

European Networks for Sustainable Concepts and Research Needs – CLARINET and NICOLE

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Abstract

CLARINET (the Contaminated Land Rehabilitation Network for Environmental Technologies in Europe) and NICOLE (the Network for Industrially Contaminated Land in Europe) offer opportunities for contaminated land researchers and practitioners to share information about current technologies and practices, experiences and expertise. The Concerted Action Programmes NICOLE and CLARINET were established in 1996 and 1998, respectively, as part of the Environment and Climate RTD Programme of the European Commission to tackle scientific and technical aspects of the problem of contaminated land. In 1999 NICOLE became self-funding. Together, the two networks combine the knowledge of academics, government experts, consultants, industrial landowners and technology developers. The two networks approach the problem from different perspectives: NICOLE's focus is primarily on the management of industrial sites still in use or owned by industry; CLARINET has the broader perspective of government decision-making within a national contaminated land policy and planning framework.

Both networks identify research priorities for the Sustainable Management of Contaminated Land, which is a prerequisite for the protection of water resources and reuse of derelict land. It is a combination of research and practical applications that will provide Europe with the right knowledge necessary for the sustainable management of environmental risks.

CLARINET and NICOLE have contributed to this special issue of Land Contamination and Reclamation as part of their support for the effective implementation of the EC Framework 5 RTD Programme, and to provide an overview of their work to a wide audience of practitioners in the field. This special issue highlights the recent and current activities of CLARINET and NICOLE and the progress that is being made towards the establishment of better risk-based land management protocols and practices in the EU. It provides an overview of current research programmes including the current call for EU research under Framework 5, and identifies commonly perceived research needs among stakeholders in European countries.

INTRODUCTION

On 15 November 2000, the EC released a call for proposals for the 5th Framework Programme, FP5 (www.cordis.lu/fp5/home.html), in the EESD programme (Energy, Environ-

ment and Sustainable Development) which included a number of Action Lines relevant to contaminated land research and development (www.cordis.lu/eesd/calls/a_200001.htm).

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Past and present human activities have introduced contaminants to the soil and groundwater with the result that many thousands of sites across Europe have a suspected contamination problem. Some of these sites may endanger water resources, ecosystems, and/or human health. They are also an under-used resource and a major opportunity to reduce the pressure on greenfield sites in Europe by recycling this scarce resource of land. However, uncertainties about the nature and significance of chemical contamination can be a major stumbling block hindering this sustainable development, thus increasing pressures on greenfield sites. Better methods are needed for assessing the likely impacts on humans and the environment, to confirm that sites are fit for their current or intended uses, and to guide the remedial actions needed to ensure fitness for use and a reduced burden of aftercare for future generations.

Effective and responsible risk-based management requires a substantial research foundation to provide a reliable scientific basis for sound decision-making. A large amount of research and development (R&D) has, of course, already been carried out, and ongoing research activities are supported by many European countries and by the European Commission. Results and experiences gained from these activities may be very beneficial to other stakeholders. Therefore, international networks for sharing information, developing case studies, disseminating research results and identifying research priorities have been launched during recent years. These networks help to avoid unnecessary duplication of R&D activities on a national basis, and to help develop the broad science base needed. Their results provide useful sources of information for practitioners in the field (Ferguson and Kasamas 1999).

The international networks CLARINET and NICOLE are two Concerted Actions which were established within

Environment and Climate RTD (research, technological development and demonstration) Programme of the European Commission, to offer such opportunities for sharing knowledge between contaminated land researchers and practitioners.

The aims of this special issue of *Land Contamination & Reclamation* are to:

- support the efforts of those wishing to make proposals to Framework 5;
- provide an interim report of activities in the two networks on risk assessment, risk management, and remediation and redevelopment/regeneration to a wider audience of practitioners and researchers in the field.

The special issue is intended to supplement the recent joint statement on the *Management of Contaminated Land for the Protection of Water Resources* (CLARINET *et al.* 2000). It has been organised in five further sections.

