

**SESSIONE 29****ENVIRONMENT-LAND USE****G 3. Land degradation: approaches for sustainable environmental management****Conveners:****Vito Summa, Maria Luigia Giannossi**

*In Italy, as in many other parts of the world, human activities such as agriculture, urbanization and production activities are leading to a gradual degradation of the soil causing serious damage to the socio-economic system. This session is aimed at building synergies between different disciplines within the Earth Sciences, to conduct research focused on the prevention of land degradation and restoring degraded areas. Contributions dealing with mapping of vulnerable areas and modeling of soil degradation at different scales, the study and evaluation of erosive processes, identification of the causes of soil degradation (changes in land use, land abandonment, population pressure, antropic and natural contamination, saltwater intrusion, land use, etc.), effects of floods, landslides and fires on soil degradation, management of water resources or studies that contribute to a sustainable use of resources, are welcome.*

## Mapping, Assessing and Modeling Impact of LUC and Climate Variability on Soil Degradation Dynamic in Semi-arid Zone of Sudan, By Applying RS and GIS Approach

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*KEYWORDS: Soil degradation, land use change, climate variability, remote sensing*

Soil degradation is one of land degradation types, is severely degraded seen in dry land, contributing to unbalanced environment, its causes are partially or mainly due to non-appropriate land use, and moreover due to climatic variation. The study aimed at mapping, assessing and modeling soil degradation dynamic influenced by land use (LUC) change and climate variability in semi- arid zone, depended mainly on remote sensing and meteorological data supported by ground truthing. The study is critical step towards sustainable management of dry land environments. The study was carried out in Elgeteina Locality which locates in White Nile State of Sudan. It is one of the degraded areas, situating in semi-arid zone. The remote sensing approach was applied for mapping and assessing the LUC impact on soil degradation dynamic (SDD) over 73 - 2009. Map and measurement of the LUC and SDD areas were based on features of the land use patterns and sand dunes formation and accumulation respectively. MSS 1973, TM 1986, ASTER 2009 and TM 2010 were used; top soil grain size index (GSI), object - based image analysis (OBIA) and change detection - matrix were applied for mapping and assessing the SDD and its relationship to the LUC and CV. SPSS- Pearson coefficient correlation matrix (PCM) and multi-linear regression analysis (MRA) were adopted for building model of the SDD influenced by LUC and CV (climate data collected from meteorological stations). The results revealed that there was partially geospatial mutual conversion occurred between SDD and LU patterns led to dynamic status of SD increasingly and decreasingly during 1973 - 1986 and 1986 - 2009 respectively. The important PCM results depicted that: SDD correlation with the residential area (RA) was strong significantly (.865\*\*) and was moderate with the farm land (FML) (.613\*\*). While SDD's correlation with climate variability was weakly, except the rainfall precipitation has constituted moderate significant correlation (.692\*\*). The resultant equation of SDD influenced by LUC and CV is  $SDD = 23.201 - .703RA + .892FML + .108FUL - 3.150E-5RF$ .

## Socio-economic implication of 2012 flood incidences and land degradation in Nigeria and the way forward

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*KEYWORDS: degradation, environment, flood, planning and socio-economic*

The study examines the socio-economic implication of 2012 flood incidences and the consequent land degradation across Nigeria with the aim of suggesting how to handle it and prepare for future occurrence. Primary and secondary data was collected

through direct contact, observations and interviews. The data collected was analysed using descriptive statistics and the results were presented using tables, graphs and maps. The results reveals that 23 states were seriously affected, 119 LGAs, 5131 villages sacked, 2400 houses destroyed, thousands of schools affected directly by floods while another thousand was used for camping people displaced, several culverts and bridges washed away, many portions of roads failed and washed away and hundreds of thousands of hectares of farmland and their crops destroyed. Other results indicated that 765 people died, 347,325 displaced, there were outbreak of diseases, traffic obstructions, increase in food price and threat to country's food security, children stayed away from school for during academic session, families separated, increase in crime and social vices and unrest. As a result, Federal Government released 17.6 billion naira, while the state government, public agencies and private organisation also supported both in cash and materials to reduce the effects of flood on victims. The conclusion was that the flood incidence of 2012 and the resulting land degradation in the country caused a lot of havoc to lives and properties, exposed that the government lacks skills in managing such scale of emergency situation, put a lot of stress on already scarce resources, destroyed the economic base of many families, spread diseases, breed disunity in many homes and increased poverty and many social vices in the country. The need to increase the capacity of various agencies with constitutional backing to perform their functions properly, proper value for the environment, strict adherence to city/ country plan, entrenching of insurance in the way of life of Nigerians are some of the ways suggested to prepare against future floods in the country.

## Sediment budget assessment at watershed scale through satellite data and GIS: its relationship to coastal erosion

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*KEYWORDS: coastal erosion, sediment budget, high-Jonian littoral*

Coastal erosion is a complex issue due to its numerous interactions between natural processes and human-induced phenomena. In active alluvial systems, understanding coastal erosion requires an insight into all the factors that interact along the coast as well as inside hydrographic catchment basins and an awareness of different time scales and spatial dimensions. In sedimentary environment, coastal evolution is regulated by the supply of sediments: it is clear that any human interference in this natural process, such as the sediment starvation through reduced river sediment yield, has consequences on the sediment budget and thus on coastal erosion patterns. From a regional perspective for Italy, the *Jonian* coastal area of the Basilicata Region is undergoing both natural and human stresses which tend to affect its resources and the community's quality of living. Dam constructions, in-stream gravel mining, changing in land use and land cover are the main causes of lack in river sediment supply to the coast which is experiencing a catalysed erosion phenomenon. River basin assessment of the spatial patterns of sediment erosion and transport is important to model the changes in the sediment budget, which permits to predict future coastline fluctuations caused by such anthropogenic interventions. A general problem is the availability of accurate

regional data. Remotely-sensed data can contribute through providing spatially distributed data to available. Remote sensing offers a privileged point of view in detecting environmental changes, and challenging opportunities in evaluating the potential effects of natural and/or human-induced events on the environment. Moreover, the synoptic spatial information that is obtained with geographical information system (GIS) provides important additional information layers for modelling soil erosion designing scientifically-based strategies, oriented to protection and sustainable planning/use of coastal environments and their fragile ecosystems. In order to increase understanding of the morpho-dynamics of the *Jonian* littoral environment and more fully appreciate the amount of coastal erosion, an evaluation of the sediment balance change inside catchment basins of the Basilicata Region has been carried out. To estimate sediment yield on a watershed scale, products derived from satellite remote sensing (multi-temporal Landsat imagery) with additional data sources have been integrated in a GIS. Validation methods used to assess the accuracy of results have been discussed. Finally, sediment budget changes have been correlated with the widespread retreating phenomenon witnessed by the study area since the second half of the 20<sup>th</sup> century.

