“Sustainable development of urban agglomerations: Evidence from Kazakhstan”

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SUSTAINABLE DEVELOPMENT OF URBAN AGGLOMERATIONS: EVIDENCE FROM KAZAKHSTAN

Abstract

Intensifying urbanization has created significant social, economic, and environmental sustainability challenges. The study aims to analyze the sustainable development of urban agglomerations in Kazakhstan. Five urban agglomerations (Aktobe, Almaty, Astana, Karaganda, and Shymkent) are evaluated using our methodological framework, which involves social, economic, and environmental sub-indices and their aggregation into an integral Urban Agglomeration Sustainability Index interpreted according to our normalized scale. The analysis utilizes 21 indicators from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, covering the period from 2016 to 2024. Findings indicate that the population of Kazakhstan's urban agglomerations increased to 8,885.1 thousand people (27.0%) between 2016 and 2024. Ongoing urbanization is characterized by both polarization and scale effect. Kazakhstan's urban agglomerations remain in a developing stage, exhibiting mostly quasi-sustainability (level B). In 2024, the Urban Agglomeration Sustainability Index was 18.2 (A) for Astana, 16.2 (B) for Almaty, 14.5 (B) for Karaganda, 13.0 (B) for Aktobe, and 11.1 (B) for Shymkent, out of a maximum of 27. The hierarchy of leaders (Astana and Almaty) and outsiders (Shymkent) has remained stable throughout the period. Functional specialization is evident: Astana demonstrates high social sustainability (7.4, A), Karaganda excels in economic sustainability (7.0, A), and Aktobe leads in environmental sustainability (6.0, A). These results underscore the need for comprehensive, balanced policies that foster simultaneous development across economic, social, and environmental domains, reduce interregional disparities, and establish mechanisms for sustainable growth.

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INTRODUCTION

In recent years, research on urban agglomerations has intensified alongside the growing complexity of urbanization, as these settings provide opportunities to examine sustainable development across socio-economic and environmental dimensions (Shao et al., 2025). Analyzing the socio-economic development of agglomerations while integrating resource, infrastructure, and environmental factors is crucial for governance, since such findings inform the priority directions of socio-economic policy (Tiwari et al., 2024). "Future cities" represent a model of sustainable urban development that responds to urbanization and climate change by integrating technology, governance, and society (Alesaily & Albialy, 2025). Sustainable urban development contributes to the well-being of future generations by balancing economic, social, and environmental dimensions (Chen et al., 2025). Continuous assessment of quality of life in urban centers creates opportunities to advance sustainable development, guide targeted urban policy, and progress toward the Sustainable Development Goals (Takano et al., 2023).

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The global population continues to grow, and it is projected that most of this increase will occur in urban areas. This trend will further enhance the role of urban agglomerations. The development of urban agglomerations and metropolises should not be limited to the growth of urban population and territory; development should cover all areas, so it is important to consider it in terms of socio-economic and environmental development (Rustiadi et al., 2021). Therefore, ensuring the efficient and balanced development of urban agglomerations has become a key strategic priority for every country. In Kazakhstan, a law on the development of agglomerations has been in effect since 2023 (Adilet, 2023c). There are two-level urban agglomerations – first (Almaty, Astana, Shymkent) and second (Aktobe, Karaganda) (Adilet, 2023a). Despite the growing body of international research on sustainable urban agglomerations development, evidence for Kazakhstan remains fragmented. Existing studies mainly focus on individual cities (Alibekova et al., 2018; Mukhametzhan et al., 2020; Nyussupova et al., 2022; Nurlanova et al., 2023), or separate aspects of urban agglomeration development (Abilov et al., 2023; Makhrova et al., 2023). Limited studies simultaneously evaluate the economic, social, and environmental dimensions of sustainability across all officially designated agglomerations of Kazakhstan. Therefore, this study addresses this gap by developing and applying an assessment tool to evaluate and compare the development trajectories of Kazakhstan's five agglomerations.

1. LITERATURE REVIEW

Current studies of urban resilience emphasize its key dimensions, including ecological, economic, social, and infrastructural aspects (Wang et al., 2025a). Uncertainties in socio-economic development and the complexity of urbanization complicate assessments of urbanization's impacts on ecosystem services, which underpin urban resilience (Yang et al., 2024). In urban agglomerations, the agglomeration economy develops. One key benefit is increased economic productivity, driven by economies of scale and innovation-rich environments (Hodges & Carson, 2012; Giannakis & Bruggeman, 2020). The economic sustainability of urban agglomerations depends largely on financial agglomeration and human capital. Concentrated financial resources facilitate efficient allocation and risk reduction, while improvements in both the quality and quantity of human capital foster innovation, attract investment, and develop knowledge-intensive business services (Ye et al., 2025; Di Giacinto et al., 2020). The development of urban agglomerations directly supports the growth of innovative entrepreneurship, especially in large urban agglomerations (Zheng & Du, 2020). The concentration of talent in urban centers promotes creativity and innovation, leading to technological advancements and economic diversification (Jiang et al., 2022; Zhang et al., 2021). A higher concentration of high-end productive service industries is strongly associated with better economic performance in cities. Clustering businesses and industries also enables shared services and resources, reducing costs and boosting economic efficiency (Peng et al., 2023). Moreover, densely populated areas can support more efficient public transportation systems, reduce per capita emissions, and promote sustainable urban living (Nichol et al., 2013). Urban agglomerations also enable efficient resource use and the development of infrastructure and transport, which support vibrant markets and improved public services (Ding et al., 2022; Gao et al., 2024). The transport and intercity roads, which effectively connect large, medium, and small cities, are important for the development of urban agglomerations (Huang et al., 2020). New modes of transport will also affect this issue. This is because new modes of transport are important for communication between the core city and the region, especially the development of high-speed railways, which contributes to economic development (Guo et al., 2020; Jin & Ou, 2023).

Urban agglomerations emphasize the significance of the distance between jobs and places of residence as a characteristic of development quality (He et al., 2020). Territory plays a vital role in the development of urban agglomerations because smaller land areas are associated with more social problems, such as housing shortages (He et al., 2019). It depends on cultural and social integration, enhancing quality of life by providing diverse opportunities and amenities (Dijkstra et al., 2013). Social urbanization is a core dimension of sustainable urban development. It seeks to ensure the full integration of diverse population groups into urban life while guaranteeing equal access to public services and infrastructure (Zhang et al., 2024). The strength of a society stems from the well-being of its people, while social stability forms the foundation for meeting their long-term needs (Razia & Abu Bakar Ah, 2023). Socially, urban agglomerations can exacerbate inequalities, leading to housing affordability crises, congestion, and strained public services. The rapid influx of people into urban areas often outpaces infrastructure and social service development, resulting in overcrowded schools, inadequate healthcare, and higher crime rates (Valente, 2024). Additionally, pressure on housing markets often raises living costs, pushing lower-income residents to the peripheries and increasing socio-economic segregation (Eccleston et al., 2018; Gurran et al., 2018; Lawson et al., 2019; Vij et al., 2021). Urban agglomerations significantly contribute to a wide range of health issues, exacerbating both physical and mental health challenges due to factors such as pollution, overcrowding, and extreme weather events. The increasing frequency of extreme urban heat events, exacerbated by climate change, poses significant health issues and challenges (Mora et al., 2017; Venter et al., 2023; Wang et al., 2023). Health impacts include both physical and mental health issues, discomfort, and heat-induced diseases that can worsen existing conditions such as cardiovascular disease, diabetes, and respiratory illnesses (Estoque et al., 2020; Wu et al., 2024). This is especially evident in the rise of respiratory illnesses and waterborne diseases in densely populated urban centers.