- **Research programmes**
 - Contaminated land research under the EU RTD Programme, Environment and Sustainable Development
 - An analysis of national and EU research programmes related to sustainable land and groundwater management
- **Proposal guidance**
 - Scientific and research needs for contaminated land management
 - Guidelines for the preparation of proposals for Framework Programme V
- **Risk management: state of the art in risk assessment**
 - Sustainable contaminated land management: a risk-based land management approach
 - Water resource protection issues in relation to contaminated land
 - Human exposure model comparison study: state of play
 - BARGE, Bioavailability Research Group Europe: European co-ordination on risk assessment of soils
 - an announcement of an international workshop on ecological risk assessment
- **Risk management: state of the art in corrective actions**

- Monitored natural attenuation: moving forward to acceptance
- Towards a framework for selection of remedial technologies for contaminated sites
- Source remediation vs. plume management: critical factors affecting the cost-efficiency

- **Remediation and redevelopment/regeneration**

- Urban brownfields in Europe
- Framework for decision support used in contaminated land management in Europe and North America
- Risk communication for contaminated land remediation
- International networks on contaminated land
- ANCORE, Academic Network on Contaminated Land Research in Europe

CLARINET

The Concerted Action, CLARINET (*Contaminated Land Rehabilitation Network for Environmental Technologies in Europe*), started in July 1998 and will continue till mid 2001.

CLARINET is a network of 16 European countries, co-ordinated by the Austrian Environmental Agency and supported by the European Commission's Environment & Climate Programme (Bardos *et al.* 1999). CLARINET brings together the combined knowledge of academics, government experts, consultants, industrial landowners and technology developers. It provides an interdisciplinary network on the sustainable management of contaminated land in Europe, analyses key-issues in decision-making processes and identifies priority research needs on technical, environmental and socio-economic topics. Overall, CLARINET focuses on the underlying scientific basis of risk-based methodologies and aims to stimulate RTD collaboration in Europe on identified research needs. CLARINET is the successor to the previous Concerted Action CARACAS (Concerted Action on Risk Assessment for Contaminated Sites in Europe) which completed its work in October 1998.

The goals of CLARINET are to identify how contaminated land (soils,

groundwaters, surface waters) can be managed effectively and sustainably (a) to ensure the safe (re)use of land, and (b) to abate resulting water pollution to maintain the functionality of soil and (ground)water ecosystems. CLARINET has four main themes:

- soil and groundwater protection;
- risk assessment;
- remedial technologies;
- decision support issues (including socio-economic and political aspects).

CLARINET's aims are to develop technical recommendations for sound decision-making in the rehabilitation of contaminated sites in Europe, to assess current approaches to contaminated land management, to identify priority research needs and to stimulate co-ordinated R&D at EU and national levels.

An international CLARINET conference will be held in Vienna on 21 and 22 June 2001. The major objective of this conference will be to present and discuss conclusions from recent work, and assess recommendations for future work with a broad spectrum of participants. Further information on this conference is available on www.clarinet.at. All researchers and practitioners in the field are cordially invited to register.

To yield an integrated approach within CLARINET, seven interlinked Working Groups are addressing problem and solution related aspects for contaminated land management. These Working Groups analyse the currently existing knowledge, identify related R&D needs and develop recommendations for improved problem-solution approaches in their respective theme. The following themes are addressed with these working groups:

Working Group 1 Brownfields and Redevelopment of Urban Areas is finalising a report describing the key issues (technical, economic and social) affecting brownfields redevelopment where contaminated land is suspected or present for CLARINET countries. The report is based on a survey of CLARINET country representatives. It

identifies common factors and differences between countries, as well as areas needing RTD. It encompasses national and regional perspectives, environmental, economic and planning permission issues and administrative procedures.

Working Group 2 Decision Support

has produced a series of papers about decision support with the NATO/CCMS Pilot Study on Remediation Technologies (see www.clu-in.org for details) and at *Con Soil 2000* (publishers Thomas Telford). It is cataloguing decision support tools in current use. This catalogue is intended to be linked to the CLARINET website in 2001. Work in progress also includes the development of a proposal for web-based provision of information to help contaminated land decision-makers in Europe, and discussion papers for a general decision 'map' for contaminated land decision-making in the context of sustainable development and (with WG7 Technology) for remedial technology identification.

