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NOTE

A new perspective on severe nuclear accidents

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Abstract

The reactions of the public in Korea to the nuclear accident at the Fukushima Daiichi plants in Japan, particularly over-reactions, are reviewed, with the conclusion that significant radioactive contamination of a small country could lead to a severe national crisis. The most important factor is the socio-economic damage caused by stigma, which in turn is caused by a misunderstanding of the radiation risk. Given that nuclear power is an important choice in the face of the threat of climate change, the public's perceptions need to be changed at any cost, not only in those countries operating nuclear power plants but globally as well.

1. Introduction

On 11 March 2011, a massive tsunami followed an extreme earthquake in the north-east of Japan and initiated a severe nuclear accident at the Fukushima Daiichi nuclear power station. Although multiple nuclear reactors were damaged, the amount of radioactivity released to the environment was estimated to be much less than that from the Chernobyl unit 4 accident. In addition, the prevailing wind at the time of major release was directed eastwards except for a short period.

While Korea is Japan's closest neighbouring country, by virtue of the prevailing wind being mostly directed to the east, it was one of the countries in the Northern Hemisphere that the contaminated air stream was last to reach. The measured radioactivity in air or rain was much less than that of the natural radioactivity normally present. No elevated environmental dose rates were identified.

Public concerns, however, were remarkable, and various kinds of over-reaction were observed. Among them, a consumer-driven trade boycott, specifically of foodstuffs, was particularly noticeable. In this note, the potential risk of a national crisis that could result from a major contamination of a country's territory and the underlying mechanism are discussed. In addition, a proposal is presented on what should be done to prevent such a crisis in the context of a severe accident at a nuclear power plant.

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2. Government and media responses in Korea

The initial action taken by the Korean government following the Fukushima event was monitoring of the situation as it developed in the Fukushima Daiichi reactors. Key questions in the early hours were the possibility of meltdown of those reactors and the timing if meltdown was inevitable. Since official information from Japan on the situation at the plant and accident mitigation activities was delayed and limited and the inter-governmental information channel was unsatisfactory, media reports were the main source of information. A couple of cable news channels covered the Fukushima events for nearly 24 h a day.

When damage to the nuclear fuel became evident from the hydrogen explosions in the reactor buildings, concerns were directed to the potential consequences of the expected release of radioactive material into the atmosphere. Attention was paid to the wind direction and its potential to change. With the judgement that the radioactive plume had the lowest chance of being directed to the west, the Korean government announced that Korea was safe due to the prevailing wind direction.

On 15 March, trace radioactivity (I-131 and Cs-137) was first detected in the air. That arrival of contaminated air occurred earlier than expected because part of the air stream took a path going up to the North Pole and then down towards the Korean Peninsula instead going around the circle of middle latitude. Media coverage became even more intensive, and the Korea Institute of Nuclear Safety (KINS) gave a daily briefing on behalf of the government on the domestic radiological situation together with the status of the Fukushima site. From 17 March, the government started to dispatch contamination monitoring teams to the major Korean ports of entry to check contamination on persons coming from Japan. That programme continued until July.

On 20 March, there was rainfall nationwide but there was no trace of fission products in the rainwater. It was explained that the rain clouds from the west were not affected by the radionuclides from Fukushima. Trace levels of I-131 and Cs-137 activities, however, were detected in the rain on 29 March which precipitated in limited areas including the city of Seoul. Somewhat higher concentrations were found in the rainwater precipitated on 6 April.

Official information on the radiological situation was provided only by KINS. However, many ‘experts’ appeared on the news media to explain the situation. Unfortunately, some of the ‘experts’ spoke ambiguously or told rather far-fetched stories which could mislead the public. In the author’s opinion, the tone of reports was milder than expected, although some irritating terms like ‘radioactive rain’ appeared in the titles of articles. Furthermore, coverage was still very intensive up to the end of May. It is known that such intensive coverage itself creates concerns in the public regardless of the tone of the reports.

3. Public reactions

When the plume arrived at the Korean Peninsula after travelling all the way around the globe, the measured activity concentrations in Korea were in the ranges of 1 mBq m^{-3} in the air and a few Bq l^{-1} in rainwater, mostly I-131 and Cs-137. The activity concentrations in air were far less than the normal radon concentration in outdoor air (equilibrium equivalent radon concentrations are of the order of 10 Bq m^{-3}). Also, the normal Be-7 activity is of the order of a few Bq m^{-3}.

However, many questions were raised by the public. Bad news travelled fast and drove out good news. There was flood of enquiries in phone calls or to the Q&A section of the KINS homepage. All sorts of questions were raised, particularly after the detection of radioactivity in rainwater. What will happen if the wind direction changes tomorrow? How can we be sure the

wind will not change? What if one gets wet in the 'radioactive rain'? What about the children? If boiling of water cannot change the radioactivity, how should I prepare baby food? Should we buy a water purifying machine? Can this machine remove radioiodine? Will the small amount of radioactivity accumulate in our body to cause harmful effects? Where can I buy KI tablets? I flew over Japan; where can I scan my body to check contamination? KINS had to operate a taskforce team to answer those questions 24 hours a day, 7 days a week for many weeks.

Quite a large number of people bought excess bottles of drinking water. After rumours about its protective action against radioiodine, brown seaweed sold out. For unknown reasons, even sun-dried salt was in short supply. Many people bought face masks, and the stock prices of mask manufacturers rose rapidly for some days.

Virtually all tour programmes to Japan were cancelled, wherever the destination. Many business trips were cancelled or postponed. Koreans in Japan at the time of accident hurried to return home. Many students who had planned to study in Japan from April (the start of the semester) were in a state of confusion.

