ECOSISTEMI

NEW LIFE

BOOK OF ABSTRACTS

1st Conference

SOIL IMPROVEMENT

TECHNOLOGY FOR DEGRADED SOILS RESTORATION

APPLIED SOIL SCIENCE
FROM THEORY TO PRACTICE

May 19th-20th, 2016
Palazzo Farnese
Piacenza - Italy

In collaboration with :

UNIVERSITÀ CATTOLICA del Sacro Cuore

COMUNE DI PIACENZA

PROVINCIA DI PIACENZA

Introduction

The processes involving land degradation, generally acknowledged by highly qualified scientific and institutional operators up until a decade ago, have become increasingly conspicuous over the years.
Today all agricultural operators, even in the most fertile areas of the planet, are familiar with this issue.
Therefore there's a pressing need to channel our knowledge of the rapidly changing soil conditions of the planet into devising new technologies aimed at limiting its loss, and tackling its degradation and desertification processes.
The present convention addresses this issue and represents a great opportunity given by the programme LIFE for the development of soil reconstitution.
The latest four years from the start of the project, which have been marked by an intense research and implementation activity, have shown that the rapid advancement of knowledge needs to rely on exchange and confrontation in order to achieve an effective synergy when so many aspects ranging from applied pedology to soil science have to be considered.
Therefore the situation has called for a multidisciplinary meeting to be held aimed at developing scientific and technological knowledge in the field of soil conservation and rehabilitation.

Paolo Manfredi

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Fundamentals of reconstitution: futures of its implementation, technology and future development

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The key considerations at the heart of reconstitution technology - a method of soil treatment whereby organic matter is incorporated into the soil mineral fraction resulting in restructuring of aggregates - are the importance of organic carbon on the soil physical and chemical fertility and the need for it to be preserved within it. This conceptual framework has been integrated with a deep understanding of the properties of a wide range of waste types which, if appropriately managed, may be effectively and skillfully optimized with this treatment.

The technology's primary objective is restoring degraded soils which have become unproductive as a result of anthropic activity. Soil improvement without the use of reconstitution technology is very expensive both in economic and environmental terms which frequently exceed the value of restored land.

The treatment starts by pre-mixing the soil with additional components such as waste of different types whose properties have a direct relevance and interest to the agricultural land that needs remedial action. Production waste used include: sludge from water treatment, sediments from hydroelectric basins dredging, waste paper sludge and wool scouring sludge.

Such matrices are unusable individually but if they are weighed out appropriately on the basis of individual characteristics, and then submitted to treatment they may be used to produce reconstituted soil. Following pre-mixing the aggregates are crushed and fragmented and after that a potential addition of humic components and a further mixing procedure are performed. At this point disintegration and reconstitution treatments take place. Disintegration is carried out by a mechanical action performed by a thorough breakdown and destructuring procedure combined with grinding and dispersal of organic components within the global mass. The final reconstitution which takes place by mechanical pressure applied by a mechanism of rotating discs and hammers incorporates the organic substance into the mineral fraction thus generating neo aggregates in reconstituted soil.

The treatment is protected by two patents which include procedure and use. It was first implemented in 2006 on a heavily degraded soil of 10 hectares restoring it to high levels of productivity. Later on the technology developed to include applicability to the production of
fertile soil by using unproductive soil to be employed for agri-environmental remedial treatments thus diversifying soil production into topsoil (surface soil) and agricultural soil.

Future technology is currently heading towards mechanical treatments which may suit different soil textures, produce soils tailored to specific crops and investigate new types of waste to be employed for reconstitution. In time such treatments may be extended to soil bioremediation technologies (bipile, landfarming, fitoremediation) and seek implementation in foreign countries.

The developments in reconstituted soils research as a tool to retrieve organic matter waste and to store carbon