Working Group 3 Groundwater & Surface Water Protection is working on a review of national approaches to groundwater risk assessment and associated soil threshold values, and the protocols used for monitored natural attenuation in different CLARINET countries. Four key issues are being considered: regulatory approaches/procedures; the likely future influence of the Water Framework Directive; where the point of compliance is set (both for protection and remediation); and monitored natural attenuation.

Working Group 4 Research Programmes and Collaboration in Europe has set up its own programme of meetings to allow national research programme managers to meet their

Specific Aims of CLARINET

1. Analysis of key-issues in decision-making processes and identification of priority research needs for the sustainable management of contaminated land in Europe. This analysis integrates risk assessment, decision support issues and remediation technologies in a systematic approach and considers the various underlying policy frameworks.
2. Creation and maintenance of a network for exchange of information on available methods, technologies and policy approaches.
3. Stimulation of international co-operation, especially for RTD, training and education networks and research infrastructures.

peers from other European countries. WG4 has drafted a 'Strategic Analysis of EU and National Research Programmes'. It also aims to stimulate international R&D collaboration and to encourage national R&D programmes to address the priority areas identified by CLARINET and NICOLE.

Working Group 5 Ecological Requirements for Land Reuse main interests to date have been in developing the state of the art for ecological risk assessment, and how this might be applied, for example ecological targets for land use and developing a conceptual framework for 'ecological fitness for use'. An international workshop on these themes is planned to take place at RIVM, The Netherlands in 2001.

Working Group 6 Human Health Effects has focused its efforts on two ongoing projects: a comparison of human exposure models and an investigation of ingestion by humans of contaminants in soil.

Working Group 7 Remediation Technologies has produced in draft form a framework for considering remedial approaches in decision-making. WG7 is also producing an overview of remedial approaches in use in different CLARINET countries, using projects from the NATO/CCMS Pilot Study on Remedial Action Technologies for Soil and Groundwater as Case

Studies (www.nato.int/ccms/info.htm) and a handbook being developed by Land Quality Management at Nottingham University and others in the UK.

NICOLE

NICOLE (*Network for Industrially Contaminated Land in Europe*) was set up in 1995 as a result of the CEFIC 'SUSTECH' programme which promotes co-operation between industry and academia on the development of sustainable technologies. NICOLE was initiated as a Concerted Action within the European Commission's Environment and Climate RTD Programme in 1996. Since February 1999 it has been self-funding.

NICOLE is the principal forum that European business uses to develop and influence the state of the art in contaminated land management in Europe. NICOLE was created to bring together problem holders and researchers throughout Europe who are interested in all aspects of contaminated land. It is open to public and private sector organisations. Its overall objectives are to:

- provide a European forum for the dissemination and exchange of knowledge and ideas about contaminated land arising from industrial and commercial activities;
- identify research needs and promote collaborative research that will enable European industry to identify, assess and manage contaminated sites more efficiently and cost-effectively;
- collaborate with other international networks inside and outside Europe and encompass the views of a wide range of interest groups and stakeholders (for example, land developers, local/regional authorities and

The CLARINET Website

The CLARINET website at www.clarinet.at offers comprehensive information on contaminated land management in Europe for all interested parties. The website covers various aspects such as EC 5th Framework and national RTD Programmes, Policy Frameworks in 16 European countries, other international networks on contaminated land, and many more. A web library provides key papers for free download, and a comprehensive hyperlink collection refers to relevant web sources in all European countries. One chapter of this website is specifically dedicated for potential proposers towards the Framework 5 Key Action 'Sustainable Management and Quality of Water' (see www.clarinet.at/research/EC-FW5.htm).

the insurance/financial investment community).

NICOLE currently has 136 members. It includes an Industry Subgroup (ISG) with 29 company members. The Industry Subgroup's objectives are to:

- move from problem identification to solution generation;
- find ways to implement identified cost-effective solutions;
- improve communication and co-operation with all stakeholders;
- broaden the focus to include 'brownfields'.

NICOLE also includes a Service Providers Subgroup (SPSG) which currently has 16 company members including small and medium enterprises (SMEs). The SPSG represents the varied interests of consultants, contractors and materials/equipment providers.

