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Korea Radioecological Data Management System: K-REDMAS

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1. Introduction

Since the Rio Declaration of the United Nations Conference on Environment and Development (UNCED) has established international principles for "sustainable development" [1], the environmental protection from ionizing radiation become a major issue in radiation protection field. To support the international consensus from the Rio Declaration, the International Commission on Radiation Protection (ICRP) recommended the necessary of the environment protection from ionizing radiation in the ICRP 103 [2]. Subsequently, the ICRP introduced the concept of reference animals and plants for the radiation protection of non-human biota [3], as shown in Figure 1. The environmental protection is to maintain the integrity of the ecosystem (diversity of species, populations, persistence of natural habit and ecosystem community) from the risk of ionizing radiation emitted into the environment due to the operation of the nuclear facilities or a nuclear accident.

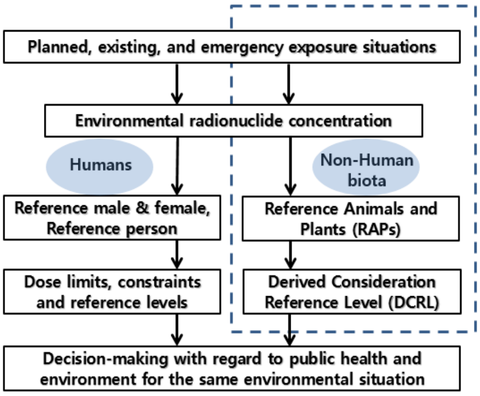

Fig. 1. A Schematic approach to the protection of both public and the environment in relation to any exposure situation.

Recently, the International Atomic Energy Agency (IAEA) issued the handbook for the transfer factor for wild animals and plants [4]. Transfer factor (TF) (or concentration ratio, CR) is the ratio of the activity concentration of radionuclide between the environmental medium such as water or soil and the living organism. Transfer factor is a necessary data for evaluating the radiation exposure dose of living organisms. The IAEA data is recommended to be used when the site-specific data is not available. Because the values of TF vary greatly depending on species and habitat environment, it is desirable to use the domestic site-specific data to improve the reliability of evaluation.

To establish the domestic database for transfer factors, field studies were conducted. In parallel, the Korean Radioecological Data Management System (K-REDMAS) was developed to manage the domestic data comprehensively. This paper describes regarding the measured domestic transfer factor data and the K-REDMAS developed by Korea Atomic Energy Research Institute (KAERI).

2. Transfer factor for the domestic ecosystem

2.1 Methods of sampling, Sample handling, and analysis

Near the Wolseong and Hanbit Nuclear Power Plants, and Daedeok nuclear complex, about 170 wildlife species were captured in different ecosystems (marine, freshwater, estuary, water bottom and terrestrial), and soil and water were simultaneously sampled at the same site. The wildlife species were collected by means of trapping, netting, fishing, diving, shooting and hand-catching by employed divers and hunters, and self-catching. Water was collected directly into sample bottles using a van Dorn sampler. The soil was sampled using a cylindrical sampler of a height of 10 cm.

The sampled fresh biota was dried by using the vacuum drier (FDB-5503, OPERON Co). Usually, the drying times of the samples were 2 to 5 days, depending on the sample conditions. After the drying, the samples were homogenized in powder form using a grinder, and a representative sample 1~3 g was taken for the concentration analysis. Water was pretreated by chemical treatment such as dissolution and extraction, and 50mL was taken for the analysis. The water samples were analyzed after removing the suspended particles through the membrane filter with pore size of 0.45μm. The sampled soils were separated into a liquid phase and a solid phase using a centrifuge.

Concentrations of 26 stable elements in wildlife, water, and soil samples were analyzed by ICP-MS (Al, Ti, Mn, Cr, Cu, Zn, Li, Ni, Co, Rb, Cs, Ba, Pb, Th, U) and ICP-AES(Ca, Fe, K, Mg, Na, Sr) since it is well known that the stable isotope in the ecological environment has the same behavior as radioisotope. Details of the field studies are described elsewhere [5].