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Soil organic carbon represents the largest pool of terrestrial carbon, 3.2 times the atmospheric pool and 4.4 times the biotic pool. Due to the size of the soil organic carbon pool, even small changes in the global soil organic carbon stocks could significantly affect the concentrations of atmospheric CO_2. It has been postulated that increasing soil organic carbon concentrations in soils at depths of up to 2 m by 5 - 15 % could decrease atmospheric CO_2 concentrations by 16 - 30 %.
The role of soil in organic carbon adsorption and preservation depends on the soil chemical-physical properties and on the type of organic matter. However soil quality depends largely on the organic matter content, which is dynamic and changes rapidly according to tillage. The amount of organic carbon in many Europe soils is decreasing, due to the intensive tillage. When organic matter decreases below the amount needed for a soil to be stable, fertile, and healthy, soil undergoes degradation.
The input of organic carbon in soil is mainly through plants and animals decomposition, root exudates and organic matter from other sources through spreading. In literature potential annual rates of carbon incorporation in agroforestry soils are reported to be highly variable and uncertain. Therefore providing organic matter, promoting carbon adsorption and removal from the atmosphere and counteracting soil degradation are very important issues.
The data produced in a few years of experimentation on reconstituted soils show that the reconstitution addresses to these issues: acting on degraded soils by counteracting degradation, preventing the increasing carbon release and allowing storage.
The reconstitution works by chemical-mechanical actions on a degraded soil added with suitable organic and mineral waste materials. Unlike spreading, in which the organic materials is distributed on the soil and farmed, the reconstitution acts intimately between soil and added materials. In the first mechanical step organic materials are mixed with mineral soil components. In the second step organic materials mixed is intimately distributed in mineral soil fraction through a disintegration and an adhesion to the fine soil fraction made by mechanical pressure on the aggregates. The organic matter is occluded in the micro and macro neo-aggregates allowing storage.
Starting from organic carbon content of waste materials and soil before reconstitution, the analytical results on reconstituted soils, constantly monitored, confirm this trend.
In fine textured soils an increase in organic carbon content and in its stable components - humic and fulvic acids - are observed.
In coarse textured soils an increase in carbon content immediately after reconstitution is observed, however, a progressive organic carbon loss and low humification rate followed.

Scientific researches on the reconstitution

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Among the aims of the New Life project, to demonstrate the suitability of reconstitution in producing a soil with good agronomic properties is one of the main. For this purpose, studies, researches and agronomic tests have been made, based on the comparison of chemical and physical analysis and yields between natural degraded soils and reconstituted soils generated from them.
Experimental comparison plots, made by different degraded soils and reconstituted soils - generated from them using different added materials -, have been made and studied for 3 years. Every six months soils samples were taken and chemically-physically analysed. The purpose of chemical and physical analyses and the monitoring of native vegetation grown on them was to study the improvements made by reconstitution on degraded soils and to find what is the most suitable material to be used in reconstitution on the basis of soil properties.
By Richards plates on disturbed and undisturbed samples, the best hydrological properties of reconstituted soil than natural one - higher volumetric water content at different suctions - were determined. The humidity at wilting point was, also, determined through a test in pots with sunflower. The obtained laboratory data were compared with the results of some pedotransfer functions - van Genuchten and Brooks and Corey models.
Two agronomic tests with maize have been set up - on degraded natural soil and reconstituted one - to evaluate yields, decreasing in reconstituted soil the amount of irrigation water in one case and nitrogen fertilization in an other. The tests have shown that maize grown on reconstituted soil had higher yields in comparison with natural one saving the 45 % water and 50 % of nitrogen fertilization respectively.
For one year the temperature fluctuations of a natural degraded soil and of a reconstituted soil were monitored. The reconstituted soil has kept more constant temperatures - low thermal day-night excursion - lower in the Spring-Summer and higher in the Autumn-Winter compared to the natural degraded soil.
A test in pot was set up to try the suitability of reconstituted soil in producing tomato. This test proved the good agronomic properties of reconstituted soil. Tomatoes in reconstituted soil pots have produced, with the same amount of water irrigation and fertilization, an average total number of red fruits twice and average total number of green fruits equal compared to degraded natural soil pots.
A greenhouse test was made to evaluate emergence and root development in maize after few days from seeding. All investigated parameters were better in plants grown in reconstituted soil compared to degraded natural one.
The analysis of the reconstituted soil on the basis of the requirements of UNI 11235 legislation - for the planning and the requalification of a green area - closed that reconstituted soil is suitable for this purpose.

Restoration soils in the circular economy era

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It has been some time now since the European Commission in the first place, and several national and regional legislations (among which also Emilia Romagna region legislation) have explicitly initiated a transition process aimed at shifting the behavioural models of citizens, enterprises and public administrations from the traditional linear economy – where the chain production-consumption-waste management did not have any detailed feedback – to a circular economy that stretched the life cycle of products to the benefit of economy and the environment. The objective is to create new markets that will consider waste from consumption as potential raw material for new processes, thus reducing the impact of waste production on the whole economic cycle.

The principles of circular economy can be applied to different contexts; any innovation aimed at perpetuating the use of resources so as to re-introduce them in the production cycle, in some cases with an enhanced potential from their original stage, becomes a formidable improvement tool for system productivity, allowing for the reduction of the negative impact of consumption of exhaustible resources.

In Europe there are numerous support actions for circular economy, all aimed at generating opportunities to strengthen competitiveness and creating new markets and new commercial opportunities through the sustainable use and re-use of resources.

The New Life project for reconstituted soil is a technological and systematic solution that allows for the reconstitution of soils, thus reconsidering their use.

The research wishes to relate the innovative potential of New Life project with the opportunities and needs dictated by the evolution of circular economy.