In addition, NICOLE includes 75 individual members from the academic sector/research community as well as 16 members from other organisations, including research planners, non-profit making organisations, other networks, funding organisations..

The NICOLE website

The networking function of NICOLE is assisted by its website at www.nicole.org. The website contains three main areas:

- NICOLE pages which reflect the evolving nature of NICOLE
- an information gateway which includes the NICOLE web board, web links, NICOLE News Service and links to NICOLE's publications, education and training pages
- a search facility.

NICOLE research

One of NICOLE's principal successes has been the initiation of a series of collaborative R&D projects with strong industry and business involvement. Projects include:

- The bioavailability of lead and mercury in contaminated soils and sediments
- Exposure factors sourcebook for European sites

- Rapid site assessment for petroleum contaminated sites
- Good practice survey
- Natural attenuation: guidelines for acceptance (see Sinke *et al.* later in this issue)
- Model for comparing/optimising remediation technologies
- Risk communication on contaminated land (see Wylie *et al.* later in this issue)
- Protection of groundwater resources at industrially contaminated sites (PURE).

Summaries for projects without a paper in this issue are provided in an annex to this paper.

The future for NICOLE

NICOLE is again at the forefront of offering support to the current call for tenders under FP5, providing unmatched opportunities to scientists and industry to meet to discuss problems/solutions and to form consortia to set up suitable proposals, in accordance with the 'problem solving' spirit of FP5. The recent workshop on 'Brownfields: How to change a potential threat into an asset' (held in Ijmuiden (NL), November 2000), brought together all stakeholders to facilitate the formation of new co-operative projects properly targeting the City of Tomorrow Key Action. NICOLE, like CLARINET, is preparing a 'problem catalogue' where industrial needs are listed according to priority as guidance for R&D performers to develop ideas for new projects addressing real problems and on which it would be easier to get industry support. On the basis of the experience gathered on projects in the first call of KA1 submitted (mostly financed, but a few rejected), NICOLE has also issued a short 'checklist' to help consortia to prepare proposals tailored to the call requirements (see Cortesi and Edwards, this issue).

A COMMON NICOLE AND CLARINET VIEW

One of the most significant areas of progress for NICOLE has been the development of close relationships with other networks, for example NICOLE with CARACAS (*Con-*

certed Action on Risk Assessment for Contaminated Sites in Europe).

Whereas NICOLE was formed to address the contaminated land issue from the perspective of land-holding companies wanting to deal with their problem responsibly, CARACAS AND CLARINET were formed to represent the perspectives of governments needing to make rational decisions about national land policies and their planning frameworks. However, the two networks share a common goal of providing a vision and identifying the means whereby risk assessment and risk management approaches can be applied effectively to ensure the safe use of contaminated land.

The maturing co-operation of NICOLE and CARACAS/CLARINET was developed through membership on each other's steering groups, and attendance at each other's meetings and workshops. The development of joint R&D needs and joint statements has played a very important role and been an outstanding example of co-operation between industry and regulators. The main achievements of this co-operation were exemplified recently through the Joint Statement on 'Sustainable Management of Contaminated Land for the Protection of Water Resources' (CLARINET *et al.* 2000) which also included the views of SENSPOL¹ and ETCA², two other Concerted Actions initiated by DG Research. This statement follows two previous joint documents. The first Joint Statement by CARACAS and NICOLE *Towards a Better Future* (October 1997) focused on research needs which identified the direction of research necessary to define the nature of, and establish the fitness for use of, contaminated land; the second Joint Statement by CLARINET and NICOLE, *Better Decision Making Now* (October 1998), discussed the way in which risk assessment and risk management could currently be applied to contaminated land management problems. These documents rep-

1. SENSPOL: Sensors for Monitoring Water Pollution from Contaminated Land, Landfills and Sediments
2. ETCA: Environmental Technologies Concerted Action

resented a broad consensus of opinion which was used as a preliminary input to guide the orientation of research on contaminated land to be addressed during the two key actions on 'Management & Quality of Water' and 'City of Tomorrow', in the Fifth Framework Programme (FP5). The co-operation with CLARINET is envisaged to remain one of the fundamental pillars of NICOLE action.