Urban agglomerations often lead to environmental degradation, including increased pollution, overuse of natural resources, and loss of biodiversity (Feng et al., 2023). Between 2000 and 2020, the population of the world's 100 largest urban agglomerations grew by 36%, while the extent of green spaces declined by 8%. Consequently, a central priority of contemporary urbanization is to improve infrastructure while preserving and expanding green areas (Chen et al., 2022). Moreover, the rapid expansion of urban agglomerations significantly increases carbon dioxide emissions. The high population density and concentration of industries in these areas often result in severe air and water pollution, leading to public health issues and environmental damage (Chen et al., 2019). While urbanization initially increases CO_2 emissions, it can later reduce them through technological development and policy measures. In managing urban CO_2 emissions, it is vital to consider future trends to prevent rebound effects. Strengthening cooperation and technology exchange among cities within agglomerations is essential to collectively achieve net-zero emissions (Ren et al., 2023). Providing financial support for the technological modernization of high-emission industries and advancing low-carbon public transportation are key strategies for enhancing ecological sustainability (Cheng et al., 2024). At the same time, environmental pollution not only leads to an ecological crisis but also negatively affects economic development. Environmental regulation is important in enhancing the cities' economic resilience. It strengthens cities' ability to withstand shocks and optimizes their industrial structure (Zhou et al., 2024). Considering regional characteristics, green technologies and industrial diversification serve as key mechanisms for sustainable development. Sustainable development in these contexts can be promoted through reducing hidden flows, ensuring equitable distribution of ecological burdens, strengthening interregional cooperation, and coordinating industrial structures (Lin et al., 2024). Within sustainable urban development, the circular economy plays a significant role by reducing waste, conserving resources, and alleviating environmental pressures (Avdiushchenko & Meinrenken, 2025).

Ensuring sustainable urban development requires coordinating the complex, dynamic interrelationship between urbanization and the ecological environment. Growing populations and urbanization are straining infrastructure and the environment, so policymakers should focus on improving transport, environmental governance, and quality of life (Huang et al., 2023). Excessive urban sprawl contributes to rising emissions and the loss of natural areas, whereas compact urban development offers a more effective pathway to ecological sustainability (Lopez-Aparicio et al., 2025). Compact urban planning not only supports economic growth but also reduces carbon emissions, thereby contributing to sustainable development and ecological security (Wang et al., 2025b).

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Environmental management should be the state's focus in planning urban agglomerations (Chen et al., 2020). Thus, as cities expand spatially, challenges also grow. From a social perspective, issues include housing shortages, income inequality, disparities in employment, and insufficient social infrastructure. Economically, challenges include growing pressure on infrastructure, uneven regional development, and structural imbalances in the labor market. From an environmental perspective, air and water pollution, ineffective waste management, and the reduction of green spaces have a negative impact on the environment; these concerns are shared by countries around the world. Sustainable development within urban agglomerations requires a comprehensive strategy that balances economic growth, social inclusion, and environmental sustainability.

Along with research into the factors and patterns of urban agglomeration development, index-based approaches to assessing the sustainable development of urban areas have been actively developing in recent years. Common approaches include the UN Sustainable Development Indices, the Urban Sustainability Index, the City Prosperity Index (UN-Habitat), the Sustainable Cities Index, and composite indices based on the normalization and aggregation of indicators (Alibekova et al., 2018). Their main advantage is their ability to integrate economic, social, and environmental indicators into a single aggregate index. However, there are differences in the choice of indicators, standardization procedures, and weighting methods. Therefore, the choice of index methodology requires consideration of both international experience and the specifics of the national statistical base. For example, Huang et al. (2023) used an integral index to assess the achievement of the Sustainable Development Goals in megalopolis regions within the DPSIR model. Chen et al. (2025) suggested a system for assessing the sustainability of agglomerations within the framework of the Economy–Society–Environment concept. Shao et al. (2025) summarized indicators and methodologies for assessing the sustainability of agglomerations, developing a system of indicators combined into the Urban Agglomeration Sustainability Index.

Numerous studies have applied various methods, broadly divided into top-down and bottom-up approaches. The former typically relies on global standards or policy frameworks, such as the SDGs, which provide uniform assessment criteria and indicator systems for countries; the latter develops indicators focused on the specific development needs and characteristics of urban areas (Shao et al., 2025). In Kazakhstan, research on agglomeration development is advancing rapidly. Abilov et al. (2023) and Makhrova et al. (2023) examine the evolution and current trends in urban agglomeration development in Kazakhstan. Alibekova et al. (2018), Nyussupova et al. (2022), and Nurlanova et al. (2023) consider sustainable urban development and propose methodological approaches for rating urban sustainable development. However, they focus primarily on individual cities and individual aspects of sustainable development and do not provide for an analysis of all five agglomerations in the country. Therefore, this study aims to analyze the sustainable development of urban agglomerations in Kazakhstan.

2. METHOD

The study is based on a comparative approach, which is implemented by comparing territorial units (urban agglomerations) by homogeneous thematic blocks (social, economic, and environmental indices) and by an integral index, Urban Agglomeration Sustainability Index, over time. The study applied a modified rating methodology to assess the sustainable development of urban agglomerations, based on Nurlanova et al. (2023). To calculate the integrated index, 21 indicators were used (Table 1): seven social, seven economic, and seven environmental for five urban agglomerations (Adilet, 2023a):

1) first level: Almaty (Almaty city, Konaev city, Gate City, Enbekshikazakhsky, Iliysky, Karasaysky, and Talgarsky districts), Astana (Astana city, Kosshy city, Arshalinsky, Tselinogradsky, and Shortandysky districts), Shymkent (Shymkent city, Baidibek, Kazygurt, Ordabasyn, Sairam, Tolebi, and Tyulkubas districts);

2) second level: Aktobe (Aktobe city, Alginsky, Kargalinsky, Martuksky, and Khromtausky districts), Karaganda (Karaganda city,

Temirtau city, Saran city, Shakhtinsk city, Abaysky, Bukhar-Zhyrausky, and Osakarovsky districts).

