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## **Ancient landscape changes in the North Marche region: an archaeological and geomorphological appraisal in the Cesano valley**

Pier Luigi Dall'Aglio, Enrico Giorgi, Michele Silani, Martina Aldrovandi,  
Carlotta Franceschelli, Olivia Nesci, Daniele Savelli, Francesco Troiani, Luisa  
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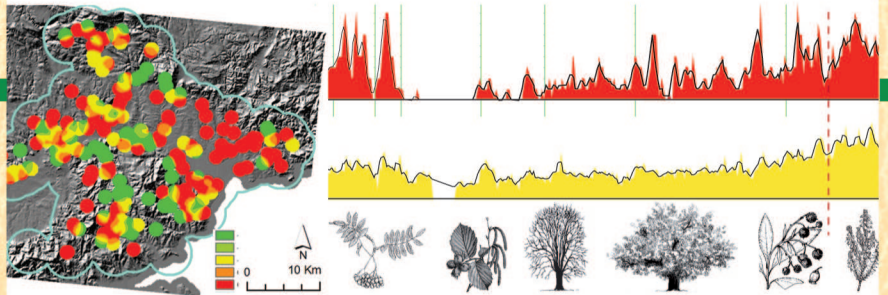
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# VARIABILITÉS ENVIRONNEMENTALES, MUTATIONS SOCIALES

*Nature, intensités, échelles  
et temporalités des changements*

*Sous la direction de  
Frédérique Bertoncello et Frank Braemer*





*Variabilités environnementales, mutations sociales*  
*Nature, intensités, échelles et temporalités des changements*

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***VARIABILITÉS ENVIRONNEMENTALES,  
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et temporalités des changements***

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Frédérique Bertoncello et Frank Braemer

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# Ancient landscape changes in the North Marche region: an archaeological and geomorphological appraisal in the Cesano valley

*Pier Luigi DALL'AGLIO<sup>a</sup>, Enrico GIORGI<sup>a</sup>, Michele SILANI<sup>a</sup>,  
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## Abstract

The paper presents an integrated and multidisciplinary study of the territory through the combination of geomorphological, historical and topographical data, with the aim to underline the most relevant changes occurred in the landscape of the northern Marche (Italy) during the Late Holocene (between the Roman and Middle Ages). In particular, the attention is focused on the transformations occurred in the Cesano River valley, through the analysis of the reciprocal influences between human presence and physical geography. A specific attention is reserved to the watercourses and bed configuration changes in relation to the territorial organization, also considering the climatic fluctuations attested after the Roman period.

**Keywords:** Geoarchaeology, Fluvial geomorphology, *Suasa*, Cesano River, Marche Region, Italy.

## Résumé

Cet article présente les résultats d'une étude paléoenvironnementale de la vallée moyenne du Cesano, dans les Marches centrales (Italie). Son objectif est de souligner les transformations du paysage de cette vallée entre l'époque romaine et le Moyen Âge à travers une analyse diachronique des relations sociétés-milieus. Dans ce cadre, une importance particulière doit être reconnue à la reconstruction des variations du tracé du Cesano – notamment à la suite des fluctuations climatiques attestées après l'époque romaine – et aux répercussions que ces variations ont eues sur l'organisation du territoire dans le contexte politique et social de l'Antiquité tardive.

**Mots clés:** géomorphologie fluviale, géoarchéologie, *Suasa*, Cesano, Les Marches, Italie.

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## The archaeological and geomorphological appraisal

Recent research has shown that an integrated interpretation of the territory is necessary to understand the characteristics of the various landscapes and their transformations over time (COLTORTI, 1997).

The integration between geomorphological analysis and historical and topographic study allows us to understand the relationship between humans and the environment and especially to detect the changes produced by such relationship (DALL'AGLIO, 2000).

In this way, the different phenomena that have contributed to the landscape shaping can be defined, such as the territorial organization during the Roman period and the variations of watercourses and related bed configurations. The latter occurred during the Late Antiquity, after an economic and demographic crisis a climatic deterioration; they have been followed by the recovery of drainage works and land cultivation which characterized the Early Middle Ages. In this respect, a multidisciplinary approach is needed for studying the modern landscape configuration. The present work, carried out in the Cesano River valley (Marche, Italy), is an example of application of this research strategy.

