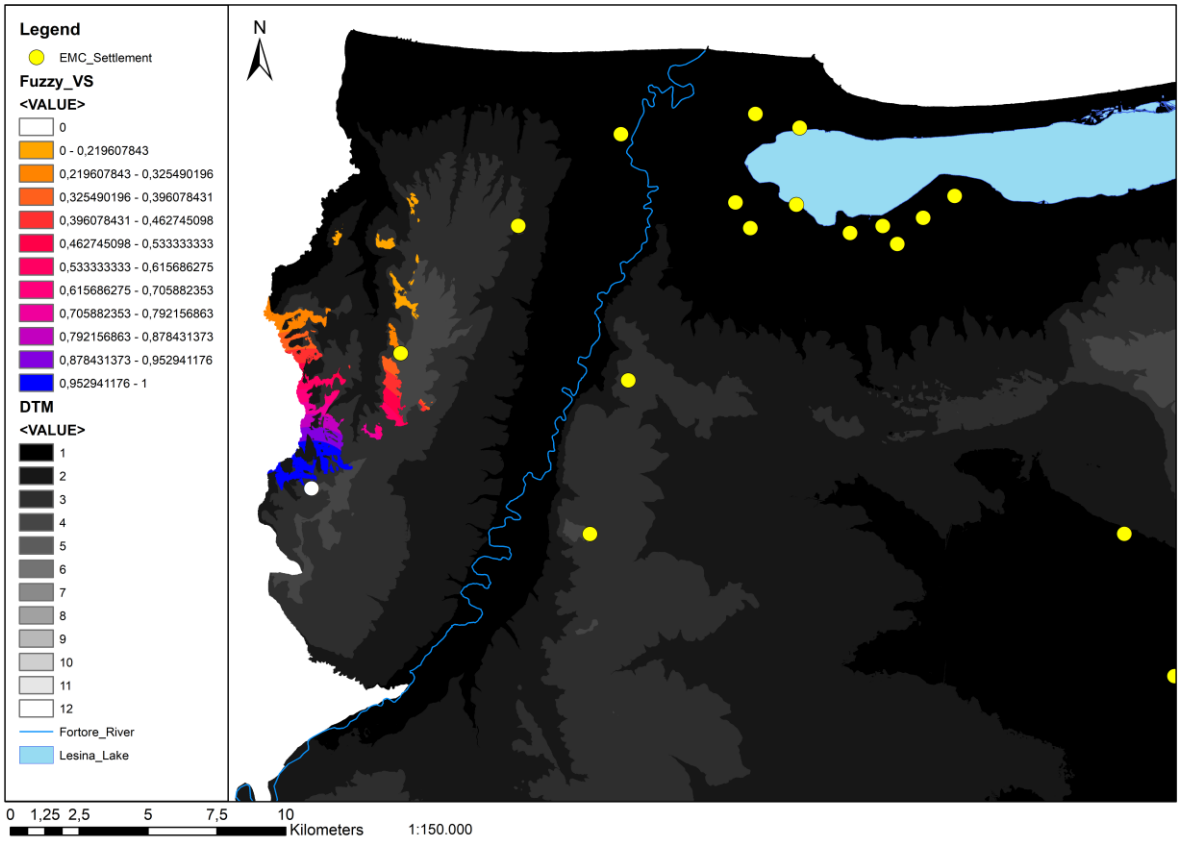


Table 241 – FVA applied to Coppe di Rose (id22)

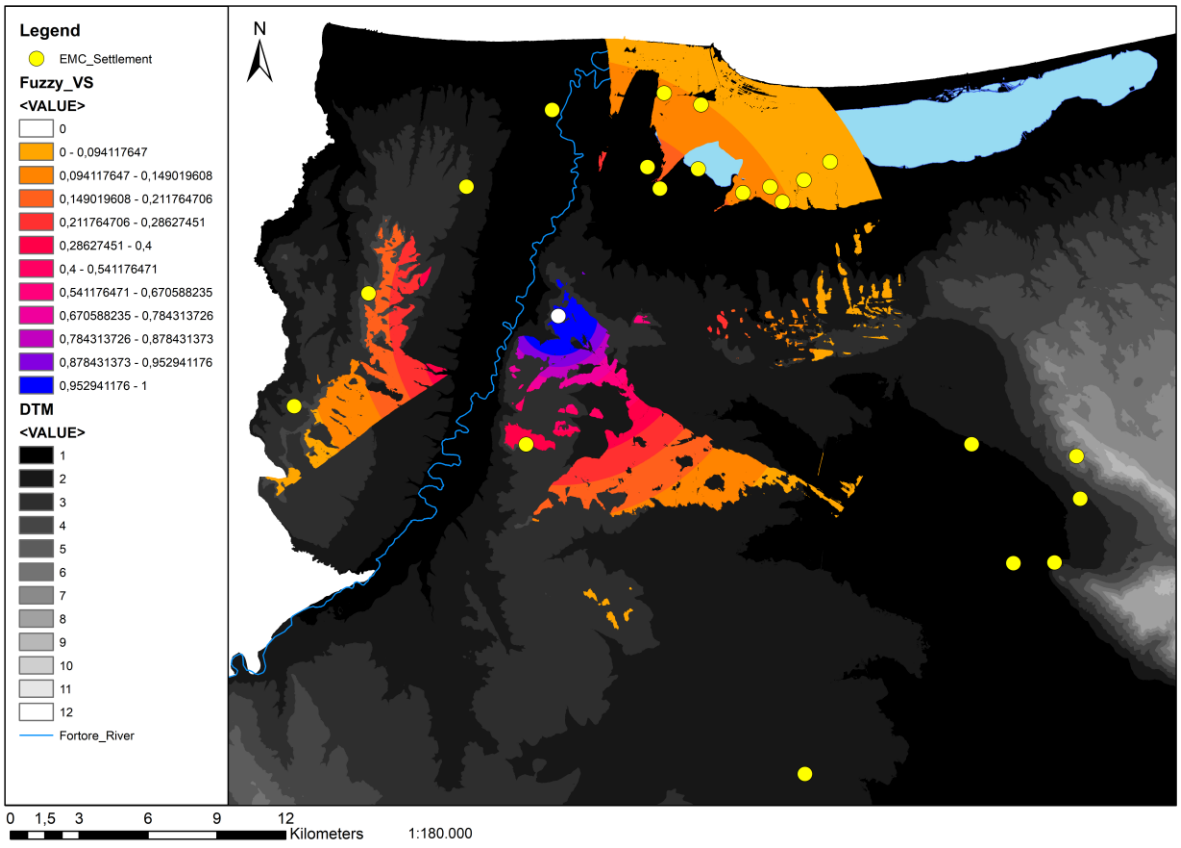
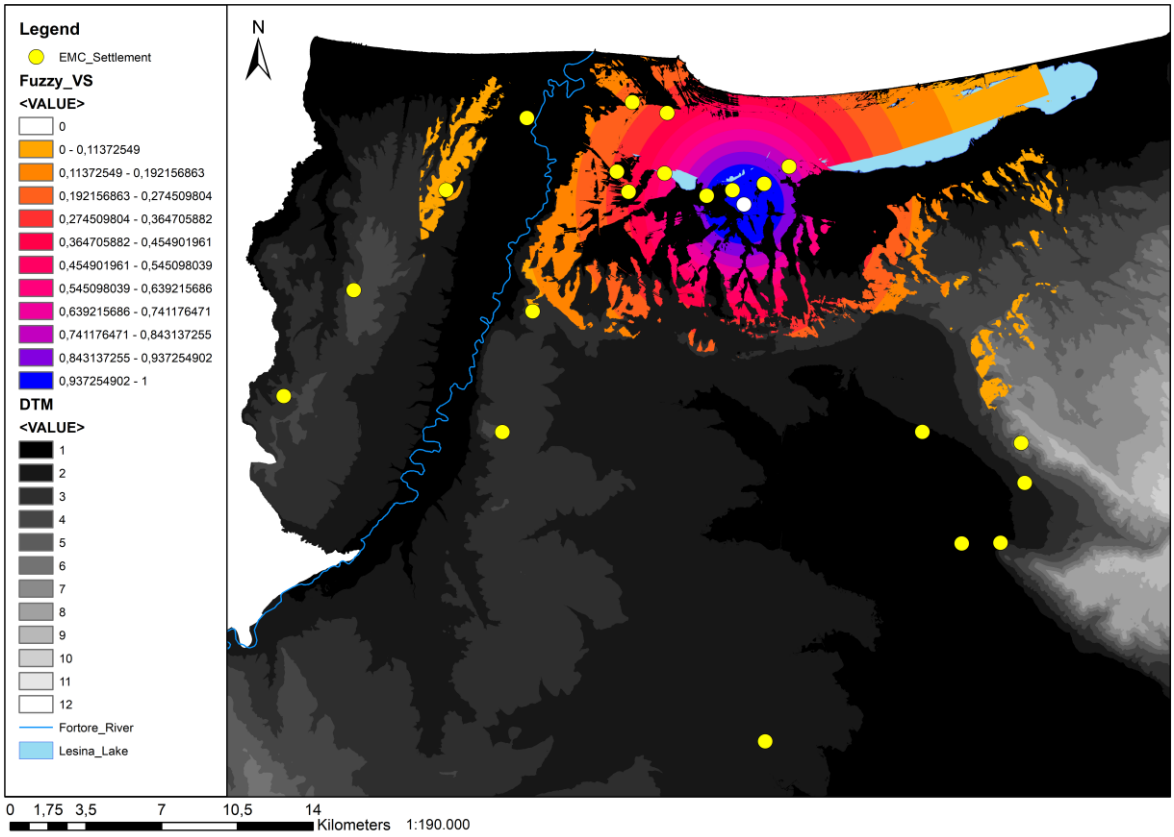


Table 242 – FVA applied to Contrada Chirò (id23)



FINAL COPPER AGE

Table 243 – FVA applied to Cammarata (id1)

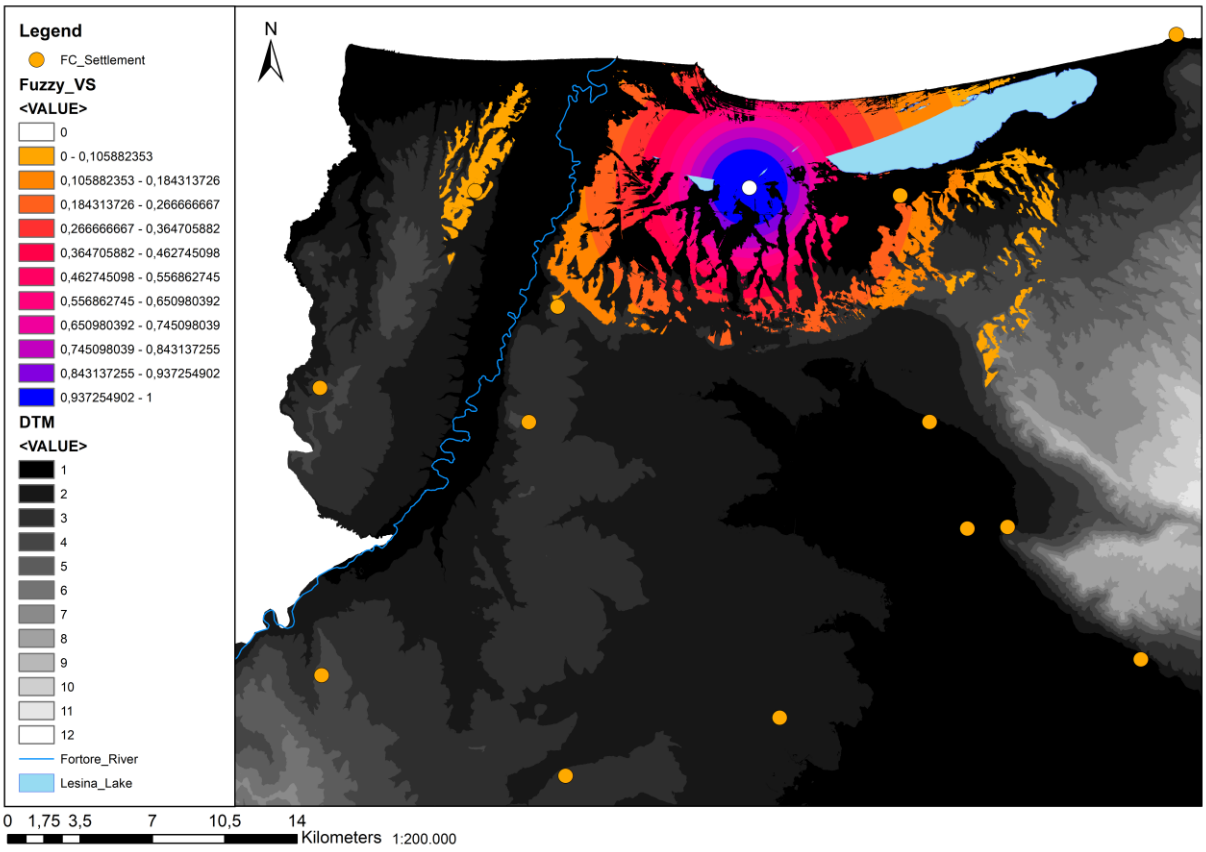


Table 244 – FVA applied to Mulino di Caldoli (id2)