The agglomeration of the first (second) level includes populated areas located near the center, within a radius of 30 (20) kilometers. In comparison, rural populated areas located along the road of national significance are considered at a distance of up to 40 (30) kilometers, and urban ones – up to 75 (55) kilometers (Adilet, 2023b).

The study uses panel data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan for 2016–2024 (Table 2). This period was selected for several reasons. First, this period reflects the early stage of urban agglomeration development in Kazakhstan, including the implementation of initiatives such as "On approval of the Interregional Scheme for the Territorial Development of the Almaty Agglomeration" (Adilet, 2016). Second, the selected timeframe allows analysis of both pre-pandemic and post-pandemic development trends, providing a more comprehensive assessment of agglomeration sustainability dynamics. The limitation of the study is the lack of 2025 data due to a 1–2-year lag in official statistics and limited district-level data, in particular, the lack of accessible and comparable statistical data at the level of district-level cities, rural districts, and individual settlements within agglomerations. Therefore, the analysis was conducted at an aggregated level, which does not allow for a full accounting of intra-agglomeration differences in the sustainable development of territories.

For each indicator, normalization was used on a scale from 1 to 9: for incentives, using a linear min-max function (1), and for disincentives, using a mirror-inverse function (2). All indicators were incentives, except the unemployment rate, self-employment, and outliers, which serve as disincentives; these are coded as unfavorable indicators and then inverted during normalization.

$$V_{scaled} = 8 \cdot \left(\frac{V_{current} - V_{\min}}{V_{\max} - V_{\min}} \right) + 1, \quad (1)$$

$$V_{scaled} = -8 \cdot \left(\frac{V_{current} - V_{\min}}{V_{\max} - V_{\min}} \right) + 9, \quad (2)$$

where V_{scaled} – normalized indicator, $V_{current}$ – value of the current indicator, V_{max} – maximum value of the indicator, V_{min} – minimum value of the indicator.

Table 1. Urban agglomeration sustainability index structure

Social sustainability subindex	Economic sustainability subindex	Environmental sustainability subindex
1. Change in the population, % 2. Housing provision per resident, m² 3. New housing construction, square meters per capita per year 4. Number of hospital beds per 10,000 population 5. Number of doctors per 10,000 population, people 6. Number of schools, units 7. Number of registered crimes, units	1. Industrial productivity per capita, thousand tenge 2. Fixed capital investment per capita, thousand tenge 3. Innovative activity, % 4. Unemployment rate, % 5. Gross regional product, mln. tenge 6. Average monthly nominal wage per employee, tenge 7. Number of registered small and medium-sized businesses, units	1. Environmental protection expenditure per capita 2. Emissions of pollutants into the atmosphere per capita, kg 3. Pollutants captured and neutralized, thousand tons 4. Number of sources of pollutant emissions, units 5. Emissions of solid pollutants, thousand tons 6. Emissions of liquid and gaseous pollutants, thousand tons 7. Pollutants disposed, thousand tons

Table 2. Source base of the study

Level	Urban agglomeration	Source
1	Almaty	BNS (2024a), BNS (2024b), BNS (2025a), BNS (2025b), BNS (2025c), BNS (2025d)
	Astana	BNS (2024b), BNS (2025c), BNS (2025e), BNS (2025f), BNS (2025g)
	Shymkent	BNS (2024b), BNS (2025h), BNS (2025i), BNS (2025j), BNS (2025k)
2	Aktobe	BNS (2024b), BNS (2024d), BNS (2025l), BNS (2025m)
	Karaganda	BNS (2024b), BNS (2025n), BNS (2025o), BNS (2025p)

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The social, economic, and environmental subindices are calculated as arithmetic means of the standardized indicators within the corresponding thematic blocks, and the integrated sustainability index is calculated as the sum of the three subindices (3).

$$\begin{cases} UASI_{integral} = UASI_{social} + UASI_{economic} + UASI_{environmental} \\ UASI_{social} = \frac{1}{n}\sum_{i=1}^{n} x_i \\ UASI_{economic} = \frac{1}{m}\sum_{J=1}^{m} y_j \\ UASI_{environmental} = \frac{1}{p}\sum_{k=1}^{p} z_k \end{cases}, \quad (3)$$

where $UASI_{integral}$ – *integral urban agglomeration sustainability index*, $UASI_{social}$ – urban agglomeration social sustainability index, $UASI_{economic}$, – urban agglomeration economic sustainability index, $UASI_{environmental}$, – urban agglomeration environmental sustainability index, x_i – normalized, *i* – indicator of social sustainability (V_{scaled}), $i = 1, n$, y_j – normalized *j*-indicator of economic sustnability (V_{scaled}), $j = 1, m$, z_k – normalized *z*-indicator of environmental sustainability (V_{scaled}), $k = 1, p$, *n*, *m*, *p* – number of analyzed indicators.

T basic weighting scheme assumes equal weighting of three factors. The indices range from 1 to 9, and the integral index ranges from 1 to 27 (Table 3).

Thus, the proposed methodology for an integrated assessment of the sustainable development of urban agglomerations is reliably applicable to conditions with minimal initial data that comply with the principles of data availability, comparability, and indicator relevance. The fundamental limitation of the methodology is the standardization within a sample of five urban agglomerations per year, so the obtained scores primarily reflect the relative positions of objects rather than the absolute level of sustainability on a national scale.

3. RESULTS

Between 2016 and 2024, the population of Kazakhstan's urban agglomerations exhibited generally positive dynamics, although the pace and sustainability of growth varied significantly. Overall, the upward trend in population across the agglomerations under consideration indicates ongoing urbanization. The Almaty agglomeration demonstrates the most stable and progressive dynamics, maintaining its status as a center of gravity. Over the period analyzed, the indicator increased by 26.9%, from 2,737.5 to 3,475.1 thousand people. This was the largest population growth, with no significant fluctuations. Similar but more intense dynamics were observed in the Astana agglomeration, where the population increased by 628.2 thousand people, or 57.3%. The pandemic surge was particularly noticeable. A new growth point is emerging there due to the capital's growing role as a resource center. The Shymkent agglomeration also shows steady growth of 24.5% (from 1,623.9 to 2,021.4 thousand people), with the regional center strengthening. The Aktobe agglomeration shows more moderate growth rates (from 592 to 719.8 thousand people, a 21.5% increase). Unlike the leaders, the most significant deviation is ob-

Table 3. Interpretation of the sustainability index

No.	Level of sustainability	Boundaries		Letter designation
		1–9	1–27	
1	Sustainable	> 6	> 18	A
2	Quasi-stable	3–6	9–18	B
3	Unsustainable	< 3	< 9	C