## The Cesano river valley

### *Geomorphological framework*

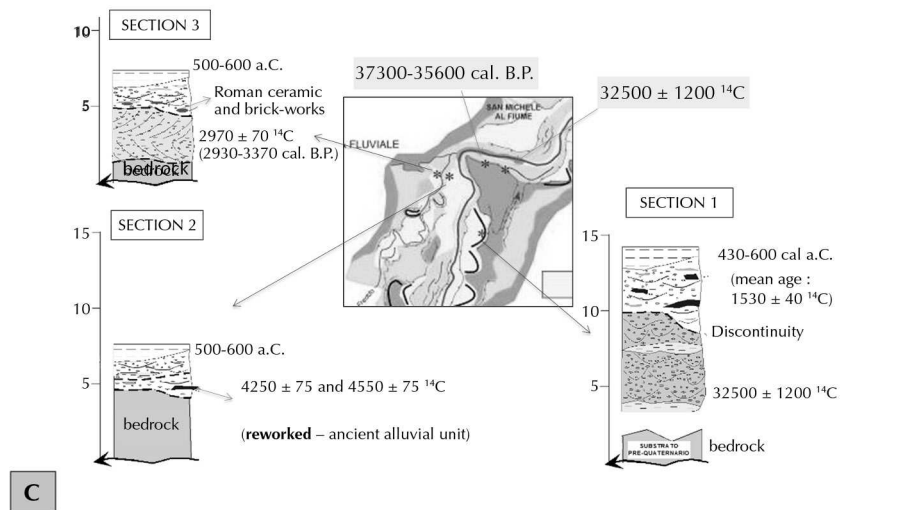
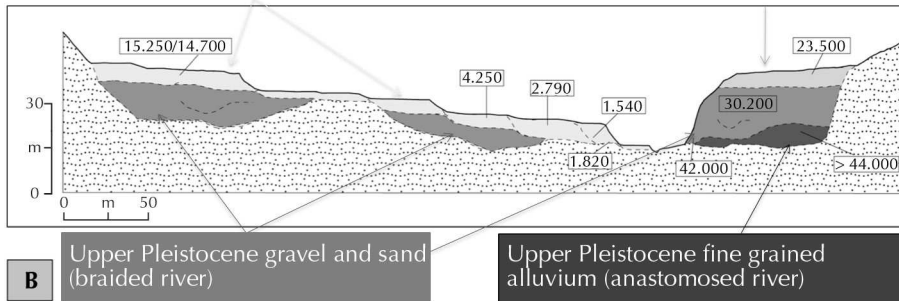
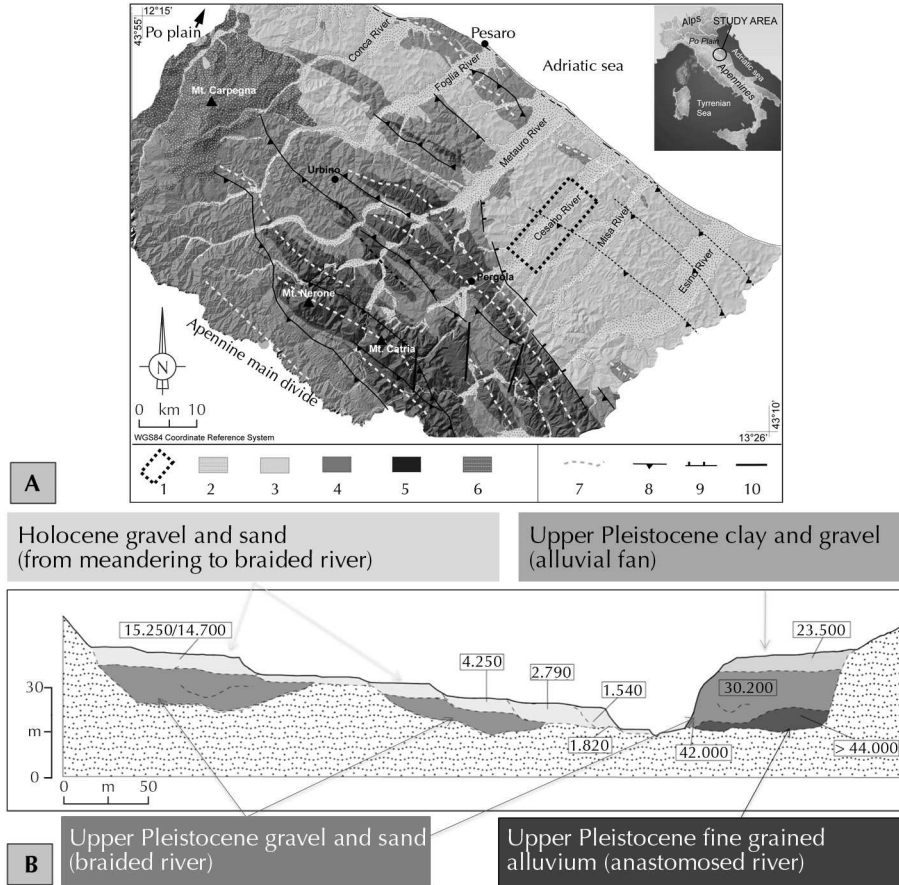
The study area lies in the external sector of the Adriatic side of the Umbria-Marche Apennines, a thrust-and-fold chain rising up since Miocene, involving a marine succession characterized by Mesozoic mainly calcareous and marly-calcareous formations evolving upwards to Cenozoic prevalently terrigenous emipelagic turbiditic terrains (fig. 1A). The uplift rate during the last 1 Ma in the inner portion of the chain is approximately equal to 0.3-0.5 mm/yr and steadily drops down towards east, assuming the lowest values in correspondence of the coastal sector. Recent research for the Misa and Cesano mouth areas estimated an uplift rate of approximately 0.15-0.18 mm/yr since Middle Pleistocene. Hence, it is assumed that the effects of tectonic uplift can be considered irrelevant for the

