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SLOPE STABILITY AND VEGETATION COVER ECOLOGICAL EFFICIENCY

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OBJECTIVES

The objective of the study has been to underline as the ecological efficiency of the different types of vegetation can influence the stability of the slopes. The ecological efficiency tightly results tied up to:

- the typology of vegetation,
- its distribution and the extension of the stains
- the coverage and the mixture
- the age
- the evolution
- the regenerative ability
- the presence of factors of trouble as the fire o pasture

METHODOLOGY

The study area, near the village of Cetara, is situated in the southern part of the Sorrento – Amalfi peninsula (Italy) at the end of the small catchment basin of the Cetus stream (3.8 km²). The mountain reliefs are essentially composed of carbonate rocks covered by the volcanoclastic deposits of the Vesuvius eruption in 79 A.D, and are characterised by steep slopes.

Surveyings have focused in the location of the typology and physiognomy of the various vegetation shapes in the river basin, leaving from the aerial photos interpretation with verification and control in field. It has given special weight to inspect in manner detailed the different ecomosaics (structural appearance), traveling in global manner the field to have not only a real sight of the significant differences in their space distribution, but also for individualize the more important relation between the different ecosystems (functional appearance) and the changes in course, which the fires, the landslides and the human activity, passed and present.

Besides they have been you execute specific reliefs of floristic-vegetation type and forest type, through the withdrawal of champions, in the first case, or the area test accomplishment, in the second.

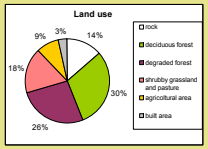
For the determination of the total overground biomass (trunk, branches and leaves) us is bases to you in part on the dendrometric parameters and in part on weighed carried out in test destructive areas. The forest and shrub age was checked through the wood samples in various situations.

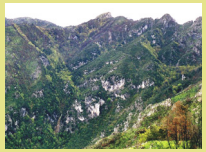
From these information, five thematic maps were edited with GIS (scale 1:5.000): soil-use, vegetation physiognomy, areas burnt in summer 2000, vegetation age (with cover > 40%) and biomass.

RESULTS

Land use

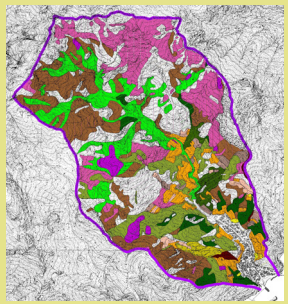
The field of the river Cetus presents a relevant uniformity of land uses, tight depending from the elevated slopes and from the abandonment of the agricoltural and zootechnic practices.





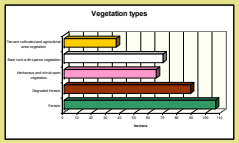
Vegetation

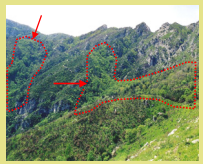
Based on the first distinction operated with land use, it has operated a detail mapping in order to characterize qualitatively and quantitatively the main vegetation typologies, with three classes of cover degree (I class: cover > 70%, II class: cover between 40-70%, III class: cover < 40)



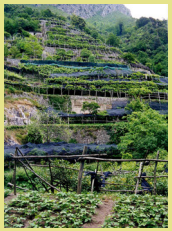
Sclerophyllous forest (*Viburnum-Quercetum ilicis*)

Roots of *Quercus ilex* that penetrates into the calcareus rock

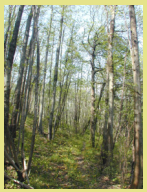




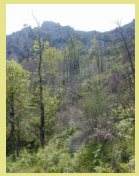
Broad-leaves forest (*Scutellario-Ostryetum*)



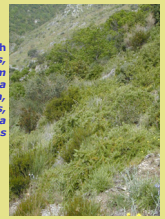
Coltivated terraces with Ctrus trees



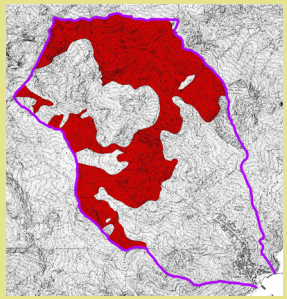
Clusters of chestnut (*Castanea sativa*)

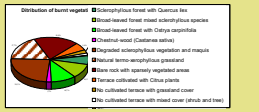


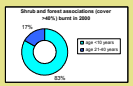
Degraded broad-leaves forest



Garrigue with *Cistus incanus, Rosmarinum officinalis, Erica multiflora, Teucium friticans, Lavandula stoecjas*







Fires

The fire, that burnt the Cetara's basin in summer 2000, interested a surface of 153 hectare, equal to 40% of the total area. Its ecological effect on the component "soil –plant" influenced the vegetation cover in the slope's stability.

