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## 1. Characters physiographic

The territory of C.M. Sheets is in IGM 533, 534, 535, 542, 543, 544 that enclose much of central and northern portion of Calabria and the Chain of Pollino. From a morpho-Physiography distinguish two main areas:

- First, Western, is mountainous and is the major Dolomitic-relief limestone, which are flanked in the south-western edges of metamorphic rocks epizonali. Some of the highest peaks of the Calabrian peninsula fall into this area, such as Mt Pollino, The Cozzo del Pellegrino, the Mula, the Caramolo Mt.

- The second area, Eastern Europe, has characteristics of basin and the land tertiary and quaternary. E 'crossed by major river in the area, the F. Coscile that after receiving its tributaries over the right (the Garga and F. F. Esaro) grafts in F. Crati portion in the bottom of the Plain of Sibari. It 'a very articulated system mountainous, with several peaks spread to the sides of the valleys of F. Gargano and the F. Coscile that found in Mt Caramolo the largest share (1827 m above sea level). The grating basin, well developed and oriented towards NW SE and E or W to ENE, appears frequently retrace the evolution of major tectonic lineation and shows a dense segmentation with high values of the Horton indicative of the importance of youth. Throughout the CM. falls in the catchment area of Coscile and partly in the basins of the Lao and Raganello physiographic and is bordered by a series of reliefs mountain culminating in 2180 slm:

LA DESTRA (1290 m)

Rossini (m1238)

PALAZZO (1131 m)

COZZO DELL'ANTICRISTO (m 1562)

COZZO Ferriera (m 1790)

COPPOLA di PAOLA (m 1919)

Timpone della capanna (m 1823)

SERRA del Prete (2180 m)

POLLINO (m 2248)

Dolcedorme (2267 m)

Pietra del demanio (855 m)

The orography of the Mountain Community has been defined in its basic connotations, through the development of the following thematic maps:

- The map exposure of the slopes;
- The map of the slopes;

- Altitude map;
- The graph of the river basin hierarchical grid.

for the display were produced as PDF files attached to this report.

## 2. **Geological and tectonic framework**

The latest geological and structural synthesis of the Border Calabro-Lucano arising from the work of several Italian Authors (Bonardi G. et al., 1971; D'Argenio B. et al., 1973, Scandone P. et al. 1974; F. Ippolito et al., 1957, 1975; Pierattini D., 1975, 1976), outline a regional geological model (Amodio Morelli L., 1978) which defines the Arch-Peloritano Calabro as a fragment of the Cretaceous Alpine Chain -paleogenic, vergent Europe, consisting of beds pens, liguridi and austroalpin, thrust in toto in the Lower units Miocene more internal future Chain Appenninica Neogenic and vergent Africa. The first two units described are part of the "Chain Appenninic" ss, the third of the "Chain Alpina" sl. The thrust latter is due on the earlier Miocene Inf. Inf. In Miocene-Middle Frido unity with the unity of Verbicaro the base overlap on S. Donato. Subsequently, from the Miocene Plio-Pleistocene, the two "chains" would have moved towards the North, then followed during Plio-Quaternary tectonic effects of disjoint. Among the lithologic Mesozoic are particularly frequent limestone and dolomite based on oil shale of the high Trias basin in Esaro last tributary in the right Coscile. I Trias limestones of the Cretaceous Lias and occupy the whole area up the imaginary line joining the centers of S. Agata d'Esaro, Lungro, Saracena, Morano e Castrovillari up behind the massive Pollino and give it the familiar connotations of rugged landscape and little vegetation. These formations are separated by the most recent and permeable of Pliocene and Quaternary from a train dell'Eocene schists blacks average, according to a line joining St. Replaced a Castrovillari; from S. To be replaced Lungro also found clay and Salif gessifere the upper Miocene in which the mine is located Salt Lungro. The village which is located in a geological-structural-geomorphological very complex area is a meeting between the sedimentary deposits of southern Apennine chain and crystal litotipi dell'Arco Calabro, behind two major tectonic lines to regional significance, the Pollino line and the line Sangineto. These are the most important tectonic structures that have controlled the tectonic evolution - sedimentary land. The line of Pollino presents characters left by most of Authors. The line of Sangineto to NE-SW trend, with features left, forms the border between Arco Calabro and the Southern Apennines, and between land and crystalline Calabrian Apennine carbonate and is the most important structural element, that NW beyond the basin of River Crati this is a system of faults in the prevailing direction  $N30^{\circ} - 40^{\circ} E$ , to a SE with an inclination of  $60^{\circ} - 80^{\circ}$  whose main floor is observable in several places at St. Donato di Ninea and Saracen where striae are visible with oblique pitch from 25th to 60th that indicate a movement transtensiv left.

