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ALPTER PROJECT NEWSLETTER
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Interreg IIB Alpine Space
ALPTER Project
'Terraced landscapes of the alpine arc'

Contents

Terracing: a barrier against land degradation

News and events

The new Alpine Space programme conference
The EU programme conference 'Alpine Space Heading for Excellence' will be held on 28th and 29th of June, 2007, in St.Johann in Pongau (A).
www.alpinespace.org

The UNESCO wine sites
Representatives from the UNESCO wine production sites will meet in St. Emillon (F) from 12th to 17th of June within the frame of VITOUR project, aimed at promoting their economic development.
www.parconazionale5terre.it/vitour_eventi.asp

Terracing Ecomuseum's Summer exibition
The *Terracing and Vineyard Ecomuseum*'s hazelnut festival and summer exibition will take place from 19th to 26th of August in Cortemilia (Piedmont).
ecomuseodeiterrazzamenti.it

The role of terracing in the defence against land degradation

Terraced landscapes were usually created for two main purposes: to enlarge available farmland surface and to counteract land degradation processes along the steepest slopes. Currently, while the exploitation of terraces for agrarian purposes is more and more rare and limited to few kinds of specialized cultures (e.g. vineyards and olive groves), their contribution to soil protection and control of runoff is acquiring a growing importance. Nevertheless, such a role is seriously compromised in case of improper management or even abandonment of terraced structures. The measures implemented by humans in order to retain slopes stability, such as terracing, implies the establishment of a new, fragile artificial equilibrium, which replaces the natural evolutionary dynamics and requires a continuous flow of inputs in order to be maintained as such. On the other hand, since these inputs are no longer provided in case of abandonment, this might lead to the breakdown of the previous equilibrium and triggering of erosion processes, thus potentially causing heavy damages in terms of increasing runoff, number and extent of disorder evidences, slopes erosion, soil losses, increasing suspended sediment load transport in water courses, economic damages and – in the most serious events – victims. A severe cycle of land degradation processes may thus be set in motion as terraced structures collapse and their protective function against soil erosion and runoff ceases.

This issue of ALPTER newsletter is entirely dedicated to the studies carried out by ALPTER project partners on this topic: from the hazard maps produced for the Slovenian Goriška Brda region and the sample area nearby Tende, in the French Maritime Alps, to the methodologies developed by the Universities of Genoa and Milan; while the former aims at building an hazard assessment model by identifying the most important factors increasing geological instability, the latter focuses on how infiltration and groundwater flow processes develop and affect dry stone retaining walls' deformation as well as terraced slope stability.

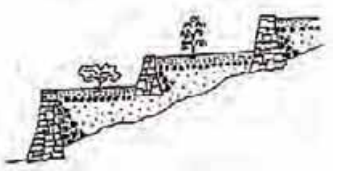
The analysis of geological and pedological conditions and the hydro-geological risk assessment on terraced landscapes represent one of the main topics investigated within ALPTER project; the forthcoming issues of the newsletter will address the other topics developed by project partners, i.e. tourism development, agrarian activities and planning measures for terraced landscapes.

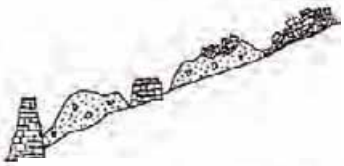
Hazard assessment in the Ligurian terraced landscape

Methods

Many authors approached the problem of hazard assessment by land degradation processes, but the results often are difficult to be interpreted. For this reason the **Laboratory of Applied Geomorphology of the University of Genoa** decided to follow an approach based on the evidences given by field survey data. The data were analysed through Multi-Statistical (MS) analysis techniques and the results will be used to build an hazard assessment model based on the decision tree technique (Murthy *et al.*, 1994; Rossiter, 1990). The aim is to provide planners with a choice instrument to decide where it is more important to operate on the abandoned terraces with the aim to reduce the hazard, as it is impossible to recover all the terraces over the Ligurian territory.

