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Wat is de reële radiologische impact van de definitieve berging van radioactief afval ?

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SOMMAIRE **INHOUD**

Ce numéro contient des textes d'exposés présentés lors de la réunion organisée par l'Association belge de Radioprotection à Bruxelles, le 20 avril 2007.

Dit nummer bevat teksten van de uiteenzettingen ter gelegenheid van de vergadering van de Belgische Vereniging voor Stralingsbescherming in Brussel, op 20 april 2007.

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LE STOCKAGE DEFINITIF DES DECHETS RADIOACTIFS, Y A-T-IL D'AUTRES SOLUTIONS POUR L'OPINION PUBLIQUE ?

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Le débat sur la gestion des déchets nucléaires à vie longue se développe actuellement dans un cadre essentiellement technique, géré principalement par les experts de l'industrie nucléaire, oubliant parfois les questions réelles posées par la société civile. Quelles sont les réelles préoccupations de la société civile et y a-t-il d'autres réponses possibles à ces préoccupations ?

Le cas de la France.

La France, par exemple, a engagé un effort considérable de recherche sur trois axes définis par une loi votée en 1991, communément appelée, du nom de son rapporteur «Loi Bataille». Cette loi fixait trois axes de recherches : le tri des matières contenues dans les déchets et la réduction sélective de leur radiotoxicité par transmutation des radionucléides à vie longue, l'enfouissement en profondeur, le conditionnement et la surveillance dans des installations de surface (Loi 1991).

Quinze ans après, comme le demandait cette loi de 1991, le Parlement – après avoir pris connaissance des réflexions d'une Commission nationale d'évaluation indépendante (CNE 2006) et organisé un débat public – a prolongé encore pour plusieurs années les efforts de recherches à faire, avant d'adopter une solution définitive de stockage des déchets radioactifs.

Mais d'une loi à l'autre, y a-t-il réellement une modification des concepts envisagés pour répondre aux préoccupations réelles des populations ?

La notion de «parties prenantes».

Depuis l'accident de Tchernobyl et la première loi de 1991, les dimensions sociales de la radioprotection ont considérablement changé. Tirant leçon des difficultés à gérer les conséquences de l'accident de Tchernobyl, aujourd'hui, l'Agence de l'OCDE pour l'énergie nucléaire (AEN) a, par exemple, proposé une implication plus forte des parties prenantes ou «stakeholders» dans la gestion des situations de crise, mais aussi pour la gestion des déchets radioactifs (AEN 2006).

Depuis, la Commission internationale de protection radiologique (ICRP), ainsi que d'autres agences internationales et des autorités de sûreté nationales prônent l'implication des parties prenantes dans ces situations avant la prise d'une décision. Elles en font même une condition du succès des opérations futures. Faut-il encore que le dialogue s'établisse sur des bases claires répondant aux préoccupations premières des populations.

Une approche inchangée de l'estimation du risque.

L'estimation du risque est aujourd'hui basée, mise à part pour le radon, sur une approche dosimétrique, que la source d'irradiation soit externe ou interne à l'individu irradié.

Pour des raisons d'efficacité opérationnelle, la CIPR a bâti un système dosimétrique et d'estimation du risque sur le concept de dose efficace, permettant l'additivité de toutes les doses d'irradiations et de leurs effets quelle que soit la nature du rayonnement et que l'exposition soit d'origine externe ou interne à l'individu exposé. Ce système remplit parfaitement son rôle dans la gestion des situations de routine que l'on appelait «pratiques» et le bilan de la radioprotection depuis son instauration est excellent.

Ce concept de dose efficace se fonde sur la notion de relation linéaire sans seuil, hypothèse non scientifiquement vérifiée, mais qui est considérée par les professionnels de la radioprotection comme un outil de gestion performant et efficace ce que rappelle la CIPR dans ses nouvelles recommandations *«Use of so-called LNT is considered by the commission to be* ***the best practical approach*** *to managing risk from radiation exposure»* (ICRP 2007).

Cette notion a conduit toutefois à des dérives que la CIPR a voulu corriger dans ses nouvelles recommandations; l'utilisation abusive de la dose collective, dans le temps et dans l'espace en est un exemple.

Les bases de la sûreté des déchets à vie longue.

Le challenge posé à l'énergie nucléaire est de faire la démonstration que la gestion de ses déchets sera sans danger pour les générations futures. Différentes échelles de temps sont considérées pour évaluer la sûreté des différentes options du stockage des déchets radioactifs.
La phase opérationnelle qui est la période entre la mise en place des déchets et la fermeture du site peut prendre plusieurs décades
La phase dite thermique - pendant laquelle les déchets génèrent une augmentation importante des températures - est estimée à 300 ans pour les déchets vitrifiés et 2000 ans pour le stockage direct du combustible usé.
La phase d'isolation durant laquelle le relargage à partir du site, des radionucléides dans l'argile des déchets de haute activité est négligeable, durera entre 1000 et 10000 ans après la clôture du site.
La phase géologique où le stockage entre dans les échelles géologiques doit durer de 10000 ans à des millions d'années. L'impact maximal est considéré actuellement comme liée au relargage différé pendant cette période.

Cette affirmation est basée sur les bases de l'intégrité physique du confinement et, lorsque celui n'est plus considéré comme suffisamment sûr, il est nécessaire d'évaluer les doses ou risques et de s'assurer du respect des objectifs fixés par les autorités de sûreté.

Quel scénario de retour à l'homme?

Compte tenu des règles de sûreté rappelées ci-dessus, le retour à l'homme se fera par la contamination des eaux de surface et de facto de la chaîne alimentaire. La contamination interne sera la conséquence d'une ingestion chronique de faibles quantités de radionucléides à vie longue, ce qui conduira à la délivrance de faibles doses à faible débit de dose.

Le système actuel est-il adapté à cette situation exceptionnelle?

Le système actuel est basé essentiellement sur le suivi des survivants des bombardements d'Hiroshima et de Nagasaki et sur les connaissances acquises après irradiation externe. La particularité de la contamination interne est plus ou moins incorporée dans le calcul de la dose efficace par la prise en compte de facteurs de pondérations tissulaires, mais elle suppose une irradiation homogène de l'organe, ce qui n'est pas avéré, loin s'en faut avec les émetteurs alpha (Lafuma 1974). De plus nous savons que les effets du débit de dose ne sont pas négligeables bien que considérés actuellement pour les irradiations externes que d'un facteur 2.

Aujourd'hui, le lien entre cette approche dosimétrique bâtie pour les pratiques actuelles et le risque réel est de plus en plus contesté pour la contamination interne par des émetteurs à fort TEL et à vie longue (AEN 2007). C'est exactement le scénario de la gestion du risque radiologique lié aux déchets radioactifs dans 10000 ans.

