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## NATURAL HAZARDS AND NATURAL HERITAGE - COMMON ORIGINS AND INTERFERENCE WITH CULTURAL HERITAGE

**ABSTRACT:** SORRISO-VALVO M., *Natural Hazards and Natural Heritage - common origins and interference with cultural heritage*. (IT ISSN 0391-9838, 2008).

The combination of high-rate morphodynamics and high-rate geodynamics makes several areas of the world appealing from the point of view of their scenery, but also dangerous for human beings and their property. In southern Italy relief-building by tectonics and intense seismic activity are the two principal causes of a widespread mass-wasting that affects almost all the mountains and hills. The other most relevant factor is climate, which is comparatively aggressive.

On steep-sided rocky slopes, and on the gentler flysch slopes of Calabria, mass-movement, intensive erosion and channel mass-transport are the predominant morphodynamic processes. The combination of the rugged-slope morphology of deeply-dissected valleys and the huge debris stocks produced by mass-movement generated a set of ephemeral streams, locally called *fiumara*, which impart to the Ionian side of Calabria a peculiar and attractive aspect, making these areas very difficult for village settlement, agriculture, forestation and cattle-rearing, but very attractive for tourist activities and wilderness. More importantly, they produce the debris budget necessary for natural beach nourishment. On the other hand, seismic mass-movement and flood hazards are very high in the *fiumara* zone. This makes it evident that the *fiumara* is a striking example of duality: high hazard and gorgeous landscape.

The development of such areas requires heavy intervention aimed at substantially reducing mass-movement and erosion activity. This, however, would result in the destruction of the natural environment in at least the lower reaches of the *fiumara* basins, in extremely high cost for the building and maintenance of intervention measures and in the high probability that such interventions might prove of short duration and low efficiency, as tectonics and climate are still strongly active. Some believe instead that land managers could take advantage of natural *fiumara* lands by exploiting the wilderness attractions of their territory, promoting compatible tourist, agricultural, and even industrial, activity and reducing hazards just to an acceptable level. The author prefers the second solution.

Cultural heritage has been subject to widespread piracy enacted by local people of all social levels who thought that their own interest preceded public interest. This attitude is under correction by right-thinking elements, but the process is far from finished, so that another contradiction is created. The cases of *Apollo Aleo* and *Hera Lacina* temples illustrate the duality of human attitudes towards cultural heritage. Natural processes alone represent a threat to these significant archaeological sites, but human activity has resulted in their almost total destruction. The atti-

tude of the local population with respect to the preservation of such an important cultural heritage reveals its dual nature: some people are concerned about the need for preserving them from destruction, others act contrarily. It is hard to regard this duality as a manifestation of the intelligence and wisdom of humankind.

**KEY WORDS:** *Fiumara* streams, Natural heritage, Cultural heritage conservation, Calabria, Italy.

### INTRODUCTION

Considered from a viewpoint close to western religions and oriental mysticism, a sort of moral dualism appears in several features of Nature. Water and fire are sources of both life and death. In a more subtle way tectonic and geomorphic phenomena, and their causative factors, are sources of beauty, wellbeing, even life, but also destruction and death.

It is well known, indeed, that wonderful natural landscapes are built by the same processes that cause destruction. We know that destruction may occur any time when processes pass from an inactive or low-grade active stage to an active stage, while the good side of this «*tajitu*» results eventually in a varied and attractive landscape. Effects of destructive phases may persist for a long time, as happened with the Plinian eruption of Vesuvius in 1850 B.C., after which a vast territory (including part of the area presently occupied by Naples) remained barren for centuries (Mastrolorenzo & *alii*, 2006).

Calabria is a region where such dualism is vividly present: the landscape is everywhere fascinating and attractive; lush vegetation flourishes; tourism is increasing; since this land has always been beautiful, Italians, Greeks and Romans all loved it, so archaeological findings are booming today. But its tectonics and climate are very aggressive, and geology is varied and complex, and weak rocks widespread. There is a long historical record of earthquake destruction and death: 380 of the 409 cities of Calabria are threatened by dangerous mass movements and floods; 7

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villages have been moved since the 1960s owing to landsliding (the last one in 2005).

This paper discusses the effects and features of such dualism for three study cases that represent part of the complex forms in which such dualism appears in Calabria. The first case is represented by *fiumara*-type basins, reported in Fairbridge (1968) as ephemeral streams characteristic of southern Italy (Ergenzinger & alii, 1978; Ergenzinger, 1987) which are a dramatic metaphor of landscape dualism. The following two cases deal with archaeological sites where interference with natural processes results in a number of conditions. Discussing these study cases, the author reaches the conclusion that humankind should better consider positive and negative impact effects of its activities on natural and cultural heritage, in order to preserve them for the future generations.