Pedotechniques:
Lights and Shadows

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Introduced in the 1980ies the term pedotechnique refers to the set of human activities that cause a significant influence of man on pedogenesis and on soilscape evolution. This occurs either by selecting and using appropriate materials for the construction or reconstruction of soils, or by introducing procedures aimed at the modification of the soil characteristics up to the design of soils for specific purposes.
Although we could affirm that every human activity on soil or with soil can fully be considered as a "pedotechnique", in these last 15/20 years, the concept of pedotechnique was extended even to all those situations that link the soils to any social, industrial or economic activities of Man. In practice to all those human activities carried on the soil or with the soil that, unfortunately, continues to be a crypto-resource.
In the field of soil management for agricultural purposes, pedotechnique is used to get substantial financial returns. However, in so doing, we often do not take into account the fundamental objective of the pedotechnique, i. e. to meet the needs of man, avoiding any undesirable environmental consequence that may occur during handling of earthy materials. We should consider that whenever there is a human intervention on the environment, originate new soilscapes and many times, new soils.
In this note, we report two emblematic case studies of "light and shade" that can characterize pedotechnique. The first, carried out in Emilia Romagna illustrates the pedotecnique implemented for the environmental remediation of a polluted Spolic Technosol, using Ca(OH)2 and smectitic marlstone. The second highlights the results of a long research project carried out in an area of Sicily characterized by the development of intensive viticulture (cv Italia) on large-scale and by the use of pedotechniques aimed at creating suitable soils for viticulture. It is highlighted that, notwithstanding the considerable financial return that the transformation of the soilscape has favored (an extraordinary light), there is a considerable decrease in the quality of the environment (a shadow cast on the future).

The role of organic matter in processes of soil restoration

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Soils differ from common altered rocks because they show a vertical stratification (horizons) produced by the incessant filtering of water and living organisms through time. These are multi-composed, open, bio-geo-chemical systems containing solids, liquids and gases, and exchange matter as well as energy with the surrounding atmosphere, biosphere and hydrosphere. These flows are extremely variable through time and space, but they are essential to the development of the profile and management of fertility and the quality of the system. Moreover, soils are also sinks of carbon, which is accumulated in relation to complex chemical, physical and biological equilibria that characterise its evolution, and limit its dispersion in the atmosphere.
Soils are also complex biological systems showing the symptoms and "illnesses" typical of living organisms, unveiled and presented under different forms, as far as our knowledge is able to grasp. In general, soil is a complex environmental sector where multiple phases of matter together with numerous "functions" intertwine - ecological rather than physiological, naturalistic rather than instrumental - but it is still mainly considered for productive, constructive or commercial purposes.
The use, or rather, "consumption" transforms soil in a passive subject, characterised by an instrumental relationship that contrasts with the choices of public administrations, of local or national interests, of planning policies and development of natural and territorial resource, of the impact of the solutions imposed by each individual, with the action of constantly changing atmospheric agents and climate, and last but not least with the diffused or point source pollution and of direct or indirect phenomena of degradation and depletion.
Soil organic matter plays a pivotal role in defining and promoting properties and characteristics of soils, with a strong influence on biological, physical and chemical processes, regardless of its relative abundance, as well as the ability of the system to "respond" to external pressures like climate and humans. Therefore, organic carbon plays an essential role in the choice and quality of rehabilitation and recovery actions for degraded, fragile systems that may be threatened by particularly strong environmental or anthropic conditions.

Moving from theory to the geospatial ground truth of contaminated soils: an innovative integrated approach

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The characterisation and successive remediation of contaminated soils[1] require the knowledge of the geospatial situation of contamination. Regulations (Title V of the Fourth section of Legislative Decree 152/06) define the criteria to be adopted in case of a potential contamination of different environmental compartments, thus recognising a pivotal role to site characterisation. In particular, the characterisation plan as described in the Legislative Decree 152/06, takes into consideration the geospatial component because it must check the possible existence of pollution in the different environmental compartments (soil, underground soil, landfills, surface water and groundwater, the atmosphere), define the extent and volumetric expansion so as to find the possible leakage paths and migration of pollutants in view of the sensitive targets (e.g. man/environment). In order to complete the representation charts of contamination, the Legislative Decree 152/06 envisages for the "topsoil" at least one composite sample extracted from the 0-1 metre deep layer, but there are no obligatory steps for the sampling method (rational or systematic) and for the number of samples to be extracted. Nevertheless, in practice the sample density often refers to Annex 2 of the Ministerial Decree 471/99, which for a site extension below 1 ha defines at least 5 sampling points, for sites between 1 and 5 ha at least 5 to 15 points and for sites between 5 and 25 ha at least 15 and 60 points. As time went by, these indications changed into standards that the majority of characterisation studies for Italian contaminated soils took as reference point. In the present research, the question is: after a decade from the enactment of the Ministerial Decree 471/99 and the Legislative Decree 152/06, and in consideration of the current scientific knowledge, are the characterisation criteria defined above still able to evaluate the spatial and volumetric distribution of the contamination of the site (on the basis of which it is then defined the dangers for human health)?
The researchers try to answer this question through the analysis of four case studies of polluted soils (contaminated and potentially contaminated soils): ILVA-Bagnoli, Piana di Solofra, Ecobat-Marcianise, San Giuseppiello-Giugliano. The results show that in all these sites: (i) the geospatial situation of contamination is far more complex than expected, and it is deeply rooted in the history of site contamination itself; (ii) the sampling of the first metre - in a single block – is not satisfactory because it does not take into consideration the actual vertical distribution of pollutants and of the hydrostratigraphy of the soil itself (within horizons of only few centimetres). The present research shows the importance of the adoption of innovative approaches to the characterisation of contaminated soils based on the use of proximal sensing tools such as EMI, ARP, portable gamma-ray spectrometers and portable XRF. These can help in the definition of detailed maps able to distinguish similar areas in terms of contamination typology, leading toward the subsequent pedological and chemical investigations. Moreover, pedological analyses – with the support of these technological tools – often provide the essential information to understand the process of situating and possible migration of pollutants toward other environmental compartments. It seems clear that this integrated approach, already particularly relevant in the phase of site characterisation, may assume an even more urgent importance in the following remediation phase.

