

Local Communities' Expectations and Demands on Monitoring and the Preservation of Records, Knowledge and Memory of a Deep Geological Repository

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While official responsibility for the preservation of records, knowledge and memory must remain with institutions, it is likely that local communities do or will have an important pragmatic role in maintaining the memory of a repository, e.g., by engaging at some level in its continued oversight. Monitoring – by collecting, interpreting and keeping data on a continuous basis – serves the purpose of preserving records, knowledge and memory. The present study report explores the role, needs and expectations of local communities regarding monitoring and RK&M preservation of radioactive waste management (RWM) facilities, in particular deep geological repositories. As a contribution to the RK&M project of the NEA and as part of its own programme of work, the FSC performed two short surveys (11 countries) and conducted interviews with a variety of stakeholders (seven countries) in 2012-13. This report will interest those responsible for the safety of future repositories, local communities who may consider hosting them, and scholars and historians of the governance of radioactive waste management.

Please note that, for technical reasons, the format of this document has been modified. However, the content of the report remains unchanged.

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Local communities' expectations and demands on monitoring and the preservation of records, knowledge and memory of a deep geological repository

Executive summary

Rationale

The OECD Nuclear Energy Agency (NEA) Radioactive Waste Management Committee (RWMC) Project on "[Preservation of Records, Knowledge & Memory across generations \(RK&M\)](#)" (2011-2014) explores and aims to develop guidance on regulatory, policy, managerial, and technical aspects of long-term preservation of records, knowledge and memory of deep geological disposal facilities (NEA, 2011a). While official responsibility for the preservation of records, knowledge and memory must remain with institutions, it is likely that local communities do or will have an important pragmatic role in maintaining the memory of a repository, e.g., by engaging at some level in its continued oversight (NEA, 2008b). Monitoring – by collecting, interpreting and keeping data on a continuous basis – serves the purpose of preserving records, knowledge and memory. The present study report explores the role, needs and expectations of local communities regarding monitoring and RK&M preservation of radioactive waste management (RWM) facilities, in particular deep geological repositories.

Another NEA RWMC Working party, the [Forum on Stakeholder Confidence \(FSC\)](#), contributed to this international project from its particular perspective of building a sustainable relationship between a facility and its hosts. The FSC has observed that both monitoring and memory preservation are high – or emerging – on local stakeholders' agenda, and these topics are also of interest in the FSC programme of work.

As the concept of oversight is elaborated (cf. ICRP, 2013), it is useful to examine current stakeholder views on monitoring and RK&M preservation as part of the oversight function.

Methodology

A questionnaire survey of FSC members was undertaken in July and August 2012. Replies were received from 11 countries. The *ad hoc* survey was considered to be illustrative and did not aim to be representative. It was followed up by structured interviews with a range of involved stakeholders from both national and local levels, for a total of 25 individuals from seven countries. The survey and interview guide are provided in annex and the interviewees are identified.

In addition, a literature review was carried out, focussing on FSC publications and other documents and publications found through internet or suggested by interviewees.

A brief update survey, formulated according to the structure of the original survey, was performed in August and September 2013. A subset of FSC countries contributed.

Findings

According to survey, literature and interview findings, there is relatively little work or guidance on how monitoring might contribute to the creation and preservation of RK&M and to what extent local communities might play a role in this process, as part of a general oversight approach. This report therefore can provide input to this debate and provide examples of initiatives or dialogues undertaken in this field. As per usual NEA practice, this report does not offer a prescriptive plan. Instead, it provides a first international glance into how the concepts of RK&M, monitoring and oversight are considered by local communities.

The study reveals that local stakeholders have an interest in monitoring and RK&M preservation in RWM facilities. Local stakeholders would like to know how monitoring will take place and which processes it is important to monitor and why. In addition, local communities recognise that monitoring should be undertaken in the early stages of the siting procedure and might be continuously refined and may not end with the closure of the facility. The nature and extent of monitoring required by local stakeholders depends on their understanding or definition of monitoring.

Broad target areas of interest for monitoring include environmental impacts and socio-economic factors, as well as health (in a minority of contexts).

Throughout the report, examples are given from specific national situations with some being analysed in detail. Substantial information is provided from Sweden, France and US and to a lesser extent from Canada, UK and Finland. These are the countries that have more advanced repository programmes, or in which these issues have been discussed to some degree, formally or informally, with local stakeholders. It is noticeable that while countries like Czech Republic or Spain have a lively tradition of highly active local stakeholders, they do not, so far, report demands from the local level on issues related to monitoring and preservation of memory.

The interviews revealed that while monitoring in the different operational phases of the repository lifetime has been a subject of debate at the local level in most countries, by contrast RK&M preservation is an emerging topic. In general, monitoring and RK&M appear to be regarded by local stakeholders as separate topics, and data (or more broadly, record) keeping in the context of monitoring is not identified as a prerequisite for the preservation of memory and knowledge for future generations. The interviews seem to demonstrate the need to explore and discuss with the concerned stakeholders how oversight of the disposal facility will be performed, how its governance should be conceived, and how oversight may evolve over repository life cycle phases.

The findings suggest that at present, the interpretation of the examined concepts may be specific to a country or a site. These concepts may evolve over time and may also have different meanings depending on who defines them. Clarification and common understanding may need to be developed through consultation among national and local level stakeholders. The process of reflecting on these concepts may already help different stakeholders to elaborate their meaning and may help engage the community in discussing their role and expectations in monitoring and preserving RK&M.

As countries advance in the implementation of underground repositories, the extent to which local communities can contribute to maintaining the memory of a repository will remain a subject for discussion and development in the next years. Local communities may seek participation in continued oversight as a means of building and sustaining their confidence in safety. However, this interest is often not specific enough to define critical aspects to be monitored nor over which time scales. Further research to identify both how monitoring could contribute to confidence in geological disposal, and how local communities in different national contexts may be involved in oversight activities could consolidate understanding of roles, demands and expectations.

Specific concerns and expectations on RK&M emerge as siting draws near, and are clearly on the agenda in countries that in 2012-13 are undergoing a licensing phase. So far, informal and formal discussions have been on-going in several countries regarding the best way to pass knowledge on to future generations. This brings us to the useful concept of oversight as “keeping an eye” on the repository system and on the implementation of decisions (ICRP, 2013; Pescatore et al., 2013). Oversight can provide a useful conceptual framework that embraces long-term monitoring and preservation of RK&M. Oversight can be exercised not only through technical parameters and administrative provisions but also through monitoring agreements made with the local hosts and other stakeholders. The decisions on the levels and evolution of oversight would be based on various factors, like the degree of confidence in the behaviour of the facility, societal, economic factors, etc. Being aware of the views of the implementer, the regulator and the concerned stakeholders over these issues may provide further insights on the nature and role of oversight of geological disposal. As stated by ICRP (2013), “decisions related to the organisation and evolution of the oversight should be discussed with the stakeholders”.

Introduction

The OECD Nuclear Energy Agency (NEA) Radioactive Waste Management Committee (RWMC) Project on “[Preservation of Records, Knowledge & Memory across generations \(RK&M\)](#)” (2011-2014) explores and aims to develop guidance on regulatory, policy, managerial, and technical aspects of long-term preservation of records, knowledge and memory of deep geological disposal facilities (NEA, 2011a). While official responsibility for the preservation of records, knowledge and memory must remain with institutions, it is likely that local communities do or will have an important pragmatic role in maintaining the memory of a repository, e.g., by engaging at some level in its continued oversight (NEA, 2008b). Monitoring – by collecting, interpreting and keeping data on a continuous basis – serves the purpose of preserving records, knowledge and memory. As the concept of oversight is elaborated (cf. ICRP, 2013), it is useful to examine current stakeholder views on monitoring and RK&M preservation as part of the oversight function.

Another NEA RWMC Working party, the [Forum on Stakeholder Confidence \(FSC\)](#), contributed to this international project from its particular perspective of building a sustainable relationship between a facility and its hosts. The FSC has observed that both monitoring and memory preservation are high – or emerging – on local stakeholders’ agenda, and these topics are also of interest in the FSC programme of work.

Local communities are recognised as key stakeholders in radioactive waste management. The working definition of “*stakeholder*” adopted by the FSC is “*any actor – institution, group or individual – with an interest or a role to play in the radioactive waste management process*” (NEA, 2013). The present report, prepared by the FSC, will focus on local communities as representatives of a societal group whose members reside in a specific locality and share a government and often have a common cultural and historical heritage (*ibid*). Related terms also used are civil society, local stakeholders or actors.

This report explores the role, needs and expectations of local communities regarding monitoring and RK&M preservation of radioactive waste management facilities, in particular deep geological repositories. It was developed through both field and desk research. A questionnaire survey to FSC members was undertaken in July and August 2012, followed by interviews with a broad range of involved stakeholders. A brief update survey in August and September 2013 gathered replies from a subset of countries. A literature review was carried out, focussing on FSC publications and other documents and publications found through internet or suggested by interviewees.

Organization of the report

After a brief presentation of the study rationale and methodology in section 1, section 2 reviews the FSC literature on aspects related to RK&M and monitoring. In section 3 the report identifies concerns and expectations of local communities regarding monitoring in the different phases of the repository life cycle and in the different national contexts, according to the results gathered from the survey and interviews undertaken as part of this project. The fourth section discusses how RK&M preservation may emerge as a subject of debate with local stakeholders in different countries in the years to come. Section 5 recognises that monitoring and RK&M preservation potentially serve to build and maintain confidence in the long-term safety of deep geological repositories. Finally, the concept of *oversight* is considered in section 6 as a term that embraces monitoring and RK&M, and its interpretation in different reports is illustrated. Final reflections, with some conclusions, are provided in section 7.

Four appendixes are offered. Appendix I summarises in a table the design features of a radioactive waste management facility that may help the memory of the site to be preserved over generations, as suggested in NEA (2007). Appendix II reports statements related with monitoring and RK&M preservation in the reviewed FSC literature. Appendix III includes the online survey questions as well as the interview guide. Finally, Appendix IV acknowledges the authors, reviewers and especially the stakeholders who provided detailed input for this report.

1. Rationale and methodology

While official responsibility for the preservation of records, knowledge and memory must remain with institutions, local communities likely do have an important pragmatic role in maintaining the memory of a repository. The most advanced programmes for implementing geological disposal facilities for radioactive waste, like those in France, Sweden and USA, have produced some discussions, formal or informally, around the contribution of local stakeholders to monitoring and memory preservation. The FSC (NEA, 2010b) listed tools by which local stakeholders may contribute to maintaining memory, such as land registers, markers, oral history, added value features or development of the culture of memory in institutions and territories. In the present study and report, the focus is on the position of local communities regarding the preservation of knowledge and memory of a radioactive waste management (RWM) facility particularly through the tool of *monitoring*, and how this may affect confidence in RWM. The rationale behind the present study as an FSC contribution to the OECD NEA RK&M initiative is that alongside its other functions, monitoring – by collecting, interpreting and keeping data on a continuous basis – serves the purpose of preserving records, knowledge and memory.

Local communities are interested in discussing information preservation, monitoring, knowledge management and memory as “control” measures that increase safety (Pescatore, 2010). The FSC has documented in various topical sessions and study reports the ways in which local communities can contribute to the preservation of records, knowledge and memory. More extensively, the issues of environmental monitoring and memory were considered in the national workshop held in Bar-le-Duc (France) in 2009 (NEA, 2010b). Round-table discussions served to explore the ways in which local communities can contribute to monitoring and to maintaining the memory of the repository.

