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## HOLOCENE ENVIRONMENTAL CHANGES AND THEIR IMPACT ON ANTHROPOGENIC ACTIVITY: SOME EXAMPLES FROM ITALY

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Geological and archaeological evidence in Italy indicates that in the pre-historical and historical times men and their activities suffered from deep environmental changes, caused by natural processes acting at different time scale.

Long-term modifications were induced by fluvio-deltaic processes, which acted over decades or centuries and strongly modified the morphological aspects of coastal zones, causing the filling in of wide lagoons and the seaward shifting of the shorelines. The delta areas of rivers Ombrone (Tuscany) and Tevere (Latium) are examined. Geomorphological evidence testifies that the environmental modifications of the two areas were almost isochronous and they occurred gradually in time intervals of some decades up to some centuries. Contemporary, archaeological studies show that human settlements had time enough to conform their structures and economies to the progressive and slow environmental changes.

Sudden changes occurred because of volcanism; some evidence of this kind of modifications are found in the volcanic area of Somma-Vesuvio (Campania) where catastrophic eruptions caused huge topographic variations over the last 3500 years and the destruction of human settlements. Unlike the delta areas, in the Somma-Vesuvio neighbouring the morphotopographic modifications were so fast and drastic that people could not conform their activities to the changed environmental conditions. However the cited examples indicate that, although repeatedly and deeply modified, this volcanic area never stopped attracting people because of the large availability of environmental resources. This is proved by the examined archaeological sites, where the remains of stable settlements alternate with eruptive or volcanoclastic deposits.

**KEY WORDS:** Delta evolution, Volcanic eruptions, Land use changes, Geoarchaeology, Central Italy.

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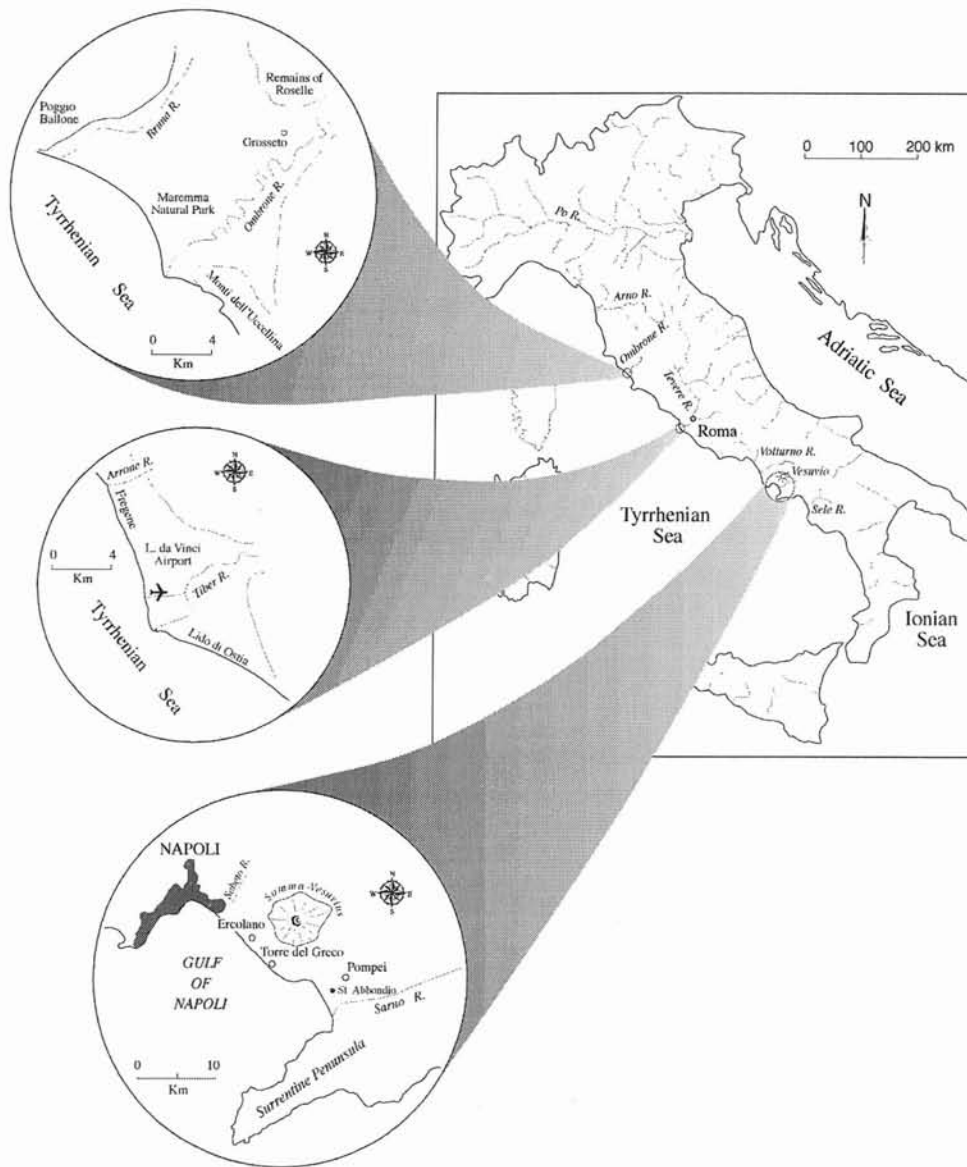
### INTRODUCTION

Natural resources are often crucial to the choice of sites suitable for human settlement establishment. Fresh water, rich soil and food availability was determinant for primitive or socially poorly organised societies, as these resources satisfied people's primary needs. More evolved societies had obviously different needs, and different resources gained importance such as strategic position to control commercial routes, availability of raw material (as salt), favourable conditions for farming, for particular facilities (as harbour) or for amusing purposes (tourism).

After the establishment of a human settlement, people must face the problems of environmental stability and the most desired places are often the less stable. The instability phenomena can be slow, although fast enough at the human time scale; they can become manifest in ten yearly or secular periods, but can also occur in a few hours. Slow instability processes hardly cause the definitive abandonment of settlements, but they induce a progressive change in the land use. On the contrary, fast processes are often catastrophic and therefore the struck living sites are necessarily abandoned. Eventually the destroyed settlements can be restored some times after the catastrophic event, depending on the capability of the territory to supply again the necessary resources.

