

УДК 911.375.3

ENVIRONMENTAL FACTOR AS AN INDICATOR OF SUSTAINABILITY
OF DEVELOPMENT OF LARGE URBAN SETTLEMENTS
OF THE REPUBLIC OF TATARSTAN

Alexander V. Antipov *, Elena M. Pudovik

*Institute of Geology and Oil and Gas Technologies,
Kazan (Volga region) Federal University, Kazan, Russia*

In modern world, where anthropogenic impacts on the environment are increasing and climate change is becoming global, the question of sustainable urban development and their ability to fulfill their key functions is becoming a priority for the scientific community. Due to increased interest in sustainability, urban development is viewed as a comprehensive approach that encompasses not only economic growth, social well-being, and quality of life, but also environmental preservation and a favorable ecological environment for future generations. The article examines the role of the environmental factor as an indicator of sustainable development of large urban settlements in the Republic of Tatarstan. The study focuses on the key peculiarity of the environmental factor in assessing territorial potential, which is considered not merely as a record of current pollution levels, but as the capacity of the natural environment to assimilate anthropogenic impact, reproduce resources, and ensure environmental safety. Using the example of Kazan, Naberezhnye Chelny, Almetyevsk and Nizhnekamsk for the period 2019–2024, a quantitative analysis was performed employing the min-max normalization method through a system of disincentive indicators of environmental sustainability (emissions of CO, NO₂, SO₂, solid substances). Integral environmental sustainability indices were calculated, spatio-temporal differentiation was revealed, and limiting factors of sustainable development were identified. The study established that the environmental situation acts as a critical constraint for the development of cities with a high concentration of petrochemical industries, while relatively balanced environmental performance is observed in the capital city of Kazan. A quantitative assessment of the environmental sustainability of large urban settlements in the Republic of Tatarstan, performed using the min-max method and the integral sustainability index, revealed significant spatial heterogeneity. The obtained results confirm that the environmental component serves as a sensitive indicator reflecting structural territorial imbalances.

<https://doi.org/10.46991/PYSUC.2026.SI1.070>

- Keywords:** environmental factor, sustainable development, urban settlements, min-max method, integral index, Republic of Tatarstan.
- References:** Bobylev S.N., Khodzhaev A.S. Ecologization of the Economy and Final Results. *Bulletin of the Moscow University. Series 6. Economics* **4** (2001), 96–107.
- Zhgun T.V. Algorithm for Constructing an Integral Indicator of the Quality of a Complex System for a Number of Consecutive Observations. *Bulletin of the South Ural State University. Series: Computational Mathematics and Computer Science* **6** (2017), 5–25.

* **Corresponding Author:** Alexander V. Antipov, Assistant, Postgraduate Student, Institute of Geology and Oil and Gas Technologies, Kazan (Volga Region) Federal University, Kremlevskaya St., 6/20, Kazan, Russia. E-mail: sasha.antipov031000@mail.ru