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# Land recovery and man-made risks: a perspective from the EU accession countries

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**Abstract**

This paper presents the results of a workshop held in Vienna in November 1998 to study the recovery of land in Easter European countries polluted by industrial spoil, military activities and improper handling of hazardous wastes, a topic which is of particular importance to these countries, emerging as they are from a period in which these topics received less attention than in the West. While the detailed situations vary from country to country among the EU candidate accession states, many of the underlying problems related to land recovery are common to all of them, and there is therefore great opportunity for mutual benefit by a meaningful exchange of information on problems, and methodologies to tackle them. The means of prioritising, monitoring and the remediation technologies are key issues in such an information network; however, without effective financing solutions, it seems very unlikely that these countries will be able to tackle their problems with contaminated land in an efficient and "sustainable" manner. The paper discusses the present situation in the first group of EU accession countries, describing the situation in the various countries and outlining the conclusions and recommendations of the workshop. 

*Keywords:* Land recovery; Groundwater contamination; Land-use planning; Accession countries; Risk assessment; Risk informed decision making

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## 1. Introduction

Polluted land is not a new phenomenon: over 10,000 years ago the early settlements of hunter-gatherers in Europe were building up impressive middens next to their villages — to the delight of modern archaeologists. Over the subsequent centuries mining and quarrying were responsible for spoiling large areas of land. The process of large-scale pollution took a new impetus with the industrial revolution, and has accelerated through the technological age; until the latter years of this century land pollution was widely accepted throughout Europe as the inevitable price of progress and employment.

But in the last few decades the importance of the environment has come to be perceived more and more clearly in Western Europe, and the approaches of earlier years are no longer acceptable today. Not merely are current and proposed industrial activities expected to clear up after themselves, but substantial progress has been made — albeit at considerable expense — in cleaning up pollution left behind by former activities.

Whether or not this perception was shared by the people of Central and Eastern European countries, the different social and political climate there meant that until 10 years ago very little was done to mitigate the adverse environmental effects of the dash for rapid industrialisation and the development of nuclear power and associated weapons. These effects included substantial swathes of contaminated land: from oil products from the extraction and processing industries; from uranium mining and processing; from metallurgical industries; from the over-zealous use of agricultural fertilisers and pesticides, and from military activities.

During the last decade, however, there has been a realisation of the extent of the problem of land contamination within these countries, and in particular, its impact on groundwater. This has led to various initiatives to identify and quantify the contamination, and in some cases to remedial activities. There are many similarities between the problems these countries have encountered, and international cooperation in the field has been seen as essential.

The European Commission[1] has developed a number of general programmes to facilitate integration of the EU accession countries into the European Union, however, their relevance with respect to the problem of land recovery is limited.

The first of these activities is the PHARE[2] programme administered by DG 1A (Enlargement[3]); this programme has the fundamental objective of helping the candidate accession countries join the EU as soon as possible. The timescale for this strongly

[1] For detailed information on the European Commission, its institutions, programmes and research activities, see http://europa.eu.int/comm.

[2] This financial programme, originally an acronym for 'Poland and Hungary: Action for the Restructuring of the Economy', has since 1991 had a much wider remit, namely to assist all the EU candidate countries of Central and Easter Europe in their transition from an economically and politically centralised system to a decentralised market economy and democratic society.

[3] At the time of writing the Directorates General of the European Commission are undergoing reorganisation. While some details of this are not yet clear, the decision has been taken to use descriptive names rather than the earlier system of numbers. In this paper both terms are given, but it should be noted that while it is intended that descriptive names be used in the future, the ones given here may yet change.

depends on the progress made by each country in adopting, implementing and enforcing the acquis communautaire[4], and in support of these objectives the work of PHARE concentrates on two main areas: institution building and investment support.

The second activity is the "Instrument for Structural Policies for Pre-Accession," (ISPA), administered by DG XVI (Regional Development). One key element of this activity concerns the improvement and protection of the environment, and here, large projects are funded to meet the requirements of legislation and the specific objectives of the accession partnerships.