Dans son nouveau document, la CIPR accepte la remise en cause de la relation linéaire dans des situations exceptionnelles. *«**Although there are exceptions,** for the purpose of radiological protection the Commission judges that below around 100 mSv, it is scientifically reasonable to assume that the incidence of cancer or hereditary effects will rise in direct proportion to an increase in the equivalent doses».*

La CIPR reconnaît dans son nouveau texte les limites de cette relation en réduisant considérablement le champ d'application de la dose collective; *«Because of this uncertainty on effects at low doses the Commission judges that **it is not appropriate,** for the formal purposes of **public health,** to calculate the **hypothetical** number of cases of cancer that might be associated with **very small radiation doses** received by large numbers of people over very long periods of time».*

La question qui se pose dès lors est : l'ingestion chronique de faibles quantités de radionucléides à vie longue est-elle une situation exceptionnelle ?

Bien que la réponse soit « non » puisque les populations du monde entier ingèrent de manière chronique de faibles quantités de radionucléides, nous n'avons pas de réponse claire prouvant que ces ingestions soient susceptibles de provoquer des effets sur la santé. À ce jour, seules des études en cours en Finlande ont pour objectif de vérifier la pertinence de cette question (Salomaa et Ikäheimonen, 2005).

Ces études aideront à répondre aux questions des populations locales sur l'impact sur leur santé du stockage de déchets lorsque l'éventuel retour à la surface des radionucléides à vie longue aura lieu. Cette préoccupation - si elle concerne bien évidemment les populations - s'adresse principalement à leurs descendants et les générations futures au travers de la contamination éventuelle de leur lieu de vie et de leur chaîne alimentaire par ces déchets.

La remise en cause de cette loi linéaire pour la contamination interne

Les récentes observations scientifiques remettent en cause bien des certitudes. Que signifie une irradiation alpha ? Que sait-on vraiment en termes dosimétrique et de risques sur la chronicité des expositions ? Autant de questions pour lesquelles nous n'avons pas toujours la réponse et qu'il faut donc poser.

La contamination chronique est-elle la somme de contaminations aiguës ?

En termes de dosimétrie, la CIPR, dans ses publications 67 et 69, affirme sans vraie démonstration que la dose résultant d'une irradiation chronique est identique à celle liée à une irradiation aiguë pour une quantité de radionucléide incorporée identique:

- « The doses calculated in this report in Part 1 are for acute intakes. For chronic intakes doses may be less than those calculated here where growth is substantial during the period of intake. » (ICRP 1994),
- « For chronic intakes, doses per unit intake could be somewhat less than those calculated here where growth is significant during the period of intake….. These coefficients can also be applied to chronic

intakes for protection purposes by determining the committed doses for each year's intake and summing for intakes over all years. » (ICRP 1995)

Nous avons vu par le passé que l'ingestion chronique de plutonium ne suivait pas, par exemple, les schémas biocinétiques annoncés basés sur une incorporation unique (Renaud Salis et al 1990). Des observations similaires sont rapportées pour l'uranium (Paquet et al 2006) ainsi que pour d'autres radionucléides ; ce qui a conduit récemment la CIPR à modifier son modèle dosimétrique alimentaire (ICRP 2006).

Ces modifications ne sont pas encore intégrées dans les études dosimétriques concernant les stockages à long terme.

Ce que nous savons

10000 ans après le stockage définitif, ne resteront que les radionucléides à vie longue dont les activités spécifiques seront obligatoirement faibles. On peut rappeler ici par exemple les activités spécifiques de quelques émetteurs alpha en comparant les masses de radionucléides émettant le même nombre de particules alpha que l'on rapportera à 1 µg de l'isotope ^{210}Po.

	Période	Masse
^{210}Po	138,4 j	1
^{238}Pu	87,7 ans	4 500
^{226}Ra	1 600 ans	262 000
^{239}Pu	24 100 ans	72 000 000
^{237}Np	2 140 000 ans	3 180 000 000
^{238}U	4 468 000 000 ans	446 000 000 000

On voit bien que pour délivrer une même énergie, il faudra des quantités considérables de radionucléides à vie longue, qui peuvent conduire à des impossibilités au niveau du scénario d'ingestion.

Autre question : peut-on à la fois craindre les radionucléides de haute activité et à vie longue comme le laisse entendre la définition HAVL; ce concept est à préciser car il peut entretenir des confusions au niveau du public.

Rappelons également que l'activité spécifique de certains radionucléides limite considérablement les quantités pouvant s'accumuler dans l'organisme. Ainsi 12 mg d'^{129}I, quantité pondérable que renferme une thyroïde humaine correspond à 60.000 Bq en unité de radioactivité. Cette radioactivité serait donc la valeur maximale que pourrait contenir la thyroïde si tout l'iode de la planète était composé du seul isotope 129.

La question est dès lors : après contamination interne chronique de radionucléides à vie longue, les schémas dosimétriques actuels sont-ils toujours valables pour ce scénario? Seule l'expérimentation nous permettra de répondre à cette question.

Au niveau du risque, nous savons que les émetteurs alpha peuvent conduire à des réponses différentes de la relation linéaire sans seuil (Raabe *et al* 1981) (Raabe *et al* 1983) (Park 1990) (Sanders *et al* 1991) (Park 1992) (Sanders *et al* 1993) (Hohryakov et Romanov 1994).

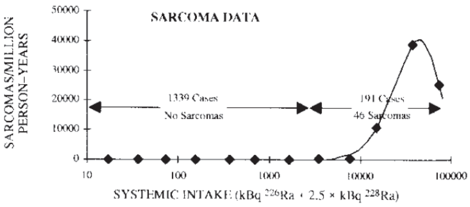

Figure 1: Relation dose-effet pour les ostéosarcomes chez les femmes peintres de cadrans lumineux au radium (d'après Rowland 1995).

L'observation des ostéosarcomes chez les peintres de cadran lumineux montre que la relation dose-effet ne répond pas à une relation linéaire sans seuil comme le montre la figure 1 ci-dessus (Rowland 1995) alors que les carcinomes de la tête sont plus proches d'une représentation linéaire. Ainsi la relation dose-effet varie avec la dose contrairement aux prédictions du modèle de la CIPR.

Après inhalation d'oxyde de plutonium chez le rat, C.Sanders montre clairement que là encore l'apparition de cancers pulmonaires ne répond pas à une relation linéaire sans seuil (Figure 2).

