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MUD: a Model to investigate the migration of ^{137}Cs in the Urban environment and Drainage and sewage treatment systems

Eduardo Gallego*

Universidad Politécnica de Madrid, E.T.S. Ing. Industriales, Nuclear Engineering Department, José Gutiérrez Abascal, 2, E-28006 Madrid, Spain

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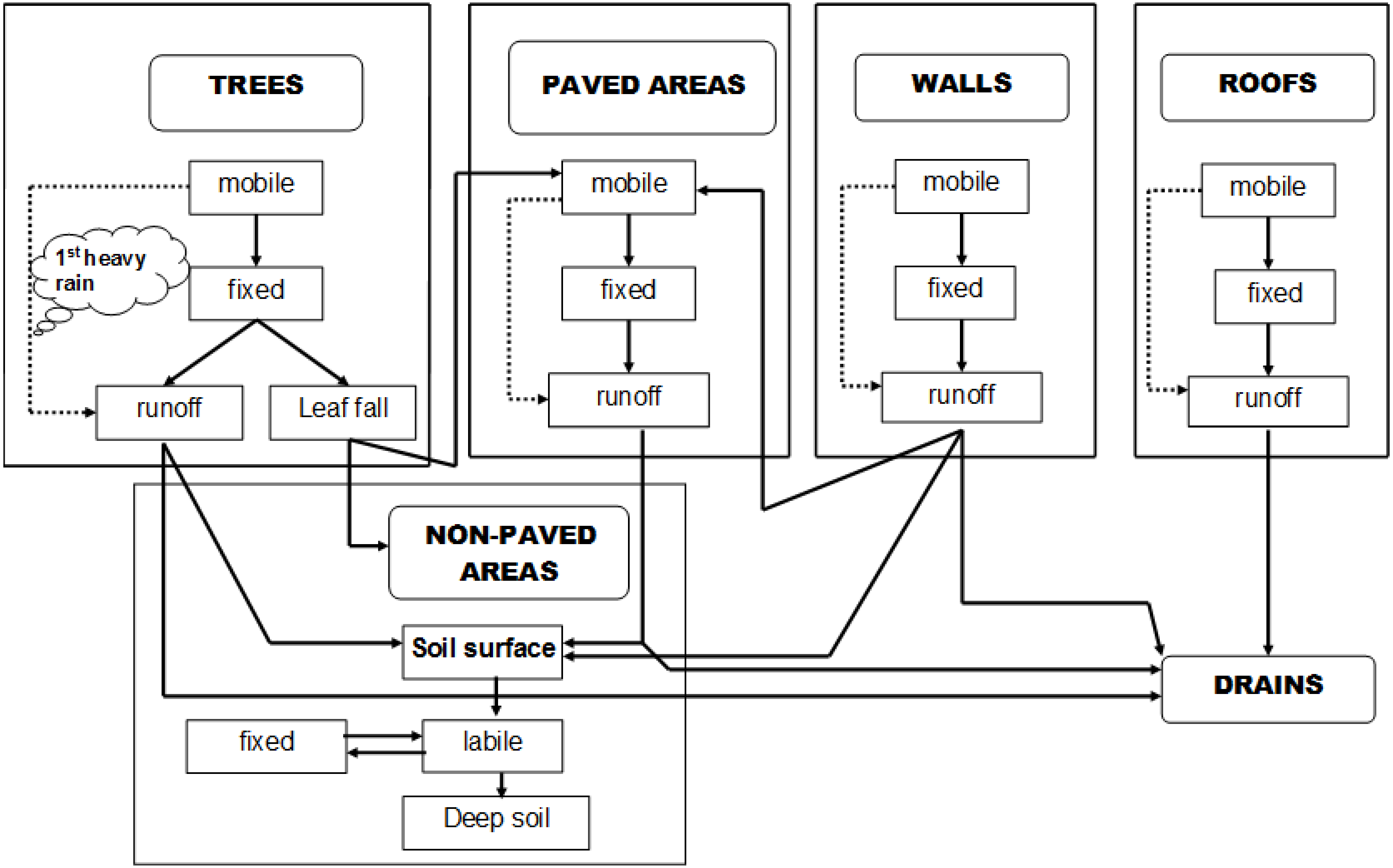
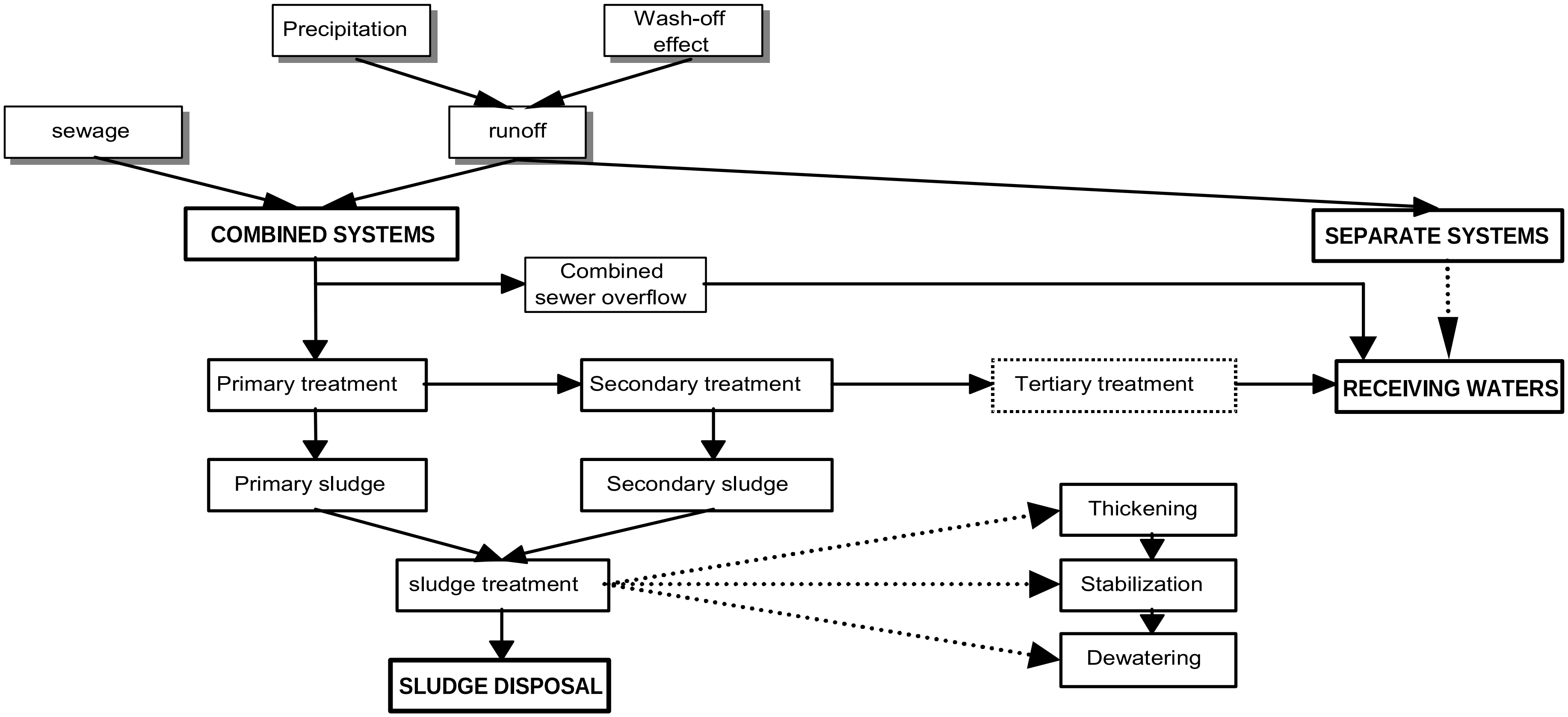
MUD: Schematic structure of the Urban Model