Numerous geomorphological and archaeological researches evidence more and more the relations between the land use changes and the environment mutability in pre-historical, protohistorical and historical times. In this paper some examples from Italy are afforded. Particularly, the slow modifications of two delta areas, on the Tyrrhenian side of Central Italy, and the fast and catastrophic changes in the Vesuvio volcanic area are examined, along with the land use variations occurred from the ancient Bronze Age up to nowadays (fig. 1).

FIG. 1 - The studied areas.



#### NON-CATASTROPHIC MODIFICATIONS: DELTA AREAS

About 10 000 years ago, wide barrier-lagoon systems were present on the Tyrrhenian side of Central Italy; most rivers coming from the Apennine chain flowed into them. These systems slowly migrated landward during the last phase of the glacioeustatic sea level rise; finally, they stabilised nearly 6000 years b.p., when the rate of the sea level rise became similar to the present one (1-1.5 mm/y).

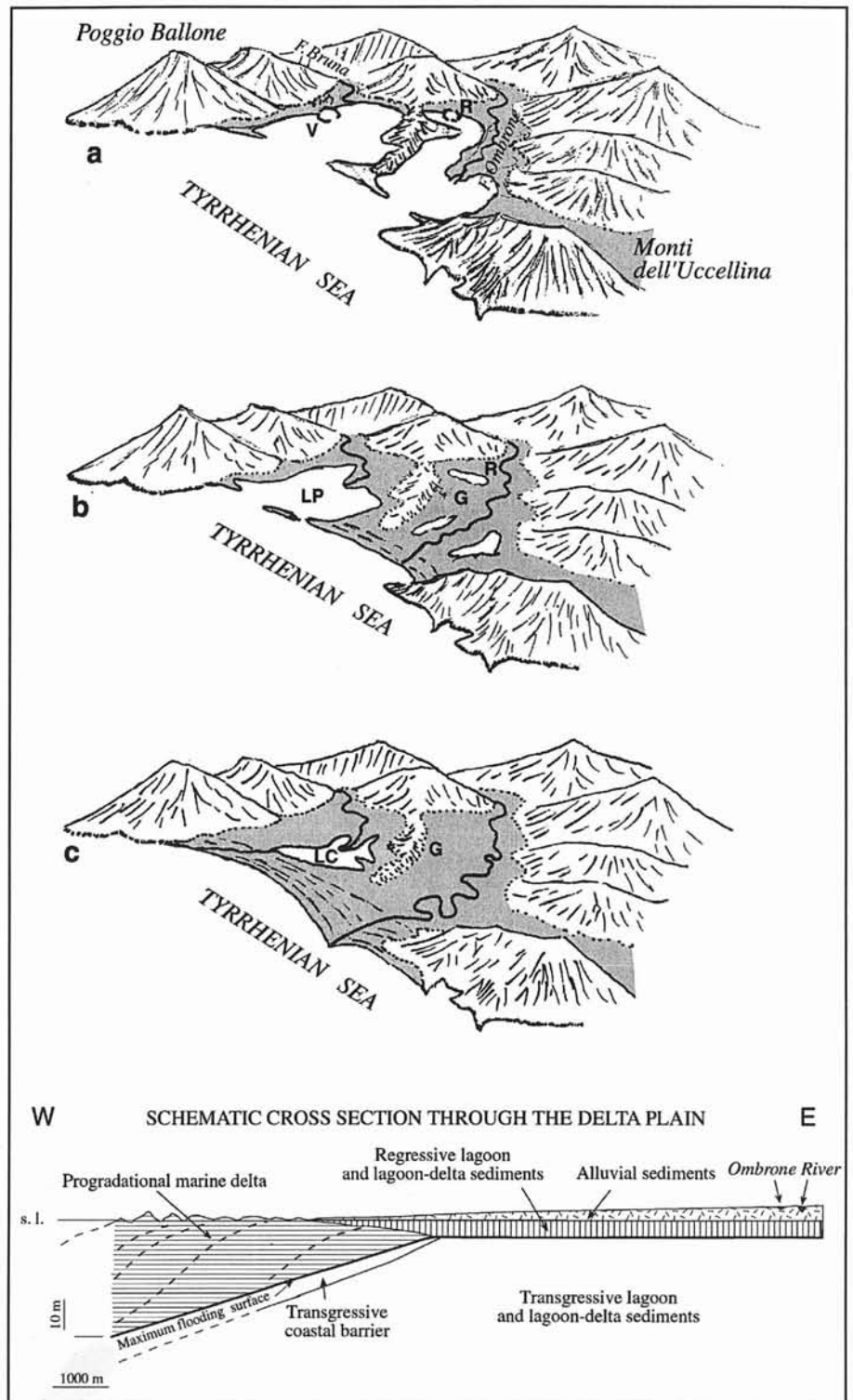
Because of the abundant solid load by streams, the areas close to the mouths of the main rivers (Arno, Ombrone, Tevere; Volturno, Sele) were slowly filled up during the last 6000 years and the lagoons were progressively changed into wide deltas.

The areas close to the mouths of the rivers Ombrone (Southern Tuscany) and Tevere (Central Latium) are examined in particular. A great deal of surface and subsurface sedimentological data, many morphological evidence and numerous historical and archaeological witnesses have allowed the reliable reconstruction of the different scenery that characterised these areas after the stabilisation of the sea level.

#### *The River Ombrone delta*

The River Ombrone delta is part of the wider Grosseto plain; it extends between Poggio Ballone, to the North, and Monti dell'Uccellina to the South (fig. 2a). The sandy beach has a falcate shape, slightly cuspidate at the river

FIG. 2 - Evolutive stages of the Ombrone delta area; a) Etruscan Period, V - settlement of Vetulonia, R - settlement of Roselle; b) Early Middle Age, G - town of Grosseto, R - resort of Rosellae, LP - *Lacus Prilius*; c) XVIII cent., G - town of Grosseto, LC - Lago di Castiglione.



mouth (fig. 3). The analysis of surface and subsurface data, jointly to historical and archaeological evidence, made it possible to define the postglacial evolution of the River Ombrone delta (Bravetti & Pranzini, 1987; Bellotti & *alii*, 1998; 1999; Bellotti, 2000). About 6000 year ago the as-

pect of this area was quite different. The Poggio Ballone and Monti dell'Uccellina relief were projecting cliffs; the shore between them was about 10 km to the East of the present location and it was divided into two inlets. The Bruna River flowed into the northernmost inlet and the

Ombrone River in the southernmost one. Several discontinuous beach ridges were present seaward. Therefore the two inlets were really two lagoons, well connected to the sea and wide about 130 km<sup>2</sup> as a whole.