Additionally, the European Commission supports, through DG XII (Research), international R&D activities on land recovery. EU Concerted Action Programmes CARACAS[5], NICOLE[6] and CLARINET[7] were established as part of the Environment and Climate RTD (Research and Technical Development) Programme of the European Commission to tackle scientific and technical aspects of the problem of contaminated land — see Section 4 for details of these programmes. These networks combine the knowledge of academics, government experts, industrial landowners, and technology developers, and increasingly involve experts from the EU accession countries. The European Commission's Joint Research Centre also pursues a number of research activities in this field.

Other international networks on contaminated land are supported by the European Environment Agency (European Topic Centre Soil) and by NATO/CCMS (Pilot studies on "Remedial Technologies for Soil and Groundwater" and "Reuse of Former Military Sites"). These activities also include participation from Eastern European countries.

As experience with managing contaminated land has grown, the perception of the problem has changed. In the early 1980s, contaminated sites were perceived as (a few) very severe incidents with poorly known, but disastrous consequences for human health and the environment. Today, the contaminated land problem is recognised as a widespread infrastructural problem. Governments and industry recognise that drastic risk control is usually unnecessary when taking into account the potential adverse effects of contamination for current and intended land uses and the environment. There remain deficiencies in the legislative and institutional frameworks necessary to tackle the problem, and there is a severe shortage of resources, both for identifying and quantifying the contamination of land, groundwater, and aquifers, and for treating it. In particular, it is clear that to aim at the highest standard — "greenfield" or "multi-functional" clean up — for the majority of contaminated sites is not technically or financially feasible.[8]

In November 1998, the Institute for Systems, Informatics and Safety (ISIS) of the European Commission's Joint Research Centre, in collaboration with the Austrian Research Centres, Arsenal and Seibersdorf, organised an international workshop on the

[4] This term covers the ensemble of legislation, administrative procedures, and practice which constitute the common "property" acquired by EU countries through their participation in the European Union.

[5] Concerted Action on Risk Assessment for ContAminated Sites (in the European Union).

[6] Network for Industrially COntaminated Land in Europe.

[7] Contaminated LAnd RehabIlitation Network for Environmental Technologies (in Europe).

[8] CLARINET/NICOLE Joint Statement: Better Decision Making Now, October 1998. Available from http://www.nicole.org and http://www.caracas.at.

subject of land recovery and man-made risks. The workshop was held in Vienna, and focused on the problems and needs of the eastern European states, particularly the accession countries. While the detailed situations varied from country to country, many of the underlying problems related to land recovery were found to be common among all of them, particularly with respect to old and often abandoned sites and as such the workshop reflected this bias. Participation was by invitation, and high-level experts from the accession countries met together with the major European, technological and policy-making players in the field of land recovery. The workshop comprised plenary sessions discussing available technologies and financial and administrative structures, presentations from the various candidate countries, and workshops tackling specific themes.[9] This paper gives an overview of the current situation as presented at the workshop, and highlights the conclusions and recommendations that were drawn up by the participants.

## 2. Current situation in the candidate countries

As was pointed out in Section 1, the majority of problems associated with land spoilage and the contamination of groundwater and aquifers are common to all the countries of Eastern Europe. The following sections describe the current situation in each of the accession countries, and explains what measures have been put into place to deal with these problems.

### *2.1. Czech Republic*

The Ministry of the Environment of the Czech Republic is responsible for the identification, assessment and clean-up of contaminated sites, and for the development of state policy in this area. Contamination of soil and groundwater is caused mainly by the chemical, petrochemical, electrical and metallurgical industries and by mining (particularly uranium) and military activities. The most important contaminants include petroleum hydrocarbons, chlorinated hydrocarbons, polychlorinated biphenyls, pesticides and other toxic substances.

The problems concerning contamination caused by military activities were first realised at the beginning of 1990 with the departure of the former Soviet Army. A survey identified 50 seriously contaminated sites and remediation actions followed shortly afterwards. During the clean-up of these sites, valuable experience was gained both by state administrative bodies and also by professional organisations concerned with dealing with contaminated sites. Clean-up was completed by the end of 1998 at 34 sites and continues further at 13 sites. The total cost of clean-up of these military sites has been estimated at 40 million Euro.