### **Multidisciplinary study of the Pietra Maura Landslide - Marsico Nuovo (Basilicata, southern Italy)**

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*KEYWORDS: Landslide, multidisciplinary approach, Basilicata (Italy)*

The work highlights the results gained from multidisciplinary surveys carried out over Pietra Maura landslide. The study area is located along the right side of upper part of Agri valley (Southern Apennine), at north of Marsico Nuovo village (Basilicata Region). The aim was to define the features of Pietra Maura landslide through geological, geomorphological and geophysical investigations. The multidisciplinary study has been possible thanks to a collaboration between the Univ. Basilicata and the National Research Council – IMAA. In detail, the multidisciplinary approach allowed to determine the complex fault systems in the upper Agri valley, the lithostratigraphic characterization focusing on deposits associated with the mobilized body, the geometry of the landslide Pietra Maura, landslide body boundaries (lateral extension) and landslide's temporary evolution. This study focus on the complex landslide affecting two rural hamlet (Masserie Calabritto and Masseria Laseggiara) that are located into middle part of landslide body, while the landslide accumulation zone is close the Marsico Nuovo dam. The study area is 25 km<sup>2</sup> wide and it is located in the Agri valley, a Quaternary tectonic depression of the axis of the Neogene-Quaternary Southern Apennines fold-and-thrust belt. Geological survey defined the structural and stratigraphic relationship in the study area, recognizing several deformation phases. Preliminary geomorphological survey was performed by stereoscopic observation of aerial photos related to different flights leading to recognition of the activity and evolution of Pietra Maura landslide. Joint interpretation of geological and geomorphological data permit us to identify a increasing slides phenomena in correspondence with tectonic structures and lithological variations. Several geophysical data highlights useful information concerning Pietra Maura landslide. In detail, the Electrical Resistivity Tomography (ERT) and Self-Potential (SP)

map defined the landslide geometry and permitted to obtain useful information on the surface and deep hydrological characteristic of the investigated area. The ERT technique provides useful data on the lithostratigraphic sequences and the sliding surfaces between the slide material and the underlying bedrock. Moreover, the geophysical data detected high water content areas. SP technique have been carried out to better analyse the groundwater circulation system and to recognize infiltration and accumulation water zones.

### **Analysis and field campaign of soil component over the Tuscany Region. Using of environmental models to the protection of natural resource.**

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*KEYWORDS: soil, soil erosion, GIS, Database*

This paper presents the activities of the Consortium LaMMA (Tuscany Region) relating to the detection of the soil component highlighting the methodological aspects regarding the description of the character and behavior of the soil by carrying out field observations and soil profiles sampled and analyzed in the laboratory and the cartographic representation at various levels of detail. It also presented the Soil database structure, its consistency, field survey state of the art as well as the availability of certain information such as the Catalogue of soils units. With this database we performed an evaluation of the Regional Territory according to the major environmental issues were also highlighted by the European Commission in its Communication COM (2002) 179 "Towards a Thematic Strategy for Soil Protection", with which it has been recognized that soil carrying out many vital functions from the environmental point of view (biomass production, storage and processing of minerals, organic and energy, filter for the groundwater protection) and it was stressed the importance of defending it from degradation processes such as: erosion, loss of organic matter, contamination, sealing, compaction, decline in biodiversity, salinisation, landslides and floods. In this context are presented some elaborations carried out by Lamma during the past years. A first example is the map of soil erosion, a study carried out using the USLE model and applied on a regional scale, for which describes the methods implementation and spatialization of the various factors that determine soil erosion, according to the original methodology proposed by Wischmeier, subsequently revised and implemented in geographic information systems. A second example is the map of the organic carbon stock present in soils, for which are described the methods of calculation from the carbon content, the density of the soil, and by the presence of fragments of rock for both the 0-30 cm, 0-100 cm sections, standards adopted as a reference to the IPCC methods. Finally, in terms of interoperability, the content and structure data as well as its spatial components are assessed with respect to the European Directive INSPIRE Data Specifications ["Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)"].

## A preliminary assessment on use of electrical conductivity measurements for soil moisture dynamic determination at the plot scale.

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*KEYWORDS: soil moisture, soil electrical conductivity, TDR*

Because its involvement in several natural processes, the amount of water stored in the shallow part of the soil (named soil moisture or soil water content) plays an important role in the soil degradation processes. Soil moisture has a central role in the dynamics of the soil-vegetation-atmosphere system not only because it constitutes the pool of water readily available for plant transpiration but also because it influences the soil microbial-activity and determines physical properties of the soil which in turn influence the plant growth. This is specially pronounced in water-limited ecosystem, like drylands, where the structure, functioning and diversity of the ecosystem are water controlled. Between the in-situ methods for the estimation of soil moisture, dielectric sensors, such as Time Domain Reflectometry, has become largely adopted in the hydrological practice. TDR sensors enable high temporal data acquisition and provide very accurate soil moisture estimates in a large class of soil-types. During last decades, a regenerate interest in the use of geophysical methods like, e.g., the electrical conductivity one has become evident thanks to the ability to collect data on a greater volume of soil reducing the invasiveness and potentially reducing the costs. Anyway, the influence of potentially "disturbing" factors, such as soil solution electrical conductivity, temperature, presence of clay minerals makes the interpretation of conductivity data not straightforward. The study area is a test site which was ad-hoc set up in one of the gardens located in the CNR-IMAA Institute in Tito Scalo, southern Italy. The garden, made with reworked soil, has an area of ~14x10 m<sup>2</sup>. A set of simultaneous TDR and electrical conductivity measurements at six point-locations were collected at irregular time-spacing during three summer months, at a depth of ~15-20 cm. A statistical comparison between the two set of measurements is presented, both for each location and for areal averaged values. Results confirm the reliability of the electrical conductivity method as a potentially valuable support to conduct research focused on the soil moisture dynamics at a small plot scale.