This territory was particularly suitable for the establishment of human settlements, both for its morphological conditions and the richness of natural resources. Since the I millennium b.C., Etruscans have populated this area, where they founded Vetulonia, close to the Bruna River, and then Roselle, in the VII century b.C., on the right valley side of the Ombrone River. Roselle, in particular, enjoyed a

very strategical position: it was on a promontory inside the lagoon (fig. 2a) and close to a mostly navigable stream that helped the mineral and wood trade from inner Etruria (Albini, 1999). Thus, Roselle's economy was mainly commercial; subordinately fishing and salt extraction were practised in the inner zones of the lagoon. This town, an Etruscan seaport, went on having economic and political importance also during the Roman domination. Its supplying with wheat and pinewood was a decisive factor of Scipione l'Africano's victory on Cartage in 202 b.C.. Roselle's decline began in the late Imperial Time and was



FIG. 3 - Aerial view of Ombrone delta area in the 1989 (Terraitaly™ product - volo Italia 1988/89. © 1988-2002 Compagnia Generale Ripresearee S.p.A. - Parma; www.terraitaly.it - Permission after DPR n. 367 of 29-09-2000).

concomitant to the lagoon filling, due to the deposits of the Ombrone River (fig. 2b). At that time Roselle was no more a seaport and its distance from the sea was such as to make impossible its defence from the Saracen assaults. The economy was based almost entirely on farming and salt extraction from the still active northern lagoon (*Lacus Prilius*). In fact, the scarce solid load supplied by the River Bruna delayed the filling up of this lagoon of about 1000 years (Pranzini, 1994b; Bartolini & Pranzini 1985).

The relations between the changing landscape and the economic and politic events were very evident during the Middle Ages. Roselle, that had become an episcopal venue in the V century A.D., lost its political importance in 1138 in favour of Grosseto that enjoyed a better geographical position. In fact it was closer than Roselle to the sea and to the river that connected it to the coastal plain and to the hinterland, where other human settlements and abundant resources were present. The economy continued being based on salt extraction as long as 1386, when the «Maestri del Sale» (Salt teachers) officially stated that the Lago di Castiglione (*Lacus Prilius*) had changed into a fresh water pond (Prisco, 1989). During the Middle Age, thus, both the northern and the southern lagoons were divided from the sea and partially filled; contemporary the delta of the Ombrone River was prograding in different ways and at different rates. Really, the Ombrone mouth and the river course underwent deep changes by unusual flood events, like those happened between 1318 and 1333 (Venerosi Pesciolini, 1925). In this period the river mouth became more cuspidate and the stream channel was rectified after a meander close to Grosseto had been cut off.

The modifications of the morphology and economy of this area were more marked in the period between 1550 and 1850, i.e. during the Little ice age (fig. 2c). During these 300 years intense and frequent rainfalls favoured the marked progradation of the river delta. At the same time, the river mouth shifted 2 km westward, due to changes of the meteomarine regime (Bellotti & alii, 1998, 1999). A similar progradation had already occurred, but in a longer period of time that lasted about 1000 years (Roman-Medieval period).

The repeated floods of the Ombrone River were disastrous for the agricultural economy; in fact marshy and malarial zones developed that forced people to move away. To oppose these problems, Ferdinando de' Medici had a bank built on the right side of the river (1557); later, the first drainage canals were dug on the same side. However, these attempts did not succeed in reclaiming the land; as a consequence the economy, no more supported by agriculture and salt extraction, was based exclusively on farming (Maioli Urbini, 1994). The first efficacious reclamation practices began in 1828; the Lago di Castiglione and the drainage canals on the left side of the Ombrone River were filled within the following twenty years.

Nowadays the delta left wing is well-preserved, with integral and densely vegetated beach ridges; presently this area is part of the Natural Park of Maremma (fig. 3). The inner plain, on the right side of the river, is mainly used as agricultural land and, subordinately, as pasture land. The

outer belt, rich of beach and dune ridges (among which those of the XVI and XIX centuries stand out), shows many tourist facilities; their building has at places modified, or totally erased, the natural arrangement of the territory (Caputo & alii, 1978; Pranzini, 1994a).

### *The River Tevere delta*

The evolution of the coastal area close to the Tevere River mouth has been reconstructed through the analysis of a great deal of surface and subsurface data, integrated by historical and archaeological data (Belluomini, 1986; Bellotti & alii, 1994, 1995; Bellotti, 1998, 2000).

Around 4500 years ago, the Tevere River and some minor rivers flowed into a lagoon about 60 km<sup>2</sup> wide. This lagoon stretched parallel to the coastline between Palo and Tor Paterno and was limited seaward by a discontinuous coastal barrier (fig. 4a). Rivers joined the sea after having flowed into the lagoon that changed its salinity depending on the river discharges. Some villages (Eneolithic settlement of Maccarese) were present on the edge of the lagoon that was a precious source for food and, probably, salt.

Nearly 3000 years ago the Tevere delta grew up to the coastal barrier, thus dividing the lagoon into two minor basins. Since then the Tevere River started flowing directly into the sea. The two newly formed basins were deprived of fresh waters; they became more suitable for salt extraction and were utilised by the Etruscans that lived there.

The salt supply and the control of the Tevere mouth induced the Romans to get rid of the Ficana etruscan settlement and to found, in the VI century b.C., the colony called Ostia (from latin *ostium* that means mouth), right at the river mouth. Ostia developed quickly and became an important military and commercial port. The port was inside the river channel, but probably it extended also in the lagoon southern basin (Bertacchi, 1960). A canal, that was likely to follow an ancient natural drainage way, connected this lagoon basin to the Tevere River. Later on, the Ostia naval base was supplanted by Miseno and, successively, the port became unfit also for commercial trade. Therefore, in the I century A.D. the Claudius' port was built immediately to the North of the Tevere mouth (fig. 4b). The harbour was protected by two long jetties, but a violent storm seriously struck it only few years after its building. Emperor Trajanus (II century A.D.) had an internal basin dug; it was connected both to the Claudius' port and, through a canal, to the Tevere River. In this way a second river mouth was open. The town of Portus grew at the margin of this harbour system that is considered the most important of the ancient times. This relatively stable territory was devoted to harbour activities during the whole Roman period, i.e. for about 1000 years.

