

NAnet Project

WORK PACKAGE 4

Natural analogues in dialogue



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CONTENTS

1	INTRODUCTION	1
2	NATURAL ANALOGUES: WHY CONSIDER THEM FOR PUBLIC COMMUNICATION ?	2
2.1	Definitions	2
2.2	Benefits	3
2.3	Difficulties	3
2.4	Potential Audiences	4
2.4.1	The performance assessment community	4
2.4.2	The public	5
2.4.3	Communications specialists	5
2.4.4	Decision makers	5
2.4.5	“Other” scientists	6
2.5	What is the purpose of using natural analogues in communication?	6
2.6	Conclusions: why bother to consider natural analogues for communication?	7
3	NATURAL ANALOGUES IN COMMUNICATION: WHAT CAN WE LEARN FROM PAST PRACTICE?	8
4	POTENTIAL APPLICATION OF NATURAL ANALOGUES IN DYNAMIC DIALOGUE	9
4.1	Insights from the RISCOM project	9
4.2	Insights from public consultation	10
4.3	The potential for natural analogues to be used in support of Performance Assessment	10
4.4	Conclusions: the potential of natural analogues	11
5	DEVELOPING THE USE OF NATURAL ANALOGUES IN THE NANET CONTEXT	12
5.1	Purpose	12
5.2	Approach to the NAnet project	12
5.3	Questionnaire	13
6	CONCLUSIONS	14

1 INTRODUCTION

Within the NAnet Project, Work Package 4 had the aims of:

- compiling and critically reviewing examples of past usage of natural analogues in the context of stakeholder communication; and
- making suggestions for the type and characteristics of potential information from analogue studies that would address issues of relevance to be communicated to different stakeholders, to foster public interest and advance understanding, based on the recommendations from experts in the field.

This report presents a perspective on the use of natural analogues for dialogue based on experience and research of the project participants. It draws on:

- practical experience in using natural analogues for communication; and
- insights about audiences and information needs from social research and consultation, including the EC funded RISCAM and COWAM projects.

The natural analogue community has a deeply held belief that analogues contain information that is relevant to the issues of radioactive waste management. However, the analogues contain a sub-set of the full range of information required for debate and discussion.

The option of not considering natural analogues does not seem to be viable. In this case, it would be easy to demonstrate that a valuable source of information and data was being ignored and the reasons for this would then be open to speculation.

However, natural analogues will be of more interest to some audiences than to others and, in the context of the current project, we would recommend greater value in using them for communicating with the safety assessment community, communication specialists and other scientists before entertaining the notion of a broader public communication package.

Additionally, there is currently a sea-change in the relationships between performance assessments, research, decision-making and consultation which means that receptiveness to natural analogues as qualitative indicators of behaviour is perhaps greater than in the past.

This suggests that the focus of any initiative on developing natural analogues for public communication should concentrate on meeting the needs of specific audiences. Determining the needs of the public is a matter for public consultation, market research and societal analysis. The natural analogue community can contribute to such processes, but should not expect to determine them in isolation. A more realistic ambition could be to work with more easily accessible audiences, namely: the performance assessment community and communicators who may be seeking to facilitate debate about radioactive waste management generally. After all, if we cannot persuade colleagues within the radioactive waste community of the value of natural analogues, then why should we expect to convince the public(s) otherwise?

2 NATURAL ANALOGUES: WHY CONSIDER THEM FOR PUBLIC COMMUNICATION ?

2.1 Definitions

Natural analogues have been defined variously as:

“....an occurrence of materials or processes which resemble those expected in a proposed geological waste repository.”

(Côme & Chapman 1986, CEC Report EUR 10315)

Another view is that a natural analogue:

“.....provides information on the behaviour of a repository which is derived from one site but applicable to another.....”

(Miller 1996, CEC Report EUR 16761)

Reasoning by analogy has long been an important aspect of thought development and debate. The notion of using natural analogues in debate and discussion about the science of radioactive waste management is a logical extension of this practice.

The NAnet project is focussed primarily on the concept of deep disposal, in which radioactive wastes are disposed deep underground in a repository engineered to provide both natural and man-made barriers to the movement of toxic species back to the human environment (the multi-barrier concept). Typically the barriers identified in the multi-barrier concept are:

- *The wasteform(s)*: which comprise the wastes themselves and any matrix in which they have been isolated and immobilised. Materials used within the EC include: cement, concrete and glass. The wastes themselves can be made up of a range of metals, plastics and other contemporary materials contaminated with radioactivity.
- *Packaging*: which forms the primary containment system surrounding the wasteform. Packaging materials used in the EC include: copper, concrete, stainless steel, and carbon steel.
- *Backfill*: which fills the void spaces around the waste packages. In the EC, backfill materials under consideration include: bentonite, cementitious backfills, sand and clay.
- *Geosphere*: which is the geological environment in which the repository has been constructed.

Because some of the radionuclides in the wasteform will remain radiotoxic for very long times into the future, the behaviour of these barrier materials has to be considered for very long periods into the future. Natural analogues provide a means of understanding what may happen on different timeframes. For example, there are the *industrial analogues* arising from industrial practices over the past few hundred years. *Archaeological analogues* have the potential to tell us about the behaviour of materials from past civilisations over thousands of years. Finally, *geological analogues* behaviour has been used by natural scientists for centuries to understand

NAnet Project – WP4 Natural analogues in dialogue

the behaviour of natural systems over tens and hundreds of thousands of years. All of these can be considered under the general term of “natural analogues”.

