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Geological storage of nuclear wastes: Insights following the Fukushima crisis

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HIGHLIGHTS

- Major factors influencing the attitude towards nuclear waste disposal were examined.
- The opinion of the Japanese youth before and after the Fukushima events was compared.
- Unemployment and earthquakes are now at the upper end of the thought of dread.
- The government and scientists are highly distrusted by the Japanese youth.
- People might still accept the repository though the NIMBY phenomenon remains high.

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ABSTRACT

The geological storage of high-level nuclear wastes (HLW) has been in the agenda of Japan for several years. Nevertheless, all the research can become meaningless without understanding the public feelings about the disposal. The events at Fukushima in 2011 altered the perception towards nuclear-waste storage in the country. This work investigates the attitude of young Japanese towards the construction of a repository following the Fukushima crisis, and examines how public perception changed after the event. A survey among 545 university students from different regions of Japan addressed three main variables: dread, trust and acceptance. The results suggest that the economy of the country is still the most concerning issue, but there was a dramatic increase of attention towards everything "nuclear". Radiation leakage and food contamination are major concerns as well. The distrust towards the government deepened after Fukushima, although more than half of the respondents would accept the repository. In a clear phenomenon of NIMBY (not in my back yard), the acceptance drops to less than 20% if the repository is to be installed near the respondents' residency. Financial incentives would increase the acceptability of the siting, although only a substantial compensation might minimise the NIMBY in potential host communities.

1. Introduction

For several years, the Japanese government has been planning to permanently isolate the high-level radioactive wastes (HLW) produced by commercial power plants in the country. According to Garrick (2002), HLW is defined as the radioactive waste resulting from the reprocessing of spent nuclear fuel from nuclear reactors, or other radioactive materials used for defence purposes. The programme involves the construction of an underground storage facility aimed at starting operations by 2030s. The concept of waste management in Japan follows the approach favoured by most countries, essentially based on HLW immobilisation and direct disposal in stable geological environments. To present however, no deep repositories have been built to fully test the reliability of the system. In this regard, the feasibility of constructing a waste facility depends not only on technical issues, but also on the public attitude and degree of tolerance towards it. Success in nuclear waste policy requires that policymakers understand such public attitudes and concerns and be capable of responding to them (Kraft, 2000). The growing debate about the potential risks and benefits of the repository has prompted a number of studies that explored the factors influencing the acceptance of the technology in Japan over the years (Hinman et al., 1993; Shimooka, 1993; Mizushima and Hayashi, 1995; Tsunoda, 2002; Tanaka, 2004a, b; Siegrist and Visschers, 2013). Gallardo and Aoki (2012) also investigated the attitude of young Japanese towards the geological storage of radioactive wastes and analysed a set of variables affecting people's perception. Nevertheless, data was

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collected before the "2011 Tohoku Earthquake and Tsunami" which led to the meltdown at the Fukushima nuclear reactor. This particular event brought to surface the worst fears of the society towards nuclear power, and generated a new perception of its risks. The accident at Tepco's power station in Fukushima drew the world's attention for several weeks and highlighted the catastrophic effects of a radiation escape. For nuclear opponents, Fukushima was a clear example of the close relationship between "nuclear" and "disaster". Moreover, the confusion and contradictory information released during the days of the crisis undermined the credibility of Japanese authorities and prompted worldwide criticism about the management of the situation. Public anxiety about the reactors safety rapidly spread out beyond Japan, leading to some countries, such as Germany, Italy, Switzerland and Venezuela, to review their policies on nuclear power. Fear intensified also in neighbour China despite repeated governmental announcements that the country faced no imminent health threats from Fukushima (He et al., 2013). March 2011 suddenly modified the world scenario, so all in all, it is hypothesised that trust in regulators and the public perception on geological disposal (and anything "nuclear" indeed) changed significantly after the crisis. Nowadays, the debate about nuclear power and its residues continues, and the construction of a geological repository is likely to follow a thorny road to the least. As an example, in March 11th 2013 about 40 Greenpeace activists managed to break into the reactor of a nuclear power station in the Cordoba province of Argentina to protest against the use of that technology (La voz del interior, 2013). In this context, the present paper investigates the attitude of young Japanese towards the siting of a nuclear repository following the Fukushima accident in 2011, and examines how public perception changed in relation to this event. A survey was conducted in Japan in late 2012–early 2013 and its results compared with findings prior to the earthquake as published by Gallardo and Aoki (2012). In line with the precedent study, the analysis focused on a handful of variables such as fear, trust in authorities, and acceptance of the facility. Furthermore, the paper examined how important nuclear issues are for the Japanese public in relation to other concerns, and explored the role of NIMBY (not in my back yard) on the HLW repository. Some general strategies to facilitate the repository siting were also explored. The paper is organised in four main parts: (1) Introduction, (2) Methods, (3) Results and Discussion, and (4) Concluding remarks. A number of subsections have also been introduced for clarity purposes and to better discriminate between key concepts. To present, the authors are not aware of other studies examining in a systematic way the change in public attitude towards HLW storage in Japan following the Fukushima event. The formulation of energy-production and disposal policies is intrinsically shaped by people's perception which in turn, cannot be analysed in historical isolation. The present study assists in gaining a better understanding about current public views on nuclear waste disposal and its evolution in time, and is expected to provide a valuable reference for policy makers and scientists assessing the viability of geological storage in Japan.