In July and August 2012, a brief online survey was conducted with members of the NEA Forum on Stakeholder Confidence on monitoring and preservation of records, knowledge and memory. The aim was to identify local communities’ position on the preservation of knowledge and memory of radioactive waste management facilities, notably to learn if this is a high-profile subject among involved local stakeholders. The ad hoc survey was considered to be illustrative and did not aim to be representative. Replies were received from 11 countries, submitted by individuals from 17 organisations, including regulators, implementers and governmental institutions, whose role brings them into close contact with local stakeholders. The countries, organisations and number of responses (in brackets) received to the survey were: FANC from Belgium (1), RAWRA from Czech

Republic (1), POSIVA from Finland (1), ANDRA from France (1), PURAM from Hungary (1), SOGIN from Italy (1), ENRESA from Spain (1), SKB, SSM and the Swedish National Council for Nuclear Waste in Sweden (3), SFOE from Switzerland (1), NDA and Environmental Agency for the United Kingdom (2) and DoE, NRC, EPA in the United States (4).

The 2012 online survey determined whether the respondent's national program involved specific local communities, or if only general information pertinent to local or civil society stakeholders could be shared. Then it asked whether local communities request monitoring of (future) RWM facilities, and if so in which domains and on which time scales (or in regard to which repository life cycle phases). The survey also asked whether communities showed interest in extended memory of a facility, and whether the national-level actors acknowledged a role for local communities in monitoring and RK&M preservation. The survey questions are reproduced in Annex III. (The 2013 update survey repeated the same questions, and asked if anything new could be reported.)

In addition, twenty-four interviews were conducted with representatives of implementers, regulators, governmental agencies and local stakeholders from seven countries. Their input complemented the survey data on local communities' demands and confidence in monitoring and the preservation of RK&M. The interview guide too is found in Annex III.

2. Review of FSC findings on monitoring and RK&M preservation

The FSC organises an international exchange of experience through annual meetings including topical sessions, national workshops and community visits, and desk studies. All of these are documented and the resulting literature is available online at the FSC website, www.oecd-nea.org/fsc/. The present section summarises the experience of the FSC with regard to monitoring and memory¹ preservation. Continued monitoring, information preservation, knowledge management and memory are all issues that figure partially in the main body of work produced by the FSC. Three reports, mentioned in Box 1, stand out in their exploration of the role and expectations of local communities in monitoring and the preservation of RK&M.

Other FSC documents also record an interest of local communities and stakeholders in monitoring, transferring knowledge to future generations and keeping the memory of the site. National examples too are drawn in this section from topical sessions and workshops where monitoring and memory preservation have been addressed. Beyond the FSC literature, a desk study was undertaken to analyse whether and how local stakeholders are involved in debating monitoring and record keeping in the context of radioactive waste management facilities and more specifically, geological disposal.

¹ As the FSC has traditionally considered “memory” issues, this expression is used in our literature review, whereas a broader field of definition is highlighted by the more recent NEA initiative “Preservation of records, knowledge and memory” or RK&M.

Box 1. Principal FSC documents addressing monitoring and memory preservation

a) *Fostering a Durable Relationship Between a Waste Management Facility and its Host Community. Adding Value Through Design and Process (2007).*

This report largely deals with the themes of preserving RK&M. It highlights the value of cultivating a positive long-term relationship between a waste management facility and the host community through partnership arrangements from the design phase of the facility as the basis for durable memory. The facility requires a physical site and will impact in a great variety of ways on the surrounding community from decades to centuries. For this, the societal durability of an agreed solution is essential for a successful relationship between the facility and the community. This relationship supports the quality of life and enables the community to assume a “guardianship” role.

The report identifies a number of design elements (i.e. functional, cultural and physical features) that favour a durable relationship between the facility and its host community by improving prospects for quality of life across generations and preserving site memory. One of the suggested cultural elements is memorialisation. Interactive museums, communication or interpretative centres can preserve knowledge and be durable markers of what the site is and why it is there. Annex I of the present document summarises a number of proposals that have been made for local communities to be involved in active oversight and local stewardship (NEA; 2008b).

c) *France Workshop and Community Visit to Bar-le-Duc in 2009 (NEA, 2010b).*

In this report the issues of monitoring and memory are abundantly considered, together with retrievability and reversibility. The section on “environmental monitoring and the issue of memory” reviews how Andra, CLIs and mayors address these concepts. Round-table discussions served to explore how local communities in different countries can contribute to monitoring and to maintaining the memory of the repository. Useful considerations from the local stakeholders’ viewpoints are summarised in the present report in Annex II.

b) *More than Just Concrete Realities: The Symbolic Dimension of Radioactive Waste Management (NEA, 2010a).*

This report partially touches upon the issues of memory preservation using symbols. Concepts like safety, reversibility or land, for example, draw on the connotations for future generations. Future generations should be able to become guardians of RWM facilities through their

In the FSC reports listed in Box 1 and other relevant FSC documents, the main findings may be summarised as follows.

a) Local communities’ monitoring concerns and expectations

The FSC recognises the importance of monitoring potential impacts involved in the different phases of the implementation of radioactive waste management facilities - the feasibility study phase or recording the baseline situation prior to construction, construction, operation phase or

post-operational phase. Changes in quality of life – meaning physical, psychological and social well-being - over the phases of a facility project should be monitored (NEA, 2004c).

In Hungary the concept of “social control” is understood as the active participation by members of civil society in the technical monitoring of activities (NEA, 2009). Each municipality carries out monitoring and control of nuclear facilities. In both of the low and intermediate level waste repositories (at Püspökszilágy and in Bábaapáti) and in the Interim Spent Fuel Storage facility in Paks trained municipal groups perform regular control of incoming materials and carries out other measurements. In addition, also local group will be trained to perform this monitoring in the future high level waste repository near Boda.

The workshop in Bar-le-Duc (NEA, 2010b) revealed that monitoring is a key issue, mainly regarding environmental concerns, to ensure safety and guarantee transparency. In some countries, like in France, health concerns are crucial. The Local Information and Oversight Committee (CLIS) attached to the Bure underground laboratory expressed a strong interest in monitoring the epidemiological status of the local population (in the perspective of a possible future deep repository at the site). However, specialists indicated that establishing a methodology and meaningful baseline measures was not feasible, given the low population density of the local area. Apart from health impacts, monitoring socio-economic variables, like property values or economic development, was also considered important by local stakeholders. For local communities in France, it is not sufficient that the implementer and the regulator undertake monitoring tasks. Like the CLIS, the Local Information Committee (CLI; one is attached to each nuclear installation) is an extremely relevant actor with the ability to identify pertinent questions and engage independent expertise. Thus, becoming involved in monitoring has benefits, like learning and fostering confidence. In addition, it enables the committees to feed the information to everyone in the community and to contribute to monitoring, if they want to. Nevertheless, the need to institutionalise monitoring is crucial, i.e. provide resources, establish a legal framework, etc.

There are two aspects where local communities in different countries have different viewpoints: the level of involvement of local stakeholders in monitoring and who interprets monitoring results. On the former, some communities want to be actively involved in monitoring whilst others just want to know the results but not monitor by themselves. In the case of Canada, Sweden, UK and the USA, FSC workshop delegates in Bar-le-Duc were of the opinion that communities did not want to monitor by themselves but want to know whether results fit with early safety and environmental assumptions. This raises a point which will be addressed also later in Section 5 and refers to taking responsibility for participating in monitoring activities. On the latter (i.e. who interprets monitoring results), Swedish communities think that environmental courts and EIA procedures are sufficient to interpret monitoring results, whereas in France, independent auditors or specific monitors, chosen by local communities, are seen to be most adequate. French local communities point not only at the role of regulators or independent bodies in performing monitoring on baseline conditions but also the CLIs for confidence building. The role of the regulatory body seemed clear and authoritative in all these cases.

b) Local communities and memorialisation

Memorialisation is understood as a cultural feature, meaning that both physical and cultural measures are taken to mark the site and tell its story, so that people will grasp and remember what is there (NEA, 2007). The artist Cécile Massart underlines the importance of archiving information for the future and marking repository sites or facilities through symbolic, artistic means (*ibid*). It is important to preserve the memory of disposal, not just for safety reasons, but also because radioactive waste has unique societal significance (NEA, 2010a). In this way, a relationship can be established between the community and the facility. Massart suggests multiplying the means through which a visitor may approach and form a relationship with the repository site. Considering the experience with memorialisation in the World Heritage programme may be helpful for conceiving and designing waste management facilities whose memory needs to be preserved. It might be possible to associate the inclusion criteria of monuments identified for protection by the UNESCO World Heritage Commission (e.g. testimony to a time and place associated with significant ideas, beliefs, events, etc) with values that a local community and society attach to the repository project (such as artistic, historic, social and scientific dimensions) (NEA, 2007).

Within the FSC, there is an interest to understand how to develop a stewardship process, how to conceptualise a '*rolling present*' in which each generation takes responsibility to ensure continuity and safety for the succeeding several generations, including a need for flexibility and adaptability to circumstances as they change. For this, the role of local communities is crucial for maintaining the memory of the site, once the period of institutional monitoring is over (NEA, 2010b). Local communities can even build their own new markers to replace old ones that have become obsolete or are fading away (Pescatore and Mays, 2008). One of the solutions for memory preservation, as identified by the STORA partnership in Belgium, is to build a radioactivity theme park or a nuclear clearing house to promote knowledge and awareness of nuclear energy and waste.

As put forward in NEA (2008a) recent generations can carry out duties that reasonably can be performed, while transferring others to subsequent generations, along with resources needed to fulfil them. This means that the stepwise decision-making appears to be the only feasible way to proceed (*ibid*). The features of the stepwise approach to decision-making allow stakeholders to gain familiarity with technical options and institutions and therefore, to build confidence in the safety and trust in the institutions managing waste.

Andra recognised that maintaining exchanges with the local public, and in particular with the CLI, is crucial for an active memorialisation of a site, since markers may not be readable in the future (NEA, 2010b). The term 'living history' was also suggested to maintain the memory of a repository composed by records based on local experience, communal archives, like photos and written material (*ibid*). Future generations can become guardians of these facilities through political and economic partnerships as well as by integrating the facilities socially and scientifically in their environment (NEA, 2011b).

Apart from being able to transfer knowledge to future generations, it is also important that it is understandable (Pescatore and Mays, 2009). At WIPP for instance, scientists claimed that a message will not be understood the same way as society evolves and therefore, maintaining meaning is one challenge in maintaining information (Pescatore, 2010). It is important that there is a strategy to maintain awareness of the repository and one simple way to do that maybe through using maps (Pescatore and Mays, 2009). Also pictorial record is needed in case words are lost (NEA, 2010c). Nevertheless, it should be borne in mind that symbols and icons may not be readable after some generations and we do not necessarily understand what is being communicated (*ibid*). Thus, the “notion of stability in time has also a symbolic component” since “to build ‘forever’ is often interpreted to mean building as soundly as possible and then adapting ‘as the need arises’” (NEA, 2008a).

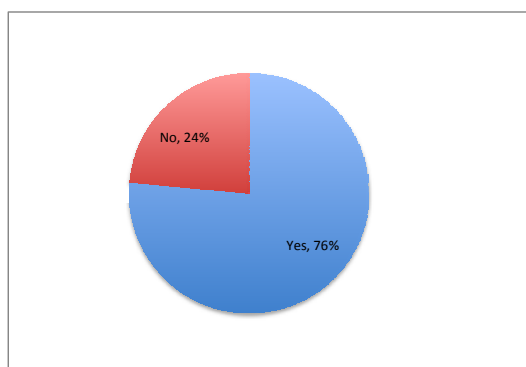
The issue of archives and markers for geological disposal is important. The recording technology when dealing with large timescales should be as basic as possible (Pescatore and Mays, 2008). Physical markers and archives may be complemented by - or integrated within - a cultural tradition that could be sustained over time starting with the planning of a repository and continuing through its implementation and beyond its closure. Because a radioactive waste management repository and site will be a permanent presence in a host community for a very long time, a fruitful, positive relationship must be established with those residing there, now and in the future. The challenge is to design and implement a facility (with its surroundings) that is not only accepted, but in fact becomes a part of the fabric of local life (Pescatore and Mays, 2009). Hence, marking the facility can also be a means to add not only cultural but also amenity value to preserve the site over many generations into the future (NEA, 2007). However, markers may not only attract people to the facility for memory purposes but intrusion (unintentional and deliberate) should also be contemplated (NEA, 2010c).