All the ports of the Roman imperial period were partially filled because of the coast progradation that started at the end of the Roman Age (as testified by Procopio in his *De bello gothico*). Furthermore the effects of the filling up were never eliminated as the harbours were poorly maintained, due to the decadence of the Roman Empire.

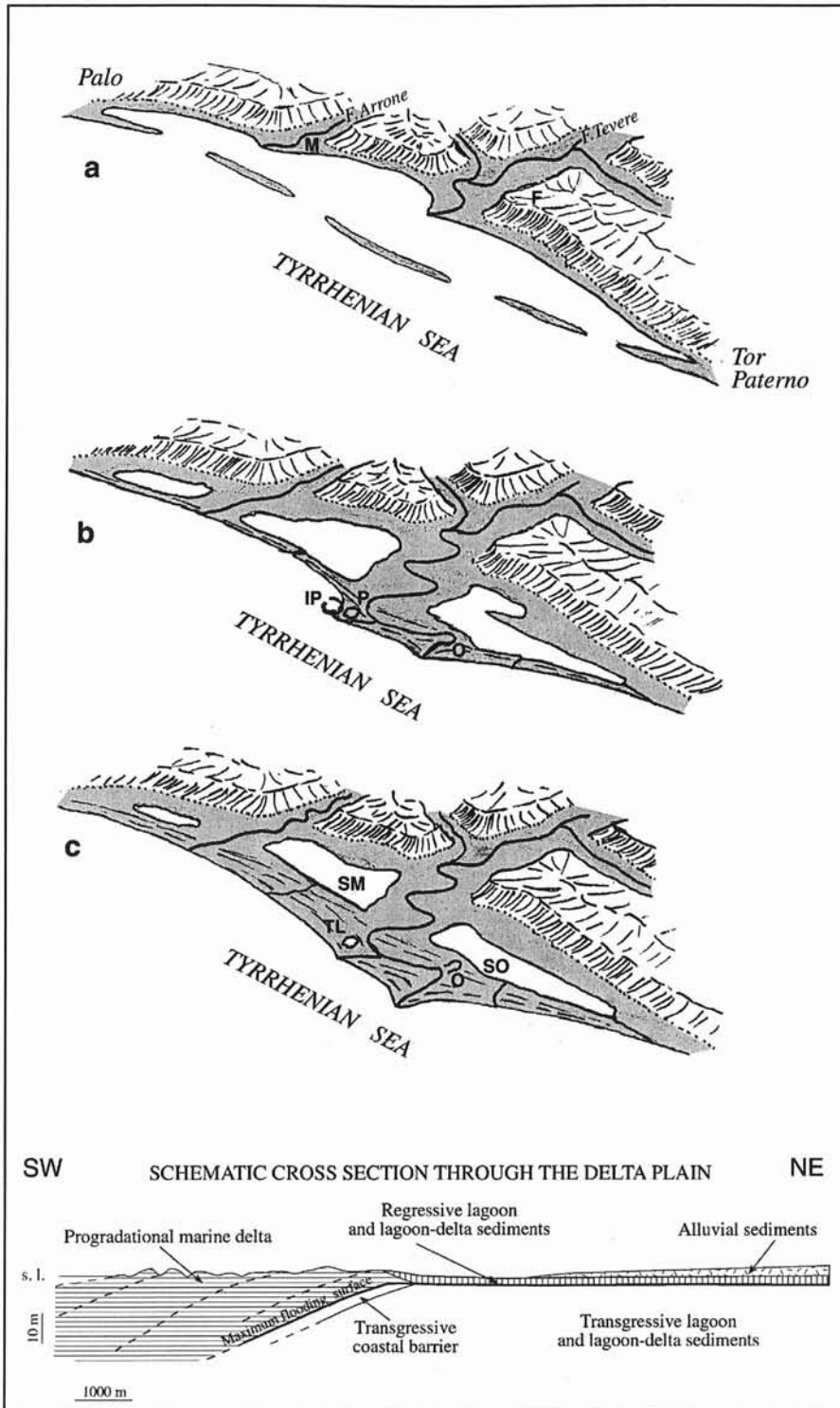


FIG. 4 - Evolutive stages of the Tevere delta area: a) Pre-Roman Period, M - eneolithic settlement of Maccarese, F - etruscan settlement of Ficana; b) Roman Imperial Period, O - Roman colony of Ostia, P - town of Portus, IP - Claudius' and Trajanus' imperial ports; c) XVIII cent., SM - Stagno di Maccarese, SO - Stagno di Ostia, TL - Trajanus' Lake, O - old town of Ostia.

During the Middle Age an erosional phase occurred; it followed the progradational phase that characterised this area during the post Roman Age. As a result the shoreline retreated to the position it had in the I century A.D. The towns of Ostia and Portus were abandoned and the resid-

ual population gathered in a small village, named Gregoriopoli, close to the Ostia ruins.

The Tevere delta area underwent deep modifications between the end of the XV century and the beginning of the XVI (fig. 4c). In this period, which corresponds to

the beginning of the Little ice age, several unusual floods of the Tevere River happened. As a consequence, the river changed its course and cut off the meander on which the Roman Ostia had been built. An intense progradation phase started. The internal basin of the Claudius' port was completely filled and the Trajanus one changed into a lake (Trajanus Lake); harbour activities concentrated again only around the main mouth of the Fiume Tevere. The shoreline moved seaward and the two basins, the relicts of the ancient lagoon, became two wide ponds where the marsh fever developed; thus this territory became increasingly inhospitable. At the end of the XIX century, after Rome had become the capital of the Regno d'Italia, land reclamation practices started in the Ostia and Mac-

carese ponds (respectively SO and SM in fig. 4c). Marsh fever was eradicated and the area could be used for agriculture.

During the XX century the progradation stopped and tourism and urbanisation of the coastal belt bloomed (fig. 5).

Nowadays the delta area of the Tevere River is relatively stable, although beach erosion occurs at places mainly due to anthropogenic factors. This stability allowed the restoration of commercial and communication activities that had characterised this area since ancient times: the intercontinental Rome airport «Leonardo da Vinci» and the small tourist ports at the Tevere mouth are manifest evidence of this restoration.