There is a lot of confusion about the relationship between natural analogues and palaeohydrogeological studies such as those undertaken within the EQUIP, PADAMOT and PERMA programmes. In the context of communication, neither the confusion between these subjects, nor the distinctions that some make between them is helpful. Therefore, in the context of NAnet Work Package 4, the term “natural analogue” can be taken to refer to any evidence of environmental processes and natural systems at work, whether on natural or man-made materials.

Evidence of such natural systems at work has the potential to offer independent evidence about what may happen to a deep geological repository. However, the question is whether these natural analogues have the potential to enable debate and discussion about the science of deep disposal amongst a broad range of different stakeholders. Both benefits and difficulties can be identified.

2.2 Benefits

Broadly speaking, there are a number of characteristics of natural analogues that should make them valuable for communication purposes.

Natural analogues are directly observable in the environment. They are as much a part of our environment and history as we are. As such, there is a tangibility about them that is not shared by experimentation in controlled and often complex laboratory conditions. Added to that is the inherent attractiveness of nature to most individuals. Most people have some interest in the natural environment and can offer experiential comment about nature. This makes nature an effective vehicle for dialogue, a fact that is often exploited by marketers and action groups.

Natural analogues can help make the timescales of interest to radioactive waste management meaningful. The notion that we are concerned about times far in excess of that for which the sphinx has been in existence has more meaning than a four, six or eight digit number.

Natural analogues are inherently qualitative. This has often been seen as a weakness since it can make them difficult to use for modelling and quantitative prediction. However, for communication purposes it can be a strength since for most people, life is qualitative and intuitive. The fact that natural analogues are the result of a range of environmental processes, operating together on some artefact or material is a direct reflection of “what will happen” and provides a means of observing the integrated consequences.

2.3 Difficulties

Ironically, the qualitative nature of natural analogues and the fact that they represent the consequences of integrated environmental processes also cause the greatest potential difficulties in their use in public communication. It can lead to natural analogues being open to a wide range of different interpretations. Their non-uniqueness can lead to different groups using natural analogues to support markedly different agendas.

There is often a hesitancy in using natural analogues for public communication arising from these difficulties. It is possible that this says more about the culture of the group seeking to use the analogue than about the intended audience. For example,

it can be very difficult for an experimental scientist to consider using a natural analogue since the conditions under which it has developed have not been controlled as they would have been in an experiment. A modeller may be hesitant because the analogue will only rarely provide quantitative information of direct relevance to a particular model. A communications specialist may be concerned about using natural analogues because it is not so easy to assert the scientific validity of an analogue (as opposed to a peer-reviewed experiment) and a physical scientist may be reluctant because the analogue may be from outside his/her sphere of scientific expertise.

The groups mentioned above are important audiences for the communication of natural analogues. However, the perceived tangibility of natural analogues means that they are often immediately seen as vehicles for communication with “the public”. This approach reflects a tendency for those seeking to communicate (the natural analogue community) to leapfrog over important stakeholder groups within the radioactive waste management community – the modellers, the communicators, the decision-makers and the “other” scientists. Hence a situation can develop where the expert community involved in radioactive waste have not necessarily bought in to the value of natural analogues. Natural analogues end up as something apart from performance assessment, research and development. Experience shows us that context is extremely important for participants involved in public consultation. If the context for the natural analogues cannot be articulated then their value in dialogue will be undermined. Additionally, if the other radioactive waste management experts do not value natural analogues then they are unlikely to get used in communication programmes.

2.4 Potential Audiences

The difficulties described above suggest that, as with any project with communication as a goal, it is important to answer the question “*with whom are we trying to communicate ?*”

There are a number of stakeholder groups who can be identified as potential audiences for natural analogues. However, for each of these groups, the relevance of natural analogues will vary. Understanding something of the needs of these different audiences may help to identify a strategy for moving forwards in using natural analogues for public communication.

2.4.1 *The performance assessment community*

Traditionally, there has been a lot of discussion about the use of natural analogues in performance assessment. Progress in this area has been slow, and is generally limited to the use of specific natural analogues to “build confidence” and provide “warm tummy feelings”. One of the problems has been the quantitative nature of performance assessment which is not easily informed by the qualitative nature of natural analogues. Whilst it should not be forgotten that the compilation of lists of features, events and processes (FEPs) for performance assessments is heavily reliant on natural analogue information, the challenges of incorporating FEPs into a systematic modelling framework share similarities with the issues of building natural analogues into the assessment.

However, more recently the clarification of a distinction between “performance assessment” and “safety case” has helped to provide a legitimate home for natural analogues. Increasingly, as explored elsewhere in the NAnet project, assessments are using natural analogues to justify (in part) the conceptual models on which numerical calculations are built. Additionally, as evidence by a recent NEA initiative, the

NAnet Project – WP4 Natural analogues in dialogue

performance assessment community is currently reviewing the handling of timescales in their work. This initiative also has the potential to harden the link between natural analogues and performance assessment.

Nevertheless, it remains quite difficult to hardwire natural analogues into specific performance assessment. One problem is that the definition of performance assessment is very loose and varies within the EC. For those who consider that conceptual models (which underpin numerical models) are part of the assessment process, analogues have far more relevance than for those who consider that the conceptual models are input to a performance assessment process that is focussed on mathematical formulation and calculation. The qualitative and non-unique nature of analogues means that it is generally in the area of conceptual understanding that natural analogues probably have their most useful role to play in communicating with the performance assessment community.