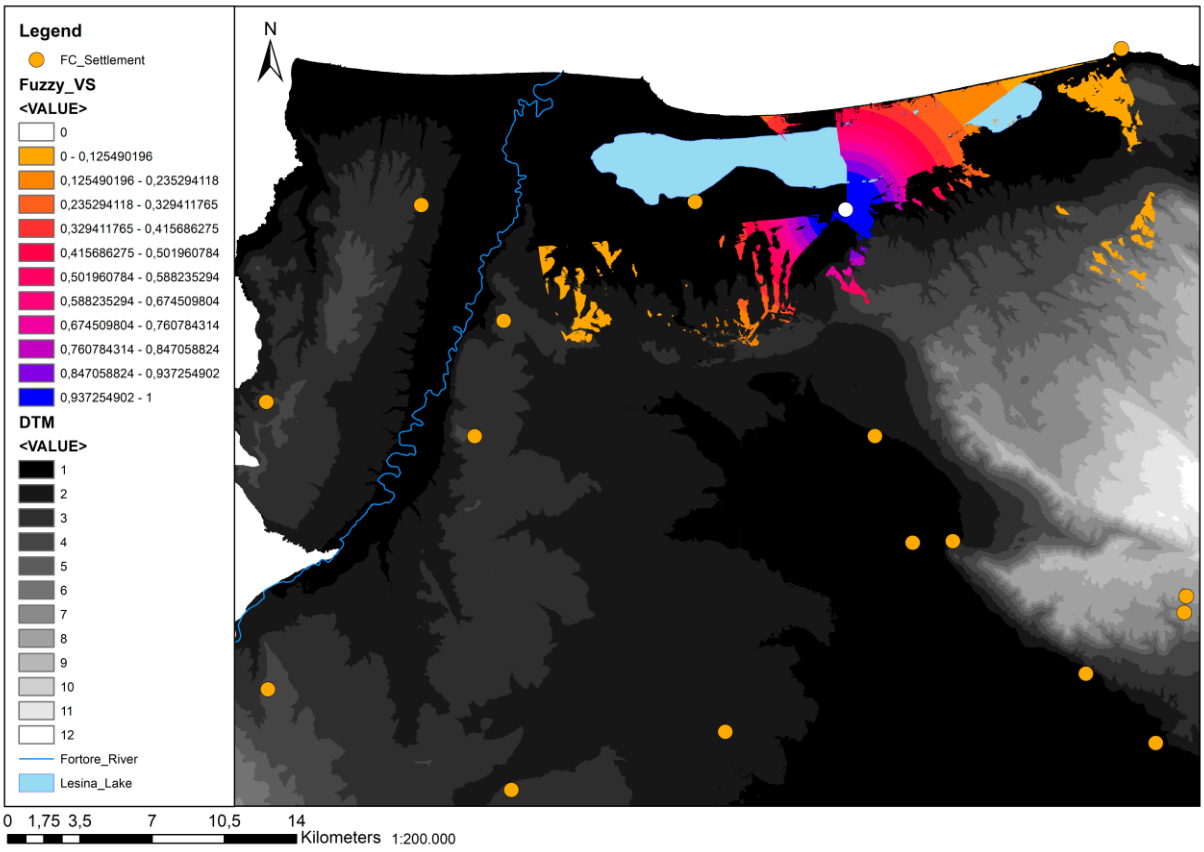


Table 245 – FVA applied to Torre Mileto (id3)

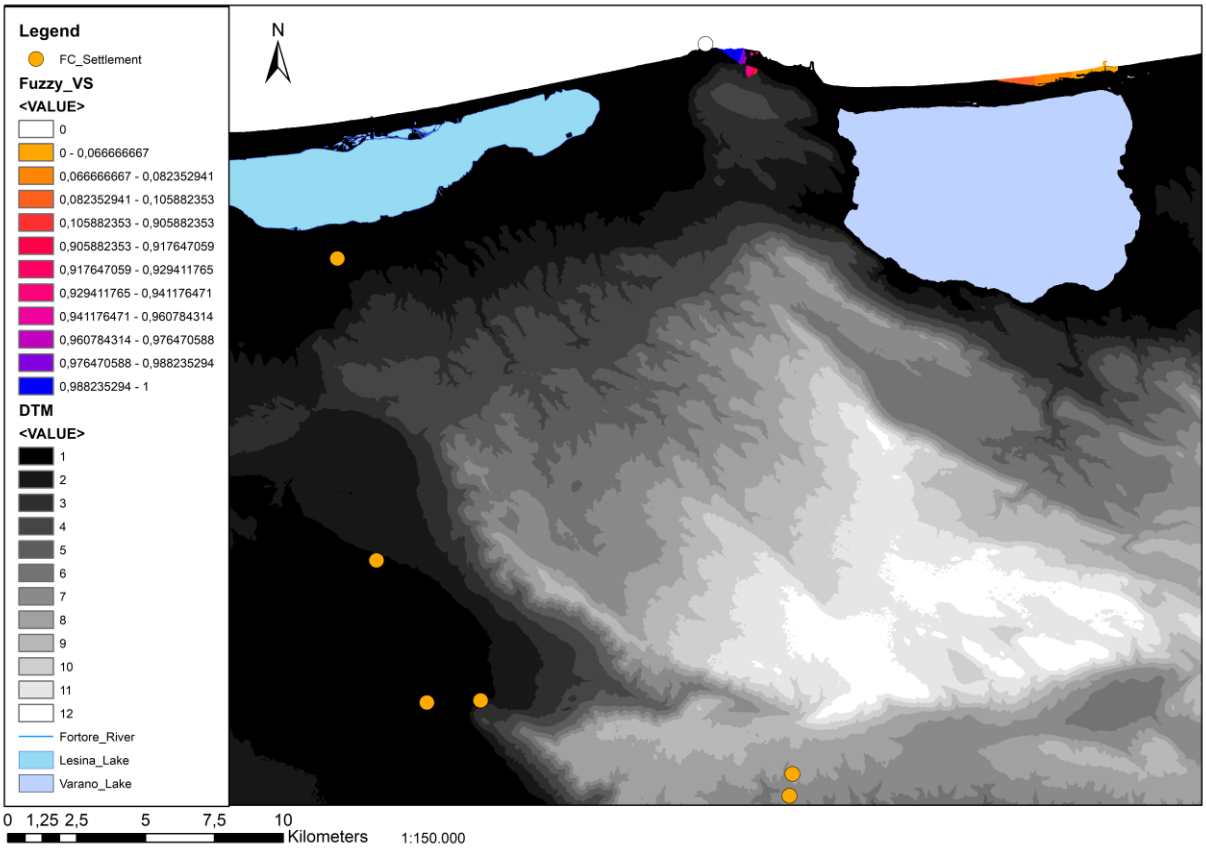


Table 246 – FVA applied to Colle Arsano (id4)

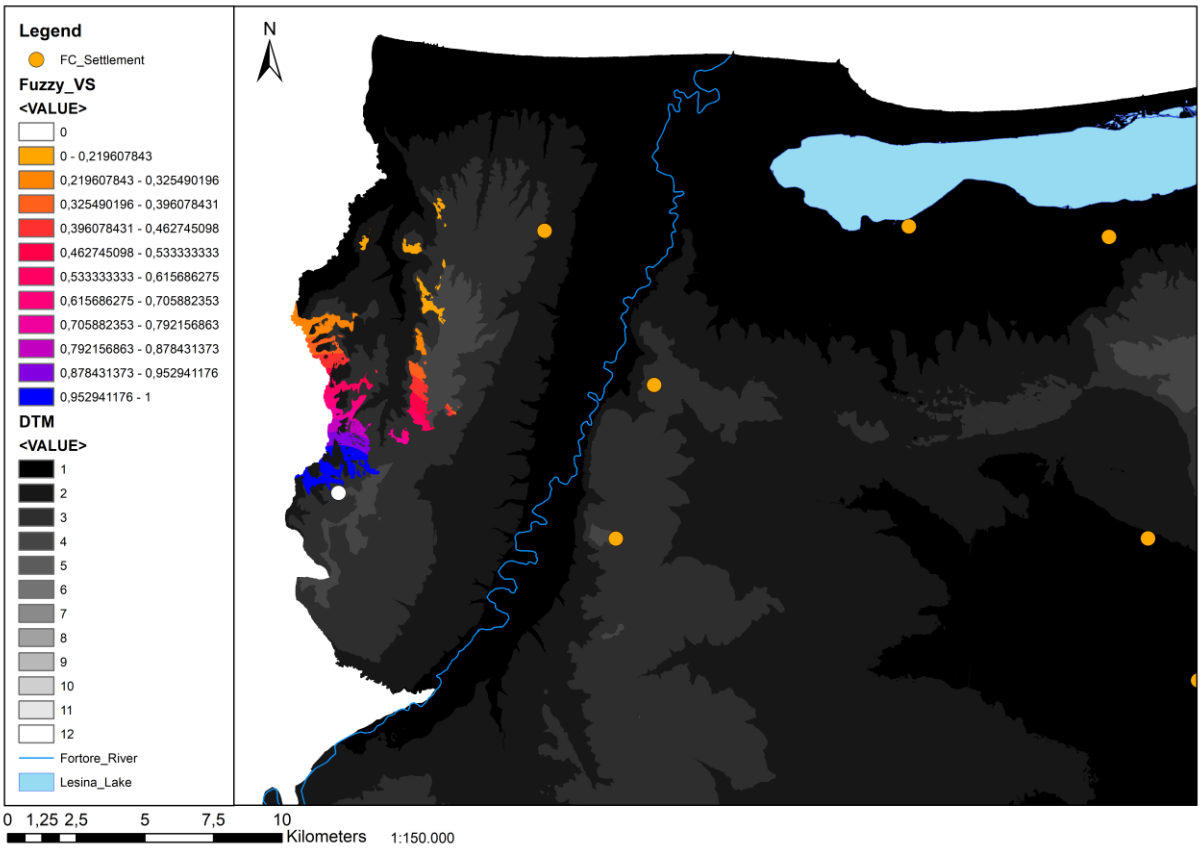


Table 247 – FVA applied to Torre Fiorentina (id5)

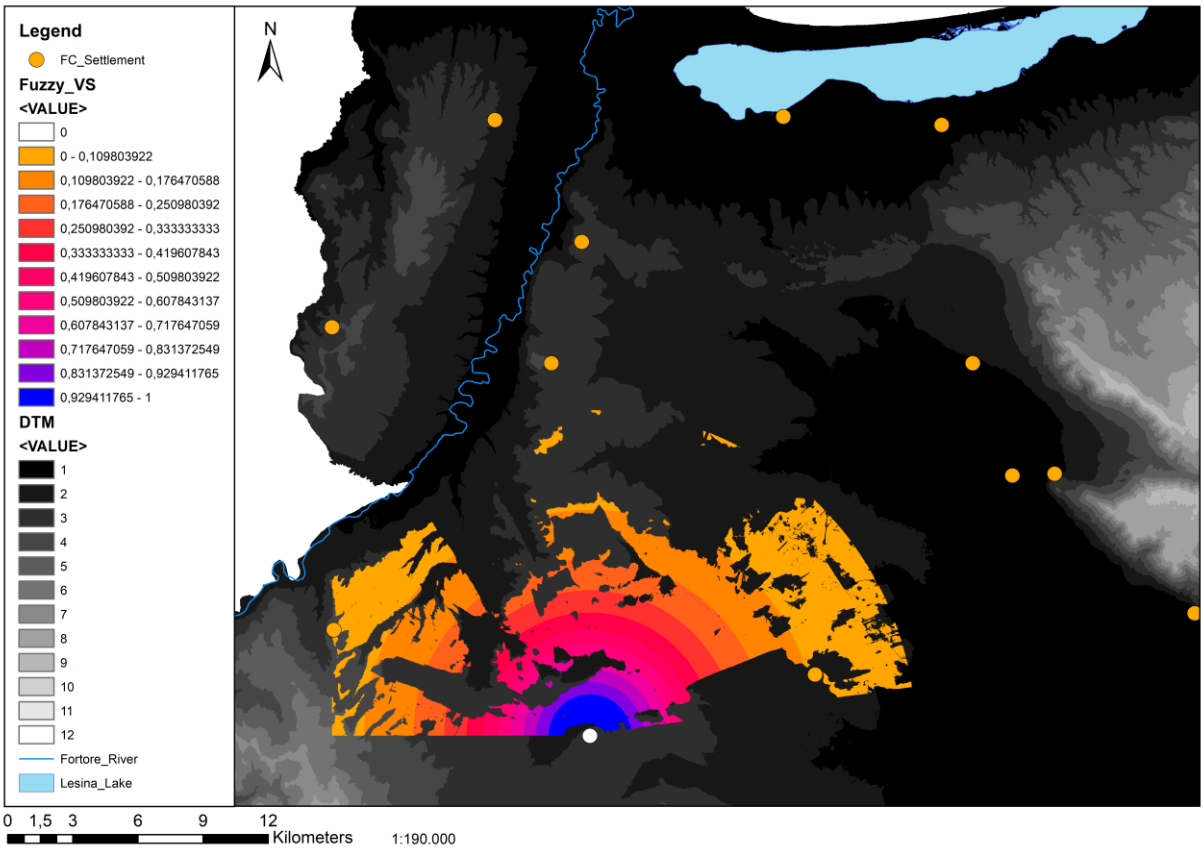


Table 248 – FVA applied to Volta Pianazza (id6)

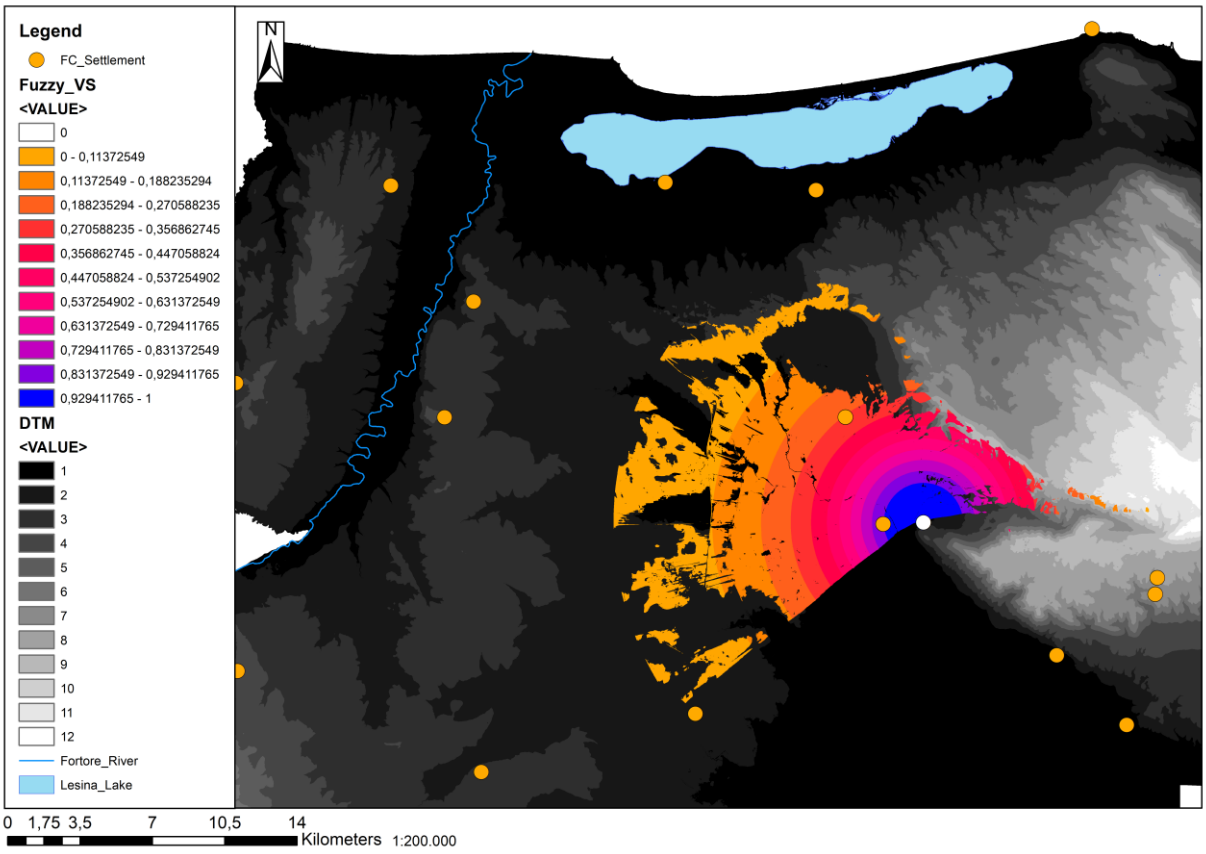


Table 249 – FVA applied to Mezzanella di Brancia (id7)

