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Editorial

Outline of the national mapping projects implemented after the Fukushima accident

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A B S T R A C T

The national mapping projects were implemented with the collaboration of many organizations in order to obtain reliable and detailed information on radiological conditions due to the Fukushima Daiichi Nuclear Power Plant accident. In the projects, repeated large-scale environmental monitoring has clarified the distributions of radionuclide deposition densities and air dose rates over wide areas and their time-dependent tendencies. In parallel, migration of radiocesium was investigated in the test sites having different environmental conditions to draw a comprehensive picture on the movement of radiocesium in the environment. It turned out that the migration velocity of radiocesium drastically varies depending on conditions and the variation was reflected in air dose rates. The radiocesium migration was slow in undisturbed fields and forest; while monitoring data in urban and water areas implied fast migration velocity of radiocesium in these areas. It was confirmed that radiocesium movement through rivers plays an essential role in long-distance migration of radiocesium.

In order to securely store the obtained environmental data and open them to the public, a database was constructed and has been maintained. In the latter half of the projects, we started construction of a numerical model to predict contamination conditions according to the statistical analysis of accumulated monitoring data, as well as numerical models to simulate migration of radiocesium.

1. Introduction

The Higashi Nihon Earthquake that attacked Japan on March 11, 2011 caused the Fukushima Daiichi Nuclear Power Plant (NPP) accident. Because of the electricity blackout induced by the tsunami after the earthquake, cooling functions of the nuclear power plants were significantly damaged. As a result, enormous amounts of radionuclides were released into the atmosphere due to hydrogen explosions, venting of radioactive air inside the vessel, breakage of suppression chambers and other causes (CS, 2012). The releases of highly radioactive plumes were considered to happen from March 12 through 22. During this period, the directions of radioactive plumes changed according to the wind direction, and released radionuclides deposited over wide regions both by dry and wet deposition.

Table 1 gives the estimation of radionuclide releases into the atmosphere from the Fukushima accident published by the Nuclear Industry Safety Agency based on burn-up analysis (NISA, 2011). Source terms were estimated by several different groups (TEPCO, 2012); nevertheless, significant differences in estimated releases of dominant radionuclides do not exist. It is believed that radiocesium with one order smaller radioactivity than that in the Chernobyl was released into the atmosphere.

According to the experience in the Chernobyl accident (IAEA, 2006; MUE, 2011), several radionuclides having long half-lives will remain in the environment and continue giving exposures to the public. Therefore, so as to evaluate the impact of the accident and to take appropriate countermeasures, reliable and detailed information on the distributions of deposited radionuclides and the resultant air dose rates are needed. Soon after the accident, many of environmental radiation monitoring facilities around the Fukushima NPP site stopped working because of the earthquake and tsunami; and this caused significant disturbances for environmental monitoring and countermeasures in the early stage of the accident (CS, 2012). On the other hand, quite a few activities for obtaining environmental monitoring data were carried out by different organizations and individuals: that is, the national government, municipalities, power corporations, universities, research institutes, private companies and so on. However, the methods, accuracies and monitoring conditions were diverse, and it was difficult to integrate the obtained environmental monitoring data and extract systematic information from them.

Considering these situations, the necessity of detailed and comprehensive environmental monitoring was claimed both in top-down and bottom-up administrative directions. The Science Council of Japan (SCJ) proclaimed that large-scale environmental monitoring should be conducted as soon as possible to detect ^{131}I which might have significantly contributed to exposure doses to the public in the early stage of the accident

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Table 1
Estimated radioactivity releases into the atmosphere by the Nuclear Industry Safety Association (2011).