## THE «FIUMARA» AS A METAPHOR OF LANDSCAPE DUALITY

### *Fiumara characters*

In South Italy, *fiumara* is not just a synonym for ephemeral streams; they develop in an environment characterized by a Mediterranean climate and, especially in Calabria, active tectonics. Their peculiar characters are described in the following (Sorriso-Valvo, 2004; Sorriso-Valvo & Terranova, 2006):

- a) small basin area extending from 8.2 to 159.8 km<sup>2</sup>;
- b) stream beds are flat, steep and coarse-grained, with braided network; main flux wanders from one bank to the other; rarely, it evolves into riffle-pool sequence (Abrahams & alii, 1995). No such equilibrium profile modification is observed in aggrading streambeds;
- c) high average slope gradient ranges from 56.8 to 182.8 %;
- d) gradient of the terminal reach of the main channel varies from 0.95 to 4.04 %, much higher than that normally found in regular rivers;
- e) the hypsometric integral ranges from 0.33 to 0.53. Such values are to be found in evolved and eroded basins, but are also typical of non-equilibrium basins where relief is continuously produced by uplift of the mountain range. In Calabria, the average uplift rate for the Quaternary epoch is ca. 1-1.2 mm/yr for inner lands and becomes less and less, down to 0 in some spots, to present values of -10 mm/yr along part of the Ionian coast;
- f) average  $F_c/Dd^2 = 0.70$ .  $F_c$  is the channel frequency (n km<sup>-2</sup>) and  $Dd$  is the drainage density (km<sup>-1</sup>). As for the hypsometric integral, such values indicate evolved basin conditions;
- g) Gravelius shape coefficient GSC range is 1.50 - 2.10. Such values indicate an elongated shape, owing to the high-rate uplift of the territory that forces streams to flow in a parallel, consequent, pattern;
- h) the width-depth ratio of the channel, in the terminal reach, may be over 400;

- i) bank full floods recur every several years in the same stream;
- j) specific discharge, somehow decreasing with the watershed extension, may reach 10.5 m<sup>3</sup> s<sup>-1</sup> km<sup>-2</sup>;
- k) coefficient of torrentiality ( $C_T$ ) ranges from 24.9 to as much as 249.5. Flood peaks in hydrograms are very sharp and seldom last more than 6 hours;
- l) basin erosion rate range is 0.82 - 3.84 mm yr<sup>-1</sup> on the 1 million year time interval;
- m) Calabria's climate is Mediterranean, with arid characters along the eastern coast and montane characters (colder winter, snow cover more than 3 months above 1600 m a.s.l., wetter summer) on the mountain ranges. Precipitation averages 1100 mm yr<sup>-1</sup>, ranges from 450 to 2000 mm yr<sup>-1</sup> and is strongly influenced by orography;
- n) natural vegetation in *fiumara* territory is typically Mediterranean, with widespread *macchia* bush at elevations up to 1000 m (Sorriso-Valvo, 1998), while forest cover dominates at elevations above 600 m, except in the limestone mountains of the north, where tops are in part bare (Sorriso-Valvo, 1993);
- o) most of the mountain reaches of the basins present as regular mountain streams, with no or few stream bed deposits. The continuous gravel and block-lined streambeds have their origins at high elevations, i.e. at about 2/3 of the elevation of equilibrium profiles, in some cases above. Aggradation is cyclical, with waxing stages corresponding to widespread reactivation of mass-movement caused by major storms, followed by longer waning stages when the debris budget provided by mass-movement vanishes (Sorriso-Valvo & Terranova, 2006).

### *Landscape*

A *fiumara* appears as an appealing landscape feature, with forest cover and pasture patches in the highest parts, followed downstream by varied natural and cultivated vegetation, where *macchia* dominates. The rugged morphology is picturesque, recalling the much larger gorges of the Lesser Himalaya.

Mass-movement, impulsive floods and erosion force transport and communication lines to follow snaky and steep paths, and places for good urban settlements are rare, so most *fiumara* territories are economically marginal lands where forest-loggers and shepherds represent the majority of working people. Traditions, however, are still preserved, especially in the ancient Greek and Albanian communities, so these areas present high cultural interest. Attempts at improving the economy by introducing modern tourist activity in the mountains and specialized agriculture in the lowlands are giving encouraging results.

### *One example: the Fiumara Amendoela basin*

For a better illustration of the *fiumara* environment, the Fiumara Amedolea basin will be briefly described.