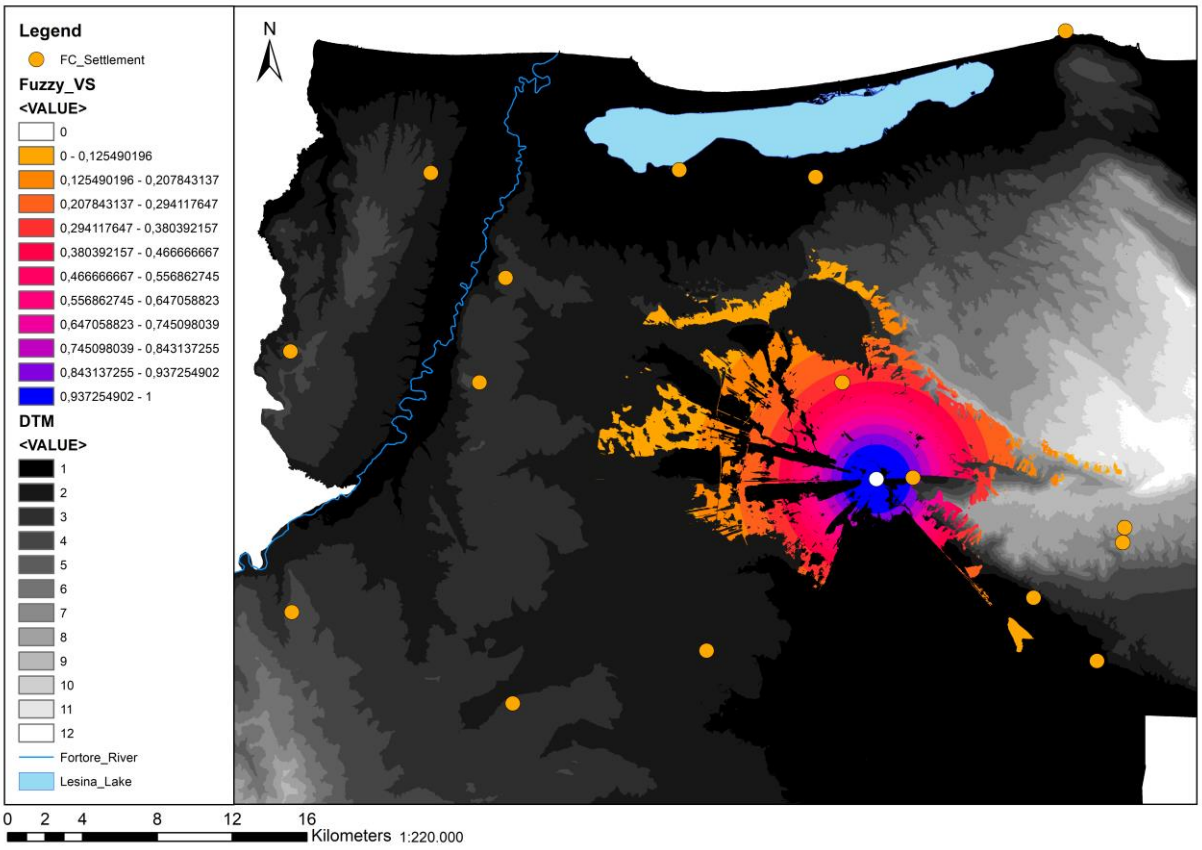


Table 250 – FVA applied to Casale Crisetti (id8)

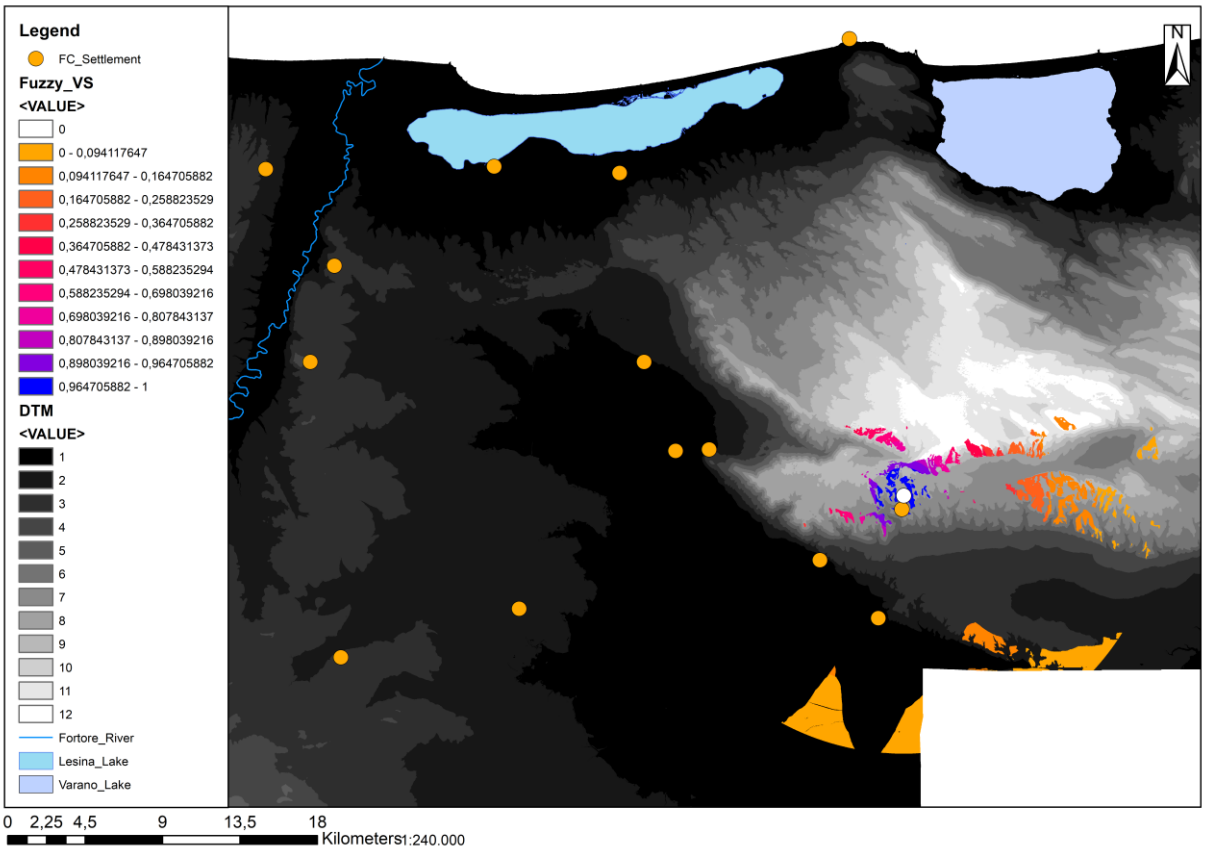


Table 251 – FVA applied to Colle di Creta-San Matteo Chiantinelle (id9)

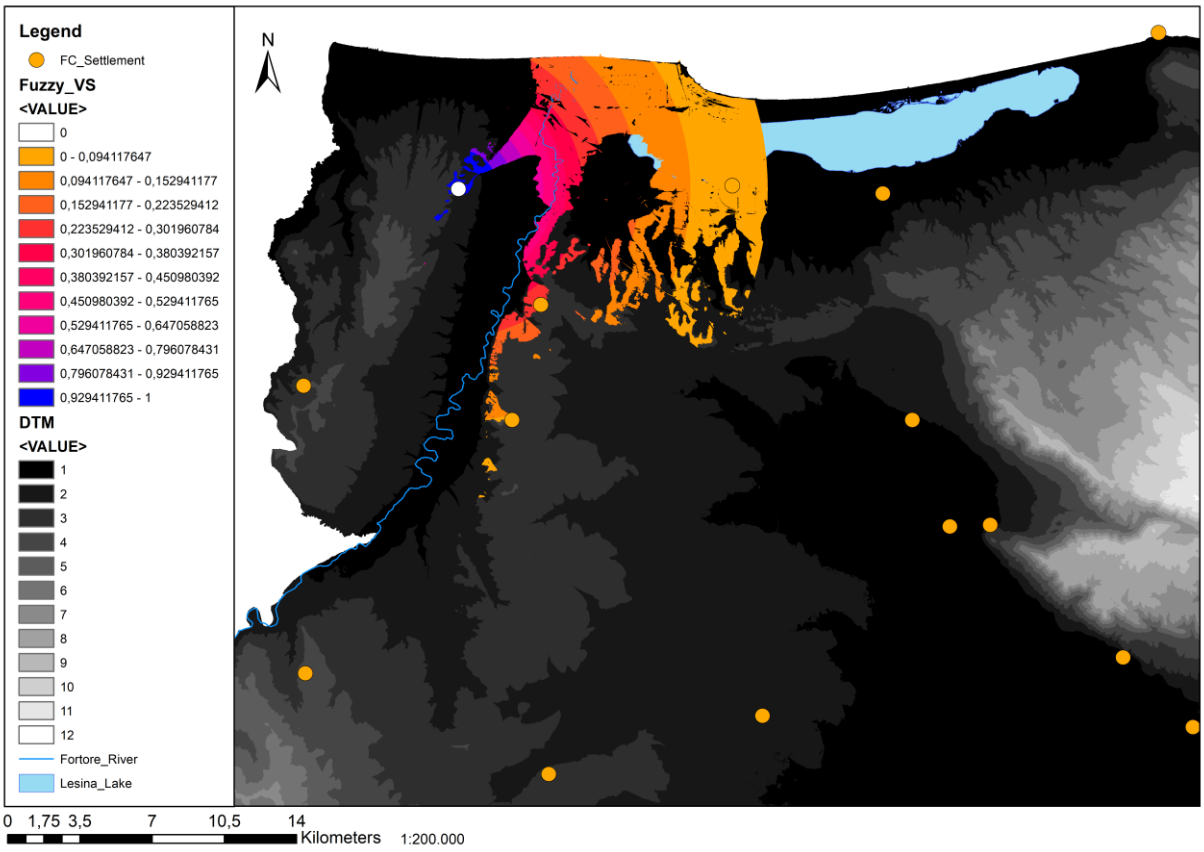


Table 252 – FVA applied to Piani di Lauria (id10)

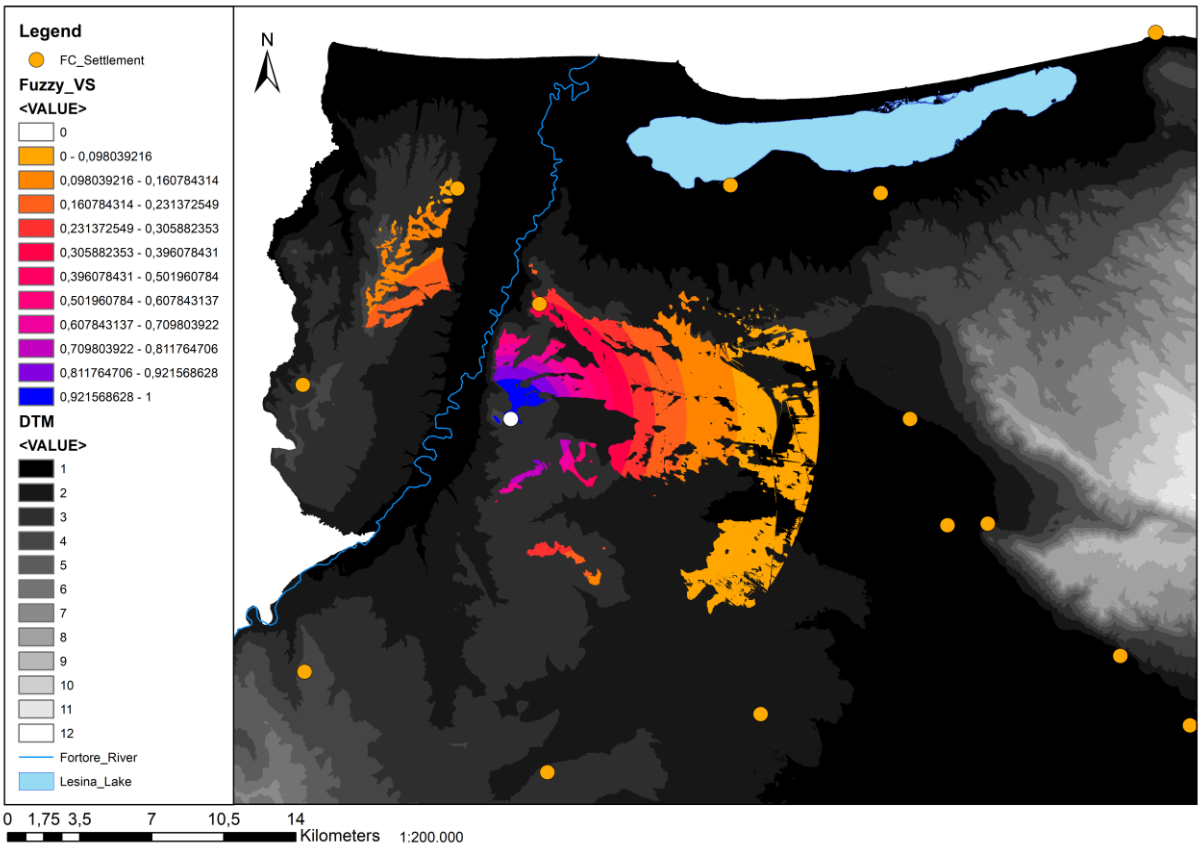


Table 253 – FVA applied to Masseria Istitito di Sangro (id11)

