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Health risks from large-scale water pollution: Current trends and implications for improving drinking water quality in the lower Amu Darya drainage basin, Uzbekistan

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Safe drinking water is a primary prerequisite to human health, well being and development. Yet, there are roughly one billion people around the world that lack access to safe drinking water supply. Health risk assessments are effective for evaluating the suitability of using various water sources as drinking water supply. Additionally, knowledge of pollutant transport processes on relatively large scales is needed to identify effective management strategies for improving water resources of poor quality. The lower Amu Darya drainage basin close to the Aral Sea in Uzbekistan suffers from physical water scarcity and poor water quality. This is mainly due to the intensive agriculture production in the region, which requires extensive freshwater withdrawals and use of fertilizers and pesticides. In addition, recurrent droughts in the region affect the surface water availability. On average 20% of the population in rural areas in Uzbekistan lack access to improved drinking water sources, and the situation is even more severe in the lower Amu Darya basin. In this study, we consider health risks related to water-borne contaminants by dividing measured substance concentrations with health-risk based guideline values from the World Health Organisation (WHO). In particular, we analyse novel results of water quality measurements performed in 2007 and 2008 in the Mejdurechye Reservoir (located in the downstream part of the Amu Darya river basin). We furthermore identify large-scale trends by comparing the Mejdurechye results to reported water quality results from a considerable stretch of the Amu Darya river basin, including drainage water, river water and groundwater.

The results show that concentrations of cadmium and nitrite exceed the WHO health-risk based guideline values in Mejdurechye Reservoir. Furthermore, concentrations of the since long ago banned and highly toxic pesticides dichlorodiphenyltrichloroethane (DDT) and γ-hexachlorocyclohexane (γ-HCH) were detected in the reservoir water for the first time in a decade. However, a relatively pronounced temporal variability in concentrations was observed for many of the substances, implying that the reservoir could contain low-risk waters temporarily. Health risk factors related to lead and chromium concentrations in groundwater were up to 200 times higher than for river water. The identified major divergence in health risk between groundwater and surface water illuminates the risk of using groundwater for drinking water supply during recurrent surface water deficits in the study area. However, the severe water scarcity and lack of financial resources in the region makes the choices of alternative water supply sources limited. Due to the presence of multiple contaminants, it appears reasonable that the aggregated toxicity of contaminant mixtures should be in focus in surface and groundwater water monitoring and management in the region.

Key words: Aral Sea, Drinking water, Groundwater, Health Risk, Surface Water