This *fiumara* is located on the Ionian side of the Aspromonte range, South Calabria (fig. 1).

It can be considered as a *fiumara* prototype, not only because of its geomorphic, biological and cultural character, but also because of its outstanding beauty (Sorriso-Valvo, 2004).

Geomorphic character is as follows:

Basin area 150.4 km<sup>2</sup>; average slope gradient 97.2%; average gradient of the terminal branch 1.81%; Gravelius elongation coefficient 1.6; hypsometric integral 0.47;  $F_c/Dd^2 = 0.664$ ;  $T_c = 85.7$ . All of these parameters are within the range of values of *fiumaras*.

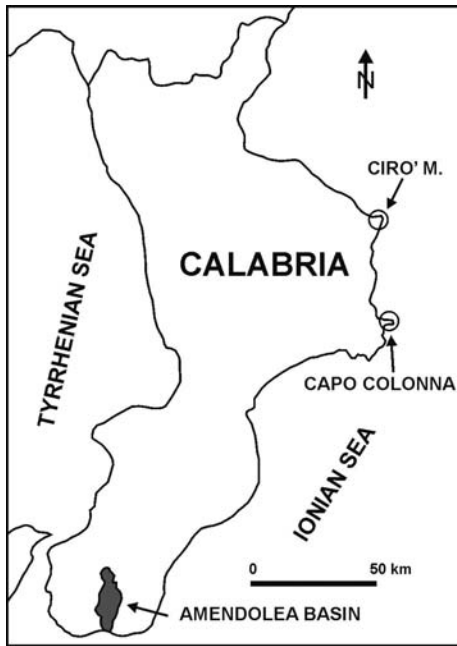


FIG. 1 - Calabria and study zones.

#### The mountain reach

The upper reach of the Amendolea *fiumara* (fig. 2) is not a *fiumara*, but a mountain torrent whose name is different: it is called Menta. It flows on a moderately dipping area at about 1400 - 1900 m a.s.l. An earth dam is being built on this mountain stream at ca. 1400 m a.s.l. (fig. 2). At the beautiful Menta fall (figs. 2 and 3), where the stream jumps down a fault scarp, the morphology of Aspromonte changes abruptly. The valley deepens dramatically and slope gradient increases to an average of over 100%. Mass-movement of various types produces debris that occupies the stream bottoms with a relatively thin cover, progressively increasing downstream, but at a low rate.

The Menta fall represents a particular case of duality in *fiumara* environments, as the site from where hikers may see the best view of the fall, is exactly where an active rock fall has recently released several hundreds of cubic metres of large blocks.