Radionuclide	Half life	Released radioactivity (Bq)			
		Reactor 1	Reactor 2	Reactor 3	Total
^{133}Xe	5.2 d	3.4×10^{18}	3.5×10^{18}	4.4×10^{18}	1.1×10^{19}
^{134}Cs	2.1 y	7.1×10^{14}	1.6×10^{16}	8.2×10^{14}	1.8×10^{16}
^{137}Cs	30 y	5.9×10^{14}	1.4×10^{16}	7.1×10^{14}	1.5×10^{16}
^{89}Sr	50.5 d	8.2×10^{13}	6.8×10^{14}	1.2×10^{15}	2.0×10^{15}
^{90}Sr	29.1 y	6.1×10^{12}	4.8×10^{13}	8.5×10^{13}	1.4×10^{14}
^{140}Ba	12.7 d	1.3×10^{14}	1.1×10^{15}	1.9×10^{15}	3.2×10^{15}
^{127m}Te	109 d	2.5×10^{14}	7.7×10^{14}	6.9×10^{13}	1.1×10^{15}
^{129m}Te	33.6 d	7.2×10^{14}	2.4×10^{15}	2.1×10^{14}	3.3×10^{15}
^{131m}Te	30 h	2.2×10^{15}	2.3×10^{15}	4.5×10^{14}	5.0×10^{15}
^{132}Te	78.2 h	2.5×10^{16}	5.7×10^{16}	6.4×10^{15}	8.8×10^{16}
^{103}Ru	39.3 d	2.5×10^{09}	1.8×10^{09}	3.2×10^{09}	7.5×10^{09}
^{106}Ru	368.2 d	7.4×10^{08}	5.1×10^{08}	8.9×10^{08}	2.1×10^{09}
^{95}Zr	64 d	4.6×10^{11}	1.6×10^{13}	2.2×10^{11}	1.7×10^{13}
^{141}Ce	32.5 d	4.6×10^{11}	1.7×10^{13}	2.2×10^{11}	1.8×10^{13}
^{144}Ce	284.3 d	3.1×10^{11}	1.1×10^{13}	1.4×10^{11}	1.1×10^{13}
^{239}Np	2.4 d	3.7×10^{12}	7.1×10^{13}	1.4×10^{12}	7.6×10^{13}
^{238}Pu	87.7 y	5.8×10^{08}	1.8×10^{10}	2.5×10^{08}	1.9×10^{10}
^{239}Pu	24,065 y	8.6×10^{07}	3.1×10^{09}	4.0×10^{07}	3.2×10^{09}
^{240}Pu	6537 y	8.8×10^{07}	3.0×10^{09}	4.0×10^{07}	3.2×10^{09}
^{241}Pu	14.4 y	3.5×10^{10}	1.2×10^{12}	1.6×10^{10}	1.2×10^{12}
^{91}Y	58.5 d	3.1×10^{11}	2.7×10^{12}	4.4×10^{11}	3.4×10^{12}
^{143}Pr	13.6 d	3.6×10^{11}	3.2×10^{12}	5.2×10^{11}	4.1×10^{12}
^{147}Nd	11 d	1.5×10^{11}	1.3×10^{12}	2.2×10^{11}	1.6×10^{12}
^{242}Cm	162.8 d	1.1×10^{10}	7.7×10^{10}	1.4×10^{10}	1.0×10^{11}
^{131}I	8 d	1.2×10^{16}	1.4×10^{17}	7.0×10^{15}	1.6×10^{17}
^{132}I	2.3 h	1.3×10^{13}	6.7×10^{06}	3.7×10^{10}	1.3×10^{13}
^{133}I	20.8 h	1.2×10^{16}	2.6×10^{16}	4.2×10^{15}	4.2×10^{16}
^{135}I	6.6 h	2.0×10^{15}	7.4×10^{13}	1.9×10^{14}	2.3×10^{15}
^{127}Sb	3.9 d	1.7×10^{15}	4.2×10^{15}	4.5×10^{14}	6.4×10^{15}
^{129}Sb	4.3 h	1.4×10^{14}	5.6×10^{10}	2.3×10^{12}	1.4×10^{14}
^{99}Mo	66 h	2.6×10^{09}	1.2×10^{09}	2.9×10^{09}	6.7×10^{09}

(Shibata, 2013). Further, many researchers and engineers who voluntarily engaged in environmental monitoring or radiation screening for inhabitants suggested the necessity of large-scale monitoring on the basis of their experience following the proclaim by SCJ.

Meanwhile, the ministry of the Education, Sports, Science and Technology (MEXT), which had the general responsibility for environmental monitoring activities after the Fukushima accident, organized the ad hoc committee to discuss what and how environmental monitoring around the Fukushima NPP site should be performed in the emergency situations. On the basis of the discussion, MEXT commissioned the Japan Atomic Energy Agency (JAEA) to implement the project to construct detailed contamination maps around the Fukushima site based on data obtained from reliable sample collection and measurements in collaboration with many related organizations including universities and research institutes (Sakaba, 2013). These projects called “mapping projects” have been repeatedly continued. By the end of fiscal year 2012, that is March 31, 2013, three series of campaigns were completed.

The common purpose of the series of the projects is to provide reliable basic data on environmental contamination conditions that would be utilized in estimating the impact of the accident to the public and also to the environment, and in decision making for appropriate countermeasures such as decontamination, return of evacuees, and determination of criteria for radiation protection. Actually, the data were successfully utilized in these prospects. This preface overviews the projects implemented in the first three campaigns from June 2011 through March 2013. The first special issue titled “Japanese national projects on large-scale environmental monitoring and mapping in Fukushima Volume 1” compiles the main results obtained during this period; the second special issue planned to be published soon will complement the results.

Table 2
Schedule and tasks of the three series of the mapping projects.