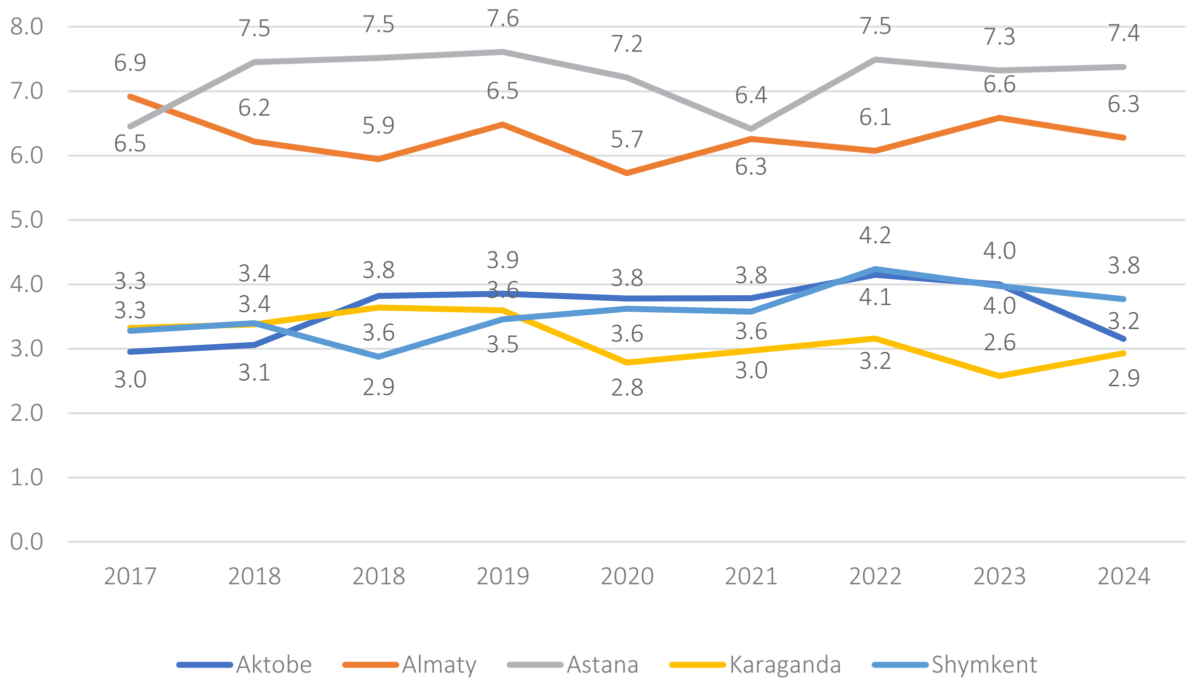
Table 4. Population of urban agglomerations of Kazakhstan, thousand people, 2016–2024

Urban agglomeration	2016	2017	2018	2019	2020	2021	2022	2023	2024
Aktobe	592	606.7	618.5	631.8	644.5	655.4	694.5	705.9	719.8
Almaty	2737.5	2820.2	2893.5	2975.3	3056.5	3212.0	3298.7	3391.0	3475.1
Astana	1097.0	1162.4	1212.2	1273.0	1322.9	1477.1	1540.6	1620.5	1725.2
Karaganda	944.2	944	940.4	939.9	940.4	937.1	938.6	941.2	943.6
Shymkent	1623.9	1668.1	1724.6	1765.7	1811.2	1853.6	1944.2	1982.6	2021.4

served in the Karaganda agglomeration, where the indicator declined slightly (from 944.2 to 943.6 thousand people, a 0.06% decrease). This trend indicates stagnation and the presence of structural constraints to development, which may be due to industry-specificity and insufficient economic diversification, or to a flow of development toward the Astana agglomeration, as it is nearby (Table 4).

In general, there is a polarization effect: the largest agglomerations (Almaty, Astana) demonstrate higher growth rates compared to smaller centers. Moreover, we observe an effect of scale: the higher the initial level of development of the agglomeration, the more stable and intense its dynamics are.

An analysis of Kazakhstan's urban agglomeration social sustainability index for the period 2016–2024 reveals uneven and asymmetric development. According to the proposed interpretation scale, only Astana and Almaty agglomerations are within the sustainable social development zone (level A), with index values ranging from 6.5 to 7.4 (A) and from 6.9 to 6.3, respectively. Despite a slight decline in 2021 in the Astana agglomeration, recovery and subsequent growth have been observed, indicating high social sustainability. Its social sustainability is highest due to increased housing availability and developed social infrastructure. The Almaty agglomeration exhibits fluctuating dynamics. In 2019 and 2023, there were periods of growth alternating with declines, particularly noticeable in 2022–2024, indicating a lack of consolidation of positive trends. Thus, its social development is constrained by the "congestion effect": high population growth is not accompanied by proportional development of social infrastructure. The remaining agglomerations are characterized primarily by quasi-stable or unsustainable levels of social development (levels B and C). The Aktobe agglomeration is mostly in a quasi-stable state (3.0–3.2, C), demonstrating short-term improvements in 2022–2023, followed by setbacks. Mostly, its social development is characterized by a relative balance of demographic, housing, and infrastructure indicators. A similar situation is observed in the Shymkent agglomeration, where indicators increased from 3.3 to 3.8 (B). Between 2022 and 2023, this indicates a transition from an unsustainable to a quasi-stable state. However, a decline occurs in subsequent years, confirming the incompleteness of the transformation process-



Note: Calculations of housing provision per resident and number of doctors per 10,000 population were based on data from the core of the urban agglomeration due to the lack of data at the level of districts and individual settlements.

Figure 1. Kazakhstan's urban agglomeration social sustainability index, 2016–2024