The relation between fire and vegetation in the mediterranean environment presents a complex reality and rather problematic, that stretches out drastically to reduce the role of the vegetation to oppose the geolocical trouble and to mask the dynamics in action on old landslide surfaces.

In fact, like observed in Cetara's field, the vegetation is made up of mosaic of the populations created from different trouble events (like the fire, the landslide, the cut, the pasture), that modify the natural mosaic produced from climatic and soil factors.

The effects of the fire on the vegetation are direct and indirect and depend above all from the fire's type, the frequency and the climatic events that verify themselves in the successive period to its passage. These come to alter deeply the features of the ground, the local climate and the runoff.

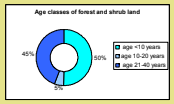
Mostly of the cases, like observed directly in the area, the fire destructed the organic matter to different depth and transformed it in ash, with alterations of the chemical and microbiological features, the creation of rabid films, the erosion of the superficial soil layers and the seeds in it contained.

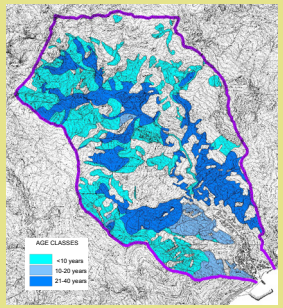
The fire, beyond that to simplify the structure of the vegetation, bringing back it, for example, to a juvenil phase, reduce too the functions of the patches to the landscape level, spoiling the "tampon" capacity with repercussion also on the stability of the some slope areas. Besides some parts of the system, repeatedly submitted to the factors of considerable regression trouble, reach to strong unstable stadiums, where it is reduced more the resilience's capacity.

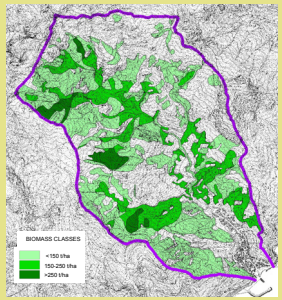
Age

The parameter age results connected, under the same conditions (ex. ferttility, vegetation type), to the development and structural dynamical processes of vegetation.

These component on the area is appeared "young"" or quite in "renewal" and is therefore distant from a phase of ecological stability and productive (in term of biomass). In fact were not surveyed forest or shrub areas with age older than 40-50 years, for causes connected both the fires and the action of wood cutting exercised in the past.







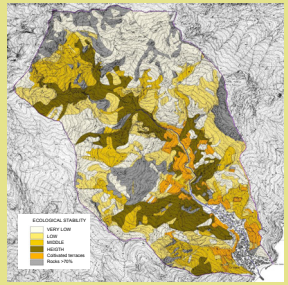
Over-ground biomass

The overload caused to the vegetation's weight (trunk, branches and leaves) on the stability of the volcanic soils in the area of survey results on the whole to have a modest influence, wheter out of the high variability of the topography or the relatively low values of biomass.

The distribution of three weight classes recognized reflects the features of vegetation "young-looking", with a greatest presence of biomass near the chestnut-woods and in some more fertile areas of broad-leaved forest with Ostrya carpinifolia, Fraxinus ornus and Acer obtusatum, orientated to north.

Intermediate values are drew along the main gullies and in some areas less degraded or with highest covering of sclerophyllous forest with a strong presence of Quercus ilex.

Besides in the superficial soils, where the overload of the vegetation it could influence much more on the destabilizing forces along a hypothetical flow surface, the roots aim to penetrate in the rocky substrate (if cracked) and therefore to anchor the soil. Such action, surely stabilizing, happen in those areas with soil thickness < 60-80 cm, mostly on the sud side.



Estimation of element a) and b)