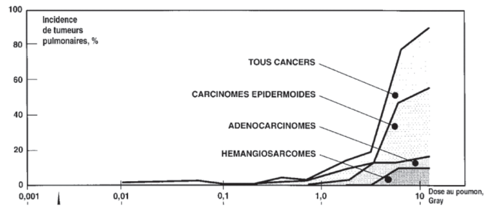

Figure 2: Incidences de cancers pulmonaires chez le rat après inhalation d'oxyde de plutonium 239 (d'après Sanders et al 1991 et 1993).

Une réponse identique est observée par J.F. Park chez le chien après inhalation de ^{239}Pu mais aussi de ^{238}Pu. Et si l'on se réfère à la publication de Hohryakov et Romanov (1994) concernant les travailleurs de Mayak, l'apparition de cancers, tout comme dans l'expérience de C. Sanders chez le rat, ne répond pas à une relation linéaire. Chez le singe, un déficit de cancers est observé après inhalation d'oxyde de ^{239}Pu si l'on se base sur une prédiction dosimétrique (Métivier *et al* 1989).

À dose égale, nous savons également, comme le montre le tableau 1, que plus l'irradiation des poumons par des émetteurs alpha est homogène, plus le risque est élevé (Lafuma *et al* 19974) (Dagle *et al* 1989). Cette observation démentant de manière catégorique la théorie du point chaud évoquée il y a plusieurs années et qui refait malheureusement surface au gré des phantasmes des personnes peu au fait.

	Risque cancer
^{244}Cm nitrate	1
^{238}Pu oxyde	0,7
^{238}Pu nitrate	0,5
^{241}Am nitrate	0,4
^{241}Am oxyde	0,3
^{239}Pu nitrate	0,2
^{239}Pu oxyde	0,2

Tableau 1: Comparaison de l'incidence des cancers du poumon en fonction de l'homogénéité de l'irradiation pour un nombre de particules alpha émises identique. (D'après Lafuma, 1974)

Enfin, nous avons remarqué, lors d'expériences de lavage pulmonaire chez le babouin, que la dose évitée par l'élimination d'oxyde de plutonium n'était pas corrélée à l'espérance de vie gagnée par l'élimination du plutonium, mais bien supérieure au seul bénéfice de la dose évitée (Nolibé *et al* 1989). Ceci a été expliqué par une redistribution des particules de plutonium restant au sein du poumon puis encapsulation de l'oxyde par une coque de collagène, protégeant ainsi les cellules à risque d'une irradiation supplémentaire.

Quelles études envisager alors pour répondre aux préoccupations entourant la gestion des déchets radioactifs à vie longue ?

Les observations passées sur la cancérogénèse liée à l'incorporation de radionucléides à vie longue et plus particulièrement aux émetteurs alpha montrent que la réponse dosimétrique ne permet pas d'affirmer clairement ce que seront les effets sur la santé du retour à l'homme des radionucléides à vie longue. Peu d'études sont faites par la voie de l'ingestion. De plus, nous n'avons aucune information pour les produits de fission, ^{99}Tc, ^{135}Cs et ^{129}I.

Il semble que de nouveaux programmes de recherche soient absolument nécessaires pour répondre aux questions légitimes des populations concernées par une situation exceptionnelle. Ces programmes devraient se baser sur des études toxicologiques aujourd'hui abandonnées et prendre modèle sur l'industrie pharmaceutique lorsque cette dernière demande l'autorisation de mise sur le marché d'un médicament (les AMM).

Cette démarche est contraignante et bien encadrée par la réglementation européenne (Commission Européenne, 2001). Elle demande en premier de la part des demandeurs une étude de pharmacocinétique et de toxicologie pour chaque forme galénique et pour chaque voie d'administration. La législation précise encore qu'aucune étude *in vitro* même si elle peut aider à comprendre les mécanismes d'action ne peut remplacer l'étude dans un organisme entier de la toxicité du produit avec une bonne fiabilité.

Transposée à notre problème de gestion des déchets, l'application d'une démarche similaire devrait conduire à étudier la toxicité des radionucléides par la voie ingestion pour des doses correspondantes à celles qui sont censées atteindre l'homme. Il faudrait donc lancer des études de toxicologie par ingestion chronique de faibles quantités des radionucléides à vie longue tels les ^{135}Cs, ^{129}I et actinides.

De premiers résultats observés en Finlande chez l'homme exposé quotidiennement à une contamination de son eau de boisson par de l'uranium naturel montre que les modèles prescriptifs de la CIPR, utilisés actuellement pour les études d'impact des déchets sont battus en brèche (Kurttio *et al* 2005) et que même à des concentrations relativement élevées en uranium, aucune toxicité rénale n'est observée (Kurttio *et al* 2006). L'approche dosimétrique aujourd'hui proposée nous paraît donc dès lors devoir être complétée pour répondre aux questions du public.

Conclusion

Les recherches menées tant en France qu'en Europe pour améliorer les connaissances techniques sur la gestion des déchets et la recherche de solutions techniques nouvelles ont largement fait progresser nos connaissances sur ce sujet. Les connaissances ont incontestablement progressé et permettent d'asseoir la gestion des déchets radioactifs sur des bases scientifiques solides (CNE 2006). En France, la loi a aussi permis d'apporter au public une information réservée jusque-là aux experts.

Il n'en demeure pas moins que, quinze ans après l'adoption de cette loi, l'acceptabilité des populations n'a pas beaucoup progressé. Tout comme il y a quinze ans, on ne cherche pas, semble-t-il, à vouloir répondre de manière directe à la question posée par les populations : quel est le risque pour ma santé et celle de nos descendants si mon eau de boisson ou mes aliments sont contaminés? Les études de radiobiologie si utiles qu'elles soient ne permettent pas aujourd'hui de répondre clairement à cette question.

Il nous paraît alors qu'à l'époque où tout le monde s'accorde pour engager un dialogue avec les «parties prenantes», il faudrait élargir le champ de recherches proposées et lancer de nouvelles recherches de toxicologie pour répondre efficacement aux craintes des populations sur leur santé. La démarche efficace mise en place par l'industrie pharmaceutique pourrait et devrait nous servir de modèle. Cette démarche, conjuguée aux efforts à venir pour diminuer le terme source dans le programme international *«Generation IV International Forum»* (CEA 2005) pourrait, espérons le, modifier l'attitude du public face à ce problème récurrent de la gestion des déchets radioactifs.
Cet effort demandé doit rassembler toutes les compétences mondiales en la manière, Il pourrait tout naturellement trouver sa place dans ce nouveau programme de recherche qu'est le forum international «Generation IV ».

