



Jun 25th, 10:40 AM - 12:00 PM

Numerical model chain of radionuclide transport in “watershed – river – reservoir” systems: development and implementation at Chernobyl and Fukushima -Daiichi Nuclear Power Plants

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Zheleznyak, Mark; Kivva, Sergii; Boyko, Oleksiy; Igarashi, Yasunori; Konoplev, Aleksey; Pylypenko, Oleksandr; Sorokin, Maksym; and Wakiyama, Yoshifumi, "Numerical model chain of radionuclide transport in “watershed – river – reservoir” systems: development and implementation at Chernobyl and Fukushima -Daiichi Nuclear Power Plants" (2018). *International Congress on Environmental Modelling and Software*. 20.

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Numerical Model Chain of Radionuclide Transport in “Watershed – River – Reservoir” Systems: Development and Implementation at Chernobyl and Fukushima -Daiichi Nuclear Power Plants

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Abstract: Turbulent two-phase flows drive transport of radionuclides released into the water systems - rivers, reservoirs, coastal areas. Radiation exposure of the population via aquatic pathways by radiocesium and some other radionuclides should be modeled taking into account the sorption-desorption exchange of these elements between water, suspended and bottom sediments. The chain of Environmental Fluid Mechanics (EFD) models of different scale of the resolution were developed to simulate the radioactive contamination of the water systems at the Chernobyl Nuclear Power Plant (ChNPP) after April 1986 accident and the Fukushima- Daiichi NPP (FDNPP) after March 2011 accident. Two models were applied for simulation radionuclide dynamics on watersheds. The simplified model RETRACE-R uses the empirical washing-out coefficients and the assumption of instant transportation of washed radionuclides from the contaminated cells to river network via GIS-derived pathways. The model DHSWM-R, which hydrological and sediment transport sub-models are modifications of the open source model DHSWM of the University of Washington, was extended by the numerical model of radionuclide transport in dissolved and particulate phase on suspended sediments and in bottom depositions. 1-D model RIVTOX and 2-D model COASTOX describe the multi-phase transport of radionuclides based on the numerical modules of river hydrodynamics and sediment transport. The model chain was implemented for rivers and reservoirs draining the watersheds at ChNPP ad FDNPP for prediction of radionuclide concentrations and justification of water protection measures. We also analyzed the impact of EFD processes on a more intensive transport of radionuclides on suspended sediments at FDNPP than at ChNPP.

Keywords: Model; Radionuclide; Watershed; River; Sediment