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GIS Modelling of Radionuclide Transport from the Semipalatinsk Test Site

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In this study, the software complex GIS-project MigRad (Migration of Radionuclide) was developed, tested and applied for the territory of the Semipalatinsk test site/ polygon (Republic of Kazakhstan), where since 1961, in total 348 underground nuclear explosions were conducted. The MigRad is oriented on integration of large volumes of different information (mapping, ground-based, and satellite-based survey): and also includes modeling on its base local redistribution of radionuclides by precipitation and surface waters and by long-range transport of radioactive aerosols.

The existing thermal anomaly on territory of the polygon was investigated in details, and the object-oriented analysis was applied for the studied area. Employing the RUNOFF model, the simulation of radionuclides migration with surface waters was performed. Employing the DERMA model, the simulation of long-term atmospheric transport, dispersion and deposition patterns for cesium was conducted from 3 selected locations (Balapan, Delegen, and Experimental Field). Employing geoinformation technology, the mapping of the of the high temperature zones and epicenters of radioactive aerosols transport for the territory of the test site was carried out with post-processing and integration of modelling results into GIS environment. Contamination levels of pollution due to former nuclear explosions for population and environment of the surrounding polygon territories of Kazakhstan as well as adjacent countries were analyzed and evaluated.

The MigRad was designed as instrument for comprehensive analysis of complex territorial processes influenced by former nuclear explosions on the territory of Semipalatinsk test site. It provides possibilities in detailed analyses for (i) extensive cartographic material, remote sensing, and field measurements data collected in different level databases; (ii) radionuclide migration with flows using accumulation and redistribution of soil particles; (iii) thermal anomalies caused by explosions and observed on the test site and adjacent territories, and (iv) long-range transport of radioactive aerosols with analysis of dynamics of spatial distribution, averaged and accumulated fields for concentration and deposition patterns.