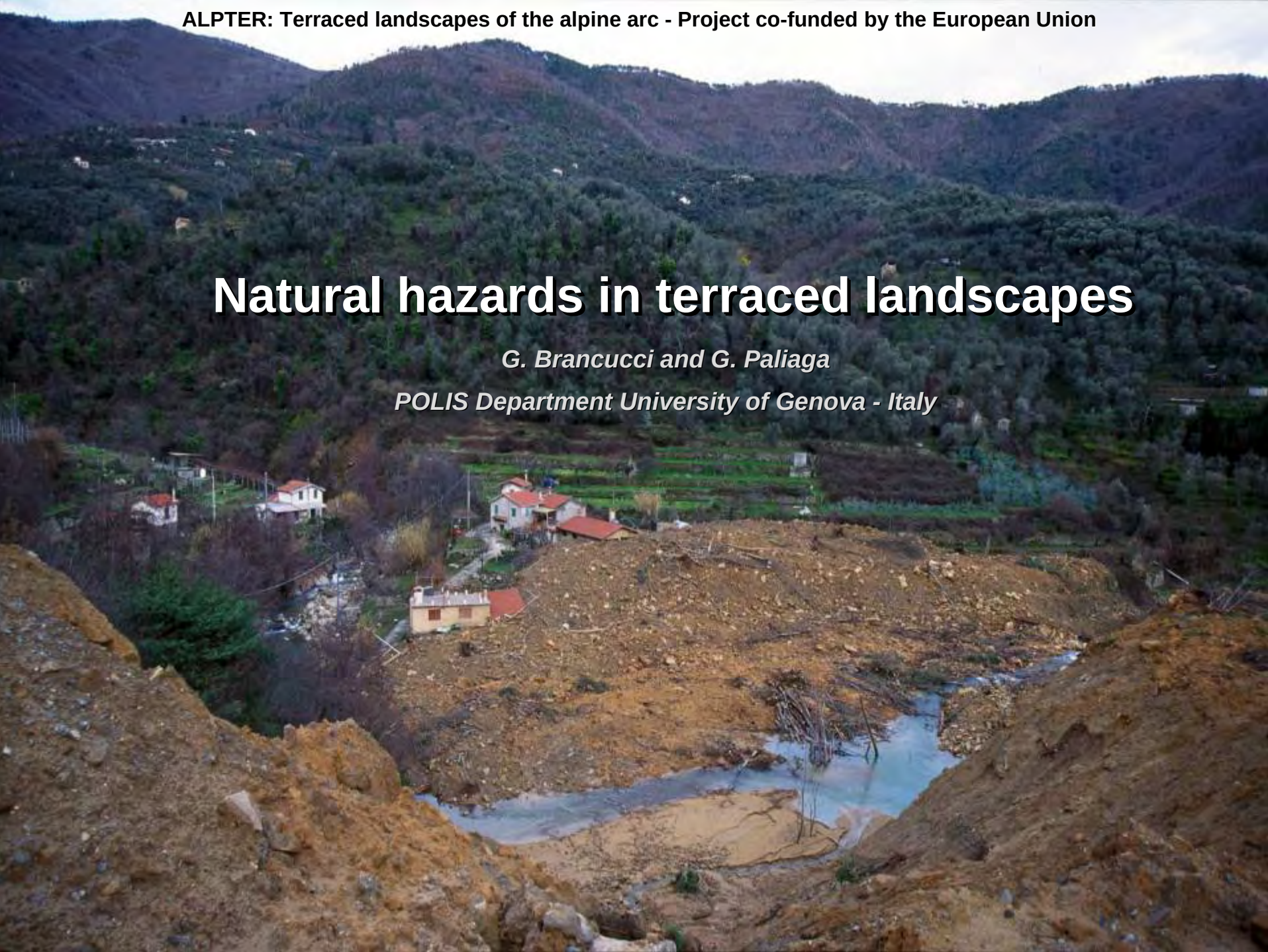
ALPTER: Terraced landscapes of the alpine arc - Project co-funded by the European Union

Natural hazards in terraced landscapes

G. Brancucci and G. Paliaga

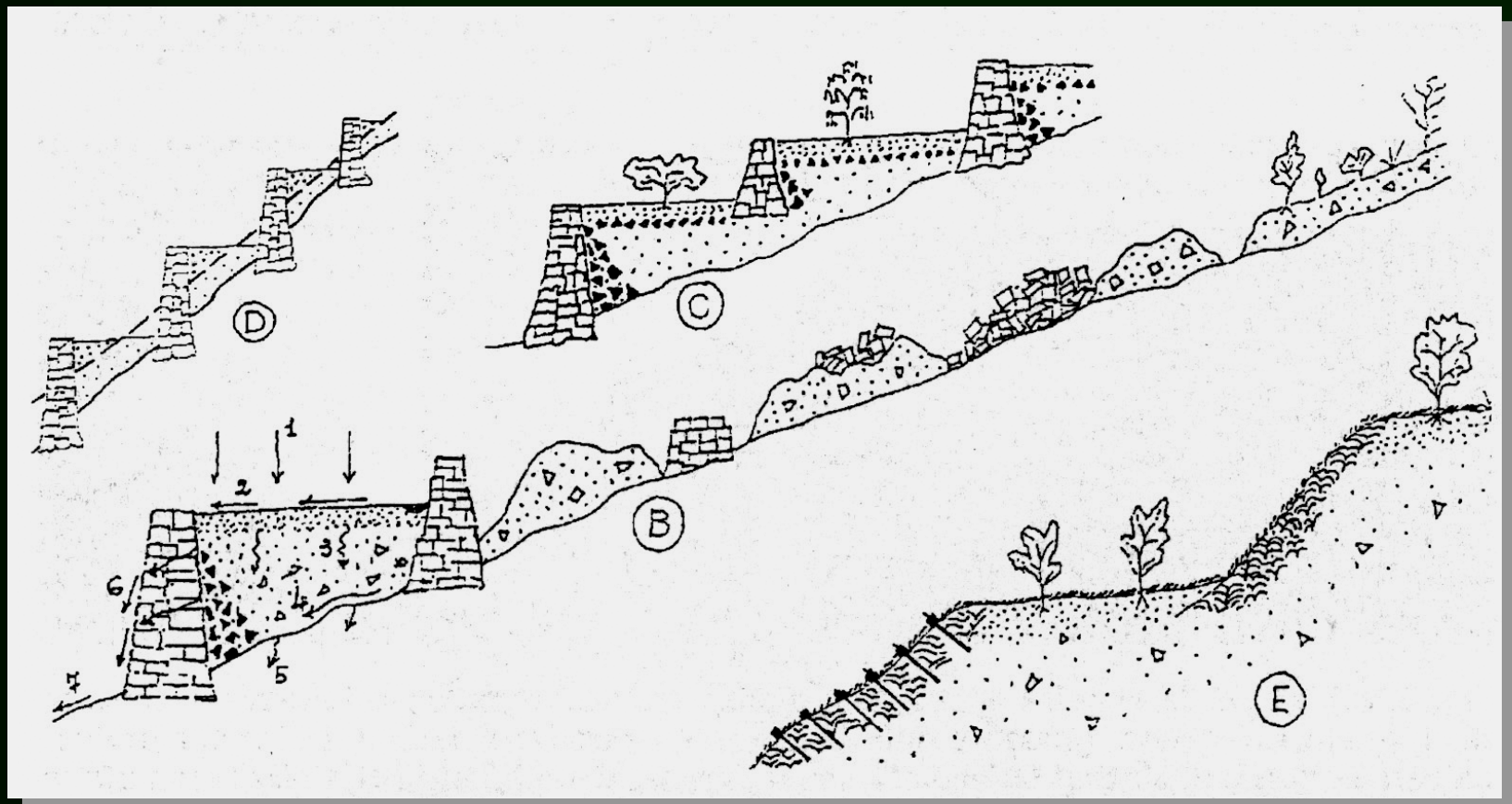
POLIS Department University of Genova - Italy