[1]With the term 'contaminated site' the reference is to all "areas where, following developed or developing human activities, it has been detected an alteration of the qualitative characteristics of soils, surface and underground waters, which concentrations exceed those imposed by the regulation"

Enzymatic indices for assessing the quality of soils restored through the use of biosolids

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Soil quality is not easy to define, although scientists agree that such property should be strictly linked to soil functionality. The Soil Science Society of America, for example, states that "Soil quality is the continued capacity of a specific kind of soil to function within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance air and water quality and support human health and habitation".
The particular attention deserved on soil quality depends on several risks concerning soils, closely related one another, affecting different world areas: the huge growth of world population, leading to a high increase of anthropic activities on soils, climate changes, fires, erosion, salinization, environmental pollution. As a matter of fact, soil, for its constitutive and functional features, is an excellent purifier and filter, thus the preservation of its quality represents an essential priority for the continuation of life on Earth. Therefore it is necessary the identification of new methodologies, possibly of wide and simple implementation, aiming at monitoring soil quality.
Soil organic fraction, in all its forms, is a parameter highly affecting soil functionality: it is not surprising that many restoring practices are based on the supply to soils of biosolids of different origin: agricultural, agro-industrial, urban one. On the contrary, it is less easy to achieve related analytical methodologies allowing the quick evaluation of the effect of restoring techniques on soil quality. This aspect is of great importance as soil resilience could, in some cases, represent an obstacle to the understanding of the effect of human activities on soil quality. The rapid investigation of the suitability of a restoration practice could have positive effects on its costs and thus on its utilization on a larger scale.
This presentation should clarify why soil enzyme activities could be considered excellent indicators of soil quality and how such indicators could be useful to rapidly understand the efficiency of certain restoring practices on soil quality, with particular focus on the effects on its biological and biochemical properties.

Restoration techniques for soil biological fertility

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The preservation and promotion of biodiversity for agriculture and food are today among the most urgent needs of the planet, a paramount objective in international and national policies. It has been pointed out in several occasions the way microbial diversity of soil is directly correlated to the diversity of the vegetation present on site, thus determining functional variations that directly or indirectly influence the growth of plants and the quality of their products. Natural soil is an open ecological system that receives and disperses energy. The energy modifications that influence natural soil are determined by the nutrition and breathing of microbial populations, by the transfer and cyclical circulation of elements, by the synthesis and degradation of organic matter. The balance of natural soil, which is not cultivated, is governed by four parameters: bioenergy, cyclical transformations, humification and pedogenesis, all closely intertwined in order to keep the ecological balance between the soil and the environment. Agricultural exploitation modifies this balance, as well as agronomic practices to accelerate cyclical transformations. One of the most important functions is carried out by microorganisms, which influence the transformations of nutritional elements so as to maintain an exchange balance between soils and plant, thus contributing to the fertility status of the ground. According to the criteria dictated by sustainable agriculture, the most important objective is to reach the highest productivity possible given the soil conditions, maintaining a high level of chemical fertility together with a high level of biological fertility. Biological, chemical and physical fertility constitute agronomic or integral fertility, which determines productivity. Therefore it is of pivotal importance to adopt the choice of a risk assessment for a loss of soil biodiversity. The present paper wishes to provide a presentation of up-to-date validated techniques aimed at assessing the health and biological fertility conditions of a soil. It is a model that can be explored at different levels. IBF is a biological indicator that embraces different parameters of direct assessment of the biological activity of a soil. The biological parameters used as indicators are the overall organic carbon content (from which the organic matter correlated is calculated), microbial breathing and the carbon of the microbial biomass. The activity of the microbial biomass of a soil is directly related to the existing organic matter, since this is the substrate ensuring its survival, and models the nutritional element cycles in order to make them more or less fit to absorption by plants. Moreover, it will be possible to show the strategies that can be adopted in the case when a site suffers a constant loss of erosion and biodiversity, among which there is the use of microorganisms as biofertilisers (in particular microorganisms characterised in extreme environments and adapted to extreme conditions; microbial consortia useful to restore the biological fertility of a soil), the use of alternative organic matrices such as quality compost for an agronomic restoration of soils with a reduced or null presence of organic substance, and the use of microbial consortia or microorganisms (such as inoculum in the soil) to restore the microbial biomass and the biological fertility of a soil at risk.