FIG. 5 - Aerial view of Tevere delta area in the 1989 (Terraitaly™ product - volo Italia 1988/89. © 1988-2002 Compagnia Generale Ripresearee S.p.A. - Parma; www.terraitaly.it - Permission after DPR n. 367 of 29-09-2000).

CATASTROPHIC MODIFICATIONS:  
THE SOMMA-VESUVIO VOLCANIC AREA

The Somma-Vesuvio volcanic activity has lasted for a very long period (Arnò & alii, 1987; Scandone & alii, 1991; Rolandi, 1997; Yokoyama & Marturano, 1997), therefore the environmental modifications in the surrounding area were repeated in times. The zones closest to the volcanic edifice underwent such catastrophic and frequent changes that, at present, there is no archaeological evidence of stable human settlements within a range of 4-5 kilometres from the summit crater. The piedmont area and the circumvesuvian plain suffered from minor modifications; as a consequence, the effects of volcanism on the development of human settlements are well documented.

The deepest environmental changes were surely due to the famous plinian eruption occurred in 79 A.D. At the beginning of the Roman Imperial Time several towns covered the Somma-Vesuvio area. Their economy was based mainly on agriculture and trade, as in the case of Herculaneum, on the coast of the Napoli Gulf. The beauty of the landscape and the mild climate favoured also the development of seaside resorts that were frequented by the rich roman patricians; this was the case of Pompeii that was built on a wide beach, close to the Fiume Sarno mouth.

Although the 79 A.D. eruption is the most celebrated of Somma-Vesuvio, about 3600 years ago, at the end of the Early Bronze Age, another huge plinian eruption occurred. Only in recent times it was demonstrated that this volcanic event, named «Avellino» eruption, deeply affected the primitive agricultural and pastoral communities of ancient Campani who lived in the volcanic area (Albore Livadie & alii, 1998; Russo, 1999). The effects of the

«Avellino» eruption on human settlements were as disastrous as those produced by the 79 A.D. eruption.

*Piedmont area of Somma-Vesuvio*

This area suffered the consequences of few, although catastrophic, volcanic events. Some archaeological evidence, of scientific and historical importance, testifies that ancient populations had inhabited this territory permanently and for a long time before the repeated eruptions of the Somma-Vesuvio volcano forced them to move away.

The most spread archaeological remains bear witness to important human settlements of Roman age that date back to the IV up to the I century A.D.. The most famous are those of the Roman towns Pompeii and Herculaneum (fig. 1), which were destroyed by the plinian eruption of 79 A.D. (Sigurdsson & alii, 1982; 1985). However, the ruins of Roman villas are largely spread all over the area.

HERCULANEUM EXCAVATIONS

The conditioning by volcanic events on human settlements is particularly evident in the site of the ancient Herculaneum. This Roman town, in fact, suffered from the effects of the volcanic eruptions that occurred since the Roman age and up to modern times. The other Roman settlements, instead, underwent only the environmental changes produced by the huge eruption of 79 A.D..

The pyroclastic products of this eruption completely erased Herculaneum and the neighbouring zones, which were buried under a volcanic cover 20 metres thick (fig. 6). The deposition of this huge amount of volcanic products caused marked aggradation phenomena. Moreover, the

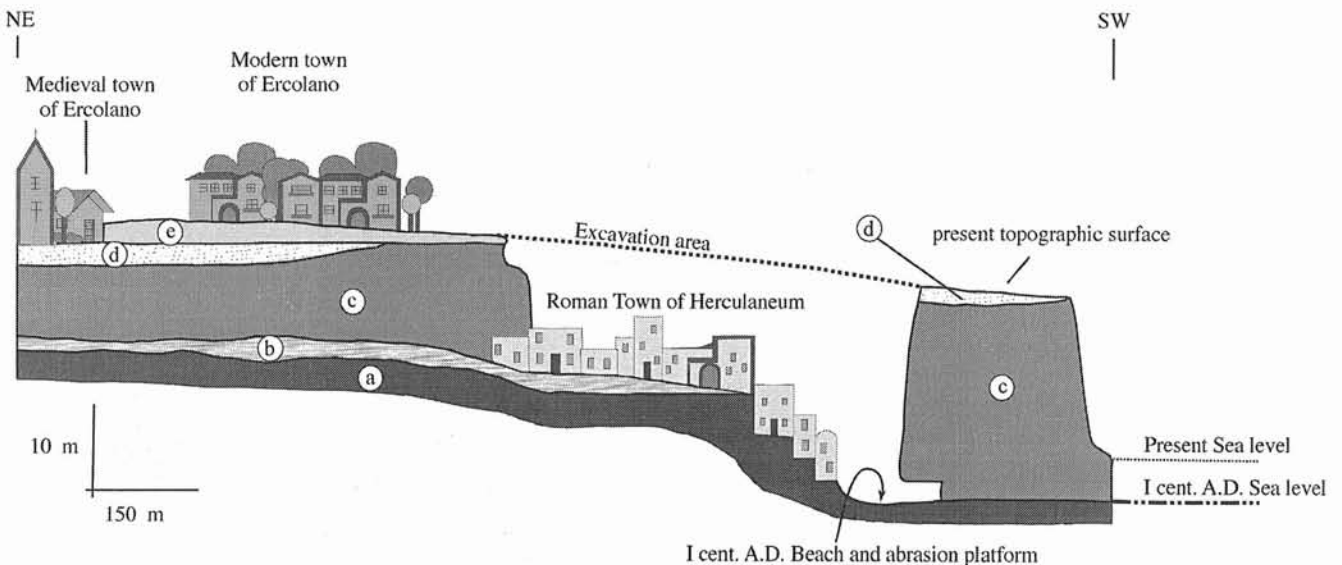


FIG. 6 - Schematic morpho-stratigraphical cross-section through Herculaneum excavations; a) late Pleistocenic volcanic tuff; b) pre-Roman palaeosoil and Holocenic lapilli and ash layers; c) 79 A.D. eruption pyroclastics deposits; d) alluvial volcanoclastic sediments; e) 1631 lava flow.