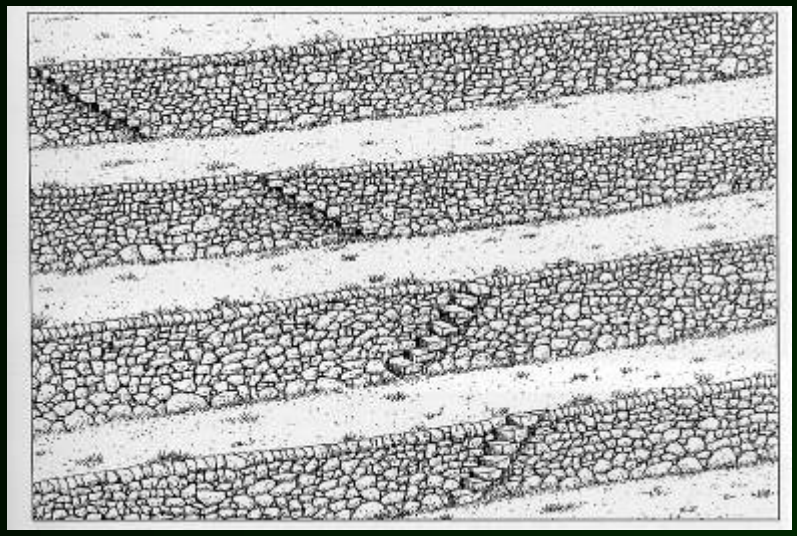
Terraces are a modification of the slopes in order to gain sub horizontal surfaces suitable to farming.

These anthropogenic structures, that represent a deep change in the landscape, need to be maintained primarily in managing the flow of the rainfall runoff.

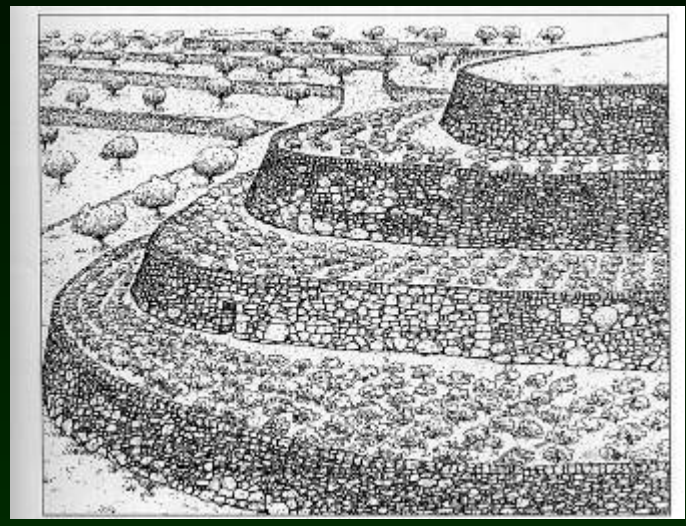
Various building up techniques



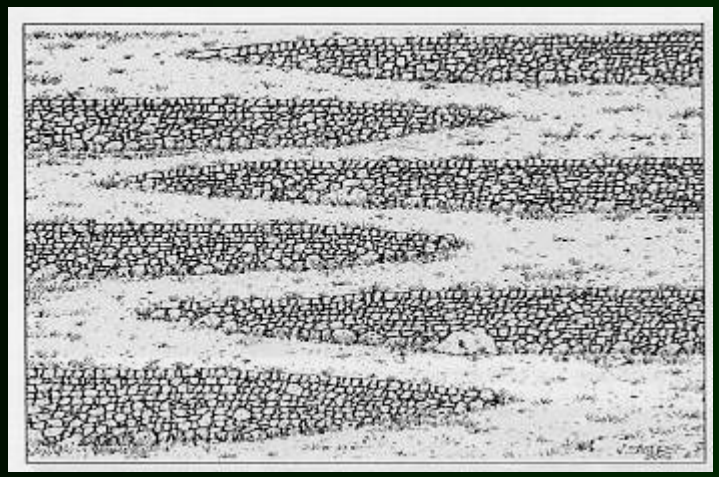
Various dispositions



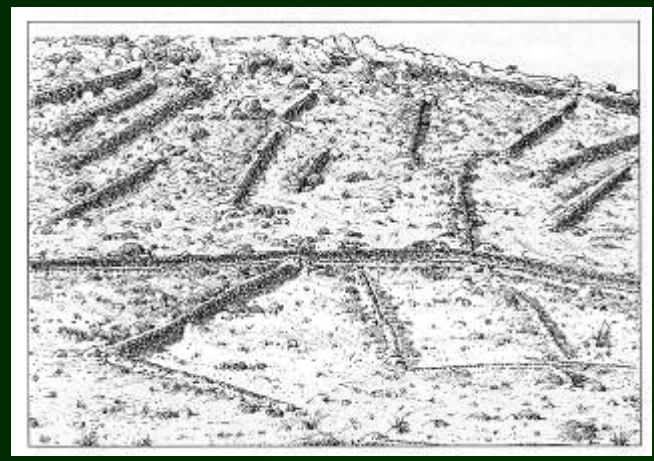
REGULAR AND CONTINUOUS



CONCENTRIC



PARALLEL DISCONTINUOS



IRREGULAR

Lithology and stones dispositions

An example of famous terraced landscape: Cinque Terre

Terraces are spread from sea level to the main watershed

ALPTER: Terraced landscapes of the alpine arc

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The hinterland of Genova

the Bisagno basin

High percentage of the slopes are modified by terraces, even in the mountains.

ALPTER: Terraced landscapes of the alpine arc

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Managed terraces

The first effects
of degradation

Degradation

Wrong recovery

Wrong recovery

The permeability of the original wall has not been conserved

Wrong recovery

Wrong recovery

Wrong recovery

Wrong recovery

Wrong recovery

Consequences of the lack and mistakes in managing a modified territory:

The effect in case of severe rainfall:
Landslides and heavy solid transport in the stream.
The stronger effects reach the lower part of the basin.

Ceriana (Imperia) landslides
and severe flood (2000)

What terraces mean in term of Geomorphic System?

- ✓ Man has become one of the processes aging in the geomorphic system.

  In some situation man is one of the dominant ones.

- ✓ Man is capable of deep changes acting in short period

- ✓ The effect is: putting the system out of equilibrium

Making terraces along large portion of the territory has induced a new equilibrium in the morphogenetic system

UNTIL THE PRESIDIUM OF TERRACES

Once man has abandoned terraces the morphogenetic system got out of equilibrium

Suddenly all the sediments being stopped for many years along the slopes became available to erosion.

Nowadays:

✓ the morphogenetic system is tending to a new equilibrium

The effects:

✓ landslides and increase of the solid transport in streams and rivers

Consequences:

✓ The coastal zone management must take into account even the management of the hinterland.