Management of sewers excavation in a Land reclamation Syndicate: problems linked to mud quality

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Consorzio della Bonifica Renana is a legal person within public law. By virtue of regional and state regulations, it ensures the control of meteoric waters and guarantees the hydrogeological defense of the territory under the catchment area of Reno river. The district measures 3.419 km2 of which 42% is a plain area and the remaining 58% is a mountainous area. Rainfall may flow within natural water courses and fall under Regional jurisdiction, or under the 1.991 km of artificial waterways managed by Consorzio. Within the latter, the majority is used for the distribution of water for irrigation or production. Clearly, such a large and complex system playing a pivotal role for the security of the territory needs constant maintenance, both ordinary and extra-ordinary. Apart from the constant mowing and the checking of embankments, waterways must be periodically cleaned and separated in order to avoid an increase in the bottom portion of canals. Should this happen, the result would be, on the one hand, a loss of capacity and flow of the reservoir, and on the other hand an increase of the hydraulic risk because water would be on a higher level than the surrounding area. At the same time, there would be an increase of pressure on the upper section of embankments, which is the most fragile of the whole context. The Legislative Decree 152/06 sets the threshold concentration of hazardous substances and heavy metals that may be present in the waste sludge, associating these to the soils used for public green areas and residential areas. The Decree also states that in case these limits are exceeded, the sediments must be disposed as waste material and cannot therefore be deposited along embankments or adjacent lands. The results from a study carried out in collaboration with Scuola di Agraria e Medicina Veterinaria of Università di Bologna in 2013 have shown that in some cases the sludge along the canals under the jurisdiction of Consorzio della Bonifica Renana exceeded the limits set by the Legislative Decree 152/06 of at least one element. The nature of EPT (Elementi Potenzialmente Tossici/Potentially Toxic Elements) present in the sludge may be geogenic, therefore the deposit in canals occurred after the erosion and transport by means of surface water, or may be of anthropic origins in consideration of the invasive presence of humans in the territory analysed, with the existence of diffused pollution sources (traffic, etc…) and point source pollution (sewage treatment plants, etc…). This implies a series of economic problems with an impact on flood safety and the environment. First of all, there would be an increase in extra-ordinary maintenance costs related to the disposal of sediments in case the limits set by the regulation are exceeded, with subsequent repercussions on flood safety because there may not be enough funds to cover the cleaning of canals. The result would be the silting of canals and the reappearance of the problems mentioned above. Second of all, there may be environmental issues deriving from the accumulation of EPT from sediments, with another risk related to the possibility that the chemical-physical parameters may change over time, and the subsequent dispersion of EPT into water and in the surrounding environmental slots.

Natural and assisted pedogenesis for PTE contaminated soils rehabilitation

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From the 19th century the exponential growth of population, the intensification of agricultural practices, the growing urbanization, the ever increasing use of energy and climate change have prompted rapid and sometimes irreversible changes in the environment, of which soil is one of its delicate and vulnerable components. In 1941, when Hans Jenny invented the equation for pedogenesis, he did not realise that human actions had to become an integral part of pedogenesis, so much so that a few years earlier Paul Crutzen (1933) defined “Anthropocene” the current geological era “where man and his activities are the main causes of environmental and climate changes”. In the taxonomic WRB (2014) system, FAO identified the soils influenced by human activities as Anthrosols and Technosols; the former derive from intense soil exploitation for agricultural needs, the latter are “soils containing artefacts”, composed of or strongly influenced by man-made materials. Since Technosols are artificial soils, they are influenced by the nature of source materials, by the treatment and management mode, by direct and indirect issues such as compaction, pollution by potentially toxic elements, by the quantity and quality of the organic materials provided. In the environments affected by the persistence of mining activities on large areas, the formation and evolution of Technosols is negatively influenced by the deposition mode and by the chemical-physical characteristics of the materials that identify the pedogenetic substrate. The case study related to the mining complex of Stazzema-Valdicastello in Pietrasanta (LU) shows an intricate diversification of substrates in relation to the changes in mining cultivation that occurred through the centuries. Landfill types are represented by gangue deposits and coarse gravel differentiated by area and by the time of deposition, others by sedimentation and floatation of fine mineral residues, all characterised by a high concentration of heavy metals resulting from the alteration of the sulfides found in geogenic lithotypes or from mineralurgical treatments. The disposal of these materials in legally authorised landfills cannot be accepted because of the quantities that should be managed, and any disposal according to Title V ot Part IV of Legislative Decree 152/06 is null. As a matter of fact, the definition of the values of the natural geochemical ground, if compared to the values detected in environmental matrices, eventually eliminate any possibility of contamination. Therefore in the sites in question it seems apt to pursue regeneration and environmental restoration projects as suggested by Directives 2006/21/CE and 2008/98/CE. Surveys and samplings carried out on several landfill areas have shown that on older deposits (about 20 years) pedogenetic processes developed naturally with the creation of an adequate soil thickness able to host herbaceous and shrub vegetation. As a consequence, there is the opportunity to stabilize mine tailings and waste using bioengineering techniques, and to proceed with their re-naturalisation by fostering and accelerating pedogenetic processes, or initiating them through the use of terrigenous materials enriched with organic matter obtained from the processing of local green waste.

