Paper

ECOSYS-87: A DYNAMIC MODEL FOR ASSESSING RADIOLOGICAL CONSEQUENCES OF NUCLEAR ACCIDENTS

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Abstract—**The time-dependent radioecological simulation model ECOSYS-87 has been developed to assess the radiological consequences of short-term depositions of radionuclides. Internal exposure via inhalation and ingestion, as well as external exposure from the passing cloud and from radioactivity deposited on the ground, are included in the model. The site-specific parameter values of the model are representative of Southern German agricultural conditions; however, the model design facilitates adaption to other situations. The ingestion dose is calculated as a function of time considering 18 plant species, 11 animal food products, and 18 processed products. The ingestion and inhalation exposure is estimated for six age groups using age-dependent consumption and inhalation rates and age-dependent dose factors. Results demonstrate a pronounced influence regarding the time of year (season) of deposition on the ingestion dose and on the relative importance of the exposure pathways. Model results compare well with activities in foods measured after the Chernobyl accident.**

Health Phys. **64(3):232–252; 1993**

Key words: accidents, nuclear; exposure, radiation; food chain; transport, environmental

INTRODUCTION

AFTER accidental releases of radionuclides into the atmosphere leading to contamination of large areas, a fast and detailed prognosis of the resulting radiation exposure to the population is required in order to evaluate its radiological consequences and to support and optimize decisions concerning countermeasures. All exposure pathways that might be important have to be considered in such a prognostic dose assessment:

1) Transfer of radionuclides through food chains and the subsequent internal exposure of humans due to ingestion of contaminated foodstuffs;
2) Internal exposure due to inhalation of radionuclides during passage of the cloud;
3) External exposure from radionuclides in the passing cloud; and
4) External exposure from radionuclides deposited on the ground.

Models for the dose assessment, after accidental releases, have to consider the time dependency of the transfer processes since equilibrium in the model compartments will not be reached for a long time. Therefore, dynamic modeling of the processes and consideration of the seasonality in the growing cycles of crops, in the feeding practices of domestic animals, and in human dietary habits are essential. Furthermore, the models have to be flexible enough to enable the simulation of the actual region-specific radioecological situation in case of an emergency.

In the late 1970s, the development of dynamic radioecological models was started and led to a number of such models (e.g., Booth et al. 1971; Pleasant et al. 1980; Linsley et al. 1982; Matthies et al. 1982; Koch and Tadmor 1986; Whicker and Kirchner 1987). Some of these models were used to estimate the radiological consequences of the Chernobyl accident soon after its event (e.g., ISS 1986). After this accident, many measurements of activity in air, soil, and foodstuffs were performed in many countries. Several of these data sets were used to test the reliability of the existing models (i.e., Brown et al. 1988; Maubert et al. 1988; Müller and Pröhl 1988; Ng and Hoffman 1988). Two international model validation studies, BIOMOVS (Köhler et al. 1991) and VAMP (Linsley et al. 1990), have been launched.

The experiences after the Chernobyl accident concerning activity measurements and questions raised by decision makers and the public showed that many aspects were not addressed in most of the existing models, especially predictions of the concentrations of activity in a variety of foodstuffs that are of less importance for the dose to the average population but of great importance for critical population groups (e.g., milk produced on extensively cultivated pastures, fruit, and berries). In many models, the possibility to consider specific feeding regimes was very limited. Moreover, most of the existing models did not (or did only to a small degree) consider the actual state of development of the different plant species at time of deposition. In

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(*Manuscript received* 12 *December* 1991; *revised manuscript received* 4 *August* 1992, *accepted* 20 *September* 1992

0017-9078/93/$3.00/0