## Bio-parks as a means of environmental restoration and enhancement for the sustainable management of a degraded land

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*KEYWORDS: Land use, sustainable management, Bio-parks*

The present study represents an innovative example of land management addressed to reuse for tourist purposes, through restoration and enhancement of the environment, of some disused quarries which later became artificial basins (reservoirs) due to outcrop of groundwaters. The environmental recovery involves a vast territory of the municipality of Castel Volturno, near Caserta, where there are 16 sand quarries, disused and

abandoned, created by abusive excavation and removal of material up to depths varying between 10 and 40 meters. The project set as its objective the creation of a small "tourist district" able to host and make better express different tourism enterprises, with the aim to redevelop an area being heavily degraded through an environmentally sustainable management. The initiatives of these companies are presently focused on a private property area of 300,000 square meters, but the project involves a redevelopment area of over 90 hectares of land. As a whole, the project included the construction of a BIO-PARK dedicated to wellness, culture and sustainable tourism, all fitted into a frame of outstanding naturalistic value. In fact, the area being object of the intervention falls within the perimeter of the Regional Natural Reserve Volturno River - Coast of Licola. This territory, between Licola pine forest of and the estuary of Volturno river, on the Domitian coast, protects a mosaic of natural environments survived to the urbanization of the coastline. The area (covering 1,540 hectares) includes the terminal end of Volturno River, two long coastal stretches to the north and south of the mouth, and the whole basin of Patria Lake. The dune ridges are colonized by mastic, heather, juniper, rosemary, buckthorn and arbutus. The brackish water, of varying extension, are an important resting, wintering and nesting site for birds. In the Reserve extensions of glasswort, thick reeds and tamarisk trees, pine forests of maritime pine and stone pine can be also found. The project complies with the recommendations of the "Environmental recovery plan of the province of Caserta compromised by the extracting activity of abandoned, abusive or discontinued quarries" of the Campania Region approved by the government commissioner for the waste emergency and waters rehabilitation and protection (Bulletin of Campania Region -BURC no. 12 dated 15/3/2004). As a whole, the project has allocated substantial resources in the experimentation of innovative methodologies for reuse for tourist purposes of flooded quarries, through their restoration and enhancement of the environment. The intervention is focused on the recovery of a wider area than the simple quarry site: it includes surrounding degraded areas and utilizes adjoining land resources being underestimated. This is not to return to the original state of the damaged bodies of water, but rather use artificial lakes for the enhancement of a land area through a responsible intervention promoting the establishment of a natural site of high environmental value in the lakes themselves. The project aims to encourage a natural state of high environmental value by creating a heterogeneous aquatic environment with excellent self-purification characteristics. The planned interventions will promote, along the time, the formation of an ecosystem; you will assist to later stages of development up to the climax where the ecosystem is stable and far from eutrophication.

## Quantitative assessment of the sensitivity to desertification in the Bradano River basin (Basilicata, southern Italy)

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*KEYWORDS: Desertification, ESAs indicators, Bradano river basin, southern Italy*

The main purpose of this study was the quantitative assessment of desertification process in the Bradano River basin study area (Basilicata, southern Italy). According to the integrated approach of the ESAs methodology (Environmental Sensitive Areas),

developed in the MEDALUS project (MEDiterranean Desertification And Land USE), the sensitive areas to desertification at river basin scale were recognized and mapped. Climatic conditions, periods of drought, rainfall variability, poor soils, land abandonment, soil worsening due to agricultural practices and high concentration of economic activities, are the environmental and socio-economic peculiarities of the Bradano river basin jointed to generate land degradation, soil erosion and soil salinization, which are the key factors to start desertification processes. The following main factors or indicators of desertification including: soil, climate, erosion, land cover, groundwater and management, were considered for evaluation of the prone areas to the land degradation process. Based on the ESAs approach, several sub-indicators affecting the quality of each main indicator were identified. Each of these parameters is grouped into different classes and a weighting factor is assigned to each class. Subsequently, four indices are evaluated: soil, climate, vegetation and management quality. A Gis-based approach was used in order to analyze geodatabase and elaborate thematic layers and quality maps. Finally the ESAs to desertification index and map, defined by overlapping the four quality layers in accordance with the developed algorithm, were elaborated. The analysis of results, points out a clear desertification sensitivity status of the Bradano basin, more than half of the entire area is prone to desertification. Most of the region shows an elevated sensitivity, as a result of the interactions between soil and land use factors, climate and the human pressures. The high sensitivity is dependent primarily by the slope gradient and the insufficient maintenance or abandonment of vast agricultural areas, that facilitate the erosion process. In the hilly sector the sensitivity to desertification is lower, due to land use, not evident human-induced modifications of the natural conditions and the adopted strategies management to protect land. In the downstream part, classified as fragile, the human actions play the most important role in the desertification processes. In conclusion, the assessment of the sensitivity to desertification in the Bradano river basin, by means ESAs methodology, can provide a significant contribution to identify the most threatened areas by desertification, in order to plan prevention, mitigation and remediation actions.