### **Fig. 1. (ci-contre)**

*A) Geological and physiographical sketch of the north Marche Apennines, including the Cesano River basin. 1: Study area; 2: Middle Pleistocene-Holocene alluvial and coastal deposits; 3: Plio-Pleistocene marine arenitic and pelitic deposits; 4: Oligo-Miocene hemipelagic, turbiditic and evaporitic deposits; 5: Mesozoic-Cenozoic carbonate multilayer; 6: Val Marecchia Sheet; 7: Main anticline axis; 8: Thrust; 9: Normal fault; 10: Transcurrent fault.*

*B) Idealized cross-sections outlining the arrangement of upper Pleistocene-Holocene alluvial suites in downstream sectors of the northern Marche trunk-valleys at 10-15 km upstream from river mouth. Numbers refer to radiocarbon ages, expressed in ky B.P. (after CALDERONI et alii, 2010).*

*C) Geomorphological sketch of the Cesano River segment, downstream the Suasa roman town. Sketch legend as in Fig. 2. Section 1 = Quarry nearby St. Michele al Fiume, Sections 2 and 3 = right and left Rio Freddo banks, respectively. 500-600 B.C. age in section 1 is inferred from 1490-1820 <sup>14</sup>C ages after Dall'Aglio et alii (2004); the same 500-600 B.C. ages in sections 2 and 3 are derived mainly from field evidence. See the text for a more detailed discussion.*



morphogenetic phases that lead to the geomorphological setting of the Upper Pleistocene-Early Holocene fluvial terraces and valleys floors (TROIANI, DELLA SETA, 2011).

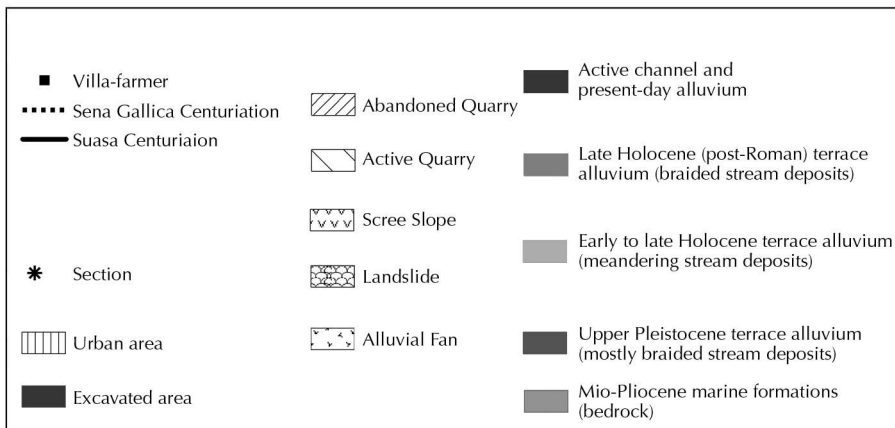
In the northern Marche area the trunk valleys are generally sub-parallel and flow mainly from SW to NE. In their middle reaches the main rivers generally show wide valley-floors matching Upper Pleistocene-Early Holocene fluvial deposits. In this area the Quaternary glacial/interglacial stages, combined with the regional tectonic uplift of the Apennines, caused the formation of a typical staircase of fluvial terraces (NESCI, SAVELLI, TROIANI, 2012). That study also reviews evolutionary models in which at least ten levels of terraces are distinguished: in particular, the higher and older ones (Middle Pleistocene in age) are tectonically driven strath terraces, while the lower and younger ones, T1-to-T4 levels, are usually characterized by thick alluvial fills (from Middle Pleistocene to Holocene in age).