MUD: Schematic structure of the Drainage Model



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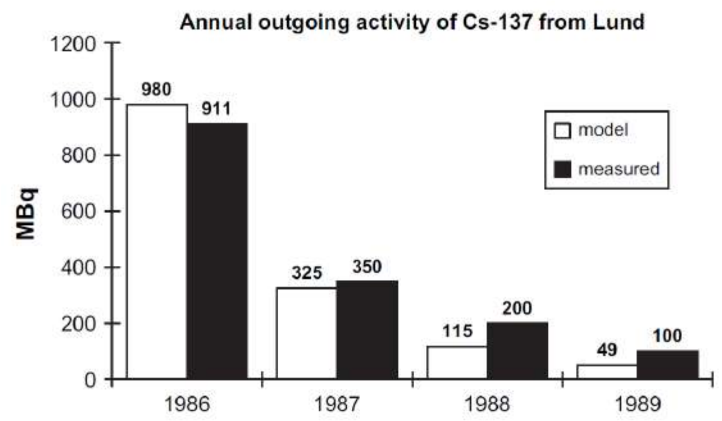
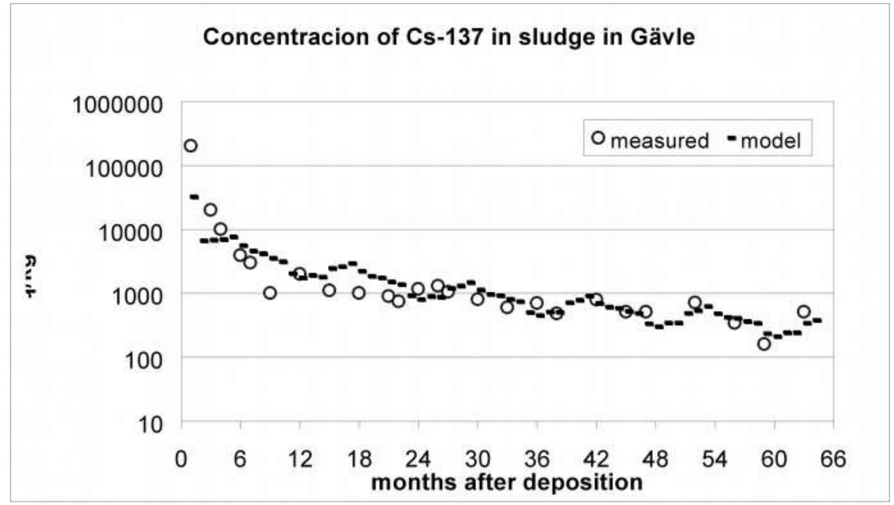
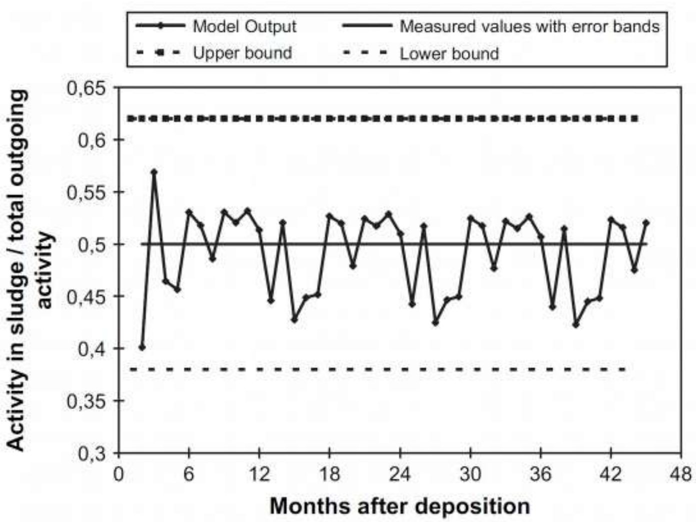
MUD: Post-Chernobyl application cases

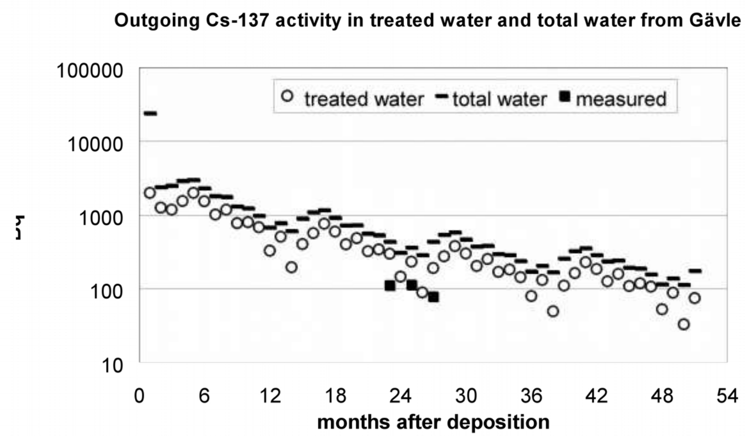


Total annual outgoing activity of ^{137}Cs from the treatment plant of Lund.





