



A contribution to the analysis of equity associated with high-level radioactive waste management



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ABSTRACT

Risk distribution is a core problem in the context of risk management. In this respect, the issue of equity with regard to the management of high-level radioactive waste is complex and has given rise to substantial literature, mainly related to the notions of consent, compensation or sustainable development. This paper aims at contributing to this debate by analysing one aspect often neglected in the ethical literature, namely the question of equity associated with the health impact of different management strategies. Therefore, we will assess qualitatively the potential exposure of individuals in the case of three management strategies – surface storage, non-retrievable geological disposal, and retrievable geological disposal –, and we will compare the results using a criterion of Rawlsian inspiration, which states that the fairest option is the one for which the least well-off groups are as well-off as possible. Our analysis shows that non-retrievable geological disposal is favoured in this regard for each vulnerable group, namely local communities, and on-site workers.

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1. Introduction

Risk distribution is a fundamental problem in the context of risk management. It is a specifically controversial matter in the case of hazardous technologies such as chemical technologies, biotechnologies or energy technologies. In the latter case, prominent examples are nuclear power and the management of the resulting waste on which we will focus in this paper.

Historically, the management of high-level radioactive waste (HLRW) was considered as a purely technical problem. It is only since the mid-seventies that its societal component has been recognized (Solomon et al., 2010, p. 19). In that context, ethical issues were soon pointed out. Equity was of course a prominent topic, with two early founding books contributing to the debate (Kasperson, 1983; Shrader-Frechette, 1993).

These studies and some more recent papers have defined the issue of equity related to HLRW as a very broad problem. Indeed, equity issues have been framed both from an intragenerational and from an intergenerational perspective, which can be considered as being conflicting (Okrent, 1998, 1999) or not (Shrader-Frechette,

2000). Intragenerational equity refers to justice among contemporary people (Taebi and Kloosterman, 2008, p. 196), whereas intergenerational equity corresponds to “temporal equity”, which is associated with equity considerations between generations (Taebi and Kadak, 2010, p. 1344). Equity embraces thus relationships between society and local communities as well as workers, but also between current and future generations. In this respect, many thoughtful papers are addressing various controversial topics such as consent, compensation, public participation in the decision process, the principle of double standard public-workers, the “polluter pays” principle, but also sustainable development (Bergmans et al., 2015; Clark et al. 1991; Cotton, 2009; Laes and Bombaerts, 2006; Mizuo, 2008; Omoto, 2005; Shrader-Frechette, 1994, 2000; Solomon and Cameron, 1985; Turcanu and Perko, 2013; Wilding, 2012). However, the issue of equity associated with the health impact of different management strategies is often neglected.

The purpose of this paper is precisely to contribute to clarify this matter by studying the equity dimension associated with the health impact of three different management strategies – namely surface storage, non-retrievable geological disposal, and retrievable geological disposal – on the basis of a criterion of Rawlsian inspiration, which focuses on the most vulnerable groups.

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The paper is structured as follows. First, the methodology is presented (Section 2). In a second part, perpetual surface storage, non-retrievable geological disposal and retrievable geological disposal are briefly described (Section 3). Then potential exposure of the most vulnerable groups is analysed in the context of these three management strategies. The focus is on local communities (Section 4) and on workers (Section 5). HLRW management options are then compared in terms of equity associated with health impact and the results are discussed (Section 6). The paper ends with a conclusion (Section 7).

2. Methodology

It is important to note that we do not aim at providing an exhaustive analysis of equity issues related to high-level waste. Our goal is more modest here, as we wish to study one specific aspect that needs to be taken into account in any thorough analysis of equity, that is, the issue of equity associated with the health impact of different management strategies. Thus we are not considering issues related to consent, to compensation, or to upstream benefits associated with the use of nuclear power. We are neither considering the benefits potentially associated with the management of HLRW with respect to the possibility to recover and to value the waste, for example.

Along with the international community, we are assuming a strategy of concentration and confinement for the management of HLRW, where the waste is isolated from man's environment, as opposed to a strategy of dispersion and dilution in the environment (IAEA, 1995; ONDRAF, 2011, p. 41). With this in mind, we identified three relevant management strategies: non-retrievable geological disposal and geological disposal integrating retrievability provisions, which are based on this concentration and confinement strategy and which are both selected as a solution by several countries. Moreover, we are also considering perpetual surface storage, which could be considered if no consensus can be reached in favour of geological disposal.