### Landscape visualization of mine excavations using data derived from UAV aerial digital photogrammetry

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*KEYWORDS: rehabilitation, abandoned mining, UAV, photogrammetry, DEM, landscape visualization*

In Sardinia open pit excavations often have created several risks and environmental impacts derived by the mining activities that deeply changed the landscape. In particular some exploitations have deeply altered the original landforms and, after the end of mining activities, many sites were totally abandoned therefore representing extremely dangerous places. In the rehabilitation of abandoned mining areas the final result is mainly conditioned by accurate measurement of the landforms of the post-mining assessment. In the field of landscape design planning of post-mine sites, the study on realism of visualization, derived from photogrammetric data, is a relevant aspect to give a natural perception of a proposed restoration. Using a predefined digital scenery generator software is possible to create a realistic 3D representations on DEM with overlapped thematic maps to

obtain a restored landscape. In this paper we present a method based on a detailed photogrammetric UAV (Unmanned Aerial Vehicle) survey to generate 3D high quality surfaces models (DEM) derived from non-metric high resolution digital images. This method uses indeed a combination of close-range and aerial photogrammetry techniques, to create high-precision digital terrain models at different consistent resolution, especially designed for high morphological steepness (vertical walls, deep excavation holes, slopes), and more in general for complex topography. The aerial and close-range photogrammetric survey was performed by a UAV with eight motors platform developed on Mikrokopter OEM components, equipped with high resolution digital SLR cameras. The survey was carried out by following a GPS waypoint based grids and several ground control points acquired with a RTK-GPS system. The aerial images taken were processed with a combination of different commercial photogrammetric software to obtain geo-referenced orthomosaic and DEM in TIN (triangulated irregular networks) format. Furthermore during the data post-elaboration process a lot of information and measures have been taken from the calculated geometrical models. With modern surveying devices such as UAV platforms, aerial photo survey and advanced visualization techniques, landscape documentation has become affordable and rewarding. Especially when combined with geographic information systems (GIS), complete 3D digital reconstruction and rendering programs constitute a powerful sophisticated and integrated method for describing, monitoring a landscape and to and manage its development.

### Multidisciplinary study of a landslide in the Southern Apennines (Val d'Agri - Basilicata Region)

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*KEYWORDS: soil degradation, mineralogy, physical-mechanical properties of soils*

Since most of the Southern Apennine slopes, in particular in Basilicata (southern Italy), are often affected by landslides, involving mainly fine sediments with predominantly clay components, our attention has been focused on a pilot area of the Val d'Agri intermontane basin. This area is affected by a historical landslide (Fosso Scazza, in the Montemurro area). The causes of the landslide are not yet fully understood. Now, the landslide shows evidence of activity, although slow, with obvious structural damage to infrastructure and anthropogenic buildings. During the first measurements, the inclinometer broke at 12 m in depth, reflecting on-going activity. The area is characterized by the presence of sandy-conglomerate and silty-clay fluvial-lacustrine Pleistocene deposits, which fall into two distinct formations, Torrente Casale and Vallone dell'Aspro, described in detail by Zembo (2010). The area is affected by deep extensional faults of the Val d'Agri Fault System, easily identified through geoelectrical tomography investigation. The geological and geomorphological survey of the area has been completed (September - October 2012) and first monitoring of ground water elevations has been performed. Ground water elevation results show a shallow aquifer ranging from the ground surface to six meters in depth. Waters circulating in the soil involved in the landslide have been characterized from a hydrogeochemical point of view. Other monitoring will take place during the maximum groundwater recharge period, in order to assess seasonal piezometric fluctuations and the composition of

groundwater. The geognostic holes are currently equipped with PVC pipes, to perform chemical-physical measurements on circulating waters, with TDR sensor (Time Domain Reflectometry) for the monitoring of the movements of the landslide. Granulometrical data indicate a prevalent silty-sand component (2-63 $\mu$ m) with gravels intercalation in the upper part of the stratigraphic hole. Clay fraction (<2 $\mu$ m) increases with depth. The mineralogical composition is dominated by sheet silicates (average 40%), even if more sandy samples reach values as low as 20%. Other minerals such as carbonates (calcite >> dolomite), quartz and feldspars occur with averages of about 35%, 8% and 6% respectively. Traces of gypsum and hematite are only present in some samples. The clay fraction of all samples is characterized by illite, mica, kaolinite and interstratified illite/smectite, which occur in varying quantities prevailing in the clayey samples. Some sandy samples in the upper portion and clayey samples also have detectable amounts of chlorite and interstratified chlorite/smectite.

### **Integrating environmental history into land degradation management for overcoming the gap between the social dimensions of environment and the strategies for land preservation and monitoring**

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*KEYWORDS: land degradation management, scientific methods, environmental history*

It is claimed that environment, sustainability and human health, are simultaneously social and natural issues. It is clear that exchanges between different branches of knowledge are fundamental for a correct approach to the study of these complex topics. Set of indicators and quantitative analysis are generally used for monitoring and preventing land degradation phenomena. But large parts of these phenomena were of human origin. So, scientific methods are often considered an information gathering exercise without critical inquiry into the underlying political and social relations. At the same time environmental history is poor without empirical evidence that can quantify and assess emerging environmental and human health risks as the basis for proper intervention. Thus an interdisciplinary approach is essential also because it offers the opportunity to improve the consensus around protection and recovery strategies imposed by stakeholders. Our purpose is to provide an overview of some issues that need to be addressed in order to integrate environmental history into the current scientific studies on land degradation.

### **Characterization of Asbestos content from natural sites in Tuscany: the CaMAM project**

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*KEYWORDS: asbestos characterization, CaMAM project, Tuscany*

Due to dangerous effects on health the industrial use of asbestos minerals is banned in Italy since 1992. As consequence, the risk of asbestos fibers exposure is no linked to industrial processes, but to the modifications of lithotypes containing them, whether as a result of natural phenomena (landslides, erosion, weathering) that as human activities (mining, earthworks, excavations, tunnels). To assess the real "natural" asbestos-related risk, the Tuscany Region administration has funded a project for the mapping and the characterization of the asbestos-bearing ophiolitic rocks cropping out in Tuscany. This project, (CaMAM: Caratterizzazione e Mappature Amianto), has been developed by a team among the Dip. Scienze della Terra (Univ. Pisa), Alitec s.n.c. and PivotConsulting s.p.a. Using the recent regional geological cartography, 66 sites of ophiolitic rocks containing asbestos minerals have been investigated using a multidisciplinary approach. Each outcrop has been initially investigated at mesoscopic scale. That has included the description of lithotypes and structures (i.e. faults, shear zones), the geometric characterization of asbestos-bearing veins (e.g. orientation, thickness, frequency, lateral extension...) and the textural and mineralogical characterization of asbestos minerals within the veins (i.e. geometry of mineral, fibers orientation respect to the vein boundaries, color...). In order to make the qualitative and quantitative assessment of contents of such asbestos minerals, representative samples of lithotypes and asbestos minerals have been collected. Overall, 410 samples have been collected. Petrographical analyses have been performed on 140 samples, XRPD analyses have been carried out on 143 samples, whereas 49 samples have been used to determine the Release Index (the only Italian legislative parameter used to assess the asbestos risk). Finally, in order to find alternative and innovative asbestos-risk assessment, new methodologies (i.e. image analyses on thin sections and the study of atmospheric particulate in area nearby inactive ophiolite quarries) have been tested. All these information have been used to elaborate an exhaustive and easily questioned GIS database.