I neogenico-Pleistocene deposits are involved in motifs folds displaced by systems faults. The deposits of Pliocene sequences and the lower miocenica are affected by folds in NE-SW direction in the field of T. River, between Acquafamosa-Lungro and Altomonte, and folds in the direction of  $N10^{\circ} E$  in the area east of Policastello. The deposits of the sequence plio-Pleistocene are arranged in a series of folds in NE-SW axis. The amount of bending is different from area to area: between T. Loppolo Ficara and have seen a series of parallel anticlinal and sinclinal a radius of curvature relatively narrow, unlike the adjacent structure Altomonte consists of a bland and largely sinclinal. A NE T. Fiumicello the folds are larger and less pronounced. The reasons folds are themselves displaced by systems faults mainly NW-SE direction, NE-SW and to a lesser extent  $N + 10^{\circ}$ . The system direction NW-SE also includes the line Sangineto.

### **3. Geomorphology**

Using the criterion of classification hierarchical forms, and with reference to those of the first order, measurements of the carbonate group of Pollino, the chain-Dolcedorme Manfria Serra, the Timpa of San Lorenzo and Falconara and up to Mount Sellaro are delimited and raised by normal-faults trascorrent left subvertical with directions around 120-130 ° N, active until mid Pleistocene (Monaco & Tansi, 1992) and are delimited to the south by a structure which is a tectonic lineations a regional value note Line Pollino that is interrupted by the normal structure, direct NE-SW with draft SE, which extends from Francavilla Marittima in Unadilla. In this particular area geomorphologic Recent research has estimated a rate of lifting, in the last 0.7 MA, approximately 1 mm / a (Westaway, 1993). Along the edges of the blocks raised will reach the maximum gradients clivometric that translate into forms that assume the characters of fault escarpments very high (up to more than 800m) as in the gorges of Raganelli, or those of a tier of embankments, with mixed Synthetic forms and antithetical with a set predominant. The tectonic depressions are areas where the rate lifting is smaller than those raised or started later. The Monte Pollino is a raised area along the fault in the same name in connection with the termination of the North Coast Chain (M. Palanuda Group) which is separated from the morphologically Sangineto separating the domain from the Apennine mountains.

Among the forms of second order are to include the paleo-surface Pollino namely depression due to erosion and river intra-mountain tectonic depressions, such as the Rotonda area and the Campotenese. On the slopes more and more high slope, usually set to very fractured rocks, develop phenomena gravitativi with predominance of type complex scroll-casting and rock debris or earth and debris. Forms typical of the high areas of the Group of Pollino remains of ancient middle surfaces, although still with significant energy. Very frequent fan forms, placed at the base of the main findings, such as that between Morano e Castrovillari, and karst forms that are attributable to the third order as mainly controlled by climatic factors, seismic and man-made.