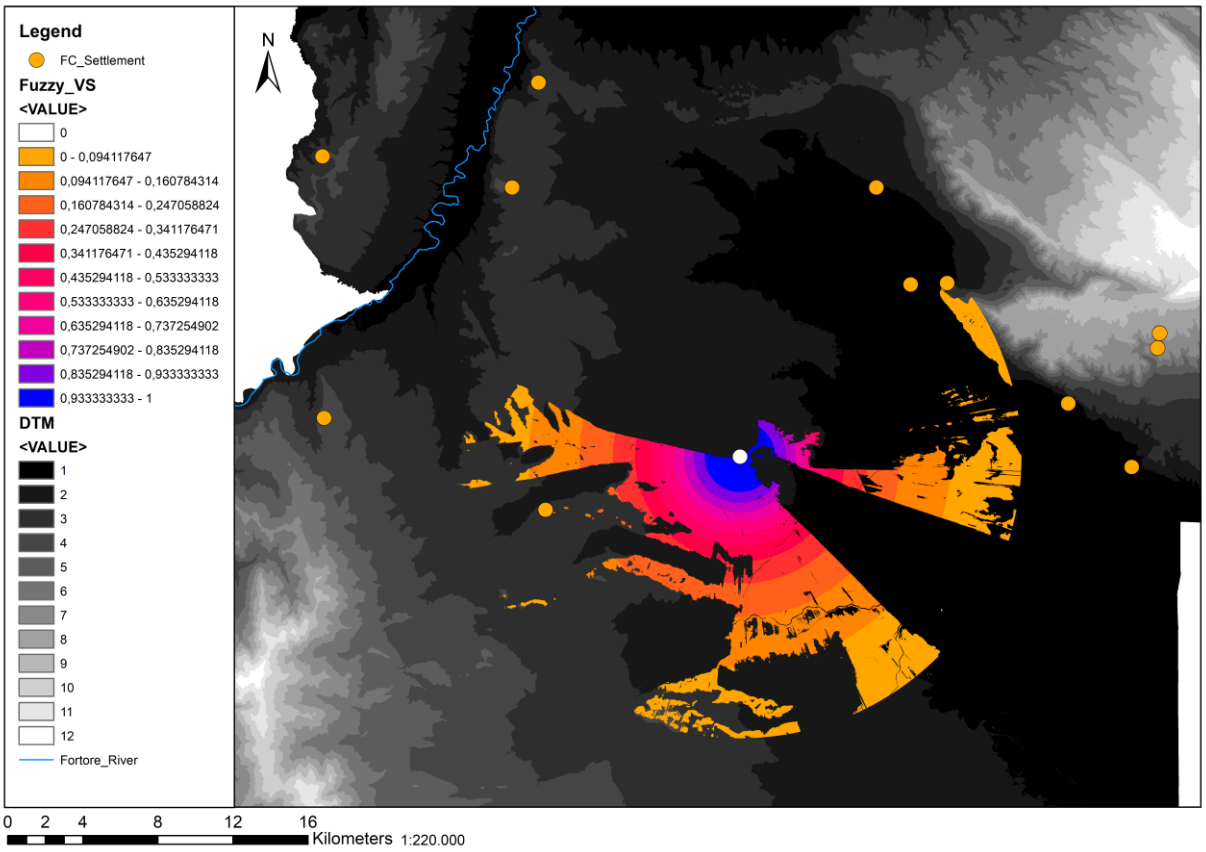


Table 254 – FVA applied to Coppe di Rose (id12)

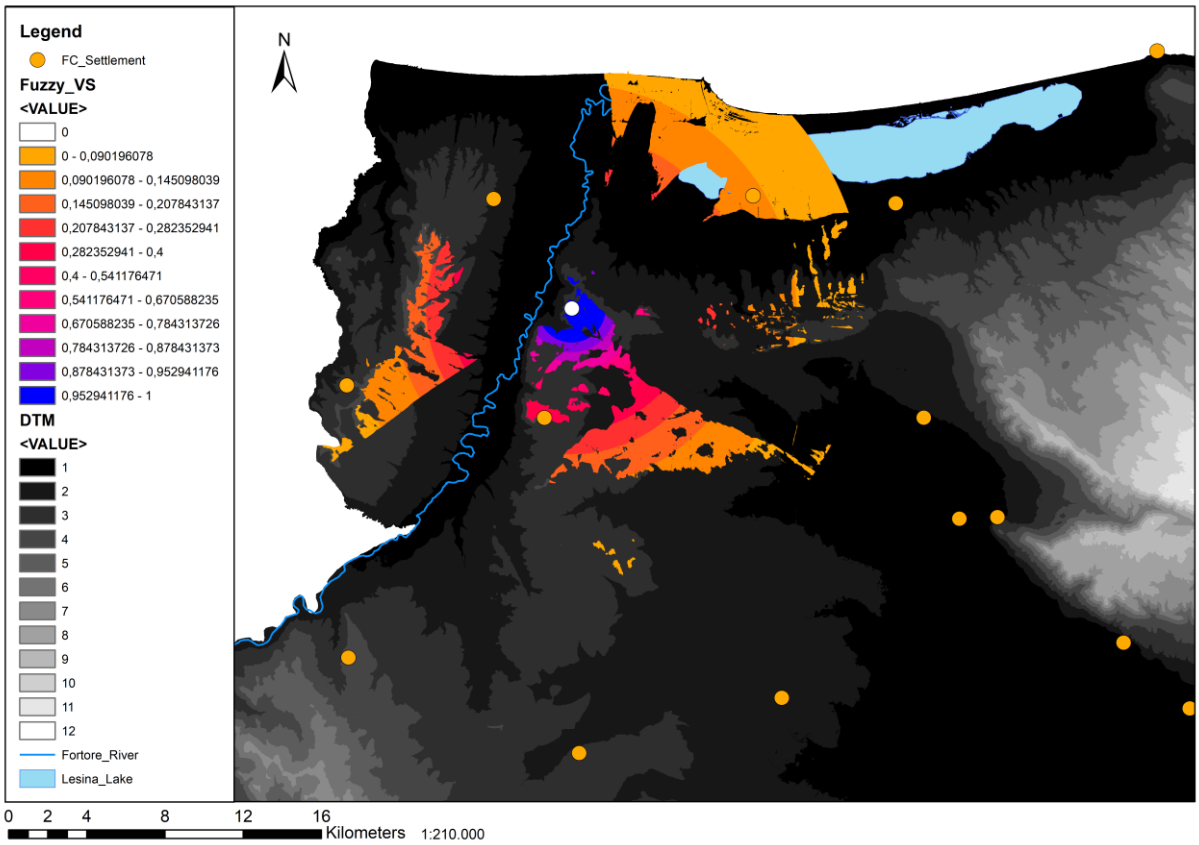


Table 255 – FVA applied to Chiancata La Civita (id13)

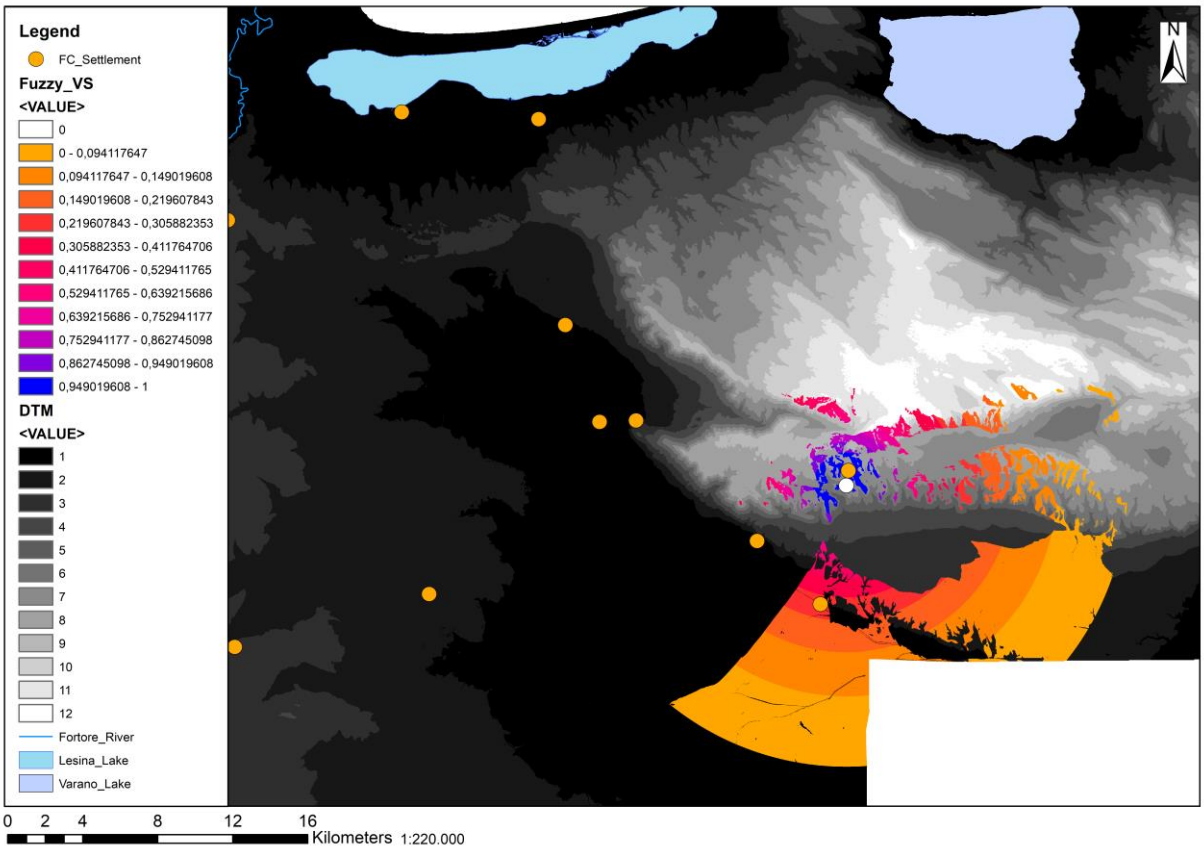


Table 256 – FVA applied to Cicerale (id14)

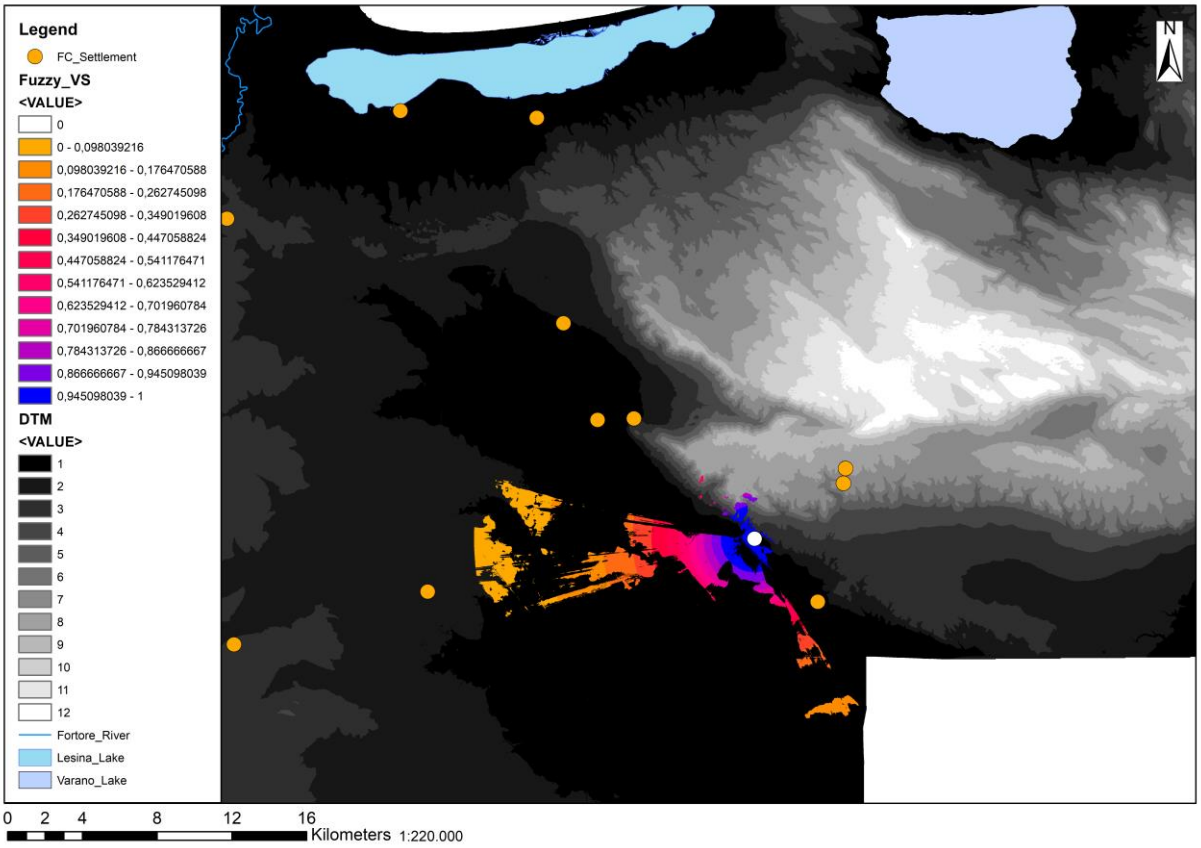


Table 257 – FVA applied to Colle d'Armi (id15)

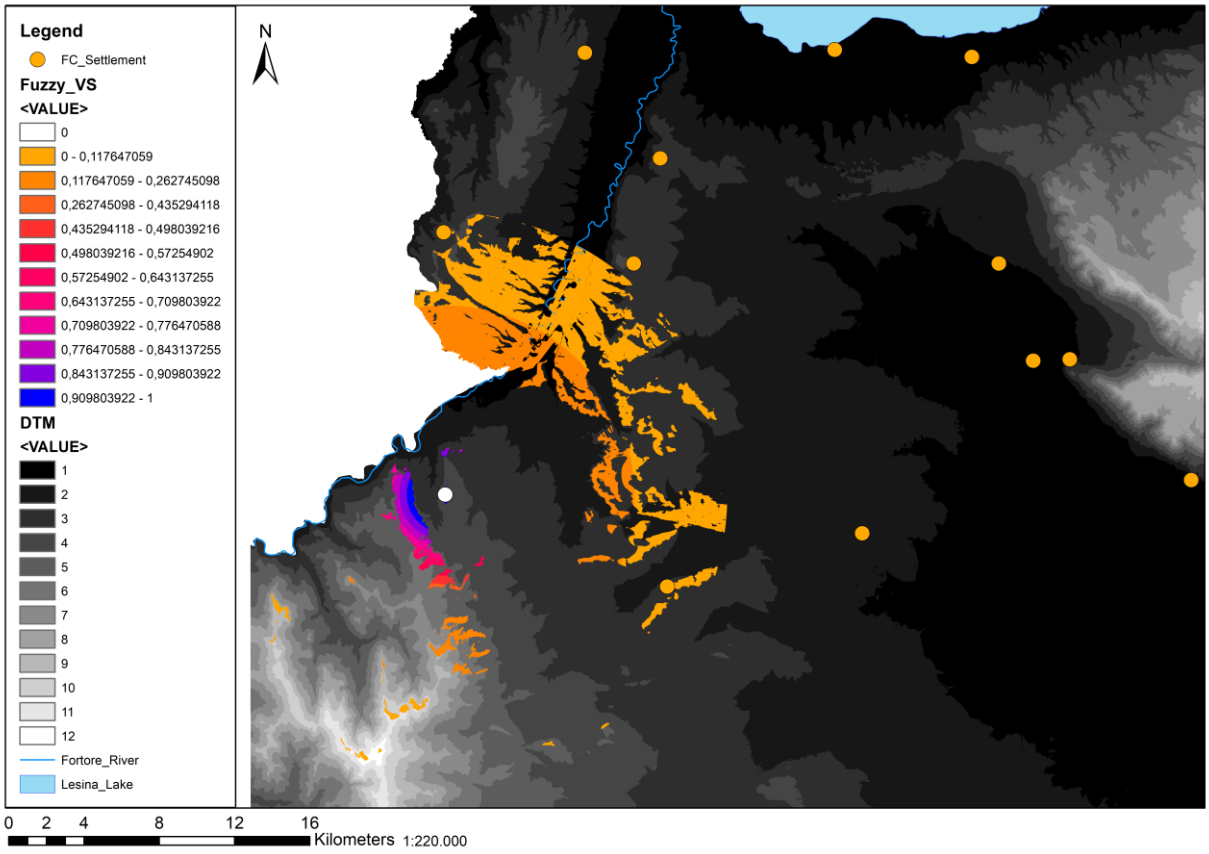


Table 258 – FVA applied to Mezzana della Quercia (id16)

