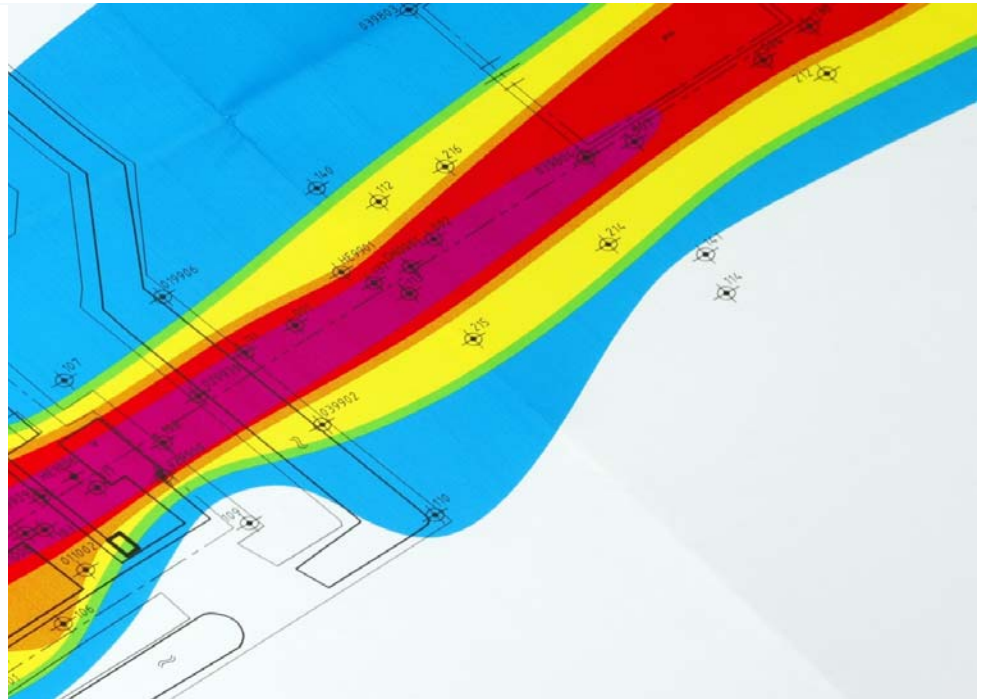
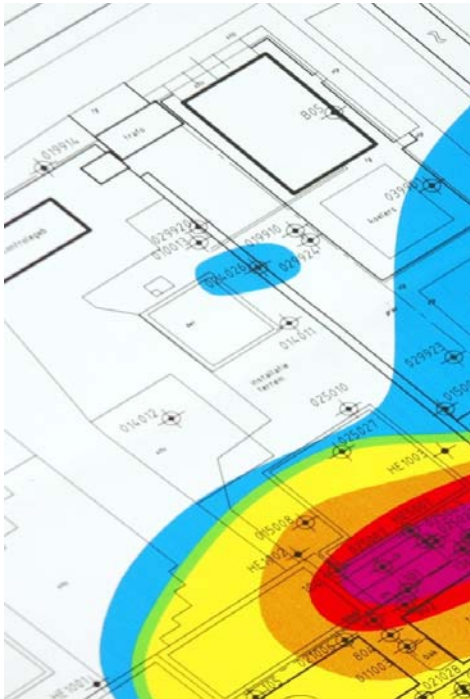




REPORT OF THE NICOLE Workshop: Environmental Decision Support Systems



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www.nicole.org

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NICOLE

NICOLE (Network for 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 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. NICOLE was initiated as a Concerted Action within the European Commission’s Environment and Climate RTD Programme in 1996. It has been self-funding since February 1999.

NICOLE’s 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; and
- Collaborate with other international networks inside and outside Europe and encompass the views of a wide a range of interest groups and stakeholders (for example, land developers, local/regional authorities and the insurance/financial investment community).