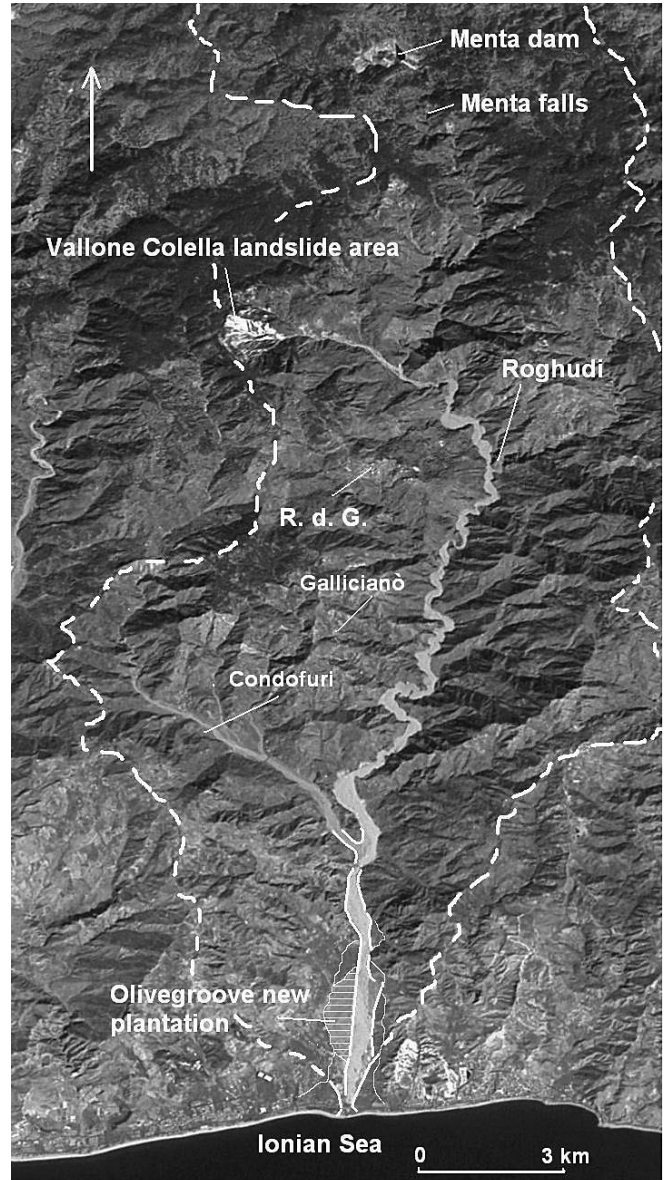


FIG. 2 - Satellite view (kind permission of Digital Globe) of the Fiumara Amendolea basin. R. d. G. = Roccaforte del Greco; the broken line is the F. Amendolèa watershed. Downstream the dam, near the Menta falls, the low local relief morphology of the upper reach changes abruptly into the deeply dissected gorge zone. Note the transformation from a normal mountain torrent to an aggraded stream due to the debris coming from the large Colella landslide on the left. More debris reaches the drainage network coming from many landslides downstream.

The mountain stream becomes abruptly a *fiumara* as the Vallone Colella tributary merges into the main stream (fig. 2). The reason for that is that the valley of this tributary is almost completely affected by a huge landslide area, probably the largest active landslide area in the rocky slopes of Calabria (Parise & alii, 1997).

Downstream of this conjunction the streambed becomes thick. Feeding from the landslide area is continuous since the extreme meteorological events of 1951 and 1954,





FIG. 3 - The Maisano waterfall.

so the *fiumara* beds are aggrading at high rates: in the last 20 years, ca.  $0.5\text{ m yr}^{-1}$  at ca. 5 km, and ca. 0.1 at ca. 20 km downstream of the conjunction. Aggradation results from the trend of a cyclical process, as illustrated above. Two villages are present in this part of the basin: Roccaforte del Greco and Roghudi (each with its Chorìo, i.e. country ward, in local Greek). Roghudi was abandoned after the storms of 1951 and 1954.

In the intermediate reach the *fiumara* slopes present a widespread landslide activity. Debris feed streambeds, but main feeding areas are concentrated in a few tributaries that form large debris fans at their confluence. Most of these fans are built by debris flows and hyperconcentrated flows. Alluvial episodes are rare. Such features are common to all Calabrian active or recent fans (Sorriso-Valvo, 1990; Sorriso-Valvo & alii, 1998). The small city of Condofuri and its country ward Gallicianò (where people are bilingual in Italian and Greek) lie in this part of the basin (fig. 2). Condofuri lies in an ancient debris fan, in a rather dangerous site. The abandoned small village of Amendolèa Vecchia (= Old Amendolèa), after which the whole *fiumara* is named, lies on a sharp ridge at the boundary between the mountain gorges and the terminal reach.

### The terminal reach

As the *fiumara* debouches out of the rocky mountain gorge (fig. 2), its bed widens in a sort of elongated fan that actually is a complex stream-bottom convex in its cross-profile. Here the thickness of the beds is over 20 m, reaching more than 90 m in correspondence with the coastal plain. Most of this coarse sediment is Holocene: its deposition is the result of the 120 m Holocene eustatic uplift of the sea level. Siding slopes are much steeper, being prevalently made of clay-rich sediments, and still heavily affected by mass-movement. As most of this reach is delimited by artificial levees, the *fiumara* bed is perched above the siding alluvial plain. The complex of the *fiumara* channel and siding plain is more than 1 km wide. Small villages and many farms are to be found in this area, where high-quality cultivations are widespread (e.g., bergamot orchards) and industrial settlements are being developed for economic improvement. Unfortunately, in some cases these good productive facilities are built on unsafe sites, as the new olive grooves shown in fig. 2. Indeed, in this section flood hazard is high: in January 1973, a bankfull discharge reached  $930\text{ m}^3\text{ s}^{-1}$ , destroying large tracts of levees and inundating villages and farms. Incidentally, such flood rate corresponds to a specific discharge of  $6183\text{ m}^3\text{ s}^{-1}\text{ km}^{-2}$ .

Unfortunately, other cases of bad land management are present in this *fiumara*. Check-dams for erosion control had been built along the middle and terminal branches in the 1990s. They were apparently badly designed, given that intervening, normal-sized floods quickly destroyed them. Indeed, they underwent suffusion, being founded on the stream deposits and not on bedrock.

As a positive side effect, this check-dam failure avoided the much worse effects of beach erosion. However, all that means total lack of territorial co-ordination and concern about side-effects.