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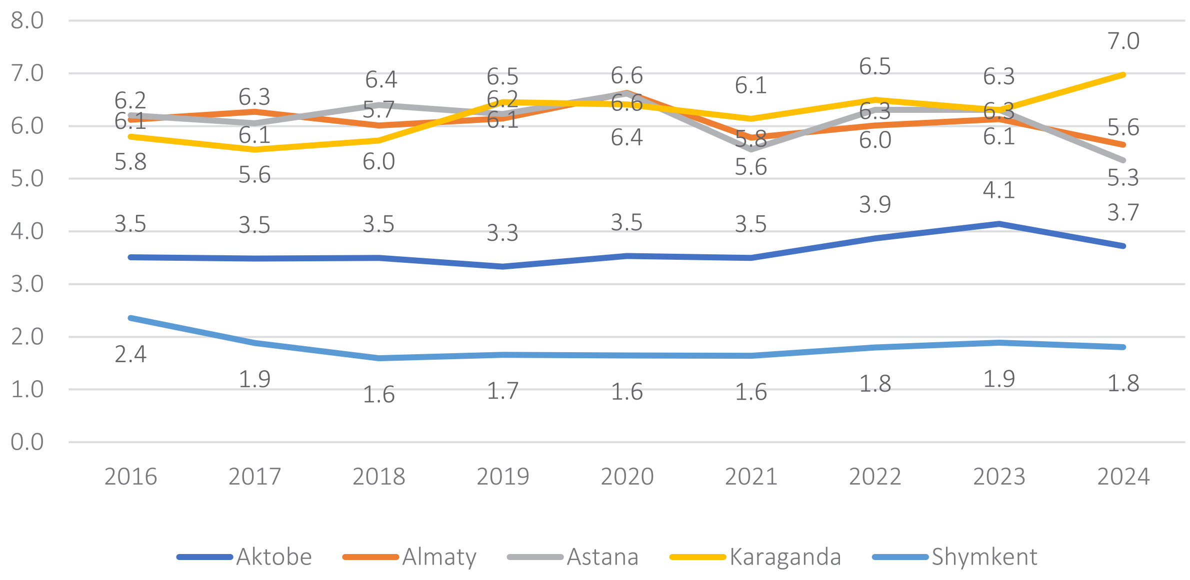
es. Social sustainability is limited by demographic pressure: rapid population growth is not offset by infrastructure development. The Karaganda agglomeration is the most problematic, with index values remaining consistently low (3.3–2.9, B/C). The absence of distinct growth phases and the downward trend after 2019 indicate structural constraints hindering the transition to a higher level of stability. Its social development remains low. The main reason for this is the almost complete absence of demographic growth. Furthermore, the relatively slow pace of housing and social infrastructure renovation failed to offset unfavorable demographic trends. Thus, the social sustainability of Kazakhstan's urban agglomerations is fragmented. Most of them are trapped in a "quasi-stability trap," failing to transition to sustainable development despite some positive trends (Figure 1).

An analysis of Kazakhstan's urban agglomeration economic sustainability index for 2016–2024 shows a more pronounced differentiation from social sustainability. The Karaganda agglomeration shows the highest and most stable level of economic sustainability (5.8–7.0, B/A). Moreover, not only stability but also a gradual increase in the indicator is observed. A strong industrial base, high levels of innovation and significant investment in fixed capital ensure sustainable economic development, even during periods of general economic instability. The Astana and Almaty agglomerations demonstrate a similar development pattern, falling within the quasi-stability range (level B). Almaty agglomeration is characterized by moderate fluctuations (6.1–5.6, A/B) without a pronounced growth trend. Economic sustainability is ensured by a high level of entrepreneurial activity, a concentrated financial sector, a developed services market, and a steady influx of investment. However, industrial productivity plays a smaller role than in Karaganda, limiting the potential for further growth. This indicates the absence of structural changes capable of bringing the agglomeration's economy to a sustainable level. In the Astana agglomeration, the situation differs from Almaty's: there is volatility in investment, despite productivity growth. Astana shows more volatile dynamics: after rising to 6.2 (A) in 2020, it fell sharply in 2021 (5.6, B), followed by a partial recovery. The Aktobe agglomeration also demonstrates a relatively low level of economic sustainability. During 2016–2021, the index increased (from 3.3 to 3.7, B), followed by an improvement in 2023 (to 4.1). The most critical situation is observed in the Shymkent agglomeration, where the index ranged from 1.8 to 2.4 (C) throughout the period, indicating economic unsustainability. The complete lack of dynamics indicates structural constraints on development and limited economic diversification. Although industrial productivity more than doubled during the study period, its absolute level remains the lowest among all urban agglomerations. Insufficient investment in fixed capital and relatively low innovation activity limit the agglomeration's economic resilience. Overall, the economic sustainability of Kazakhstan's agglomerations is characterized by high differentiation and structural heterogeneity. A combination of stable growth zones (Karaganda agglomeration), quasi-stable agglomerations (Almaty and Astana agglomerations), quasi-stable but relatively low zones (Aktobe agglomeration), and unstable levels of development (Shymkent agglomeration) is observed (Figure 2).

The dynamics of Kazakhstan's urban agglomeration environmental sustainability index are largely inertial. The Aktobe agglomeration demonstrates the highest levels of environmental sustainability, but its dynamics are more volatile. Over the period, index values fluctuate between 6.7 (A) and 6.0 (A). Particularly notable is the sharp decrease in 2018–2021 (5.7–5.8), which corresponds to a quasi-stable level (B). The agglomeration maintains its leading position due to its highest per capita environmental protection expenditure, which exceeds that of most other regions. This helps offset the negative environmental impacts of industrial production. Positive dynamics are evident in the Astana agglomeration, where the environmental subindex increased from 5.01 to 5.79 (B). However, this is insufficient to transition to a higher level of sustainability. Its environmental sustainability is gradually improving. The most significant factor behind this growth was a multiple increase in environmental protection expenditure per capita. Shymkent agglomeration consistently maintains a score in the 5.8–5.0 (B) range, which corresponds to quasi-stable development. However, a decrease in the indicator was observed from 2017 to 2022, followed by a partial recovery. This trend indi-



Note: Calculations of gross regional product and innovation activity were based on data from the core of the urban agglomeration due to the lack of data at the level of districts and individual settlements.

Figure 2. Kazakhstan's urban agglomeration economic sustainability index, 2016–2024

cates a relatively balanced environmental situation, despite the possible increase in anthropogenic pressure. Despite relatively low environmental expenditures, environmental sustainability is maintained thanks to lower per capita industrial emissions compared to the largest industrial agglomerations. The Karaganda agglomeration demonstrates the most contradictory environmental dynamics. Despite significant expenditures on environmental protection measures, the high concentration of metallurgy and coal mining enterprises is accompanied by significant air pollutant emissions, resulting in a relatively low environmental sustainability subindex (4.9–4.7, B). In the Almaty agglomeration, the indicators remained virtually unchanged throughout the period (4.4–