2.4.2 *The public*

The public is not a homogenous group. The information needs of such a group cannot be anticipated by a specialist group such as the natural analogue community. Additionally, the information needs will be very dependent on national and local context and culture and will also change over time. Analysis of such transitory and heterogeneous needs would usually involve a major social science effort. Additionally, communication with the public is strongly influenced by the relationship between those receiving the information and the information provider. It is therefore difficult to conceive that natural analogues can be presented in a package that will suit all situations and all individuals.

2.4.3 *Communications specialists*

However, most radioactive waste management programmes have communication specialists working at the interface between organisations/institutions and the public. These communicators maybe specialists in their own right, who are actively involved in discussing the science of deep disposal in public dialogue programmes. Identifying the needs of such communicators may be one way of beginning to make natural analogues more available to the public. If the communication specialists are not aware of the possibilities of natural analogues in dialogue, then how can we expect them to be reflected to the public(s). This raises the question of the needs of the communicators – again an issue that can be discussed with them. However, once again, the needs may be different depending on the objectives of the communication strategy which (s)he is pursuing.

2.4.4 *Decision makers*

Decision-makers, whether they are trying to determine waste management policy or research priorities (to give two examples) are generally looking for weight of opinion. Their decision will be very context-specific and very dependent on individual relationships or the results of consultation. The direct communication of natural analogues is therefore not likely to be seen of particular relevance to the decision-maker. However, the views of those individuals or groups whose opinion the decision-maker is seeking will have an impact, and there should be some scope for natural analogues to be used in communication with these groups, particularly those with a scientific background or culture.

2.4.5 “Other” scientists

A problem with identifying the needs of other scientists is that it involves crossing a cultural divide that exists between different types of expertise. This is very difficult for anyone with a scientific training to do. However, the potential for dialogue as a result of this is great, partly because people are pushed outside their comfort zones and partly because there is much to debate scientifically in a natural analogue because of their non-uniqueness and the fact that they develop under uncontrolled conditions.

2.5 What is the purpose of using natural analogues in communication?

Considering that the potential audiences for natural analogues varies so widely, the objectives of using natural analogues in communication will also vary widely. However, it is important to consider some general principles. The use of the term “communication” tends to imply a one way process of information provision. It is therefore possible to conclude that the purpose of the communication is to send a message or educate the audiences. This is a rather patronising idea and the analogue community will need to work hard to ensure that the laudable objective of using natural analogues more widely in support of debate about radioactive waste management is not devalued because of the way this objective is articulated. To illustrate this point, Box 1 reproduces a perspective on the use of natural analogues for public communication based on descriptions given in a previous draft of this report.

A perspective on the use of Natural Analogues in Public Communication

Derived from comments from Rachel Western on an early draft of this report.

The technical note “Review of Analogues for Public Information” presents [the authors’] views on the use of analogues by stakeholders concerned with deep disposal of nuclear waste. I was struck when reading the document that the role of analogues does not appear to be clear-cut. At 2.4.1 the document refers to confidence building and providing a ‘warm tummy feeling’ for assessors, and in the appendices there are extensive examples of the use of analogues in PR materials. However it is apparent that the use of analogues in this way is not rigorous because the analogues may not be pertinent to the comparisons they are used for.

I feel that there is a need to move away from the persuasion model of engagement that analogues have latterly been used for, towards more of a dispassionate, impartial setting out of information. Though it is not possible to gather analogue information that contains the benefits that would come from a more controlled source, they may still have a role to play as indicators. For this to work there would need to be a different starting point. Rather than aiming to convince we should be aiming to question.

I think that NAnet has asked the wrong question, it has assumed that analogues have an important role to play and move from there to set out how that usefulness should be injected. I believe that the historical origin of the present context in which analogues and the disposal programme find themselves need to be set out and examined. In my view there is an embedded political impetus that is being addressed and challenged elsewhere but within NAnet.

At 3.1.3 the point is made that the use of the cement at Hadrian’s Wall could lead to the ‘unwanted message’ that storage could be an equally valid option. There is a role for the Hadrian’s Wall data to be used in this debate, but for this to happen we need

to move away from a loaded agenda where one particular outcome is valued above another.

To conclude I would argue that:

- The background and relevance of analogues needs to be set out objectively
- The motivation of persuasion needs to be abandoned in favour of a motivation of examination

Unfortunately this document speaks from the propagandist model of information provision which does not have a role to play in future discourse. A fresh approach which is not PR based should be taken that takes as its starting point the utility of analogues to questions surrounding long term waste management so that a wider audience can make judgements about the best route to take.

2.6 Conclusions: why bother to consider natural analogues for communication?

Natural analogues have a number of attributes (for example their tangibility and their relationship to the environment and culture in which they are found) that make them interesting topics of conversation for certain groups outside the natural analogue community. They also have attributes (for example their non-uniqueness and qualitative nature) that open up scientific debate about their origin and history.

The option of not considering natural analogues does not seem to be viable. In this case, it would be easy to demonstrate that a valuable source of information and data was being ignored and the reasons for this would then be open to speculation.