In the Cesano valley the typical sequence of alluvial terraces, from T1 to T3, can be found even if some valley sectors lack the older levels. Moreover, in some places terraces are too much remoulded and discontinuous to be easily recognized and stratigraphically defined.

Fig. 1B sketches out the typical arrangement of the Upper Pleistocene-Holocene alluvial fills (the so-called “third-” and “fourth-order” of terraces) that generally compose the most part of valley-floors within the study area (CALDERONI *et alii*, 2010). After the last interglacial down cutting phase resulting in deeply and sometimes unevenly incised bedrock, a first alluvial fill-stage started, whose deposits pre-date the radiocarbon dating possibility (more than 44000 yr B.P.). Such deposits are overlain unevenly by gravel and sand of braided plain dating about from 33000 up to 23000 yr B.P. generally compose the main alluvial filling. The upper part of these sediments was re-incised in late-glacial and post-glacial times; the re-incision produced a rather complex Holocene suite of minor terraces which hint at erosional stages alternating with minor aggradation events. Hence, the terracement in Holocene times was generally characterized by cut-and-fill episodes that formed strath, fill-strath and minor fill terraces (NESCI, SAVELLI, TROIANI, 2012). Thin clayey and gravelly alluvium mostly of in-grown meandering channels formed during these stages provided ages from 15000 up to 2500 yr B.P., therefore from Early Holocene to Roman times. This sequence of erosional and depositional events characterized the morphoevolution of the main river valleys in the whole northern Marche Region from the uppermost late-Pleistocene up to Roman times.

Fig. 2 shows a morphostratigraphic sketch of the middle Cesano valley-floor from San Lorenzo in Campo to Santa Maria in Portuno that comprehends the ancient town of *Suasa*. In particular, *Suasa* lies on the Upper Pleistocene alluvial deposits (of braided-stream) partially reworked in latest Pleistocene-early Holocene by a palaeo-meander. All along the valley sector shown in Fig. 2 at least three distinct Upper Pleistocene-Holocene terrace-surfaces, corresponding to as many distinct alluvial fills, can be recognized. The first one is the main glacial alluvial fill, the second one corresponds to the in-grown meanders stage and the third

**Fig. 2.** *Archaeological and morphostratigraphical sketch of the Cesano River valley-floor from San Lorenzo in Campo to Santa Maria in Portuno.*





one hint at a re-imposition of a braided-plain in post-Roman times (DALL'AGLIO *et alii*, 2004). After this phase a straight-channel pattern established, which characterizes the Cesano River even today.

A few kilometres downstream from the *Suasa*, a detailed analysis based on archaeological, stratigraphic, and geomorphological data, also supported by radiocarbon dating, has been carried out (fig. 1C). In the section 3 (left bank of Rio Freddo, a tributary of the Cesano river) the radiocarbon age of 2970 yr B.P. of oak remnants from a meandering-stream deposit confirms the occurrence of a high-sinuosity channel in pre-Roman times with vegetation similar to the present one (*Quercus*). The section 1, from the right bank of the Cesano river, shows braided deposits unevenly overlaying a previous glacial braided-plain alluvium dating back to about 32 500 yr B.P. *Quercus* wood fragments from the uppermost deposits provided several radiocarbon ages allowing to estimate a calibrated age of 400-600 B.C. The section 2, from the right bank of Rio Freddo stream, provided contrasting ages related to ceramic brickworks associated to a trunk of *Quercus*. This association can be the result of a local complex erosional-depositional behaviour spanning from about 4 500-4 250 yr B.P. up to 5<sup>th</sup>-6<sup>th</sup> century B.C. (DALL'AGLIO *et alii*, 2004).

