Elemental composition and toxicity of waters of the transboundary rivers of Kazakhstan

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In the modern conditions, the planet's resources of fresh water are subject to serious anthropogenic changes associated with depletion and pollution, especially in the transboundary aspect. Control of the quality of water flowing into the territory of Kazakhstan is an urgent topic for the Republic, since the country receives about 50% of fresh water resources through the transboundary water flows from Russia, China, Kyrgyzstan, Uzbekistan and Tajikistan.

CSince 2007, the RSE Institute of Nuclear Physics jointly with the RSE Kazhydromet have been performing the activities on survey and monitoring of the radiation and environmental situation in the border sections of the rivers flowing into the territory of Kazakhstan. The methodology, developed by the team of scientists from Central Asia (Kyrgyzstan, Uzbekistan, Tajikistan, Kazakhstan) and the United States, is used in survey of the transboundary Rivers Syrdarya and Amudarya under the international project "Navruz". Every year, in spring and autumn, the samples of environmental objects are collected at the control points located at 15 border areas (Figure 1) of the transboundary rivers and analytical studies are performed using IGS, RChA, NAA, XRF, MS-ICP and OES ICP methods.

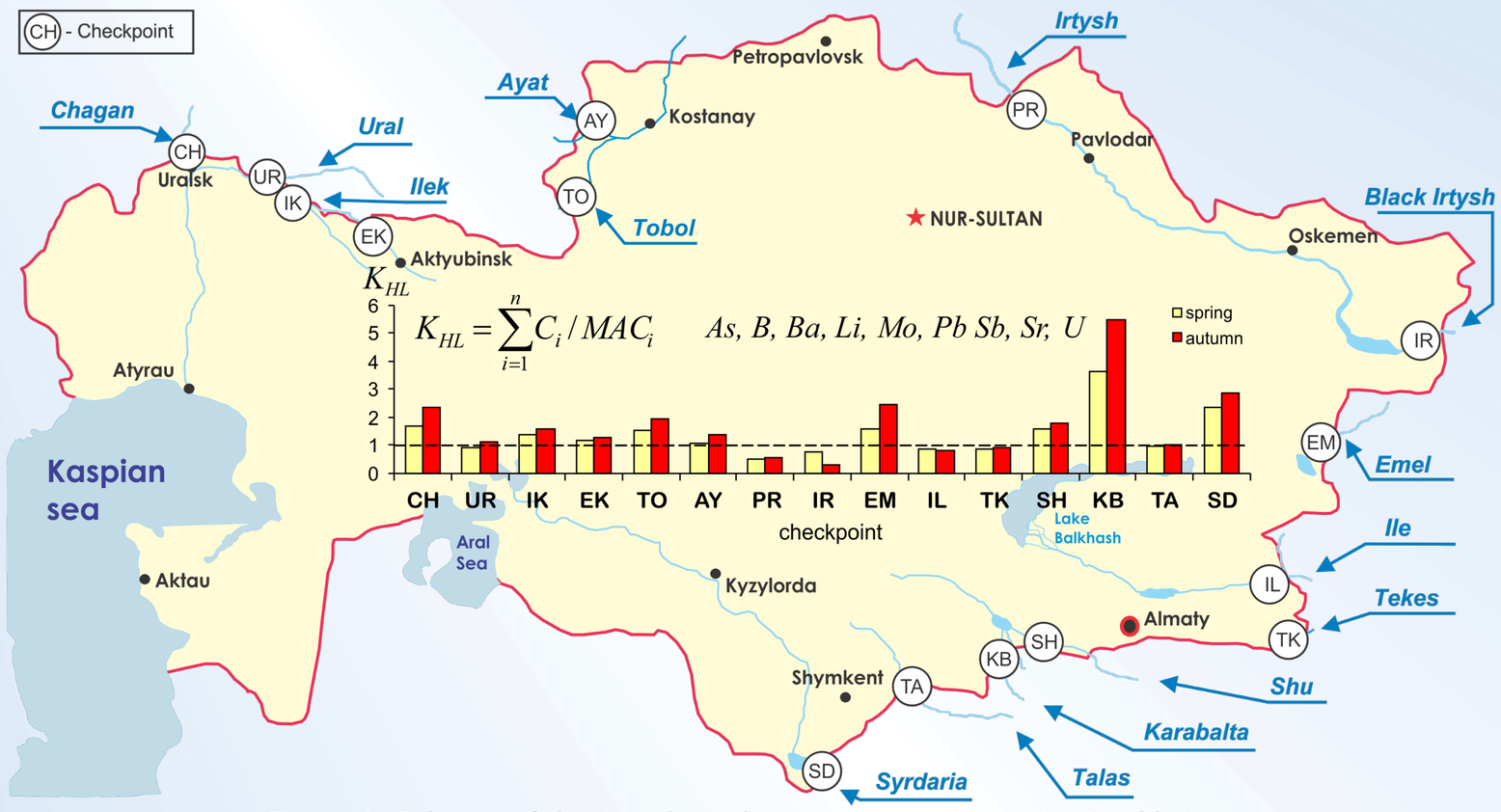

Figure 1. Scheme of the transboundary rivers monitoring in Kazakhstan. Chemical toxicity of waters of these rivers (center)