However, natural analogues will of more interest to some audiences than to others and, in the context of the current project, we would recommend greater value in using them for communicating with the PA community, communication specialists and other scientists before entertaining the notion of a broader public communication package.

3 NATURAL ANALOGUES IN COMMUNICATION: WHAT CAN WE LEARN FROM PAST PRACTICE?

In the past, various attempts have been made to use natural analogues in public communication. For example, in the eighties and nineties, Nirex was intimately involved with two options for the management of radioactive wastes: near-surface disposal and deep disposal. During the course of this work, Nirex produced information that was intended to keep the public abreast of Nirex's activities and the scientific understanding that lay behind them. Sometimes the information included details of how natural, archaeological and anthropogenic analogues could be used to demonstrate, for example, the longevity of engineered barriers and the stability of the geosphere. This work was sometimes of sufficiently high profile for it to be included in Company Annual Reports, though these examples are not described in the appendix, which focuses on the use of natural analogues for explaining deep disposal to a wider readership.

The range of natural analogues used by Nirex in publicity material in the last 20 years is very wide. The most commonly used examples relate to the longevity of cement and iron. These examples reflect Nirex's cementitious concept for the phased deep disposal of intermediate and certain low-level waste.

Primarily, Nirex presented this information in two main ways: first through a free and widely distributed newspaper and second through advertisements in the local and national press. Both these methods are examples of "strategic" action, in which the overall aim is to *convince* and hence to improve acceptability.

Another general impression from the past use of natural analogues in public communication is the lack of impact that they have had. This may be due to the emphasis on the use of written media. It suggests that natural analogues may not be effective in static forms of communication. Alternatively, it may be because of the underlying objective to convince. Experience in dialogue is constantly reinforcing the idea that audiences are very sensitive to underlying motivations, and any suggestion of propaganda can undermine the value of any information provision exercise.

4 POTENTIAL APPLICATION OF NATURAL ANALOGUES IN DYNAMIC DIALOGUE

The experiences described above, together with academic research into enabling discourse, suggest that any successful attempt to use natural analogues in communication needs to aim to promote questioning, rather than convince. A fresh approach could be adopted that takes as its starting point the ability of analogues to provide information relevant to questions surrounding long-term radioactive waste management so that a wider audience can make their own judgements on the issue. This would be a dynamic use of analogues to promote dialogue that would be markedly different from the public relations oriented attempts to use analogues in communication in the past.

Recent work in the UK provides some insights into the potential of using natural analogues for such dynamic forms of dialogue with a range of different audiences. These insights are discussed below.

4.1 Insights from the RISCUM project

The European Community RISCUM project has been running for nearly three years with the objective of enhancing transparency in nuclear waste management. As part of that programme, a web-based dialogue project was undertaken in a few selected schools. This sub-project had two key aims: to examine the effectiveness of using online communications means (i.e. the Internet and World Wide Web) in establishing discussion on radioactive waste and its management; and to collect the views and issues of importance to a sample group of young people on this topic.

By virtue of its interactive nature, the project was able to collect a number of direct quotes from 15 – 16 year olds involved in the project. From this data, two key points for any dialogue processes involving natural analogues can be identified. The report on this work records that “Real people – those associated with some aspect of the project content – would have added greater interest to the project and online resources and to stimulate discussion with groups of students”. This underlines the importance of the information providers as an enabling factor in the communication process.

Additionally, direct quotes from one of the students included:

“Should have extra pages at Advanced level. Should be graphics and diagrams. It should be made interactive to get the student involved” [Q-BD2] and

“More graphs, diagrams etc.; possibly showing actual means of storage; include negative aspects of nuclear power, waste management, e.g. accidents, potential impacts on health etc.” [Q-BD4]

These statements may help identify potential areas where natural analogues can help a dialogue process by expanding on and providing evidence for fairly generalised scientific assertions. The possibility of using natural analogues to illustrate and illuminate issues and queries arising from a broader debate on radioactive waste management is also reflected in a recent public consultation exercise undertaken by an independent market research organisation on behalf of Nirex.

4.2 Insights from public consultation

The Nirex Phased Disposal Concept – a specific example of deep geological disposal was the subject for this work. An independent Market Research Organisation – the Future Foundation were commissioned to undertake and report on focus group research with publicly recruited individuals. The topic for this public consultation was to determine the perceived hazards and public concerns with the Nirex Phased Disposal Concept.

The Future Foundation held eight focus group discussions with members of the UK public. All groups comprised equal numbers of men and women but their composition varied in terms of age, life stage and socio-economic circumstances, allowing us to achieve a broad cross-section of the UK population. The groups were conducted in Carlisle, North London (Cockfosters), Paisley and Cardiff. The Carlisle and North London groups were held in late November/early December 2001, while the Paisley and Cardiff groups were held in January 2002.

Each group of people attended two sessions, held on successive evenings. The first session was a general discussion of the issues of nuclear energy and radioactive waste. The second session focused on the specific issue of the phased disposal concept. In both sessions, people were given printed material that explained the issues. They were then asked to comment on what they had read.

The report of this consultation is publicly available and includes many quotes from the participants and an analysis from the researcher. However, at the end, the researcher records a list of “Technical questions that people would like to be answered”. These questions have been reproduced in full in Appendix A and include a number of questions where natural analogues could prove extremely relevant in discussing the issue. Those questions are highlighted in Appendix A

Appendix A identifies a number of areas where the public are getting quite quickly to issues where a discussion could be well supported by natural analogues. However, if the facilitators or institutional representatives involved in the discussions don't know that natural analogues are relevant to those questions then they will not necessarily think to use them. This appears to be a significant area of potential for the use of natural analogues in public communication.