2.2 TF and K_d

The transfer factor (TF) and the equilibrium distribution coefficient (K_d) are calculated by the following equations. Eq.(1) represents the transfer factor for aquatic biota and Eq.(2) represents the transfer factor for terrestrial biota, and Eq.(3) calculates the equilibrium distribution coefficient of the radionuclide between water and sediment or suspended particles in water for aquatic ecosystems such as lake and sea.

$$\mathrm{TF} = \frac{C_{biota}}{C_{water}} \quad (1)$$

$$\mathrm{TF} = \frac{C_{biota}}{C_{soil}} \quad (2)$$

$$K_d = \frac{C_{sediment}}{C_{water}} \quad (3)$$

where

C_{biota}: whole-body concentration of organisms (Bq/kg-fresh)
C_{water}: nuclide concentration in the water system (Bq/L)
C_{soil}: nuclide concentration in soil (Bq/kg-dry)
K_d: equilibrium distribution coefficient (L/kg)
$C_{sediment}$: concentration of nuclides in sediments (Bq/kg-dry)

Figures 2 and 3 show the domestic transfer factors for seaweed sampled around Wolsong and Hanbit Nuclear Power Plants, and the comparison with those of IAEA TRS 479 [4]. The domestic transfer factors were lower by several to several hundred times than those of IAEA. The difference seems to be ascribed by the fact that the organisms constituting each group and the environmental conditions are different each other.

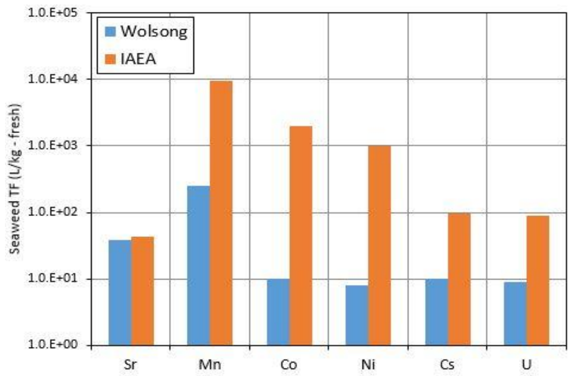

Fig. 2. Comparison of the transfer factor for the domestic seaweed near Wolsung NPP with those of IAEA.

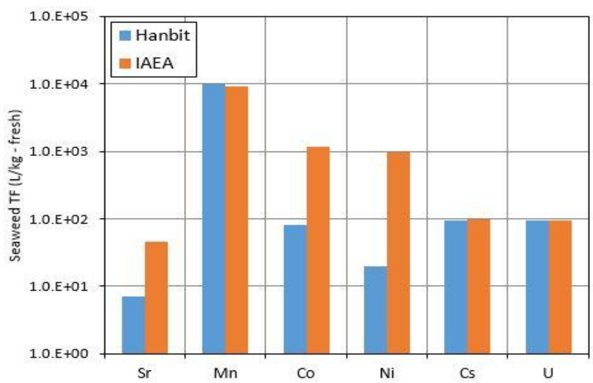

Fig. 3. Comparison of the transfer factor for the domestic seaweed near Hanbit NPP with those of IAEA.

3. Korea Radioecological Data Management System (K-REDMAS)

Parallel with the field study on transfer factors for the wildlife around the domestic nuclear facilities a computer program (K-REDMAS) was developed to manage the radioecological data comprehensively. Figure 4 shows the start screen of the K-REDMAS.

The K-REDMAS can manage the radiological data effectively including the following major functions.

3.1 Major functions of data management

- Search: Search the registered data for the specific category such as element, species, and type of data
- Graph: Plot of searched data
- Add / modify / delete of data
- Other formats: Export input data in different formats such as Excel spreadsheet

3.2 Procedure to draw a graph

After the user has completed the search of data for a specific category, the resulted data set can be graphed. Options of the graph tool are as follows.

