Application of mathematical modelling techniques for evaluation of radionucleide accumulation levels in biota

R. Avila[a], S. Kazakov[b], A. Pakhomov[b], I. Pakhomova[c] and S. Fesenko[d]
[a] *Facilia AB, Gustavslundsvägen 151C, 167 51 Stockholm, Sweden;* [b] *Nuclear Safety Institute of RAS, 52, B.Tulskaya, 115191 Moscow, Russian Federation;* [c] *Scientific Centre of Radiochemical Safety, 40, Shukinskaya, 118241 Moscow, Russian Federation;* [d] *IAEA Marine Environment Laboratory, 4, Quai Antoine 1er B.P. 800, MC 98012 Cedex, Monaco*
pahomov@ibrae.ac.ru

In the majority of the cases associated with radioactive contamination of the environment, forest and lake ecosystems as natural filters and radionuclide storages relate to critical ecosystems. These two types of natural ecosystems as well as meadow prevail in the areas where NPP are located. To solve the entire complex of radioecological problems, the authors have developed the models for 137Cs and 90Sr migration in forest ecosystems that take into account the transformation processes of 137Cs and 90Sr in a soil-litter system, age- and season-specific dynamics for the tree layer and seasonal biomass changes in the understory, as well as radionuclide entering into food chains. A mathematical model for the migration of varied kinds of admixtures is developed and enhanced on the pattern of the 90Sr, 106Ru, 125Sb, 137Cs, 144Ce radioactive micro-admixture in lake ecosystems. The model takes into account the fact that micro-admixture withdraws out of the water both as a result of molecular/ ion-exchanging sorption on the boundary of the bottom sediments/ water layer and as a result of the detritus-forming process. When describing a vertical radionuclide migration in bottom sediments through a diffusion equation, the increase in the bottom sediment layer is considered. The authors have developed the mathematical models describing a long-term behavior of 90Sr and 137Cs in meadow ecosystems and taking into account basic processes that define the 90Sr and 137Cs biological accessibility for root absorption as well as the transformation processes in soil. For the assessment of biological effects of a radiation factor on the biota, a complex of dosimeter models is developed to evaluate the internal/ external doses to biota taking into account different geometry of the exposure source of ionizing radiation.

The represented mathematical models were successfully used during an environmental expertise performed for a number of Russian NPP and also when assessing environmental effects from the implementation of countermeasures in the Mayak facility region, as well as the effects of radioactive contamination in the Bryansk Region resulted from the Chernobyl accident.

The complex of mathematical migration and dosimeter models developed by the authors may be used to solve theoretical or applied radioecological issues with regard to the investigation of radionuclide behavior peculiarities in different ecosystems, as well as the evaluation of radiation impacts on organisms, populations or entire ecosystems. Besides, the models can be parameterized for specific forest/ water/ meadow ecosystems in varied situations associated with nuclear pollution of environment.

Article published by EDP Sciences and available at http://www.radioprotection.org
or http://dx.doi.org/10.1051/radiopro:2008578