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THE RADIOLOGICAL SAFETY OF DISPOSAL OF RADIOACTIVE WASTE IN BELGIUM

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National context

Since the start of the research programmes (research, development and demonstration or RD&D) on disposal of radioactive waste in Belgium a distinction was made between the disposal of the short-lived waste, for which surface disposal was the reference option, and the high-level and long-lived waste, for which the deep disposal in a stable clay layer is the reference option.

Since the governmental decision of June 23, 2006 the disposal programme for the short-lived waste has entered the project phase. The main objective of this phase is the preparation of a license application by 2010, in continued dialogue with the local stakeholders.

The deep disposal programme of high-level and long-lived waste is focusing on the Boom Clay layer as a potential host rock. The research programme was started in the seventies and with SAFIR (1989) and SAFIR 2 (2001) two major state-of-the-art reports on the national programme were published. Although there is a broad international consensus for deep disposal, with national decisions for deep disposal as the option to be implemented (e.g. in Sweden, Finland, US, France, Switzerland, …), no high-level policy decision for disposal has yet been taken in Belgium.

An important evolution on the international and national level the last two decades has been the increasing attention for and effort on the dialogue with societal stakeholders. On the Belgian level the partnerships with the municipalities of Dessel, Mol and Fleurus/Farciennes for the short-lived waste programme are illustrating this increased attention for the non-technical dimension of disposal programmes.

Disposal is legally defined as the emplacement of waste in an appropriate facility without the intention of retrieval. On the other hand the possibility to retrieve the waste has been defined in Belgium as an important design requirement for the disposal of short-lived waste with the decision of the Council of Ministers in 1998. An equivalent decision for the high-level and long-lived waste has not been taken yet.

Regulatory framework on safety and protection

The different levels of the radiological safety and protection regulatory framework are:

- International conventions (such as the London sea dumping convention and the non-proliferation treaty) and recommendations (ICRP and IAEA);
- European directives on radiation protection and environmental protection;
- Federal radiation protection regulations and regulatory guidance;
- Regional regulations on environmental matters.

Principles of radiation protection

Besides the general ICRP recommendations on radiation protection (e.g. publication 60 in 1990), ICRP has also formulated specific recommendations related to long-term radiological safety of disposal of radioactive waste. An important emphasis is placed on the optimisation principle. Optimisation is seen as a judgmental approach, based on sound engineering and managerial principles, rather than a formal cost-benefit analysis.

On the international level there is also an ongoing discussion of the ethical principles related to the protection of future generations. Even if we have the duty and responsibility to protect future generations, we are also clearly limited in our ability to take decisions that can guarantee protection over very long time scales. How this balance can be or should be struck is also a matter of an ongoing international (and in some countries national) debate.

The assessment of long-term safety of disposal

The challenges when dealing with the long-term safety assessment of disposal of radioactive waste are related to:

- the long time scales that have to be dealt with (hundreds to many thousands of years);
- the increasing uncertainties with respect to system behavior and system performance;
- the regulatory definition of protection criteria for the far future.

In the methodological approach for assessing long-term safety of disposal the following elements are essential:

- the robustness of the system (i.e. a performance that is not much affected by remaining or irreducible uncertainties);
- the scientific basis leading to adequate system understanding;
- the quality and characteristics of the site and design that provide safety;
- safety assessments provide only cautious indications of safety and can not be considered as exact predictions of system behavior and performance;
- use is made of multiple lines of arguing and reasoning to assess system safety, e.g. with the use of multiple safety indicators (dose, risk, radionuclide fluxes and concentrations, radiotoxicity and activity comparisons with natural situations, …);
- uncertainty management as a central element of safety assessments and in the development of the scientific and technical assessment basis.

Long-term safety of surface disposal of short-lived waste

The three main elements contributing to the long-term safety of surface disposal of short-lived waste are:

- the containment and isolation by the engineered barrier system
  - a site with favourable characteristics has to create the environment that does not disturb this engineered containment and isolation (e.g. seismic and geomechanical stability, no risk of flooding);
  - there is design flexibility, such that to some extent weaker elements of a site can be compensated by the engineered barriers.
- an active institutional control & surveillance over 200 to 300y
  - to avoid human intrusion, that can lead to exposure risks and system disturbance;
  - to control and guarantee negligible releases, i.e. control of containment function of the engineered barriers;
  - to allow periodic (e.g. 10 years) safety re-evaluations;
  - to organize the transition from active control to passive control (based on aspects such as land use restrictions, markers, archiving of information, …)
- limits on total activity and activity concentrations of the safety relevant radionuclides
  - limitation of some long-lived activation and fission products and actinides;
  - to be implemented through a system of waste acceptance criteria and procedure.

Long-term safety of deep disposal of high-level and long-lived waste

The long-term safety of deep disposal relies on the following main elements:

- the natural clay barrier as the major contributor to the isolation and containment of the radioactive waste.
  - Radionuclide migration times of more than 10^4 y for the non-retarded fission and activation products like Cl-36 and I-129, and up to many millions of years for the strongly retarded actinides;
  - Stability of the Boom Clay over geological time scales (10^6 years);

    - Determining for long-term safety are the long-lived non-retarded fission and activation products.
- The engineered containment of the heat-emitting HLW and spent fuel by metallic containers in concrete buffer during thermal phase (a few thousand years);
- The durability of waste matrices that is cautiously assessed; this is not a determining factor for long-term safety.

Final considerations

- At the current level of knowledge, both on the national and international level, and in view of the legal framework in force, there is a broad consensus that disposal solutions under development can offer sufficient protection to man and environment for the waste to be managed (current nuclear energy programs).

  Given the long time scales to be dealt with the ethical dimension of the problem has to thoroughly and openly discussed at a broad international and national level.
- The importance of a multi-disciplinary step-by-step development of a disposal solution
    - Based on periodic re-assessments of knowledge, arguments and uncertainties through decision oriented safety cases;
    - Based on a balanced technical and societal process and approach.
- Important challenges for the near future in Belgium are:
    - Project category A – licence application by 2010 in a continued collaboration with the local stakeholders and authorities;
    - Confirmation of a national long-term management policy for the category B&C waste through a process of a broad societal dialogue;
    - Establishment of the basis for the siting process, again in a process of dialogue with the parties involved.

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CITIZEN PARTICIPATION IN HIGH-LEVEL WASTE MANAGEMENT A BRIEF COMMENTARY.