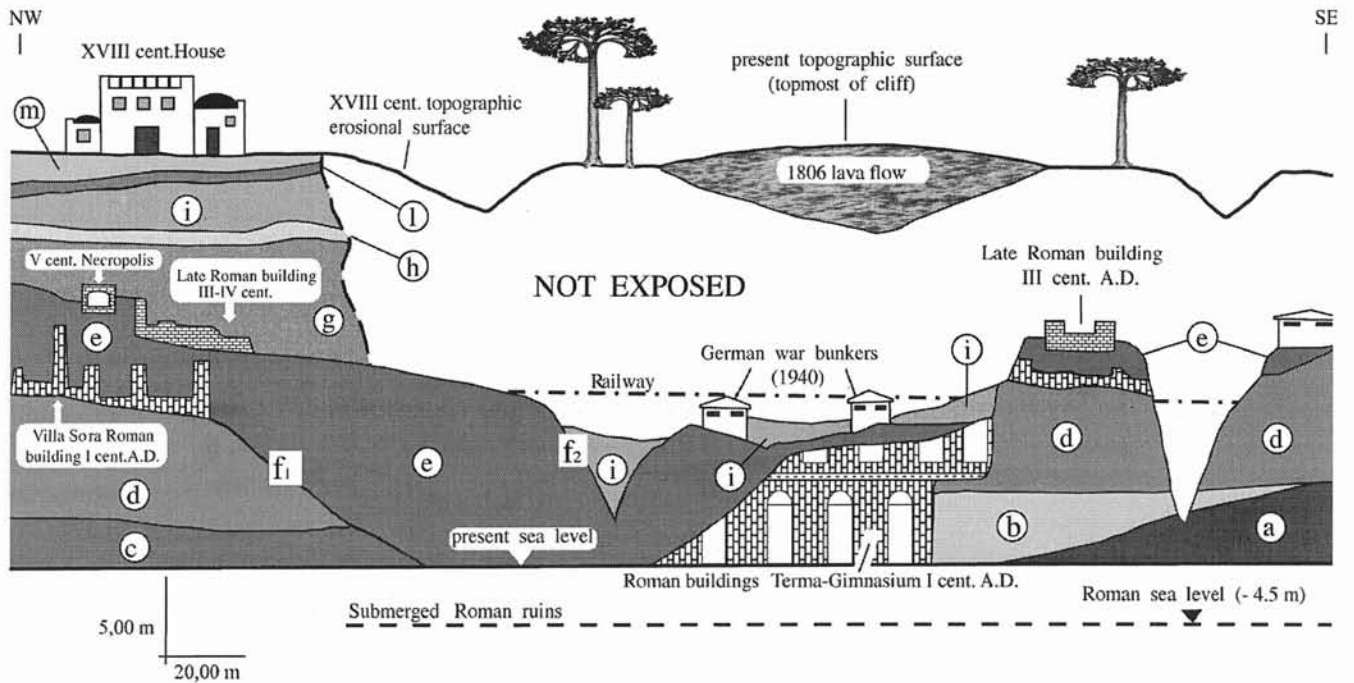


FIG. 7 - Schematic morpho-stratigraphical cross-section through the cliff of Torre del Greco along the Vesuvian coast; a) late Pleistocene lava dome and its autobrecciated deposits; b) Holocenic lapilli and ash layers separated by palaeosoils; c) Holocenic Nuée ardente deposits; d) «Avellino eruption» pyroclastic deposits; f<sub>1</sub>) ancient erosional valley surface; e) 79 A.D. eruption pyroclastics deposits; f<sub>2</sub>) post-Roman erosional valley surface; g) 472 A.D. eruption pyroclastic deposits; h) 610 A.D. eruption lapilli layer; i) X-XII cent. volcanoclastic colluvium and anthropogenic sediments; l) 1631 (?) eruption lapilli layer; m) XVII cent. anthropogenic sediments.

largest shore progradation ever recorded in the Vesuvian area occurred. In fact, during the Roman age the shoreline was about 500 metres outward and the sea level about 4 metres lower than the present one, as archaeological, geomorphological and geological evidence testifies (Sigurdsson & alii, 1985; Pagano & alii, 1997; Aprile & alii, 1999).

The deep environmental modifications that followed the 79 A.D. eruption obviously swept away most of the activities of the Herculaneum inhabitants. Many of these activities, such as harbour and maritime activities, were never restored. Thermae fruition and the relevant recreational and cultural activities disappeared forever. Trades came to an end for an unspecified period of time, since the deep topographic modifications completely erased the most important communication roads, like the Via Popilia. Agriculture had the same destiny. The building structure of settlements changed deeply too; the country villas (perhaps small farms) and the «otium» villas close to the sea, that had characterised this locality, lost their reason to exist. The same thing happened to the places of worship and to the necropolis, as the volcanic eruption destroyed the topographic reference marks that had inspired their location.

In spite of this general destruction, the local environmental resources persisted in this area. Its vicinity to the sea and the mountains, the water availability, the fertility of soils, the favourable climatic conditions and the plenty of building materials allowed the repopling in times of

the Herculaneum area. In fact various human settlements that date back to the Late Roman Age and, chiefly, to the Middle Age testify to the renewal of anthropogenic activities right in the place where the ancient Herculaneum town rose (Pagano, 1966). In more recent times this same area was partially destroyed by the 1631 eruption. This volcanic event played the same morphogenetic role as the 79 A.D. eruption. The economies of the local centres were shaken again, but they did not faded definitively; in fact the territory has been exploited since then without any break. Also the modern Ercolano rises on the lavas erupted in 1631 that surround the late medieval town (fig. 6).

#### THE TORRE DEL GRECO CLIFF

The geo-archaeological scenery exposed at the south-eastern cliff of the Torre del Greco port (fig. 1) is particularly interesting. This cliff is about 20 metres high and runs parallel to the present coastline for nearly 200 metres and at a distance of about 10 metres inland. The stratigraphic examination of the cliff exposure singles out the succession of products from different volcanic events with human settlements that followed one another during the last 2000 years (fig. 7). It is clearly evident that each settlement developed within a different geomorphological context.

An ancient landscape, quite different from the present one, is discernible at the base of the cliff; it was shaped on

the lavas and autobreccia (a, in fig. 7) of a pre-historical local vent (Di Girolamo, 1970). The most outstanding morphological feature of this old landscape, referred to the Bronze Age, is a wide valley that flowed into the Tyrrhenian Sea when the sea level was far below the present one. Pyroclastic fall products (b, in fig. 7) and nuée ardente deposits (c, in fig. 7) of the following eruptions filled up this fluvial depression; the presence of interbedding palaeosoils testifies that the valley infilling occurred in subsequent phases.