In some countries, monitoring and memory preservation are jointly considered with the topic of reversibility and retrievability. In France, for instance, monitoring and human presence over several hundred years is mandated by law and will be further specified in the Reversibility Act by 2015. Monitoring is considered important to enable reversibility, as pointed out by Mr. Krieguer from Andra in the Bar-le-Duc workshop, as it provides essential information on the engineered facility and its performance (NEA, 2010). Monitoring also allows the implementer to periodically re-examine reversibility, apart from contributing to safety and security (Aparicio, 2010).

3. Concerns and expectations on monitoring expressed by local communities

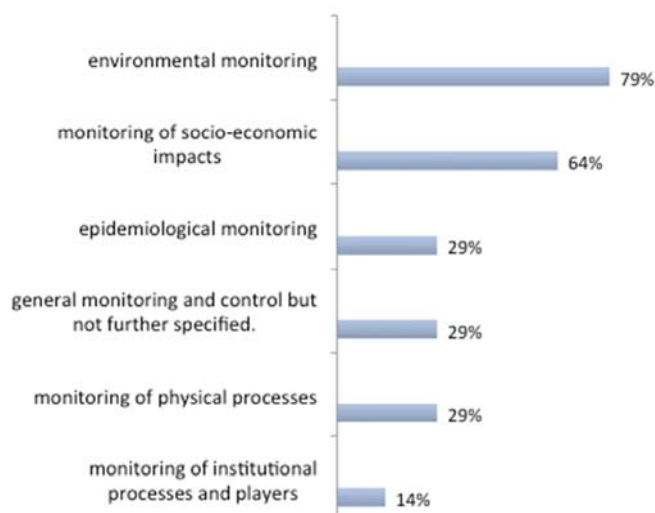
The survey results and the interviews undertaken for this study found that local communities have concerns and expectations on monitoring over the different phases of a facility project, prior to construction, operation and post-operational periods, even if these concerns are often vague and ill-defined. Slightly more than two thirds of the survey responses indicate that local communities ask for monitoring of RWM facilities (Fig. 1). In countries like Hungary or Finland, the respondent assessed that local communities did not demand monitoring of RWM facilities. In other countries, it was noted that demands were not clear at the current stage of the RWM programme.

Figure 1. *Local communities' demand for monitoring of RWM (according to FSC members in 2012 survey; 17 respondents)*



In most countries, monitoring demands refer to environmental monitoring in the first place and then to monitoring of socio-economic impacts. Epidemiological monitoring is considered by less than one third of respondents whilst monitoring of institutional processes and players is seldom requested (Figure 2).

Figure 2. Areas in which local communities demand monitoring of RWM facilities (according to FSC members in 2012 survey; 17 respondents)



In some cases, local communities are not asking today for a specific topical area to be monitored, but according to an interviewee, all areas are likely to feature on the agenda if and when a decision is taken to commit to next stages of the RWM programme.

The following sub-sections identify the main concerns and expectations in the pre-operational, operational and post-operational periods². When considering long-term, different **time scales** can be used, from several decades (to transfer information to succeeding generations for managing decisions), one to two centuries (referred to actual operations and continuous data checking and re-certification of data and licenses) or a few centuries for memory keeping and reviews of license. Pescatore (2010) states that *“in order to achieve the long-term objective we must focus on the timescale for transferring the information and knowledge to the next generation in a way that it does not foreclose their options for managing it in turn, which we characterise as a timescale of the order of 30 years”*. A plan for thousands of years is not credible, and therefore, it is important to think short to medium term (from generation to generation) in order to prepare the long-term.

The distinction between different timescales is not clear-cut when trying to assess stakeholders' concerns and expectations on monitoring. Rather, we argue that monitoring is recognised as a long timescale activity that needs to be undertaken early on and will continue far in the future. Nevertheless, in order to better structure the information on monitoring concerns and

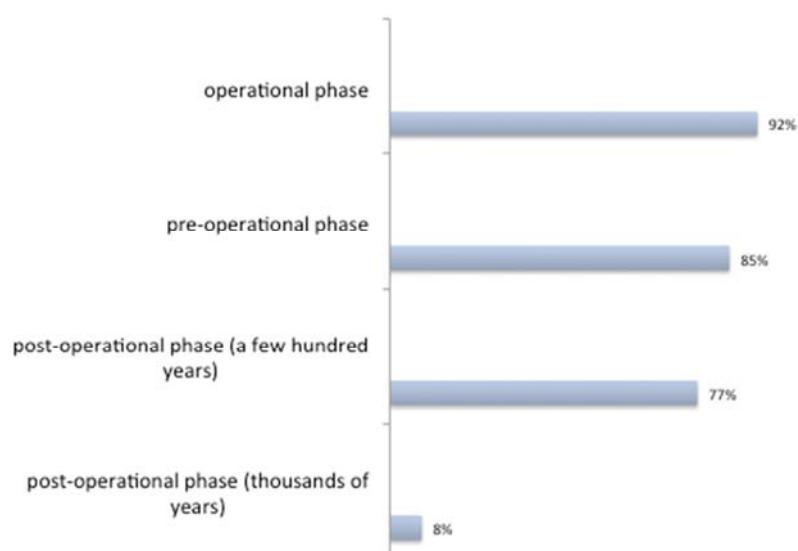
² These are the three basic phases for the development of a geological repository from a safeguards perspective (IAEA, 2010).

challenges, we separate between “pre-operational and operational phases” and “post-operational phase”.

Concerns and expectations in the pre-operational and operational phases

In this section, the concerns and expectations of local communities regarding monitoring in the pre-operational and operational phases are described. The results presented in this section rely on the written survey, desk studies and interviews. When we asked in the survey on which time scales monitoring is demanded, the respondents assessed that most demands focus on the pre-operational and operational phases (Figure 3).

Figure 3. *Time scales for local demands on monitoring of RWM facilities (according to FSC members in 2012 survey; 17 respondents)*



The following sub-sections deal with three research strands. Firstly, in some countries, like Sweden and Canada, local stakeholders have been recently involved in discussions where monitoring has emerged as an issue. Secondly, in other countries (US, France, Hungary), monitoring initiatives have already been undertaken in the pre-operational phase (Yucca Mountain, WIPP, the Bure Underground Research Laboratory in France) and operational phase (WIPP, Bataapáti, Püspökszilágy and Paks) mostly in the area of environmental and technical monitoring.

For instance, in Hungary, at the Paks plant, at the Püspökszilágy repository, and in Bataapáti repository trained municipal groups perform technical monitoring activities. They received training, on their own request, to regularly perform direct control incoming materials and carry out other measurements (NEA, 2009).

Finally, other areas of concern for monitoring purposes include socio-economic and institutional monitoring.

a) Monitoring as an emerging issue for local communities

In Sweden, little attention has been paid to monitoring until recently. It is a fairly new topic that is emerging. According to interviews with Swedish representatives, there is not yet any relevant documentation on this specific topic from the point of view of the local level. However, the issue of monitoring is among the issues that have been raised as part of the review of SKB's application for a geological repository. Stakeholders have identified aspects that they consider ought to be elucidated in the material submitted as part of the application, including the issue of monitoring (Östhammar municipality, 2012; Riksarkivet, 2012; Swedish National Council for Nuclear Waste, 2012a). At the local level, Östhammar municipality reviewed SKB's licensing application to construct a deep geological repository in the municipality during 2011 and spring 2012. . Among the important statements from the municipality's review comments is "Today, there is no legal demand on monitoring, however, there could be a demand in the future. Therefore the municipality feels that it is necessary that SKB present which preparations they have made if monitoring becomes a legal demand." (Östhammar municipality, 2013; Soderblöm, 2013).

The need to monitor conditions during the operating period in sealed parts of the repository to ensure that they evolve in accordance with the assumptions in the safety assessment, has been a topic of discussion in Sweden, i.e. the process between the initial state and the target state (that is expected to prevail for the rest of the pre-closure period). This issue was first raised by the National Council (Swedish National Council for Nuclear Waste, 2012b) and has thereafter been raised by other stakeholders (Östhammar municipality, 2012).

The municipality wants "to ensure that there will be equally high quality assurance throughout the whole process, from construction to operation and closure. This includes monitoring as well" (Östhammar municipality, 2013). A representative from Östhammar municipality reported in interview that "there is a common feeling in the community that monitoring may be necessary. If something is dangerous, people feel you need to monitor this. [...] We need to be prepared as these issues may arise in the future or later in the process". For this reason, several representatives of local communities from Sweden and the UK have been involved both in the MoDeRn project and in the RK&M project, namely to learn how oversight and monitoring can be prepared. According to Erik Setzman from SKB, the interest for the subject of monitoring is slowly increasing, especially the need for post-operational monitoring (personal communication, 2013).

Similarly to the Swedish case, in Canada, participants in the dialogue workshops held to develop a management approach for the long-term care of used nuclear fuel, requested to NWMO the need "to elaborate on the nature and extent of monitoring envisioned in the implementation of the Adaptive Phased Management approach" (NWMO, 2005). Participants considered that monitoring is important for the following reasons:

- to ensure long-term protection of human and ecological health;
- to provide the public with assurances that the facility continues to be safe;

- to allow future generations to measure and assess their stewardship over the used nuclear fuel;
- to allow for continuous learning and provide well-informed decision-making; and
- as a precondition for future retrieval of the material, regardless of the intended purpose (NWMO, 2005).

During the dialogue activities conducted throughout 2009 to help design the process to identify a location for a repository, questions on the monitoring aspects of adaptive phased management were raised: how will monitoring be conducted to ensure safety, how long will this monitoring extend, and how will the community be involved. In its response, NWMO states that “decisions about detailed plans for how monitoring is to be implemented at the site will ultimately involve the host community in order to address their concerns and preferences, as well as others including regulatory authorities” (NWMO, 2009a). Later on, as part of the engagement activities of NWMO in 2012, the issue of long-term monitoring is again raised as part of the questions posed about nuclear security. Some participants were interested to learn how the monitoring system would be managed, for how long into the future it would be operational, the role of the local community regarding input on monitoring and if it would continue after decommissioning and closure of the facility (NWMO, 2012).

In France, monitoring is one of the key themes identified by ANCCLI (the national federation of Local Information Committees and Commissions), CLIS de Bure and IRSN (France’s technical support organisation) in the framework of their “technical dialogue on intermediate and high level long-lived radioactive waste”. This initiative launched in 2012 by the three actors sought to identify the main challenges associated with the decision-making process regarding these categories of waste, as well as to anticipate key issues that could arise during the 2013 public debate on the “Cigéo” project (the proposed industrial implementation of a deep repository in Meuse/Haute Marne) or regarding subsequent development of the French geological disposal programme. Apart from the themes on “radioactive waste inventory”, “storage versus disposal and reversibility”, questions on the theme of “safety, radiological protection and environmental and health monitoring” have been raised to be further investigated. Hence, monitoring over the different phases of the repository cycle and memory preservation are current topics of concern by local stakeholders.

b) Environmental monitoring and epidemiological studies

The interpretation and the target of monitoring vary among countries and among the groups of stakeholders considered. The topics for which monitoring is demanded are mainly environmental monitoring and to a much lesser extent, epidemiological monitoring and socio-economic monitoring. The latter will be discussed further below.

It is worth noting here that during the FSC workshop hosted by Ondraf/Niras in 2003 entitled “Dealing with Interests, Values and Knowledge in Managing Risk” (NEA, 2004a), the Chairman of the

Working Group on Land Use, Health and Environment of the PaLoff partnership in Fleurus and Farciennes, Mr. Bernard Jonckers, already pointed out the interest of the partnership in monitoring environmental and health impacts throughout the development of the project. He mentioned that “the working group compiled a list of environmental impacts for every decision-making and implementation phase – study, construction, operation, closing, monitoring, abandonment” and that a similar procedure was followed for health impacts. Health impacts were considered very important in the Fleurus-Farciennes region due to the long-lasting effects of coal-mining. He also added that the “working group proposed that in the future, in addition to nuclear safety, the health condition of the residents also be monitored” (NEA, 2004b). In 2009, in the FSC national workshop in Bar-le-Duc, France, foreign and French participants addressed specific questions on the role and expectations of local communities regarding environmental monitoring (NEA, 2010b), as described below.