On these bases the first phase of the research regards the terraces census all over the Liguria region, making use of aerial photographs and thematic cartography. Then the second phase keeps on with the field survey in three sample areas. The survey allows to control the real extension of the terraces acquired in phase one, as well as to collect data about terraces conditions to be elaborated through the MS analysis. Below the preliminary work on the first sample area, the Bisagno basin, is described.

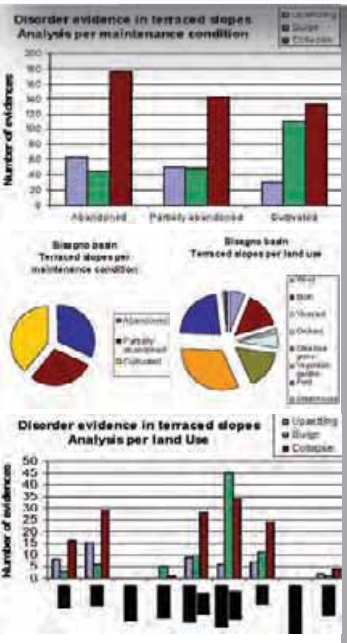




The study area of Bisagno Basin

The Bisagno basin, which covers a surface area of about 96 skm, is one of the two of Genoa's hinterland. The substratum is composed by marly mudstone, mudstone, shale, clayschist, and alluvium deposits only in the lower part of the basin; in a short distance from the sea, the mountains get to a maximum altitude of 1000 m a.s.l.. The climate is typically Mediterranean along the coastline, but in the hinterland the winter is cold; the mean annual precipitation is between 1600 and 1800 mm (Brancucci, 1994).

The main degradation features in the basin are debris flow and rotational and complex landslides; some large historical landslides are present in the basin together with some deep gravitate deformations in the eastern part. The lower part of the basin holds a high flood risk level: many events in the last forty years produced damages and victims. Man-made terraces cover more than 15% of the surface area of the entire basin; nowadays most of them are abandoned.



Survey work and first elaboration results

Researches decided to perform the analysis of the territory on the basis of the slope unit. This methodology seems to be the more appropriate, because of the particular evolution followed by abandoned terraces; terraces in a slope must be regarded as a system because of the strong linkages among the whole structure. The data collected per slope unit in the quick survey regards: kind of terraces, percentage of the slope surface modified by terraces, number of disorder evidences in terraces (upsetting, bulge and collapse), land use, maintenance conditions, mean height of the terraces and a parameter measuring the fragmentation of stones in the walls.

The figures beside show the preliminary results obtained from the survey on a surface area covering 90 % of the Bisagno basin. The quick survey has allowed collecting data from more than 300 terraced slopes, which have been analysed in a GIS environment together with the lithology and the main morphometric features. The diagrams show that the disorder evidences in terraces are primarily concentrated in the slopes facing south and north and with a high slope gradient. Lithology doesn't seem to affect particularly the disorder. At the same time, the graphs put in evidence how disordering is almost equally present in abandoned and in cultivated terraces, while the more frequent evidences are present in little slopes rather than in large ones.

Conclusions

The gathered data allows to perform a preliminary basic statistical analysis that gets some early results. The lithology of the substratum, which is partly responsible for the drainage, seems not to significantly influence the stability of terraces. This result, which may look in contrast with the erosion models, may be interpreted with a stronger effect on stability caused by others parameters. At the current stage of the analysis these may be identified mainly in the slope gradient and aspect; the first is related to the intensity of erosive processes and the second to weathering, which in the studied area is influenced by strong rainfalls, often related to southern wind. The high number of disorders in terraced structures facing north may be related to the tendency of retaining moisture.

These preliminary remarks will be better defined once the data survey will come to an end in the other two sample areas, which present some differences (lithology, altitude, climate etc.): the MS analysis will succeed to identify the parameters that probably are responsible of terraces disorders and to classify the threshold levels that will be used in the decision tree model. The final results will allow associating to every terraced slope a hazard value, useful to plan recovery politics.