Both NICOLE and CLARINET provided support in the form of chairpersons and discussion leaders for all sessions of the recent DG Research workshop, 'Protection of Groundwater from Contaminated Land, Sediments and Landfills' (Venice, 21–23 June 2000). They made a significant contribution to the definition of immediate R&D priorities in the Framework 5 Programme and to demonstrating the need to progress towards an eco-efficient/cost-effective approach to contaminated land remediation.

CONCLUSIONS

In recent years CLARINET and NICOLE have helped Europe make great strides in forging a common understanding of the problems left by our industrial heritage. It is now widely recognised in Europe that the emerging disciplines of environmental risk assessment and management are vital in helping us tackle the contaminated land problem. Without these tools, and the decision-making framework in which they can be used, the costs of regenerating former industrial sites will continue to impose a severe burden on industry and the public purse with possible consequences of:

- continued dereliction which reduces quality of life and stigmatises affected communities;
- a distorted and inefficient market in land which may have been contaminated;
- increased pressure to develop green-field sites;
- lack of confidence on the part of investors, both in the technical solutions to deal with contamination and the potential regulatory obligations

that developers or owners might subsequently face;

- negative perceptions among affected communities which can lead to fears about health risks and environmental damage, and reduction in property values.

Together the two Concerted Actions CLARINET and NICOLE are working to provide a vision, and to identify the means, by which risk assessment and management can be applied effectively to ensure the safe use of contaminated land to protect the environment. Effective solutions require the close collaboration of scientists and engineers, industry problem holders, policy makers, technology developers, academics, and research programme planners as well as focused and transparent approaches that are economically viable. The results will be important to all in Europe to maintain:

- a safe and attractive environment;
- sustainable reuse of former industrial areas for homes, businesses and leisure areas etc.;
- effective and timely solutions at a viable cost to society.

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ANNEX

NICOLE RESEARCH PROJECTS

For further information please visit: www.nicole.org

The Bioavailability of Lead and Mercury in Contaminated Soils and Sediments

One of the main objectives of this recently completed project was to identify major gaps in knowledge and to highlight these for future research possibly within the Fifth Framework Programme of the EU. The important gaps in knowledge and requirements for further research, with regard to mercury, include:

- The need for standard methods for assessing the bioavailable concentrations of mercury in soils.
- Methods for collecting representative samples of soils from heavily contaminated sites where liquid-phase mercury (Hg) is present.
- Movement of liquid-phase mercury through pores and fissures in soils, concrete and other buried materials to groundwater and the mobility of other mercury species.
- The timespans over which the relatively inert form of mercury (HgS cinabar) can be transformed to more mobile and bioavailable forms (including methyl mercury) and the conditions most likely to facilitate this (and the persistence of all forms of mercury in soils and made land).
- Possible synergistic/antagonistic effects of other contaminant metals and organic chemicals also present in the contaminated soils with the mercury.
- The dynamics of the sorption/desorption of mercury by humic substances and soil minerals.

The review of the behaviour of lead has shown marked differences in the toxicology and soil/environmental chemical behaviour between mercury and lead. Both of these metals are commonly encountered soil contaminants on industrial sites and a full understanding of their respective behaviour is necessary for assessing and managing the risks associated with contaminated land, especially in the case of 'brown-field sites' intended for redevelopment for urban/residential purposes.

Exposure Factors Sourcebook for European Sites

The aim of this completed project was to produce a user-friendly handbook of appropriate default exposure factors for use in risk-based decision-making related to contaminated land. Exposure factors are the variables used to estimate human contact with various types of media, for example soil, air, groundwater. They include variables related to human activities (e.g. time indoors vs. outdoors, weekly hours at work) and physiological parameters (e.g. inhalation rates, body weight, skin surface area). Appropriate values to use for exposure factors will vary depending upon cultural and geographic factors that influence behaviour. For example, children playing outdoors will have potentially higher skin surface area exposures in hot climates than in cold climates.

