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# An Intercomparison of Model Predictions for an Urban Contamination Resulting from the Explosion of a Radiological Dispersal Device

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## 1. Introduction

The METRO-K[1] is a model for a radiological dose assessment due to a radioactive contamination in the Korean urban environment. The model has been taken part in the Urban Remediation Working Group within the IAEA's (International Atomic Energy Agency) EMRAS (Environmental Modeling for Radiation Safety) project[2]. The project is to provide an opportunity to compare modeling approaches and model predictions that describe radionuclide behavior in an urban environment. The project has been carried out for 5 years from 2003 to 2007, and a final report will be published this year as one of the IAEA's TECDOC. The major activities of the Working Group have included three areas. One of them is a modeling exercise based on a hypothetical situation involving a point-release of a radionuclide in an urban environment, specifically a release resulting from a radiological dispersal device (RDD) involving an explosion. This exercise is intended to provide an opportunity for an intercomparison of model predictions among participants. Three different models including the METRO-K have been taken part in this scenario. In this paper, the model predictions for a hypothetical RDD scenario that have been carried out as a part of the Working Group's activities are compared and discussed.

## 2. Methods and Results

### *2.1 Hypothetical RDD Scenario*

The EMRAS's Urban Remediation Working Group discussed a number of types of hypothetical scenarios that could result in the accidental or deliberate dispersal of radioactive materials in an urban environment. This hypothetical scenario was designed to provide an opportunity for a comparison between model predictions in an RDD situation including the effectiveness of various remediation actions in decreasing a long-term radiation exposure and doses to persons living or working in the test area. The primary input information for the modeling exercise is a contamination on a reference surface at six selected buildings. The test site was selected as a representative area of a major city (Fig. 1) ; it includes large buildings, residential areas, a major highway, other roads, car parking area, grassy park areas and trees. The origin of the event is at a fountain in the park (center in Fig. 1). It was assumed that a 5 kg conventional explosion of a RDD containing 50 TBq of $^{137}$Cs in a powder form had happened.

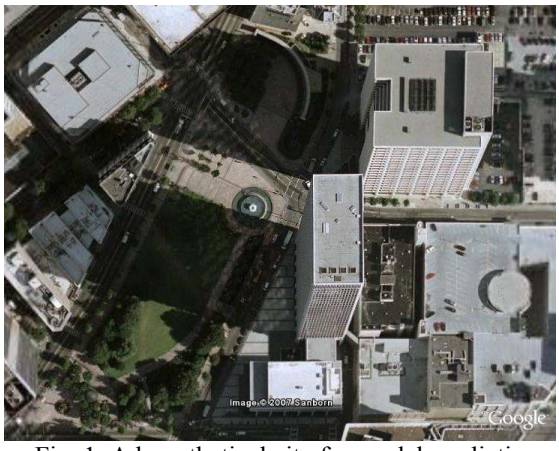


Fig. 1. A hypothetical city for model predictions (Building 1 is 60 stories and for commercial office)

### *2.2 Concentration on a Reference Surface*

The event was assumed to happen on 1 July of year 0. The weather at the time of the event was assumed to be dry, with a wind speed of 5 m/sec in the prevailing direction (from west to east). Release height was assumed to be ground level. Deposition velocities were assumed to be 0.3 cm/s for the respirable fraction and 8 cm/s for the non-respirable fraction. The respirable fraction was assumed to be 0.5, and the airborne fraction was assumed to be 0.3. Based on these assumptions, a simulation of an explosion event was performed using the HOTSPOT code. The remediation actions following the event were provided by the Working Group, together with the time of application to be assumed.

### *2.3 Intercomparison of Model Predictions*

The predictions of three different models (METRO-K, CPHR and RESRAD-RDD) were submitted to the Working Group. The models were originally developed for different purposes and used different modeling approaches and data. Assumptions applied for the description of a RDD scenario are different from one another. Therefore a RDD scenario essentially is open to an interpretation of a rather wide range of factors depending on the judgement of the modeler.

Fig. 2 shows the $^{137}$Cs concentrations at the outdoor of Building 1. For the RESRAD-RDD model, it was

assumed that paved areas receive about the same level of an initial contamination as the reference surface. The CPHR model assumed that the surfaces around the buildings are reference surfaces, which creates the same initial concentrations as the RESRAD-RDD model. While the METRO-K model assumed paved areas as an outdoor surface. A deposition velocity to paved areas is almost an order of magnitude less than that to a reference surface. Concentration decline of the METRO-K model was very steep through the entire period because of the assumption that an outdoor surface is composed of paved areas.