NICOLE currently has 126 members. Membership fees are used to support and further the aims of the network, including: technical exchanges, network conferences, special interest meetings, brokerage of research and research contacts and information dissemination via a web site, newsletter and journal publications. NICOLE includes an Industry Subgroup (ISG) – with 28 members; a Service Providers Subgroup (SPG) with 43 members; 38 individual members from the academic sector/research community; and 17 members from other organisations, including research planners, non profit making organisations, other networks, funding organisations. Some members are involved in both the ISG and the SPG. For further general information, further meeting reports, network information and links to contaminated land related web sites, please visit NICOLE's web site: www.nicole.org.

Membership fees are currently 3,500 EURO per year for companies (1,750 EURO for smes), and 150 EURO per year for academic institutions. For membership requests please contact:

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Executive Summary

Projects dealing with environmental problems can be quite complex. This is caused both by the nature of the subject itself, for example the complexity of contamination sources and their interaction with the ground environment (e.g. soil and groundwater), and by the involvement of many different stakeholders. Thus, reaching a conclusion regarding the best solution taking into account all relevant factors can be challenging, yet is a crucial matter given the often high (remedial) costs involved. To guide and support the decision making process, decision support systems or tools (DSSs / DSTs) are increasingly applied in the environmental field. DSS are used in various stages of the project focusing on different levels of detail. Furthermore, different general approaches, evaluation procedures, levels of stakeholder involvement, and degrees of flexibility are applied.

DSSs / DSTs continue to be developed to support analyses of decisions pertaining to environmental management. DSTs integrate environmental data and simulation or conceptual models into a framework for supporting decision-making for site characterisation, monitoring, or remediation. DSTs are tools that facilitate the use of data, derivations and models and/or structure the processes in decision making.

Optimally a DST should integrate, analyze and present environmental information to help project managers select the most appropriate responses. It should therefore strike a balance between the level of sophistication needed to address the wide range of site conditions and ease of use. For example a tool or system should not require data that it is not possible to supply, for example, sampling points at an unaffordable frequency. It should also have robust approaches to quality assurance and control (QA/QC), in particular error checking the problem definition process. However, a DST is not a general panacea; care must be taken by the user to ensure that the capabilities of the system or tool are suitably matched with the situation requiring a decision.

This workshop presented a range of decision support tool/system functions with some examples and case studies. Its discussion related to the capabilities and limitations of such tools and systems and their degree of acceptance in daily decision making processes. An important question it sought to address was “do we need ‘trust’ in decision support systems or tools or does it need ‘courage’ to use and rely on their outcomes”?

The workshop considered the use of decision support in site investigation. It included a presentation on the US TRIAD approach which exploits real-time decision making in site characterisation and the effective use of a data quality strategy in identifying what information is needed where and when and why. Companies from France and Spain presented their corporate strategies for site management and assessment and the key decision criteria underpinning these strategies. There were also presentations on the work of public authorities in Spain and Italy on contaminated land management and how these affected site owners. A number of decision support techniques were presented, including techniques for using human health and ecological risk assessment in decision making, sustainability appraisal and cost benefit analyses, along with procedures for strategic site management decision making.

The theoretical advantages of a decision support tool or system are that it considers a transparent, consistent, reproducible and uniform comparison of scenarios on the basis of a (full) range of parameters. It reduces complexity to manageable proportions and helps determine the key process and parameters that impact a decision, so raising the effectiveness of the decision-making process in a strategic sense. An interesting use of decision support is in comparing scenarios to find their relative strengths and weaknesses. It also facilitates communication and interpretation, and can play an educational role. In particular good decision support tools assist the broader visualisation of the decision making problem, and break decision making down into effective and usable stages. For any decision making tool the output has to be in a clear and usable format for the stakeholders whom it is meant to help. The idea of using stages and decision gates can be a particularly powerful contaminated land management approach. Gates are points where a firm choice is required before the next stage in decision making can be approached. Decision making is made stronger if these “gates” incorporate a wide range of stakeholders, for example the entire site management team and wider stakeholders as well, for example the regulator. The degree of inclusion needed depends on the nature of the decision being taken.