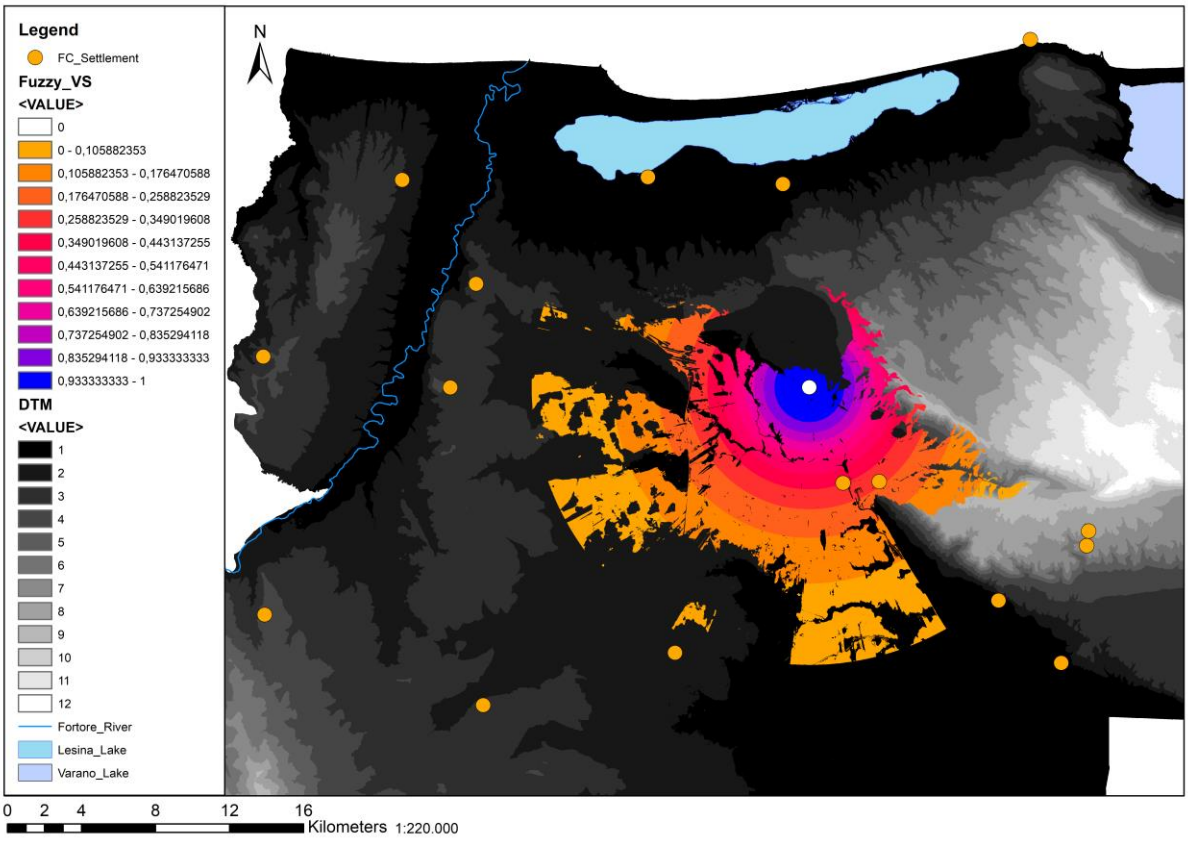
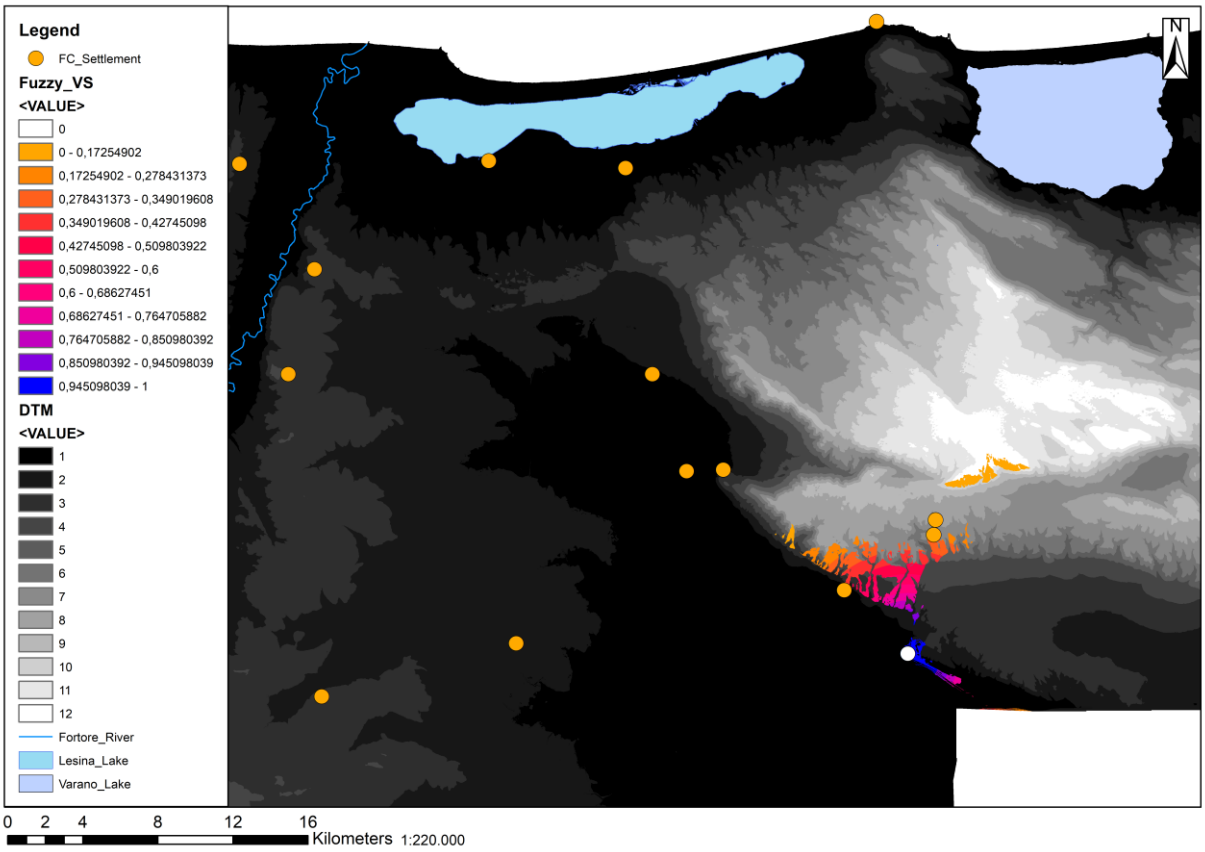


Table 259 – FVA applied to Ciccalento (id17)



EARLY BRONZE AGE

Table 260 – FVA applied to Colle di Creta (id1)

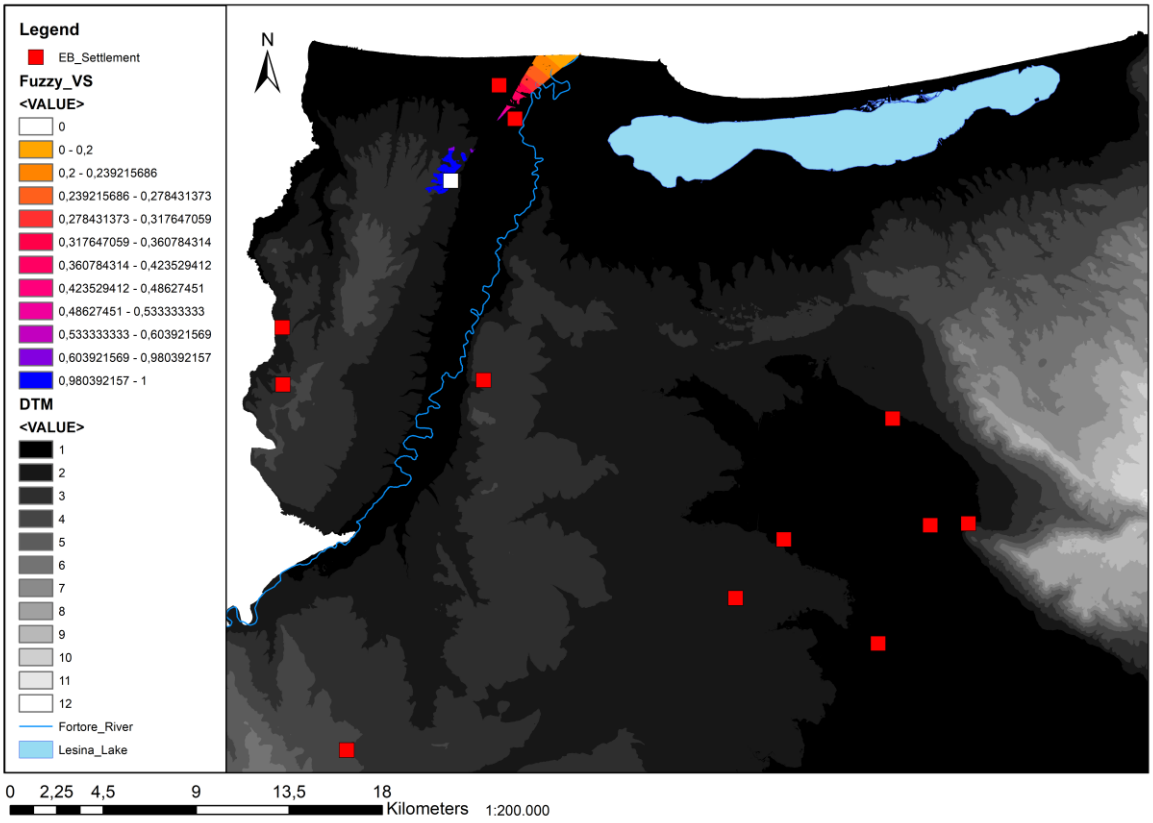


Table 261 – FVA applied to Località Guadone (id2)

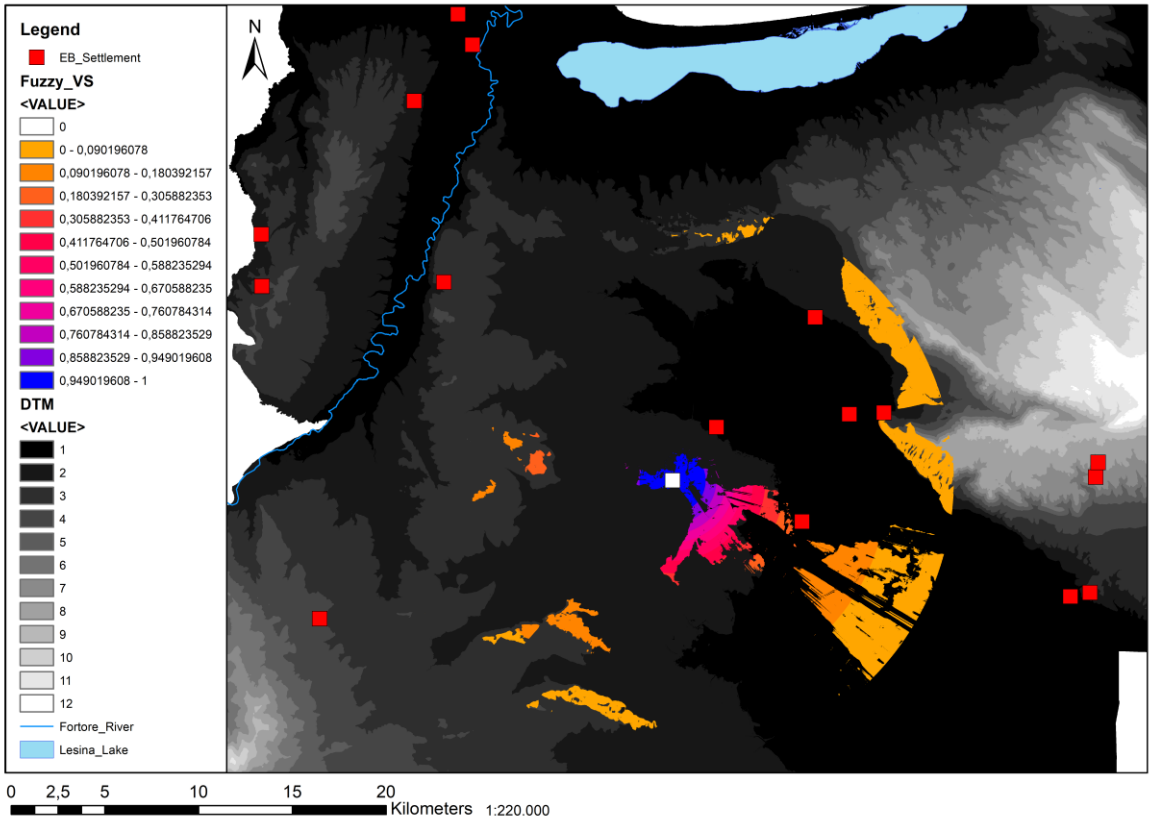


Table 262 – FVA applied to Monte Granata (id3)