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1. Introduction

In recent years I have been drawn personally (as a researcher) into lively discussions on the pros and cons of public participation in decision making involving complex technological choices. Over the years, an ever expanding circle of people seem to have developed an interest in (the outcomes of) such debates. Members of academia, self-employed consultants, business managers and public servants alike appear to hold sincere convictions that the answer to a number of wide-ranging contemporary problems (e.g. the 'great divide' between experts and laymen or political representatives and citizens; sweeping economic and technical changes with associated problems of social exclusion, etc.) lies in a greater degree of 'involvement' or 'participation' of the people most affected by these dynamics. In the context of radioactive waste management (RWM), there has been a noticeable change over the past decade in governance practice. Formerly the area was characterised by severe and sometimes violent polarisation between actors, typically in the context of top-down attempts to site a management facility in a (more or less) unwilling host community. By now, in many Western countries one can observe the emergence of innovative programs of cooperation among stakeholders, ranging from organised dialogue to formal partnerships[1]. Views on societal and technological solutions for

1 A number of European research initiatives reflect the increasing importance attributed to citizen or stakeholder involvement in RWM: the network COWAM (Communities and Waste Management) was the first European forum for dialogue among the full range of stakeholders, while the priority themes identified there have been researched in a participative manner by COWAM 2. A third and currently ongoing program, COWAM in Practice (CIP), will foster national working groups devoted to researching and proposing solutions for governance problems identified by the stakeholder participants. The EC-sponsored RISCOM II project has offered a model for understanding and achieving transparency (identified by the EU White Paper as one of the chief requirements for good governance). There has been intense elaboration and input worldwide from social scientists on deliberative methods and theory, and experimentation with reframing through consultation and involvement, on local or national levels. The RISCOM approach is now being further elaborated in the ARGONA project (ARenas for waste GOverNAnce).

managing short-lived low- and intermediate level waste (LILW) or long-lived intermediate and high-level waste (HLW) are not necessarily shared among these stakeholders, technical proponents and public authorities[2]. However, the parties engaged in these innovative governance approaches increasingly share the idea that radioactive wastes do exist and need to be handled properly and that therefore RWM, independently of national energy choices, is a common concern. Increasingly, too, stakeholders share the objective of developing fair and equitable decision-making processes in RWM in order to reach sustainable options acceptable for both present and future generations. In sum, there seems to be a general interest in the gradual building and testing of more inclusive governance models, distributing power and problem framing across a broader base.

Such a description may at first glance convey a rather harmonious picture of public involvement in RWM, but – as with most things – the devil is usually in the details, and it is there that the picture becomes more complicated and ambiguous. The present contribution to the debate therefore aims to offer some (although necessarily limited) reflections on whether we are justified in fostering such high hopes for participation in the context of new approaches to RWM in general, and HLW management in particular. I believe that in the present climate of either enthusiastic excitement or panicky chatter (depending on the point of view), it may be wise to take a breath and make room for a moment of reflection. For this purpose, I will comment on some ideas or propositions advanced in the papers of Peter De Preter and Henri Métivier published in the present issue of *Annalen van de Belgische Vereniging voor Stralingsbescherming*[3]. However, before going into the specifics of these contributions to the debate, I propose to first open up the horizon a bit further and reflect on the supposed benefits of public participation in policy making in general. Therefore, I will start off with an analysis of 'participation' from the vantage point of everyday language use. Such investigation, even if only summarily undertaken in the present context, can be very helpful in bringing out the 'fuzzy' network of themes, topics and expectations.

2 Furthermore, disagreement subsists among various groups in society on whether to continue to exploit the nuclear power option; clearly, national energy scenarios and therefore the waste volumes to be generated in the future will have impact on the strategies and decisions considered now.

3 First presented in a BVS meeting on 20 April 2007.

2. Participation, yes… – but what do you mean precisely?

2.1. A vernacular understanding

No matter how intricate the philosophical theories and classifications, at the most fundamental level they are always rooted in everyday experience shared in everyday language. This is the case also for the concept of ‘participation’, hence the need for some clarification on that level.

A quick dictionary search shows that the word ‘participation’ is used in many different ways. Synonyms include ‘attendance’, ‘entry’, ‘membership’, ‘engagement’, ‘involvement’, ‘joint management’, ‘say’, ‘voice’, etc. All of these words include a notion of ‘partaking’, but their use is not restricted to specific contexts: one can participate in economic, social, political, and many other types of activity. Most of the time ‘participation’ is accepted as something positive, but nevertheless, taken by itself, the notion of ‘partaking’ is quite neutral: one can participate in projects with ‘good’ or ‘evil’ outcomes, and one can do so willingly or unwillingly. Participation can also be more or less intense (hence the distinction between ‘active’ vs. ‘passive’ forms of participation). Etcetera.

Perhaps it is useful to clarify things a bit further by using the metaphor of a game. There are many kinds of games, but all have particular objectives (defining what that particular game is all about), rules (which have to be understood by all players in order to play the game fairly) and strategies (which players can rely on to play the game successfully). Participation in the game can then be promoted on a number of accounts: e.g. to restore a notion of ‘fair play’ shared by participants, to bring new players into the game (which were previously excluded because they felt the game was too difficult for them, or because they did not belong to the right social class, etc.), or to ensure that every player understands the rules correctly so that each can chose an appropriate strategy. In a more radical sense, for some of the players ‘participation’ can also mean having a say in the rules of the game, or, to carry the matter to the extreme, re-inventing what the game is all about. Substituting ‘objectives’ by ‘social order’, ‘rules’ by ‘institutions’, ‘strategies’ by ‘action’, and ‘fair play’ by ‘social peace’ already gives you a fair idea of the issues at stake when ‘the game’ is a political one… Finally (but this is really stretching our ‘game’ metaphor) if life experience is seen as the sum of experiences gained in different games, or simply as the enjoyment one gets out of playing (without any real objective), participation can also mean enhancing opportunities for people to consciously choose whatever games they want to participate in order to lead a fruitful and fulfilling life.

2.2. Participation in complex technological issues

Let us return to the issue at hand, namely participation in technological decisions. Difficulties of generalisation notwithstanding, two (mutually intertwined) problematic issues stand out in the very large and equally diverse body of scientific thought dealing with technology assessment and/or policy: *uncertainty* and *inequality*. Participation is frequently advanced as a remedy to both (Rahnema 1992; Joss & Bellucci 2002).

The issue of *uncertainty* is widely seen as a key characteristic of modern science and technology. In fact, it is the main driving force behind different policy movements such as the acceptance of the precautionary principle as a guideline for environmental and health policy on a national and international level, and behind new developments in technology assessment practices. The claim is that a particular (technological) choice can only be justified fully if policy makers are ready to anticipate and reduce the uncertainties linked to this choice, or at least clearly state the limits of 'state-of-the-art' knowledge.