### **4. Climate and rainfall**

Internal surveys show a climate of type Apennines, with a long rainy season from autumn to spring, cool summers in higher-hot and muggy in the most depressed areas. The rains are common in snowy winter quarter to exceed their quotas 1200 m but affect all the years also the high hills. The peaks of the Pollino and the plateau of the Sila snowpack (which reaches a seasonal average of 220 cm to Camigliatello Silano) remains on the ground for about 150 days, while nell'Aspromonte (where the height of fresh snow can also reach the 3 m), due to the current sirocco that promote their ablation, the mantle remains to the ground for about 100 days. The analysis of social conduct heat from Bellecci et. al. (2003) indicates that this autumn is warmer than spring and that variations in the mounths, there is a sudden transition between the warm season and cold, with small variations intra-seasons. The index of standardized anomaly (SAI) of minimum temperature, average and maximum rainfall and number of rainy days shows an increase in minimum temperatures and a decrease of maximum temperatures between 1921-1990. In the area of Pollino is observed in the period 1921-1990, a decrease of precipitation and an increase in rainy days.

### **5. Flood risk in PAI Calabria**

### **6. The assessment of the risk of landslide adopted by PAI Calabria**

In the towns of C.M. have been classified areas at risk as is summarized in the table below.

landslides risk (Source: Calabria PAI)

By analyzing in detail the relationship-type landslide risk areas resulting in built-up areas of the Mountain Community is a result of risk levels and topography and the activities of these landslides.

### **7. Research for NetWet3**

As part of this work provides a contribution to the flow of the river most important of the Coscile, and susceptibility to landslides over the entire territory of the Mountain Community. For the basin Coscile was developed a forecasting model of full time with a return of 20.50 and 100 years that helps to enrich the knowledge of the risk of hydraulic defined by the Plan Excerpt Basin for attitude hydrogeologic of Calabria ( PAI) (Caracciolo et al., 2001).

In the context of landslide danger of Cities of the Montana provided by PAI is added with research developed in NetWet3 Project, the assessment of the landslides Suscettibilità Community territory for Montana whose assessment was developed and applied a standard methodology for probabilistic based on remote sensing techniques.

For obvious correlation between transport of solid water and processes morpho-evolution line bank, was also prepared a comparison between the lines the shore at various dates, at the mouth of Lao and Crati.

### **8. Sources documentary**

Given the value of indicator attributed to historical and documentary sources, as part of this work, has contributed to the entire database of historical and documentary sources. We suggest the following sources from which information can inferred, with different degrees of reliability at risk as well as hydrogeological cross and the construction of hydraulic works of defense.

The sources are differentiated according to different criteria and methodologies. For the purposes of assessing the risk of discrimination is the possibility or otherwise of the event georiferire ie locate and classify (T. Caracciolo, G. Chiodo, 2005).

The main information regarding the risk hydrogeological and used in this work are:

1 - historical maps. Sources geographical diachronic a different degree of accuracy and precision.  
2 - aerial photo interpretation of Sunrise: sources diachronic a different degree of resolution in relation to the share of flight and found with traditional or digital cameras.  
3 - Archive PAI: archives and historical archive is at the Basin Authority's Calabria region.  
4 - ODA Archive: archive of historical documentary sources of Environmental Literature at the Department of Soil of Calabria.

5 - Archive alphanumeric Plan forecast and prevention of the Province of Cosenza.

6 - Archive alphanumeric Plan Regional Forecast and Prevention

7 - State Archives of Cosenza (For S)

8 - All floodwater from the Parliamentary Commission of Inquiry 1970 (De Marchi Commission).

9 - Areas of flooding - Geotechnical Investigation, 1973.

10 - Areas of Reclamation - report Commissariale of 1913.

11 - Areas covered by subsidies and hydraulics - Archive of Reclamation in Sibical (Information System of Reclamation Calabresi at the Center CHARTPLOTTER the Calabria Region.

12 - Database of names at the Center CHARTPLOTTER the Calabria Region.

13 - bibliographic sources and newspapers.