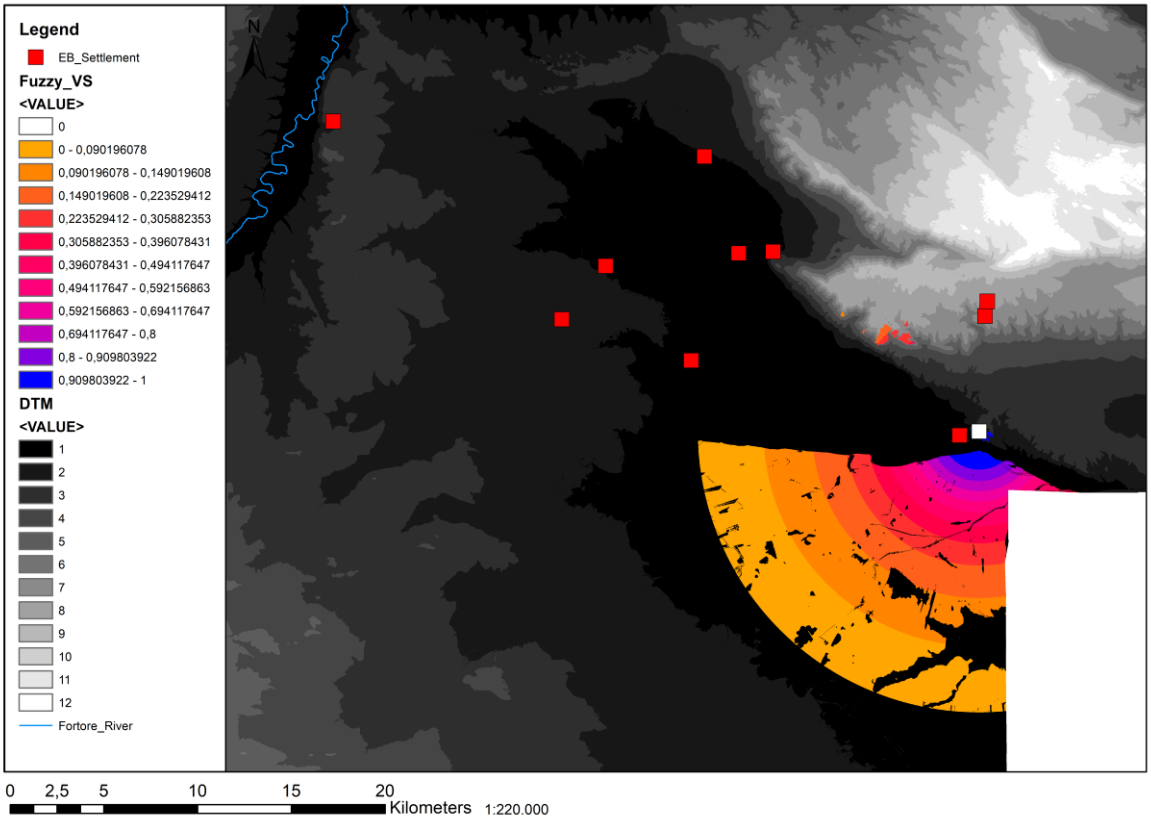


Table 263 – FVA applied to Chiancata La Civita (id4)

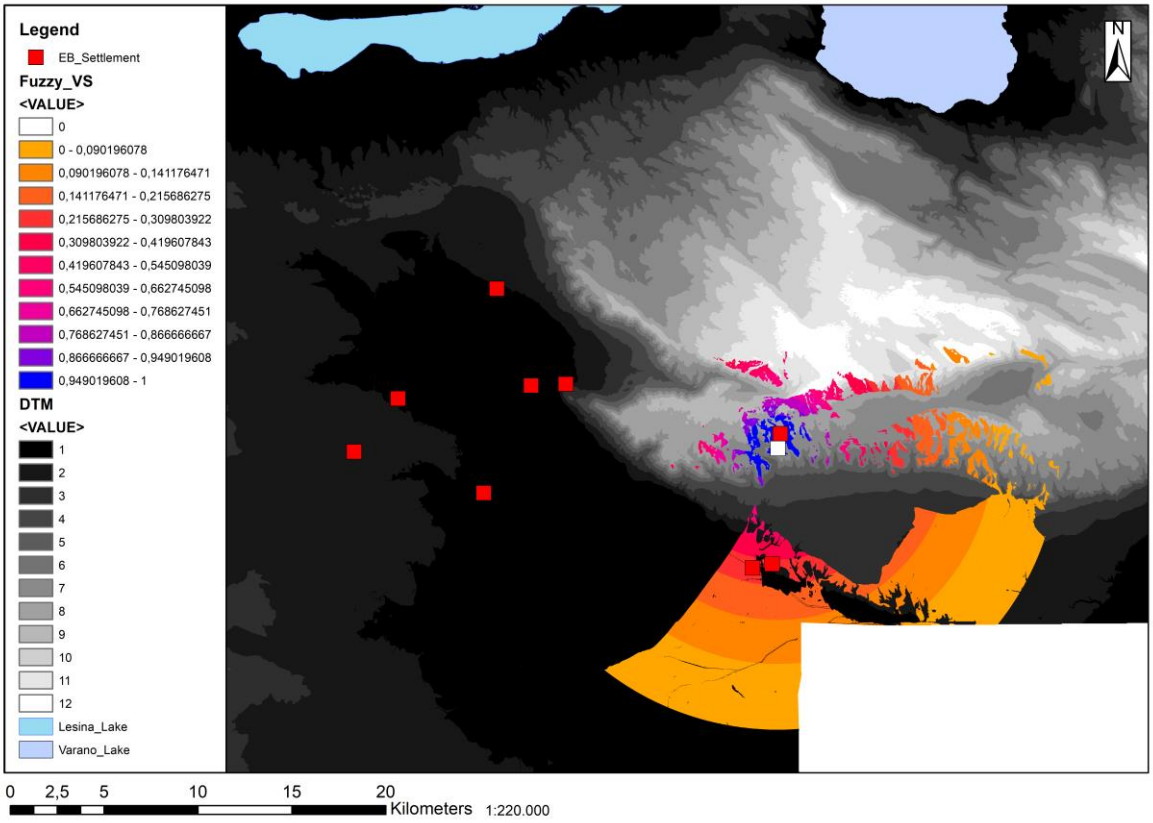


Table 264 – FVA applied to Cantalupo-Tre Ponti (id5)

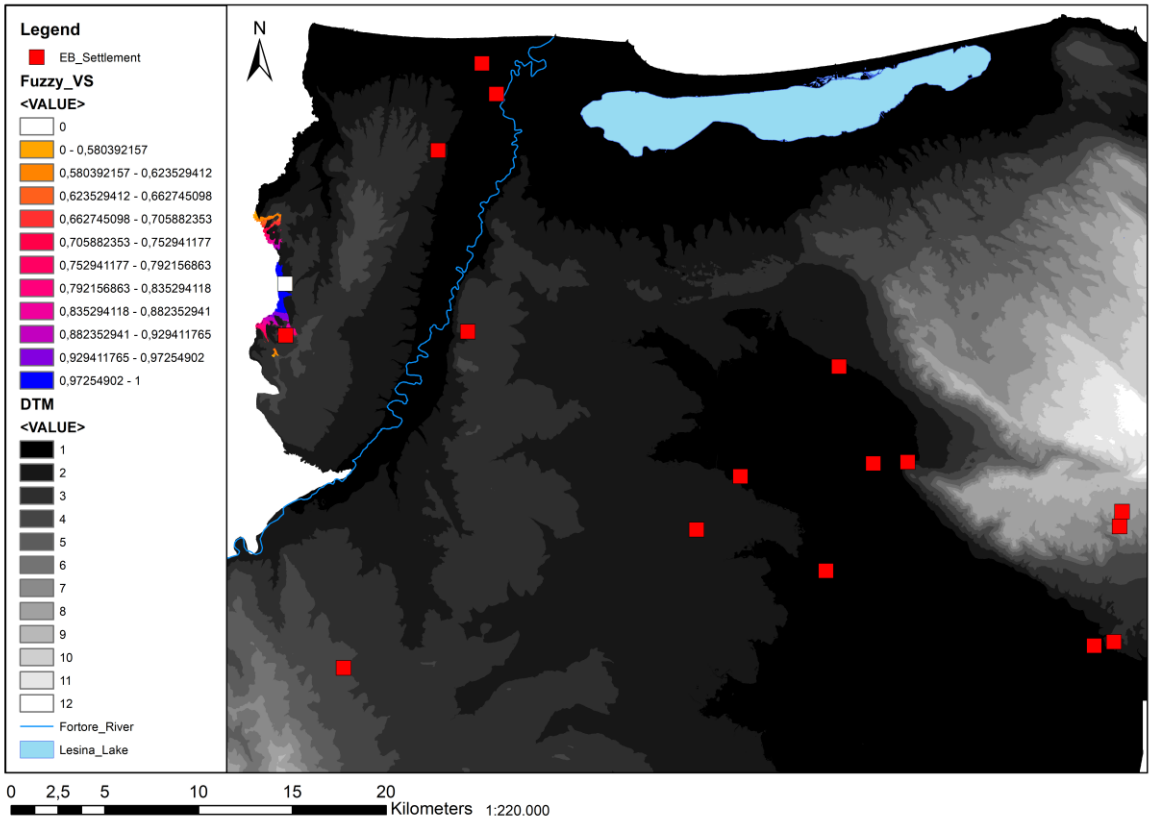


Table 265 – FVA applied to Masseria Iacovelli (id6)

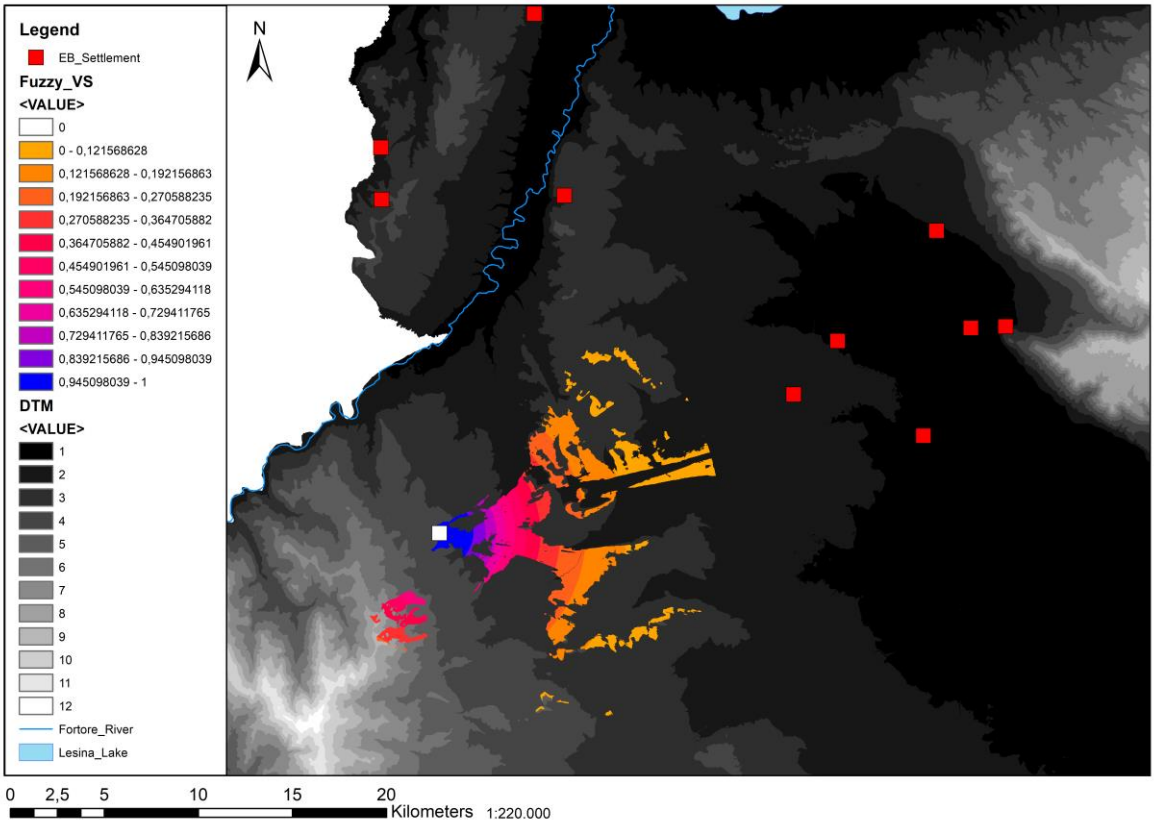


Table 266 – FVA applied to Colle Arsano (id7)

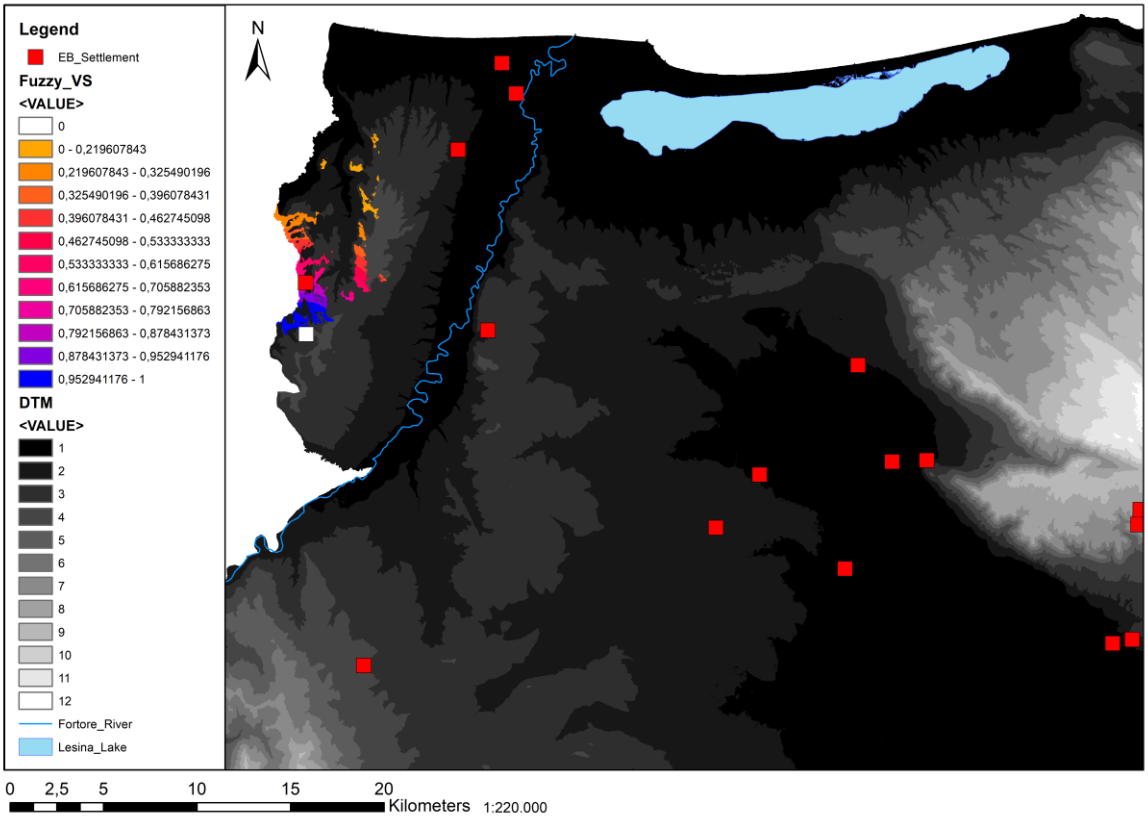


Table 267 – FVA applied to Piani di Lauria (id8)