These three options will be studied and compared with respect to equity regarding their health impact on different stakeholders.

The conception of equity we are endorsing in this paper is inspired by the *maximin* principle of John Rawls, who is advocating a conception of justice as fairness (Rawls, 1999). As a reminder, Rawls has developed a contractarian approach, where rational individuals in an "original position" are agreeing upon the guiding principles of society. In such an "original position", individuals are behind "a veil of ignorance", meaning that they are setting aside their personal attributes – social, cultural, economical, etc. This thought experiment is designed so that individuals are not tempted to adapt the principles according to their own needs and desires. Rather, not knowing their position in society will lead them to agree upon principles that are fair to all individuals involved. Regarding the distribution of well-being, the resulting principles are the following: "Social and economic inequalities are to be arranged so that they are both (a) to the greatest expected benefit of the least advantaged and (b) attached to offices and positions open to all under conditions of fair equality of opportunity" (Rawls, 1999, p. 72). Principle (a) is called the *maximin* principle, because it is about maximizing the *minimal* position.

The *maximin* principle appears to be highly relevant for comparing HLRW management strategies insofar as its focus is on the least advantaged, and HLRW management will necessarily lead to a situation where some groups will be worse-off. In Rawls' *Theory of justice*, the *maximin* principle applies to well-being, which is very broadly defined. Indeed, being well-off refers to "the *means* or *instruments* by which satisfaction or happiness can be achieved.

Economic income is one such means; others include opportunity, power, and self-respect" (Peyton, 1994, p. 10). This criterion has thus an economic connotation. However, in this paper, we are only focusing on equity issues related to health impact of different management strategies. Hence, for the purpose of our analysis, the *maximin* principle we are referring to is a "stripped" version of Rawls' principle, where well-being is only defined in terms of health impact.

The least well-off groups are thus corresponding to the groups that are the most disadvantaged with respect to health impact, i.e. the most exposed. Two groups are identified as being potentially disadvantaged due to their proximity with the waste, namely local communities and on-site workers. Hence, if we apply our "stripped" version of Rawls' principle, the fairest HLRW management option will be the one for which these two groups are better off with respect to health impact.

Regarding health impact, our goal is not to provide a quantitative assessment of the health impact associated with different options, which would be anyway highly unrealistic without reference to a specific, well-defined project. Rather, we intend to provide a qualitative comparison between surface storage and geological disposal integrating retrievability provisions or not. Therefore, we will focus on the notion of potential exposure of individuals. Potential exposure corresponds to "exposure that is not expected to be delivered with certainty but that may result from an accident at a source or an event or sequence of events of a probabilistic nature, including equipment failures and operating errors. Due to the large uncertainties surrounding exposures that may occur in the future, they are considered as potential exposures" (ICRP, 2013, p. 20).

The qualitative assessment of potential exposure of the most disadvantaged groups – local communities and on-site workers – will be used in order to determine the fairest management option between the three options under scrutiny.

More specifically, potential exposure is determined by four dimensions (ONDRAF, 2010, p. 238–245):

- the distance between the radiation source and the receiver,
- the presence of protection barriers and their characterization,
- the likelihood of contact of receivers, associated with "planned exposure situations", which are "exposure situations resulting from the operation of deliberately introduced sources" (ICRP, 2013, p. 20). It is thus related to the exposure of workers during monitoring and maintenance and to the exposure of citizens during the transport of the waste or whenever they are given the possibility to visit the facility for example. On the contrary, it is not linked to contact in case of incidents – in such a case, the potential difference between the three options will proceed from the three other dimensions,
- the potential for harm of the source: the potential damage related to the radioactive source, which is function of the radiological characteristics of the radionuclides contained in the waste. The potential damage depends on the decay mode, the decay half-life, and the volumic activity.

Potential exposure is intimately linked to the occurrence of accidents and to safety. Some of its components, however, are also highly relevant for the analysis of health impact associated with malicious acts such as sabotage, theft, acts of terrorism, or any other malevolent act involving radioactive material or their facilities. Indeed, the distance, the protection barriers and the potential for harm of the source are three components which are also at stake when focusing on these security issues. Hence, potential exposure focuses on health impact associated with safety issues, but also with security issues.

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