Rapid Site Assessment for Petroleum Contaminated Sites

Members of Petroleum Environmental Research Forum (PERF) and NICOLE are jointly participating in the Rapid Site Assessment project. Its objectives are to develop, apply, and transfer technology and information which will assist in rapid, cost-effective approaches to site characterisation. The project is used as forum for: (a) exchanging information about new technologies and frameworks, (b) promoting a greater awareness and understanding of rapid site assessment approaches, and (c) advancing regulatory acceptance of the approach. Three petroleum companies have signed the participation agreement and three others have submitted proposed research contributions. Three NICOLE members are participating in the project by jointly conducting a field study to evaluate the MIP/Geoprobe tool. The work required to complete this project is shared by programme participants; however, participants who wish to make monetary contributions may also participate.

Good Practice Survey

The aim of the good practice survey (completed project) has been to suggest good practice for site sampling and assessment. There are several principal steps that define an investigation strategy.

1. An unambiguous definition of objectives.
2. Unambiguous definition of the population affected.

3. Sampled environmental variables must be relevant to the objective of the survey, but no relevant variables must be omitted.
4. Determine the precision needed for the objectives.
5. Determine the means of measurement, and ensure that these are available when needed;
6. Determine the best approach for sampling. (Two main approaches can be distinguished (a) strategy estimating how much of a contaminant is present, leading to classical or design-based sampling, and (b) predicting, as accurately as possible, where the contaminant is present, leading to geostatistical or model-based sampling.)
7. Clear presentation and illustration of the findings. (Geographical information systems (GIS) can play a central role here in the presentation of findings. GIS can show the extent of the environmental problem in its real context, allow a link to be made with hydrological models, and show possible alternative strategies. The degree of error and uncertainty should also be presented.

Beneficial Reuse of Materials from Land Reclamation

One of the project 'partnerships' that has developed through the NICOLE network is the 'Beneficial reuse of materials from land reclamation'. BG plc, VHE plc, the Welsh Development Agency, TNO and British Steel plc will be demonstrating and evaluating, emerging and novel, reuse approaches applied to both materials and areas of land for reclamation and regeneration. Our three general priority areas will be:

- restoration of post-industrial sites through minimising reliance on landfill to provide a technical basis for risk-based application of monitored natural attenuation;
- reuse of derelict sites for energy forestry in former coalfields;
- rehabilitation of closed landfill sites through reduction, reuse and recycling.

In addressing these priorities, a range of approaches will be selected on the basis of their potential to deliver commercial, environmental and social value through waste minimisation, recovery of secondary materials, energy generation and more sustainable land reclamation and regeneration practices. This initiative is known as 'exSite' and the partners will concentrate their efforts

and resources on enabling technologies, processes and strategies to be demonstrated and evaluated on site and at field scale. The overall aim of exSite is to generate sufficient field data to bridge the confidence gap which prevents widespread adoption of *ex situ* on-site methods of decontamination, restoration and rehabilitation. This is an ongoing project under the aegis of exSite. Further information is available on www.exsite.org.

Model for Comparing/optimising Remediation Technologies

This completed project concerns the further development of the 'REC' (risk reduction, environmental merit and costs) decision support system developed in The Netherlands for the analysis and evaluation of alternative clean-up strategies for a polluted site. Decision support systems are used in many fields and for several different purposes; their aim is to:

- help individuals or groups make decisions;
- support rather than replace them;
- raise the effectiveness of the decision-making process;
- provide a structure for the evaluation to simplify the analysis and synthesis of large amounts of information.

REC is particularly suitable for comparing alternative clean-up strategies for a single contaminated site. Risk reduction focuses on the local consequences of a soil remediation project at the site concerned whereas environmental merit assesses a remediation project from the general interest point of view. In REC, all costs incurred from the moment of decision until the end of the remediation project are considered. Since cost estimates are uncertain and since costs may be incurred at different moments, the costs of an alternative are obtained by discounting its annual costs and by including safety factors which limit the uncertainty in the cost estimates.

PURE

NICOLE also supports a project funded by the first call of the Fifth Framework Programme 'Protection of Groundwater Resources at Industrially Contaminated Sites' – PURE. PURE is aimed at preventing contamination of groundwater from multi-polluted industrial sites by priority contaminants such as recalcitrant chloro-organics, BTEX and heavy metals, providing innovative, comprehensive, widely applicable approaches.