Ratio of the outgoing ^{137}Cs activity in sludge to that in sludge plus treated water (Lund)



Observed versus estimated ^{137}Cs activity in sludge and in water (Gävle)

MUD: sensitive parameters

- **For dry deposition**,
  - Deposition on roofs and on paved areas, which alone could explain up to 90% of the uncertainty in the results considered in many cases
  - The built-up fraction of the urban area
  - The runoff to overflow (annual fraction of runoff, which is discharged to receiving waters without treatment), together with the constant rates of removal of activity by rain. **Annual overflows** are relevant for the pollution impact on the receiving waters.
- **For wet deposition**,
  - The amount and duration of the first heavy rain are significant only for the first month after fallout.
  - Then, deposition on and natural decontamination of urban surfaces, with the built-up fraction and the annual runoff to overflow become more sensitive.
- **For the drainage model**,
  - Dry Weather Flow (flow entering the treatment plant in dry weather), the capacity of storage tanks in the sewer system and the partition coefficient K_d between solid and dissolved fractions of contaminant.

Recent references after Fukushima

IACSIT International Journal of Engineering and Technology, Vol. 6, No. 5, October 2014

Modeling Migration of Cs-137 in Sewer System of Fukushima City Using Model for Radionuclide Migration in Urban Environment and Drainage System (MUD)