On the other hand, the issue of *inequality* reflects the fact that resources and opportunities to influence the decision-making process (starting from defining or structuring the problem definition to implementing solutions) are not the same for everyone. Additionally, those who take decisions may or may not be those who in the end become affected.

Developing things a bit further, both issues can be clarified by drawing upon an analytical distinction (in an ideal-typical sense) between three dimensions of human action and understanding: a cognitive, normative and a pragmatic one. Hence, this leads to the following scheme:

Uncertainty:

- **Cognitive uncertainty:** with knowledge production accelerating, cognitive uncertainty may be generated as the understanding of phenomena becomes ever more complex, and at the same time, principal limits of knowledge emerge. This is often called the 'problem of expertise': policy makers are often faced with a lack of uncontested factual knowledge;
- **Normative uncertainty:** scientific developments might raise new questions and problems for which ethical principles or existing standards or norms are not applicable. Alternatively, it might be unclear which values are at stake for different social actors or the public at large;
- **Pragmatic uncertainty:** results from the difficulties encountered in policy-making processes to reach conclusions and, under the above-mentioned conditions of cognitive and normative uncertainty, to implement decisions in a turbulent social environment. Not only the consequences of developments, but also the reactions of social actors and the possible interactions with other policy fields can be very uncertain.

Inequality:

- **Cognitive inequality:** reflects the inequalities in the degree to which different social actors have knowledge of technological and scientific issues;
- **Normative inequality:** reflects the plurality of (possibly conflicting) norms and values on a particular technological development;
- **Pragmatic inequality:** reflects the unequal distribution of institutional or informal influence on decision-making processes shaping the technology in question, as well as the unequal distribution of resources that enable actors to take part in such processes.

It is often argued that over the last decade or so problems related to uncertainty and inequality in technology policy have become more exacerbated in our increasingly 'complex' world. In any case, policy makers either implicitly or explicitly **have to** make a choice regarding issues of uncertainty (i.e. ‘what is the adequate knowledge base for tackling the policy question?’) and inequality (i.e. ‘who to involve and why?’). But what would be the advantage of more ‘inclusive’ participatory policy processes in a ‘complex world’? Well, in *cognitive* terms, participation is expected to regenerate technological developments on the basis of a different mode of understanding, in particular the locally produced knowledge of the environments new technologies are supposed to work in. In *normative* terms, participation is seen as a new source of legitimacy, no longer stemming from the top-down dictates of authorities and their associated experts, but rather from following correct and inclusive procedures giving a ‘voice’ to the otherwise ‘voiceless’. Finally, in *pragmatic* terms, the claimed advantages of the participatory approach include giving new and creative answers to failed (top-down) strategies, with a view to include ‘patients’ in their own care.

In this participatory view on policy making, communications and interactions among multiple actors evidently are of key importance. The challenge is to somehow advance in the direction of effective checks and balances in between different actors in a (technology) policy debate, inhibiting any communicative distortion through the use of coercion, and thereby assuring the **quality** of ongoing interactions and communications. This in turn implies judging ongoing interactions from a certain ‘vantage point’. Therefore, the issue at hand is not just to promote participation as such; rather, one should meticulously consider the reasons why participation is sought after in a particular context, and carefully prioritise and implement the interventions needed to promote a more participatory mode of decision making in the ‘real world’, which will always be marked by political power games and manoeuvres (Goorden 2007). In the next two sections, we will tentatively investigate the ‘participatory potential’ present in the two decision-making contexts sketched by Henri Métivier (section 3) and Peter De Preter (section 4).

3. How can future generations participate in questions pertaining to their health and safety?

Management of radioactive waste is in many respects a classical representative of the class of intractable technological problems introduced in the previous section. What makes this problem so difficult to handle is not only the technical knowledge required to build and operate RWM facilities, but also the complex ethical questions it raises. Different actors in the debate tend to adhere to different conceptions of (environmental) fairness and justice. For instance, the general opinion among scientific experts (geologists, engineers, modellers, assessors, etc.) in the field is that by striving towards the best technical solution (from the point of view of safety and health-related criteria) and by trying to find the perfect site matching these criteria, people will be rationally convinced and will accept the solution proposed to them. Setting aside the fallacy of this reasoning from a purely strategic point of view (as witnessed for instance in the Belgian experience with siting a LILW repository – cf. De Preter's paper), this 'expert logic' tends to be at odds with other legitimate perspectives. For instance, local candidate communities for hosting a radioactive waste repository will refer to a principle of autonomy and correspondingly expect to have a say in the final decision. Thus, according to the latter position, 'justice' means that local actors should have the opportunity to learn about the advantages and disadvantages of various RWM options and, having considered these, decide on acceptance or rejection of these options. Furthermore, there is the difficult question of relating the justification for building and operating a RWM facility to the justification of the activities generating the waste in the first place (nuclear industry, hospitals, universities, research centres, etc.). And – to make matters even worse – questions of intragenerational ethics (distribution of costs and benefits over current generations) are compounded by questions of an intergenerational nature (distribution of costs and benefits over present and future generations). Still, these different conceptions somehow have to be reconciled in one integrated long-term solution. Conceptually, this integrated solution has to address the terms of a distributive formula expressed as follows: ***«Who distributes what to whom by what procedures and with what outcomes?».*** Furthermore, such an integrated solution will have to address the different logics of the different stages involved in RWM (i.e. strategic choice between a number of general RWM options, site selection, repository pre-design on a conceptual level, detailed design, implementation, operation, and post-closure).

