

**Problems of Freshwater Mercury Pollution in Natural and Manmade Reservoirs
and Possible Ways for their Remediation.**

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Problems of demercurization of the Nura River in Central Kazakhstan

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The River Nura in Central Kazakhstan (average long-term flow in the Karaganda-Temirtau industrial region $6 \text{ m}^3/\text{s}$) is polluted with mercury as a result of the discharge of wastewater from acetaldehyde production at PO Karbide in Temirtau in 1950-1997. Several hundred tons of mercury are believed to have entered the river. In the 1950-60s Karaganda GRES-1 powerstation dumped more than 5 million tons of coal ash in the River Nura in the region of Temirtau. This ash is the basic component forming technogenic mercury-containing silts in the Nura. The mercury occurs in the silts as low-solubility compounds, basically in the form of various oxides, adsorbed on the surface of the silt particles. The most polluted section of the river is in the 25 km below Temirtau. Here in the riverbed there are 0.5 million tons of silt and 10 tons of mercury, with an average and maximum concentration of mercury in the silts of 50 mg/kg and 400 mg/kg respectively. In the same section in backwaters and oxbow lakes there are 0.3 million tons of silt and 5 tons of mercury. The silts also form deposits on the banks of the river with a thickness of up to 3-4 m. 1.5 million tons of silt and 60 tons of mercury is buried in these deposits in the first 25 km, and in the same area there is an additional 40 tons of mercury in the top layer of the floodplain soils.

Transport of mercury mainly occurs during floods, both with disturbed technogenic silts, and by desorption of mercury from the surface of silt particles. Due to the high pH of Nura water, for the most of the year the mercury content is below the maximum permissible concentration ($\text{MPC}_{\text{water}}$). The mercury content in soils of non-flooded irrigated farmland, in fish and in leaves of water plants is above background levels for the whole extent of the area studied and, in general, corresponds to the level of mercury pollution of the river sediments. However this concentration only exceed sanitary norms in a few cases (MPC_{soil} 2.1 mg/kg, MPC_{fish} 0.3 mg/kg, $\text{MPC}_{\text{predatory fish}}$ 0.6 mg/kg). To model the behaviour of mercury in future an understanding of the mechanisms of chemical and microbiological processes occurring in the technogenic silts of the Nura is required, and also of the trophic chain in water communities.

Temirtau and PO Karbide are located upstream of the discharge point for wastewater into the River Nura, on the bank of the Samarkand reservoir (total volume 250 million m³), into which mercury was also discharged both in waste and recycled waters, and due to atmospheric transmission (the factory had a plant for thermal regeneration of mercury wastes). 75 km downstream of Temirtau is Intumak reservoir, total design volume 190 million m³, with an unfinished dam that does not have a regulating or emergency spillway. Now during floods it can be filled up to 3/4 of the total volume, and by autumn empties to 10 million m³ of dead volume. Further downstream, 100 kms from Temirtau, is the dam of Samara hydrocomplex, forming a reservoir of 14 million m³ which is now not filled. Near to Astana (former Tselinograd) 250 kms downstream from Temirtau the River Nura is connected with the River Ishim by a gravity canal, which has not been operated for the last 10 years because of the threat of mercury pollution.

A proposal is being developed to clean up the River Nura from mercury, the urgency of which is due to the need to provide a water supply for the growing population of Astana, the new capital of Kazakhstan. The proposal involves removal of the most mercury-polluted soils and silts and their burial in containment structures, inaccessible to surface and groundwaters. To prevent the remaining technogenic silts spreading downstream it is suggested to complete the Intumax reservoir dam and to use it, and also probably Samara reservoir, as effective settling ponds. Use of modern technologies for cleaning the water from mercury is also proposed in the 25 km of the Nura-Ishim canal.

Research into the extent of the mercury geochemical anomaly in the area of Temirtau was carried out in 1997-98 under INTAS-KZ 95-37 and INCO-Copernicus IC15-CT96-0110 projects. Now the World Bank has announced a competition for a project on demercurisation of the River Nura.