Development of Freshwater Foodchain Model for Calculating Tritium Transfer in Aquatic Organisms in Freshwater Following Nuclear Accident

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1. Introduction

In the field of radiation protection, tritium was not major concern, because the radiological impact of tritium is not significant comparing with other radionuclides. Interest in tritium has grown after the experience of the release of tritium from the Fukushima Daiichi Nuclear Power Plant accident [1, 2] and the high OBT (Organically bound tritium) level measured in aquatic organisms [3, 4]. Tritium can pose a health hazard due to internal exposure via inhalation or ingestion, but health effect of external exposure could be negligible.

A model has been developed to estimate tritium concentrations in aquatic organisms and the effect on human health. Calculation was performed on the Fukushima accident case.

2. Materials and Methods

2.1 Aquatic Food Chain Model for Tritium

The model calculates the OBT and HTO (tritiated water) transfer through the aquatic food chain following accidental releases of tritium. It is based on a dynamic model for OBT and an equilibrium model for HTO. It considers 4 types of aquatic organisms: phytoplankton, zooplankton, prey fish, and predatory fish.

2.2 Input Data and Assumptions for Calculation

Measurement data of tritium concentration at Hiso River in Iitate village from 2011 to 2014 were taken from Ueda et al. (2015) [5].

Fig. 1. Sampling location of Rivers in Fukushima prefecture. Figure taken from Ueda et al. (2015) [5].

Fig. 2. H-3 concentration in Hiso river water. Data taken from Table 1 of Ueda et al. (2015) [5].

3. Results and Discussion

River water in some regions of Japan have been contaminated with radionuclides released from Fukushima Daiichi nuclear power plant (FDNPP)
accident. We calculated HTO and OBT concentration in aquatic organisms which were inhabited at Hiso River in Iitate village in Fukushima Prefecture from 2011 to 2014. Fig. 3 (a) and (b) show the predicted activity concentrations of H-3 in 4 types of aquatic organisms at Hiso River for two cases: 1) the use of mean background H-3 concentration (0.4 Bq/L) in river water, 2) use of fitting data (contaminated by FDNPP accident) presented in Fig. 2. About 1,200 ~ 1,400 days after the Fukushima accident, concentration levels of H-3 in aquatic organisms inhabited at Hiso River become similar to those aquatic organisms inhabited at rivers with background levels of H-3. OBT concentration was predicted to account for less than about 5% of H-3 concentration in aquatic organism.

Comprehensive analysis with monitoring data and simulation results from other model will be conducted after collecting sufficient data. The developed tritium aquatic food chain model will be used as a tool to estimate contaminated levels of aquatic food and ingestion doses for accidentally release of tritium.

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