M. A. Pratama, M. Yoneda, Y. Yamashiki, Y. Shimada, and Y. Matsui

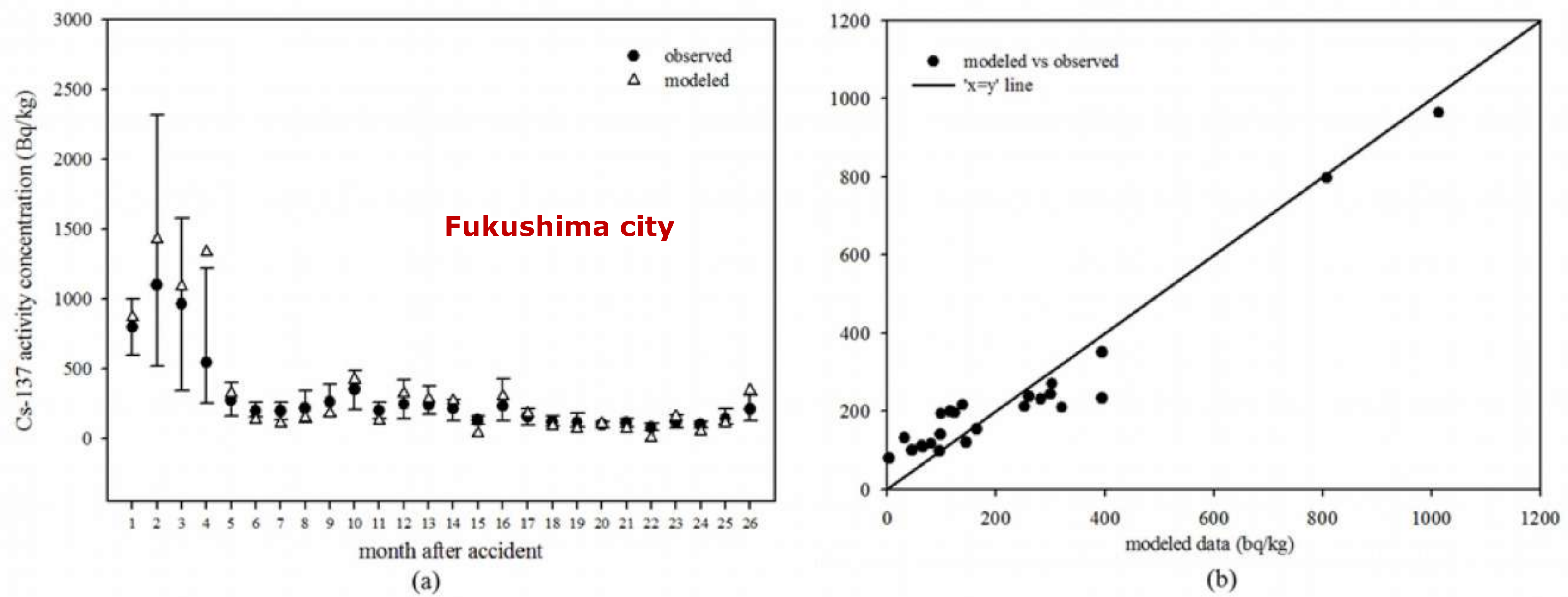


Fig. 5. Comparison between result of the model and empirical data (a) and scattered plot of modeled data And empirical data compared to x=y line (b).

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Modeling and identifying the sources of radiocesium contamination in separate sewerage systems

Check for updates

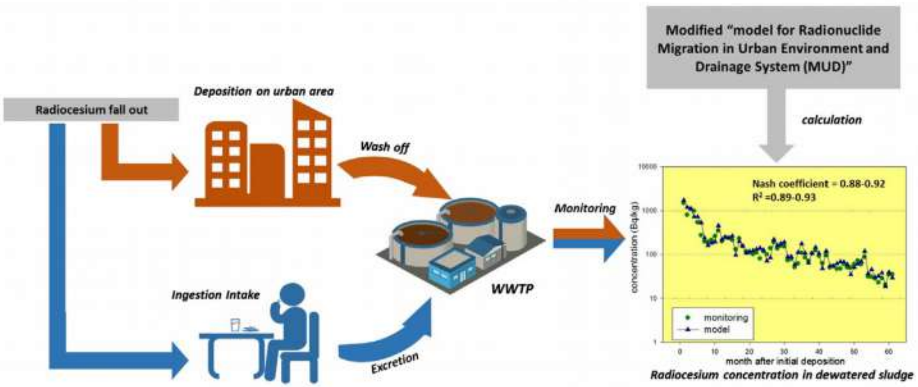
Mochamad Adhiraga Pratama [a,*], Minoru Yoneda [a], Yosuke Yamashiki [b], Yoko Shimada [a], Yasuto Matsui [a]

[a] *Graduate School of Engineering, Kyoto University, Japan*
[b] *Graduate School of Advanced Integrated Studies in Human Survivability, Kyoto University, Japan*

HIGHLIGHTS

- Following the Fukushima accident, sewers in urban areas of Fukushima have been contaminated with radiocesium.
- The two main sources of radiocesium contamination are rainfall-derived inflow and infiltration (RDII) and human excretion.
- We tested our model in Fukushima, Koriyama, and Nihonmatsu Cities, and the results agree with the observed data.
- The quantification of radiocesium fluxes brought by snowmelt runoff could improve the accuracy of our model.

GRAPHICAL ABSTRACT



Recent references after Fukushima

- Pratama et al., 2018

We developed a compartment model based on MUD to predict the concentration of radiocesium in sewer sludge by simulating these two processes. A comparison between the estimated and observed data gave high values of n (0.88–0.92), indicating that the model has reliable predictive power. The model also achieved high values for r^2 (0.89–0.93), which means that the estimated and observed data show the same time-dependent pattern. Upon finding that the estimated data tended to underestimate the observed data in the winter season, we incorporated the effect of snowmelt runoff on radiocesium contamination into the model. By factoring in the contribution of radiocesium influx from snowmelt runoff, we improved the predictive power of the model.

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3. Model of Radiocesium contamination in separate sewers

We used the Radionuclide Migration in Urban Environment and Drainage System (MUD) model developed by Gallego (2006) as the base for the simulation in this study. MUD consists of two sub-models, namely, "urban" and "WWTP." The urban sub-model explains the migration of radionuclides from the ground surface into the sewer system.

types of the ground surfaces where the radionuclides were deposited: soil, trees, paving, roofs, and walls. The Urban Sub-Model (Fig. 4) takes all the following processes into account:

- Deposition. Deposition of radionuclides onto ground surface becomes an initial input in this model. There are two types of deposition, dry and wet. This study only includes dry deposition due to limits in the available data.