✓ We need an integrated and multidisciplinary approach to the problem.

Abandon of the hinterland

Increase of the urbanisation

Erosion
Raise in fluvial solid transport
Widespread slope instability

Reduction of permeability
Increase of rainfall-runoff
Increase of stream transport
Reduction of catchment's travel time

INCREASE OF GEOMORPHIC HAZARD

The focal point to reduce conflicts, to get a better landscape and territory management and to reduce one of the most important factor of the hydrological hazard is

To include terraces in the risk assessment procedures and strategies.

Terraces census → Aerial photography, cartography, survey…

↓

Hazard analysis (DEM, morphometry of the surface, floods, landslides…)

Natural processes ↔ Hazard analysis (DEM, morphometry of the surface, floods, landslides…)

Hazard maps

Vulnerability assessment

Risk analysis

Risk maps

GIS analysis, monitoring and modeling

Terraces census in a large area

Ligurian territory extends on more than 4000 km^2

Remote

Bibliographic data
Cartographic analysis
Aerial photography

Definition of
the real
extension

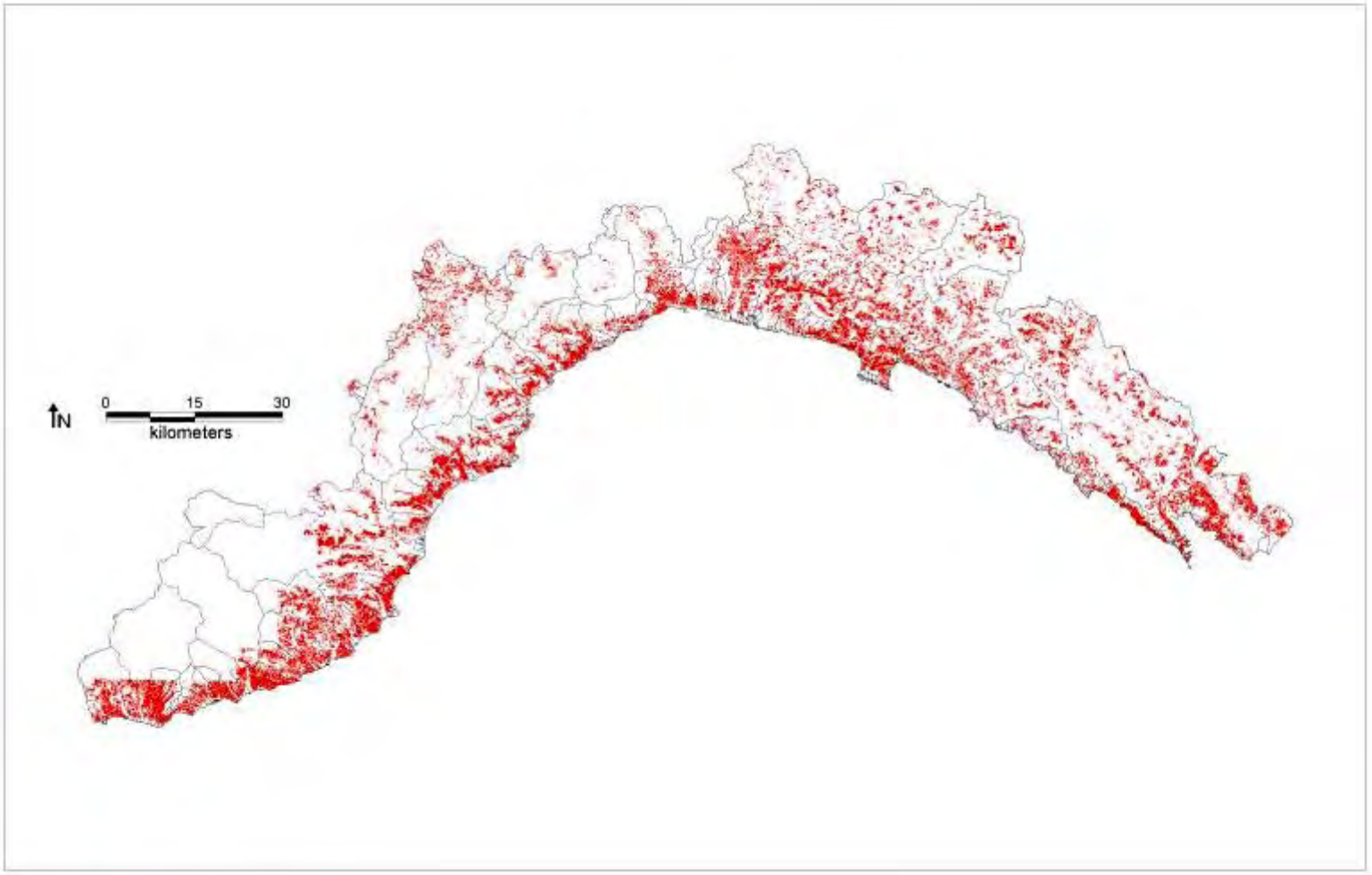
Direct

Field survey

Real extension
and conditions,
use,
type of vegetation
…