All respondents to the FSC survey indicate that environmental monitoring appears to be one of the main concerns in the pre-operational and operational phases from the point of view of local stakeholders in all countries. For the West Cumbria partnership, monitoring mainly refers to assessing impacts on water, soil, biota, and radiological contamination (West Cumbria MRWS, 2012a) whereas in France, apart from monitoring water quality, air quality, noise levels, flora, fauna and radioactivity, the Local Information and Oversight Committee (CLIS) attached to the underground laboratory of Bure also stipulate a need for epidemiological studies (NEA, 2010b). In 2003, a national group consisting of the French Institute for Public Health Surveillance and including CLIS, the Nuclear Safety Authority, Andra and regional epidemiology units, met once to consider how to develop meaningful epidemiological baseline studies. After that, the CLIS created an internal working group on ‘environment and health’ to address health expectations related to a future underground repository (NEA, 2010b). In fact, according to the Act No. 2006-686 of 13 June 2006 on transparency and security in nuclear, the CLIS mission inter alia is to allow its members to gather the maximum of data (environmental, epidemiological, etc) that can serve as reference points in the future. In this regard, CLIS can conduct studies and surveys, including epidemiological studies or to perform any measurement and analysis in environmental emissions or discharges from nuclear facilities. For local committees, to perform credibly this role, the support of independent experts is crucial (Dallemagne in NEA, 2010b).

Andra questions the relevancy and significance of epidemiological studies under the current population situation³ and has declined to undertake such analyses. As explained by the French implementer in an interview, the CLIS do not directly monitor but rely on external experts and

³ The following quote from the 2009 FSC Bar-le-Duc (France) National Workshop proceedings may clarify concerning the initiative by the CLIS de Bure to introduce epidemiological studies. “A national group was set up by the French Institute for Public Health Surveillance including as stakeholders the CLIS, ASN, Andra, and regional epidemiology units. Its objective was to consider how to produce a meaningful baseline (which population, which pathologies?). Despite expressed interest by the CLIS, the group met only once in 2003. Concerns were about the difficulty of identifying for study a suitably meaningful population sample in an area of low population density. To reach a statistically significant sample, the reference population would be spread quite far from the possible disposal area. The potential impact would not be the same for all members of the sample, and final results might therefore be meaningless.” (NEA, 2010b)

relevant institutional actors to obtain information in the specific area of interest. The CLIS mission is to gather information, disseminate it and serve as a reference point for the public.

There are a number of monitoring initiatives undertaken by local communities and associated with radioactive waste management facilities in different countries. Despite the differences across different contexts, these initiatives show us the concerns of local stakeholders regarding monitoring and the active role they would like to play in implementing monitoring processes as part of a larger process in which the community builds a durable relationship with the facility.

The mayor of Soulaines-Dhuys at the Group of European Municipalities with Nuclear Facilities (GMF) seminar “Local reality and radioactive waste management” held in Hornachuelos (Córdoba, Spain) in February 2013 explained the activities of CLI Soulaines with regards to environmental and health monitoring. An epidemiological study was undertaken in 2010 by the *Institut de Veille Sanitaire* to determine the frequency of deaths and hospitalizations by cancer in the population living around the storage facility for low and intermediate level waste Centre de l’Aube in the departments of Aube and Haute-Marne compared to the reference population⁴. Furthermore, they carried out biomonitoring projects to analyse the potential contamination from the repository based on bioindicators, one of these studies using bees.⁵

With a view to preparing for the environmental monitoring to be performed during the operational phase of Cigéo, the geological repository industrial implementation, over a period of approximately 100 years, France’s operator Andra established the Permanent Environmental Observatory (OPE) in 2007. OPE is situated in the area of Meuse and Haute-Marne departments, where the site for the construction of the deep geological repository is planned and the Underground Research Laboratory is situated. The purpose of OPE is to describe the environment in detail before and after the potential construction of the deep geological repository for high level and intermediate level long lived radioactive waste and also to monitor its evolution. Andra works in partnership with a number of specialised companies and research laboratories to study all environmental settings - water, air, soil, flora, fauna – and to prepare the future disposal facility’s monitoring plan.⁶ According to Andra’s representative, the CLIS are not an actor in the OPE, rather an observer, as their role is informing themselves and inform the people about the OPE.

In Sweden, the host communities, like Östhammar where the existing short lived waste repository (SFR) is located and Oskarshamn, hosting the central interim storage (Clab), expect continuous environmental and radiological monitoring around the facilities. This is also a legal requirement on the implementer and the regulator during operation (personal communication).

⁴ <http://cli-soulaines.fr/activite-de-la-cli/>

⁵ For further information www.gmf-europe.org/documents

⁶ <http://www.andra.fr/download/andra-international-en/document/355VA-B.pdf>

In the US, CEMRC at New Mexico State University is conducting an environmental monitoring program and an in vivo radiobioassay research project in the vicinity of WIPP.⁷ This project began implementation during the WIPP pre-operational phase and is continuing during the operational phase. During the 1990s, surveys undertaken in the vicinity of WIPP showed that the public were concerned about health and environmental impacts of WIPP. Thus, CEMRC, as an oversight independent body, informs the public and the environmental science community. According to most interviewees, including DoE and local representatives, CEMRC enjoys a higher level of trust than EPA or DoE. Representatives from DoE at WIPP maintain that in fact, DoE, with local encouragement, continues to fund, via a grant, the independent monitoring organization CEMRC to continue its work.

Hungary is probably one of the European countries where public oversight and information associations around radioactive waste management and disposal sites are most active with regards to oversight and monitoring. In particular, it is interesting to note the role of the “social monitoring and information association” (TEIT) in connection to the interim storage for spent fuel at Paks NPP and the “local public control and information association” (TETT) linked to the low and intermediate level waste repository at Bataapáti (NEA, 2010c) and also of Isotope Information Association (ITT) in Püspökszilágy. The original purpose of these associations was the monitoring of background radiation and informing local residents (Vari and Ferencz, 2012). Members of civil society are trained for one year to actively undertake technical monitoring activities (NEA, 2010c). The members of the Bataapáti control committee are responsible for “randomised, on-demand radiological control measurements of waste packages. They are to compare resulting data with the expected data as recorded in the waste register” (*ibid*). Similarly to the French committees, they call on independent experts, in this case the Hungarian Academy of Sciences, to interpret research documents and help disseminate technical information in a broadly understandable manner (*ibid*).

c) Socio-economic monitoring

Other concerns raised by local stakeholders regarding monitoring include changes in quality of life and socio-economic variables. In the US, socio-economic impacts of WIPP were evaluated during the Environmental Impact Assessment (Little et al., 1986), but are not being monitored during operation. Several interviewees pointed out that WIPP is placed far from any community and socio-economic impacts, apart from providing jobs, are rather marginal.

In the case of Yucca Mountain, Nye County proposed a comprehensive programme of environmental monitoring, including monitoring of socioeconomic factors (DoE, 2008). According to interviews conducted with local representatives, Nye County concerns were mainly health, safety, welfare and economic well being but also making sure that transportation would not be excessive. In fact, the Nye County Nuclear Waste Repository Project Office conducted independent scientific investigations, such as the early warning drilling program and groundwater evaluation program, to

⁷ <http://www.cemrc.org/projects/wipp-monitoring/>

better design a monitoring system to protect Nye County resources⁸. In contrast to Nye County, Clark County has clearly expressed its opposition to Yucca Mountain since 1985. Clark County set up a Monitoring Program to collect information on economic, fiscal, environmental, and public health and safety information as a baseline for Yucca Mountain Project policy discussions.⁹ A local representative of the Clark County Comprehensive Planning Department states that the monitoring program was set up in anticipation to show and document changes to society, economy and environment. It is important to set up the baseline information early on and continue throughout construction and after construction. He claims that DoE did not plan to measure the impacts of Yucca Mountain on local communities and were trying to convince that all was positive. However, negative impacts would include transportation and losses of property values and tourism, as reported in interviews.

In the UK, the West Cumbria partnership recommends scoping and monitoring economic impacts from an early stage and on an on-going basis. The partnership points out that impacts might include changes in investment in the area, traffic impacts, possible effects on visual or physical environment and on tourism and changes in employment (West Cumbria MRWS, 2012b). Monitoring institutional players was mentioned also in the case of the UK. According to an interviewee, the partnership in West Cumbria was also interested in institutional monitoring. Thus, the members were interested in working with the radioactive waste management agency to see for instance, how they behave, how is the interaction, if there is a sense of trust and confidence or if they are transparent.

In Sweden, little attention has been paid to monitoring until recently. It is a fairly new topic that is emerging. Interviewees suggest that there is not yet any relevant documentation on this specific topic from the point of view of the local level. During 2011 and spring 2012 Östhammar reviewed SKB's license application to construct a deep geological repository in the municipality. Some of the important points from the municipality's statement is that it is necessary that SKB presents which preparations they have made to address the possibility that monitoring becomes a legal demand in the future. The municipality wants "to ensure that there will be equally high quality assurance throughout the whole process, from construction to operation and closure. This includes monitoring as well" (Östhammar municipality, 2013). A representative from Östhammar municipality reported in an interview that there is a common feeling in the community that monitoring may be necessary. If something is dangerous, you feel you need to monitor this. [...] We need to be prepared as these issues may arise in the future or later in the process (personal communication). For this reason, several representatives of local communities from Sweden and the UK have been involved both in the MoDeRn project and in the RK&M project, namely to learn how oversight and monitoring can be prepared.

⁸ See nyecounty.com

⁹ See www.clarkcountynv.gov

Similarly to the Swedish case, in Canada, participants in the dialogue workshops held to develop a management approach for the long-term care of used nuclear fuel, requested to NWMO the need “to elaborate on the nature and extent of monitoring envisioned in the implementation of the Adaptive Phased Management approach” (NWMO, 2005). Participants considered that monitoring is important for the following reasons:

- to ensure long-term protection of human and ecological health;
- to provide the public with assurances that the facility continues to be safe;
- to allow future generations to measure and assess their stewardship over the used nuclear fuel;
- to allow for continuous learning and provide well-informed decision-making; and
- as a precondition for future retrieval of the material, regardless of the intended purpose (NWMO, 2005).

Finally, it is interesting to mention here the case of Switzerland, which advocates the concept of “monitored long-term geological disposal” and suggests the construction and operation of monitoring facilities in parallel with the main disposal facility. The Sectoral Plan for Deep Geological Repositories (SFOE, 2008) under the lead of the Swiss Federal Office of Energy establishes the need to monitor socio-economic impacts in the siting regions in the pre-operational phase. Thus, in Stage 1 (i.e. selection of geological siting areas), socio-economic studies are prepared, together with the siting regions, to evaluate social, demographic, environmental and economic impacts of a geological repository. Later on, in Stage 3 (i.e. site selection and general license procedure), in-depth monitoring of socio-economic and environmental impacts is carried out.

Concerns in the post-operational phase

In this section, the main observations from the FSC survey, interviews and desk study raised by local communities regarding concerns relative to monitoring and oversight in the post-operational phase are identified. Generally, we can argue that requests for monitoring during the post-operational phase are not so clearly articulated by local communities, compared to monitoring during the pre-operational and operational phases. However, a general view that we should not “walk away” from these facilities, even when we think they will be safe (Pescatore and Mays, 2009), appears to be confirmed through interviews.