The following is an example of information derived from analysis of historical maps that shows how over time About 200 years the river has Coscile Crati into the river to catch a phenomenon or, more likely, for remediation activities end of river in the areas of dui waterways. Acquired from documentary sources were unable to obtain a series of useful information for risk analysis plumber. The essay points out that running the perimeter of different areas in the flood basin Crati based on different sources. The analysis of different sources documentary has brought the development of a PAPER AREAS OF HISTORIC floods in PIANA of Sibari (SOURCE CALABRIA PAI), in which different colors indicate different sources for information as evidenced by the following figure. The risk analysis in hydraulic Towns of CM deducted from documentary sources made it possible to derive qualitative assessments of risk hydraulic as shown in the table below.

## **9. Multiparametric approach to the definition of landslide susceptibility from the territory of C.M**

As part of studies for the project NetWet3, was developed a methodology that leads to the definition of an indicator called susceptibility which is a method of multivariate statistical analysis using GIS technology is particularly appropriate for this type of investigation.

The susceptibility to landslide is defined as the propensity of a all'innescarsi of landslides making it useful in terms of prevention potendosi estimate the degree of instability on the one side over another.

The analysis consists in giving weight to each parameter reported as "cause" of damage, allowing to interact, using statistical formulas, parameters with their "weights" to highlight the potential instability of a slope based on probabilistic. The technique is based on Bayes Theorem (BW Morgan, 1968), which, each "frequency" can be used to calculate the probability of a future event. For the analysis of susceptibility to landslides have been mapped areas in the state with the landslide of active or quiescent. The "weight" of classes issues was defined by Western Van (Van Western CJ, 1993), the natural logarithm of the ratio between the density of landslides in the class under consideration and that of all the landslides in the area of study:

$$W = \ln \left( \frac{\text{densità classe}}{\text{densità mappa}} \right) = \ln \left( \frac{N_{pixSi}/N_{pixNi}}{\sum N_{pixSi} / \sum N_{pixNi}} \right)$$

This methodology is innovative in that the probabilistic analysis is the same objective: the weights assigned are extrapolated from data mapped and then actually present in the study. Finally, by adding different weights of all the predisposing factors considered, there was a "Charter of susceptibility to landslide," in which they were identified, based on the characteristics of the territory, five classes of increasing susceptibility based on the value of W calculated . For high values of W, has given a high probability that there are movements gravity. The paper obtained consists of a continuous range of values ranging from a "minimum" (negative) to a "maximum"

(positive), and was later reclassified in order to have a scale of values with a distance equal (equal value) divided into 5 classes.

## **10. Learning activities**

The organization of the stage to collect documentation concerning sources for their heterogeneous nature and diachronic which accordingly is given a value that ranges from mere reporting and / or location of an event, its detection, perimeter and cataloging. It is enough in this regard, consider that were examined historical sources, newspapers, letters and correspondence that scientific publications in any event permit:

- systematize and organize a database alphanumeric;
- census of the flood and landslides with criterion diachronic and proceed to their mapping to detection and analysis of the factors of danger;
- determine the intensity of events and the vulnerability of the items on display.

Of particular interest, especially for landslides and coastal erosion, is the analysis aerophotos with stereoscopic techniques and procedures, complemented and supplemented by in situ observations and the development of a Card Collection, (IFFI tab of SS.TT . NN adapted to Calabria), which classifies phenomena, based on their type and state of activity. The class of landslides include: slides, flows, falls, topples, fast flows, ground and / or cones of debris, fan casting from detrital and mixed lens surface deformations.

The learning activities and thus leads to the formation of cards inventory of landslides, flooding and coastal erosion and its database representing the level of the first analysis of danger '. For landslides activity detection involves the examination of four classes of events: landslides, areas of intense erosion, DGPV, landslides not mapping.

## **11. Findings of susceptibility**

For the analysis has been carried out fot interpretation through analysis on stereoscopic pairs of Flight frame of Calabria 2001. Preliminary analysis concerned the definition and the relative weight of individual classes of acclivity and exposure of the slopes. The territory is mainly in hilly areas covered by sub flat for 29% and, at the reliefs and 25% in mountainous areas with very acclivity slope greater de 50%.