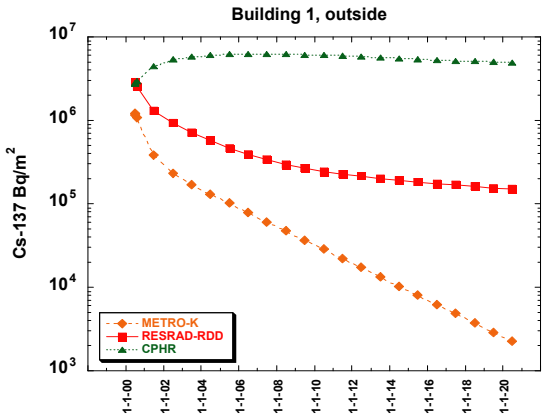


Fig. 2. $^{137}$Cs concentrations at outside of Building 1

Fig. 3 shows the dose rates on the first floor of Building 1. Major discrepancies between the models are as follows ; Street trees are included in the METRO-K model as an important exposure source, while they are not included in the RESRAD-RDD model. In addition, soil intrusion was included in the RESRAD-RDD model, while it is not included in the METRO-K and the CPHR models.

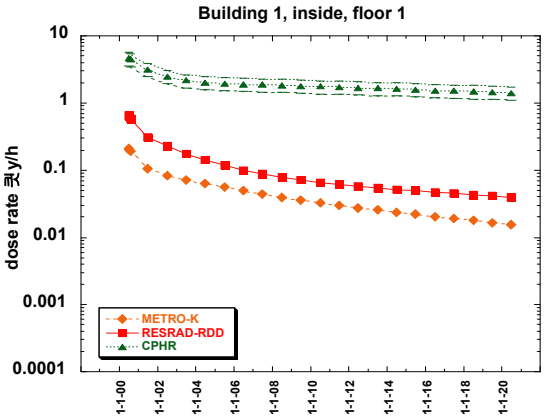


Fig. 3. Dose rates on the first floor of Building 1

Fig. 4 shows the annual doses for the first 5 years, showing the predicted effects on the annual dose of several different remediation actions. The METRO-K model uses kerma pre-calculated by Meckbach et al. using the SAM-CE Monte Carlo photon transport code for dose calculations, and the RESRAD-RDD model uses shielding factors, obtained with the RESRAD-BUILD code. Dose reduction for overall remediation actions varied considerably between models, but this was to be expected, since different models assume difference in dose contributing surfaces and different efficiencies in a dose reduction.

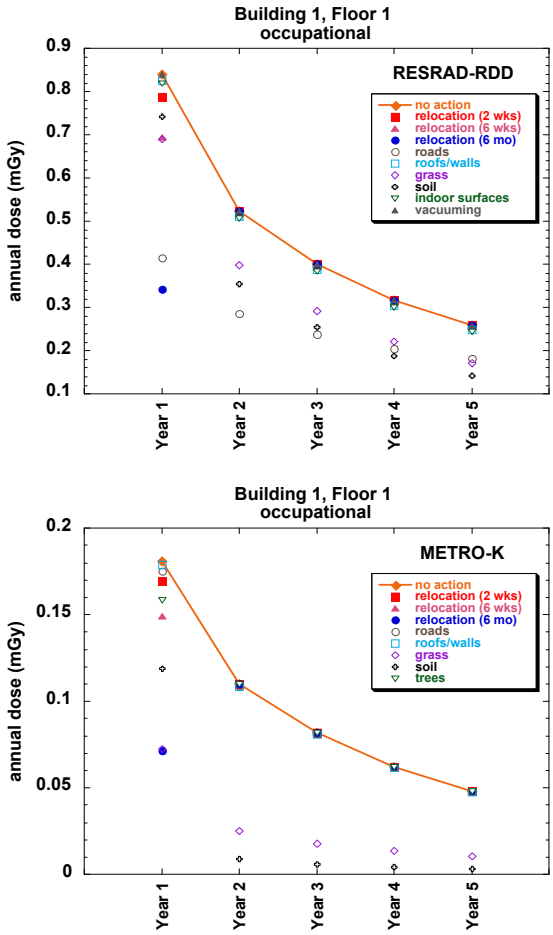


Fig. 4. Annual doses with remediation actions

## 3. Conclusions

For the radioactive contamination of a hypothetical RDD scenario, the METRO-K model has been taken part in the IAEA's EMRAS project. Owing to less information on a RDD scenario, the discrepancies between the model predictions for a RDD scenario were greater than that for Pripyat scenarios which were also performed in the EMRAS project. Therefore it is clear that the experience and the judgement of an assessor are very important factors.

## REFERENCES

[1] W. T. Hwang, E. H. Kim, H. J. Jeong, K. S. Suh and M. H. Han, A Model for Radiological Dose Assessment in an Urban Environment, Journal of Radiation Protection, Vol. 32(1), 1-8 2007.
[2] http://www-ns.iaea.org/projects/emras/.