Other cases of very bad effects of badly-designed and/or built structures are to be found along several Calabrian *fiumara* streams. Such cases most often include: levees cut for road crossing; building onto the riverbed, inside the artificial levees; bad design of levees as regards hydraulics; channel covering with urban streets and boulevards in aggrading traits; gravel quarrying; drilling wells on the bed to exploit subalveous groundwater, with rapid and dramatic effects on saltwater wedges in the deltas. Some of them can be considered as mistakes, others are a deliberate breach of laws and rules, as in the case of the terminal reach of the Fiumara Novito, South Calabria. The border of two adjacent cities runs along the *fiumara*. Both siding communities decided to build a waste deposit area each on its own bank. Besides the problem of pollution owing to the fact that the bedrock is a coarse, very permeable alluvium, waste deposits were built in large part in the area within the levees. The effects of that were clear after the big storm of September 2000, when the flood eroded part of the deposits, with consequences that do not need illustration. During the flood, the *fiumara* built a fan-shaped barade-up of debris and garbage at its mouth; such bar lasted only a few days. In fact, owing to strong surfs the coastal drift swept it away quickly, and siding beaches enjoyed a waxing stage.

Two key questions rise: are such devastating activities the result of ignorance or of deliberate illegal acts? How can the highly educated people ruling public agencies act in such an irresponsible and illogical way?

Apart from the man-made problems it is evident from the above description that the *fiumara* is a striking example of duality: high hazard and beautiful landscape; good and very bad land use.

## INTERFERENCE OF NATURAL HAZARDS WITH CULTURAL HERITAGE

Two case studies are illustrated here to show how natural processes may change local morphology resulting in a long-term and increasing danger for cultural heritage.

### *The Cirò Marina subsidence and the Apollo Aleo temple*

Cirò Marina is a city of 6000 people located along the shore of the Ionian Sea in North Calabria, on the flat Punta Alice promontory (fig. 1). In July 2004 a ground crack ca. 4 km long, parallel to the coastline (fig. 4), damaged several houses and caused a sudden acceleration of the on-

going subsidence of the coastal plain and beach between the crack and the sea. The ground between the crack and the sea coast includes ca. 20% of Cirò Marina, comprising valuable farmland, seaside tourist resorts and the remains of the Apollo Aleo temple. This temple most probably formed a sacred system together with the temple devoted to Hera Lacina, built by Greeks on the Capo Colonne promontory, 80 km south of the Punta Alice promontory.

Subsidence actually affects a much larger territory along this coastal area (Guerricchio & Melidoro, 1975; Guerricchio & *alii*, 2000). An event similar to the one which occurred in 2004 had occurred there in August 2000: there is neither a detailed report nor a map of the 2000 event, but most of the houses damaged in July 2004 had been damaged already in August 2000, so it is probable that the 2004 event was a replica of the earlier one. Witnesses report similar events in 1980 and the 1940s, with fewer details and reliability as we go back in time.

The crack had maximum vertical and horizontal displacements of ca. 4 and 2 cm, respectively. For a long tract it corresponds to a scarp some 2 m high whose attitude is consistent with respect of the current displacement. The nature of the phenomenon that is causing such episodic movements is still an open question: landsliding and/or aseismic creep along a fault, with the contribution of seasonal consolidation of swamp clayey deposits, are the possible causes, while other hypotheses, such as the subsidence caused by gas exploitation offshore, should be discarded as the scarp is detectable on aerial photos shot well before gas exploitation was initiated (Sorriso-Valvo & *alii*, 2005). This scarp corresponds with the inner shore of a formerly permanent coastal swamp, the Vurga swamp, that now is only flooded in winter, thanks to drainage works in the 1930s. A beach dune strip separates the pebbly beach from the ancient swamp.

The Apollo Aleo temple (fig. 4) was built by the Enotrian people with wood and terracotta in the 6<sup>th</sup> Century B.C. The myth says that they built it here because this was the sacred area dedicated to Apollo by the Thessalian hero Philoctetes, the hunter, a companion of Odysseus, after his return home from the Trojan War. The temple was rebuilt with stone walls and columns in Hellenistic style in the 3<sup>rd</sup> Century B.C. by the Brettian people, who by then had forced the Enotrians out of Calabria (Genovese, 2001). It is probable, but no data are available yet on this topic, that the Vurga swamp was present at that time. Fish and methane (whose emission is indirectly proved by several reports in past centuries) would make this site very suitable for vaticinal practices.

The Apollo Aleo temple lies today at the elevation of only 5 m a.s.l. In addition, 10 m high dunes lie in the rear beach. This situation is inconsistent with the common practice of building temples in elevated places near the coast, where they could easily be seen offshore and at the same time be relatively protected against piracy. Given its present location and altitude, the temple would be not visible to ships offshore.