### **Evaluation of functional biodiversity to enhance agroecosystem sustainability**

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*KEYWORDS: sustainability, functional biodiversity, agroecosystem services*

By analyzing different agroecosystem management's practices (biodynamic-organic and conventional) we try to evaluate environmental sustainability through analysis of the functional biodiversity, that guarantees ecosystem services, such as soil fertilization, soil nutrients recycling, air and water soil circulation, pest control, pollination which are useful to crops. To study functional biodiversity, we use bioindicators, sensible organisms to environmental quality. To evaluate agroecosystem food web complexity, we analyze species diversity of some groups of bioindicators belonging to the key trophic levels: decomposers-bacteria, fungi and earthworms in soil; producers -weeds in crop field and in field margin; primary consumers - key insect crop pests; secondary- tertiary consumers -predators and parasitoids of key insect crop pests. Fieldwork data are collected in ten horticultural fields, in Venice and Treviso provinces, five managed in biodynamic-organic and five in conventional way. The crop chosen is Treviso red chicory (*Chicorium intybus* L.). Data elaboration takes place at two levels: 1- quantitative analysis of species number composition evaluated using NMDS (non-metric

multidimensional scaling); 2- qualitative analysis of functional traits of organisms that make ecosystem services possible.

Some preliminary results are: (1) Quantitative and qualitative analyses using A.R.I.S.A. technique show as soil bacteria communities samples comply to an appreciable extent to a "bacterial biogeography" due to their less efficient spread capacity compared to other groups such as soil fungi, whose communities appear more related to soil management and less shaped by geographical factors. (2) Analyses of soil microbial activity using the FDA (Fluorescein Diacetate) hydrolysis test show significantly higher values in biodynamic-organic managed fields. (3) Density and number of earthworms species outnumber in organic-biodynamic fields. Earthworms analyses within an innovative QBS-e (Biological Soil Quality Index based on earthworms) framework show how different ecological categories are well represented only in biodynamic-organic fields. (4) Considering pest control quantification data on crop, we found an initial peak of Lepidoptera caterpillars in conventional fields, which was followed by agrochemical treatments, while there was a trend slightly more regular in biodynamic-organic fields. About the presence of predators on aboveground parts of the crop, there was a massive presence of individuals in biodynamic-organic fields. (5) The weeds communities data show a difference between species number only in the field margin in favor of biodynamic-organic management; we analyzed also some functional traits such as the presence of entomophilous species, that can be an indirect measure of pollination ecosystem service.

### **PRO\_Land project – an example of integration of remote sensing and in situ methodologies for evaluating land degradation in Mediterranean areas**

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*KEYWORDS: land degradation, salinization*

The "Assessment methodologies for controlling land degradation processes and impacts on the environment" project (PRO\_Land) started in 2012 with the general purpose of supporting policies and interventions achieve a sustainable use of natural resources through the development of multi-disciplinary methods and techniques to identify the characterization of land degradation processes. This goal will be realized through the assessment of land degradation at different spatial and temporal scales and the creation of international cooperation in combating degradation. The project will complete its activity by 2014. Italy and Greek are the countries involved in the project. The PRO\_Land project is supported by the Operational Program ERDF Basilicata 2007 – 2013, Projects for European territorial collaboration. The project is composed by three actions: study of soil, water and vegetation degradation to develop best practices for sustainable land management; exchange of experiences to identify and analyze land degradation in other geographical contexts, and management and dissemination of results. Such activities will be carried on by the project partners and by the involvement of several local end-users and stakeholders operating in the selected regions. Basilicata region (Southern Italy) is affected by the land degradation phenomena. Along the Ionian coast these phenomena are intensified by of strong anthropic action (agriculture and tourism) and the climatic and geological

conditions favoring phenomena such as erosion and salinization. The Ionian coast has a valuable natural and cultural value that must be preserved with a focused study of the causes of ongoing deterioration. Similar land degradation can be found in various parts of Greece. In particular, on the island of Crete, soil features and climatic conditions are important predisposing factors that lead to degradation processes such as erosion and salinization, both along the coast and inland areas. These areas were chosen as common test-sites in order to compared different methods: the use of satellite time series to understand vegetation dynamics, land cover alterations and soil compaction, and in situ monitoring of soil and water quality. During the first year of activities, we have: collected and harmonized existing ground data, particularly on soils, vegetation, land use systems and productivity; analyzed and synthesized state, causes, impacts and trends of land degradation in test-sites.

### **Spatio-temporal analysis of land degradation phenomena combining satellite data, regression modeling, and GIS**

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*KEYWORDS: land degradation, vegetation, Basilicata*

Within land degradation studies vegetation is one of the key components to analyze, because of its central role within the environment. Distribution, health conditions, and species richness of vegetation have multiple interactions and feedbacks with soil, climate, and anthropic activities. Basilicata region, which is located in the core of Southern Italy, includes many areas still productive but often affected by degradation phenomena linked both to the inherent susceptibility of several pedological and morphological features and to improper management practices (inadequate reforestation/afforestation plans, intensive agricultural systems, European Common Agricultural Policies). In the framework of PRO-LAND project (PO-FESR Basilicata 2007-2013), we used information on photosynthetic activity dynamics and spatial regression models to support appropriate mitigation and preventive actions to combat land degradation in Basilicata. To this purpose, we used a time series (2000-2012) of a satellite vegetation index (NDVI MODIS - Normalized Difference Vegetation Index Moderate Resolution Imaging Spectroradiometer) derived from the NASA product MOD13 provided every 16 days at 250-meter spatial resolution. MODIS NDVI were used to identify areas characterized by significant negative vegetation trends. Our results show that hot-spots of negative trends of medium-high magnitude are scattered within the investigated area and are mainly located in man-managed areas (prevalently devoted to agriculture). Successively, we tried to identify spatial correlations between areas marked by vegetation decline and several soil and surface parameters by using continuous or logistic regression modeling and GIS. Statistical analyses put into evidence that the spatial pattern of the observed trends is mostly linked to steepness and texture of the surface. The integrated approach used in this work, was aimed at linking degradation processes with their driving forces, providing a knowledge platform for the assessment of land degradation phenomena in Basilicata. Of course, this procedure can be adopted at a coarser or finer scale (pan-European or catchment level) by adopting the most suitable satellite and explanatory data.