LIFE+ Ecoremed:
degraded soil assesment and reconditioning

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The characterization: in polluted sites, the main problem is the spatial detail of environmental characterization that allows to gain realistic information on the dimensions of pollution (concentration and soil volume) and mainly on the actual risks for environment and health. Such information are necessary for defining if and how to plan soil remediation or risk mitigation projects that are also related to the foreseen use of the site. As regards the agricultural soils, the indirect risks for human health, due to the uptake of potentially toxic elements and their accumulation in foodstuffs, have to be evaluated either by bioavailability analysis or by monitoring in vivo the uptake of PTE by species iper-accumulating the specific PTEs of the site.
The Geophysical survey with different sensors (profiler, dual-EM, gamma ray, ARP e XRF) allows to identify the areas with anomalies so to can guide the following phase of direct sampling and measurements. Only with a rational sampling scheme it will be possible to gain realistic, and not casual, information about the real pollution level of the site (see F. Terribile presentation).
Reclamation protocol of the project: it has already been validated in 4 pilot scale sites (Trentola Ducenta (CE), 3.000 m^2, Giugliano (NA), 1.000 m^2, Teverola (CE), 4.000 m^2, Soglitelle (CE), 4.000 m^2) and validation is underway at open filed scale (San Giuseppiello, Giugliano (NA), 60.000 m^2, Marcianise (CE), 35.000 m^2).
The Ecoremed protocol considers a compost fertilization with the aim to restore fertility of soils, often degraded by compacting, and to improve the growth of plants and to stimulate the metabolism of soil bio-degrading microflora.
In the sites with organic pollution (i.e. PAHs, hydrocarbons) the selection and isolation of the most efficient bacterial strains and finally their multiplication and re-inoculation into the polluted soils, is also considered.
The use of poliannual plants (i.e. poplar, eucaliptus, giant reed,…), coupled with grasses and brassica species, at the same time allows: to define the indirect risks for human health by the analysis of PTEs accumulated by plants; to avoid the access and the improper use of the site; to limit the dispersion of contaminated soil particles; to progressively reduce the bioavailable fraction of soil PTEs; to stimulate the microbial metabolism thanks to the rhizosphere effect; but mainly to improve the landscape quality so to assuming a symbolic and educative function through the demonstration to population that a degraded site has been transformed in a permanent vegetal structure (i.e. park, forest, garden).

Dredged sediments as component of agronomic substrates alternatively to the soil resource

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Dredging of marine and fluvial sediments has become a renowned environmental issue, since each year in Europe about 200m m3 of sediments are dredged, more than a half of which are contaminated and costly in terms of disposal techniques. Moreover, beyond 5m m3 of land are subtracted to soil to be used in nurseries for plant cultivation, resulting in increased costs and a heavy environmental impact.
Taking into consideration both these issues, the European project LIFE "Hortised" (LIFE14 ENV/IT/113 HORTISED) aims to 1) treating decontaminated sediments via phytoremediation using the "Agriport" (European project Eco-Innovation ECO/08/239065/S12.532262) and 2) reusing phyto-treated sediments in the field of agronomy as a growth substrate for horticultural plants in Italy and Spain.
Hortised project began in October 2015, ending on 31st October 2017; it is coordinated by the Dipartimento di Scienze delle Produzioni Agroalimentari e dell'Ambiente of Università di Firenze, with the participation of Universidad Miguel Hernández di Elche in Spain, of the Istituto per lo Studio degli Ecosistemi of CNR in Pisa, and of Zelari (ZELARI PIANTE s.s.) enterprise in Pistoia and CALIPLANT (VIVEROS CALIPLANT, S.L.) in Spain.
The possibility to reuse sediments as growth substrate for ornamental plants has already been proven within the LIFE "Cleansed" project (LIFE12 ENV/IT/000652). The satisfying performance of results therefore opened the doors to the possibility of demonstrating the potential of decontaminated dredging sediments also as growth substrate for "food" species. Life "Hortised" project will help to evaluate the growth and quality of fruits of the pomegranate and strawberry species in the substrate composed of the treated sediment compared to traditional substrata.
The reuse of sediments in the field of agronomy may prove particularly important for the sustainable management of waste because it would eliminate the high disposal costs, thus reducing the environmental impact.
The possibility to consider sediments as a resource rather than waste implies: an update process of environmental policies, in line with the recent guidelines provided by the European Union.

