Earth Observation based long-term disaster risk analysis: regional assessment

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Purpose of this paper is to demonstrate the possibility to integrate the satellite observation data, ground measurements and modeling into the combined regionally adapted approach for socio-ecological risks assessment. Approach constructed is oriented to regional threats analysis; scenario analysis of coupled ecological and social consequences of natural and technological hazards; long-term risks assessment; orientation to decision support on crisis management and monitoring.

Approach is based on utilization of limited number of transparent indicators received from satellite observations, in-field measurements, and multi-scale phenomenological modeling. For the scenario modeling regionally adopted climate projections (NCAR IM/LCN and HadCM3 climate models) reduced with local meteorological data and greenhouse gases concentration satellite measurement has been used. Risk analysis based on general stochastic optimization robust model adapted and recalculated to number of particular cases (such as environmental transformation, catastrophe management, etc.). In this framework the number of analytic tools for calculation of the risks indexes has been proposed. In particular the equations for estimation of natural disaster risk (as the function of predicted number of selected types of natural disasters), direct and indirect “deferred” socio – ecological risk of natural and technological disasters, air and water contamination risks, and population morbidity risk have been constructed and tested on selected case studies.

As the threat indicators the satellite observed spectral indexes were proposed. For the case studies analyzed the Normalized Difference Vegetation Index, Enhanced Vegetation Index, Photochemical Reflectance Index, Plant Stress Status Index, Structure Intensive Pigment Index, Normalized Difference Water Index, and Temperature Comparative Index (reduced to Landsat satellites MSS and TM & ETM sensors) were used. It was shown than the analysis of temporal and spatial trends of these indexes as well as its inter-correlations allows to estimate the behavior of ecosystems and to forecast the corresponding change parameters.

Using the approach developed the long-term risks of floods and inundations for Ukrainian territory was estimated; morbidity risk as the consequence of technological “*phosphorus*” accident in Western Ukraine July 16, 2007 has been assessed; water quality degradation risk connected with natural and technological disasters on Western Bug river basin (Ukrainian part) was modeled; soils, ground and surface water contamination risks induced by technological “*red mud*” disaster in Hungary Oct 4, 2010 to Ukrainian part of Danube basin was analyzed.

The results obtained shown that the integrated approach for assessment of multi-term socio-ecological risks connected with natural disasters and selected types of technological hazards has been developed (also in view of global change tendencies). The set of spectral indexes as the indicators of defined threats has been defined, selected, validated and tested on number of case studies. Important cases of socio-ecological risks were analyzed and mapped. The approach proposed could be successfully applied onto number of different cases (such as natural hydrological, hydro-geological disasters, natural landscapes fire risk, desertification and biodegradation), and expanded for the other regions after relevant adaptation.