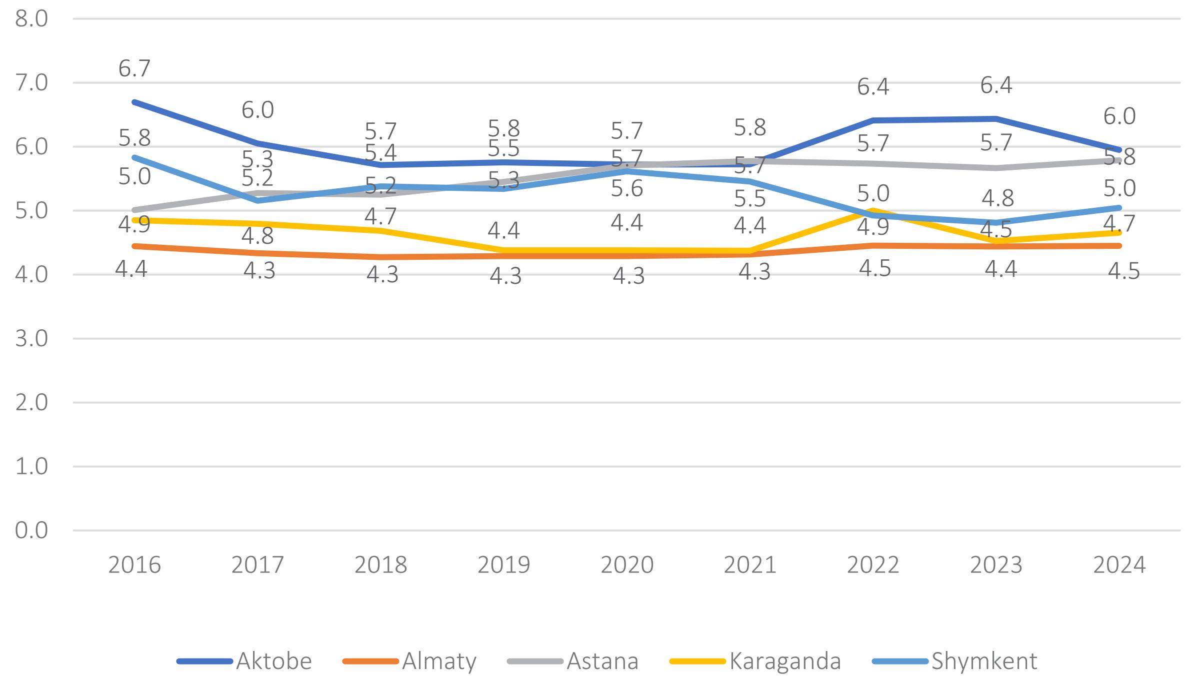


Figure 3. Kazakhstan's urban agglomeration environmental sustainability index, 2016–2024

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Table 5. Kazakhstan's urban agglomeration sustainability index, 2016–2024

Urban agglomeration	2016		2017		2018		2019		2020		2021		2022		2023		2024	
Aktobe	13.5	B	12.9	B	13.2	B	13.2	B	13.4	B	13.5	B	14.7	B	14.9	B	13.0	B
Almaty	17.1	B	16.5	B	15.9	B	16.8	B	16.4	B	16.2	B	16.5	B	17.1	B	16.2	B
Astana	17.6	B	18.5	A	18.9	A	19.1	A	19.2	A	17.3	B	19.3	A	19.0	A	18.2	A
Karaganda	14.0	B	13.7	B	14.0	B	14.4	B	13.4	B	13.3	B	14.7	B	13.3	B	14.5	B
Shymkent	11.5	B	10.4	B	10.2	B	10.9	B	11.3	B	11.1	B	11.5	B	11.2	B	11.1	B

4.5, B), indicating stagnation in the environmental situation without significant improvement. The environmental sustainability of Kazakhstan's agglomerations is characterized by structural polarization and low rates of change. Despite some positive developments, most agglomerations are not demonstrating a transition to sustainable development, except for the Aktobe agglomeration (Figure 3).

An analysis of Kazakhstan's integral urban agglomeration sustainability index for 2016–2024 reveals general development trends across economic, social, and environmental factors. Overall, all agglomerations, except the Astana agglomeration, are in the quasi-stable range (level B), indicating a lack of transition to sustainable development and the presence of systemic constraints. The Astana agglomeration holds leading positions throughout the period. It demonstrates sustainable index values (17.6–18.2, B/A), with a brief decline in 2021, followed by a recovery. A-level periods indicate an approach to sustainable development. These high values reflect balanced development across all three components: leadership in the social subindex, strong economic results, and consistent improvement in the environmental component. The Almaty agglomeration consistently ranks second, with index values ranging from 16.2 to 17.1 (B). Despite relatively low environmental indicators, its high level of social and economic sustainability ensures its stable position among the leaders. The absence of significant fluctuations indicates stagnant development: there are no sharp deteriorations, but there is also no progress toward sustainability. The Karaganda agglomeration occupies an intermediate position (third and fourth places) with index fluctuations in the range of 14.0–14.5 (B). Despite relatively high economic sustainability, the integrated indicator declines due to weak social and environmental parameters, preventing the agglomeration from reaching a higher level. The Aktobe agglomeration integral index ranged from 13.0 to 13.5 (B), with the highest value in 2023 (14.9). An increase in the environmental subindex partially offsets moderate social and economic development results, but no significant growth in the integrated index is observed. However, the dynamics are fluctuating, and the decline in 2024 confirms the instability of the achieved results. The Shymkent agglomeration consistently ranks last (fifth place). Despite positive demographic trends, a relatively weak economic base and the lack of significant growth in the environmental subindex limit improvements in overall sustainability. Index fluctuations indicate a development level with signs of instability (Table 5).

Overall, several key patterns can be identified. First, a stable hierarchy of agglomerations is observed: leaders (Astana and Almaty agglomerations) and the outsider (Shymkent agglomeration) remain unchanged throughout the period. Second, all agglomerations exhibit limited growth: even with improvements in individual indicators, they do not enter the sustainable development zone. Only the Astana agglomeration has demonstrated sustainable development, but at the lower limit. Third, the dynamics of the integrated index are cyclical, reflecting the influence of external factors and the lack of mechanisms for consolidating positive changes.

Thus, the integrated assessment confirms that the sustainability of Kazakhstan's urban agglomerations is in the developing stage and characterized by quasi-stability. The differences between agglomerations stem from the structural features of their development, but none have reached a sustainable level. This demonstrates the need for a comprehensive and balanced policy focused on the simultaneous development of economic, social, and environmental spheres, as well as reducing interregional disparities and creating sustainable growth mechanisms.

4. DISCUSSION

Kazakhstan's cities offer significant economic opportunities and prosperity. The urbanization peculiarities in Kazakhstan are the overpopulation of the largest cities (Nurlanova et al., 2023), confirmed by our findings. The phenomenon of urban agglomeration in Kazakhstan has attracted significant attention as the country transitions toward a more urbanized, industrialized economy. Positive consequences of agglomeration in Kazakhstan include enhanced economic growth, increased investment, and improved infrastructure. Cities such as Almaty and Astana have become central hubs for economic activities, attracting both domestic and foreign investments (Abilov et al., 2023). These urban centers benefit from economies of scale, as the concentration of businesses and industries increases productivity and innovation. Agglomeration also facilitates greater access to education, healthcare, and other essential services, thereby improving living standards for the urban population (Cao et al., 2023). Urban residents' satisfaction with conditions and quality of life is lower than that of rural residents (Mukayev et al., 2023). Rural and low-income households are particularly unlikely to move to high-cost areas, even though job prospects and average incomes are better there. Agglomeration has exacerbated inequalities, with significant disparities in income and access to services between urban and rural areas. The influx of people into cities has strained housing markets, leading to affordability issues and the proliferation of informal settlements. Additionally, the rapid urban growth has outpaced infrastructure development, resulting in traffic congestion, inadequate public transportation, and insufficient utilities.