Successively, this ancient landscape was completely buried under the pyroclastic flow deposits, about 5 metres thick, which Pagano & alii (1998) attributed to the «Avellino» eruption (d, in fig. 7). A renewed fluvial landscape evolved on this deposits (f<sub>1</sub>, in fig. 7). The traces of a wide valley are easily discernible; it ended into the sea at a long distance from the present coastline and about 4.5 metres below the present sea level. The remains of «otium» villas (like Villa Sora) and thermae (Terma-Gymnasium) built before the I century b.c., are found on the deposits of the Avellino eruption. These buildings evidence that during Roman times this area, close to the sea, was devoted to recreational activities; probably it was also the site of a small landing.

The pyroclastic deposits of the 79 A.D. eruption (e, in fig. 7) completely modified the morphology of this coastal area; moreover the products that reached the sea caused the consistent coast progradation already cited. The landscape at that time should be characterised by low relief surfaces gently dipping towards the sea and abruptly ending in high and vertical cliffs. A new erosion phase originated a fluvial landscape characterised by deep valleys (f<sub>2</sub>, in fig. 7).

Many archaeological relics testify that this territory was inhabited again. The human activities, however, changed deeply mainly because of the increased distance from the sea. The ruins of country houses of the III and IV century indicate that agriculture, till than little practised, largely spread over the area. Moreover the remains of a necropolis that dates back to the V century (fig. 7) indicate the existence of worship places, probably far from inhabited centres. The pyroclastic products of the Vesuvio eruption occurred in 472 A.D. (g, in fig. 7) buried both the country houses and the necropolis. This volcanic event and the following one, occurred in 610 A.D with a short interval (h, in fig. 7), caused the abandonment of this area where intense volcanoclastic sedimentation began (i, in fig. 7). However, the relics of walls and fill deposits indicate that this territory was inhabited again from the X-XII century up to the XVII century; the necropolis became a rubbish dump, which testifies to the vicinity of inhabited centres. A thin lapilli layer probably deposited by the 1631 eruption, overlays these relics and is overlain, in its turn, by fill deposits (l and m, in fig. 7). The foundations of a noble residence of the XVIII century are found on an erosion surface shaped on the lapilli layer. Finally, the present topographic surface is present at the topmost of the cliff; it developed partially on the lavas erupted in 1806. This surface is cut by the railway trench

carried out in the XIX century and is surmounted by modern buildings, the oldest being the German bunkers of the Second World War.

### *The Circumvesuvian Plain*

The Vesuvio eruptions caused aggradation and progradation phenomena also on the plain that surrounds the volcanic relief. These morphological modifications affected human settlements of different epochs. Unfortunately, the flat topography and the thickness of the volcanic deposits do not allow appreciating the way the relations between volcanic events and anthropogenic activity changed with time. These relations, however, have been fairly well reconstructed on the basis of drilling data (Cinque & Russo, 1986; Barra & alii, 1989; Albore Livadie & alii, 1990; Di Vito, 1999; Pescatore & alii, 2001).

Stratigraphic data show the progradation of the coastal plain of Fiume Sarno in response to the different eruptive events. They testify also the existence of transitional and coastal environments (ponds, swamps) that suggest the presence of protohistorical and historical settlements in lagoon environments (Albore Livadie, 1982). The same observations apply to the coastal plain of Fiume Sebeto that extends to the NW, between the Vesuvio and the city of Napoli (Di Vito, 1999).

### THE ARCHAEOLOGICAL SITE OF SAINT ABBONDIO

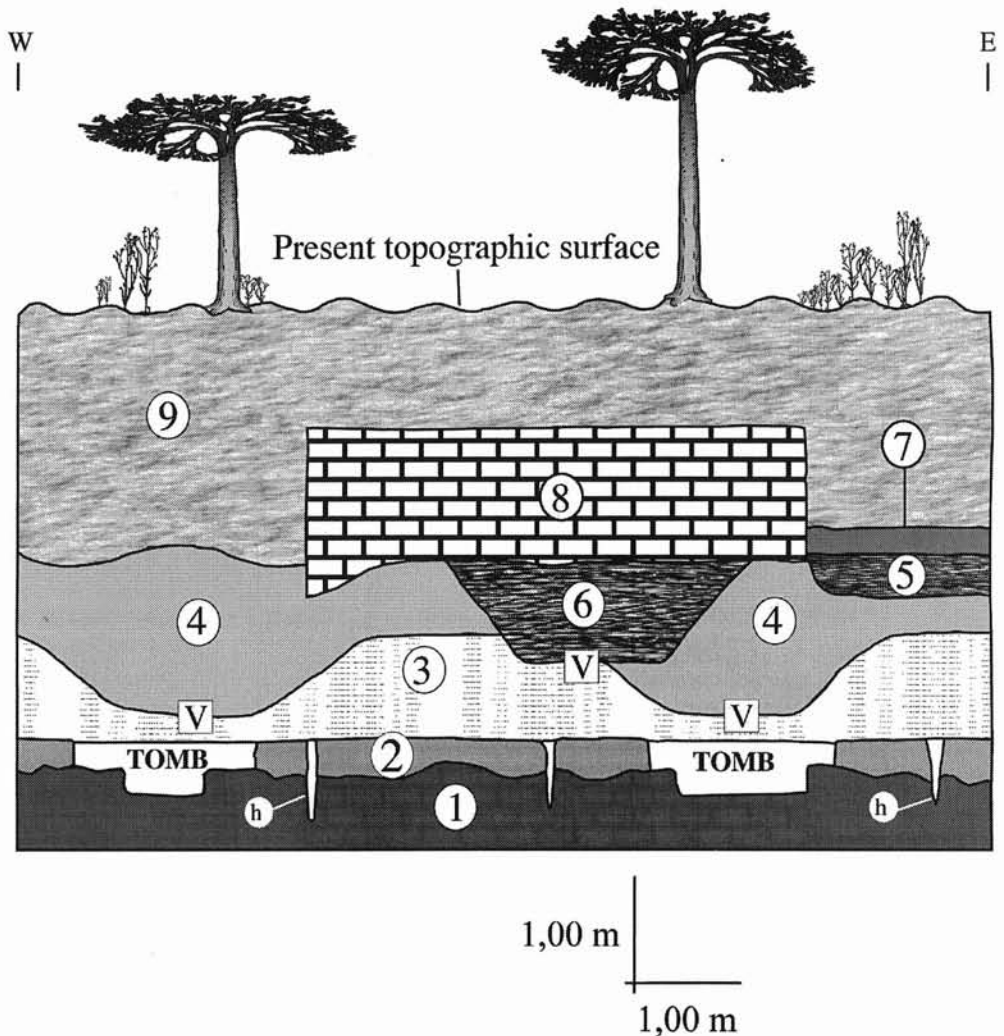
This site is the most important of the circumvesuvian plain; it is on a low volcanic relief, to the SE of the excavations of the ancient Pompeii (fig. 1). The Saint Abbondio site provides important data about human settlements of pre-Roman ages, particularly of the Bronze Age (Mastroberto, 1997; 1998).