In France, the “permanent group on radioactive materials and waste” of the national association of local information committees and commissions (ANCCLI) puts forward specific questions regarding monitoring during the operational and post-operational phases within the framework of the dialogue on medium and long-term radioactive waste (ANCCLI, 2012). The questions address environmental and health monitoring, as follows:

- Which are the monitoring needs in the pre-operational, operational and post-operational phases of the geological repository facility? Which will be the measures undertaken and where?
- How would stakeholders be involved in the different types of monitoring?
- How will memory be preserved? Will memory be available in 50, 100 or even 1000 years?
- Which are the objectives of post-closure monitoring? Will safety monitoring be maintained after closure?
- What does “passive oversight” mean?

Hence, French local stakeholders clearly demand more information on monitoring in the different phases of the geological disposal facility as well as more information on memory preservation. At present, these are issues being discussed in seminars organised by the national association with the support of the TSO IRSN, to assist the local level and build local stakeholders’ capacities for the current and future debates on the Cigéo project.

In the case of Sweden, according to the safety case, SKB maintains that post-closure monitoring is not necessary and that any decisions on post-closure monitoring need to be taken by the generation that is the decision-maker at the time of closure. The requirements and possibilities for post-closure monitoring will depend on social conditions and development of technology (Bäckblom and Almén, 2004). One of the concerns expressed by Oskarshamn community regarding the closure of the repository referred to responsibilities and who would take over after the implementer is released from responsibility for the facility (2008). According to a local representative from Östhammar, the demands from the community at present are not specific enough to define critical issues to be monitored, nor on which time scales. SKB plans for and expects demands for environmental monitoring from the community at least during operation period until some time after closure. These demands will be further defined as part of the on-going licensing procedures.

For the West Cumbria Partnership in the UK, waste must be monitored while it is in the facility and there will also be a period of institutional control and monitoring during the post-closure phase (West Cumbria MRWS, 2012a). However, according to several interviewees from the UK, it seemed far too early in the UK, during the lifetime of the partnerships, to discuss these issues.

The case of the WIPP is different since “monitoring will continue for as long as practicable during the period of active institutional control (100 years) and/or until the DoE can demonstrate to EPA that there are no significant concerns to be addressed by further monitoring. The post-closure monitoring program will have to be responsive to societal concerns at the time of closure” (Wagner et al., 2002). In fact, one interviewee from Carlsbad mentioned that the community may want to extend that period of time and that the definition of parameters to be monitored should be based on science.

Indigenous people in Canada have been very explicit about the need to monitor both the environment and the nuclear waste management system. For instance, they recommended setting

up a special First Nations/Aboriginal Nuclear Waste Monitoring Agency to be active as long as possible (First Nations Nuclear Fuel Waste Dialogue Working Group, 2004). In the regional dialogue held with Métis people in Ontario in 2009, questions were asked regarding how to monitor leaks and transportation of used fuel. One group stated that monitoring should involve Métis people and also be hands-on (NWMO, 2009).

It is also interesting to note that in the dialogue workshops held in Canada to develop a management approach for the long-term care of used nuclear fuel, a small group of participants “objected to long-term monitoring, particularly if it were to be intrusive in nature”. Intrusive monitoring, they argued, “may detract from the integrity of the storage system and is, in fact, unnecessary given that breaches of containment are very unlikely” (NWMO, 2005).

In Finland, according to Posiva, there are no local community demands on monitoring in the post-operational phase. Posiva is running a monitoring programme as part of the repository project at Olkiluoto, the site selected for the repository. The Olkiluoto monitoring programme has been conducted since 2004, when the construction started on Onkalo, the underground rock characterisation facility (Posiva, 2012). During the Environmental Impact Assessment procedure, before the Decision in Principle, the municipality of Eurajoki had an active role in expressing their concerns and demands. Nevertheless, the role of the municipality with regards to monitoring is rather passive and a high degree of trust in the managing institutions is in place, according to Posiva representatives.

4. RK&M preservation

Apart from the case of France, there is hardly evidence of a strong formal demand on the preservation of records, knowledge and memory by the local level. The largest part of interviewees suggests that not much formal discussion has taken place on this issue, but there seems to be an implicit interest by local communities, as implementation of a geological repository approaches. At that stage, it is expected that higher demands will arise to plan record keeping and memory preservation. Informally, these discussions have been taking place and RK&M preservation seems to be an emerging area of work in the field of geological disposal for the years to come. In this context, participants at the FSC workshop in Bar-le-Duc (France) developed the concept of “*living history*”, reflecting on the need to maintain the memory of a repository through records based on local experience, communal archives (photos, written material, etc) (NEA, 2010b).

Stakeholders in France have expressed the wish to have a continued memory keeping beyond centuries¹⁰. Discussions have been held on the contribution of local people to preserve memory and will be more important in the future. The memory issue is an integral topic addressed at CLIS meetings (Boissier et al, 2011) and the role of local communities is regarded as crucial for maintaining the memory of the site, once the period of institutional monitoring is over (NEA, 2010b). Andra also deemed necessary in 2010 to launch a project on memory preservation based on the following topics (Boissier et al., 2011):

- work to reinforce the reference solution;
- preliminary work to prepare the memory preservation of a future deep geological repository;
- theoretical studies;
- three reflection groups with local population around Andra sites (Centre de la Manche, Centre de l’Aube and Cigéo facility);
- opportunity studies to create dedicated buildings for memory preservation.

It is interesting to note that the three reflection groups are aimed to attract the interest of local populations in the issue of memory preservation, but also to collect their views on the best approach for them to actually preserve memory (*ibid*).

¹⁰ Based on Andra’s response to a questionnaire sent to the Integration Group for the Safety Case (IGSC) members presented at the Second Workshop of the RK&M Project held in September 2012.

According to current regulations, Andra must maintain and pass on the memory of the repository to future generations for at least five centuries after its final closure. The approach followed in surface disposal facilities, like Centre de la Manche, can be applied to Cigéo during this timescale (Andra, 2010). Charton and Ouzounian (2008) argue that “easements and exchanges with the representatives of the populations concerned” are complementary to archives for memory preservations. Charton recognised that maintaining exchanges with the local public, and in particular with the CLIs, is crucial for an active memorialisation of the site, since markers may not be readable in the future (NEA, 2010b).

At Andra facilities, different mechanisms are in place for communicating with the local population – local information committees, hearings, newsletters, etc - and hence, maintaining collective memory (*ibid*). In the post-closure safety case for a geological repository, Andra’s reference solution includes the development of active memory among local stakeholders based on a general knowledge of the repository. A synthesis memory is planned to be widely distributed to support this knowledge.¹¹ In addition, Andra plans to open an “Ecotheque” in Bure in 2013 where all samples taken as part of the OPE will be stored at least 100 years. The Ecotheque is part of the project to preserve the memory of the environment (Andra, 2013).

In the US, apart from the monitoring requirements included in the regulations, the need to maintain active institutional controls for as long as practicable possible, are also established by the US EPA. Passive institutional controls (PICs) are also required by EPA regulation to indicate the danger of the wastes and their location (Wagner et al., 2002). At the local level, one interviewee stated that the community of Carlsbad has not intensively focused on long- term issues, but is part of the agreement with EPA and also a legal requirement. Although he claimed that the RK&M discussion has been ‘on and off’ at local level, the community will be addressing these issues in a more focused way in the next years. Also representatives of DoE acknowledge that as closure of the facility approaches, the opportunity will arise for the community to participate in planning for the permanent markers to be installed, determining monitoring to continue into the post-closure and deciding record storage requirements. This is expected to take place during public participation in regulatory changes that will be initiated by the facility with the regulator for the WIPP PICs program.

In Sweden, SKB has considered the issue of preservation of information for future generations (Bowen-Shrire et al., 2008; Eng et al., 1996; Engstroem-Laarouchi S., 2010). In the license application for the deep geological disposal facility, SKB explains that it will prepare an action plan for long-term preservation of information in international cooperation (NEA, 2012b). The International Review Team of SKB’s post-closure radiological safety case notes that SKB needs to address the transfer of knowledge and skills by the repository operator, supervisory authority and the community in charge of the repository site. The International Review Team suggests mechanisms that SKB could consider to preserve knowledge and memory of the site (*ibid*). Similarly, the Swedish

¹¹ Based on Andra’s response to a questionnaire sent to the Integration Group for the Safety Case (IGSC) members presented at the Second Workshop of the RK&M Project held in September 2012.

Radiation Safety Authority's General Advice on the Application of Regulations (SSMFS, 2008:37) concerning the protection of human health and the environment in connection with the final management of spent nuclear fuel and nuclear waste partly considers these issues and states that '*a strategy for preservation of information should be produced so that measures can be undertaken before closure of the repository*'. In addition, local representatives in Sweden also consider that RK&M preservation should be a concern at all levels: local, regional, national and even international. According to Erik Setzman from SKB, Östhammar demands more specific plans or strategies not only for monitoring but also for RK&M within the licensing procedures for the planned spent fuel final repository in Forsmark. According to him, the interest in monitoring, RKM in general as well as the potential combination between the subjects is gradually rising (personal communication, 2013).

In its review of SKB application for constructing and managing a geological repository, the Swedish National Council for Nuclear Waste, National Archives and Östhammar municipality have made comments on memory keeping, as shown in Box 1.

Box 2. Summary of comments on memory keeping submitted to the Swedish Radiation Safety Authority (SSM) and the land and Environmental Court in the first phase of reviewing SKB's application

The *Swedish National Council for Nuclear Waste* observed in its statement that it is not clear how SKB intends to preserve and administer information about the final repository. The results of the SKB's on-going activities are not reflected in the application. It is the Council's view that the issue of which information and knowledge that shall be preserved is intimately connected to design of the processes and systems that shall ensure the preservation and transferral of information. Since the documentation regarding the constructing the repository is a substantial part of the information that shall be transferred to future generations it may become too late at the time of closure to decide which information that shall be preserved and how it shall be done. The conclusion is that a plan for information and knowledge preservation, including which information that can and shall be preserved should be designed already before the time of disposal and then be revised as the work proceeds. In summary, the National Council considers that SKB's application should be supplemented with a plan for management of information and knowledge. The plan ought to present how SKB intends to preserve information regarding the repository during the time of disposal and transfer the knowledge for management of future generations.

In its statement, the *Swedish National Archives* criticizes the account of knowledge preservation and finds that SKB has failed to explain how they intend to comply with Section 6, paragraph 1 of the Radiation Protection Act (1998:220) regarding preservation of information for the future. The authority finds the account to be insufficient and states that SKB should already have started planning how this information is to be managed and subsequently updated and revised continuously. The authority points out that such documentation effort should not be postponed until the actual closure of the final repository. The Clink application also lacks an account of how information is to be preserved.

Östhammar Municipality raises the issue of memory keeping in its statement to the SSM and the Land and Environmental court. The municipality regards that memory keeping is a very important part of the project's operation and demands a clearer treatment of information preservation and that SKB return at given intervals during the entire operating period and prior to closure with an external environment and future

analysis focused on information preservation and monitoring. According to the application (page 14) it is stated that it is SKB's ambition to preserve and management information in a way that society has the possibility to choose an alternative for the future that is at that point in time considered appropriate. The municipality does not consider this sufficient, that long term memory keeping shall not be managed by SKB's ambition, but clear regulation

Source: email communication by H. Bjarnadottir (Swedish National Council for Nuclear Waste) on 22 April 2013.

In the UK, according to an interviewee, the fact that Sellafield maintained poor records in the past involved more complexity in decommissioning legacy nuclear sites. This lack of consideration of record keeping in the early days of nuclear development, has probably increased awareness that records and knowledge preservation is a key area to tackle in the future. There are 19 nuclear sites in the UK all owned and operated by different companies with different types of information collected in different ways, with differing quality and format (Gray in NEA 2010d). The UK Nuclear Archive project aims to deliver a memory facility which addresses this problem. As such, it is understandable that West Cumbria partnership was concerned about preserving information and knowledge for future generations and demanded further information to the NDA. They also point out in the Final report that "records of the location and general contents of the facility would be held by the National Nuclear Archive" (West Cumbria, 2012a).

In other countries, like in Finland, there are currently no demands on the preservation of records, knowledge and memory from the local community, according to Posiva representatives.