The Astana and Almaty agglomerations demonstrate the most harmonious combination of social, economic, and environmental factors. The Karaganda agglomeration confirms that high industrial specialization without corresponding development in the social and environmental spheres does not ensure the highest level of sustainability. Meanwhile, the Aktobe and Shymkent agglomerations require more comprehensive development that simultaneously strengthens social infrastructure, increases investment activity, and improves environmental policies. Coordinated development of these three sustainability components is key to improving the integrated sustainable development index of Kazakhstan's urban agglomerations. Environmental degradation is a significant concern, driven by increased pollution and the overuse of natural resources in urban areas. The concentration of industries in cities like Karaganda has led to heightened levels of air and water pollution, adversely affecting public health and local ecosystems (Jin & Ou, 2023). Much attention should be paid to environmental issues in the development of Almaty and Astana cities (Alibekova et al., 2018; Nurlanova et al., 2020). The risks associated with agglomeration in Kazakhstan are multifaceted. Environmental risks include the long-term impacts of pollution and resource depletion, which threaten the sustainability of urban growth (Lovinskaya et al., 2022).

Our results show that social and economic sustainability in Kazakhstani urban agglomerations is mostly low. Differences in their social and economic development are largely determined by their industrial specialization. The Astana agglomeration serves as the country's administrative, political, financial, and business center. The Almaty agglomeration specializes in financial services, trade, transportation, education, and innovation, serving as Kazakhstan's largest economic and logistics hub. The Karaganda agglomeration has a distinct industrial focus, focusing on metallurgy, coal mining, mechanical engineering, and manufacturing. The Aktobe agglomeration focuses on mineral extraction and processing, development of the oil and gas complex, ferroalloy production, and chemical industries. The Shymkent agglomeration is characterized by a predominance of processing industries, food production, pharmaceuticals, small and medium-sized businesses, and a developed agro-industrial complex. Social risks involve the potential for increased socio-economic disparities and reduced social cohesion, which can lead to social unrest and political instability. Economic risks include the possibility of over-reliance on specific industries, making cities vulnerable to economic downturns (Tian et al., 2023). Addressing these risks requires comprehensive urban planning and policy interventions that promote sustainable development. Strategies such as investing in green infrastructure, improving public transportation, and implementing policies for affordable housing

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are crucial. Moreover, effective governance is essential to coordinate efforts across various levels of government and stakeholders, ensuring that urban growth is managed sustainably and inclusively (Mukhametzhan et al., 2020).

It requires strategic changes related to the intensity and quality of urbanization (Guan et al., 2018). Currently, the term “smart urbanism” is widely used in the management of urban agglomerations (Caprotti, 2019; He et al., 2020). Digital technologies have a significant impact on sustainable and effective management of urban agglomerations (Kourtit et al., 2017; Fang et al., 2020). For example, for social sustainability, new job opportunities are possible through digitization (Kaliyeva et al., 2025). Successful management of urban agglomerations involves not only the state but also interaction with other entities. The importance of developing local government and urban policy is high, i.e., the influence of “bottom-up” municipal inter-municipal dynamics is significant. As urban agglomerations are composed of cities and districts, municipal cooperation is an important element in managing their development (Kim, 2020). Therefore, urban agglomeration development is an interrelated model in which state, market, social, and spatial factors provide the basis for urban development worldwide (Jacobs, 2016).

In summary, both positive and negative effects accompany the development of urban agglomerations in Kazakhstan. On the one hand, agglomerations serve as centers of economic growth, investment, and improved living standards; on the other, they exacerbate social inequality, overburdened infrastructure, and environmental problems. High costs of living, a shortage of affordable housing, and uneven access to services reduce social resilience, while the concentration of industry and resources increases environmental risks. Overall, the sustainability of agglomerations remains limited due to the imbalance between economic growth, social security, and environmental safety, which requires comprehensive and coordinated urban development management.

CONCLUSION

This study aims to analyze the sustainable development of urban agglomerations in Kazakhstan. The sustainable development of Kazakhstan’s urban agglomerations is systemically imbalanced, and the current urbanization model has limited ability to ensure long-term sustainability.

First, a structural asymmetry in sustainability has been identified: none of the agglomerations simultaneously demonstrate high levels of social, economic, and environmental sustainability. Astana is characterized by a relatively high level of social sustainability due to its concentration of resources and well-developed infrastructure, while Karaganda boasts economic sustainability driven by its industrial base and innovative activity. Environmental sustainability, however, is fragmented and often determined not by the level of development, but by the sectoral structure and nature of pollution.

Second, a key constraint to sustainable development is not so much a scarcity of resources as the uncoordinated distribution of resources and institutional inefficiency. This is evident in the fact that population growth in the largest agglomerations outpaced the development of social infrastructure, leading to congestion and reduced quality of life, despite the territories’ economic potential. In the economic sphere, sustainability is dependent on the level of technological advancement: low innovation activity in some agglomerations hinders the transition to sustainable growth, even with increased investment and production. In the environmental context, increased spending on environmental protection has not always led to improved indicators, suggesting the low effectiveness of environmental policies and the dominance of sectoral factors, primarily industrial pressures.

Third, the existing urbanization model in Kazakhstan reinforces spatial polarization and reproduces a “quasi-stability trap.” Most agglomerations are in an intermediate state, where isolated positive shifts are observed, but these are not consolidated and do not lead to a transition to sustainable development.

This is due to the cyclical nature of indicator dynamics, dependence on external shocks, and the lack of mechanisms for long-term sustainability. Moreover, agglomeration processes contribute to the concentration of economic activity, investment, and innovation, while also exacerbating social inequality, raising the cost of living, putting pressure on housing and infrastructure, and worsening environmental problems, including pollution and environmental degradation.

Finally, the proposed integral urban agglomeration sustainability index helps to assess the sustainable development of urban agglomerations. However, it is constrained by the availability of official statistics at the district level for cities, rural districts, and individual settlements within agglomerations. Equal weighting of indicators may not fully reflect their relative contribution to sustainability. Min-max normalization evaluates the relative rather than absolute performance of agglomerations, and the results are sensitive to the selection of indicators included in each sustainability dimension. These limitations are identified as directions for future research, including the application of alternative weighting techniques and the incorporation of additional indicators as official statistical data become available.

The study results demonstrate that the main barrier to the transition to sustainable development in Kazakhstan's agglomerations is not a lack of growth, but a lack of synchronization between social, economic, and environmental processes. Therefore, there is a need for a transition from sectoral to integrated agglomeration management, including the coordination of demographic, economic, and environmental policies, the development of institutional mechanisms, and the implementation of smart and sustainable urbanism principles, which will enable a qualitatively new level of urban development.

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Writing – original draft: Gulmira Galymkyzy, Laura Ashirbekova, Zaira Satpayeva.
Writing – review & editing: Gulmira Galymkyzy, Laura Ashirbekova, Zaira Satpayeva.

