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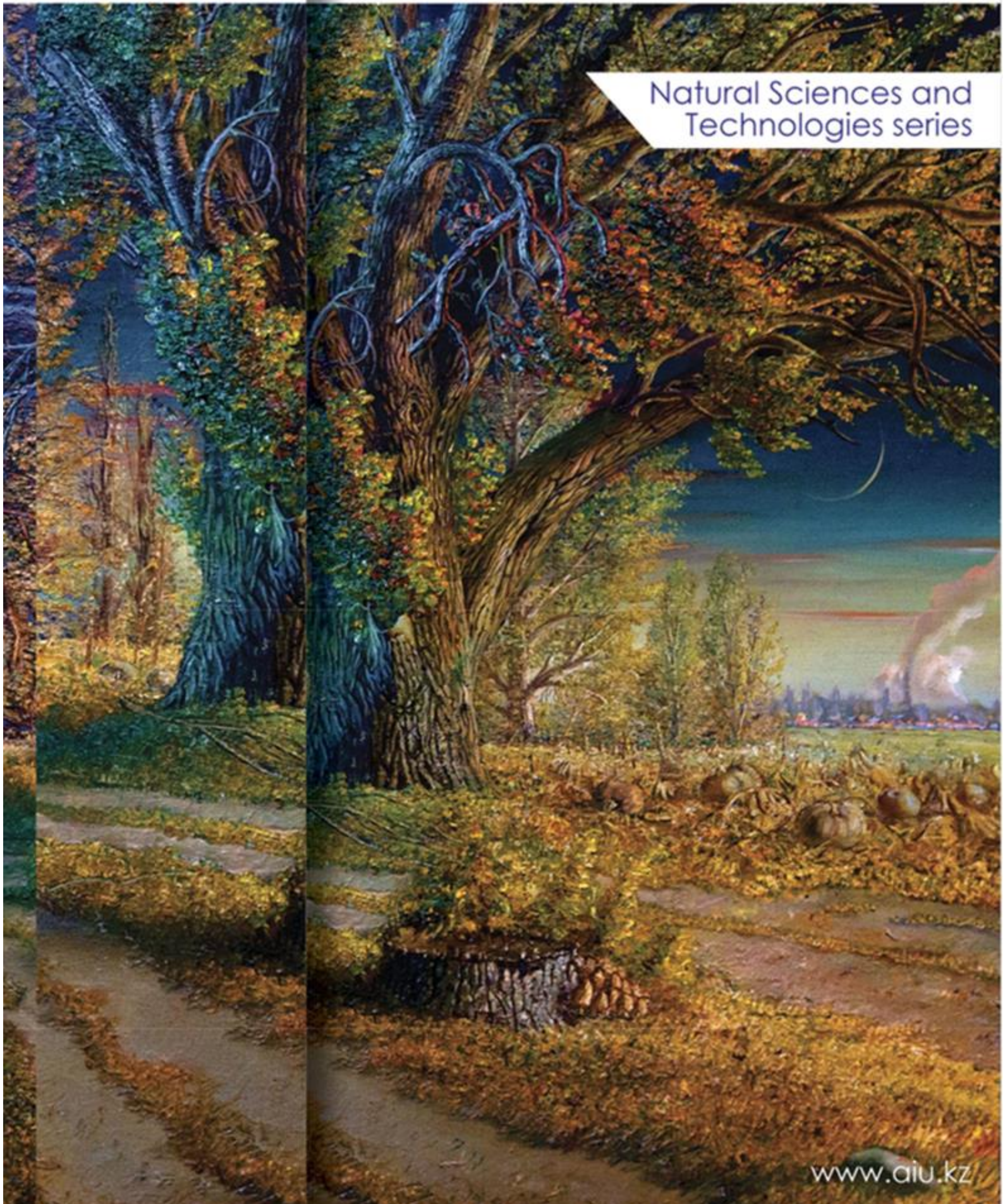

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CONTENT

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THE NURA RIVER CLEAN-UP FROM MERCURY