[9] Clean-up technologies for chemical, biological and nuclear wastes; risk assessment for contaminated land (including fitness for use assessments); soil restoration technologies; monitoring and aftercare of contaminated sites; and management of risk and of emergency situations.

The contamination caused by industrial activities was brought into sharp focus with the process of privatisation of state property, especially as the result of interest shown by foreign investors. This process started in 1992, and a very important step in this area was the inclusion of the requirement of an environmental audit for privatised companies as a condition for the transfer of state property to the private sector. To date, the Ministry of the Environment has assessed over 5500 environmental audits, of which some 10% had revealed significant contamination. In 250 cases, a detailed risk assessment analysis was performed to quantify the level of contamination. The Government has approved over 300 agreements for reimbursement of costs for cleanup and a total of some 125 million Euro has been set aside for this work

During the last 50 years, uranium mining and milling in the Czech Republic have had a significant negative impact on the environment through the creation of waste dumps, tailings and other workings. It is estimated that there are 58 million $m^3$ of mining waste in dumps and 56 million $m^3$ of tailings, and that 4 million tons of leaching acids has been injected into the ore-bearing sandstones. A comprehensive environmental impact assessment covering these activities has been concluded and the first stages of the remediation programme have begun.

### *2.2. Estonia*

The most serious environmental problems in Estonia are connected to:

- mining, particularly oil shale;
- the chemical and oil shale processing industries;
- fuel storage; and
- military sites.

Most of the contaminated areas lie in north-eastern Estonia. Oil pollution is by far the greatest problem, affecting groundwater and soil over large areas and penetrating to considerable depths. The uppermost aquifers are contaminated in the Tallinn–Paldiski area and groundwater is no longer extracted from those, instead it is now abstracted from the deep Cambrian–Vendian aquifer, which is protected by a blue clay layer.

The most serious environmental problems originating from the chemical industries are related to oil shale processing and rare metals production. It should also be noted that the soil and groundwater contamination problem is specific to Estonia, since the composition of shale oil is environmentally more hazardous than regular heating oil. It contains on average of 25% water-soluble phenols, in addition to a number of aromatic and polyaromatic compounds, and has a density close to that of water, which complicates separation from water. Careless handling and storing of shale oil has caused serious contamination throughout Estonia, especially close to fuel storage sites and asphalt production plants.

The mining of oil shale also lowers the water table affecting an area of approximately 1500 $km^2$. The impact of dewatering, 200–300 million $m^3$ per year, has been to reduce availability of water from the upper aquifers — indeed in some areas they are partially or totally dry — and drainage water from the mines that contaminate the rivers with oil

products and phenols. Solid wastes total about 135 million tons and cover an area of about 340 ha, and have the additional hazard of being capable of self-ignition.

Leakage from old fuel oil storage vessels and pipelines from Soviet times constitute another major source of contamination. For years, thousands of tons of black oil have leaked and flowed unchecked from central boiler houses, railway tanks and storage vessels.

Again, the awareness of the problems and extent of the land and groundwater contamination came with the withdrawal of Soviet troops and the privatisation of industrial enterprises. Today, the privatisation process is almost complete, but the responsibility of government and private owners is not exactly defined by legislation. Foreign purchases, however, usually have to perform an environmental audit before the contract is given, but such an environmental audit has not been made an obligatory condition in the privatisation process. The Ministry for the Environment has carried out soil and groundwater investigation since the mid-1990s, and the problems of past pollution are considered in the Estonian Environmental Strategy and National Environmental Action Plan (NEAP). Remediation work has begun, but many of projects are still to be carried out and the funding source is still uncertain. Today, one of the major problems to be faced is the prioritising and cost-benefit assessment of these projects.

### *2.3. Hungary*

The environmental problems of land and groundwater contamination in Hungary follow similar trends, and result from the especially vigorous industrial development that took place, without enforcement of environmental legislation, up to the late 1970s and early 1980s. Heavy metals, petrochemical substances, and pesticides are the major sources from within the processing industries, with additional contamination coming from mining and military activities. The extent of the problem was recognised about 10 years ago, and the National Environment Program, which includes the National Environment Remediation Program, was started in 1996.