A landslide hazard map for Goriška Brda (Slovenia)

Goriška Brda is a hilly region located in the Western part of Slovenia, along the Italian border, at an altitude between 300 and 800 m a.s.l.. The geological substratum of the area is made of flysch rocks (sandstone, marl, claystone, limestone, calcarenite), delimited by limestone in the North and alluvial sediments in the South, thus determining geological conditions that are prone to landsliding. Landslides actually cause considerable damage in the Goriška Brda region. Most of them are triggered on steep convex slopes due to increased water content as a consequence of high precipitation or human influence. Farmers usually repair the terraces for few weeks per year, canalizing water and thus letting it flow downstream in a safe way.

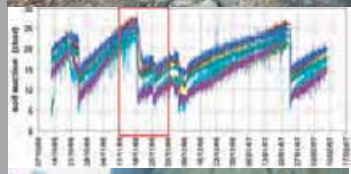
The **University of Ljubljana,** jointly with the **SRC SASA Research Centre**, developed a landslide hazard map; the input data used for its elaboration were gathered during a period characterized by a number of heavy precipitation events, that was recorded in Goriška Brda in September and October 1998 (175 mm just in one day). More than 800 mostly shallow landslides were triggered, affecting about 1.7 % of the considered area.

The elaboration of the susceptibility map took into consideration 8 factors: lithology, slope, curvature, dip of the strata, stream power index, wetness index, maximum 24-hour precipitation, land use. Dempster-Shafer theory of evidence algorithm (Dempster 1969, Shafer 1990) was used to elaborate the map using Idrisi and TAS softwares.

First of all, the events are hierarchically related to the factors mentioned above. For each factor characteristic values are obtained, which are then compared to the neighbouring values. The hazard map shows landslide susceptibility (ranging from 0 to 1), taking into account all the factors. From the map elaboration one can argue some general results. For instance, in the Goriška Brda region landslides more often appear on NE or SW oriented convex slopes, having an inclination of about 20 degrees, preferably covered by vineyards; moreover, the landslides usually appear about 70 m below the ridges. Other considerations can be made with regards to roads (1/10 of them are risky) and terraces, which are built for half of their extent in areas prone to landslides.

As a conclusion, it can be said that about 3/4 of the studied area is more or less prone to landsliding. Slope, dip of strata and depth of mobile material (debris) seem to be the most important controlling factors. Nevertheless, landslides often are triggered by human factors. For example, it has been estimated that more than half of the landslides occurred in 1989 in Haloze hilly area, Eastern Slovenia, were indirectly caused by human activity.

Infiltration and flow processes in terracing: monitoring and numerical modelling

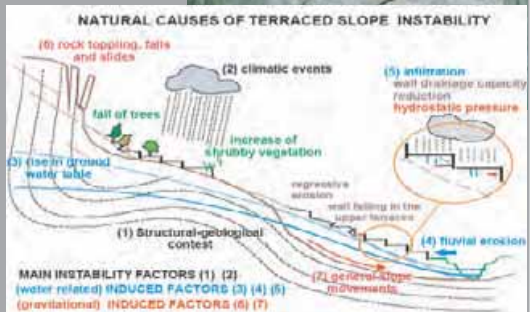


The **Department of Earth Science from the University of Milan** is carrying out a research focusing on infiltration and groundwater flow processes, occurring in the backfilling soil of dry-stone retaining walls along terraced slopes. The study aims at investigating how flow develops and evolves and evaluating its effects on dry stone retaining walls' deformation as well as slope instability. Infiltration and water flow processes are among the main factors controlling slope stability, since they determine the hydrostatic pressure and stress distribution in the backfilling soil, thus affecting the wall drainage capacity. The research implies geotechnical and hydro-geological investigations, based on a number of field and laboratory surveys and tests. The main parameters which were measured or calculated are: soil hydraulic conductivity, permeability, infiltration velocity, soil density, organic content and soil moisture. The usage of tensiometers also allows a direct measure of the so-called 'soil suction', i.e. the attraction that the soil exerts on the water, measured through the force required to remove water from the soil. Additionally, the shear strength properties are obtained by means of laboratory tests. In order to monitor the variation of soil moisture and pore water pressure during a whole seasonal cycle, a terraced site was equipped by a set of tensiometers located at different depth levels, with continuous and automatic data recording. Researchers have been gathering data since October, 2006. The investigations are performed in a number of test sites, selected according to the spatial distribution and the existing land cover (e.g. bush, grass, vineyards, orchards).

