



**Interuniversity National Consortium
“Chemistry for Environment”**

AN INTRODUCTION TO THE SISIFO PROJECT

Development and implementation of remediation techniques for environmental remediation and removal of dangerous contaminants derived from industrial activities.

After Italian Law 426/98, the question of the contaminated industrial sites assumed national relevance. More than 40 locations were defined as “sites of national interest”. Areas in which the contamination grade and the type of pollutant pose a problem of national level. Behind these, there are at least 2000 sites of regional interest in Italy.

Analytical difficulties exist. This is due to the complexity of the soil matrix, the often insufficient availability of detailed historical data about the areas, and, finally, due to the unpredictable effects of mobility of contaminants. The latter is really hard to predict. Generally such evaluations use mathematical modelling, but it is difficult to find valid data that can be used as input of the models. Besides, the determination of the present status of a soil contaminant and its possible evolutionary states is complex.

On the basis of the available data, considerations about need of intervention for enhancing soil quality must be made. Identification of the possible techniques and their economical feasibility is necessary. A preliminary assessment of the environmental impact of the remediation processes must be performed too. In fact the application of these techniques may also lead to a worsening of the general local environmental status.

It is advisable to realize an intervention model supported by appropriate tools such as maps of soil contamination, a manual of the procedures for the characterization of the sites, methods of treatment, and remediation criteria. This is fundamental for a proper planning of the best possible site reclamation. This must be studied considering the local environmental characteristics, the type of polluting agents and according to the future destination of the area. A major issue are also acceptable costs for the subjects responsible for the remediation.

Public interest about reclamation of sites is obvious, considering that most of these ex-industrial areas is a public property or is owned by companies with public fundings. Furthermore, in order to proceed to establishment of new factories, companies, especially small-medium enterprises, need public assurance about acceptable environmental quality of the recovered areas.

At present days the problem of reuse of the ex- industrial areas is already consistent and it will become more severe in the next future. The ratio between demanded staff and surface to recover is rather low and the job requires high expertise. Due to the severe social and environmental situation the ACNA site, along with the area around Saliceto interested by the landfill of Pian Rocchetta, were characterized and tagged as reclamation site of national interest by Ordinance no. 2986 in 1999 and a Government Commissary was nominated. This was the chosen solution to tackle “*the situation of emergency deriving from the situation of social and environmental crisis of the area*”. Besides research and experimentation of proper recovering techniques, the Commissary was also to provide for education and specialisation of personnel needed for all the phases of remediation at ACNA.

All these activities were focused on finding the best available technologies for remediation and safety disposal of the area. Economical feasibility in relation to the different realities of the region was one of the main issues of the study.

According to the ordinance a new research centre (see afterwards) was established in the area to investigate on new available technologies for remediation and safety disposal and for designing non-conventional ones, considering technical and economical feasibility issues. In this case, non-conventional means all those chemical, physical, or biochemical methods which are

reported in literature, but are scarcely used at a practical and industrial level. Among these we can cite:

- biological processes with supported biomass, both with static or fluid bed;
- membrane processes (ultrafiltration, nanofiltration and inverse osmosis);
- electro-oxidation, both as a primary and supporting treatment (electro-floatation, electro-coagulation, electro-osmosis, etc.);
- catalytic photo-oxidation;
- application of supercritical fluids;
- wet oxidation, both with pressurized oxygen and with Fenton's reagent;
- biological treatments, using natural bacterial strains (native or selected), or genetically modified organisms.

According to provisions of the ordinance, for what concerns technical aspects of the remediation of ACNA, the Commissary co-sponsored an external project: the SISIFO Project. It was proposed by INCA Consortium and had a duration of 24 months (ended in December 2003); funds summed up to 2,200,000 Euro. Fourteen INCA research units (from universities of Genova, Torino, Alessandria, Milano, Venezia, Viterbo, Napoli, Cagliari, and Cosenza) worked in strict collaboration under the supervision of a scientific co-ordinator. The team comprised all the needed expertise for fruitful interdisciplinary research in the field of soil remediation.

In general terms the research identified different treatments to remove contaminants or to abate their load in the area. However, such methods can be grouped in two main sectors. The first is *bioremediation*, which uses microorganisms for degradation of pollutants. The second is the so-called *chemiremediation* and uses chemical oxidation for destruction or detoxification of the contaminants. In both cases the treatment can involve the raw soil matrix or a liquid extract of the soil, which can be obtained via soil-washing, e.g. using natural surfactants for removal of pollutants, natural leaching agent for metals, etc.

The research activities of SISIFO were conducted in the laboratories of the different INCA research units. Nowadays research is being continued in the INCA's Soil Remediation Laboratory which was recently established at the facilities of the ACNA research centre of Cengio (Savona, Italy). Besides continuing SISIFO activities and scale-up studies, the lab is designed to satisfy the scientific, technical and socio-economical needs for recovery of ex-industrial areas. In fact, INCA owns proper interdisciplinary know-how to support soil-remediation processes for areas to be reused for industrial/commercial or recreational/lodging purposes.

The new laboratory, born from the collaboration of INCA with some local public environmental, scientific and technological agencies, took advantage of some existing facilities. Nonetheless the sole investment of INCA for equipment was 200,000 Euros. The laboratory will strictly collaborate with INCA's Research Units all over Italy and the INCA National Laboratory of Marghera (Venice).

The main activities of the laboratory in Cengio will be studies for degradation of pollutants derived from former activities of ACNA, investigations for migration of pollutants in soils and waters, conception of new technological in-situ processes for chemical and biological remediation of soils, and devising of non-conventional techniques for depuration of liquid wastes. Besides performing also technical and economical feasibility studies, the laboratory will have an active consulting and analytical support role during the on field application of the remediation processes.

From an economic and productive point of view there are two types of effects. The first is the application on-field the results of research, especially for what concerns academic know-how in the field of remediation. This will possibly allow wide reuse of ex-industrial areas and identification of their new destination, thus favouring new industrial or residential installations. The second result is the creation of a pool of technicians with appropriate know-how in the field of remediation. Highly qualified know-how and staff will help small-medium enterprises for spin-off activities and, consequently, expansion of their activities on the national and European market.