The current subsidence in the Cirò Marina area is occurring at a rate of ca. 7mm/yr. This value has been mea-

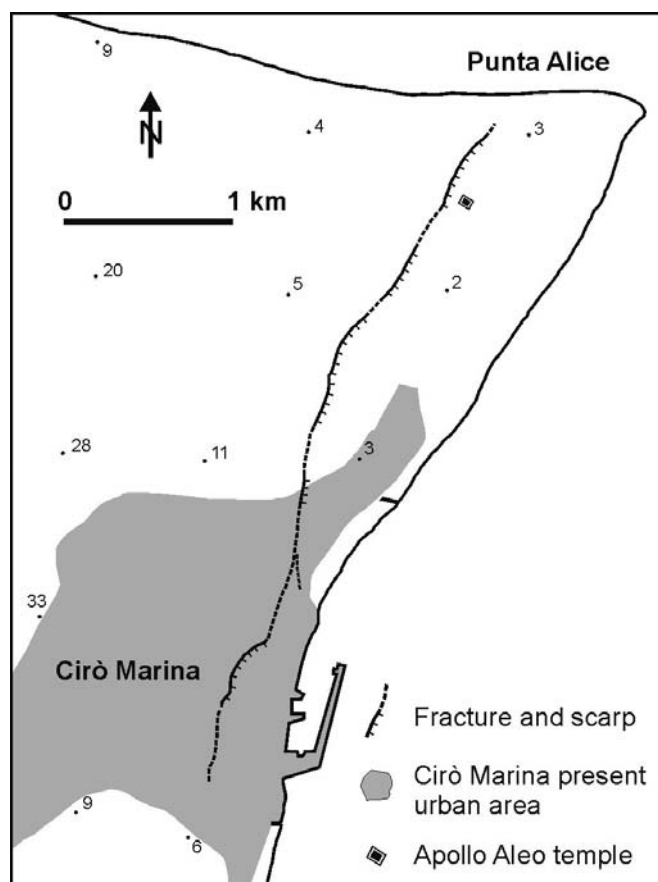


FIG. 4 - The Cirò Marina zone affected by the active crack. Figures are elevation above sea level.

sured by precision levelling performed between 1972 and 1991, and the origin of the subsidence is considered to be tectonic (Guerricchio & *alii*, 2000). The discontinuous subsidence caused by the local movements at Cirò Marina accounts for an additional ca. 5 mm yr<sup>-1</sup>, so ca. 12 mm yr<sup>-1</sup> is the total estimated local subsidence in the area where the temple was built. At the present subsidence rate, not including the localized subsidence of Cirò Marina, whose time of initiation is unknown, the Punta Alice area has reduced its elevation of ca. 16 m in respect of the 3<sup>rd</sup> Century B.C. The site of the temple was also more distant from the shore. Indeed, given the present slope of the sea bottom, the coast line would lie ca. 1 km offshore. In such a position the temple should have been visible and defendable.

The Vurga swamp could be there however, because it was, as it is now, fed by brooks coming from hills.

#### *The Hera Lacina temple*

The Hera Lacina temple (fig. 5) was built in the 5<sup>th</sup> Century B.C. on the Capo Colonne promontory (Lena, 2001), on a marine terrace 20 m above sea level. The archaeological site includes other buildings. The temple was damaged in Roman times, but it endured until the 16<sup>th</sup> Century A.D., when it was dismantled in order for its material to be used for new buildings. The site was built in a safe place as regards subsidence, which is null or very small in this area. It is difficult to state today whether Greek colonials were aware of the subsidence on the Ionian coast of Calabria or not. There is no mention of that in the known literature of *Magna Graecia*. They were, certainly, aware of coastal erosion, which is today very intense because the terrace deposits lie on soft clay. So they built the temple on a site visible offshore, but at a prudent distance from the sea cliff. Sea erosion is causing a cliff retreat whose rate has been estimated in a range between 0.61 to 2.27 m yr<sup>-1</sup> in the last 110 yrs (Lena, 2001). Coast retreat rate was probably smaller in Greek times until the end of the 18<sup>th</sup> Century, when three small islands lying a few hundred metres offshore could reduce the impact of



FIG. 5 - The remaining column of the Hera Lacina temple.

surf (De Tavel, 1812). Sea erosion eventually dismantled these islands at the beginning of the 19<sup>th</sup> Century, allowing the surf to reach the cliff with its maximum erosive power.