### **Historical and geographical framework**

The valley of Cesano River was characterized in the Roman age by the presence in the middle valley of a single centre with administrative autonomy: the *municipium* of *Suasa*. This centre was probably born as *praefectura* or *conciliabulum* and became *municipium* after the 49 B.C. (GIORGI, 2010: 55-61; DALL'AGLIO, DE MARIA, PODINI 2007). The lower valley, instead, was fully included in the *Ager Senogalliensis*, attributable to the colony of *Sena Gallica*, which was founded at the Misa mouth after the battle of *Sentinum* (Sassoferrato). In fact, in 295 B.C. the consular armies defeated the Italic coalition and the Celtic tribes of Senoni, and the territory was included in the possessions of the state property under the name of *Ager Gallicus*.

However, the event that had more social and political consequences for the entire northern part of the region was the application of the *Lex Flaminia de Agro Gallico et Piceno viritim dividundo* in 232 B.C. During these assignments new administrative districts were created, the *praefecturae*, as *Suasa*, while the *agro* affected by the occupation was divided into regular plots of land, assigned to individual owners. The flat areas were limited and restricted to the river valleys. This particular morphology has prevented the creation of large extensions land divisions. Despite this, the persistence of roman centuriation is visible in the Cesano valley, where two different registers for orientation and development have been identified: one in the Middle Valley around the town of *Suasa*, the other in the lower valley and related to *Sena Gallica*. In fact, the territory of the roman colony of *Sena Gallica* was extended from the mouth of Misa to that of Cesano, including the corresponding coastline (BONORA, DALL'AGLIO, 1991: 28-33; SILANI, CASCI CECCACCI, 2010: 275-283). In the Middle Valley of River Misa there was the roman

town of *Ostra*, which has a similar genesis to *Suasa* but with a greater continuity of life until the beginning of the Middle Ages.

With the system of the roman centuriation, a profound change in the landscape started, also involving other local infrastructures, such as the roads. At this time the consular *Via Flaminia* was building (223-220 B.C.) and we assist to the structuration of the entire road system related to it.

A *diverticulum* of this axis, as documented by the itinerary sources (*Itinerarium Antonini*), started from *Ad Calem* (Cagli) and passing through the Valley of River Cinisco, went along the left bank of the Cesano up to the mouth, in the vicinity of the *statio* of *ad Pirum Filumeni* (at Marotta), where it reached the coast road. The path of this main road of the *Suasa's* territory, in the bottom valley, isn't mentioned among the towns reported by the ancient itineraries. This situation, which emerged from historical and topographical considerations, was confirmed by the results of archaeological excavations. According to them, in fact, the early occupation stages of the site date back several decades before the construction of the system road of the *Via Flaminia*, in the first half of the 3<sup>rd</sup> century B.C. Thus, the settlement was developed as a road-center along a pre-Roman axis. This route connected the area of Sassoferrato with the Adriatic coast, using the path on the crest throughout the internal portion and then, holding down the right bank just below the hills (DALL'AGLIO, 2008: 83-90).

In any case, from the earliest stages of Romanization, in the 3<sup>rd</sup> century B.C., the arrangement of the main Roman structures in the valley was been defined. In parallel, the rural settlement of the valley developed, as the field walking surveys have revealed. The archaeological data, in fact, show an intense scattered population that is not restricted to the main settlements (*vici*) but apparently widespread through numerous other private properties (*villae rusticae*, farms, rural huts). The terraces in the valley bottom are certainly the most exploited places by the settlement of Roman sites, but also other areas continued to be occupied, in some cases from the Iron Age, such as the plains and hillsides morphologically stable and with longer favorable exposure.

In addition to the risks related to the statistical or quantitative use of the data derived from the field walking surveys, we have to consider for this specific case a scarcity of analytical data, not enough for recognizing the transformations of the rural population in the same Roman period.

In general, we can distinguish about 400 roman rural sites in the lower and middle valley (an area of approximately 140 sq km), only a few tens of which could hide an overlapping with settlements dating back to the previous period.