All these data are used to elaborate flow modelling. The numerical model is conceived to enable estimations about soil moisture content and pore water pressure changes under different recharging conditions, thus representing a useful tool for planning agricultural activities and performing geotechnical analyses, in particular by determining the main factors influencing wall deformation and stability.

The researchers performed a number of flow development simulations, which needed to be validated by comparing measured and calculated values of pore water pressure. Different scenarios can be simulated, e.g. considering low permeable layers, drained or undrained walls.

The results of the flow model represent an important input data for the stress-strain analysis of the soil-wall system stability: the final aim is actually to analyse the flow effects in terms of maximum shear strain and wall deformation as well as to identify the relative importance of instability factors.



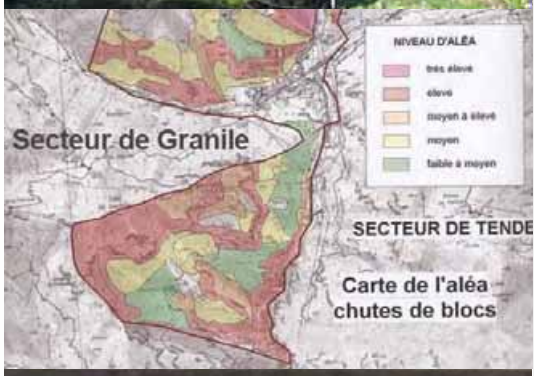
MEETING AND STUDIES IN THE UPPER VALLEY OF RIVER ROYA (F)

The ritual meeting of ALPTER project partners took place on the 10th and 11th of May in S. Dalmas de Tende, in the Maritime Alps (France). The meeting gave the partners the opportunity to discuss the final outputs of the project, but also to visit an area that used to be rich of cultivations on terraces (vineyards and chestnut woods in particular) and nowadays appears mostly abandoned. The trip on terraces focused around the small settlement of Granile, that - contrary to other villages – is still inhabited, even by young people, who settled here recently (although many of them come here just during the weekends). Thanks to their owners, the buildings are well maintained, with use of traditional techniques and materials.

An hydro-geological study was performed also in this area, and particularly in the valley downstream to Granile, thanks to the efforts provided by an ALPTER partner, **A.D.I. (Association for Digital Geographic Development, from the Sophia-Antipolis University of Nice)**.

The study took origin from the geographical location of the National Route, leading from Ventimiglia to Tende and running under a steep slope about 300 m high. In the last years, this road was quoted more than once on local newspapers, for the fall of rocks that took place on the road and the resulting damages and danger for passing vehicles (see picture on the right). Protective works were realized on the slope, installing steel nets and building concrete walls, aimed at containing the risk. The steep slope overlooking the road is largely terraced: terracements were cultivated until the seventies, but still now they are not completed abandoned. Nevertheless, it was noticed that rock falls mostly originated from areas without terraces, and it is here where the protective measures will concentrate.

The research activities implied monitoring and mapping terraces, rock falls events and other disorders, as well as the analysis of the relationship between the two of them. The results seem to support the hypothesis that terraces build a form of defence against natural hazard, confirming the role as territorial protection measure they play and offering an alternative to less sustainable works realized nowadays.



ALPTER

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- A.D.I.
  Association for Informatic Geographical Development (FR)
- Regione Valle d'Aosta
  Agriculture and Land Prot. Department (IT)
- Regione Bregaglia (CH)

Observer partner:

- U.N.E.S.C.O. - Regional Bureau for Science in Europe (ROSTE)

Other partners:

- Slow Food - Foundation for Biodiversity

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