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ECOLOGICAL AND GEOCHEMICAL CHARACTERISTICS OF SPRINGS IN URBAN AREAS: FROM LOCAL SAMPLING TO RISK ASSESSMENT
(the case study in North-East of Moscow district)

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Groundwater composition is governed by natural factors such as water runoff that dissolves rocks and acquires organic content from soils. The expansion of urban and industrial areas has significantly altered groundwater formation processes, introducing technogenic salts content (Cl^-, SO_4^{2-}, NO_3^-, NH_4^+) comparable to natural ions composition. Compliance with SanPiN and WHO guidelines for individual elements is insufficient for water quality characterization, as essential elements may be deficient or toxic elements may appear in bioavailable migration forms. This study presents ecological and geochemical characteristics of 23 springs in the Northeastern Moscow Region (2023–2025). Nearly all springs met Russian and WHO standards, except two exceeding nitrate or COD limits. Essential elements (Ca, Mg, Se) showed variable contributions to daily intake depending on mineralization. Modeling of non-essential elements (Ni, Co, Pb, Cd, Cu) indicated that higher organic content increases organic complexation, altering toxicity potential, with $CdCl_2$ posing particular risk due to high solubility and cellular uptake. A Water Quality Index (WQI) used in this study combines several key parameters, and, based on their role, establishes the range from excellent quality to unsuitable for consumption. The studied sources were divided into groups: with “good” WQI (30% of sources), with “excellent” WQI (70% of sources). Springs with “good” WQI are primarily located in the Klyazma River valley with its developed infrastructure. In these springs, concentrations of Cl^-, SO_4^{2-}, NO_3^-, Na^+ are within the normal range, but consistently high. The composition of “excellent” WQI of most springs shows no significant seasonal dynamics. Generally, seasonal variations below 30% indicate stable hydrogeochemical conditions and their relative independence from anthropogenic influence. Comprehensive risk assessment should therefore consider elemental speciation, essential element adequacy, and seasonal dynamics.

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Keywords: groundwater quality, essential elements, seasonal dynamics, springs, migration forms of toxic metals.

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