Pratama et al., 2018

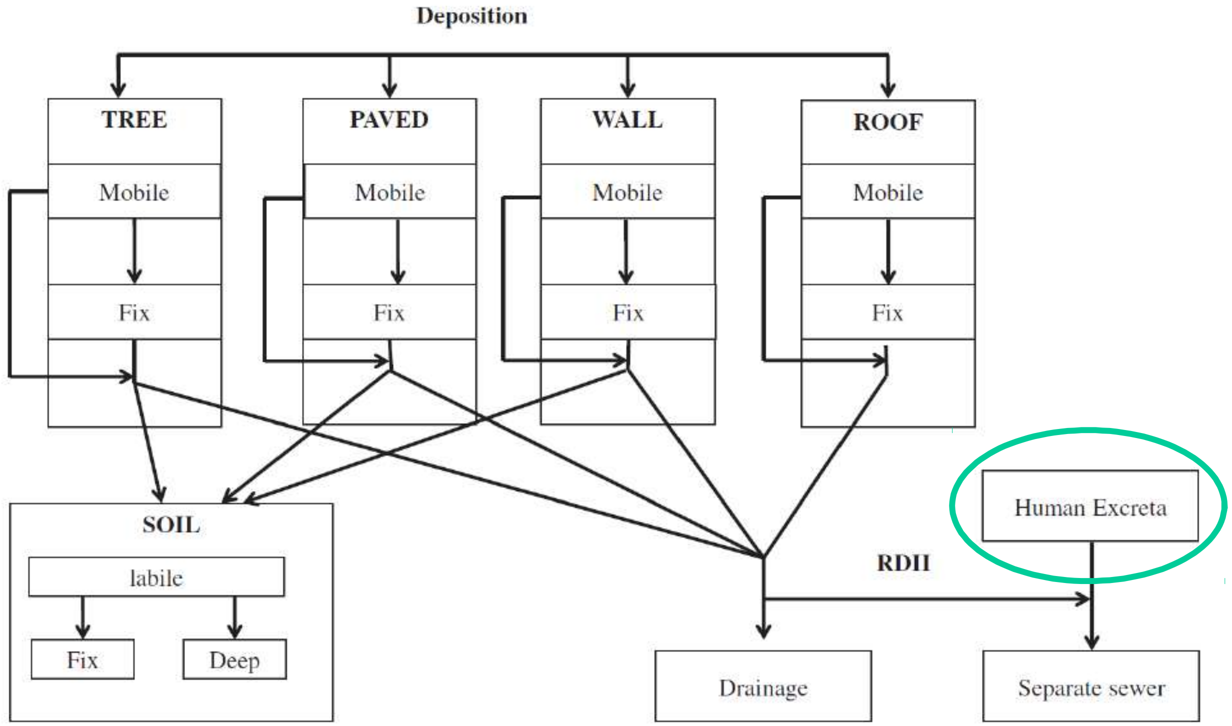
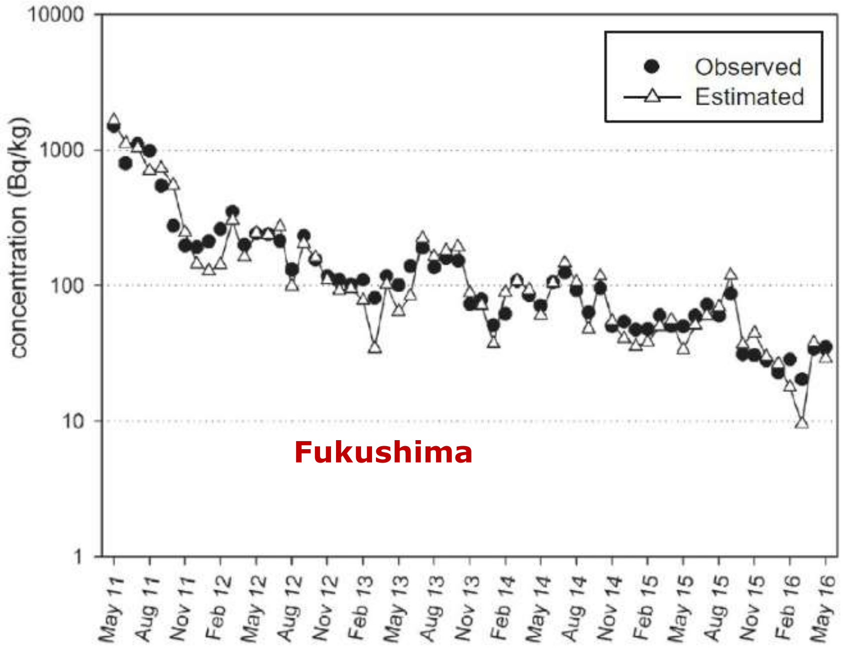
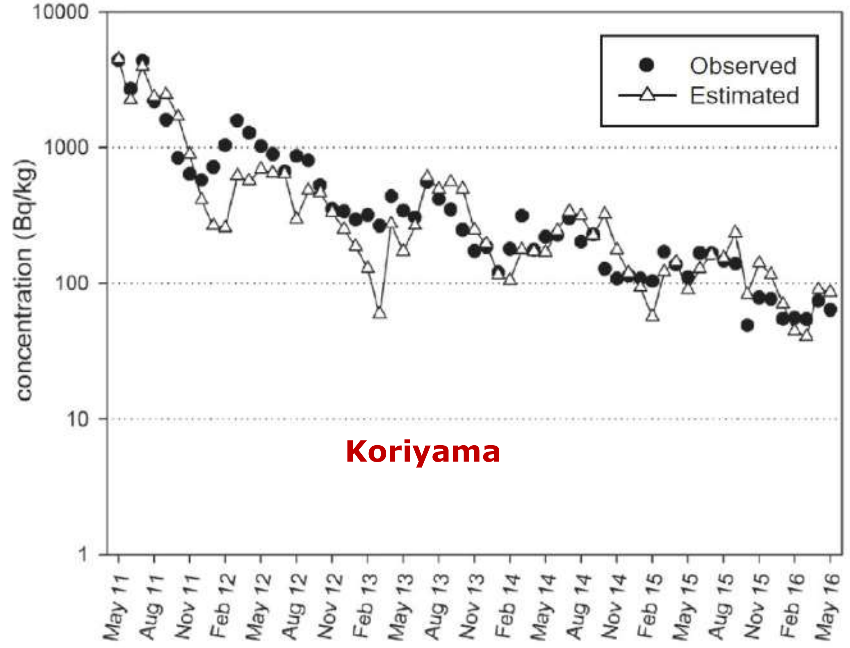
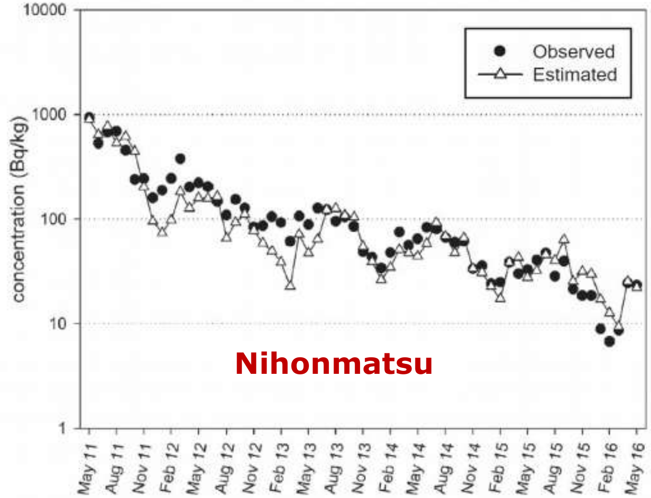


Fig. 4. Structure of the Urban Sub-model. Three more compartments were added to the original MUD model in order to model the radiocesium contamination in a separate sewer: "Human Excretion," "RDII," and "Separate Sewer".

Cs-137 concentration in sewage sludge







Pratama et al., 2018