#### *Danger and possible solutions*

In the Apollo Aleo area, the combined effects of the present subsidence rate of that part of the Punta Alice promontory where the temple was built (ca. 1.2 cm/yr) and the current sea level rise (ca. 1 cm/yr) mean that the sea will take more than 200 years to submerge the temple site. But if the subsidence is caused by a landslide that could undergo faster movements, and/or sea level rise will follow current global models, the time to submersion is much shorter.

Possible solutions to these problems are under consideration (Sorriso-Valvo & *alii*, 2005). Hypotheses hold that the city of Cirò Marina could be moved to a safer location when the subsidence has advanced to such a stage that sea ingression is possible with very strong surf.

The temple could either be moved or adapted to become a submarine archaeological area. In the latter case, countermeasures against wave erosion would be necessary until the sea depth was sufficient to make wave-impact negligible. For some idea of what needs to be moved or defended against surf erosion archaeological excavation campaigns need to be completed as soon as possible.

As regards the Hera Lacina temple, the present distance to the cliff from the ruins of the temple, with the unique existent column, is ca. 50 m. Given the present high rate cliff retreat, this important archaeological site could be reached in only 20-80 years. The solution will lie in marine works aimed at substantially reducing shore erosion.

In both cases there is still time before the countermeasures become urgent, and no warning signs have yet been perceived by archaeological and government authorities.

## DISCUSSION

The cases illustrated depict the situation in which the natural and cultural heritage of Calabria finds itself at present. Such a situation applies to most of southern Italy.

A duality problem is particularly evident in the fact that the prized landscape aesthetics are a consequence of the same processes that cause widespread economic marginality to these lands: complex geology, tectonic activity, aggressive climate, human activity.

Cultural heritage has been subject to widespread internal piracy enacted by local people of all levels of society who thought that their own interest took precedence over public interest. This attitude is being addressed but the process is far from over, so another dualism occurs in the nature of these lands.

The *fiumara* streams are a paradigm of duality of landscape.

The major problem is that *fiumara* territory suffers from slope instability and flooding to such an extent that its economic development has been strongly hampered over the last few centuries (Fortunato, 1911).



## REFERENCES

It is a common belief that the development of these areas requires a strong reclamation activity, with heavy intervention aimed at substantially reducing mass-movement and erosion activity. This, however, would result in the destruction of the natural environment in at least the lower reaches of *fiumara* basins, in expensive intervention measures, and in the high probability that such interventions may prove of short duration and low efficiency, as tectonics and climate are strongly active.

Some believe we could take advantage of natural *fiumara* lands by exploiting their wild beauty and promoting compatible tourist, agricultural and industrial activity, reducing hazards to an acceptable level. Such a line is indeed being followed by national and Calabrian governors, who have established several protected areas which cover more than 27% of the whole region.

A further step towards natural development might include the difficult decision of selecting the basins where interventions are not affordable or sustainable and leaving *fiumara* locations to develop by themselves as totally reserved areas. Besides improvement of wilderness and biodiversity, such a decision would improve the amount of debris budget for natural beach nourishment, helping to solve another problem for Calabria: the current beach erosion caused by the construction, in the second half of the last century, of several check-dams along torrent and *fiumara* branches, resulting in the stopping of most of the debris that formerly fed coastal areas.

The cases of the Apollo Aleo and Hera Lacina temples illustrate a duality involving human attitude towards cultural heritage. In the past there was no concern about cultural heritage. Starting with the Renaissance such concern has been growing in the public eye, but still some people create great problems. Natural processes already represent a threat to these important archaeological sites, and human activity has almost resulted in their destruction, even if such aggressive human behaviour arose, until few decades ago, from widespread poverty and the need for building material in a territory where good material is scarce. The Coliseum in Rome was damaged for the same reasons.

In Italy humankind has been in the past a destructive agent as regards cultural heritage. Even today awareness of the values of cultural heritage is still not common. Public interest hardly ever takes precedence over personal interest. This is the prevalent attitude towards cultural heritage among the Italian people.

There is room for concern not only regarding people's general failure to grasp the nettle but also the attitude of land managers and governors towards the value of cultural heritage and the need to put public over private interest. Quite apart from any lack of education or social responsibility, ordinary people and people in positions of authority may not be committed or really understand the value of cultural and natural heritage (in spite of declarations, rules and laws). This raises a general question in the context of several other pressing issues (lack of care for the environment, wars, extreme capitalist acts, and so forth): is humankind's duality without solution? Is *Homo sapiens sapiens* (wise, wise Man, in Latin) an appropriate name for our species?