In his paper, Henri Métivier discusses mainly the questions related to the post-closure phase of a HLW repository – i.e. the phase following the 'sealing' of the repository, during which active monitoring activities are no longer planned to take place. In this phase, the overriding substantive ethical issue related to RWM is one of presenting convincing evidence that the impact of the HLW repository on human and environmental health within 'acceptable' limits. This particular aspect of HLW management is highly unusual – even compared to other complex technological issues – in the sense that it is unique for the environmental impacts of a technological programme or option to be assessed within a timeframe of one million years and perhaps even more. Nevertheless, Métivier reports in his paper that the experts who look into this question continue to rely on the standard dosimetric approach to risk assessment as developed by ICRP, despite the fact that the radiation exposure conditions from which this risk assessment model were derived (mainly the data obtained from the follow-up of the victims of the Hirosjima and Nagasaki bombings – i.e. people externally exposed to high doses of ionising radiation at high dose rates) differ enormously from the likely exposure patterns resulting from the very slow diffusion of radionuclides from a waste repository to the surface level (contamination of surface water and of the food chain, resulting in internal contamination due to a chronic ingestion of small quantities of long-lived radionuclides – in sum, internal exposure to low doses of ionising radiation at low dose rates). Hence, the question raised by Métivier: do the high-ranking experts and expert bodies (such as ICRP) answer the basic question put by the future local populations (i.e. 'Which impact will the radioactive waste buried here have on our health?') or do they rather pursue a different agenda – i.e. one of steering away from scientific 'unknowns' into the safe haven of 'expert consensus'? Métivier's answer to the first question is negative, and the main thrust of his paper is a plea for launching a new experimental programme – one that does meet the legitimate demands of the people, since it would be based on detailed toxicological studies of the consequences of ingesting small quantities of the type of long-lived radionuclides one would expect to find in the food chain thousands of years after the repository closure. In the concluding section of his paper, Métivier suggests that this programme should be taken up as a 'natural' correlate of the 'Generation IV International Forum' (GIF) research related to the diminution of the 'source term' in HLW management. Arguably, Métivier's suggestion makes sense from a purely logical point of view. However, I question whether the logical force of the argument will suffice for making a difference in practice. I suspect that since one cannot reasonably expect laypeople to become neither proficient nor influential enough to participate in the field of radiation protection to defend their own interests, it is up to the nuclear experts themselves to 'lobby' actively in favour of such a new experimental programme at the level of influential international science policy organisations. On this point, larger questions on the functioning of such organisations enter into the picture: e.g. Who has the power to influence agenda setting in GIF?; What counts as 'sufficient evidence' for ICRP to trigger a change in its recommendations?; How can the practices of these institutions be challenged 'from the outside'?, *etcetera*. Such questions in turn call for the involvement of social science researchers (sociology, ethics, political science) in nuclear science networks…

4. Citizen participation in practice: A comment on the Belgian experience

Peter De Preter's paper focuses on the practical decision-making context of RWM in Belgium. In Belgium (as in many other countries), two main disposal programmes are running in parallel: one for the disposal of LILW, and one for the disposal of HLW. I will have a look at each of these programmes in turn, again focusing on the aspects of citizen participation.

4.1. LILW management: The Belgian partnership approach

I will not repeat here the chain of events leading to the present involvement of local citizens and stakeholders in the programme of LILW management; this history and its implications is analysed in great detail in Bergmans (2005). Within the confines of this paper, it is of course impossible to discuss in detail the pros and cons of the participation model embodied in the Belgian 'partnership approach'. Let me just quickly mention some of the most conspicuous characteristics which also help to develop an understanding of the issues related to participation. The following characteristics seem to stand out (Bombaerts et al. 2007):

- The partnerships were initiated by NIRAS – the organisation responsible for finding and implementing radioactive waste management solutions, and thus with an interest in finding a quick solution (taking into account of course all necessary safety and environmental standards) to the LILW management problem after some costly previous failures. In particular, now that the community of Dessel has been selected (by a government decision) as a potential host for the LILW repository, NIRAS seems to be very focused on moving ahead – despite the concerns raised by both Dessel and Mol to keep enough room for the flexibility inherent in the logic of participatory approaches;

- The history of the search for a LILW repository site has been marked by a quite abrupt change from a strategy based on a justification in technical terms to a more 'pragmatic' one. After the failure of a top-down approach (were potential sites were selected – without prior consultation with local communities – based on their technical suitability to host a repository), NIRAS representatives usually explain that they were no longer looking for the 'ideal' site for the 'ideal' concept, but rather for a 'suitable' site for a 'befitting' concept. This change in justificative discourse was spurred by a government decision, requesting that NIRAS should perform site investigations first and foremost in the existing nuclear communities and additionally in any municipality that would be willing to volunteer, thus promoting socio-political factors as key determinants for site selection. Quite understandably (in view of their greater 'familiarity' with the subject), the only municipalities that engaged themselves in the process were nuclear communities. So there are actually good grounds to claim there was a certain degree of 'forced participation' involved. However, in the context of RWM this seems to a large extent unavoidable, as at least part of the waste to be disposed of is already stored at one or more locations. Besides, as a counter-argument, one could posit that not all Belgian nuclear communities (e.g. Doel and Tihange, where the Belgian nuclear power plants are located) were willing to engage in the siting process and NIRAS abstained from further site investigations in those locations;

- The partnership approach puts the emphasis on local (i.e. municipal) capacities to integrate the siting project in a wider development project (thus, priority is given to local actors in participation). Doing so it limits empowerment of citizens to the negotiation of a local order – i.e. a contextually appropriate solution;

- Furthermore, the partnership approach is clearly based on a clear-cut and traditional boundary between the 'collective interest' represented by public authorities and 'local interests' represented by citizens. In effect, federal authorities (e.g. the regulator) and/or government representatives were only involved in the process 'at a distance';

- The partnerships open the discussion on expert knowledge and techniques; this enables a move away from a 'rhetoric of fear' based on risk perception and media amplification. On the downside however, the partnership approach runs the risk of turning the participants into an 'expert club' themselves and thus loosing the link with the vernacular understanding of risk in the community.

To sum up, partnerships have undeniably proven to be a successful format for the preparation of an integrated pre-design proposal for a disposal site that enjoys the necessary support of the community itself. There are reasons to believe that a partnership model with specific extended competences (as it is already the case with MONA and STORA) will be the most suitable body to start negotiations in the next phase. However, one should be clear about the nature and limits of participation in RWM up till now. To turn back to my 'game' metaphor, new 'players' (local citizens, stakeholders and politicians) are 'invited' by NIRAS to join the 'LILW repository siting game' – and more or less voluntarily agree to do so (e.g. because the waste is already on their territory anyway, and the new partnership at least provides them with more means to influence decisions) – while the objectives (i.e. finding a potential LILW repository site) and – to a lesser extent – the rules (e.g. concerning the acceptability of scientific arguments) are firmly controlled by NIRAS. Furthermore, this particular 'game' represents only a rather insignificant part of the larger game of RWM as a whole, or of course nuclear energy policy.

4.2. Future participation in the HLW management programme

Looking at stakeholder or citizen involvement in RWM in Belgium we therefore see a much focused, but somewhat isolated approach, concentrated around participation of local stakeholders in a siting process for a final repository for LILW. In spite of several declarations of intent, a participatory approach thus far has not crystallised for any other aspect of RWM. This seems to result to a large degree from the rather fragmented and incremental way through which the Belgian RWM policy is developed. Especially in the case of HLW management, there is a pronounced imbalance between the amount of resources put into the technical and scientific research programme compared to the effort to set up appropriate dialogue structures. At this moment, NIRAS is deciding on a strategy to set up such structures, as a recently passed federal law on 'strategic environmental impact assessment' (SEA) requires NIRAS to develop a so-called 'waste plan' as a basis for defining and discussing the implications of different strategic options for dealing with all radioactive waste streams with 'relevant' stakeholders.

