



Risk Management of Radioactive Waste in Brazilian Law: Precautionary and Preventive Measures

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1. Introduction

The scientific and technological progress provided by radioactive and nuclear technology in current society often seems to be contradictory. On the one hand, there is a significant improvement in the quality of human life. On the other hand, it cannot be ignored that this technology generates radioactive waste, which creates risk with potential damage to the environment and health if not properly managed. Therefore, it is necessary to implement a framework of principles that guide decision-making processes in a risk scenario involving radioactive waste, especially in terms of precautionary and preventive measures [1]. In this regard, this work aims to present a legal analysis on risk management of radioactive waste based on the Precautionary and Prevention Principles.

2. Methodology

Considering that the present study is theoretical and analytical, the main research method was bibliographical and documentary. Thus, the study focused primarily on reading doctrines and articles that debate environmental risk management and the Precautionary and Prevention Principles, as well as the legal and regulatory framework about risk management of radioactive waste.

The research was also based on the analytical method, which consists of the analysis itself on the issues related to the subject and the use of the Precautionary and Prevention Principles on risk management of radioactive waste. Last but not least, a critical analysis was developed around how the precautionary and prevention measures can structure and systematize radioactive waste management.

3. Results and Discussion

Although the Precautionary and Prevention Principles are similar, they have structural differences that are worth mentioning. The Precautionary Principle is related to cases in which there is scientific uncertainty about the risk of damage from an activity that can potentially cause a significant environmental impact. It is applicable to hypotheses of abstract and potential hazard, in which there are indications that the activity will result in damage. The Prevention Principle is associated with scientific knowledge or certainty about

the risk of damage from an activity that can potentially cause an environmental impact. For that reason, preventive measures must be taken to mitigate or inhibit irreversible damage to the environment [3] [4].

To illustrate the difference between precaution and prevention when it comes to radioactive waste, the immobilization of liquid radioactive waste and the isolation of radioactive waste in a deep geological repository are preventive measures, as they refer to the certainty that the radioactive waste will most likely be dispersed and cause damage if these measures are not taken. In contrast, the implementation of a multiple-barrier system in repositories to contain radioactive waste and conservative scenarios in risk assessment are precautionary measures, as there is no certainty about the possible interactions of the environment and human beings with the barriers.

In other words, the Precautionary Principle weighs the risk of damage and the uncertainty about it – which does not apply to the Prevention Principle, since it is not applicable to uncertainties. When using these principles in risk management of radioactive waste, three aspects should be taken into account, namely [5]:

- (i) Weigh the cost-effectiveness and the pros and cons of the measures to be adopted;
- (ii) Study the acceptance of radioactive waste risk in society;
- (iii) Take proportional (not excessive) precautionary and preventive measures.

Risk management has a direct impact on the consideration of effective measures and decision-making to preserve the environment. In this matter, the first mentioned aspect involves the cost-benefit of using the Precautionary Principle. For instance, a geographic location for radioactive waste disposal may have several benefits today, but in the future, its cost may become unaffordable [6]. This is a legitimate problem in radioactive waste management, such as the disposal of disused sealed radioactive sources, which rely on the presence of geological barriers to contain the high radioactivity. An issue like this can even affect the decision on the risk of using or not using nuclear energy, as it produces waste that needs proper treatment [7].

It can also be noticed that the Precautionary and Prevention Principles are supported by Law, but not necessarily applied by legal means in the risk management of radioactive waste. There are also technical mechanisms that implement these principles in risk assessment, such as the Environmental Impact Study (EIA) and its Environmental Impact Report (RIMA), prepared prior to the installation license for an activity with radioactive and nuclear material or any activity that represents a risk to the environment.

Such technical mechanisms were established by the Brazilian National Environmental Policy (*Política Nacional do Meio Ambiente*) and by the Resolution No. 01/1986 of the Brazilian National Council for the Environment (CONAMA) – which also provides for the mandatory designation of public hearings in the environmental licensing process, with the participation of communities that are affected by or interested in the activity [8] [9].

That brings us to the second aspect of applying the Precautionary and Prevention Principles in risk management of radioactive waste, that is, the social acceptance of risk. In fact, CONAMA issued Resolution No. 09/1987, specifically about the community participation through a public hearing during the environmental licensing process. The acceptance of radioactive and nuclear risk by society is influenced by subjective facets, often based on prejudice and lack of information on the subject. Accordingly, public participation has a fundamental role of involving and educating the interested or affected community [6].

In regard to appropriate precautionary and preventive measures, which is the third aspect of using the Precautionary and Prevention Principles in risk management, there is, as an example, the Brazilian Nuclear Policy (*Política Nuclear Brasileira*), a national public policy associated with nuclear risk assessment,

which includes radioactive waste and provides for precautionary and preventive measures in that matter [10].

4. Conclusions

For all of the above reasons, it is possible to verify that, in the risk management of radioactive waste, the Precautionary and Prevention Principles must be applied, but with caution and never excessively – especially the Precautionary Principle, whose uncertainty has to be about a risk of significant damage. Furthermore, in order to emphasize the relevance of developing a principle-based legal framework as a foundation for decision-making in cases involving radioactive waste, it is crucial to implement effective information about risk and understand the different approaches to precautionary and preventive measures in risk management.

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