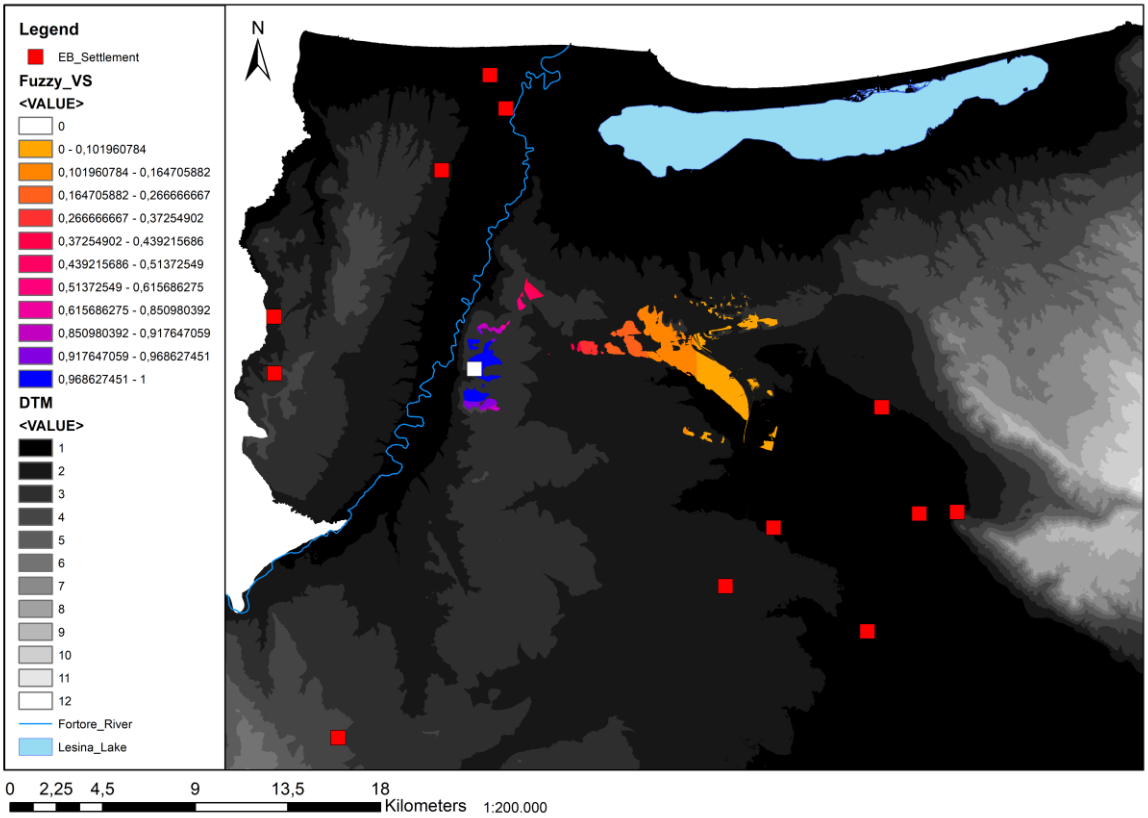


Table 268 – FVA applied to Chiarappa (id9)

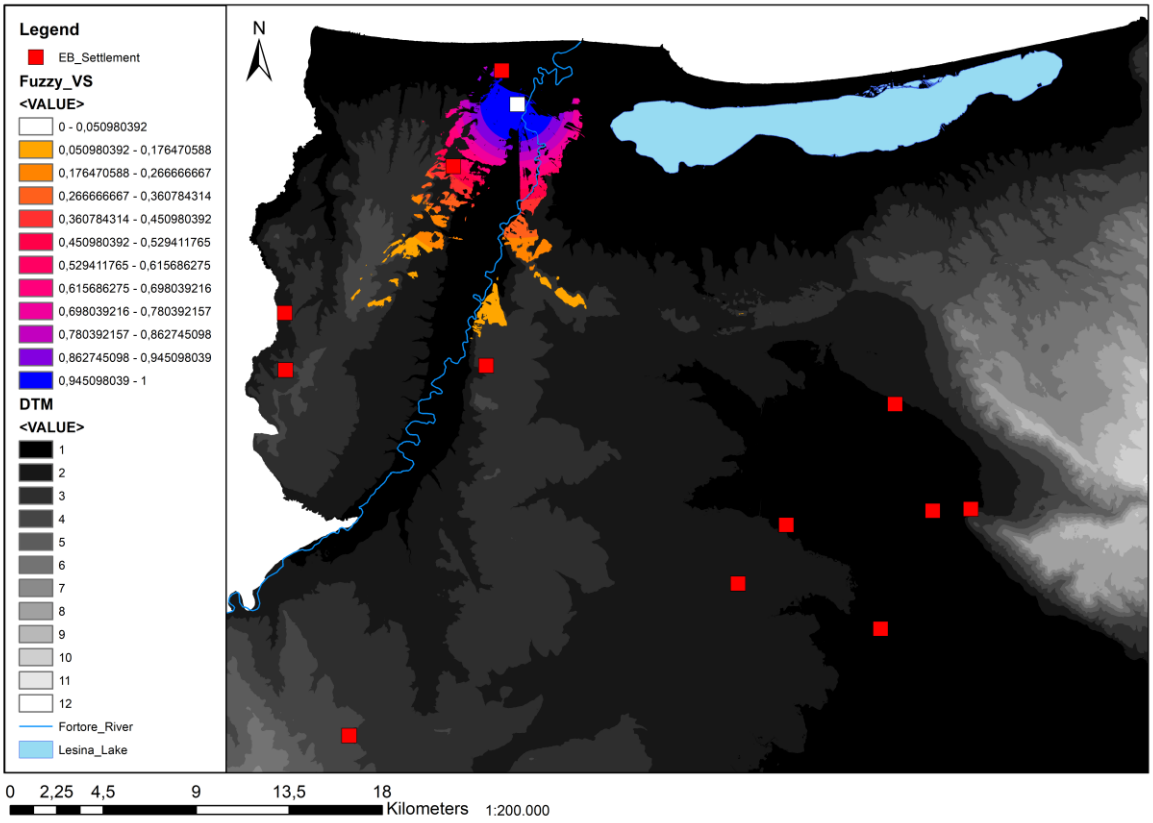


Table 269 – FVA applied to Brancia Km 10-Volta Pianezza (id10)

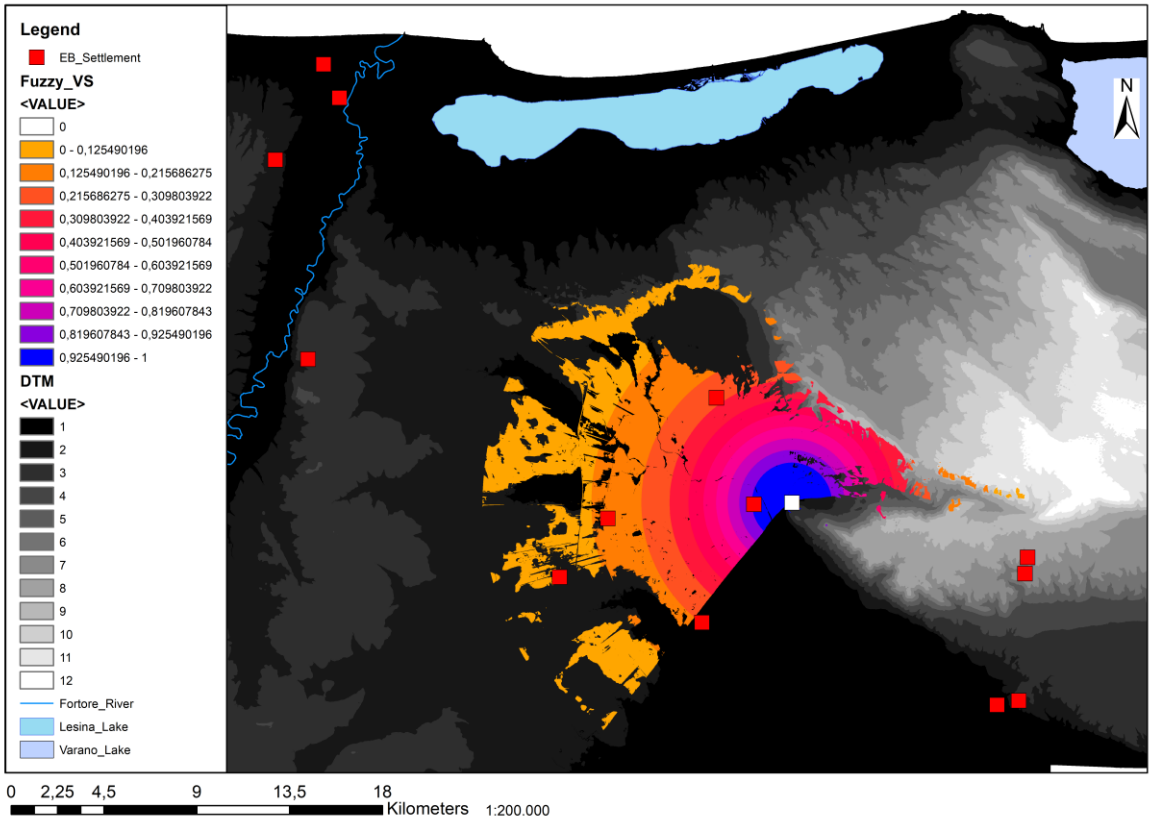


Table 270 – FVA applied to Ciccalento (id11)

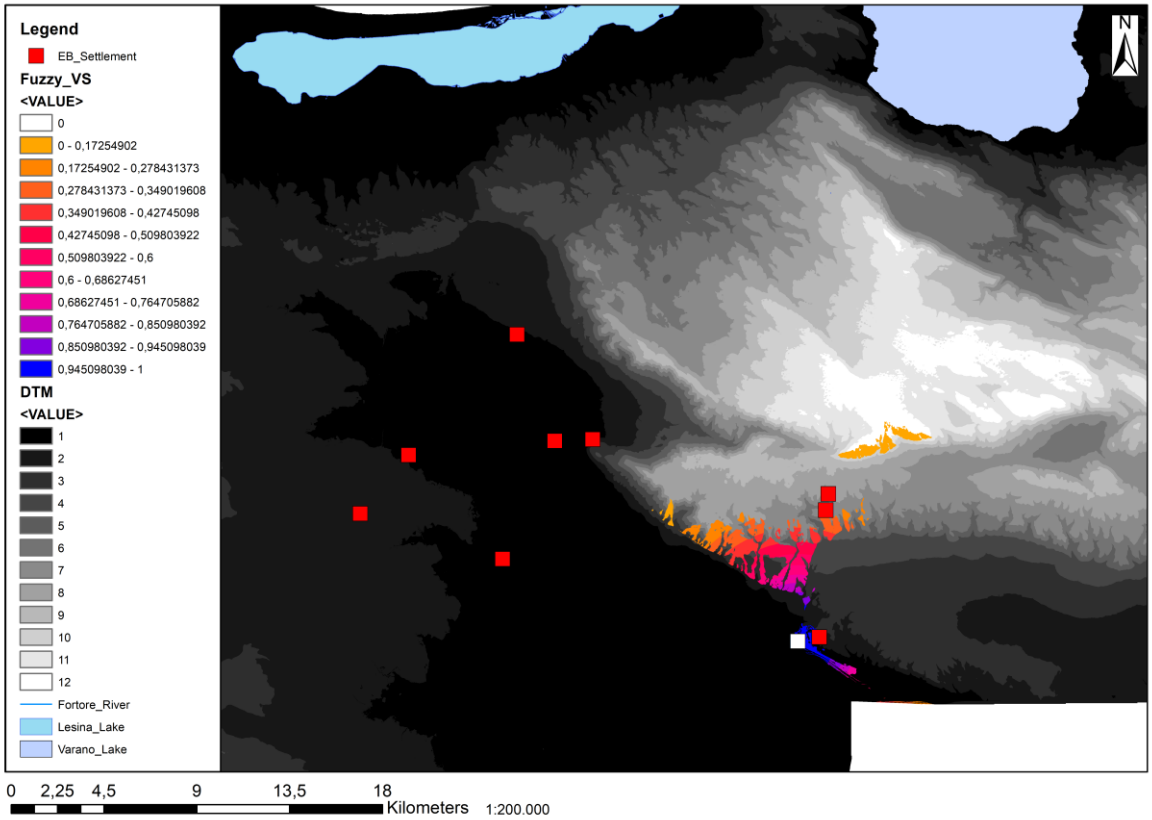


Table 271 – FVA applied to Casale Crisetti (id12)

