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Development of Triad approach based system for ecological risk assessment for contaminated areas of Kyrgyzstan

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This research is aimed to develop a high-effective system of an ecological risk assessment and risk-based decision making for anthropogenic ecosystems, with particular focus on the soils of the Kyrgyz Republic. The study is focused on the integration of Triad data including chemical, biological and ecotoxicological soil markers to estimate the potential risk from soils of highly anthropized areas impacted by deposition of different pollutants from mining operation. We focus on technogenic areas of Kyrgyzstan, the former uranium-producing province.
Triad-based ecological risk assessment for technogenic sites are not currently used in Kyrgyzstan. However, the vitality of such research is self-evident. There are about 50 tailing dumps and more than 80 tips of radioactive waste which are formed as a result of uranium and complex ores (mercury, antimony, lead, cadmium and etc) mining around the unfavorable aforementioned places. According to the Mining Wastes' Tailings and Fills Rehabilitation Centre established in 1999 by a special Government's Resolution, one of the most ecologically dangerous uranium tailings resides in Kadzhi-Say. Although uranium processing is no longer practiced in Kadzhi-Say, a large number of open landfills and uranium ore storages still remain abandoned at the vicinity of this settlement. These neglected sites have enormous problems associated with soil erosion known as "technogenic deserts". The upper soil horizons are deprived of humus and vegetation, which favor the formation of low-buffer landscapes in the zones of maximum contamination. As a result, most of these areas are not re-cultivated and remain in critical environmental condition (Bykovchenko, et al., 2005; Tukhvatshin, 2005; Suranova, 2006).
Triad data for assessing environmental risk and biological vulnerability at contaminated sites will be integrated. The following Triad-based parameters will be employed: 1) chemical soil analyses (revealing the presence of potentially dangerous substances), 2) ecological parameters (assessing changes in microorganism's community structure and functions, bioindication); and 3) toxicological bioassays (utilizing classical endpoints such as survival and reproduction rates, genotoxicity). The output will be consisted of 3 indexes: 1) Environmental Risk Index, quantifying the level of biological damage at population–community level, 2) Biological Vulnerability Index, assessing the potential threats to biological equilibria, and 3) Genotoxicity Index, screening genotoxic effects. Multi-criteria Decision Analysis (MCDA) will be used to integrate a set of environmental Triad data to be obtained during the project, which will be carried out in order to estimate the potential risk from soil contamination of the highly anthropized areas of Kadzhi-Say, which have been impacted by deposition of heavy metals.
The basis of the development under this research is studies with a particular focus concerning the biocenosis mapping of Kyrgyz soils (Mamytova et al., 2003, 2010), investigations on interaction of humic substances with soil contaminants (Jorobekova, Kydralieva, Khudaibergenova, 2004; Khudaibergenova, 2005, 2007), and in addition, technical approach for ecotoxicological assessment of soils (Terekhova, 2007, 2011). Soil ecotoxicological estimation has been studied with a battery of tests using test-organisms of many trophic levels. Currently, bioindication of soils with various humus states is under study (Senesi, Yakimenko 2007; Yakimenko, et al., 2008).