4.3 The potential for natural analogues to be used in support of Performance Assessment

In line with international initiatives seeking to promote an inclusive approach to repository development, many countries are re-evaluating the relationship between performance assessments, decision-making and public consultation. Nirex has been considering an evolved performance assessment methodology based on applying discrete modelling approaches in different timeframes. The idea is that, for each timeframe a base scenario could be described that represents the expected evolution of the repository, and variant scenarios look at departures from that. The benefit of dividing the assessment into different timeframes is that modelling approaches, performance measures and justifications that are appropriate to that timeframe can be used.

This approach, if adopted, offers the potential to accommodate a number of factors directly within the assessment:

NAnet Project – WP4 Natural analogues in dialogue

- Societal concerns can be addressed as variant scenarios and so scenario development could be done in a consultative manner, as advocated by the NEA ten years ago;
- Alternative performance measures can be used as appropriate for different timeframes, which shifts the focus slightly away from risk as the only measure of repository effectiveness;
- Multiple lines of reasoning, which could well include reasoning by analogy, have a defining role to play in determining the base scenario – the expected evolution of the repository system.

If this method is adopted, then natural analogues, alongside experimental research and theory have a significant role to play in the development of the assessment basis. However, there are many practical issues that could preclude the full adoption of this approach to performance assessment. It is very computer intensive and the data to support the full range of models for the different timeframes may not exist. Nevertheless, even if not modelled in this manner, the notion that the performance assessment community begin to think about, and justify the modelling problem from the conceptual viewpoint of “what might happen” is significant. These evolved attitudes may lead to natural analogues being viewed as valuable by the performance assessment community and their peers.

4.4 Conclusions: the potential of natural analogues

The discussion above reinforces the long held view that the full potential of natural analogues in public communication is not yet being realised. This is not a new conclusion and so the interesting question is why that potential remains, as yet, unreleased. The above insights suggest two very important criteria that need to be met if natural analogues are to get wider usage in communication. They have to be seen to be relevant by the audience and they are more likely to be effective in responding to questions raised as a result of a broader context, rather than in being of interest in their own right. This suggests a need for the natural analogue community to adopt an audience focus in considering the role of natural analogues in communication.

Additionally, there is currently a sea-change in the relationships between performance assessments, research, decision-making and consultation which means that receptiveness to natural analogues as qualitative indicators of behaviour is perhaps greater than in the past.

This suggests that the focus of any initiative on developing natural analogues for public communication should concentrate on meeting the needs of specific audiences. Determining the needs of the public is a matter for public consultation, market research and societal analysis. The natural analogue community can contribute to such processes, but should not expect to determine them in isolation. A more realistic ambition could be to work with more easily accessible audiences, namely: the performance assessment community and communicators who may be seeking to facilitate debate about radioactive waste management generally. After all, if we cannot persuade colleagues within the radioactive waste community of the value of natural analogues, then why should we expect to convince the public(s) otherwise?

These ideas are developed further in the next section.

5 DEVELOPING THE USE OF NATURAL ANALOGUES IN THE NANET CONTEXT

5.1 Purpose

The purpose of any dialogue is very important and needs to be very clear. It also needs to be shared by those involved - the audience will very quickly pick up on any disjoint between what is said and what is believed. In the context of NAnet, the recommendation is that the purpose of using natural analogues in communication is to open up dialogue between different stakeholder groups by engaging interest and encouraging thought beyond cultural boundaries. Natural analogues provide information that is relevant to these discussions the purpose of the NAnet Work Package 4 should be to consider ways of introducing this information into dialogue situations.

5.2 Approach to the NAnet project

A first step in opening up any form of dialogue is to raise awareness. The natural analogue community has a deeply held belief that analogues contain information that is relevant to the issues of radioactive waste management. However, the analogue contains a sub-set of the full range of information required for debate and discussion. Figure 1 represents the notion of an information pyramid.