1.1. Background of geological disposal in Japan

Until the Fukushima crisis in 2011, more than 50 nuclear power stations scattered throughout the country constituted the core for electricity generation in Japan. Research and development for geological disposal in Japan was initiated in 1976 as a key national project (JNC, 2000). The establishment of an organisation to implement the storage as well as demonstrations of repository technology commenced after the year 2000. According to the road map of the Atomic Energy Commission of Japan (AEC), the vitrified HLW should be stored underground by 2030. From a technical point of view, there is ample consensus throughout the world that geological storage is currently the most favourable option to deal with HLW. Existing scientific research still confirms that in view of the available technologies and the pressing need to dispose the wastes in only a few years, a deep underground facility is the most acceptable solution.

The geology of Japan is complex and largely affected by tectonic and volcanic activity. Therefore, the Japanese disposal concept places greater emphasise in radionuclide containment by engineered barriers rather than geological immobilisation. In this regard, the disposal implies the construction of a deep facility with a variety of concrete and bentonite barriers able to isolate the migration of radionuclides far beyond the foreseeable future. One of the first steps to ensure the long term safety of such a disposal is the selection of a stable geological environment. This led to the construction of the underground research laboratories of Mizunami and Horonobe, to verify in-situ the reliability of nuclear waste disposal in crystalline rocks and sedimentary deposits respectively. In spite of the major advances achieved and the vast number of publications so far released (eg. Kimura and Muraoka, 1983; Koide et al., 1991; Kimura et al., 1995; Umeki et al., 2003; Sugita et al., 2007; Ohi et al., 2013; etc.), the authors argue that the majority of the Japanese people are not aware of the existence of HLW and its management. In dialogue with stakeholders (i.e. university students, colleagues from other disciplines in the scientific community, and residents of varied background and age in areas where our projects are undertaken) we found not only low levels of awareness but much scepticism if not fear, when realizing that the underground disposal will take place in a country prone to earthquakes and volcanism. Thus, all the technical work carried out over the years can become useless if it is not accompanied with measures to build confidence and achieve reasonable levels of credibility by the public. Regardless of the technical outcome, the destiny of the geological disposal programme is ultimately dependant on the position that the society takes towards it. An analysis of the attitude of the general public is considered crucial to assist policy makers in defining new lines of action that complement all the work that is being carried out by the authors and colleagues on HLW underground disposal in Japan. Findings from the present work are expected to contribute with the programme in moving forward and not end up being a mere theoretical exercise.

1.2. Previous research

The disposal of nuclear waste is generally perceived as a hazard and as such, it leads to public concern and resistance. Previous research by Gallardo and Aoki (2012) upon a population of about 170 university students of various disciplines showed limited awareness of the Japanese youth in relation to the siting of a nuclear waste facility in the country. The students expressed deep concerns about the leakage of radionuclides although their anxiety was overridden by issues with a more direct impact on daily life such as the economy, the health and pension system, and taxes. At that time, nuclear-power generation and the geological disposal of nuclear wastes were ranked almost at the bottom of the list within a series of items that could worry the Japanese society. The study indicated also certain distrust in the authorities and the scientific community. The Parliament was the most distrusted party, as respondents thought that any bill being approved by it would be in favour of the government agenda rather than people's welfare. On the other hand, more than 80% of the students considered that conclusions presented by the scientists working in the programme could be biased Despite all this negative perception, about half of the interviewed individuals stated that they would still accept the construction of a HLW repository in the country. Furthermore,