As discussed later, however, during the centuries the landscape was dramatically changed together with the binomial human-environment. This aspect is absolutely more significant than simple numerical data. The urban reality of *Suasa* shows a slow decline from the 4<sup>th</sup> century A.D. Its abandonment seems to reveal a progressive diminution of the garrison in the territory, which becomes real abandonment in many areas of the urban area before the middle of the 5<sup>th</sup> century A.D. (GIORGI 2010: 55-61).

The lack of attestations about *Suasa* in the written sources which list the stations of the *diverticulum*, generates two important considerations: the first one, that the *diverticulum* of the *Flaminia* should take the Cesano valley on the left bank, in order to not to cross the area of *Suasa*; the second one, that *Suasa* originated as a road centre, next to an older road system, at present identified in an axis that, following paths along the ridge up to the Cesano valley, connected *Sentinum* to *Sena Gallica*, thus keeping on the right bank.

In 49 B.C. in the *Ager Gallicus* was created the urbanization system based on *municipia*, proper towns with their own territory. Between the municipalities born in 49 B.C. on prefectural districts, there was *Suasa*. The rural settlement of the valley had to be very consistent. In this regard, the recent field walking survey has shown intense populating, divided into a number of properties consisting of *villae rusticae* and farms. The terraces on the valley bottom and on hill sides, morphologically stable and with a favourable exposure, were chosen as preferential settlement sites.

About the transformations of the rural population in the Cesano valley during the centuries of the Empire the examples are insufficient to define in statistical terms any specific trend. The centre of *Suasa* shows a slow decline since the 3<sup>rd</sup> century: the abandonment appears to be due to a continue occupancy of some spaces within the urban area, used or as cemetery or as quarry areas, at least until the 6<sup>th</sup> century.

Between Late Antiquity and the Middle Age a general population decline, in relation to the Greek-Gothic war (535-553 A.D.), followed by a worsening of the economy in the region, generated a change in the urban roman settlement, also showed by the persistence or disappearance of the Episcopalian in various centres. In the Cesano valley the disappearance of the Roman town of *Suasa* contrasts with the persistence of the maritime centre of Senigallia, linked to the Byzantine Pentapoli. During the early Middle Age, in the territories before belonging to Esarcato and Pentapoli and then to the Ravenna archbishopric, there is a substantial continuity with the land partition of the Roman time. The *fundus* remains the base unit, but recording a fractionation process progressively stronger. The absence of intermediate administrative centres often indicated that the property land administration was done in the main centre, place of reference and meeting of the rural population. The same phenomenon characterizes also the Cesano valley, which had its administrative seat (*rectorium*) in the town of Senigallia, circulating the land products also by sea (SILANI, 2010: 579-586 *cum bibl.*). During the 12<sup>th</sup> century the situation changed and the Ravenna's properties survived under difficult conditions, in relation to the increasing pressure of the roman Church and to the Municipalities autonomies tendencies.

The settlement texture of the valley during the early Middle Age was characterized by the absence of relevant urban centres and by the presence of a spread rural settlement in the territories property of the Church and monasteries of Ravenna. Also in the Cesano valley, two characteristic elements of the population during this period were parish churches and monasteries. The study of the relationships

between these centres and the road system provides important general indications about the population settlement and in particular, concerning the development of the road system during the Middle Age. In fact, four of the six monasteries identified in the valley (S. Abbondio, S. Vito sul Cesano, S. Lorenzo in Campo, S. Gervasio *in Bulgaria*) are aligned along the *diverticulum* of the *via Flaminia*, which from Cagli reached the coast running along the left bank, but the two others (S. Maria *in Portuno*, S. Maria *in Götuli*) are placed along the road identified on the right bank and passing through *Suasa*.

These brief considerations about the road system in the Cesano valley between Late Roman and the Early Middle Age allow us to recognize a substantial continuity during the Roman and the Middle Ages, in particular for the main road axis. In our case, also the secondary routes continue to be used, in fact the ancient *Flaminia's diverticulum* remains in use even when the town of *Suasa* disappears, with the consequent formation of a series of little nucleus on the lateral ridges. Along this axis in the Middle Ages the town of Pergola was born and from the Early Middle Age also the Monastery of San Lorenzo in Campo, the centre which inherits the ancient function of *Suasa*. This fact determines a sort of rationalization of the road system, also because the previous town of *Suasa* was on the right bank of the river, that is opposite to the *diverticulum* (SILANI, 2010: 579-586 *cum bibl.*). Some cases-studies, for example the Esino Valley, show that also when the ridge road replaces the bottom valley road in terms of role, the second one is maintained. In our case we could suppose an opposite situation: the bottom valley road remains the main axis, while the secondary road axis was placed on the ridges, along which often important reference centres for the population, as the parish churches, take form.