The grouping of lithologic litotecnic classes in uniform is based on criteria correlate with the characteristics of shear-earth and rock masses. On the basis of the Charter on the Use of Soil CLC Level 3 to scale 1:100.000, have defined the main classes' use which shows the little relevance in urbanized areas than in agricultural and forest land.

The analysis notes photo-interpretety a landslide in the area (excluding erosion) around 5% with values of frequency of landslide events that have been differentiated according clivometric, litotecnic and land use to show how charts below. The trial has implemented an assessment of landslide hazard by drawing up a map of landslide susceptibility particularly useful for planning activities. In the case of the area studied, indicating that the danger of the territory, as a landslide, is basically little high but there are still situations of high risk and hazard in built-up areas, in particular, indicates Lungro, for whom it is necessary structural.

## **12. Coastal erosion**

In order to provide assessments of the dynamics in the coastal areas of end Crati and Lao will provide the data of erosion and nourishment in areas adjacent to those mouths with their levels of risk. You should specify here that while the mouth of the crater and remained stable in 50 years that the Lao is behind the 136m.

## **13. Human activities, landscape and hydrogeological risk**

### **13.1. Environment**

The occupations of public lands and obtaining concessions of land to implant hilly vineyards and olive groves, is accompanied to reclamation and deforestation leading to extensive disruption of the hydrological events that led floods and floods (Teti, 2003) also stem from other sources reported that flooding in Cosenza in 1590 and in 1603 respectively Crati and Busento. The earliest documented floods the plains of Crati and Coscile refer to the first half of '500 and are documented in Sollazzo of Corigliano. The trebling of the population between the Calabrian '500 and '700, while a decrease in the first half of '600, villages in hilly determined deforestation and land reclamation that radiates from population centers covering the hills between 250 msm, Limit below which the malaria, and the share of 750 beyond which it was not possible to cultivate olive trees. E 'in this period that we are witnessing a radical change of scenery increasingly connoted by olive trees, crops and pastures gradually replacing forests and the' establishment of a widespread erosion of fertile soil and transport solid downstream in increments floods of coastal (Brasacchio, 1977). Between 1630 and 1635 the most fertile land of the fief of Corigliano, those Apollinara were repeatedly flooded in 1655 so that the Mayor of the City was forced to complain about lower revenue due to abandonment of those lands.

The eighteenth century is closed with a Calabria marked by indelible scars on the effects of seismic crisis of 1783. The high number of victims of the country destroyed, the enormous amount of landslides induced (about a thousand, with the formation of at least 215 lakes of the barrier and the profound alteration of the landscape were the occasion for a general and widespread analysis of the state of territory hitherto unknown to which accompanies the first systematic work of reconnaissance and representation of the status of the territory.

Between 1777 and 1778 the Plain of Sibari appeared to Swinburne (1968 reprint) impenetrable and pervaded by lethal miasma smell the marshes: "... many centuries, alas! have now passed since men lived in this flat number sufficient to ensure the wholesomeness. Since then rivers have dropped without regulation and without brakes on these fields depressed and desolate leaving, after having returned to their beds, black puddles and swamps that stinking poison the entire region and carry the people ever farther .... " The "culture of random exploitation of resources, the great season of reclamation, the conquest of new spaces to crops and agricultural exploitation at the expense of forest, through unprecedented destruction of forests" had made between the sixteenth and seventeenth century Of southern Italy, "one of the most magnificent of erosion of soil from around the Mediterranean basin" (Bevilacqua, 1996). The reclamation of wetlands and coastal ponds, begun under the Bourbons with the first studies Afan de Rivera, led to crop already made during the eighteenth century of vast areas ranging from Raganello and left the hydrographic Coscile (Rizzi Zannoni, 1811). They bought purely organic with the approval, in 1906, the first Special Law for Calabria who defined in the reclamation in its broadest of hydrogeological general basic unit of land identified in the catchment area. The ability to make productive water from the complex network of

hydrographic basin is largely manifested at the turn of the nineteenth and twentieth when the availability of water made possible the modernization of mills Oil mills and the spread of crops and citrus dell'ulivo which together reclamation of coastal areas, marked the most radical changes in the agrarian landscape.