N. Shaposhnikova[1], M. Johnson[2], A. Seitkan[1]

[1]Astana International University, Kazakhstan, Astana
[2] University of Nottingham, United Kingdom, Nottingham

Abstract. Mercury is an extremely hazardous chemical according to the World Health Organization. Mercury contamination of the Nura River remains an urgent problem. The Nura is the largest river of the Nura-Sarysuysky basin. One of the main sources of mercury pollution in the Nura river was a factory located in Temirtau. This study seeks to evaluate the effectiveness of the Nura River clean-up project, i.e. assessment of effective in reducing the impacts of mercury pollution. According to the report of the World Bank, the contaminated sediment was removed and the levels of mercury in the sediment declined to a safe level but other research demonstrated that the concentration of mercury in the river sediment exceeded the standard safe limit.

Key words: the River Nura, mercury, contamination, clean-up, river restoration

Healthy river systems provide humans with essential ecosystem services and goods and are fundamental to the success of human civilisation. The need to utilise river services whilst also reducing river risks, such as drought and flooding, has triggered attempts to develop more ecologically sensitive river management approaches, that are more sustainable in the future; termed River Restoration (Postel & Richter, 2012). This concept is illustrated in the case study of the River Nura and its contamination with mercury. The purpose of this paper is to evaluate to what extent to which river restoration was effective in reducing the impacts of mercury pollution.

The Nura is the main river in North Kazakhstan. The river begins at Kyzyltas Mountain and discharges into the Kurgaldzhino wetland. The river is highly meandering with a total length of 978 km and a width range between 40 – 50 m. The highest river flows occur during the spring season when snow thaws and are typically between 5.9 and 19.6 m^3/s. The peak flood flows are between 40 and 980 m^3/s, and the riverbanks are typically 2 - 4 m high. The catchment area is 58.000 km^2 (Heaven[a] et al., 2000).