### **Analysis of asymmetries in the persistence probability of vegetation cover activity as an early warning tool to combat land degradation**

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*KEYWORDS: Vegetation resilience, Satellite remote sensing, Statistical mechanical models*

Vegetation cover activity is deeply linked to environmental phenomena and particularly sensitive to environmental stress. Healthy vegetation cover reacts to shocks and, in the presence of favourable conditions, tends to develop and extend. On the contrary, adverse climatic change, human pressure, soil degradation, water or nutrient shortage can exert a negative influence on the ability of plants and ecosystems to recover from disturbances. The first overall effect of the complex mix of heterogeneous factors driving degradation in still productive areas is a reduced efficiency of the reactive skill of vegetation. In these cases, if we look at the temporal variability of the vegetation activity and to its deviations from a mean reference level, we expect that the duration of fluctuations above the mean value shortens whereas the duration of fluctuations below the mean becomes longer as a result of incoming land degradation and reduced resilience. Our basic idea was to analyse land cover activity as a mechanical statistical problem of fluctuating surfaces and to estimate the probability associated to the persistence of positive/negative fluctuations for inferring regional asymmetries in the photosynthetic activity or in the temporal variability of biomass. In the context of the land degradation problem, which is becoming a planetary issue, we can use vegetation indexes (NDVI) obtained from satellite time series that are available at different spatial resolution for identifying non-degraded areas where vegetation shows early signs of vulnerability and where field investigations are required. This approach can be particularly useful for the early detection of climate change effects. Here we present the analysis of a time series of 25 years of 8 km GIMMS AVHRR-NDVI maps of the European territory we already found to be able to capture details on vegetation cover activity also in complex territories such as the Italian peninsula. Our estimations of characteristic positive and negative trends put into evidence the ability of our methodology to pick up vulnerable areas that are especially located in the southernmost regions of Europe but are not confined to them.

### **Hydrological characteristics of degraded soils of a landfill in Northern Italy: a comparison between instrumental data and predictive models**

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*KEYWORDS: Degraded soil, Hydrologic characteristics, Pedotransfer functions*

The coverage soils of a landfill in Piacenza (Italy) are actually involved in a Life + project (10 ENV/IT/0400 Life New Life), which has, among their objectives, the restoration of degraded soils by treatment for their improvement with an innovative reconstitution method consisting in an incorporation of organic matter by mechanical and chemical processes that originate new aggregates of soil. The aim of this study is to describe some aspects of soil's degradation; the degradation is described by the results of chemical and physical analyzes and those relating to the vegetation ecological study. For this purpose, we focus on the determination of the hydrological characteristics. Through the tensiometric cassette and the Richard's plates the amount of soils water content at -0.10 KPa, -10kPa and -31.62 KPa and -1496.24 KPa pressures was measured; the available water content for plants was subsequently calculated. The water volumetric content at the different pressure values and the resulting water retention curve were compared with the predictive models, which are mathematical models that correlate the water retention and hydraulic conductivity with some easily measurable chemical and physical parameters of the soil such as: texture, density, porosity and organic carbon content. The 18 PTFs used in this study are based on two models: van-Genuchten and Brooks-Corey; it was also used the SPAW program. Through the calculation of RMSE, the best curve in describing the behavior of the investigated soils was identified. To describe the soils degradation the real water retention curves were compared, also, with an ideal curve derived from the average of the PTFs curves developed for a hypothetical soil. The inputs for this hypothetical soil, which was assumed non-degraded, are: silty loam texture, bulk density 1.4 g cm<sup>-3</sup> and particle density 2.6 g cm<sup>-3</sup>, (such as landfill soils), depth 1 m (deeper than the landfill soils), organic carbon content 1% (lower than the average of 2.6% of the landfill soils), well structured. This comparison shows that the investigated soils have less available water content than the hypothetical soil, this combined with the low depth and compacted structure represents a state of degradation.

### **Tracing groundwater salinization processes in coastal aquifers: a hydrogeochemical and isotopic approach in Na-Cl brackish waters of north-western Sardinia, Italy**

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*KEYWORDS: salinization, geochemistry, Nurra*

In the Mediterranean area the demand of good quality water is often threatened by salinization, especially in coastal areas. The salinization is the result of concomitant processes due to both marine water intrusion and rock-water interaction, which in some cases are hardly distinguishable. In north-western Sardinia, in the Nurra area, salinization due to marine water intrusion has been recently evidenced as consequence of bore hole exploitation. However, the geology of the Nurra records a long history from Paleozoic to Quaternary, resulting in relative structural complexity and in a wide variety of lithologies, including Triassic evaporites. To elucidate the origin of the saline component in the Nurra aquifer, may furnish a useful and more general model for the salinization processes in the Mediterranean area. In addition, due to intensive human activities and recent climatic changes, the Nurra has become vulnerable to desertification and, similarly to other Mediterranean islands, surface-water resources can periodically suffer from drastic shortage. With this in mind we report new data, regarding brackish waters of Na-Cl type of the