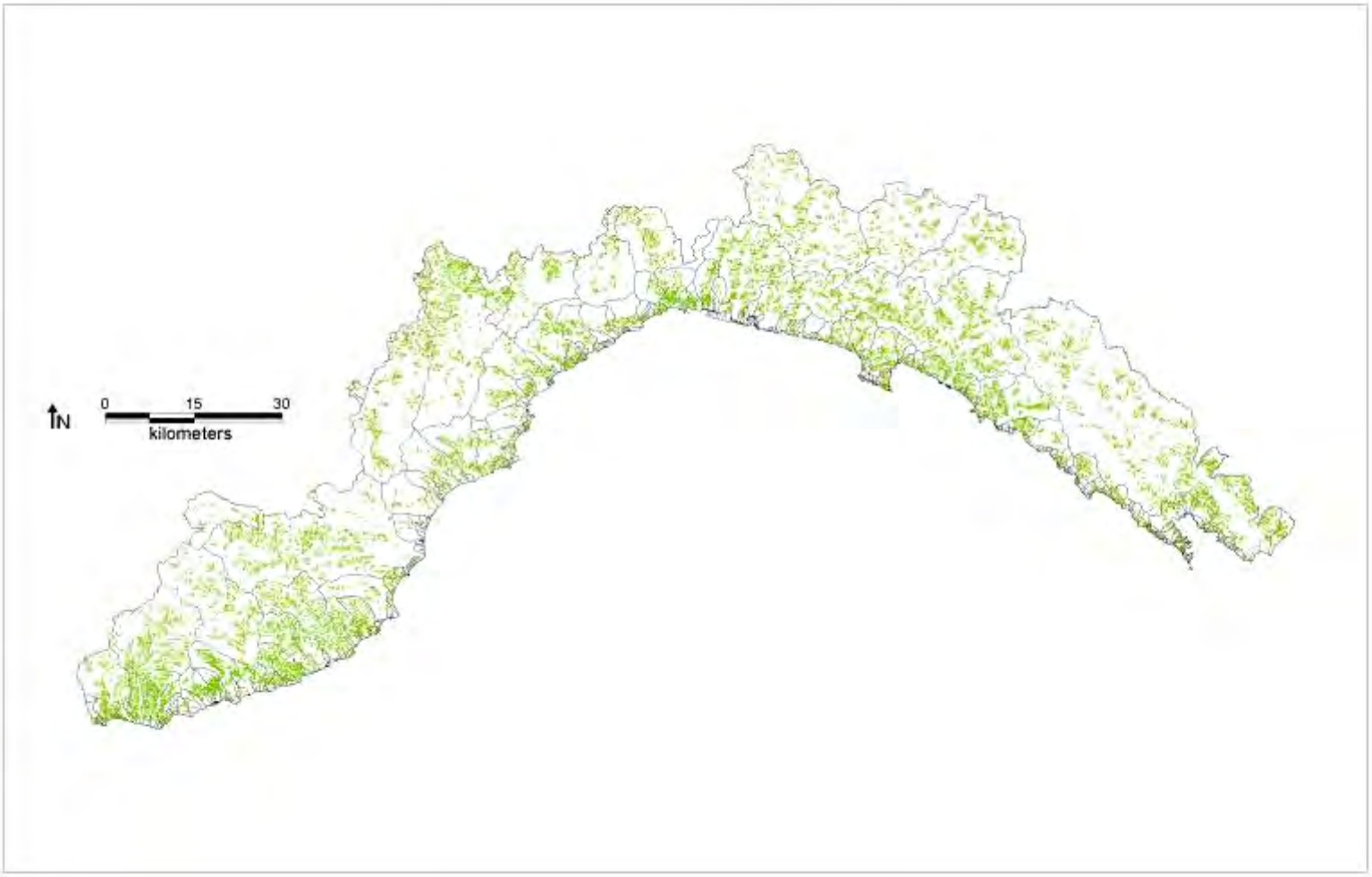
Terraces census - *remote*

Better definition of the real extension



Terraces census - *remote*

Better definition of the real extension

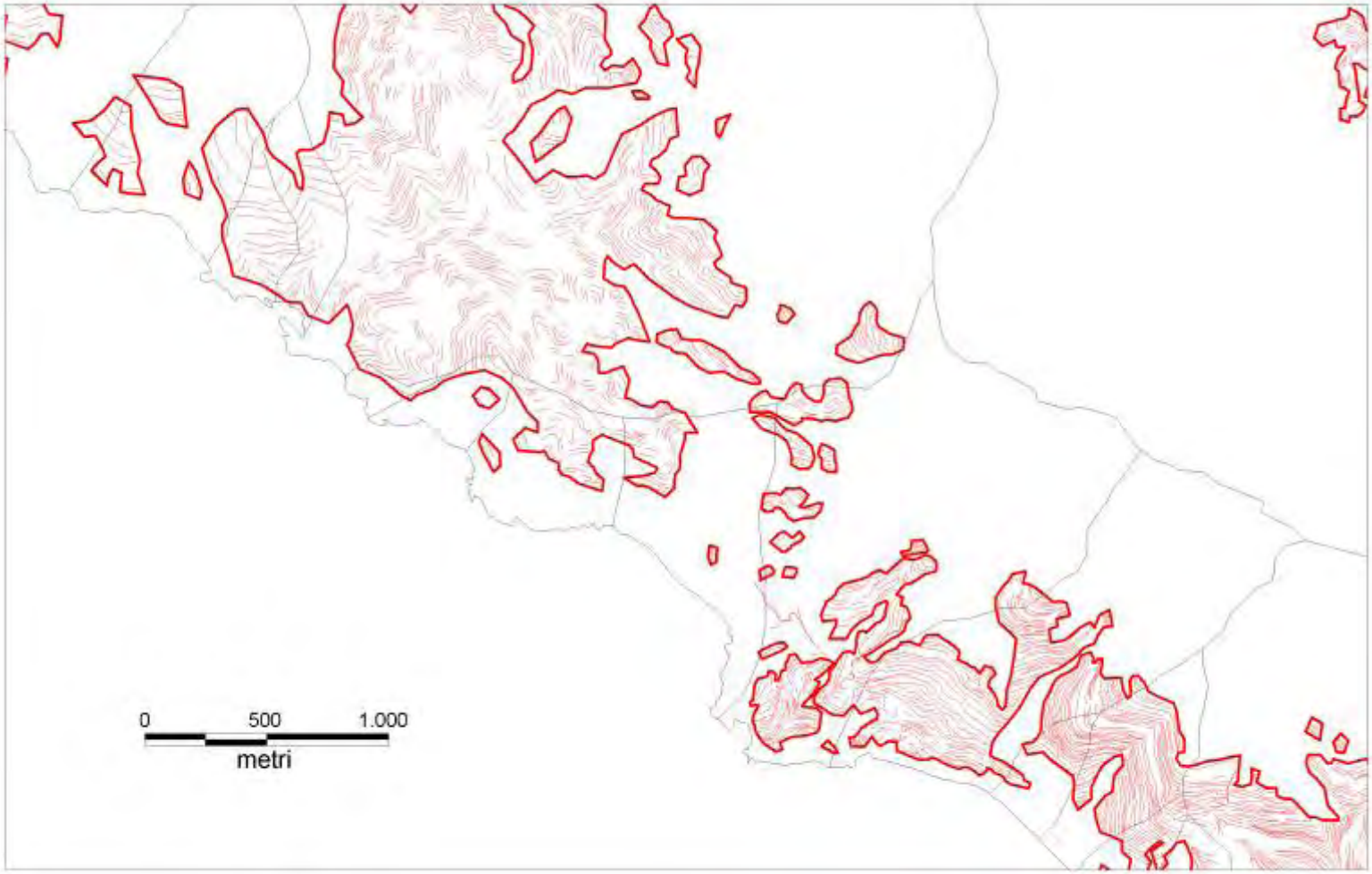


Terraces census - *remote*

Better definition of the real extension

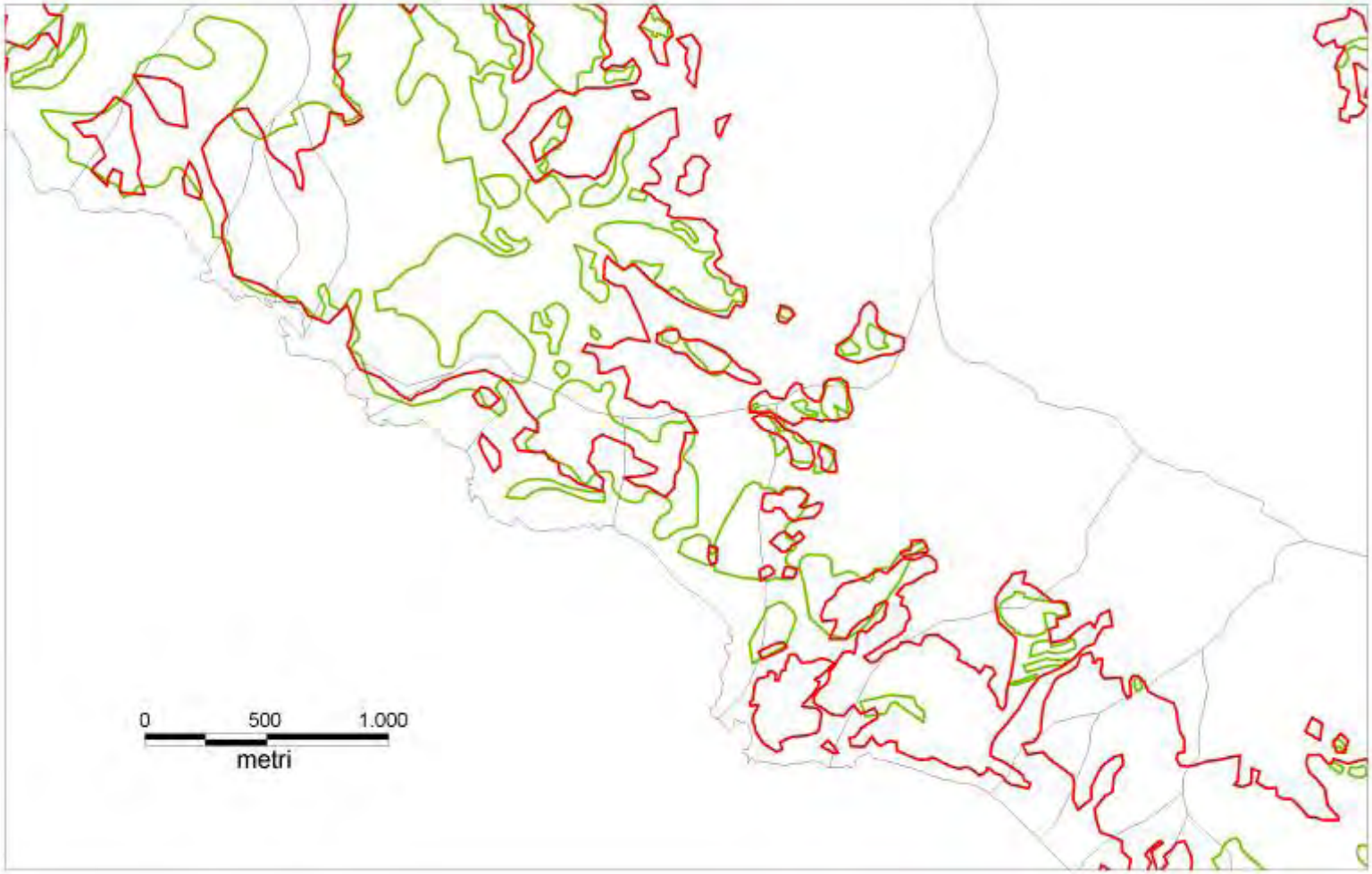
Terraces census - *remote*

Better definition of the real extension



Terraces census - *remote*

Better definition of the real extension



Terraces census - *remote*

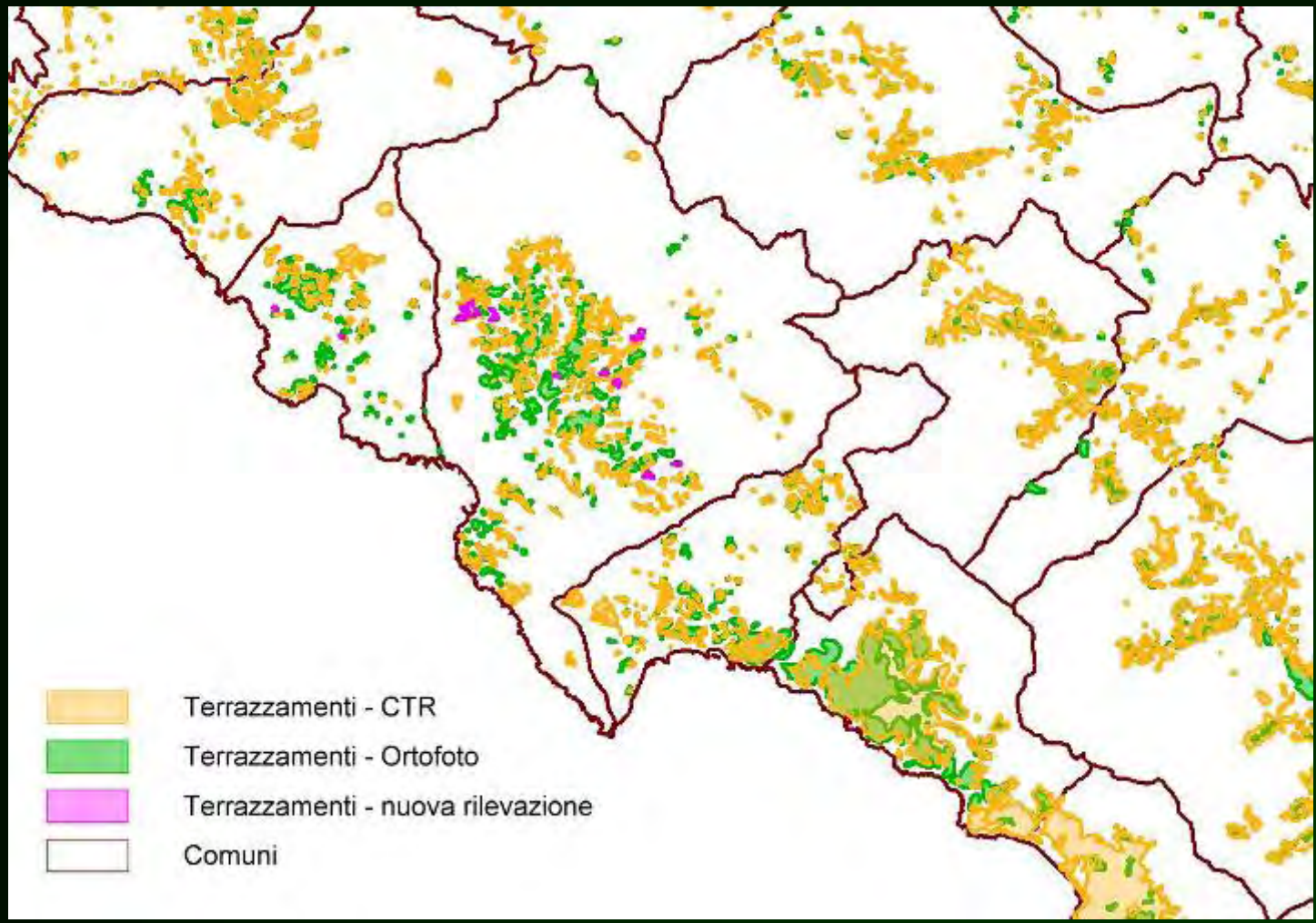
Better definition of the real extension

Terraces census - *remote*

Better definition of the real extension

Terraces census - *remote*

Better definition of the real extension



Terraces census – *field survey*

Quick survey

To be performed
on large areas

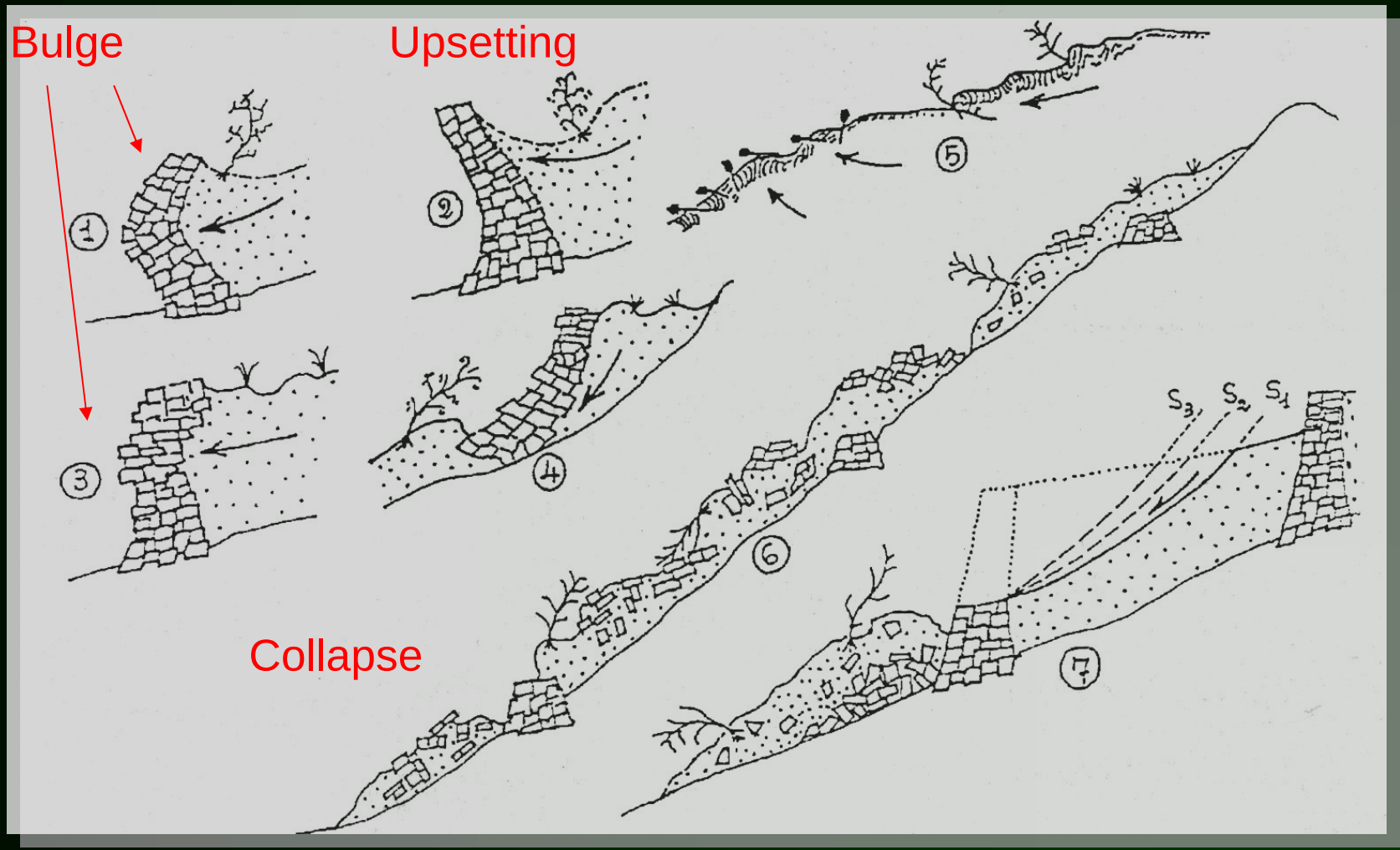
Analysis per slope unit:
Kind of degradation,
maintenance conditions,
land use
…

Detailed survey

To be performed
on case histories areas

Detailed analysis of terraces:
Structures,
Conditions
…

Degradation



Terraces census – *field survey*

Terraces census

field detailed survey

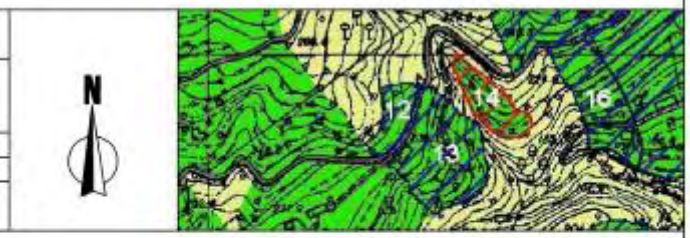
Bacino Rio Fontanelle | Area campione: Palazzo Scannabaggi | ZONA PROGETTO: A2

