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Dose Assessment of Urban Environment Based on Deposition Measurement Data After Fukushima Daiichi NPP Accident

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1. Introduction

When an accident occurs in nuclear power plants (NPPs), released radioactive materials from the plant could be distributed and reached at urban area. As lots of people live in urban area and the accident would affect many people in cities, it is very important to build a model and evaluate its deposition, redistribution and effect. Therefore, we joined the Modelling and Data for Radiological Impact Assessment program (MODARIA) II on IAEA, especially Urban Environments Working Group, to test and improve the capabilities of models in which perform the assessment of radioactive contamination in urban environments. In this study, we evaluated a scenario where the assessment starts at deposited rate of radioactivity materials on urban ground with Fukushima Data provided by the WG. The purpose of this evaluation is to share the results from several countries with different models and to compare to the actually measured data.

2. Methods and Results

2.1 Environmental Data in Fukushima-City

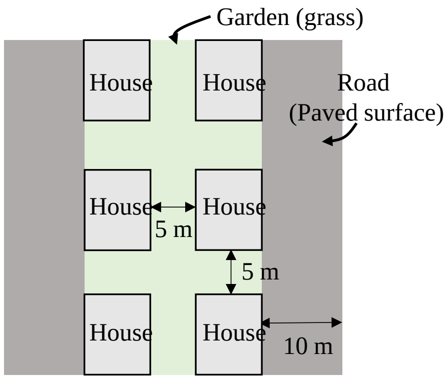
Fukushima-City is the target area of this exercise. The general description is that Fukushima prefecture has a population of about 280,000 and an area of about 760 square kilometers. Before the Fukushima NPP accident, the air absorbed dose measured in Fukushima prefecture was about 0.04 μSv/h[1]. The composition of the surface activity density of each radionuclide to that of cesium-137 was determined according to the report of UNSCEAR. The relative isotopic composition of deposited radionuclides is shown in Table I [2]. The geometry mean surface density of Cs-137 in Fukushima at 2012/5/31 was 144 kBq/m^2.

Table I: Composition of Radionuclides Deposited

Radionuclides	Deposited activity normalized by Cs-137
Ag-110m	0.0028
Te-129m	1.1
Te-132+I-132	8
I-131	11.5
Cs-134	1
Cs-136	0.17
Cs-137 + Ba-137m	1

2.2 Typical Location and House

To begin with, we were provided the information about the typical location and house model which from a survey of the actual location relevant to the participants in the individual dose measurements. The typical Japanese houses are located in between 10m-wide paved roads. Furthermore, between the houses, there is a garden made of grass. The house has two stories and the material is wood. Fig.1. shows the schematic drawing of the typical location and the typical model of Japanese houses



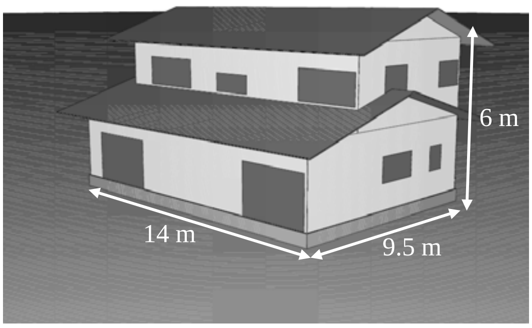


Fig. 1. Schematic drawing of typical location in Fukushima-City and the typical model of Japanese house [3]

2.3 Application on METRO-K Model

In this study, we used the model METRO-K which was developed in Korea to evaluate radioactive dose from urban surfaces. Since the starting point of this model is an air concentration, as shown in the Fig.2, and that of the scenario is the ground deposition, we calculated the initial air concentration of radioactive materials at first.

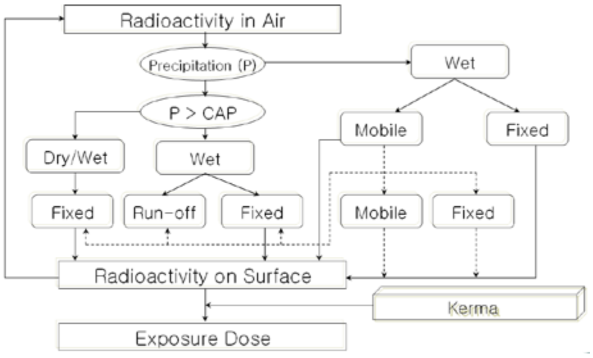


Fig. 2. Schematic diagram of METRO-K.

In order to apply this model, we used a dose kerma value of one of the house types in the METRO-K[4]. However, when it comes to the house location geometry of the scenario, it was different from our model. Thus, we adjusted the kerma value in order to reflect the difference between the model and the scenario. For instance, the house type in the METRO-K is surrounded by all four sides; on the other hand, in the scenario one of the sides of the house is paved road. After deriving the kerma, we calculated the exposed dose caused by each deposit nuclide. As we assumed that people living in Fukushima city do not eat food from that area, we neglected the internal dose from food ingestions.

2.4 Assessment Results

We evaluated the dose on a person who stands at the 1st floor in the house and at right outside of the house. Table II shows the external exposed dose results from each location and radionuclides. According to the results, the total dose of a person who is at the indoor and outdoor are 7.83E-04 mSv and 1.40E-03 mSv a day. The highest contributing radionuclides to the total results are in order Cs-134 and Cs-137. It is because those are less deposited than iodine but have high dose conversion factor, which means that those highly effects on human body.

Table II. Annual External Exposed Dose Result

Radionuclides	External Exposed Dose (mSv/day)	
Location	Indoor	Outdoor
Ag-110m	1.40E-06	2.43E-06
Te-129m	2.46E-08	4.39E-08
I-132	0	0
I-131	6.69E-16	1.29E-15
Cs-134	5.60E-04	9.98E-04
Cs-136	8.85E-12	1.55E-11
Cs-137	2.22E-04	4.00E-04
Total	7.83E-04	1.40E-03

3. Conclusions

In this study, we performed an external exposed dose assessment of people living in Fukushima city with the scenario based on deposition measurement data after the Fukushima accident. The METRO-K model was applied to conduct the evaluation and we calculated the dose on a person at indoor and outdoor. Through the assessment, we derived total dose due to every deposited nuclides and its contribution. As a result, what the results show is expected to contribute to the improvement of urban environment models and preparedness for a nuclear accident.

Acknowledgement

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