The first activities in Hungary in remediating environmental damage were directed at former Soviet military bases. The government's 1991 short- and medium-term action plan, which identified the tasks of surveying, assessing, and eliminating accumulated pollution — presented by abandoned Soviet barracks and training grounds after they had left Hungary — can be considered as the starting point for the remediation programme. About 150 abandoned sites were investigated, and half of them needed immediate cleanup intervention. The remediation of the most polluted former Soviet military sites should be completed in the next 2 years.

In the same period, as a result of the heavy metal contamination of soil in the territory and surroundings of the Metallochemia factory, the local health authority stopped its operation in 1990. This was the first occasion in Hungary on which a factory's activity was stopped on environmental grounds. The main pollutant was lead, and following a detailed risk evaluation, various precautionary steps were undertaken prohibiting the growing of crops and the consumption of groundwater. A remediation program has been worked out, but due to lack of funds, work has yet to begin.

In fact, groundwater pollution is a particularly serious problem in Hungary since 90% of the country's drinking water comes from this source, and so serious pollution could

deprive the country of drinking water. The scope of the Remediation Program reflects this situation, and work has started on the creation of a homogeneous database containing details of contaminated sites. Analysis of this data has allowed a national priority list of polluted sites to be drawn up for which remediation activities are considered to be most urgently required. Site assessment and feasibility studies then follow: 15 sites were selected in 1996 and a further nine in 1997. Of these, eight sites in 1996 and five in 1997 required emergency measures to prevent additional environmental damage. Based on the results of the assessment of the 24 sites investigated, seven of them did not have considerable environmental damage. Rehabilitation of the environment to specified limits (soil and groundwater) has begun for six polluted sites, and at two of them work has already been completed. The annual budget for the above program is about 5 million Euro, and a total of about 30 million Euro is invested annually on all programs dealing with environmental remediation.

### *2.4. Poland*

Poland is the eighth largest European country (ca 312,700 $km^2$) with a population of over 38 million, concentrated mainly in central and southern territories where larger industrial districts have been developed. Most of the country is made up of lowlands (about 90%), and the major land uses include arable land, hay meadows, cattle grazing and fruit production, covering altogether about 60% of the total land area; a further 28% is covered by forest. Urban areas and communication lines occupy less than 5% of the country surface, while wastelands and other uses take together some 3.3%. The majority of these last areas are regarded as heavily and/or moderately degraded and according to recent estimation their total surface amounts to about 850,000 ha. These include waste dumping sites, landfills, and industrially degraded or derelict grounds, which require some degree of reclamation. The structure of land use is helpful for assessing land degradation issues encountered in Poland. Agriculture is the major industry affecting land quality. It is estimated that nitrogen, phosphorus, potassium (NPK) fertilisation, combined with acid deposition from man-made sources, has resulted in acidification of sandy soils — which are the dominant soil types in Poland. Acidification is regarded as a major factor responsible for chemical degradation of soils. Contamination by heavy metals and sulphur in agricultural soils has been recognised, and a recent countrywide agrochemical soil inventory has been conducted by the Soil Science Institute.

Land contamination problems in the urban areas due to the activities of the chemical, petrochemical and metallurgical industries also are present in Poland. These are known and inventoried, but with a few notable exceptions remediation technologies and programmes have not been implemented due to lack of funds. Apart from petroleum derivatives and toxic chemicals, sulphur mining and processing is another source of environmental hazards and features as a hot-spot on the land recovery map of Poland.

Poland also suffered, as other countries have suffered, from land contaminated by Soviet military activities. Major hazards in these areas are linked to oil spillages, illegal waste dumping and storing of toxic chemicals. It is estimated that of the total of 70,000 ha occupied by the former Soviet Army, 500 ha are heavily contaminated with petroleum and hazardous toxic chemicals, and urgently require reclamation.