Also in Canada, the need to preserve memory is also raised by indigenous people. In the regional dialogue with Métis, it was acknowledged that "the next 4000 generations must understand how we worked together to come to this decision, and what we hoped their future might look like as a result of our decision-making" (NWMO, 2009b). In addition, people participating in NWMO engagement activities in 2012 questioned the ability to inform future generations about the repository's presence, as connected to security. Some people felt that knowing the exact location of the facility would not contribute to increasing security, whilst others were more concerned about how to transmit the knowledge about the facility to future generations (NWMO, 2012).

5. Building stakeholder confidence

This section points out how confidence may be built and reinforced through monitoring and RK&M preservation, as revealed in interviews and documentary data. As acknowledged in the interviews, monitoring contributes to creating trust, ensuring transparency and maintaining stakeholder confidence. Monitoring seems also important to meet expectations on long-term safety and security, in some cases, as well as for long-term stewardship. Some stakeholders also refer to independent oversight bodies (e.g. academics, experts or local committees) as important factors to build public confidence. In addition, we see that in some countries the discussion on reversibility and retrievability is linked to monitoring and RK&M preservation, for safety and confidence building purposes.

Firstly, for local communities, monitoring is a key issue to both ensure safety and guarantee transparency. Most interviewees stated that monitoring has a function for ensuring safety as well as for strengthening confidence that the repository does not have undesirable impacts on human health and the environment. In fact, an interviewee indicated that both, safety and confidence, are interlinked and only if people believe it is safe, they will have confidence. Similarly, another interviewee mentioned that “monitoring itself is not enough to build confidence, but helps to achieve it”. An interviewee from France expressed that safety does not rely on surveillance and for this reason, monitoring has to do more with achieving confidence. In Sweden, the representative of the Swedish National Council for Nuclear Waste Monitoring argues that monitoring not only technical, but also social aspects is important to get trust and confidence.

One aspect that we may consider critical at this point and was raised earlier in Section 3 is the role of local communities in monitoring activities. There are different views depending on national contexts. Some interviewees emphasised that local stakeholders should not be delegated the responsibility for conducting monitoring activities but just provide them with information on a regular basis during the operational and post-operational period for confidence building purposes. In different institutional contexts, local stakeholders have a different view and think that they should be involved actively in monitoring activities, like in the French case. Thus, even if monitoring may contribute to building confidence in geological disposal, local expectations and roles with regard to monitoring depend very much on national contexts.

Secondly, the involvement of independent bodies in performing monitoring is important for contributing to public confidence. In the US, the interviewees noted that the majority of people around the WIPP have confidence in the safety of the facility. According to an interviewee from DoE,

the main rationale for requesting monitoring would be the need to verify in action. Additionally, the role of CERMC and the autonomous professors involved, who “may speak out without feeling oppressed by the political environment” is crucial for building confidence, as raised by one interviewee from the local community. He added that the establishment of this oversight body was done in collaboration with State representatives who discussed on what to monitor, who would be in charge or how much would it cost, among other issues. However, he criticised the fact that the State does not receive any financial support for accommodating the repository and they do not pay for their time spent to review, to be involved, travel expenses, etc. The case of Yucca Mountain is different, since the Nuclear Waste Policy Act (1982) provided for the Affected Units of Local Government within the vicinity of the site to oversee and participate in the Yucca Mountain project. The aim of Congress was *“to increase public confidence in the scientific integrity of the repository programme, provide citizens the means to interact with the federal government, and demonstrate a commitment to external oversight”*¹².

Furthermore, according to most interviewees, local communities tend to want a role in engaging in monitoring programmes. As pointed out by Pescatore and Mays (2008) “when local communities [...] participate in monitoring site development and operations, they are building their capacity to act as guardians and therefore ensure another layer of defence in depth”. Enhanced oversight by both authorities and stakeholders may be part of a confidence-building process.

Finally, monitoring and memory preservation are an inextricable part of the discussions on reversibility and retrievability in some countries, like France or the UK. Monitoring is essential to enable reversibility as it provides information on the engineered facility and its performance (NEA, 2010b). Within Andra Memory Project, a theoretical study examines the interactions between memory and reversibility of storage in order to identify the memorisation requirements for the various reversibility phases and what could be the consequences of these phases if the memory of the centres were to disappear (Charton, 2012; Boissier et al, 2011).

The West Cumbria Partnership indicated that “a lack of trust appears to us to be at the root of many of the key concerns raised by the public and stakeholders” (West Cumbria MRWS, 2012b). They recognise that research on the best ways of monitoring is in the early stages and further work needs to be done. As raised by a UK interviewee, trust is a confidence factor and monitoring is needed to build confidence. Also in the UK, the concerns from local communities on monitoring were linked to retrievability. Monitoring is essential as far as it helps to understand if the repository operates safely and if not, if waste can be retrievable. It is noted that local communities would want to know exactly how monitoring will happen if a facility is ever built. In addition, any site-specific safety cases would need further monitoring and independent reviews before they are considered adequate by the regulators and other stakeholders (West Cumbria MRWS, 2012a).

¹² <http://www.mcnucprojects.com/links.htm>

6. Reflections on the concept of oversight

This report brings together the concepts of monitoring and RK&M. As put forward by Nachmilner (2013) monitoring is mostly understood as collecting technical data and one of the motivations for this is to keep memory as part of maintaining safety and oversight of a closed disposal facility. So far, monitoring and RK&M are generally regarded in general as separate topics and there is no connection between both. The concept of oversight considered here suggests that monitoring plays an important role for the active keeping of records, knowledge and memory. Pescatore et al. (2013) suggest oversight as an overarching term which embraces both monitoring and RK&M.

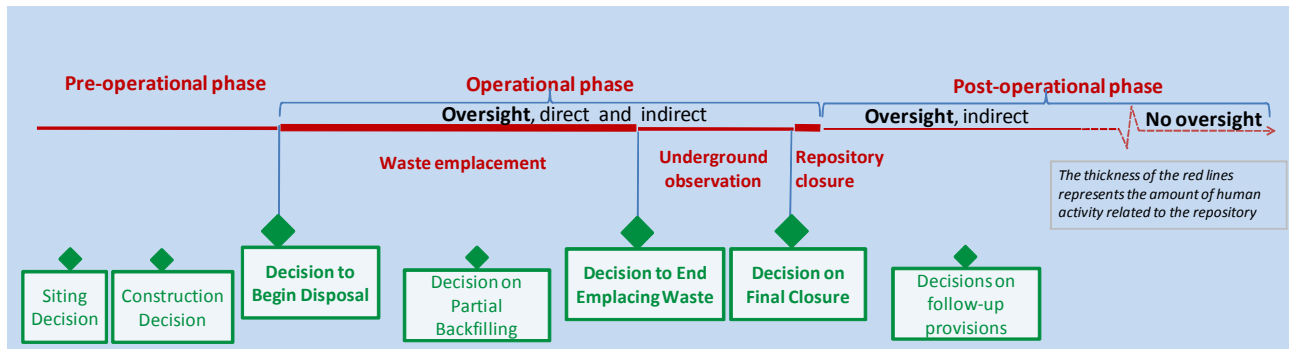
The concept of ‘oversight’, as put forward by the ICRP (2013), is useful as an overarching term which embraces both monitoring and RK&M. As stated by ICRP (2013) and NEA (2011; 2012a) “oversight is the more general term that refers to society ‘keeping an eye’ on the technical system and the actual implementation of plans and decisions”. In a nutshell, oversight is the general term for “watchful care” (Pescatore et al., 2013). As stated by ICRP (2013) and NEA (2011d; 2012) “oversight is the more general term that refers to society ‘keeping an eye’ on the technical system and the actual implementation of plans and decisions”.

The ICRP report on radiological protection in geological disposal outlines that, from a radiological viewpoint, the application of the protection system is influenced by the level of oversight or ‘watchful care’ of the disposal facility that is present (p. 6). Oversight can be exercised through different activities, like monitoring technical parameters, monitoring institutional provisions or even monitoring the implementation of agreements made with local hosts. The ICRP guidance states: “The different decisions to be made relating to the evolution of the oversight should be discussed with stakeholders” (2013, p. 18). The different actors – implementers, regulators, policy makers and local communities, outside experts, etc. – may be engaged in planning and undertaking oversight and monitoring activities at the different phases of the disposal facility development and implementation. Thus, monitoring serves the purpose of oversight and, as such, is part of oversight. When direct oversight ceases, in tens to hundreds of years after the start of operations, the ICRP suggests that other forms of passive control may be in place, like memory, records or other measures decided jointly by the authorities and stakeholders (2013, p. 18).

The ICRP report indicates that there are three main levels or types of oversight: *direct oversight* when access to the waste is possible, i.e., when disposal galleries are still open; *indirect oversight* when direct access to the waste is no longer possible without re-excavation, i.e, for some parts of the disposal facility or for the full facility after sealing; and *absence of oversight* in case the

memory of the disposal facility was lost (see Fig. 4). The periods of indirect oversight and no oversight correspond to the post-operational phase, when the human presence is no longer required to directly manage the facility.

Figure 4: Repository lifecycle phases and examples of associated decisions (ICRP, 2013)



The term “oversight”, as defined above, is marginally covered in FSC documents. Most references to “oversight” are related to the Local Information and Oversight Committee (CLIS) around the Underground Research Laboratory set up in Bure, in the area of Meuse / Haute-Marne “departements” (France), the public oversight and information associations established in the vicinity of nuclear sites (storage, disposal, construction or investigation area) in Hungary or linked to monitoring. Furthermore, the term “community oversight schemes” is proposed as referring to non-financial incentives to increase confidence, and in turn possibly support for siting the facility within the potential host community (NEA, 2010c). In addition, “expert oversight groups” are also considered by the FSC as mechanisms to promote the interaction between stakeholders and specialists (NEA, 2004c). In all these cases, oversight would involve any systems or actions to watch and check a situation carefully to make sure it is done correctly.

Furthermore, during the interviews, “oversight” was barely used, apart from in interviews from the US. It is interesting to mention here that an interviewee acknowledged that there seems to be an overlap between monitoring and RK&M preservation. Providing perpetual care will help to maintain the memory of the site and pass knowledge on to future generations so that they can decide how the facility is managed. According to the US Nuclear Waste Policy Act “oversight and monitoring are different in nature but complementary in practice” (Nye County Board of County Commissioners, 2006). In the case of Yucca Mountain, the geological repository for high-level radioactive waste in the US that is currently defunded, Nye County refers to the oversight activities as “those related to institutional or policy oversight and involving predecisional review and comment on DoE policy regarding Yucca Mountain Project-related transportation, waste handling, storage and /or emplacement”. In contrast, “monitoring involves the assessment of local conditions that could be affected by the Yucca Mountain Project and assessment and reporting of actual or potential impacts on those conditions” (Nye County Board of County Commissioners, 2006).

During the MoDeRn international conference held in Luxembourg from 19-21 March 2013, the word “oversight” was presented as a term embracing both monitoring and control and going

beyond these concepts, a term which recognizes the coexistence of technical and societal factors. It includes regulatory supervision and control, but also the preservation of societal records and societal memory of the presence of the facility. Whilst some participants at the conference seemed at first confused by this new terminology, it opened some avenues for further reflection afterwards during the working group sessions.¹³

As mentioned above, 'oversight' has different connotations depending on the country and on the person who uses the term. In the US, for instance, there are several technical oversight groups that can carry out scientific, radiological, financial or other forms of monitoring of nuclear. Representative of the Department of Energy in WIPP claimed that oversight was part of the pre-operational consideration for the Compliance Certification Application. The Waste Isolation Pilot Plant Land Withdrawal Act resulted from political discussions at the state and federal levels, limiting waste types and quantities, and mandating oversight by the Environmental Protection Agency for long-term radiological safety and by the State's New Mexico Environment Department for overseeing the implementation of the laws regulating the disposal of hazardous constituents in the waste.