Nurra, including major ions and selected trace elements (B, Br, I and Sr) and isotopic data, including  $\delta^{18}\text{O}$ ,  $\delta\text{D}$  in water, and  $\delta^{34}\text{S}$  and  $\delta^{18}\text{O}$  in dissolved sulphate. We also analyzed a set of Nurra Triassic evaporites for mineralogical and isotopic composition. The brackish waters have Cl contents up to 2025 mg/l and the ratios between dissolved ions and chlorine, with the exception of the Br/Cl ratio, are not those expected on the basis of a simple mixing between rain water and seawater. The  $\delta^{18}\text{O}$  and  $\delta\text{D}$  data indicate the waters are meteoric in origin. A relevant consequence of the meteoric origin of the Nurra Na-Cl type water is that the Br/Cl ratio, extensively used to assess the origin of salinity in fresh water, should be used with care also in near coastal aquifers. Overall,  $\delta^{34}\text{S}$  and  $\delta^{18}\text{O}$  in dissolved sulphate suggest that water-rock interaction is the responsible for the Nurra Na-Cl brackish water composition. Evaporites dissolution also explain the high chlorine contents since halite has been detected in the gypsum levels. Finally, the Nurra Na-Cl brackish water are undersaturated with respect to the more soluble salts involving, in a climate evolving toward semi-arid conditions, that the salinization process could dramatically intensify in the near future.

### A participated monitoring of supraglacial vegetation in the Italian Alps for investigating the climate change impacts on debris covered glaciers

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*KEYWORDS: participated monitoring, supraglacial vegetation, debris covered glacier*

The increasing glacier ablation rates as well as the greater intensity of rock degradation processes on the slopes is enhancing the concentration of debris in the terminal portions of several glaciers of the Alps. Those glaciers whose tongue is located at an altitude below the vegetation potential limit may host a vegetation colonization by supraglacial herbaceous vegetation, shrubs and also trees. Supraglacial vegetation may be used as a valuable proxy for characterizing surface instability and surface morphologic characteristics of debris covered glaciers. Morphological, chemical and physical characteristics of tree rings may in fact record both the disturbance signals of stress caused by the movements of the debris and the ice beneath and the climatic signals. The most recent dendroglaciological researches carried out on supraglacial trees growing on the Miage Glacier, the only Italian glacier characterized by an extensive colonization of supraglacial trees, has allowed the reconstruction of the past surface movements of the glacier for the last decades. The most stressed areas are in the medium-lower portion of the tongue towards the margins and tree colonization is strongly controlled (with regard to tree growth and distribution) by the substrate characteristics (ice and debris) and by its instability. It is therefore important to survey and analyze the supraglacial vegetation and to monitor the early stages colonization of the debris covered glaciers. Promoted by the Italian Glaciological Committee, a participated monitoring of supraglacial vegetation to be repeated annually was organized since 2011 with the aim of characterizing climate change impacts on the Italian debris covered glaciers. The monitoring is coordinated by the dendrochronology group of Milan Univ., Dept. of Earth Sciences and it is open to hikers who frequent the Alpine glaciers, and people or experts interested in Glaciology,

and it should be performed by filling a predisposed form available at: <http://www.glaciologia.it/rilevamento-vegetazione-epiglaciale/>. The two surveys performed up to now (years 2011 and 2012) saw the participation of 20 surveyors that have monitored 24 glaciers sending the compiled form together with the photos to the official e-mail box: [glaciovveg.unimi@gmail.com](mailto:glaciovveg.unimi@gmail.com). Eleven glaciers presented an abundant debris coverage of the tongue, namely: Lana, Belvedere, Locce Nord, Miage, Brenva (dead ice), Vedretta d'Amola, Verra Grande, Aurna, Lys, Valle del Vento, Chérillon. Brenva, Locce Nord and Belvedere Glacier present a diffuse vegetation cover. Miage and Brenva Glacier present an abundant and diffuse shrub and tree cover, respectively.

### Asbestos and other fibrous minerals contained in the Gimigliano-Mount Reventino Unit (Calabria Region, Southern Italy)

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*KEYWORDS: metaophiolite, asbestos, Gimigliano-Mount Reventino Unit*

The study concerns the investigation on asbestos and other fibrous minerals in 25 specimens of serpentinites and metabasalts collected in the metaophiolitic sequence of the Gimigliano-Mount Reventino Unit (GMRU). For this purpose, mineralogical studies of serpentinites and metabasalts are currently being carried out by PLM, XRPD, SEM/EDS, TG/DSC, TEM/EDS investigations. PLM and XRPD studies show that metabasalts, which are either massive and banded, consist of (in order of decreasing abundance): chlorite, epidote, albite, amphiboles (actinolite, tremolite and riebeckite), quartz, muscovite, calcite and serpentine. Serpentine samples contain (in order of decreasing abundance): serpentine minerals, magnetite, tremolite, chlorite, calcite (this latter occurring as veins) and minor clay minerals. At the microscope scale serpentinites are characterised by the typical mesh texture, with pseudomorphs replacing olivine and bastitic texture on ortho- and clino-pyroxenes, with rare relics in the inner portions. Moreover, widespread serpentine veins are characterised by fibres grown either at low angle ("slip" serpentine) and perpendicular ("cross" serpentine) respect to the vein elongation. SEM and TEM/EDS investigations show asbestos tremolite, asbestos actinolite, asbestiform and massive antigorite, lizardite and chrysotile. Chrysotile shows mainly the classical cylindrical fibres, antigorite is characterized by lamellar and fibrous shape, lizardite exhibits only plate-like morphology. At the SEM observation, the tremolite and actinolite fibres appear thin, rigid and approximately 30  $\mu\text{m}$  in length. The DSC patterns of all serpentinitic samples show: a main peak in a T range of 625-650  $^{\circ}\text{C}$ , due to the chrysotile breakdown; an endothermic peak in a T range of 697-765  $^{\circ}\text{C}$ , diagnostic of lizardite and antigorite. A sharp exothermic peak is recognised at 820-826  $^{\circ}\text{C}$  in all samples, which indicates the crystallization of forsterite. The DSC curve for metabasalt samples showed the characteristic endothermic peaks of serpentine minerals and tremolite-actinolite ranging from 612 to 643  $^{\circ}\text{C}$  and from 964 to 969  $^{\circ}\text{C}$ , respectively. Other investigations to deeply characterize the fibrous phases are going on.