Sottoarea terrazzata n° 12

CARATTERISTICHE DIMENSIONALI GENERALI

Superficie area terrazzata (mq) : 1661

N° di fasce successive: 3



STRUTTURA TERRAZZI

Tipologia: muratura a secco

H media muri: 3.00 m

Larghezza media lenza : 5.00 m

Pendenza media muri : vedi sez.

Pendenza media lenza : vedi sez.

Paramenti murari : pietre di media pezzatura

Litologia pietre: Vedi-Inquadramento geomorfologico

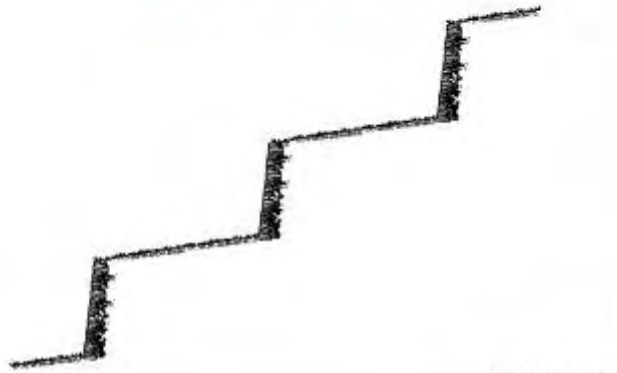
Collegamenti verticali: sentiero ortogonale alle fasce

Presenza manufatti/ripari: nessuno

Accessibilità: scarsa

Stato conservazione terrazzi: scarso

note: n/a



Sezione scala 1:200

COLTURE

Coltura prevalente: incolto

Tecnica colturale: n/a

Tipo di suolo: vedi -Inquadramento geomorfologico

Stato di conservazione delle colture: n/a

Note:

REGIMAZIONE IDRICA

Sistema di regimazione idrica: n/a

Verso di pendenza della lenza: verso valle

Stato di conservazione della regimazione idrica: n/a

Note:

Aree di particolare valore paesistico - segnico: no

Aree di particolare valore storico - culturale: no

RISCHIO IDROGEOLOGICO: R.I. = R2

REGIME NORMATIVO VIGENTE: Em-ma

Terraces census - *field quick survey*

Modelling the hazard

One of the contribution to the project that the Laboratory of Applied Geomorphology is developing together with the Regione Liguria Spatial and Landscape Planning Department is a model to quickly and precisely monitor and survey the terraced territory with the aim of GIS technologies and to predict the geomorphic hazard in a large and complex area.

Integration of surveyed data and morphometry data

↓

Dynamic model of geomorphic hazard

↓

The model will allow to individuate the areas where the recovery is indispensable

↔

The approach is based on the evidences given by field survey data; these data are analysed with the MS technique 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 object is to give a choice instrument to planners 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.

Many authors have approached the problem of hazard assessment by land degradation processes: some of them estimate soil losses (Nearing et al., 1989; Morgan et al., 1998), others model the slope stability and landslide susceptibility through validation procedures on surveyed areas (Rowbotham and Dudycha, 1998).

These methods are essentially based upon the multivariate statistical analysis of landscape features associated with past landsliding (Lieneback Gritzner et al. 2000; Carrara et al. 1991).