Vegetation types	TROUBLE RESISTANCE C1	C2	C3	C4	C5	RESILIENCE (regeneration capability) C6	C7	C8	C9	C10	C11	stability f
LEG	F	P	C	I		F	P	C	I			
1 Sclerophyllous forest with *Quercus ilex*	3	3	3	3	10	3	2	2	2	9		90
2 Broad-leaved forest mixed sclerophyllous species	2	2	2	2	8	2	2	2	2	8		64
3 Broad-leaved forest with *Ostrya carpinifolia*	1	2	2	2	7	3	1	3	2	9		63
4 Chestnut-wood (*Castanea sativa*)	1	2	3	1	7	2	1	3	1	7		49
5 Degraded forest	1	2	1	1	5	1	1	2	1	5		25
5 Degraded sclerophyllous vegetation	1	2	1	2	6	2	2	1	1	6		36
6 Garigue	2	3	1	0	6	3	1	1	0	5		30
7 Natural secondary grassland	1	1	0	0	2	2	1	0	0	3		6
8 Steppe	2	2	0	0	4	3	2	0	0	5		20
9 Bare rock with sparsely vegetated areas												1
10 Terrace coltivated	1	0	0	1	2	1	0	0	1	2		4
11 No cultivated terrace with grassland cover	1	1	0	0	2	2	1	0	0	3		6
11,1 No cultivated terrace with shrub cover	1	1	0	1	3	2	1	1	1	5		15
11,2 No cultivated terrace with mixed cover (shrubs and trees)	1	2	1	1	5	2	2	1	1	6		30
12 Olives groves	1	1	0	2	4	2	1	2	2	7		28

F= FIRE; P=PASTURE; C=CUTTING; I=DISEASES

0=indifferent; 1=low; 2=middle; 3=high

Column C5=C1+C2+C3+C4; Column C9=C6+C7+C8+C9; Column C11=C5xC10

Vegetation stability

To determine the eco-stability of the different vegetation types presents in Cetara's basin, it has look for individualize a synthetic qualitative approach based on the main physical-ecological features verified in the typologies of vegetation, through the identification of the following elements:

a) the resistance at the troubles due to the fire, the pasture, the cutting and the disease, keeping in mind the ecological factors connected to the species of the present population (height, foliage density, health, features of the radical system, density of the different layers, selvicoltural treatment);

b) the resilience or renovation capacity owing some troubles (see above), regarding the different seeding capacity, the asexual reproduction and the replay to soil alteration;

d) the extension of the patches;

e) the age of the vegetation before the fire of year 2000;

f) bio-physical alteration due to the fire, that affected also on the soil features.

To every element it was attributed a value being derived from a relative scale of syntetic judgment, divided from 3 to 5 classes, how reported here :

Estimation of element c)

Cover classes for each vegetation type	Value
100%	1
90%	0,9
80%	0,8
70%	0,7
60%	0,6
50%	0,5
40%	0,4
30%	0,3
20%	0,2
10%	0,1

Estimation of element d)

Extension of patches (ha)	Value
<2	0,5
2-5	1
6-10	1,5
>10	2

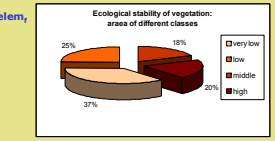
Estimation of element e)

Vegetation age	Value
<10 years	1
10-20 years	1,3
>20 years	1,5

Estimation of element f)

Burnt areas in 2000	Value
SI	0,5
NO	1

The total stability for each patch is egual:
ST1: $(st1_1*cov_1+st1_2*cov_2+.....st1_n*cop_n)*elem_d*elem_e*elem_f$
$st1_i$ = stability1 for vegetation type i present in the patch
$cop1$ = cover vegetazion type i (estimation element c)
$elem_d$ = estimation element d
$elem_e$ = estimation element e
$elem_f$ = estimation element f



CONCLUSIONS

The repeated fires, burning the vegetation, alter therefore the bio-physical stability of the system "plant-soil", changing deeply the hydrological regimen, the protection of the soil by the plants and reducing the eco-stability.

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The abandonment of:

- the ~~chestnut coppices~~, characterized from monopytics associations, with reduced herbaceus and bushy covering and with many trees died, can introduce further problems on the protection and stability of the sides;
- the coltivated ~~terraces~~ located in the upper zones of slopes can make worse the risk to collapse because of the special meteorological events, since these terraces had a specific net of water drainage.

In the areas where there was been landslides in the past, the alteration or the partial disappearance of the soil causes a regression of the vegetation that remains influenced, in its dynamics, by the topographical features (exposure, slope, altitude) and by the reduction of water and nutritive resources in the soil, determining a heterogeneous mosaic (ex. in the gorges).

The irreplaceable action of soil protection exercised by the forests and by those association bound at these for direct dynamism, in the slope areas, can occur only if exist three conditions:

- efficiency of the vegetation associations like integrated system (ecosystem);
- enough extension and covering in the basin;
- equilibrated distribution inside the basin.

Former tracks of deep soil erosion that have altered the vegetation associations

Burnt grasslands on the vitric soil with heigh thick subject to exstremely rapid mud and debris flows

The presence of smooth and not cracked rocks don't allow to roots to anchor the soil