Within the Polish legal system, there are no specific generic values or regulations establishing admissible chemical concentrations in the ground, nor any binding country-wide classifications of contaminated lands. National guidelines and standard values have been developed for the assessment of contamination by heavy metals and sulphur in agriculture. In addition, the State Inspectorate for Environmental Protection has published advisory guidelines for risk assessment in tackling ground and groundwater pollution by heavy metals, inorganic compounds, and aromatic, polycyclic and chlorinated hydrocarbons. However, it is the opinion of the Risk Abatement Centre for Central and Eastern Europe (RACE)[10] that "Poland needs a massive change in contaminated land management. Developing risk-based tools and incorporating risk-based methods into environmental policy would result in significant progress in both determining the scope and assessing potential remediation costs needed for effective contaminated land management. A national program for the remediation of high-risk sites as well as series of national incentives for local/regional programmes to redevelop moderately polluted sites (brownfields) is urgently needed."

### *2.5. Slovenia*

Slovenia, with an area of approximately 20,000 $km^2$ and a population of about 2 million, is a moderately wealthy industrialised nation. The problems of land contamination are not as acute as the other accession countries, and some legislation is already in place particularly those concerning wastewater. It is estimated there are between 3500 and 4000 factories, plants and workshops that produce industrial waste. The major problems the country faces concern the reclamation of old industrial landfill sites, and the control and monitoring of industrial wastewater.

Regarding old landfill sites that present a problem of contamination, all have been identified and rehabilitation feasibility studies have in most cases been performed; however, the reclamation activities have been slow to start because of a lack of financial backing and unsolved ownership issues. A few examples of these landfills will be described to illustrate the problem.

- Landfill for uranium ore tailings. Ore mining started in 1982 and the production of yellow cake 2 years later. Due to the high cost of production and the drop in world price for yellow cake the mine was closed in 1992. In one of the mill tailing sites, there are 620,000 tonnes of tailings and 80,000 tonnes of mine waste. This weight presents a

[10] Established in 1996, RACE serves as a regional center that provides a forum for implementing significant policy changes, transferring technology, increasing public awareness and coordinating activities aimed at solving environmental and natural resources problems in CEE. As a non-governmental, international, cooperative research and education center, RACE utilizes risk based tools for prioritizing problems and managing the environment with regard to social, legal, economic, and political considerations. For additional information, the RACE address is: Risk Abatement Center for Central and Eastern Europe, ul. Kossutha 6 , 40-833 Katowice Poland. RACE has been established within the Polish Institute for Ecology of Industrial Areas (e-mail: ietu@ietu.katowice.pl).

potential for an earth slide. It is estimated that to stabilise the mill tailings site 7 million tonnes of material would be needed.

· Industrial landfill for waste from an organic acid production plant. Citric acid was the main product from the company (which has since gone bankrupt), and the landfill site was also used for household waste. The landfill covers approximately 9 ha and is up to 10-m thick. It has never been properly managed and does not have a protective lining and presents a danger to the underground waters flowing towards Italy.

· Industrial landfill for pesticide production waste. The pesticide production plant had been dumping waste into a disposal site that was considered to be safe, as it was considered to be isolated from groundwater. Subsequent analyses of local drinking water indicated the presence of pesticides and identified the source as being the "safe" disposal site. The pollution had been transported through the soil to the groundwater, so to protect the groundwater in the future the polluted soil also has to be removed.

When we look into the related topic of wastewater, the quantities and number of contaminants in these discharges vary according to the size and type of manufacturing process, the type of technology employed, the treatment methods before release etc. In most cases, untreated industrial wastewater ends up in surface watercourses. Because of the growing levels of pollution in rivers and streams and contamination of underground waters, the Ministry responsible for environmental protection initiated certain activities to encourage polluters to treat industrial wastewater before release. In 1995, a nation-wide monitoring activity was initiated measuring certain carcinogenic substances such as Pb, As, $CHCl_3$ and pesticides such as atrazine and alachlor, and metabolites thereof. Although these activities in the area of water protection and waste management undoubtedly lead to an improvement of the environment it is thought the environmental policy is still too rigid and government measures are slow and insufficient.