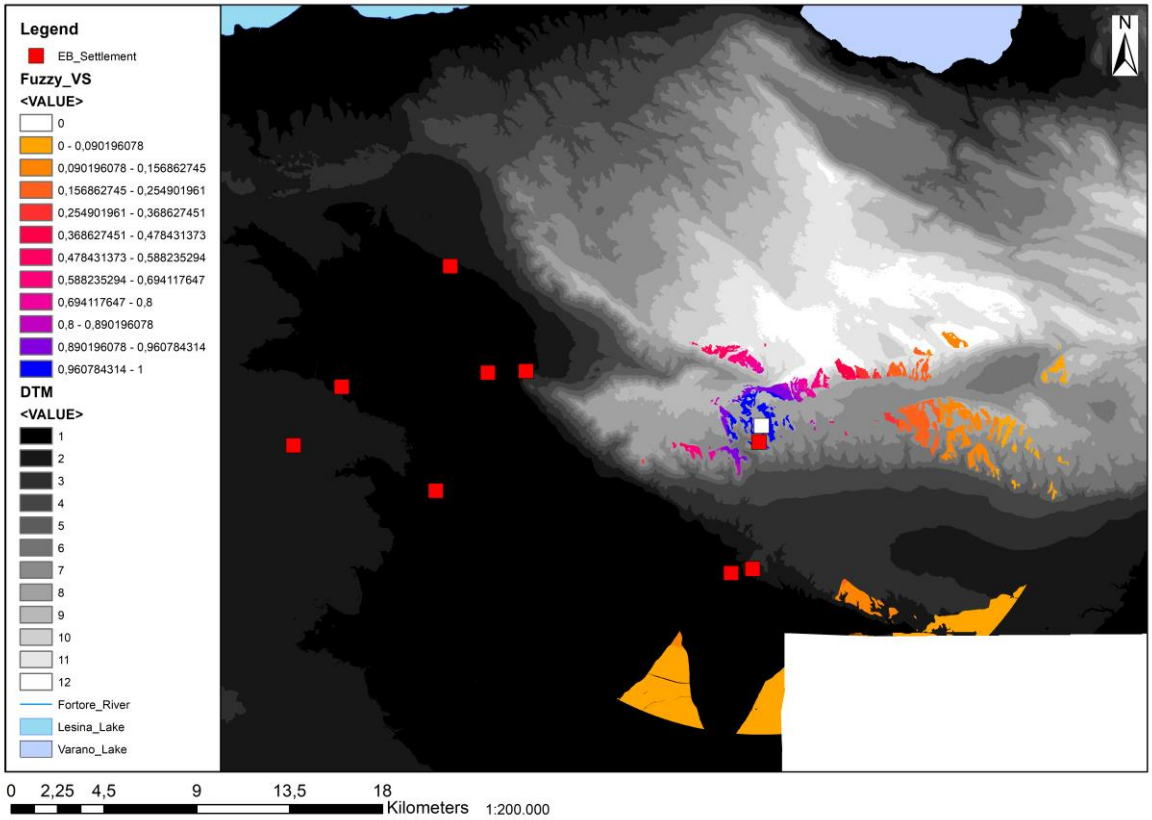


Table 272 – FVA applied to Masseria Mezzanella di Brancia (id13)

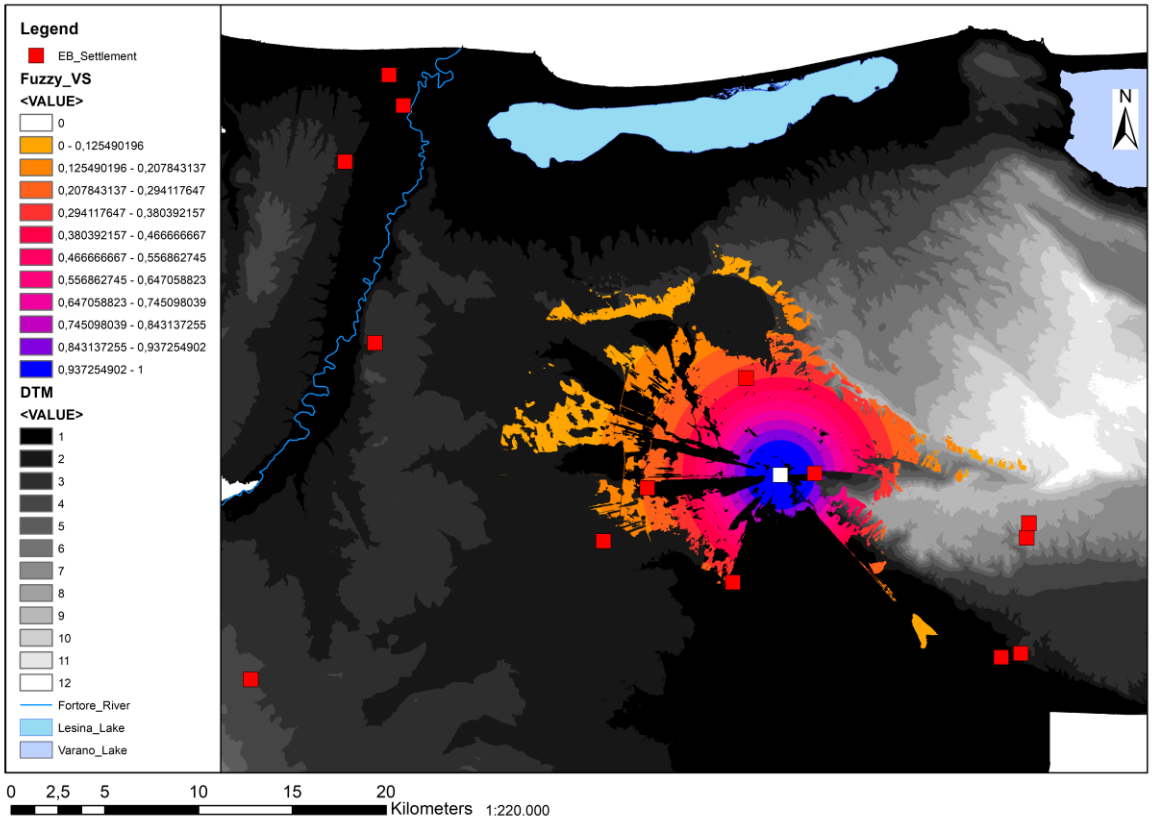


Table 273 – FVA applied to Brecciara (id14)

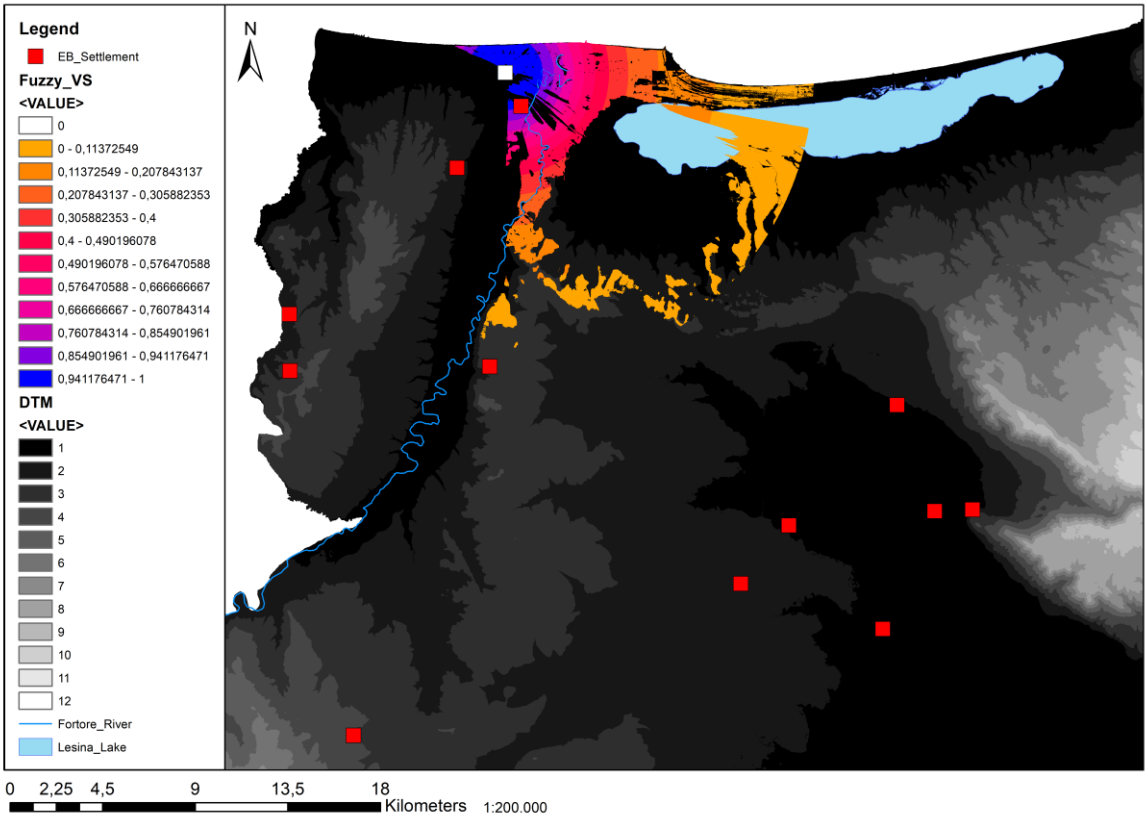


Table 274 – FVA applied to Mezzana della Quercia (id15)

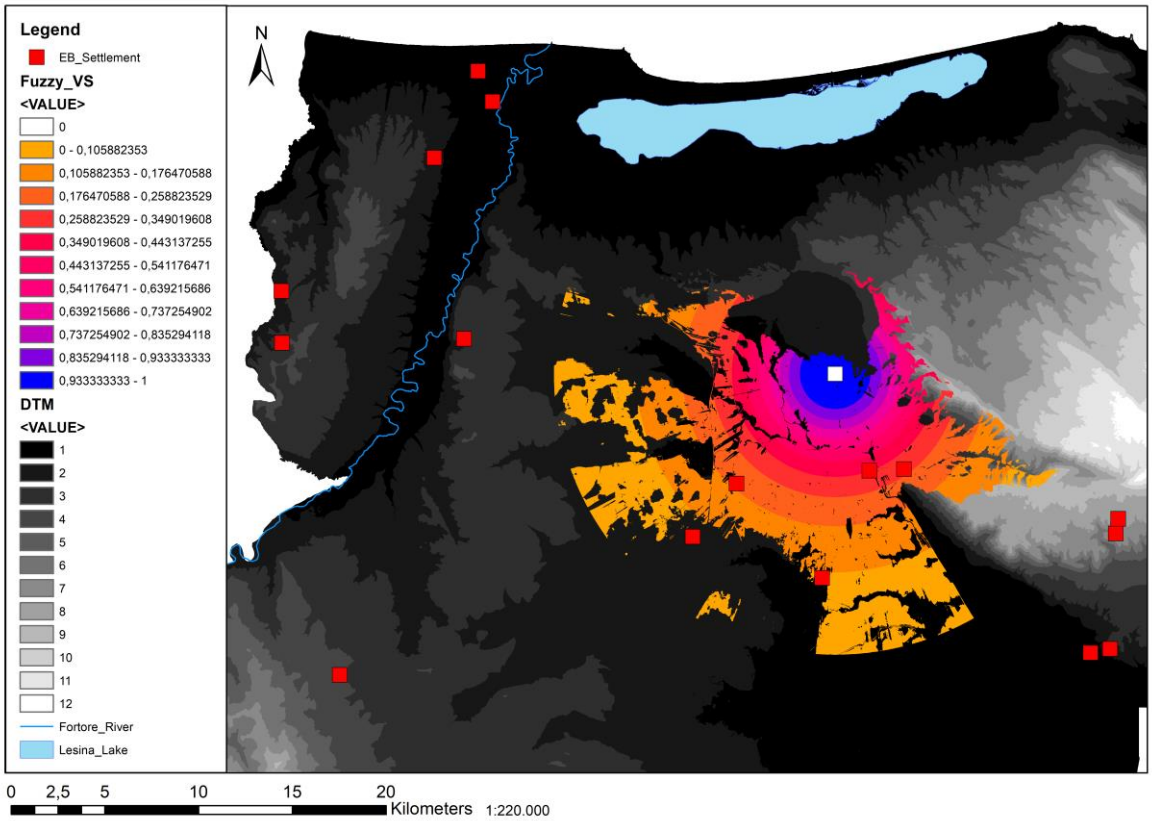


Table 275 – FVA applied to Oliveto Torre dei Giunchi (id16)

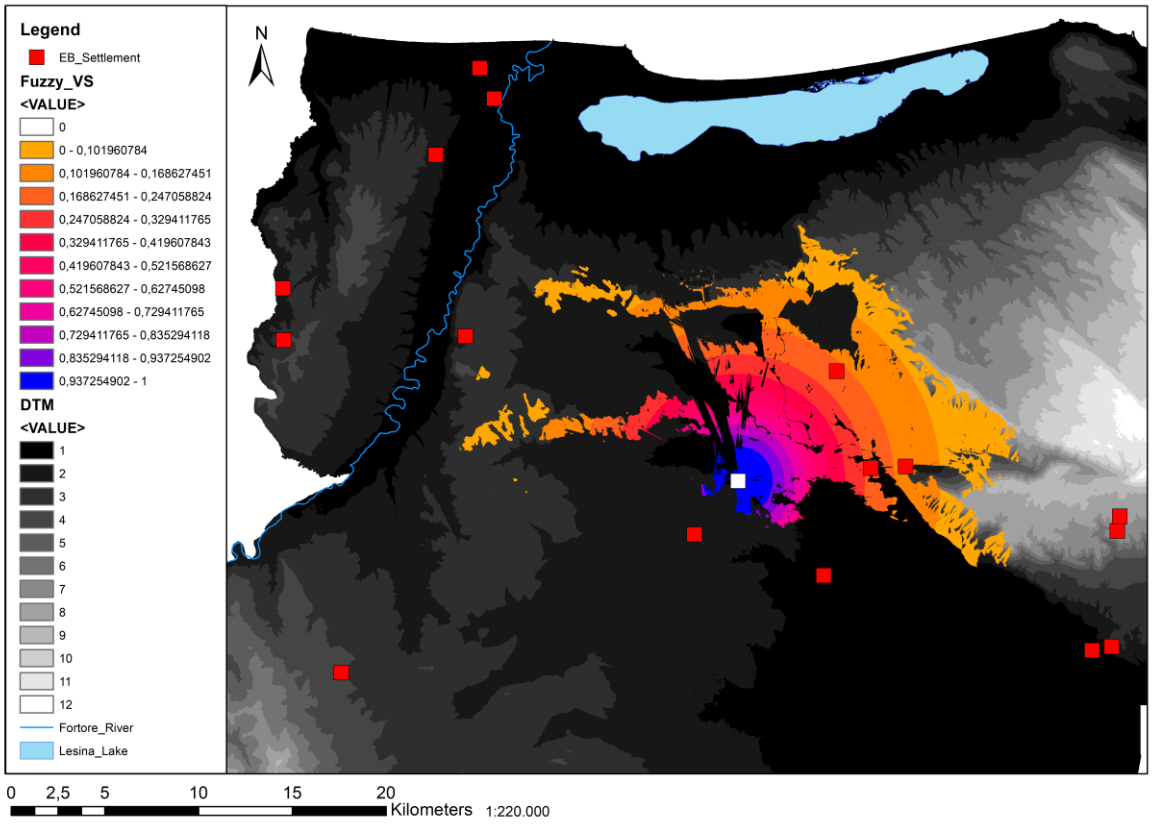


Table 276 – FVA applied to Portata Casone (id17)