The archaeological excavations show the stratigraphic succession indicated in fig. 8. The eldest traces of palaeosoils and human settlements are found in the weathered portion of the pre-historical lava flows, at the base of the sequence. <sup>14</sup>C dating indicates for this layer an age ranging between 4900 ± 75 y b.p. and 4300 ± 65 y b.p. (Calderoni, pers. comm.).

In particular, some pile-holes (h, in fig. 8) indicate that hut villages should have existed. The village probably overlooked the surrounding plain; perhaps it was a fisherman or farmer village who lived on the resources of the nearby sea or coastal lagoons and on the fertile soils of the alluvial plain. The finding of «impasto» pottery indicates that this village dates back to Ancient Bronze Age. At the beginning of the Middle Bronze Age this village was replaced by a necropolis; some tombs and their contents are still preserved (Colombo & alii, 1997).

The pyroclastic products of the Avellino eruption, occurred between the Ancient and the Middle Bronze Age, (Albore Livadie, 1982), overlay these archaeological remains. <sup>14</sup>C dating on some remains of an hearth, found at the base of these volcanic products, indicate an age of 3655 ± 40 y b.p. that confirms the relative age ascribed to the Avellino eruption (Calderoni, pers. comm.).

FIG. 8 - Schematic cross-section through Saint Abbondio archaeological site near Pompeii. 1) Pre-historic lava flow; 2) weathered lava flow and palaeosoil; 3) «Avellino eruption» pyroclastic deposits; 4) pre-Roman volcanoclastic alluvial sediments; 5) and 6) anthropogenic sediments with archaeological materials; 7) I cent. A.D. pavement; 8) Roman Villa wall; 9) 79 A.D. eruption pyroclastics deposits; h) hole of Old Bronze Age huts village; Tomb = Early Middle Bronze Age necropolis.



The deposition of the Avellino pyroclastic products surely changed the topography also in this area, denying any possibility to restore the ancient activities in the future. In fact, the aggradation phenomena erased the plain and lagoon environments that had supported the local inhabitants; moreover the coast progradation moved the sea away and fishing activity was never recovered. Some evidence shows that this area was inhabited again in the Classic Age (IV-IV century b.C.). The most significant are the remains of subtrapezoidal artificial canals related to the archaic Pompeii (Mastroroberto, Pers. Comm.); they indicate that agricultural practices spread again (fig. 8).

Alluvial volcanoclastic sediments overlay the erosion surface shaped on the Avellino eruption products. They show on top the traces of ploughing furrows (s, in fig. 8) and vineyard growing that confirm the proneness of this area to agriculture. This proneness is testified also by the presence of a canal and by the remains of a country house farmyard that had existed until the devastating 79 A.D. eruption. The wine production, in particular, should have

been a very common activity in this area; it is singular, in fact, that in the III century b.C., this area was known for a shrine devoted to Dionysus, the god of wine (Elia & Pugliese Carratelli, 1979).

Some other evidence (fig. 8) indicates that this area was inhabited, and its resources exploited, by men until the 79 A.D. eruption erased every trace of life.

#### FINAL REMARKS

Some geomorphological processes, both of non-catastrophic and catastrophic kind, occurred in the last 10 000 years, deeply changed the physiography of the examined territories; these environmental modifications affected directly the development and the same existence of the human settlements.

The delta areas of the rivers Ombrone and Tevere underwent slow and similar geomorphological processes, so that they followed analogous paleogeographic evolutions.

The environmental modifications of the two areas were almost isochronous and they occurred gradually in time intervals of some decades up to some centuries. As a consequence, human settlements had time enough to conform their structures and economies. The locations of archaeological sites and the historical sources indicate that the most important settlements of the Roman Age had a position suitable to control the river traffics or to install harbour structures. Later on (in the Medieval and Renaissance times), the changed environmental conditions made those territories more suitable to salt extraction and to pastoral and agricultural practices. In more recent times, the extraction activities disappeared and tourism came by the side of agriculture. As a consequence the coastal belt was intensively urbanised and the harbour activities were partially restored. The environmental modifications that made this change of the land use possible were partially anthropogenic. In fact, thank to the advanced technologies, man is now an important morphogenetic agent, capable to induce deep changes in the natural aspect of the landscape.

Catastrophic morphoevolutive events affected the area of Somma-Vesuvio. Volcanic activity strongly interfered with time in the development of important human settlements. The piedmont and plain zones underwent the deepest changes due to the repeated volcanic events. Unlike the delta areas, in the Somma-Vesuvio neighbouring the morphotopographic modifications were so fast and drastic that people could not conform their activities to the changed environmental conditions. However the cited examples indicate that, although repeatedly and deeply modified, this volcanic area never stopped attracting people because of the large availability of environmental resources. This is proved by the examined archaeological sites, where the remains of stable settlements alternate with eruptive or volcanoclastic deposits. Anyway, the restoration of the anthropogenic activities required different time intervals, depending on the position of the struck sites as respect to the volcanic edifice. In the proximal areas the restoration never occurred or it took some millennia because of the total and sudden destruction. The reestablishment of human settlements and of the related anthropogenic activities is clearly documented in the piedmont zones and in the plain surrounding the volcano. However, the time elapsed between the volcanic events and the reappearance of men in the same site changed in time; the most ancient settlements were restored after some centuries but more recently the time interval became shorter because of the decreased dependence on the local resources.

All the examples so far described witness the close interdependencies between the environmental modifications and the evolution of human settlements. The evolutive dynamics of a territory results from the interaction between natural processes and human activities. In the past the natural processes, both catastrophic and non-catastrophic, surely played the primary role in this evolution. In more recent times, however, man and his activities have gained an increasing importance. Actually, man has become an important geomorphological agent, able to interfere with the «normal» evolution of slow geomorphological processes.

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