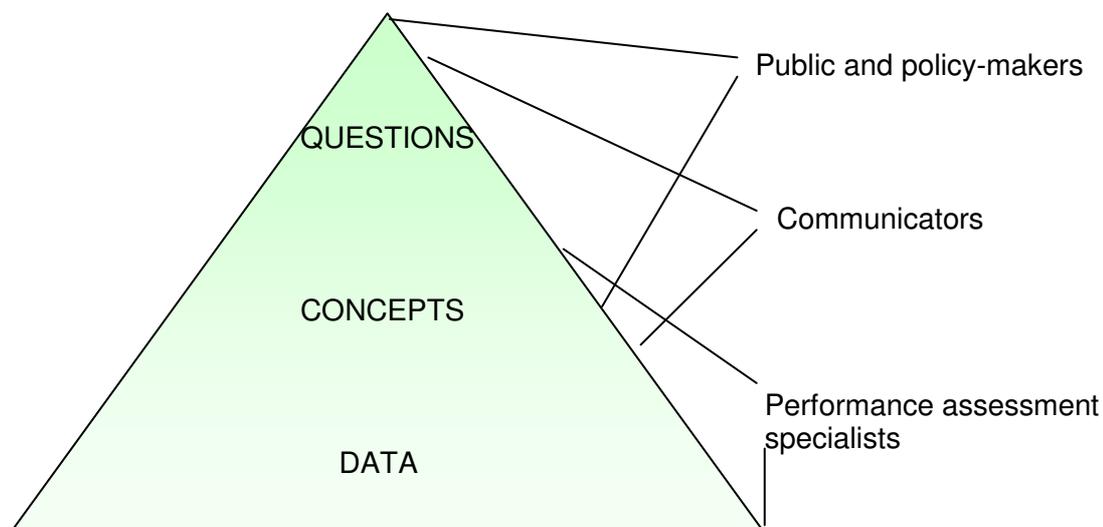


Figure 1: Information Pyramid and the information needs of different audiences

Whilst Figure 1 makes some sweeping generalisations about the information requirements of different audiences and also about the relationship between information about data, concepts and questions it does help to consider how information from natural analogues can be used in dialogue.

Work Packages 1, 2 and 3 of NAnet are undertaking a review of available natural analogues to identify their key features and the issues to which they relate in terms of geosphere, near field and surface environment of a deep geological repository. Primarily, these analogues will provide information about concepts and, to a certain

extent, data. Figure 1 suggests that, this being so, the performance assessment community should be involved in the review and its output in order to identify where natural analogues can provide information about data and concepts that can help develop credible models for performance assessments.

However, the relationship between natural analogues and the questions that sit at the top of the information pyramid is not so clear. Therefore the role that natural analogues can play in dialogue with communicators and consequently with the wider public needs to be carefully thought through.

Dialogue is a responsive process. The important issue in successfully using natural analogues in dialogue with communicators and the wider public will be determining whether analogues can provide information of relevance to the questions being asked. There is now quite a lot of experience about the sorts of questions people will ask in the context of radioactive waste management – Appendix A providing one such example.

As defined above, natural analogues will only ever provide information about the behaviour of natural systems. Broadly speaking, the sorts of questions raised about the behaviour of natural systems can be classified into four key themes:

- *Time*: how can you be sure that the repository will work over the timescales involved?
- *Depth*: How do you know that you can build something so deep underground?
- *Process*: How do you know what processes will operate in the repository?
- *Precedence*: Has this ever been done before and how successful has that been?

If this classification is useful to the communicators, then it could provide the basis for classifying the natural analogue studies compiled in Work Packages 1, 2 and 3 into an index. The index could then point those involved in dialogue towards natural analogue information that may help them explore the evidence for different points of view on these questions.

5.3 Questionnaire

It was felt important to obtain responses from actual potential users of natural analogue information. A questionnaire was designed (see Appendix B) and sent to all the NAnet team members asking them to circulate it to potential interested individuals within their organisations. Unfortunately only a few (10) responses were received. This meant that a statistical evaluation was not be worthwhile, but it is felt that some qualitative assumptions can be drawn from the results.

The major comment to make from the analysis of the returned questionnaires (see Appendix C) is that all respondents thought that the critical reviews of the various analogue studies would be potentially useful ! It is also interesting to note that the majority of respondents have not used analogue studies in any assessment work, in preparing safety cases or in communication exercises. However, the majority of respondents did suggest that they use analogue information when considering features, events and processes and in the interpretation of results.

6 CONCLUSIONS

This work package of the NAnet project was established to consider the communication aspects relating to natural analogues. We would like to suggest the following conclusions:

The option of not considering natural analogues does not seem to be viable. In this case, it would be easy to demonstrate that a valuable source of information and data was being ignored and the reasons for this would then be open to speculation.

However, natural analogues will of more interest to some audiences than to others and, in the context of the current project, we would recommend greater value in using them for communicating with the PA community, communication specialists and other scientists before entertaining the notion of a broader public communication package.

Additionally, there is currently a sea-change in the relationships between performance assessments, research, decision-making and consultation which means that receptiveness to natural analogues as qualitative indicators of behaviour is perhaps greater than in the past.

This suggests that the focus of any initiative on developing natural analogues for public communication should concentrate on meeting the needs of specific audiences. Determining the needs of the public is a matter for public consultation, market research and societal analysis. The Natural Analogue community can contribute to such processes, but should not expect to determine them in isolation. A more realistic ambition could be to work with more easily accessible audiences, namely: the performance assessment community and communicators who may be seeking to facilitate debate about radioactive waste management generally. After all, if we cannot persuade colleagues within the radioactive waste community of the value of natural analogues, then why should we expect to convince the public(s) otherwise?

A. TECHNICAL QUESTIONS THAT PEOPLE WOULD LIKE TO BE ANSWERED

The following questions arose... Those coloured in yellow are examples of the sort of questions that people ask that could be answered with reference to natural analogues.