However, decision support tools and systems are not a panacea. They may have stringent data requirements (concerning the quality and amount of input parameters). Verification or validation can be very difficult, and many available tools suffer a lack of peer review evaluation. Clearly tools and systems need to be regularly updated. Some tools and systems fail to be transparent about their use of factual information versus value judgments, in particular regarding their use of weighting factors. Clearly input uncertainty affects output quality, in other words: rubbish in = rubbish out. A further difficulty with decision support tools and systems is that finding approaches acceptable to all stakeholders can be difficult. Dealing with uncertainty is perhaps the most contentious area in the use of decision support. Many tools or systems employ iterative approaches to manage uncertainties. It is also important to take into account the data or information quality needed for particular decisions, for example, as the US EPA Triad approach suggests, in some circumstances it may be better to have a large number of data points of intermediate accuracy to one or two very accurate measurements.

Successful decision support approaches tend to take a tiered iterative approach, rather than making conclusions in a single step. The proper engagement of stakeholders is vital. Decision support needs to be based on an adequate site conceptual model and good data management. Decision support systems and tools rely on internal concepts and models. It is important that these are understood and accepted by the stakeholders involved in the decision making process, and that their appropriateness to the problem under consideration can be demonstrated. Decision support is a marriage between factual information such as measurements and the value judgements used in the internal structure of the decision making approach. Decision support tools or systems do not make decisions. They are structured approaches to supporting decision making by professionals.

A widespread fear is that software based decision support systems might have unfortunate consequences in the hands of inexperienced users. Conversely there is also a widespread optimism that the appropriate kind of decision making support could improve the general quality of practice in contaminated land management, and equip stakeholders with more limited knowledge to at least question or challenge suggestions being made to them. In some (but not all) countries there appears to be a desire for decision support systems or tools as a means of ensuring equitable and reproducible risk management decision making between different local regulators.

The experience of this workshop is that generically decision support tools and systems still have some way to go in gaining the trust of contaminated land management professionals. Individual tools and approaches have clearly gained widespread acceptance, in particular those related to procedures or visualisation / collation tools for complex data and information. This may be especially important where there are repeated standard calculations and derivations, where a good decision support tool can reduce possibilities of calculation errors between assessments.

Decision approaches making use of expert systems or other forms of embedded values find far less easy acceptance. This may be because they have not tended to have widespread use in practical contaminated land management, and because few well scrutinised case studies have been published. For such systems and tools there is a need for better evaluation and validation before they will gain widespread acceptance by contaminated land management practitioners, whether these be clients, consultants or regulators. A further barrier to acceptance may also be a lack of a common terminology and vocabulary for both categorising decision support approaches, and indeed for use by the tools and systems. However, value based expert tools may have an important role to play in at least challenging decisions made more conventionally by particular project teams and encouraging them to think more deeply about what might be their own values and preconceptions.

Conclusions

NICOLE members have mixed views about the use of decision support systems and tools and there is some confusion about what is actually encompassed by the term. For some only software based expert systems are included, others a broader view of what constitute decision support tools, including written protocols and flowcharts. Across the workshop the broader interpretation appeared to prevail.

Hence from NICOLE's point of view decision support tools encompass guidance and protocols; visualisations such as conceptual site models; management techniques such as stage / gate decision making; and software tools for information / data management and visualisation. These techniques



are finding widespread use, and are seen as tools for experienced practitioners rather than for use by the “lay” community.

Decision support tools and systems that embed expert judgements in a decision making structure or concept are less well accepted. In part this may be because they are “disliked” with experienced practitioners preferring to use their own “grey matter”, as made evident in the workshop syndicate exercise; and in part because they are seen as poorly documented and validated with little practical track record. All the same, there is a desire, at least from some NICOLE delegates for effective and validated decision support systems and tools that can support more reproducible and evidence based decision making at the local regulatory level.

The full report provides summaries of the papers given, along with a discussion based on points raised during the meeting, and comments from a number of delegates after the meeting.



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