Communities ask for oversight in perpetuity, active safety and prolonged stewardship, including monitoring (Kotra in NEA, 2008). A State representative in Carlsbad points out that numerous organisations are involved in the oversight of Waste Isolation Pilot Plant (WIPP) that safely disposes defense-related transuranic radioactive waste. Among others, the Environment Department of the State of New Mexico regulates the handling of the hazardous components of mixed waste under the Hazardous Waste Act and the Resource Conservation and Recovery Act; the U.S. Environmental Protection Agency (EPA) is responsible for certification and enforcing waste facility permits; the Department of Energy (DoE) is responsible for oversight and monitoring health and safety operations and Carlsbad Environmental Monitoring & Research Centre (CERMC) independently monitors health and environmental parameters during the pre-disposal and operational disposal phases. This Centre also carries out the 'lie down and be counted' programme, which characterises and monitors internally deposited radionuclides in the general population living around WIPP on a routine basis.¹⁴

The Nye County community clearly advocates for permanent oversight of facilities. Participation in and updating of local, state, federal and international archives and land record systems is required along with an active programme for continuing oversight of the facility (Kotra in NEA, 2008). According to the Nye County Board of Commissioners, they have the "core duty" of oversight of DoE's Yucca Mountain Project policy, "now and for the indefinite future". For them, the purposes of oversight are to:

¹³ Personal communication by C. Pescatore. "I think this is an interesting remark at this stage of the project, when the concept of oversight has been adopted and is being disseminated in international forums. It should be noted that the major part of participants in this international seminar had a technical background and represented mainly waste management organisations, regulatory bodies, research organisations and consultancies."

¹⁴ <http://www.cemrc.org/departments/internal-dosimetry/programs/lie-down-be-counted/>

- monitor federal policy regarding Yucca Mountain project and ensure the citizens are of informed of policy decisions as well as the consequences of those decisions;
- give Nye County the opportunity to provide predecisional input on all aspects of future DoE activity in Nye County and
- provide DoE and the federal government with input from the community's perspective (Nye County Board of County Commissioners, 2006).

In this capacity, the Nye County Nuclear Waste Repository Project Office set up various initiatives over the years to follow the project. They conducted oversight of Yucca Mountain Project, comprising five programme elements: 1) socio-economic, transportation and emergency response; 2) regulatory and licensing oversight; 3) government and community relations; 4) programme management and 5) independent scientific investigations programme.¹⁵

¹⁵ <http://www.nyecounty.com>

7. Final reflections

This study paper reviewed various sources of knowledge and viewpoints concerning *monitoring, preservation of records, knowledge and memory (RK&M)*, and *oversight*, in the context of local community involvement with a deep geological repository for radioactive waste. The findings suggest that at present, these are concepts whose interpretation may be specific to a country or a site. These concepts may evolve over time and may also have different meanings depending on who defines them. Clarification and common understanding might have to be developed in consultation with stakeholders. The process of reflecting on these concepts may already help different stakeholders to grasp their meaning and engage the community in discussing their role and expectations in monitoring and preserving RK&M.

According to survey, literature and interview findings, there is relatively little work or guidance on how monitoring might contribute to the creation and preservation of RK&M and to what extent local communities might play a role in this process. This report seeks to provide input to this debate and provide examples of initiatives or dialogues undertaken in this field. This report does not offer a prescriptive plan, but provides a first glance into how these concepts are considered by local communities on the international level.

This study shows that local stakeholders have an interest in monitoring and RK&M preservation in RWM facilities. Local stakeholders would like to know how monitoring will take place and what it is important to monitor and why. In addition, local communities recognise that monitoring should be undertaken in the early stages of the siting procedure and might be continuously refined and may not end with the closure of the facility. The nature and extent of monitoring required by local stakeholders depends on the understanding of monitoring.

Broad areas of interest to be monitored include environmental impacts, socio-economic factors and health issues in specific cases. In parallel, there is a vague, not clearly defined, interest in RK&M preservation.

In some countries, like France, monitoring and RK&M are conceived as inextricably linked together and both national and local actors are closely working on these matters. The implementer, Andra, undertakes specific research programmes, studies and initiatives, like the Permanent Environmental Observatory. In parallel, the national technical support organisation IRSN helps recognized local stakeholder groupings (ANCCLI, and CLI) to exchange, build competence and identify questions and challenges regarding the geological repository project in France. Future challenges cover issues related to monitoring and preservation of RK&M.

In most countries, demands and expectations on monitoring are more clearly defined than those on RK&M, where there is hardly evidence reported on a formal demand. This report has provided several examples of local demands and expectations in monitoring and RK&M in Canada, Sweden, UK and US. In other countries, like Finland or Eastern countries, these demands are not so clearly articulated. Nevertheless, it has become apparent that there is an interest by local communities in various countries to explore these concepts further as they become involved in different phases of the radioactive waste management programme.

The challenge, as recognised in Pescatore and Mays (2009) is to design and implement a facility which becomes part of the fabric of local life and even something of which the community can be proud, that provides added cultural and amenity value across the generations. As countries advance in the implementation of underground repositories, the extent to which local communities can contribute to maintaining the memory of a repository will remain a subject for discussion and development in the next years. Local communities may seek participation in continued oversight as a means of building and sustaining their confidence in safety. However, this interest is often not specific enough to define critical aspects to be monitored nor over which time scales. Further research to identify both how monitoring could contribute to confidence in geological disposal and how local communities in different national contexts may be involved in oversight activities may help to clarify roles, demands and expectations.

The results from the study of Bergmans et al. (2012) undertaken in the context of the MoDeRn project are complementary to those of the project presented here. Bergmans et al. (2012) observe that the meaning of monitoring and the extent to which it contributes to long-term safety differs from experts to lay stakeholder groups. For the experts, monitoring is about collecting information on the repository system, observing through measurements its behaviour and impact. For lay stakeholder groups, the interpretation of monitoring is much wider and touches upon the relationship between stakeholders and the development of repository monitoring programmes, confidence building and trust. From Bergmans (2013), lay stakeholders consider that monitoring would cover any data gathering related to the behaviour of a repository and its natural and social environment, from the site investigation to post-closure. She argues that citizens seem to be less concerned about what parameters to monitor and where, and more interested in the comprehensiveness of the monitoring programme. Therefore, monitoring would require keeping an eye on the facility, even after closure, and having a response plan in case action needs to be taken.

The MoDeRn project suggests that monitoring should be recognised as a “socio-technical activity” that involves the “pursuit of social and institutional innovations as much as technical and industrial innovation” (Bergmans et al. 2012). This approach can be strengthened by recognising that RK&M can play a role as a means to support monitoring activities. We observe that specific concerns and expectations on RK&M emerge as siting draws near and are clearly on the agenda in countries that in 2012-13 are undergoing a licensing phase. So far, informal and formal discussions have been on-going in several countries regarding the best way to pass knowledge on to future generations. This takes us to the useful concept of oversight as “keeping an eye” on the system and on the

implementation of decisions (Pescatore et al., 2013). Oversight can provide a useful conceptual framework that embraces long-term monitoring and preservation of RK&M. The decisions on the levels and evolution of oversight would be based on different factors, like the degree of confidence in the behaviour of the facility, societal, economic factors, etc. Being aware of the views of the implementer, the regulator and the concerned stakeholders over these issues may contribute to provide further insights on the nature and role of oversight of geological disposal. As considered by ICRP (2013) “decisions related to the organisation and evolution of the oversight should be discussed with the stakeholders”. In summary, oversight can be exercised not only through technical parameters and administrative provisions but also through monitoring agreements made with the local hosts and other stakeholders.

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Annex 1. Design features for RK&M

Table 1. Design features that favour a sustainable relationship between the RWM facility and the community

	Characteristics	Value Added	Strategies to achieve the desired feature	Potential application to the preservation of RK&M
Functional				
Multi-functionality or polyvalence	The installation serves several functions at the same time: it assures its mission of safely managing RW and also supports other uses like recreation or education.	Offers opportunities for a wider range of persons to come into contact with the installation and to bring it into their lives. Offers opportunities for the community to draw a range of benefits (prosperity	Designers and community stakeholders explore community needs for additional functions, work closely with regulators to reconcile demands for safety and for parallel uses.	Scientific, cultural and/or recreational functions of the RWM facility deliver added cultural and amenity value which helps to fit the site into community life over generations (see Canada, France, Sweden and Spain examples below).
Adaptability	Foreseeable functions can be accommodated at acceptable or no cost.	Supports the near-term multi-functionality of the installation.	Designers choose appropriate materials and structures to accommodate foreseeable uses and to make necessary transformations easy.	Proper foresight on the end use of the facility and site or technical provisions for quick transitions to other types of facilities (e.g. reactor site into a seaside housing area in Kävlinge –Sweden; nuclear archive at Dounreay, Scotland ¹⁶ .
Flexibility	New and unforeseen functions can be accommodated at acceptable cost.	Supports longer-term multi-functionality, including complete transformation of structure or uses.	Designers anticipate that new functions will be introduced by future users; they assure robustness and avoid building in features that narrowly restrict potential uses.	

¹⁶ The initial idea was to transform the reactor building into a national registered monument, but it would be too expensive to be maintained (Gray in NEA, 2010d).

Cultural				
Distinctiveness	The facility is attractive, recognisable and “like no other”	The installation may become an icon, a well-known, emblematic and admired feature of the place. People may draw pride from its presence, it can become a positive part of local identity.	Artists and architects apply their highest creative and design skills, incorporate state of the art and /or traditional materials, introduce innovative engineering, etc	The facility may become an icon and a showcase for innovation and design (ex. Of future SNF facility in Sweden). Innovation and tradition can help achieve a waste facility to have a nice visual impact (see examples of COVRA in the Netherlands and Äspö).
Aesthetic quality	The facility is nice to look at and to “experience”.	People may draw pleasure from the presence of the installation rather than avoiding it or rejecting it.	Architect, artists and community stakeholders consult on desirable look, layout and landscaping.	
Understandability	The facility and its functions are understandable.	People can connect the radioactive waste management project and installation to various parts of their lives and their knowledge.	Stakeholders (technical and societal) engage in an open, transparent and collaborative process to work out the RWM project. Information and education programmes.	Archiving and transmission of data through training, “telling a story”, building up understanding (e.g. France, Belgium, Spain).
Memorialisation	The facility and site are marked so that people (now and later) know both what is there and something about its context.	People can integrate into their sense of place the meaning of what the site is and why it is there. Features of local identity and culture are preserved and showcased. Society’s choices and achievements are recorded.	Interactive museums. Communication centres. Art installations. Durable markers.	Preserving knowledge through a science centre or time travel museum (Oskarshamn), “experimenter facility”, communications centre (STORA, Belgium), interpretative centre (Port Hope, Canada).

Physical				
Integration	The installation respects the “genus locus” (spirit of the place), fits into the landscape and complements its.	The installation does not intrude on or disrupt people’s living space and their attachment to the place.	Architects study and respect the “genus locus”.	Consider long-term and integrated planning for compatibility with the neighbourhood (Port Hope, Oskarshamn). ¹⁷
Amenity	The site includes features that enhance its attractiveness, convenience and usability.	People may actively go toward the site and draw satisfaction from using it.	Architects, artists and community consult on desirable landscaping and equipment.	Using the LLW storage area for sports or even a more far-sighted use would be as a garden. The latter would aim to preserve green acreage and enjoyment for centuries to come (Port Hope).
Accessibility	A large proportion of the installation surface is open, fences and barriers are reduced to the essential.	People get a feeling of security and familiarity rather than a sense of threat.	Architects, planners and regulators seek to reconcile protection and openness.	Can provide an identity for those in local communities as guardians rather than outsiders (e.g. Port Hope).

¹⁷ It seems relevant here to note that in the FSC-11 proceedings, Buser states that “a strategy has been to site a facility somewhere where people have no interest in natural resources, but the fact is that the presence of infrastructure will create the interest” (NEA, 2010c).