### Tunnel boring asbestos-bearing rocks is a problem of ophiolite but it is not limited to ophiolite

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*KEYWORDS: tunnel, asbest, tremolite, fibers*

Layers of phlogopite and tremolite bearing marbles are known in the meta-sedimentary, (not ophiolitic) Mesozoic sequences cropping out in the Antigorio Valley (Lepontine Alps). Preparatory geological investigations carried out within the frame of a tunnel boring project have recently allowed us to discover in the same units local, important stockwork of tremolite and calcite (with minor talc and phlogopite) veins. Laboratory scale, crushing tests carried out on these rocks proved the release of significant quantities of asbestos and allowed predictions about the amount of airborne fibers that will be present on site during boring. The same tests have highlighted (once more) that the number of fibers that will be released strictly depends on the mode of crushing and also that fibers are found in the sieve fractions greater than 100 microns. In the specific case, a TBM (Tunnel Boring Machine) boring dolomite marble with a content of tremolite ranging from 2 to 15%, and producing about 10% of fine material (size below 100 micron), could release between 10E+12 and 10E+14 fibers per hour and per meter of advance on a front of 14 m<sup>2</sup>. Asbestos occupational hazard related to excavation of ophiolitic rocks is known and deeply investigated but also the hazard related to excavation of other rocks bearing potentially asbestos minerals (such as tremolite and actinolite) should not be overlooked.

### Critical slowing down theory and desertification management

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*KEYWORDS: Slowing down, Desertification, Thermodynamics, Equilibrium*

A new view to desertification phenomenon based on thermodynamics laws for open systems has been followed in this report. Desertification is defined as irreversible land degradation that is caused by human activity and climate fluctuations leads to deterioration of human well-being. Ecosystem equilibrium determines long-term land productivity, and thus well-being of those dependent on land resources. Therefore, combating desertification is a condition of sustainable development. According to the second law of thermodynamic, the maximum level of entropy is an attractive for systems to reach equilibrium. The dynamics and spatial organization of ecological communities are strongly affected by various feedbacks between the biotic and abiotic environments. In any systems that are close to a critical transition, recovery upon small perturbations becomes slow, a phenomenon known as critical slowing down. In this report the desertification has been analyzed based on ecosystem approach and considered as a consequence of environmental perturbations and non-equilibrium conditions. Results and analyzes of this report can be helpful for development of sustainable ecosystems and combating desertification.

### The "Coquand Section": a historical-scientific-touristic geosite in the Parco Archeominerario di San Silvestro (Campiglia Marittima, Tuscany)

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*KEYWORDS: geosite, skarn, Coquand Section*

Following shut down of mining activities and consequent abandonment of mining areas, many of them are now first-class outcrops visited by scientists from all over the world and training ground for new generations of geologists. Nevertheless, these sites are under threaten to become forgotten, inaccessible or, even worse, eventually lost. The present work illustrates the rescue and potential development from both a scientific and touristic point of view the geosite "Coquand Section" located in the Parco Archeominerario di San Silvestro (Campiglia Marittima, Tuscany). We report on a procedure suitable also for other areas, based on collaboration among academic, research and local institutions. The "Coquand Section" is a 20 m-wide niche, scalloped during the first half of XIX century by mining engineer Henry Coquand (mine director at that time) where the type-section of the Fe-Cu-Pb-Zn(-Ag) sulfide-bearing Temperino skarn body is exposed. The "Coquand Section" has since been studied by naturalists and geologists leading to current theories on the formation of skarn ore deposits. Among these pioneering works, it is worth to note that by the German geologist Gerhard Vom Rath in 1868, representing the first description of a mineralogical zoning in a metasomatic skarn body. The "Coquand Section" is thus a geosite of prime importance, of great relevance in reconstructing the evolution of scientific ideas on skarn formation throughout almost two centuries. Despite its importance, the "Coquand Section" suffered in the last decades a lost of interest, with lack of maintenance works. A collaboration between Parchi Val di Cornia S.p.A., the Univ. Pisa and the IGG-CNR was set up, and two student stages were performed, clearing out the outcrop from vegetation, and carrying out a detail topographic and geological survey in order to produce a new 3D version of the "Coquand Section" map, as well as collecting further scientific field data. This work is the base to produce an illustrative panel to be located in front of the "Coquand Section", so that visitors can learn about the historical and scientific relevance of this extraordinary geosite.

## **Airborne dispersion of asbestos fibers induced by serpentinites mining: a simulation in the Pievescola area (Tuscany, Italy)**

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*KEYWORDS: asbestos, ophiolites, geohazard*

In Italy, the environmental hazard related to asbestos is still high, also due to airborne dispersion of fibers as a consequence to mining activities into asbestos-bearing rocks, as serpentinites or basalts. The Ministerial Decree 14/05/1996 provides a method to define the hazard deriving from the exploitation of the asbestos-bearing rocks quarrying, but the proposed procedures are unclear from a geologic point of view, and not so effective for a precise assessment. We present an integrated approach based on geological, mineralogical and petrographical standard investigations on serpentinites and we test a model of airborne dispersion of fibers in order to propose more effective procedures in order to assess the asbestos-related hazard. The adopted approach consists of 5 successive steps: 1) detailed structural mapping and collection of samples representative of the outcropping rocks, 2) petrographical study of selected thin sections of serpentinites with the aim to assess the presence of fibrous minerals, 3) X-Ray powder diffraction analyses for the identification of the species of fibrous minerals, 4) determination of the Index of Release according to the Ministerial Decree 14/05/1996 in order to determine the amount of fibrous minerals released by crushing of the asbestos-bearing serpentinites and 5) modelling of the airborne dispersion of asbestos fibers by the quarrying activity based on the data collected in the previous steps. This integrated approach is based on standard geological techniques that can be applied not only by researchers but also by geological consultants and requires standard equipment that are commonly found in public and private laboratories. This approach has been simulated for an area located west of Pievescola, south of Casole d'Elsa (Tuscany), where no quarrying activity occurs or is scheduled for the future. According to the simulation performed in the Pievescola area, this integrated approach can be regarded as effective, even if liable of improvements. The implications of the adopted approach allow to identify valuable procedures to minimize the asbestos-related hazard. Particularly, the procedures adopted can be able to provide useful suggestions to make more effective the present-day legislation.