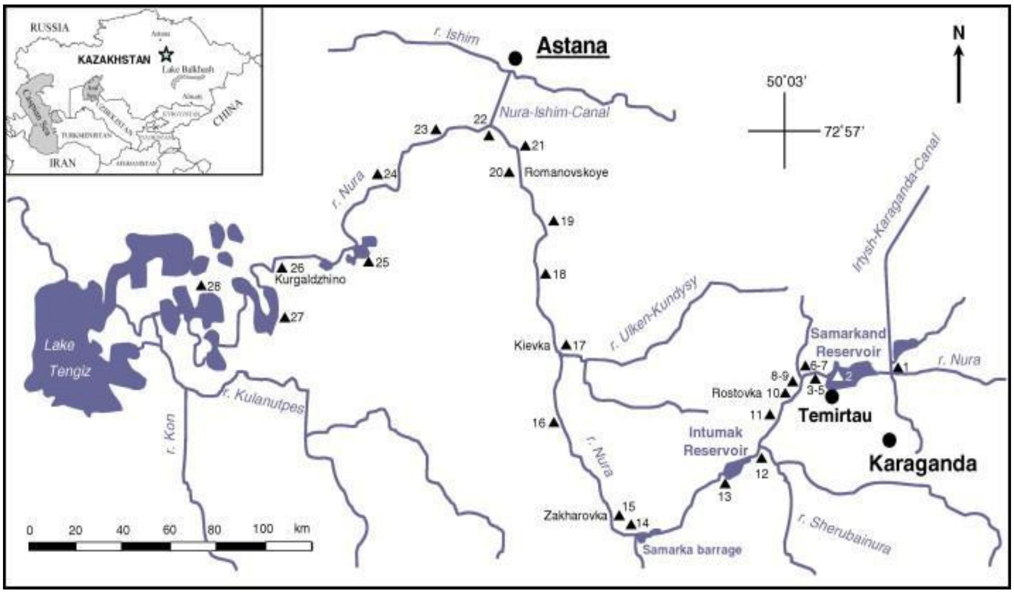

Figure 1 - The river Nura map

Figure 2 - View of Nura River

The Nura was previously contaminated by mercury (Hg) as a result of an acetaldehyde production factory, which operated in Temirtau for nearly 50 years. The factory's wastewater treatment plant was not updated during the last 25 years, which led to significant amounts of mercury being released into the river (Ulrich et al., 2007, Heaven et al., 2000). Mercury is one of the most toxic metals and exists in a variety of forms. The organic form (methylmercury) is a very dangerous neurotoxin when in aquatic environments, as it accumulates in the aquatic food chain (Boening, 2000). The implications of mercury exposure in the food chain can lead to dangers to human health (Trasande et al., 2005).

During the former factory's activities, more than 150 tons of mercury waste was discharged into the river (Ullrich et al, 2007). According to Heaven et al., (2000a) the concentration of mercury was measured between 150 to 240 mg/kg in the first 15 km from the source of the contamination and progressively declined downstream. The concentration of mercury in the sediment of the Intumak reservoir was 2.1 mg/kg. However, a large amount of sediment has been deposited in this reservoir with a lower mercury concentration (5% Hg) compared with the first 15 km (95% Hg). According to estimations, the river bed between Temirtau and Intumak reservoir contains approximately 9.4 tons of mercury and more than 110 tons of mercury have been deposited on the river floodplain, with a mercury concentration range from 50 to 1500 mg/kg (Heaven[a] et al, 2000, Heaven et al., 2000b).

There are number of issues associated with the mercury contamination of the Nura. Firstly, the human health risk associated with increasing demand for clean drinking water. Secondly, flooding could increase the mercury contamination of the river's floodplain due to deposition, leading to further environmental degradation (World Bank.org, 2010). Finally, polluted river water is likely to have significant detrimental consequences for the flora and fauna, especially for the internationally significant Korgaldzhino wetland. This place is included in the UNESCO World Heritage list due to its crucial role in the migration and protection of water birds, especially endangered species such as the pink flamingo (Unesco.org, 2012).

The Government of Kazakhstan and the World Bank adopted appropriate measures to address the contamination issues and invested more than 97.80 million US $ in the clean-up of the river (World Bank, 2014). The Nura River clean-up project aimed to provide access to clean and safe water for the population in the river basin and increase downstream flow in the summertime. River remediation projects included several components. In the first stage, mechanical dredging techniques were applied to clean-up the river. Dredging involves removing contaminated sediments from the river bed and transporting them away (Fuglevand and Web, 2012). The river dredging area was identified at 30 km which runs from the source of the contamination to the Intumak reservoir. During the river clean-up activities, a secondary channel was dug along a section of the river and discharge was redirected into the new channel. The purpose of the artificial channel was to enhance the productivity of the dredging operations and to avoid resuspension of contaminated sediment and further pollution of the river downstream (World Bank.org, 2002). Rehabilitation of the river floodplain involved excavating the contaminated soil layer. As a result, nearly 2 million m^3 contaminated mercury material from the riverbed and floodplain were safely deposited at the newly constructed hazardous waste landfill (World Bank.org, 2013).

Figure 3 - Landfill for mercury contaminated material

Although the World Bank reported that the project has achieved its priority objectives, it appears that the effectiveness of the clean-up is questionable. According to the report of the World Bank, the contaminated sediment was removed and the levels of mercury in the sediment declined to a safe level to meet Kazakhstan's water safety standards (World Bank.org, 2013). However, the Nura River's ecological monitoring report from RSE "Kazgidromet" Ministry of Energy of the Republic of Kazakhstan demonstrated that the concentration of mercury in the river sediment exceeded the standard safe limit of mercury in sediment of 0.02 mg/kg. For instance, 5.7 km downstream, level exceeded the safety limit at 7.98 mg/kg in 2016, and 2.45 mg/kg in 2017. The sample test near Sadovoe village showed 4.31 mg/kg in 2016 and 5.13mg/kg in 2017 (Kazgidromet.kz, 2016).