The NAA, MS-ICP OES-ICP methods determined the values of more than 30 elements. From the obtained data, it was established that the highest concentration of the elements such as As, Ba, Li, Mo, Sb, Sr and U correspond to the waters of the rivers of South and South-East Kazakhstan (Emel, Shu and, especially, Karabalta Rivers). At the same time, the concentration values of such toxic elements as Li and U in some surveyed rivers are either close to the MPC values recommended by the World Health Organization or above these values. The figures in the form of histograms show the distribution of some toxic elements concentration in the river waters according to the monitoring results of the period 2016-2020. It was shown that the highest content of Cr was found in the waters of the Ural, Chagan and Ilek Rivers. Higher (than in other rivers) concentrations of Sb were recorded in the Irtysh and Emel Rivers. The high content of Mo was recorded in the waters of the Emel and Karabalta Rivers, in comparison with other rivers. The high content of Zn was recorded in the Emel, Or, Ural and Ayat Rivers. The content of Ca, K, and Mq in most of the studied water samples significantly exceeds the corresponding Clarke values.

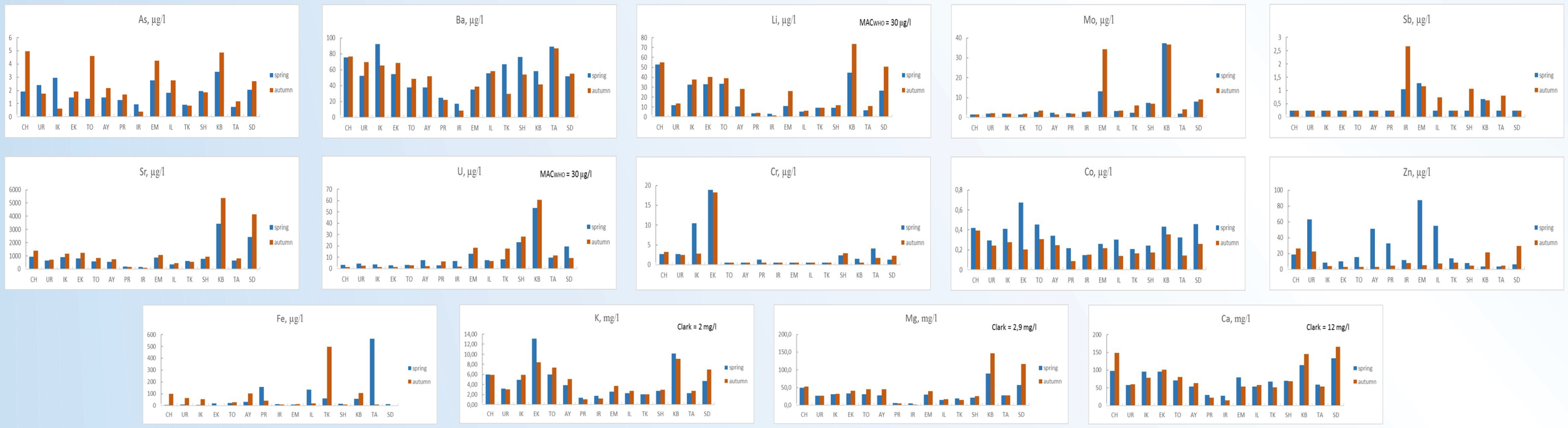

Figure 2. Histograms of the concentration values distribution of some toxic elements at the control points of the transboundary rivers of Kazakhstan

In accordance with the methodology, established by the "Sanitary Rules of the Republic of Kazakhstan", the values of total toxicity of the waters (the limiting hazard indicator KLHI) were calculated based on the data on concentration of U (element of hazard class1), As, B, Ba, Li, Mo, Pb, Sb, Sr (elements of hazard class 2) in the waters of the studied rivers. At the same time, the values of the maximum permissible concentrations, recommended by the World Health Organization, were used for comparison with the standard level and the Standards of the Republic of Kazakhstan were used for Li and Sr. The calculation of KLHI for the period 2016-2020 (Figure 1) showed that in most of the control points, the KLHI values exceed the sanitary standard 1, the Karabalta river is the most polluted river.

According to the obtained results, it is shown that almost all transboundary rivers of Kazakhstan are exposed to pollution. The pollution of the Shu River is most likely associated with its tributary, the Kichi-Kemin River, which in the past was heavily polluted as a result of the waste inflow from the destructed tailing-pool of the mine Aktyuz in Kyrgyzstan. The geo-chemical anomaly in the upper and middle reaches of the Shu River in Kyrgyzstan is also caused by the Shu-Sarysu uranium-ore province, where considerable number of spent, developed and reserve uranium deposits are located. Contamination of the Karabalta River occurs, possibly, as a result of wedging into its bed of underground water contaminated by seepage of waste from the tailing-pool of the Karabalta mining plant, due to failure of its waterproofing. The presented results indicate the need to continue monitoring of the transboundary rivers of Kazakhstan and to organize a detailed survey of some of them, first of all – the Karabalta and Shu Rivers (border with Kyrgyzstan), and the Emel and Irtysh Rivers (border with China).