- Why does Nirex use stainless steel for its containers? Isn't lead a more effective means to contain radioactivity? Isn't titanium more resilient and longer lasting?
- Aren't the walls of the 500 litre drum too thin? Wouldn't they be easily damaged or pierced? Hasn't Nirex thought about making the walls thicker?
- Is cement effective as waste packaging and backfill? Is Nirex proposing to use normal cement from the local hardware store?
- Why has Nirex chosen 4 cubic metres as the size for a box? And why a 500 litre drum? Why not use a bigger container – or smaller?
- Why can't you just keep on repackaging the waste?
- Why would you ever need to repackage the waste? Why not get the packaging right in the first place?
- How do you put waste into a container without contaminating the outside of the container?
- Does conditioning produce more waste?
- Can I stand safely next to a container?
- Is anyone else testing and monitoring Nirex's specifications?
- Do Nirex staff visit the waste producer sites? Do they take the waste packages away and test them at Nirex's laboratories?
- Why do the waste packages need to be placed inside transport containers? Does this mean that the packages aren't adequate?
- Would a lorry carrying radioactive waste be given a police escort? Would the vehicle be marked or unmarked?
- Has a test crash been conducted on a transport container with actual waste inside? Is it possible that the impact of a crash would trigger some kind of reaction or explosion in the waste?
- Would transport containers be able to withstand a fire generated by aviation fuel?
- Why do the waste packages need to be taken out of the transport containers on arrival at the repository? If the containers afford an extra level of containment and protection, then why remove them?
- If the waste packages are safe, then why do workers need to be protected by shielded bays?

NAnet Project – WP4 Natural analogues in dialogue

- If the packaging is effective in containing the radioactivity, then why would there be any need to monitor contamination of the rail tunnel and vertical shaft?
- Is it more dangerous to have the waste distributed at different sites or to stockpile the waste in a single location? Does putting all the waste together increase the risk of an accident or explosion?
- Has an underground repository already been built? If yes, then why isn't it already being used? Is there a technical reason for needing to keep the waste packages on the surface for a few more decades?
- Where will the repository/repositories be built?
- How will you dig a hole big enough for a repository? Won't the earth on top of the repository be looser than before (because you've dug it up)? And won't that affect the ability of the geology to contain the waste?
- Has anyone ever built anything this far down? On this scale?
- What is the capacity of the repository?
- How many vaults are there going to be?
- How quickly will the vaults be filled up?
- What will be done with the additional waste that is generated in the future? (Based on an assumption that the proposed repository would only accommodate the waste that is currently in existence.)
- Is the repository a fixed size? Or can it be expanded to accommodate additional waste?
- How many repositories need to be built?
- Won't the weight of all the overlying rock crush the vaults and the containers?
- Will it be possible to close the repository immediately in an emergency situation?
- What would happen if there was a spillage in the contaminated areas? How would it be dealt with?
- What would happen if the overhead crane malfunctioned? How would it be retrieved and repaired?
- How would the waste packages be monitored? Would monitors be fitted on the inside or the outside of each container? If there was a leakage, would the monitors remain intact or would they be damaged by the radioactive materials?
- What are the 'acceptable levels' of radiation that workers would be exposed to? What does 'acceptable' mean?
- How do you decontaminate things?
- What happens to the water that is used to decontaminate things? Does it wash away into the wider environment?

NAnet Project – WP4 Natural analogues in dialogue

- Are you going to have a drift tunnel or a vertical shaft – or both? Why can't you decide which is best?
- Will you backfill everything (ladders, rooms, etc) – or just the vaults containing the waste packages?
- Would it be possible to retrieve the waste packages from the backfill?
- Can the repository be accessed after closure? Is anything ever really sealed and closed?
- Have you got enough cement to carry out all the necessary backfilling and the sealing of the repository?
- What would be the impact of earthquakes on the repository and the waste?
- Or the impact of shifting tectonic plates?
- Could the level of the land fall, so that the repository was no longer so deep underground after thousands of years?
- What are the implications of rising sea levels?
- How do scientists know how long a material will remain radioactive?
- Given that waste has only been generated for a few decades, how are scientists able to predict the waste's behaviour over the course of hundreds and thousands of years?
- How do scientists know how the materials of the barriers (for instance, the stainless steel canisters, the backfill cement) will interact with the radioactive waste over the very long term?
- How can scientists be sure that the materials won't behave differently once they're placed at deep levels?
- Once the repository has been closed, how will people know if there has been a leakage?
- Are you expecting that waste will eventually leak out of the containers?
- Is rock effective at stopping the spread of a leakage? How long does it take for radioactivity to travel through rock?
- If there's a leak underground, does the radiation go up or does it go sideways?
- How do you limit the spread of a leakage into the surrounding geology once it has started?
- What would be the impact if the radiation did leak to the surface?
- What impact will groundwater have on the vaults and containers?
- If you dropped a bomb on a storage facility, would there be a nuclear explosion?

NAnet Project – WP4 Natural analogues in dialogue

- Can you make a bomb from the waste? Can containers be turned into weapons?
- If there was an explosion or leakage, how far away would people need to be to be safe?
- What is going to be done with high level waste?
- What are the precise timescales for each phase?
- Would the repository take in other country's waste? Or are we just dealing with UK waste?
- What are other countries doing with their waste?

B. QUESTIONNAIRE

Below is the questionnaire that was sent out to all of the NAnet project group requesting them to pass on the most relevant staff within their organisations.

Questionnaire for users of analogue information

The NAnet project is a thematic network which brings together a partnership of 10 organisations who are either users or providers of analogue information. The overall aim is to promote more considered application of analogue information in safety assessments of radioactive waste repositories and for communication purposes.