## 3. Legal framework

There is no common legislation dealing with land recovery either within the EU or the candidate accession countries. However, there are a number of EU Directives[11], agreed or proposed, which are relevant to the problems of soil contamination and land recovery covering waste management, water quality, and industrial pollution control. These directives need to be implemented by the candidate countries into their national law imposed by their acceptance of the constraints of the Treaty of European Union and the acquis communautaire. They deal, however, with the conditions attached to current activities, and do not in general regulate how to treat problems left over from earlier activities.

· The **Waste** Framework Directive and the complementary **Hazardous Waste** Directive set out the overall structure for an effective waste management regime,

[11] A Directive of the Council of the European Union represents an agreement among the Member States, on the basis of a proposal from the European Commission, on a legislative objective to be attained. This objective must be attained by the laws, regulations and administrative arrangements appropriate for each Member State.

including the development of cleaner technologies, technical improvements to products and disposal techniques, and use of waste as a source of energy.

- A **Landfill of Waste** Directive is under consideration, which would require all waste to be treated before being used for landfill. Mixing of hazardous and municipal waste would be phased out, and prices for landfill would have to cover the costs of closing the site and at least 50 years of subsequent care.
- The proposed **Water** Framework Directive has as a principal objective the protection of the environment, aiming at "good" status for all groundwater and surface water by the year 2010. This target may represent a significant challenge for some Central and Easter European states. The Directive would also require river basin management plans to be drawn up, based on an assessment of water needs and of the impact of human activities on water resources. It would also incorporate a number of existing Directives covering water protection.
- The **Nitrates** Directive introduces an agricultural code of practice with the aim of reducing nitrate use.
- The **Integrated Pollution Prevention and Control ("IPPC")** Directive aims to prevent, or where that is impracticable, to reduce, emissions from industrial installations to air, water and land. A requirement of particular interest in this Directive is that of avoiding waste production. The Directive also includes requirements concerning the cessation of industrial activities, including the avoidance of pollution risks and the return of the site to a satisfactory state.
- When we come to consider accidents causing acute pollution, it is worth noting the **Seveso II** Directive on the prevention of accidents involving dangerous substances, as well as the **Civil Protection Action Programme**, which could include action to mitigate the effects of such accidents.
- On the basis of discussions with Member States, industry, banks, insurance companies, non-governmental organisations and other independent experts, the Commission is preparing a **White Paper on Environmental Liability**. It is expected that this white paper will cover the contamination of land, though apparently only that which arises in the future.

## 4. The role of research and development

Land is "fit for use" when it can be used for a particular purpose without posing unacceptable risk to human health and the environment. Uncertainties about the nature and significance of chemical contamination can be a major stumbling block hindering sustainable development, and increasing pressures on greenfield sites.

There are many areas where significant improvements in the science base would greatly reduce the cost and increase the certainty of fitness-for-use assessments. Much work has been undertaken worldwide into developing remediation techniques, and in many domains, there are effective restoration and recovery techniques available, but they are simply too expensive. Research in the field of contaminated land management is needed to develop cost-effective solutions, to assess the likely impacts on mankind

and the environment, to guide remedial actions needed to ensure fitness for use and to reduce aftercare for future generations.[12]

In this respect, it is worth mentioning the EU Concerted Action programmes, CARACAS, NICOLE and CLARINET (see Section 1), which were established as part of the Environment and Climate RTD Programme of the European Commission. The activities of NICOLE focus primarily on industrial sites still in use or owned by industry. CARACAS had the broader perspective of governments that have to make rational decisions within a national contaminated land policy and planning framework. CARACAS, which ran from 1996 to 1998, brought together the combined knowledge of academics, government representatives and other experts from all EU Member States plus Norway and Switzerland. The conclusions and recommendations derived from this international partnership have been published recently in two volumes[13], and have obvious direct relevance to the accession countries. Volume 1 focuses on scientific aspects of risk assessment and research needs in key areas of contaminated land risk assessment. The policy frameworks in which risk assessment and risk management are carried out in European countries are described in Volume 2.

