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THE ROLE OF CLIMATE AND URBANIZATION IN THE DYNAMICS OF CHANNEL PROCESSES AND GEOCHEMICAL FLOWS IN THE AMUR RIVER

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This paper explores the impact of global climate change and basin-wide urbanization on the hydrochemical cycles of the Amur River, viewed through the lens of channel processes during extreme flood events. Despite significant advancements in understanding floods as a primary driver of the rivers hydrochemical regime, a comprehensive synthesis of research in this field has been lacking. Our analysis demonstrates a clear upward trend in regional climate shifts: from 1989 to 2024, the average annual air temperature rose by 1.3°C, with a total increase of 2.0–2.1°C since the beginning of instrumental records. This warming has fundamentally altered the frequency of high-magnitude floods, accelerated channel transformations, and reshaped geochemical cycles within the river discharge. The Amur River is characterized by a unique hydrological regime. Recurring catastrophic floods in recent years (2013, 2019–2021) demonstrate the impact of hydrodynamic factors on the dispersion of contaminants. Turbulence during peak discharge activates resuspension processes, leading to the re-entry of heavy metals from benthic sediments into the water column, effectively turning the riverbed from a sink into a major pollution source. The study details the mechanisms of channel processes and the periodicity of geochemical cycles, establishing a definitive link between these phenomena. Particular emphasis is placed on the transboundary transport of pollutants from major industrial hubs in China and the Russian Federation, as well as the role of background chemical compounds. Large tributaries of the Sungari and Ussuri rivers are the main sources of anthropogenic trace elements in the Amur. Urbanization contributes to the local accumulation of lead and cadmium in bottom sediments of coastal areas, creating zones of potential secondary pollution. We describe the migration pathways of heavy metals, finding that their concentration increases 2.5–3.5 times during flood stages. Furthermore, flow turbulence and channel dynamics intensify chemical interactions, creating pronounced spatiotemporal heterogeneity in geochemical fluxes. The paper assesses the synergistic effect of anthropogenic pressure and natural factors on water quality, while analyzing how temperature and chemical variables (metal compounds, organic matter) influence the self-purification capacity of aquatic ecosystems.

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