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Source identification and health risk assessment of heavy metals in the freshwater of Central Asian river

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Western Kazakstan is the largest oil and gas production center in Central Asia known for the vast majority of industrial venues. Around 60 active fields are located there along with several refinery and metalworking factories, contributing to the contamination of the Ural river basin by critical contaminants such as heavy metals. While local and international reports provide on the hydrological state of the basin and its usage, no research has been carried out to assess the potential effect these contaminants (particularly Pb, Cd, Cr(VI)) may have on the health of the population residing on the Ural river. Considering the wide range of heavy metals present in the surface water of the basin, Principal Component Analysis has been conducted to identify their main anthropogenic sources. The exposure assessment scenario was based mainly on accidental ingestion and dermal contact via swimming as the river is widely used for recreational activities. Preliminary results demonstrate that the non-carcinogenic risks are insignificant (HI<1), while carcinogenic risks exceed the threshold and could have an accumulative effect on the health of the population, with Cr(VI) having the most significant contribution (up to 99% of the total cancer risk). Cancer risks remain within the range of 1.9*10-7 – 3.4*10-6. Deterministic and stochastic risks were estimated with country-specific exposure parameters based on environmental monitoring data provided by the governmental institute. Provided that the cases of using Ural's surface water for drinking purposes have been reported, the study also provides a stochastic risk assessment for the drinking pathway to draw attention to the occurring lack of clean drinking water in the region. The study imparts that minor activities such as swimming in the surface water of the river could cause additional risk to the well-being of the population, thus study results will be useful for considerations of future water treatment protocols. Furthermore, the Ural river has a considerable effect on the Caspian Sea, being one of the main dispensing rivers for the basin, thus its sustainability is crucial not only on the regional scale but has international relevance.