CLARINET, which runs from 1998 to 2001, is the follow-up project to CARACAS. The primary objective of CLARINET is to develop technical recommendations for sound decision making for the rehabilitation of contaminated sites in Europe. The scope of CLARINET includes scientific, environmental and socio-economic issues related to contaminated land management, and focuses particularly on brownfield redevelopment and groundwater restoration. CLARINET will identify priority research needs and stimulate co-ordinated R&D activities, both at a European and a national level.

## 5. Conclusion and recommendations

Following the plenary sessions parallel workshops tackled the themes of: “clean-up technologies for chemical, biological and nuclear wastes”; “risk assessment for contaminated land (including fitness for use assessments)”; “soil restoration technologies”; “monitoring and aftercare of contaminated sites”; and “management of risk and of emergency situations.” The results from these workshops were presented in the final plenary session and general conclusion and recommendations were drafted, which are presented below.

- Land recovery is considered a critical problem in all the candidate accession countries, arising from its consequences on water resources and use of the land, with many of the specific problems being common to all countries.

[12] CARACAS/NICOLE Joint Statement: Towards a Better Future — Establishing Fitness for Use and Sustainable Development of Contaminated Land in Europe, October 1997. Available from http://www.nicole.org and http://www.caracas.at.

[13] Ferguson, C., Darmmendrail, D., et al. Risk Assessment for Contaminated Sites in Europe, Volume 1, Scientific Basis, LQM Press, Nottingham, UK. 1998. Ferguson, C. and Kasamas, H. Risk Assessment for Contaminated Sites in Europe, Volume 2, Policy Frameworks, LQM Press, Nottingham, UK. 1999

· There is no common legislation for dealing with land recovery. This is true for the European Union as well as the candidate accession countries. There are, however, directives and proposed directives that are relevant to land recovery and man-made risks; these concern waste management, water quality and industrial pollution control and risk management. However, key issues have been identified for the problem of land recovery, i.e. the need for different approaches for dealing with past contamination and new contamination, and the need for defining an "acceptable" level of clean-up being dependant on the proposed land usage.

· There is a need for research and development focusing on methodologies for assessing the consequences of different policies and strategies, including different economic and legal instruments.

· Compatible national and regional, central information systems must be established covering the collection, assessment, up-dating and management of information and effective communication among interested parties.

· There is a need for transnational mechanisms and systems for exchange of knowledge, methodologies, expertise, best-practices, and for training.

· In dealing with the man-made hazards of land contamination the aims of each country should be: to reduce the risks to a level consistent with the economic, social and environmental needs, and to bring land affected by contamination back into beneficial use.

· While the priority is to implement the existing specific directives for waste management, water quality and industrial pollution control and risk management, each country should consider what other measures may be necessary to deal with the problems of past contamination to ensure the necessary infrastructure for environmentally friendly development and to set clear conditions for investment.

Based on the general conclusions stated above, the following key recommendations have been put forward.

· Criteria that should include an assessment of risk should be central in the decision-making process connected to land recovery problems in order to ensure maximum efficiency in the use of resources. Screening or tiered approaches should be adopted and benchmarking of qualitative methods for risk assessment is suggested.

· An inventory of available techniques used in land recovery should be created along with selection and validation criteria.

· The following priority R&D actions have been identified.

– Development of screening techniques for the detection of pollution to improve the targeting of resources.

– Development of more cost-effective soil remediation techniques with priority being placed first on monitoring natural attenuation, in situ bioremediation, reactive barrier technologies, then on other promising in situ and ex situ technologies and finally as a last resort to off-site intrusive techniques.

· Priority should be given to monitoring "before" and "after" remediation and this should be coupled to predictive process modeling in support of decision-making processes. There is a particular need for the development of low cost monitoring equipment, strategies and methodologies and the development of criteria to deal with the problems of sites containing multiple types of contaminants.

- The research and development needs of the candidate accession countries should be integrated into existing international networks dealing with the problems of land recovery and man-made risks such as: CLARINET, NICOLE, NATO/CCMS and ETC/S.
- The execution of joint projects focusing on real problems is seen as the most effective and efficient means by which knowledge and expertise are exchanged between the EU member states and the pre-accession countries, and finally exchanges of scientific personnel and the hosting of international workshops should be actively encouraged.

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