Annex II. Role of local communities in RK&M preservation

NEA (2010a) suggests that by integrating the facility in the surrounding community, citizens can contribute to maintaining safety and long-term stewardship. Within the FSC literature, there are multiple references to different RK&M aspects made by local communities. Proposals made by local stakeholders include, for example, science museums, visitors' or communication centres complementing the radioactive waste management facility, interlinking the cultural design features of distinctiveness, understandability and memorialisation. This way, the facility meets different aims: preserving knowledge, demonstrating waste management concepts and solutions, public accessibility of information, site memorialisation, reinforcing regional identity, generating tourism revenue and/or recreational amenity (NEA, 2007). These museums may allow visitors and future generations firstly, to understand the technical dimension of the waste management activity and secondly, to show the culture of the host community and its active relationship with the facility (*ibid*).

In Table 2 below, references to FSC documents are included, showing the role of local communities in contributing to maintaining the memory of a repository and their involvement in different aspects of monitoring.

Table 2. References to the role of local communities in preserving RK&M in FSC reports

Country / representative	Reference / quote	Reference document
Belgium / STORA ¹⁸	STORA recommended a communications centre in the vicinity of the repository site, to serve as the point of reference for information regarding radioactivity, its applications and consequences. An interactive science exhibit on radioactivity (or radioactivity theme park) should be part of this centre. STORA also recommended a nuclear clearing house to promote knowledge and awareness of nuclear energy and waste.	NEA (2007)
Canada / Port Hope	The Port Hope End Use Advisory Committee has put forward an idea to build an “interpretative centre” or museum. This would pass along history on the nuclear industry and “how we got to be what we are” in the local community. Port Hope was the site of a radium processing industry, then was stigmatised by legacy waste, and finally stepped forward to manage the waste on residents’ own terms.	NEA (2007)
France / Mr. Jean Marie Krieguer (Andra)	Monitoring is important to enable reversibility, as it provides essential information on the engineered facility and its performance.	NEA (2010b)
France/ Mr. Patrice Charton	Monitoring and the issue of memory: monitoring mandated by law (“Reversibility Act” by 2015). Without memory preservation, closed down industrial sites become lost or unreadable in as little as 20-30 years. Andra system of archiving information in the Centre de l’Aube for the LILW facility. Drawings, symbols or texts microengraved may not be readable by future generations. Active memorialisation considered for the future HL and IL-LL waste repository will rely notably on maintaining exchanges with the local public. The CLIS will play a fundamental role.	NEA (2010b)

¹⁸ Formerly STOLA.

France / from round table discussions	<p>Monitoring is a key issue, principally in regard to health and environmental concerns. Communities are also asking for monitoring to measure impacts on socioeconomic variables. Monitoring should be launched before a given facility starts its operation in order to record the baseline situation.</p> <p>Local communities have an important role in contributing to maintaining the memory of a repository as they will play a crucial role when the period of institutional monitoring is over. A double back-up system seems to be the most appropriate, comprising an official, national set of mechanisms to preserve the records of the repository and an active involvement of local communities by means of their own cultural mechanisms and customs.</p> <p>Possibility of creating a unique monument in the region that would attract visitors and contribute to carrying memory forward.</p> <p>Major items: land registers and markers, regular dissemination and “translation” of the information, oral history, added value from the installation contributing to ensuring a viable place in a sustainable community, developing the culture of memory in institutions and territories.</p>	NEA (2010b)
France /Andra	The storage facilities de l’Aube and La Manche function as tourist destinations. At Centre de Stockage de l’Aube, there is a museum-like visitors’ centre.	NEA (2007)
Spain / Enresa	Laboratory facilities at El Cabril are available for use by universities and administrations, serving for research and for regional environmental monitoring.	NEA(2007)
Sweden / Ms. Josefin Päiviö Jonsson (SKI)	A major theme of the ensuing FSC discussion was “when will the implementer be freed of responsibilities?” Should this take place before or after sealing? During the post-closure monitoring period? Some FSC members thought that future government liability may prove to be a controversial issue in countries other than Sweden.	NEA (2008b)
Sweden / Oskarshamn	The municipality of Oskarshamn has considered a Science Centre or a Time Travel Museum looking at spans of hundreds or thousands of years in both historical and prospective terms.	NEA (2007)
Sweden / KSO	The idea of an on-site environmentally-oriented geoscience centre or “Experimenter Facility” was highlighted by Sweden’s Association of Municipalities with Nuclear Facilities, KSO.	NEA (2007)

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Switzerland	EKRA19 (2000) recommends the use of markers. Inter and transdisciplinary approaches are needed in order to develop marker systems than can effectively be implemented: proposals made by specialists of a single domain are often wrong. The political and sociological dimensions are important, including the semiotics, societal changes and the problem of “misuse”.	NEA (2010c)
United Kingdom	NDA report on the interest of communities in discussing the strategy for information and memory preservation	NEA (2010c)
United Kingdom / Elizabeth Gray	The UK Nuclear Archive: there are 19 nuclear sites in UK all owned and operated by different companies with different types of info collected in different ways, with differing quality and format. Beyond the location and shape of the physical building, the project looks at information and knowledge preservation. The shared intent is to deliver a memory facility for the area but there is still discussion of how to do that in practice.	NEA (2010c)
UK / Knowles & McMorro (MRWS)	<p>Local authorities seek to maximise the options for future generations. R&R could provide a means to take advantage of better technological solutions if these are developed at some point. Also, the local authorities are aware that standards and perceptions can change with time; as an example, disposal options that seemed acceptable only decades ago (Sellafield, National LLWR), no longer are considered in the same way.</p> <p>Monitoring and testing performance are also issues of concern to the local authorities, becoming perhaps more crucial as the national approach is to seek “suitable” (i.e., not necessarily “best”) geology with the repository to be designed to site circumstances. Access to potential future assets also draws attention as a potentially critical area for negotiating a solution acceptable to community and government in a region where many jobs are supported by reprocessing, and given that government intends to include spent fuel in the inventory and potentially may include plutonium and uranium.</p> <p>Importance of the opportunities which could be generated by the continued scientific research</p>	Knowles & McMorro (2010)

¹⁹ Expert Group on Disposal Concepts for Radioactive Waste set up by the Federal Department for the Environment, Transport, Energy and Communication in June 1999.

	associated with monitoring and retrievability.	
US / Ms. Janet Kotra (USNRC)	<p>Nye County (Nevada) wants to keep own record libraries about Yucca Mountain: “If the community is saying that Nye County needs a long term role and that the link between the facility and future generations is the community itself then there is a need to promote the long term role of the community as they will provide the human capital to pass on knowledge about the facility to future generations. To enable this to really develop will need cultural links to the facility possibly through energy development”.</p> <p>To date in the US, this long-term active oversight orientation has been superimposed on existing regulation and some specific rules have not yet been worked out. Long-term oversight may mean an obligation to refurbish markers and monuments, and proper ways to maintain records in order to transfer knowledge to future generations. In some regulatory frameworks credit is given for safety provided by existing institutional controls. The US regulatory requirements for disposal in a geological repository set out obligations in terms of landownership and control, records maintenance, performance confirmation, post-closure monitoring, monuments and markers, archives and records preservation and post-closure oversight.</p>	NEA (2008b)
US	Communities are now saying that they want active safety and prolonged stewardship including monitoring. There is a strong articulation of the polluter pays principle in US law which means that the fund for the repository design, construction, operation, local governance, oversight and protection measures are negotiated by the county with the implementer.	NEA (2008b)

Annex III. Online survey and Guide for interviews

The following questions were submitted via an online survey facility to the membership of the FSC in July/August 2012:

Instruction: Your programme may not have in view specific local communities at this time; in that case, please share any general information that is pertinent to local or civil society stakeholders.

1. My national programme has specific candidate or nominated site communities at this time. (Y/N)
2. Are local communities in your country asking for monitoring of the future RWM facility? (Y/N)
3. If yes, in which areas?
 - environmental monitoring
 - epidemiological monitoring
 - monitoring of socio-economic impacts
 - monitoring of physical processes
 - monitoring of institutional processes and players
 - general monitoring and control but not further specified
4. If yes, on which time scales?
 - pre-operational phase
 - operational phase
 - post-operational phase (a few hundred years)
 - post-operational phase (thousands of years)
5. Are local communities in your country showing interest in the issue of preserving RK&M of the RWM facility for time periods beyond closure? (Y/N)
6. Do any actors in your national context acknowledge that? (Y/N)
7. If yes, which actors?

8. Are there any documents in your country dealing with monitoring or RK&M preservation for RWM facilities that consider the point of view of local communities? (Y/N)

In depth follow-up was performed by interviewing persons who had provided substantial information to the survey, as well as several individuals known to the FSC who could provide direct insight into local community views. In all a total of 25 persons contributed.

The guide below was used to structure the interviews. It includes general questions which were modified depending on the interviewee and the national context.

1. *What do local communities understand as “oversight”?*
2. *Are local communities in your country interested in MONITORING? What do they understand as MONITORING?*

If no, do you have an opinion on why they are not interested?

If yes, have local communities in your country actually requested MONITORING?

- a. How they are asking for monitoring?
- b. At which phase/period (pre-operational, operational, post-operational)?
- c. What is/was the main rationale?
- d. On which areas? (environmental monitoring, epidemiological monitoring, monitoring of impacts, monitoring of physical processes – which physical processes?, socio-economic monitoring, general monitoring and control without further specifications...)
- e. Which local actors are interested in monitoring?
- f. What is being done at national and local level to address these concerns?

3. *Have local communities in your country identified /demanded to address the issue of preserving records, knowledge and memory of the RWM facility in the long-term?*

If yes,

- a) when?
- b) how?
- c) What specific areas have been identified or addressed?
- d) Time scales of interest?

If no: Why? Do you believe that they are not interested? lack of awareness? Other priorities (short-term)?

4. *Do you think that local communities in your country can play a role with regards to monitoring and record keeping?*

a) If yes, how? when, at which stage?

b) If no, why?

5. *Which do you think are the main tools (markers, registers, dissemination, oral history, etc) considered by local communities to maintain memory?*

6. *When talking of preservation of RK&M, are timescales considered similar to monitoring or different?*

7. *What are the confidence aspects of monitoring and RK&M?*

8. *Are there any studies (including documents, research, surveys, reports, policies, consultations, documented dialogues, etc) in your country dealing with monitoring and preservation of RK&M for RWM facilities considering the point of view of local communities?*

a) If yes, please provide copies within the limits of legally established confidentiality

b) If no: why do you think there are no studies on this issue (lack of interest by RWM agencies, by local communities, lack of awareness, long-term issue, etc?)

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We are grateful for the participation and contributions of stakeholders and specialists. Consultant Meritxell Martell carried out and reported the literature reviews, survey and interviews on the basis of indications by Claudio Pescatore, Principal Administrator at the OECD NEA RPRWM Division, and consultant to NEA Claire Mays, who also provided thorough review of the successive versions of this report. The study progress was presented at the FSC-13 and 14 meetings (Autumn 2012 and 2013) as well as at an RK&M project meeting in April 2013. Reviews and feedback were received from working party and project members as well as some interviewees.

Replies to the first Summer 2012 brief survey were received from 11 countries, submitted by individuals from 17 organisations, including regulators, implementers and governmental agents whose role brings them into close contact with local stakeholders. The countries, organisations and number of responses (in brackets) received to the survey were: FANC from Belgium (1), RAWRA from Czech Republic (1), POSIVA from Finland (1), ANDRA from France (1), PURAM from Hungary (1), SOGIN from Italy (1), ENRESA from Spain (1), SKB, SSM and the Swedish National Council for Nuclear Waste in Sweden (3), SFOE from Switzerland (1), NDA and Environmental Agency for the United Kingdom (2) and DoE, NRC, EPA in the United States (4).

A second brief survey in Summer 2013 received replies from a subset of countries, including Finland, Hungary, Italy, Sweden (2), Switzerland, and the UK.

Apart from the brief online surveys undertaken for this study, some stakeholders provided more extensive written comments or granted interviews. They are:

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