This contamination might be when the mechanical dredging techniques have some specific limitations such as the generation of sediment residuals (Bridges et al., 2010). Another limitation could be that the executors of the project had numerous violations in the design technology of cleaning works. This was indicated by local authorities and non-government organisations and seemed to be ignored by the clean up's executors. Finally, implementation of the river clean-up activities could have been affected by public perception. For example, the farming community did not provide permission to clean-up the river in their farm areas, and required financial compensation (Toxic.kz, 2014). It seems that in the planning stage of the project, managers might have ignored community interests, contributing to the quality of the project outcomes. Furthermore, it seems that the excavation of the secondary channel could have a significant negative impact on the ecosystem. Taking into consideration that the Nura River has lower availability of water in summertime, it seems an alternative channel may not have been necessary. Building the channel could have been an extra unneeded financial expenditure.

Another component of the river restoration was the reconstruction of the Intumak Dam which improved water management alongside construction of the hydropower station which provided economic benefits. The reconstruction of the dam increased the safety and capacity of the reservoir from 56 million m^3 to 108.9 million m^3, and the construction of the spillway provided an opportunity to regulate downstream flow. Furthermore, reconstruction of the dam significantly reduced risk of downstream flooding from the unpredictable implications of climate change (World Bank.org, 2001).

Figure 5 - After the reconstruction of the Intumak dam

Despite the benefits of the reconstruction of the Intumak dam to the economy and human well-being, it could have led to environmental degradation of the area. The increasing capacity of the reservoir and trapping of pollutants may significantly increase pressure on the local environment. For example, downstream river bank erosion, flooding of the surrounding areas, and disruption of the ecosystem and sedimentation of the reservoir (Kondolf, 1997). Moreover, it seems that the reconstruction did not consider pipes for sediment transport, and the reconstruction of the Intumak dam may have been completed in an unsustainable way. These may have long-term effects in damaging, and potentially destroying, the natural hydraulic and ecological regime of the river. It is suggested that a sustainable approach to flood management, such as planting vegetation along the river might be a more suitable approach of flood prevention, having a beneficial impact on the ecosystem.

In conclusion, the Nura River clean-up was essential for the wellbeing of the population and the healthy environment. In terms of the effectiveness of the mercury clean-up activities, it seems that the river was cleaned only partly and further use of the water to meet the drinking demands of the capital city requires further investigation and monitoring.

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Аннотация. По данным Всемирной организации здравоохранения, ртуть является чрезвычайно опасным химическим веществом. Загрязнение ртутью реки Нуры остается актуальной проблемой. Нура — крупнейшая река Нура-Сарысуского бассейна. Одним из основных источников ртутного загрязнения реки Нура был завод, расположенный в Темиртау. Исследование включало оценку проекта Всемирного банка, в какой степени восстановление рек было эффективным для снижения воздействия ртутного загрязнения. Согласно отчету Всемирного банка, загрязненные отложения были удалены, а уровень ртути в отложениях снизился до безопасного уровня, но другие исследования показали, что концентрация ртути в отложениях рек превысила стандартный безопасный предел.

Аңдатпа. Дүниежүзілік денсаулық сақтау ұйымының мәліметі бойынша сынап өте қауіпті химиялық зат. Нұра өзенінің сынаппен ластануы өзекті мәселе болып қала береді. Нұра – Нұра-Сарысу бассейнінің ең үлкен өзені. Нұра өзенінің сынаппен ластануының негізгі көздерінің бірі - Теміртау қаласында орналасқан зауыт болды. Осы мақалада Дүниежүзілік банктің өзенді қалпына келтіру бойынша жобасының сынаппен ластану әсерін азайтудағы тиімділігі қарастырылды. Дүниежүзілік банктің есебіне сәйкес, ластанған шөгінділер жойылып, шөгінділердегі сынап деңгейі қауіпсіз деңгейге дейін төмендеді, бірақ басқа зерттеулер өзен шөгінділеріндегі сынап концентрациясы стандартты қауіпсіз шектен асып кеткенін көрсеткен.