Following this approach we decided to collect data about terraces in studied areas with two methods: the quick survey to be performed on large areas of the region and a more detailed survey for restricted areas. All the data have been collected in a GIS to perform an integrated analysis with aerial photography and DEM

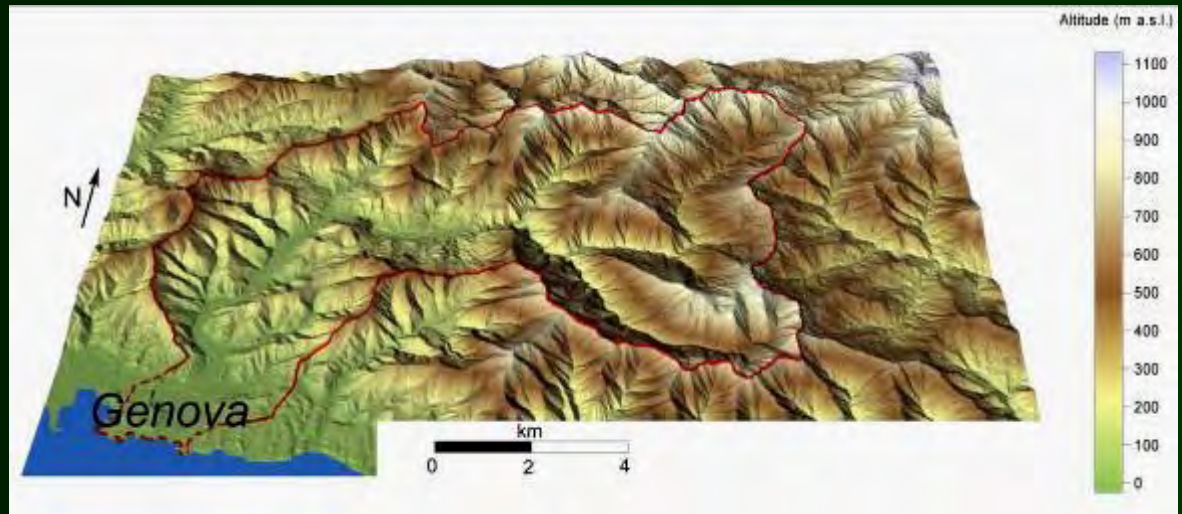
Following Carrara et al. (1991, 1995) approach we decided to perform the analysis of the territory on the basis of the slope unit.

This methodology seems to be the more appropriate because of the particular evolution followed by the abandoned terraces: terraces in a slope must be regarded as a system because of the strong linkage among the whole structure.

In fact the lack in managing the rainfall runoff processes implies that the degradation of terraces moves like an avalanche process: a disease in a terrace quickly extends to the close ones in the slope.

The Ligura case studies

The Bisagno river basin



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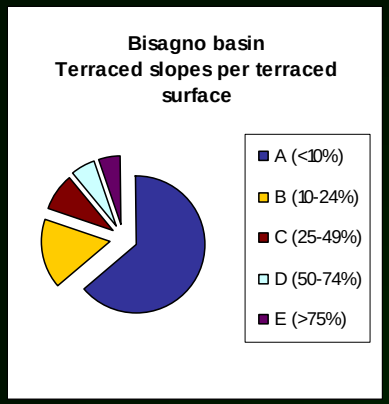
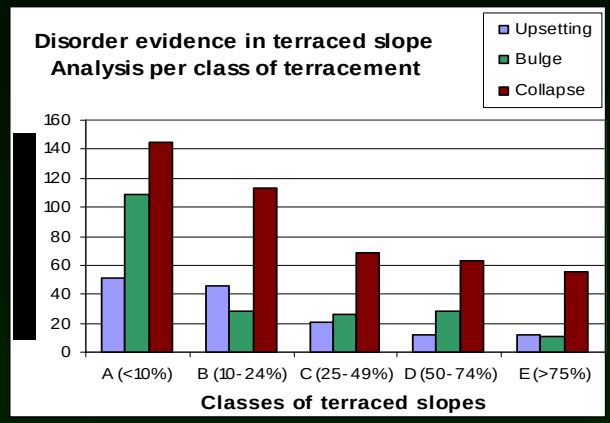
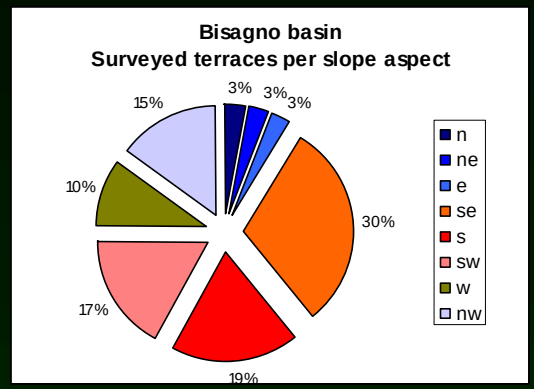
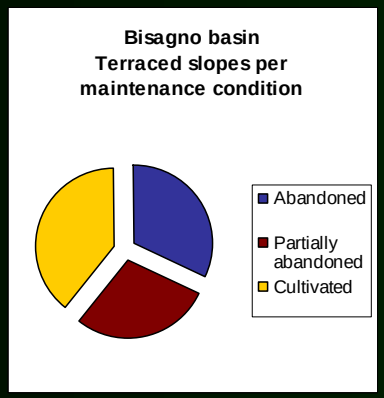
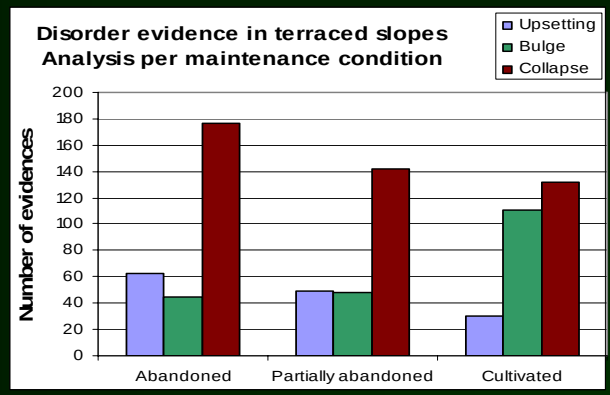
The Bisagno river basin filed survey – data analysis