The most obvious changes would be recognizable in the new hierarchy of roads and in the disappearance of the ordinary and extraordinary maintenance, resulting in a “weakening” of the road structure and in local modifications of tracks, due to political, but also environmental and historical reasons.

Although in the Cesano valley the main route remains unchanged, the monastery of St. Lorenzo in Campo, which is located along it, preserved in the oldest name *in silvis*, a toponym that suggests the ancient presence of a landscape rich of large forested areas, probably relevant for the failure of the efficiency of road maintenance (DALL'AGLIO *et alii*, 2004: 213-219).

## Main conclusion

The integration of the geomorphologic, historic and topographic data is at the base of our study of the landscape and is necessary to understand the human-environment relationship and related changes.

The study of the Cesano valley is a relevant example for this subject, in particular, concerning the changes that occurred between the Roman time and the Early Middle Ages.

The division of the territory during the Roman period, which occurred after the assignment of the conquered lands to settlers with the *lex Flaminia de agro Gallico et Piceno viritim dividundo* of 232 B.C. (PACI, 1998), caused a profound transformation of the landscape.

The tracking of the land division was designed in strictly relation to the physical geography of the area. The result was a “small agricultural revolution” of the territory that was included in a massive and growing network of drainage, regimented and supervised.

The geomorphological arrangement found by the ancient agrimensors when the centurial net was established, was characterized by the presence of terraces in the valley bottom, close to the hillsides and by flats along ridges and slopes. These morphological units offered the most favorable conditions for the practice of agriculture.

The overall geomorphological arrangement of the valley bottom is derived from a major aggradational phase of the braiding channels of the Upper Pleistocene Cesano River. The subsequent dissection of the alluvial fill during uppermost Pleistocene-Holocene led to the formation of the terraces, which characterize the present-day valley bottom. Specifically, the fluvial terraces that were formed during the late Upper Pleistocene-early Holocene suggest the occurrence and persistence of a meandering river configuration. It is only after the Roman age, that a braided channel configuration was restored. Finally, a single-channel pattern with straight course replaced the braided configuration up to now.

The Holocene changes can be regarded as the result of a series of factors, natural and human (COLTORTI, 1997). In fact, during the 5<sup>th</sup> and 6<sup>th</sup> centuries A.D., the progressive abandonment of the town of *Suasa* and its final disappearance due to population decline following the Greek-Gothic War (535-553 A.D.), is the indicator of a general phenomenon of transformation of the territory.

The depopulation of the countryside leads to stop the maintenance of drainage channels and the control activities of the waterways, with the emergence of waterlogging and hydraulic disruption phenomena, and of wastelands (DALL'AGLIO *et alii*, 2004: 213-219).

A profound climatic cooling also marks this dynamic, which led to aggradation phenomena along the Cesano River. The land division and the cultivated landscape of the Roman period were gradually replaced by a landscape of woods, swamps and not-governed watercourses. In this new landscape the population preferred to settle on the heights along the ridges rather than on the valley terraces, which were more difficult to defend. This situation characterizes the beginning of the medieval period, during which the territory achieved the overall landforms that still characterize the Cesano valley.

Another confirmation of this framework, originated by combined natural and human actions, comes from the history of the medieval monastery of San Lorenzo in Campo. The monastery was born with the name of San Lorenzo *in Sylvis*, as indirect witness of the presence of large woodlands. It is located on an alluvial fan on the left bank of the Cesano River, along the ancient *diverticulum* of the *Via Flaminia*

and over a precedent roman settlement (DALL'AGLIO, 1991 : 12-23). Slightly elevated on the surrounding plain, it becomes the new center of attraction for this area after the decline of the town of *Suasa*, encouraging the reoccupation of the lands and the recovery of agriculture works in the middle valley. This transformation of the landscape ends during the Middle Age, as revealed by the change of title of the monastery, from now called monastery of San Lorenzo in Campo (DALL'AGLIO, 1994: 151-157).