Philosophy of "full remediation" were inspired, from the '50s, the policies of the Fund for the Extraordinary Intervention in the south with which we complete the construction of a complex and articulated network of irrigation and colo who completed the remediation the Plain of Sibari, organically launched after 1925, which marked, first from villages in the rural areas of remediation, and the year of agrarian reform, the restocking

Flat where, gradually reducing the risk of floods, the last major flooding incidents have affected the river Coscile with broken walls in 1923, in the 1925-26 and 1930-31.

The expansion of towns construction of CM in the last 30 years, less the comparison between the areal extensions of urban perimeters in 1954 and 2003, shows increases between 100 and 300% of the land occupied housing while the expansion in the presence of demographic dynamics suggest that, during the years 1991 -- 2001, decreases in the population or stable conditions. The availability of soils buildings, machines and modern technology have led to physical marginal areas of the ancient towns known historically as little more stable or otherwise inaccessible, with consequent increases in risk areas for landslide as it emerges from the comparison executed on aerial photographs and comparison with the geological mapping.

### **13.2. Afforestation**

Among the factors most important anthropogenic have changed the landscape regional and stabilized the mountain slopes is intense and include long work of reforestation. The bare area reforested in the first 20 years of application of special legislation (Special Law 1117/1957) was evaluated in 122,000 ha of which will add 30,000 ha of degraded forests again (Charter of the Mountain, 1976). Public intervention was aimed at consolidating the sides disesteated higher acclivity in compliance with the provisions of the Plan of Max for Calabria developed in 1957 by the scheme to the south. The plan showed the following values of agricultural and forest area in failure (landslides and erosion):

- River Lao 25% of which 0.5% in landslide
- River Coscile 21% of which 2% in landslide
- River Raganello 27% of which 4% in landslide

At the time of drafting the Charter of the Mountain by the Ministry of Agriculture and Forestry (1976), the Community of Montana Pollino already had 20,942 ha of forest equal to 31.8% of its land area.

In 1974 the total extension of woodland in Calabria was 422,000 ha corresponding to an index of woodiness, 28% (ISTAT data), in 1997 the woodland was 570.000ha (Data IFN) with an index of woodiness 38 %.

### **13.3. Human activities in the basin of River Crati**

A reconnaissance activities and census of manufactures and indicators of degradation was performed during 2001 under the Service monitorage Hydraulics of Calabria Region. The data that is exposed in the table shows a high index of degradation with implications on surface and underground water of exceptional significance even if you think the phenomenon of concomitant reduction of more than 10m in from 1976 to today, the surface piezometric effect of the proliferation of points out through underground wells.

#### **14. Tips for a successful policy of soil conservation**

The intervention in the area of soil conservation in Calabria has not yet strategically as is happening throughout the Italian territory. The use of a type of emergency multiplies the cost of operations and will not prevent disasters.

The level of danger in Calabria hydrogeological and Italy is grown in relation both to decreased anthropogenic pressure in hilly and mountainous areas that parallel to the congestion of medium and large urban areas and coastal. So do not come unless the reasons for planning to scale Basin as provided for by Law 183/1989, a reversal of trend in 'land use and planning of interventions aimed at prevention. If you recognize the need for continued cyclic characteristic of emergency must be an end result of the high economic and social costs, it follows that the soil conservation must take exceptional importance in order to so-called fundamental structural weaknesses that affect the demographic aspects that those geographic and urban armor. These operate in a preventive as development objectives are closely related to stability and functionality of the territory. Overcoming therefore the logical to assume that the emergency planning which means that even programs of soil conservation are located within a unitary framework and operations of the territory, scheduled basin scale.