A Development of Domestic Food Chain Model Data for Chronic Effect Estimation of Off-site Consequence Analysis

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1. Introduction

A food chain model (FCM) is a model to estimate the chronic health effects of radiation from the ingestion of foods which are produced from the radiological contaminated environments. The FCM includes complex transport phenomena of radiation materials on a biokinetic system of contaminated environments. An estimation of chronic health effects is a key part of the level 3 PSA (Probabilistic Safety Assessment), which depends on the FCM estimation from contaminated foods ingestion.

A cultural ingestion habit of a local region and agricultural productions are different to the general features over worldwide scale or case by case. This is a reason to develop a domestic FCM data for the level 3 PSA. However, a generation of the specific FCM data is a complex process and under a large degree of uncertainty due to inherent biokinetic models.

As a preliminary study, the present study focuses on an infrastructure development to generation of a specific FCM data. During this process, the features of FCM data to generate a domestic FCM data were investigated. Based on the insights obtained from this process, a specific domestic FCM data was developed.

2. Methods and Results

The FCM is constrained by the adopted analysis code, because the FCM is related to the off-site consequence analysis approach. The typical consequence analysis in PSA adopts the MACCS2 code, which is developed by Sandia National Laboratories (SNL), as a tool [1]. The COMIDA2 code is a preprocessor for the FCM of the MACCS2 code system [2].

2.1 COMIDA2 code

This study surveyed the data in the FCM which are based on the COMIDA2 approach because of the relevant modeling approach. The COMIDA2 preprocessor has a structure as shown in Fig.1. To execute COMIDA2, three input data files are prepared.

- Scenario file (*.inp)
- Crops and animal data file (*.par)
- Nuclide specific data file (*.var)

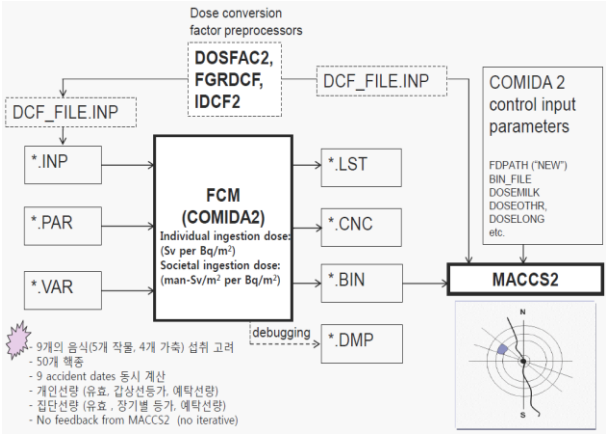

Fig. 1. Configuration of COMIDA2 code.

Individual dose estimation in the COMIDA2 is defined as following equation:

$$D_i = A \sum_{k=1}^{N} \left[\sum_{j=1}^{F} GC_k DS_k CR_j \right]$$

Where

CR_j = the individual consumption rate for the foodstuff j.

In the COMIDA2, nine foodstuffs: grains, leaf vegetables, roots, fruits, legumes, beef, milk, poultry, and "other" animal crop are defined. To obtain a specific FCM data for an estimation of individual dose, the individual's annual consumption rate (kg/yr) for the nine foodstuffs should be provided.

Meanwhile, population dose estimation is defined as following equation:

$$D_i = A \sum_{k=1}^{N} \left[\sum_{j=1}^{F} GC_k DS_k AP_j \right]$$

where

AP_j = the agricultural productivity for the foodstuff category j.

To obtain a specific FCM data for an estimation of population dose, the annual productivity for the nine foodstuffs should be provided. It is noted that the annual productivity is a specific site dependent parameter, which should be defined by user in the MACCS2.

2.3 Survey of Domestic Food Data

To generate a domestic FCM data, in particular, individual's annual consumption rate and agricultural productivity for the nine foodstuff categories should be assessed. In this study, the relevant data obtained from the national scale data. A local region date near a plant

site has a large uncertainty due to population size and complex supply system of foodstuffs. A national scale data may reduce the uncertainty and problem due to the complex supply system. It is noted that the domestic agriculture products are mainly consumed by the national constituent without an export, so an undesirable disturbance or assumptions in the estimation could be reduced by the national scale data. For this work, relevant national data surveyed from KOSIS (Korean statistical Information System) internet system.

2.3 Results

Table 1 shows the personal consumption rates and productivities of the nine foodstuffs categories for the domestic region at 2012. It is noted that the national farmland area and population to calculate a personal consumption and productivity were applied to 17,300,000,000 square-meter and 50,849,000 persons at 2012, respectively.

Table 1: Personal consumption and productivity of nine foodstuffs for the domestic region (2012)

foodstuff		Production (ton)	Personal consumption (kg/person)	productivity (kg/sq-m)
1	grain	4,201,131	82.62	2.43E-01
2	leafy vegetables	4,542,152	89.33	2.63E-01
3	roots	1,136,310	22.35	6.57E-02
4	fruits	4,441,988	87.36	2.57E-01
5	legumes	184,851	3.64	1.07E-02
6	beef	234,000	4.60	1.35E-02
7	milk	2,110,000	41.50	1.22E-01
8	poultry	1,189,400	23.39	6.88E-02
9	pork	750,000	14.75	4.34E-02

2.2 Features of Domestic Data

The obtained FCM data were compared with the MACCS2 default data which is provided by SNL as an example in the MACCS2 distribution package. Fig. 2 shows a comparison of the annual productivity for the nine foodstuffs between MACCS default data, preliminary study data, and domestic data. In preliminary study, 100 persons per a unit farmland area as the productivity ratio from the obtained personal consumption rate was applied as similar to the example case provided by the MACCS2. From this study, it is observed that an effect of the domestic region to generate the FCM data is a different to the default data of the MACCS2.

3. Concluding Remarks

The present study was developed a domestic FCM data to estimate the chronic health effects of off-site consequence analysis. From this study, an insight was obtained, that a domestic FCM data is roughly 20 times higher than the MACCS2 defaults data. Based on this observation, it is clear that the specific chronic health effects of a domestic plant site should be considered in the off-site consequence analysis.

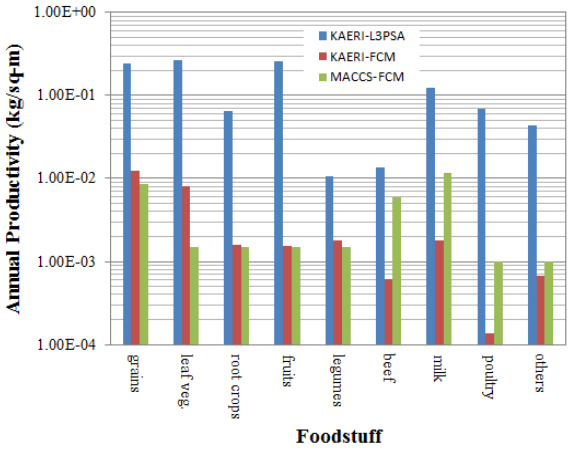

Fig. 2. A comparison of annual productivity for the nine foodstuffs between MACCS default data, preliminary study data and domestic data.

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