Tools for proximal soil sensing and site-specific reclamation

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The measurement and interpretation of soil spatial and temporal variability is the first step required to program site-specific interventions. The characterization and monitoring of such variability is carried out through the quick acquisition of a large number of measured data by means of proximal sensors, which relate to several soil characteristics. The term "proximal sensors" means a set of technologies which measure soil features through a sensor in direct contact with the ground, or at a distance of less than 2 m. In addition to their non-invasive nature, the benefit of using proximal sensors is given by the possibility of obtaining a large amount of data that can be geo-referenced through the use of GPS, quicker and cheaper than the traditional methods. Furthermore, most of proximal sensors can be used with an on the go configurations, greatly speeding the acquisition of data.
Tin the framework of the project LIFE08ENV/IT/000428 Monitoring for soil protection SOILPRO (http://www.soilpro.eu/), the research group on digital soil mapping of the CREA-ABP of Florence has used some proximal soil sensing techniques based on the use of: i) electromagnetic induction sensor (EM38-MK2, Geonics); ii) spectrometer of gamma rays (The Mole, Soil Company); iii) Veris sensor 2000Xa (sensor for measuring the electrical conductivity of the soil continuously); iv) diffuse reflectance in the visible-near infrared spectroradiometer (Vis-NIR). Likewise all geophysical measurements, the ECa does not univocally represents the variability of a single soil characteristic, rather it is a multivariate function of various parameters (water content, clay, salinity, permeability, etc.). The "The Mole gamma rays" spectrometer instead relies on the measurement of the gamma rays naturally emitted by radionuclides present in soil and rocks. The Veris 2000Xa is a rather large and heavy instrument (about 3 tons), with metal wheels, which must be pulled by a tractor, a car or a quad. The Veris 2000XA is designed for use with tractors (500 cc or more), and in applications where space is limited, as the vineyards. Having extendable wings, you can obtain an EC mapping deeper with a second passage on the field. You can get maps of soil texture and salinity.
Among the quick and non-destructive methods of soil analysis, which are alternative to complex and expensive traditional laboratory analytical methods, the use of reflectance spectroscopy in the visible (Vis 400-700 nm) and near infrared (NIR 700-2500 nm) is acquiring increasing importance and interest both in research and for the development of new practical applications. The research interest is mainly addressed to the quantification of the main soil properties, including organic matter content, textural composition, and mineralogical characteristics, but several studies have also focused on the quantification of the availability of nutrients, particularly macronutrients, pH, cation exchange capacity (CEC), and organic matter fractions.

Life+12 ENV/IT000439 GreenWoolF: Green hydrolysis conversion of Wool wastes into organic nitrogen Fertilisers

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EU-27 has the second world sheep population, numbered about 100 million heads in December 2011, the majority of which were based in the UK (25 %), Spain (20 %), Romania (10 %), Greece (10 %), Italy (9 %), France (9 %) and Ireland (4 %) (Source EU-Eurostat 2012). The EU flock is made of crossbred sheep not graded for fine wool production; the primary role is meat, whilst the milk market is relatively small, being confined to Mediterranean regions. The annual wool clip amounts to more than 200 000 t (18-20 are produced in Italy) and its management is a problem for the EU livestock sector. Indeed, wool from sheep farming and butchery industry is very coarse making it practically unserviceable for the textile industry.
Unserviceable wool is mostly disposed in landfills or illegally thrown over, with serious ambient threats since it can affect the pastures and bring illness, where it does not readily degrade. Thus, shearing, storage, transportation and disposal of waste wool in accordance with current EU Regulation, heavily weigh on the profit of sheep farming.
The Life+ 12 ENV/IT000439 GreenWoolF, supported by the LIFE 2012 EU financial instrument, aims at demonstrating that waste wools can be recycled into organic nitrogen fertiliser with good soil amendment properties. Raw wool could be recycled into value-added fertiliser for foliar feeding and soil fertilization. The project includes designing, building and testing of a transportable, demonstration hydrolysis plant; in the first part of the project a laboratory-scale plant to hydrolyse coarse wool was built to optimize the process parameters. Now, at the end of the third year of LIFE+ GREENWOOLF (the project will finish in June 2016) a demonstrative unit capable of treating up to 20 kg of wool has been built and it's fully operational. The new plant uses direct steam instead at high temperature and pressure that allows considerable energy and water savings. This controlled Green hydrolysis converts wool keratin (the wool protein) into simpler compounds, tailoring the release speed of nutrients to plants. Wool contains elements such as carbon, nitrogen and other nutrients, which play an essential role in plant nutrition. Chemical analyses such as amino acid analysis and molecular weight distribution performed on the hydrolysis products obtained revealed that the wool was completely degraded, the reaction product containing low molecular weight proteins and amino acids. Several product batches tested for germination showed an index higher than 100% without collateral phytotoxicity. The presence of amino acids, primary nutrients and micronutrients in wool hydrolyzates, along with a concentration of heavy metals below the standard limit, confirms the possibility of using wool hydrolyzates as nitrogen based ecologically fertilizer.
In the next months, pot trials will be performed on potato crops, grapevine and small fruits, using the liquid hydrolyzate. The results will be compared with the harvest obtained using the conventional fertilization method. Furthermore, a preliminary evaluation of the cost of the process has been done, concerning the investment and operating costs, assuming that two years will be necessary to reach the break-even.