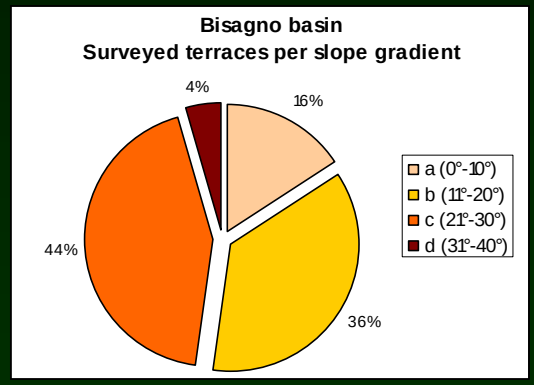


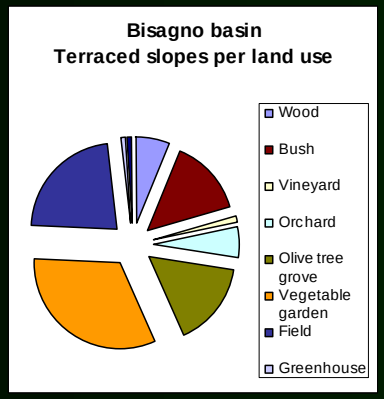


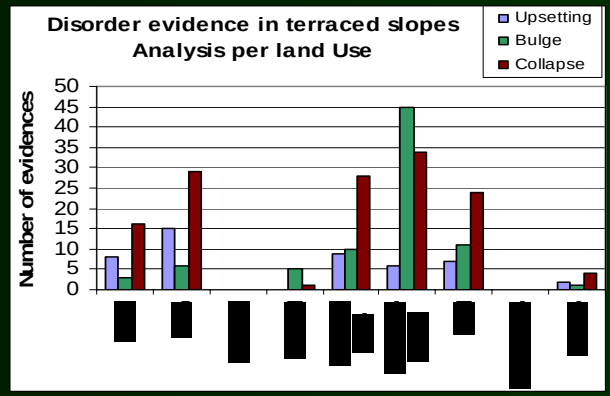


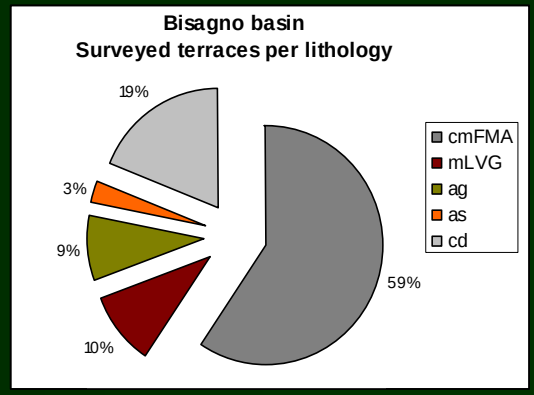




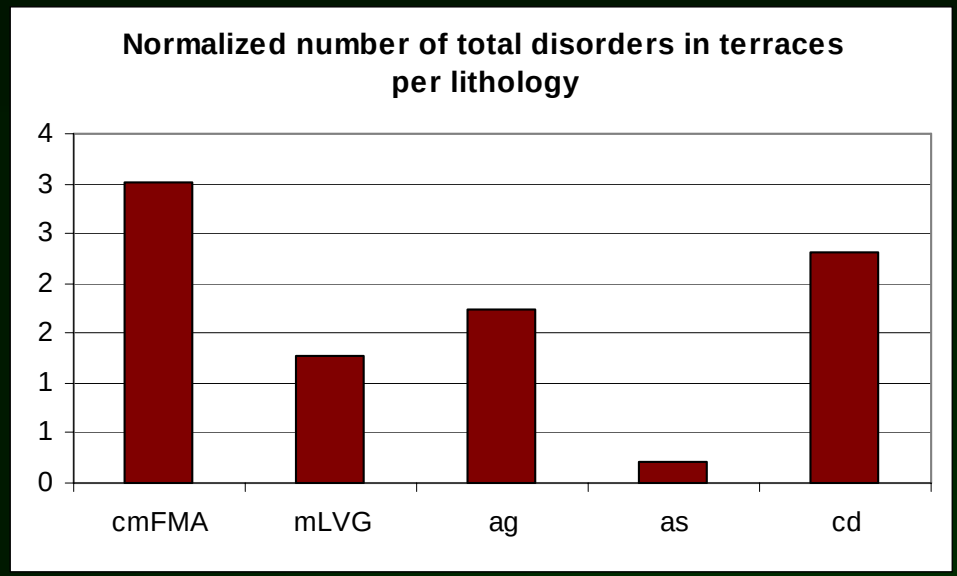


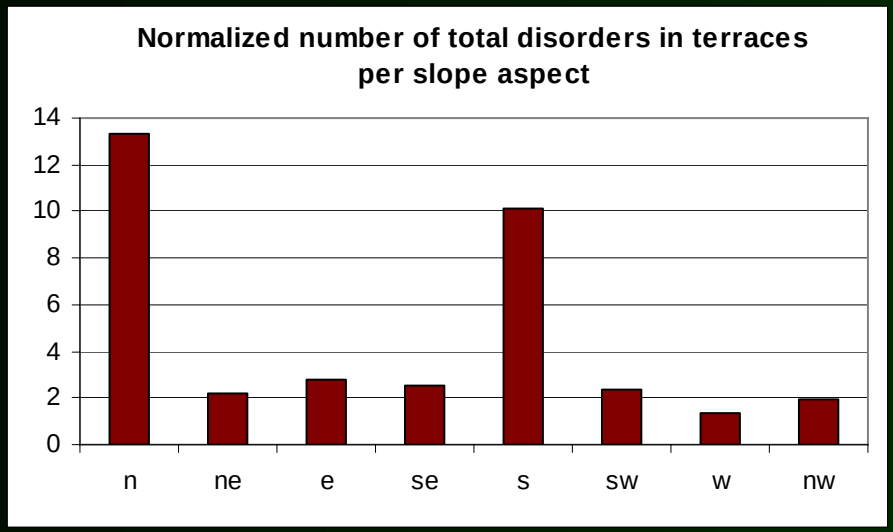


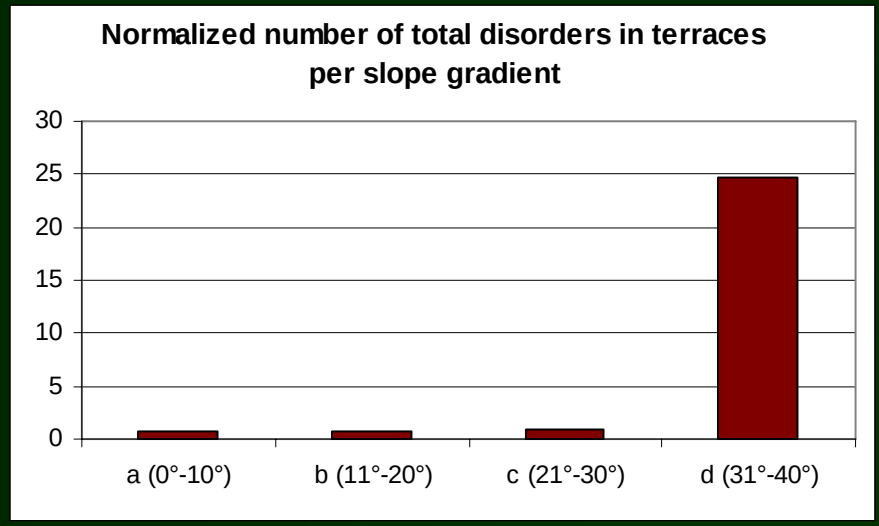




The Bisagno river basin field survey – data analysis







Final remarks

The many terraces in the studied area are largely abandoned; often is hard to precisely assess the conditions of stonewalls because of the spreading of vegetation and difficulty in access.

Despite of this problem the collected data allows to perform a preliminary basic statistical analysis that gets to some early results.

Lithology of the substratum, which is in part responsible of 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 actual phase of the analysis these may be identified mainly in the slope gradient and aspect; the first is related to the intensity of the erosive processes and the second to weathering that in the studied area is influenced by strong rainfall that often are related with southern wind.
The high number of disorders in terraced structures facing north may be related with the tendency of retaining moisture.

The MS analysis will avoid to identify the parameters 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 that will allow planning the recovery politics

Thank you for the attention

Gerardo Brancucci,
Guido Paliaga

Laboratory of Applied Geomorphology,
POLIS Dep.t – Faculty of Architecture,
University of Genova

Stradone S. Agostino, 37 16123 Genova

Tel.: +390102095788
Fax: +390102095843

brancucci@arch.unige.it
gpaliaga@arch.unige.it
www.geomorfolab.it