When it was known that heavily contaminated water had spilled into the sea at the Fukushima site, supermarkets stopped selling fish, particularly walleye pollack, imported from Japan. Later, consumers became reluctant to eat marine products at all, even domestic products. People assumed the contaminated water would come to the seas near Korea. The government had to explain the patterns of ocean current from the Fukushima area and details of the behaviour of schools of fish.

In the era of a networked society supported by the social networking services—internet sites, blogs, Facebook and Twitter—unfavourable rumours spread fast and cause over-reaction. All kinds of hearsay, including even intentionally cooked up stories, flew over the network space. One example was that the Japanese government couldn't prevent trading of contaminated foodstuff so Koreans were at risk. Some people measured radiation levels here and there with their own survey devices and posted photos of the meter readings on the internet when they found some elevated readings as if those results were due to the Fukushima accident.

Among other occurrences, public reactions in relation to contamination of consumer products should be reiterated. In Korea, all foodstuffs produced in Japan, regardless of the specific location of production, were boycotted by consumers and this led to the formation of an unintentional trade barrier which lasted for months. Japanese-style restaurants suffered a decrease in diners and even difficulties in acquiring particular foodstuffs needed in the preparation of dishes. It was known that most of the foreign buyers of Japanese goods, not only foodstuffs but also industrial products, asked for certificates of non-contamination. Fortunately, only a very limited area of Japan was affected by virtue of the prevailing wind direction and non-contamination certificates could be provided without great difficulty because most of the goods were produced in non-contaminated areas. However, this experience has serious implications for any future events.

4. Implications

The east-bound prevailing wind direction during most of the major release period was a stroke of good luck for Japan in the midst of tragedy because most of the radioactivity released to the atmosphere was deposited into the Pacific Ocean instead of populated inland areas. Although the damage caused by the tsunami followed by the nuclear accidents was enormous, in another sense a national crisis was just averted. If the prevailing wind had been in the opposite direction, radiological damage to Japanese society could have been extreme. This supposition leads to a new concern about severe nuclear accidents, particularly in countries with small territories like Japan or Korea.

In a severe nuclear accident in a small country, the worst-case scenario may result in significant contamination to virtually all of the country's territory. Indeed the most pessimistic scenario could include the following: difficulties with food supplies, severe damage to the export trade and tourism, social disruption caused by fear, shortage of electricity due to forced shutdown of operating nuclear reactors, and removal of foreign capital, which are enough to lead a country into crisis. Small countries are particularly vulnerable. Experiences in Belarus after the Chernobyl accident support this proposition. This important lesson that stigma can cause major damage to a society affected by nuclear accidents should be reiterated through the experience of the Fukushima accident. Compared with such potential for socio-economic impact, the health effects that could result from radiation exposures may be regarded as rather less serious.

It should be noted that such severe impacts resulted not from the real direct effect of radiation but from the socio-psychological amplification of fear. Stigma is a particular culprit. The impacts of stigma are often very wide, in the sense that its magnitude and persistence over time is not well known [1]. The root of such amplification, misunderstanding by the general public of the effects of radiation, is linked to deep-seated fears. Intensive coverage by the mass media plays an amplifying role at the societal level [2]. This implies that the potential major damage of nuclear accidents comes from a misunderstanding of the health risks of radiation. In other words, such damage could be prevented or largely reduced if people understood the truth of the health risks associated with radiation or radioactivity.

Given that the use of nuclear power is a choice in an era facing the threat of climate change and that the occurrence of nuclear accidents is unavoidable, although their likelihood can be reduced by great efforts in nuclear safety, the potential for social amplification of fears and misinformation should be combated by all means. Continued operation of nuclear power plants without an improvement in public understanding of the health effects of radiation could be regarded as putting a country at high risk. This presumption can be extended to the effect of potential radiological attacks with dirty bombs or radiation dispersal devices (RDDs) including covert release of radioactive material. There is an estimate that the economic damage of a RDD attack in New York or Los Angeles could reach a trillion dollars [3]. Therefore countries with no nuclear power plants are not necessarily immune to socio-economic damages from radiological events.

New strategic and effective actions to improve proper public perception of the risk of ionising radiation exposure are vital and should be pursued at all costs. The radiation protection community as a whole has succeeded in informing the public that radiation is dangerous, but has failed to teach precisely how dangerous it is. In other words, the radiation protection community should at least share responsibility for changing the public's perception of radiation risk. Such an effort is vital and urgent. Endeavours similar to the traditional methods may fail again—an active, innovative, effective and sensitive strategy of communication is needed.

Successful reforms of public perception in a few countries at the domestic level are not enough because stigma deploys its power through the regime of global trade. This means that while nuclear power plants are in operation and a large amount of radioactive material is in use on planet Earth, changing public perception regarding radiation effects at the international level should be regarded as a global problem. Actions at the level of the United Nations are needed, or at least initiatives at the level of the G20 Summit or OECD should be sought.

5. Conclusions

The Fukushima nuclear accident cast serious questions over nuclear safety and our preparedness to cope with a severe nuclear reactor accident, and even questions over the

sustainability of nuclear power itself. The accident had a large impact on Japanese society, politically and economically, but much more severe damage was narrowly averted by virtue of the prevailing wind direction. The most important lesson here is that major contamination of a large part of a country can put that country in crisis due to the specific economic impact of stigmatisation. Furthermore, if such contamination involves long-lived radionuclides, e.g. Cs-137 having a half-life of 30 years, the damage could last for decades. In this regard, the following points should be emphasised.

- A new look at the risk of severe accidents in nuclear reactors is needed.
- Additional safety provisions should be considered to mitigate large releases of long-lived radionuclides.
- Reform of public perception about radiation health risks should be pursued at the global level to prevent unnecessary damage caused by stigma.

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