LIFE+ Climate Change E_R: reduction of greenhouse gas emissions from agricultural sources in Emilia-Romagna region

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With LIFE Climate changE-R the Emilia-Romagna Region aimed to innovate and enhance the environmental policy instruments for agriculture, toward the strategy Europe 2020.
Climate changE-R foresees 1.853.900 € of expenditure, 48 % granted by the EU, i twill be concluded on December 2016. It is characterized by the partnership among farmers, AgroFood holdings, institutions and bodies involved in innovation and research (APO Conerpo, ARPAE, Barilla, CoopItalia, CRPA, CRPV, CSO, Granarolo, Parmareggio, UNIPEG e Consorzio Parmigiano-Reggiano). The project background believes that agriculture is directly affected by the negative consequences of climate changes but can, to some extent, help to mitigate these consequences by adopting more sustainable agricultural practices. Climate changE-R is the Emilia Romagna Region's Life+ project to develop cultivation and livestock-raising techniques that reduce the emission of climate-altering gases into the atmosphere, with the same yields and product quality. There has so far been no specification for this type of approach in the current legislation governing sustainable production, either from the public authorities or in the methods adopted independently by farms. The gases with the greatest effect on climate change are carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4). According to experts, agriculture and livestock contribute as a whole to 6.7 % of gas emissions into the atmosphere. The main objective of the Climate ChangE-R project is to develop specifications for the agricultural and livestock sector that are more environmentally friendly and more virtuous in terms of greenhouse gas emissions. By applying the farming specifications demonstrated by Climate changE-R, greenhouse gas emissions from agriculture in the Emilia-Romagna Region will be reduced by 200,000 tons of CO_2 equivalent to three years, in line with the objectives of the Europe 2020 Strategy. The outputs of the project Climate changE-R consist of an estimate that is "customized" to regional conditions in the GHG emissions from agriculture, in an absolutely ground-breaking and systematic approach, from cradle to farm gate. To calculate the gas emissions from different crops, or to calculate the carbon footprint (CF), the project is using the LCA methodology, applying it to the entire production chain, with an overall sustainability approach of the system. The project proposes to work also improving sustainability of the whole territory, by taking action in all production steps and by increasing consumer awareness. These goals are pursued through an integrated approach to agriculture, and to the processing and distribution organizations. Until now, estimates on global GHG emissions due to the agricultural sector were based on calculation factors defined at an international level, and they often deviate significantly from our operating conditions. Thanks to Climate changE-R, impact assessments of farms can rely on real data, collected in a database, available for each farm or processing enterprise in Emilia-Romagna so that they can calculate the environmental impact of their own production. These data may be useful for obtaining environmental certifications. The technical work was mainly focused on the construction of baselines useful to check the effects of good practices applied. These were then the subject of demonstration actions on farms and animal husbandry involving the world of technicians, holdings and farmers.
In addition to that, the basic component has concerned the action of governance with the adoption by the Emilia-Romagna Region of good practices that have been integrated in the policy instruments and particularly in the RDP 2014-2020 that includes measures and operations useful to grant the Climate change-R best practices.

LIFE10 ENV/IT/000400 NEW LIFE
Total budget: 4.025.473 €;
EU Contribution: 1.929.837 €

Under the patronage of:

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www.lifeplusecosistemi.eu

thanks to:

Paolo Manfredi
Federico Arcuri
Chiara Cassinari
Elena Murelli
Marta Romagnoli

printing finished in Piacenza - ITALIA - May 2016

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