- ABRAHAMS A. LI G. & ATKINSON J. F. (1995) - *Step-pool streams: adjustment to maximum flow resistance*. Water Resources Research, 31, 2593-2602.
- DE TAVEL D. (1812) - *Lettere dalla Calabria*. Rubettino, Decollatura (CZ), 126 pp.
- ERGENZINGER P. (1987) - *Chaos and order-the channel geometry of gravel bed braided rivers*. Catena supplement, 10, 85-98.
- ERGENZINGER P., GÖRLER K., IBBEKEN H., OBEMHAUF P. & RUMHOR J. (1978) - *Calabrian Arc and Ionian Sea: vertical movements, erosional and sedimentary balance*. In: H. Class, R. Roeder & K. Schmidt (Eds.), «Alps, Apennines, Hellenides». E. Schweizerbart'she Verlagbuch-handlung, Berlin, 359-373.
- FAIRBRIDGE R.H. (1968) - *The Encyclopedia of Geomorphology*. Reinhold Book Corp., N.Y., 1295 pp.
- FORTUNATO G. (1911) - *Il Mezzogiorno e lo Stato Italiano*. Laterza, Bari, 450 pp.
- GENOVESE G. (2001) - *Culti apollinei, presenze epicoriche e tradizioni filoteteie al Promontorio di Crimisa*. Rendiconti Morali Accademia dei Lincei, 9, 12, 586-672.
- GUERRICCHIO A., CANTAFORA L., GUERRICCHIO M. & PONTE M. (2000) - *Discovery of submerged fixed archaeological structures in the Crotona coastal strip between Strangoli Marina and Le Castella (Calabria region, Italy)*. Proceedings of 6<sup>th</sup> International Symposium on Land Subsidence - SISOLS 2000, 95-106.
- GUERRICCHIO A. & MELIDORO G. (1975) - *Geological investigations applied to the archaeology of the buried city of Sybaris*. Bulletin of International Association of Engineering Geology, 12, 83-88.
- LENA G. (2001) - *Caratteristiche geografiche e geo-archeologiche della fascia costiera tra Capo Colonna e Capo Rizzuto; i problemi di conservazione dei beni culturali e la pericolosità geologica dell'area. Interventi di salvaguardia*. In: G. Lena (Ed.), «Problemi geoambientali nella costa fra Capo Colonna e Isola di Capo Rizzuto». A. M. P. Capo Rizzuto Pubblicazioni, 19-32.
- MASTROLORENZO G., PETRONE P., PAPPALARDO L. & SHERIDAN M. (2006) - *The Avellino 3780-yr-BP catastrophe as a worst-case scenario for a future eruption at Vesuvius*. P.N.A.S., 103, 12, 4366-4370.
- PARISE M., SORRISO-VALVO M. & TANSI C. (1997) - *Mass movement related to tectonics in the Aspromonte massif (southern Italy)*. Engineering Geology, 47, 89-106.
- SORRISO-VALVO M. (1990) - *The fill-and-cut sequences in the Trionto river valley*. In: M. Sorriso-Valvo (Ed.), «Excursion Guide-Book. IGU-Co.M.T.A.G. Symposium on Geomorphology of Active Tectonics Areas, Cosenza, June 1990». GEODATA, 39, 71-78.
- SORRISO-VALVO M. (1993) - *The geomorphology of Calabria - A sketch*. Geografia Fisica Dinamica Quaternaria, 16, 75-80.
- SORRISO-VALVO M. (1998) - *Italy*. In: A.J. Conacher & M. Sala (Eds.), «Land degradation in mediterranean environments of the world». Wiley, New York, 41-57.
- SORRISO-VALVO M. (2004) - *Fiumare*. In: R. De Filippis, C. Brusa, A. Cantile, A. Di Blasi, P.R. Federici, A. Gherdovich, V. Sanseverino, B. Vecchio, M. Marrani (Eds.), «Italia - Atlante dei tipi geografici». Istituto Geografico Militare, Firenze, 161-163.
- SORRISO-VALVO M., ANTRONICO L. & LE PERA E. (1998) - *Controls on modern fan morphology in Calabria, Southern Italy*. Geomorphology, 24, 169-187.
- SORRISO-VALVO M., GULLÀ G. & ANTRONICO L. (Eds.) (2005) - *Indagini, studio e monitoraggio del dissesto in atto nel centro abitato di Cirò Marina. Relazione Finale*. Convenzione tra CNR-IRPI e Regione Calabria, Assessorato alla Protezione Civile, per lo studio ed il monitoraggio del dissesto di Cirò Marina. IRPI, CS, 162 pp.
- SORRISO-VALVO M. & TERRANOVA O. (2006) - *The Calabrian fiumara*. Zeitschrift für Geomorphologie, 143, 105-121.

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