The HLW management issue is inevitable also marked by the 'seepage' of political and economic interests in the process. HLW raises a political question laden with controversy, drawing together both questions of ethical principles and political expedience. There is no reason why the Belgian HLW management programme – once it moves from the research phase into the (more visible) planning, siting and construction phases – would be exempt from such profound controversy. Therefore I believe it to be unavoidable that the future Belgian HLW management programme will be closely associated with the general debate over the future of Belgian energy provision and general economic policy. It is therefore also easily understandable that the implementation of an impact assessment procedure on such a sensitive issue represents a rather onerous task. Credibly sustaining a position of neutrality for the SEA process (as for any other 'instrument of law') is challenging when the assessment process itself begins to impinge upon major economic and political interests. Moreover, one of the central political aims (as expressed in the relevant European directives) of the SEA procedure – namely to increase public participation and interaction – pushes the question of HLW management into a new and unfamiliar territory. Nevertheless, notwithstanding the fact that the 'spirit' of the European directives and national legislation underlines public participation as a desirable goal in itself, I believe it is justifiable to ask whether – and under which conditions – impact assessment processes can really become 'tools for democracy' rather than political instruments, serving only as a post factum legitimation to decisions already made elsewhere and by someone else. It is evident that such broad questions cannot be answered in general; the way EIA or SEA processes are actually implemented makes a huge difference. This in turn depends on a lot of contextual factors, e.g. local or national political traditions, history of the planning process, strength of environmental associations, etc.

Arguably one of the most important factors in this regard is the behaviour of the initiator of the SEA or EIA process (i.e. NIRAS in the Belgian context). The developer of the 'waste plan' is after all at relative liberty to comply with the aims of legislation in a number of ways. If the only goal is to fulfill the 'minimal conditions' set down by legislation, it is unlikely that public participation (or the impact assessment process in itself) will have any impact on decision making. Thus, even though the legality of an EIA or SEA procedure will generally be undisputed, questions over its legitimacy will likely remain (while the basis of legitimacy of course differs according to the actor asked). Here, factors such as the degree of trust invested in NIRAS, the possibility to independently challenge the position taken by the implementer, the (perceived) dominance of the nuclear sector, the offer of real alternatives of equal merit in the 'waste plan', etc. will tend to determine the perceived legitimacy of the process (Petts 1997). Another crucial factor will likely be the behaviour of the competent authority for the 'nuclear part' of SEA and EIA processes – i.e. the federal agency for nuclear control (FANC). From the point of view of public participation, the degree to which this agency is seen to be able to act independently from nuclear industry interests will be of crucial importance. There is some reason for concern here. The FANC was created by law in 1994 (i.e. some 20 years after the first nuclear power plants started delivering electricity), but became operational as late as September 2001, and is up till now plagued by (political) controversies which to a certain extent impair its ability to function properly. Indeed, criticism on FANC is often harsh. The most heard comments are about the closed character of the organisation, about the lack on staff and about the slackness with which the agency seemingly responds to its legally defined tasks. The question what constitutes an effective regulatory body – and perhaps more importantly, one that is seen to be effective – is of course very complex, but nevertheless some factors stand out as being of more or less crucial importance. Israelsson (2005) calls these the 'cornerstones' of a nuclear regulatory agency, and he identifies four of these: i) the existence of a distinct legislative framework; ii) the independence and separation of regulatory functions; iii) a suiting strategy for inspection and control; and iv) a set of effective enforcement powers. Taking these cornerstones, supplemented by more specific criteria, as a guideline for assessing FANC's (potential for) legitimacy 'in the public eye' could be an interesting venue for inquiry before embarking on ambitious impact assessment procedures.

Arguably the most important criticism on EIA as a potential vehicle for broad public participation comes from practical implementation experience. Hokkanen (2001), reflecting on the Finnish EIA procedure carried out in four municipalities identified as potential hosts for a spent nuclear fuel repository over a period of three years (1997-1999), comes to a rather bleak conclusion: *«…as it stands, the EIA process is one in which elite groups interact to the practical exclusion of ordinary people. […] Thus it can be claimed with some justification that the function of participation in EIAs in general is directed specifically towards those who already wield representative power…»* (p. 128). Thus, Hokkanen sees the emergence of a new 'elite group' of participants in so-called 'direct' participation processes such as EIAs – that is to say a kind of oligarchy emerges as a direct reflection of initial access to 'participatory resources' (i.e. people who are already active in the political stratum in general, who already operate in many arenas and have many ways of exerting political influence will have an important head start over others). He then goes on to enumerate the reasons for this state of affairs, which he condenses into six factors (p. 129): 1) little or no tradition of direct participation in Finland; 2) the novelty of EIA procedures for members of the general public; 3) the unclear nature (at least for the general public) of the relationship between EIA and political decision making; 4) the exceptionally long-term character of the process for finding an adequate solution to the problem of HLW management (leading to 'participation fatigue'); 5) the long-term nature of the process also gives interested people enough time to form their opinion on the subject, as a result of which further repetitive participation may be deemed unnecessary; and 6) the self-selecting nature of interventionary acts, also in EIA procedures (i.e. a small group of people become increasingly adept at successfully ‘playing the participation game’ according to their needs, motivations and objectives).

So, taken together, EIA or SEA processes seem to offer rather dim prospects of becoming ‘vehicles for participatory democracy’. This statement is however not meant to imply that I am in favour of participation for the sake of participation. By way of a thought experiment, one could think of a situation where all citizens would be equally politically involved in an issue such as RWM. It is clear that these conditions would likely lead to the dominance of sharp differences and protracted conflicts across society. In this paper, I merely want to stress – again – that if the focus of the discussion is to be the need to include more opportunities for participation in decision making on RWM, it is important to consider what exactly this means. Those who promote public participation without further qualifications should perhaps be viewed with equal suspicion as those who stick to the old top-down expertocratic way of ‘doing business’.

5. Conclusion

Hidden behind an apparently simple plea for more participation lies a daunting complexity of (possibly conflicting) goals, expectations, experiences, conceptions of the self and society, and so on. This is no less true in the field of complex technological questions (including RWM), where participatory mechanisms seem to have found a new lease on life. Quite simply, there are no easy ‘ethical’ answers to the inherently ‘political’ question of participation. However, I have argued that, rather than being depressed by this state of affairs, one should feel invigorated by the political possibilities lying before us. It is too early to say where these will take us, but there are strong indications that something is stirring, and that it will be difficult to revert to the old ‘expertise-as-usual’…

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