This reconstruction is also confirmed by the geomorphological data described above. The floods related to the climate deterioration and caused by the lower human presence, occurred before the construction of the monastery of San Lorenzo (during the 7<sup>th</sup> century A.D.) and are probably datable at the 5-6<sup>th</sup> century A.D., as confirmed by radiocarbon analysis and fluvial deposits stratigraphy investigated in the vicinity of San Michele al Fiume, a few miles downstream *Suasa* (DALL'AGLIO *et alii*, 2004 : 213-219). Further evidence in support of this reconstruction comes from the analysis of the evolution of the middle valley, where the monastery of Santa Maria in Portuno was placed. Also in this case the name is indicative and specifically linked to the Latin divinity of *Portunus*, in relation to the presence of a ford crossing the river or of a little harbor. Actually, at present, the river is more than 2 km far from the site. However, the geomorphological survey, supported by the analysis of remote sensing images, confirms the existence of a paleo-meander datable to the Roman period on the basis of the morphoevolutive model described above. Although this is still a hypothesis to be verified, the paleo-meander fits perfectly in the reconstruction of the centurial mesh for this part of the valley.

Later, as the two reported examples demonstrated, the Roman arrangement was deleted and a new plan was made on a different physiographic framework between the Late Antiquity and Middle Ages thus conducing to the birth of a new landscape.

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## VARIABILITÉS ENVIRONNEMENTALES, MUTATIONS SOCIALES

### *Nature, intensités, échelles et temporalités des changements*

*Sous la direction de Frédérique Bertoncello et Frank Braemer*

La perception des interactions entre les facteurs naturels et anthropiques sur l'évolution des environnements et des sociétés est une préoccupation majeure de la communauté scientifique, au croisement des sciences de la Terre, de l'Environnement et de la Société. La question centrale est celle de l'impact respectif des processus naturels (climatiques essentiellement) et anthropiques dans les dynamiques sociales et environnementales, que l'on peut désormais restituer avec de plus en plus de finesse. Pour dépasser les interprétations déterministes et mécanistes qui recherchent des relations directes de causes à effets, et envisager les relations sociétés-milieus dans la perspective d'un système en co-évolution, il est nécessaire de proposer des modèles de représentation et d'interprétation de plus en plus nuancés et adaptés à la variabilité des situations étudiées et des fonctionnements régionaux des géosystèmes et des anthroposystèmes. Cela passe par la mobilisation de données hétérogènes (climatiques, paléoenvironnementales, archéologiques, historiques...), souvent lacunaires, de résolutions chronologiques et spatiales variées et différents degrés de précision. De même, les effets des changements climatiques et des actions anthropiques sur les environnements et les sociétés ne se manifestent pas avec la même intensité, selon les mêmes rythmes ni les mêmes échelles. Pour confronter, dans l'espace et dans le temps, des dynamiques environnementales et sociales, des outils méthodologiques permettant de mesurer et de modéliser le changement commencent à être élaborés.

Ce sont ces questions de nature, d'intensité, de seuils, d'échelles et de temporalité des impacts climatiques et anthropiques, principaux enjeux de la modélisation des dynamiques socio-environnementales, qui ont été explorées au cours de ce colloque.

Our perception of the interactions between natural and human factors on environmental and social dynamics is a major concern of the scientific community at the crossing of Earth, Environmental and Social Sciences. The central question is the relative impact of natural (mainly climatic) and human processes on the evolution of ancient environments and societies, which we can now perceive with more accuracy. In order to go beyond mechanical and deterministic interpretations seeking direct causal links, and to consider on the contrary human-nature interactions in a co-evolutive perspective, it is necessary to propose finely-tuned models adapted to the regional diversity of the geosystems and anthroposystems. This implies to mobilise heterogeneous data (climatic, palaeoenvironmental, archaeological, historical...), often incomplete, with various chronological and spatial resolutions and degrees of accuracy. Moreover, the intensity, rhythm and scale of the impacts of climatic changes and human activities on the environments and societies can differ greatly. New methods and tools allow change measurement and modelling in order to compare environmental and social dynamics, in space and time. This conference aimed to investigate these questions of nature, intensity, threshold, scale and temporality of the climatic and social impacts, key issues in the modelling of socio-environmental dynamics.