- Category: x-axis value
- Values: y-axis value.
- Series: Select the value to be displayed as series.
- Inquiry: Draw a graph with selected data, category, values, and series
- Copy: Copy the graph to the clipboard
- Save: Save the graph as pdf or graphic file format

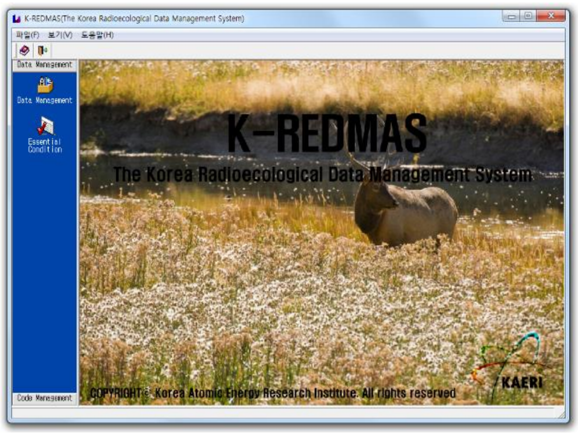

Fig. 4. Start screen of K-REDMAS.

Figures 5 and 6 show some example results made using K-REDMAS.

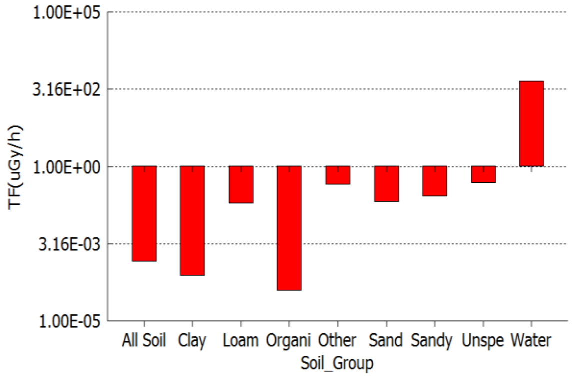

Fig. 5. Transfer factor (TF) extracted for soil group.

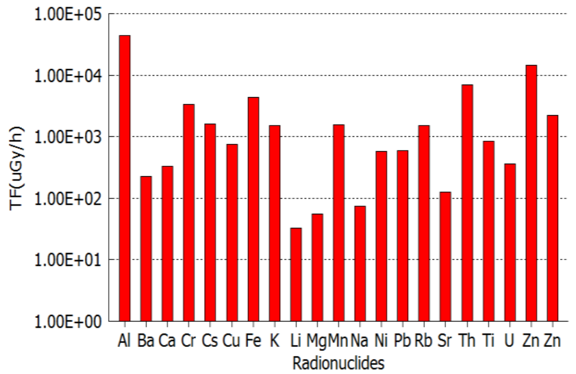

Fig. 6. Transfer factor (TF) extracted for elements.

4. Conclusions

The transfer factors for the domestic wild biota were investigated through field studies, and the Korean Radioecological Data Management System (K-REDMAS) was developed to manage the radioecological data comprehensively.

The studied database of domestic transfer factors for wildlife is planned to be used as input values of TFs for Korean wildlife dose assessment models. It can also be provided with the international societies such as the IAEA to contribute to an improvement of the international database for wildlife transfer factors.

5. Acknowledgments

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6. REFERENCES

[1] The Rio Declaration on Environment and Development, The United Nations Conference on Environment and Development, 1992.
[2] ICRP, The 2007 Recommendations of International Commission on Radiological Protection, ICRP Publications 103, 2007.
[3] ICRP, Environmental protection: the concept and use of reference animals and plants, ICRP Publications 108, 2008.
[4] IAEA, Handbook of Parameter Values for the Prediction of Radionuclide Transfer to Wildlife, Technical Report Series, No.479, 2014.
[5] Korea Atomic Energy Research Institute (KAERI), Development of technologies to protect environment from the radiation risk of emergency exposure, KAERI-RR-4240, 2016.