This questionnaire has been drafted to provide input to the NAnet project in order to develop a better view on application of analogue information in the development of repository programmes. The NAnet project is being co-ordinated by Enviros Consulting. Please see the NAnet website at:

<http://www.enviros.com/zztop/nanet/nanetmain.htm>

The purpose of this questionnaire is to ask about your personal understanding of analogues and their place in radioactive waste management, as well as obtaining your recent experiences of using analogue information. This questionnaire is being sent to you by an appropriate NAnet partner member, please pass onto any of your colleagues who would be relevant to complete it as well. All responses will be strictly confidential.

There are 12 questions. Please provide as much information as you are able. We are happy to accept typed or hand-written responses on paper, or electronic replies.

The feedback from this questionnaire will be treated as non-attributable information and the various views will be compiled to appear as a chapter or appendix of the final report for the NAnet project.

If you have any concerns or comments on the questionnaire please contact either John Dalton or the NAnet partner member who sent it to you.

Please send your reply, by 27th February 2004, to John Dalton (UK Nirex Limited, Curie Avenue, Harwell, Didcot, OX11 0RH, UK. Tel. +44 1235 825500; fax +44 1235 825469; or email john.dalton@nirex.co.uk).

General

1. What main area does your job cover? (Please tick or circle as appropriate)

Performance assessment modeller

Communication function

Site characterisation

Other, please describe

2. What is your main discipline

Engineer

Geologist

Physicist

Chemist

Mathematician

Other, please describe

3. Does your job explicitly make use of analogue information in safety assessments and elsewhere, or does your position require a consideration of analogue information?

Yes No Don't know

Please explain

4. How would you rate your knowledge of:

a) in terms of extent of the existing literature

High Medium Low

b) potential for using field studies or anthropogenic examples – even if not explicitly identified as analogues

High Medium Low

5. What do you understand by the term 'analogue'?

6. In developing an assessment, do you use analogue information in the following:

a) considering Features, Events or Processes	Yes	No	Don't know
b) developing conceptual models	Yes	No	Don't know
c) parameterisation of models	Yes	No	Don't know
d) evaluating uncertainties	Yes	No	Don't know
e) interpretation of results	Yes	No	Don't know

7. What do you consider to be the strongest and weakest uses of analogue studies in a repository assessment programme?

8. What do you see as the most important limitation of using analogues in a repository assessment programme?

9. Does this limitation put you off using analogues in a repository assessment programme?

Analogues in recent PA/safety cases or communication

10. Have you recently used analogues in any assessment work or in preparing a safety case or in a communication exercise? If so, which analogues did you use and in what way?

11. Do you think analogue information is used to best effect in PAs or when producing safety cases or in communication exercises? If not, how would you envisage improvements?

Possible Future Developments

12. NAnet is seeking to establish an international library (electronic database) of analogue information that would be available to everyone via simple look-up tables.

NAnet Project – WP4 Natural analogues in dialogue

a) Do you consider the critical reviews of the analogue studies being written and presented in this way as potentially useful? [See an attached example for the Kronan Cannon study.].

b) Could it be improved?

Please provide any additional information or comments which you feel might be useful in this exercise. Thank you for your help.

C. ANALYSIS OF RESPONSES TO THE QUESTIONNAIRE

The following table provides an analysis of the responses received. However, as only a few (10) responses were received statistically significant results cannot be reached, but a qualitative conclusion can be made.

Question				
1. What main area does your job cover?	Performance Assessment Modeller	Communication Function	Site Characterisation	Other
	50%	10%	30%	10%
2. What is your discipline?	Engineer	Geologist	Physicist	Chemist
	20%	40%	0	40%
3. Does your job make use of analogue information in safety assessments and elsewhere?	<i>Yes</i>	<i>No</i>	<i>Don't Know</i>	
	80%	20%	0	
4. How do you rate your knowledge of existing analogues?	<i>High</i>	<i>Medium</i>	<i>Low</i>	
a) In terms of the existing literature?	10%	70%	20%	
b) Potential for using near field studies of anthropogenic examples?	10%	70%	20%	
5. What do you understand by the term 'analogue'?				
6. Do you use analogue information in the following?	<i>Yes</i>	<i>No</i>	<i>Don't Know</i>	
a) Considering features, events or processes	60%	20%	20%	
b) Developing conceptual models	50%	10%	40%	
c) Parameterisation of models	50%	30%	20%	
d) Evaluating uncertainties	40%	40%	20%	
e) Interpretation of results	70%	10%	20%	
7. What do you consider the strongest and weakest uses of analogue studies in a repository assessment programme?				
8. What do you see the most important limitation of using analogues in a repository assessment programme?				
9. Does this limitation put you off using analogues in a repository assessment programme?	<i>Yes</i>	<i>No</i>	<i>Don't Know</i>	
	20%	70%	10%	
10. Have you recently used analogues in any assessment work or in preparing a safety case or communication	<i>Yes</i>	<i>No</i>	<i>Don't Know</i>	
	30%	60%	10%	

NAnet Project – WP4 Natural analogues in dialogue

exercise?				
11. Do you think analogue information is used to best effect in Pas or when producing safety cases or in communication exercises?	<i>Yes</i>	<i>No</i>	<i>Don't Know</i>	
	10%	50%	30%	
12. NAnet is seeking to establish an international library (electronic database) of analogue information that would be available to everyone via simple look-up tables	<i>Yes</i>	<i>No</i>	<i>Don't Know</i>	
a) Do you consider the critical views of the analogue studies being written and presented in this way potentially useful?	100%	0	0	
b) Could it be improved?	60%	30%	10%	