REFERENCES

1. Abilov, A. Zh., Makhrova, A. G., & Safronov, S. G. (2023). The latest history of the development of Kazakhstan's urban agglomerations. *Regional Research of Russia, 13*, 316-327. https://doi.org/10.1134/S2079970523700697
2. Adilet. (2016). *On approval of the Interregional Scheme for the Territorial Development of the Almaty Agglomeration: dated May 24, 2016, No. 302. Resolution of the Government of the Republic of Kazakhstan*. (In Russian). Retrieved from https://adilet.zan.kz/rus/docs/P1600000302
3. Adilet. (2023a). *On approval of the list and composition of agglomerations: dated June 19, 2023, No. 486. Resolution of the Government of the Republic of Kazakhstan*. (In Russian). Retrieved from https://adilet.zan.kz/rus/docs/P2300000486#z8
4. Adilet. (2023b). *On approval of the Rules for the formation of the composition of the agglomeration: dated March 31, 2023, No. 44. Order of the Acting Minister of National Economy of the Republic of Kazakhstan*. (In Russian). Retrieved from https://adilet.zan.kz/rus/docs/V2300032206

http://dx.doi.org/10.21511/ppm.24(3).2026.27

5. Adilet. (2023c). *On the development of agglomerations. The Law of the Republic of Kazakhstan: dated January 1, 2023, No. 181-VII LRK.* Retrieved from https://adilet.zan.kz/eng/docs/Z2300000181

6. Alesaily, Z., & Albialy, A. (2025). Future cities: A bibliometric review, 1875 to 2024. *Sustainable Futures, 9,* Article 100801. https://doi.org/10.1016/j.sftr.2025.100801

7. Alibekova, G., Panzabekova, A., Abilkayir, N., & Satpayeva, Z. (2018). Sustainable development issues of Almaty as the largest metropolis in Central Asia. *IOP Conference Series: Earth and Environmental Science, 177,* Article 012010. https://doi.org/10.1088/1755-1315/177/1/012010

8. Avdiushchenko, A., & Meinrenken, C. J. (2025). Circular economy concepts for accelerating sustainable urban transformation: The case of New York City. *Cities, 166,* Article 106223. https://doi.org/10.1016/j.cities.2025.106223

9. BNS. (2025a). *Dinamika osnovnyh socialno-jekonomicheskih pokazatelej po gorodu Almaty [Dynamics of the main socio-economic indicators in Almaty city].* (In Russian). Retrieved from https://stat.gov.kz/api/iblock/element/region/291724/file/ru/

10. BNS. (2024a). *Dinamika osnovnyh pokazatelej socialno-jekonomicheskogo razvitija Ilijskogo rajona Almatinskoj oblasti [Dynamics of the main socio-economic indicators of districts and cities of Almaty region].* (In Russian). Retrieved from https://stat.gov.kz/api/iblock/element/region/291755/file/ru/

11. BNS. (2024b). *Spisochnaja chislennost vrachej vseh specialnostej na konec goda [The list of doctors of all specialties].* (In Russian). Retrieved from https://stat.gov.kz/api/iblock/element/3690/file/ru/

12. BNS. (2025b). *Innovacionnaja aktivnost predprijatij [Innovative activity of enterprises].* (In Russian). Retrieved from https://stat.gov.kz/api/iblock/element/region/42794/file/ru/

13. BNS. (2025c). *Statistika okruzhajushhej sredy goroda Almati [Environmental indicators of Almaty city].* (In Russian). Retrieved from https://stat.gov.kz/ru/region/almaty/dynamic-tables/1523/

14. BNS. (2025d). *Statistika okruzhajushhej sredy Almatinskoj oblasti [Environmental indicators of Almaty region].* (In Russian). Retrieved from https://stat.gov.kz/ru/region/almatyobl/dynamic-tables/1523/

15. BNS. (2024c). *Osnovnye socialno-jekonomicheskie pokazateli gorodov, rajonov i monopromyshlennyh gorodov Akmolinskoj oblasti [Key socio-economic indicators for cities, districts and single-industry towns in Akmola region].* (In Russian). Retrieved from https://stat.gov.kz/api/iblock/element/region/291554/file/ru/

16. BNS. (2025e). *Dinamika osnovnyh pokazatelej socialno-jekonomicheskogo razvitija goroda Astany [Dynamics of the main socio-economic development of Astana city].* (In Russian). Retrieved from https://stat.gov.kz/api/iblock/element/region/291556/file/ru/

17. BNS. (2025f). *Statistika okruzhajushhej sredy goroda Astana [Environmental indicators of Astana city].* (In Russian). Retrieved from https://stat.gov.kz/ru/region/astana/dynamic-tables/1523/

18. BNS. (2025g). *Statistika okruzhajushhej sredy Akmolinskoj oblasti [Environmental indicators of Akmola region].* (In Russian). Retrieved from https://stat.gov.kz/ru/region/akmola/dynamic-tables/1523/

19. BNS. (2025h). *Osnovnye socialno-jekonomicheskie pokazateli gorodov, rajonov i monopromyshlennyh gorodov Turkestanskoj oblasti [Socio-economic indicators by districts and single-industry towns of Turkestan region].* (In Russian). Retrieved from https://stat.gov.kz/api/iblock/element/region/291845/file/ru/

20. BNS. (2025i). *Uroven innovacionnoj aktivnosti v oblasti innovacij [Level of innovation activity in the field of innovation].* (In Russian). Retrieved from https://stat.gov.kz/api/iblock/element/region/45705/file/ru/

21. BNS. (2025j). *Statistika okruzhajushhej sredy goroda Shymkent [Environmental indicators of Shymkent city].* (In Russian). Retrieved from https://stat.gov.kz/ru/region/shymkent/dynamic-tables/1523

22. BNS. (2025k). *Statistika okruzhajushhej sredy Turkestanskoj oblasti [Environmental indicators of Turkestan region].* (In Russian). Retrieved from https://stat.gov.kz/ru/region/turkestan/dynamic-tables/1523/

23. BNS. (2024d). *Osnovnye pokazateli socialno-jekonomicheskogo razvitija Aktobe [Dynamics of socio-economic indicators by districts of Aktobe region].* (In Russian). Retrieved from https://stat.gov.kz/api/iblock/element/region/291758/file/ru/

24. BNS. (2025l). *Uroven innovacionnoj aktivnosti (2003–2025) [Level of innovation activity (2003–2025)].* (In Russian). Retrieved from https://stat.gov.kz/api/iblock/element/region/46900/file/ru/

25. BNS. (2025m). *Statistika okruzhajushhej sredy Aktobinskoj oblasti [Environmental indicators of Aktobe region].* (In Russian). Retrieved from https://stat.gov.kz/ru/region/aktobe/dynamic-tables/1523/

26. BNS. (2025n). *Osnovnye socialno-jekonomicheskie pokazateli gorodov, rajonov i monopromyshlennyh gorodov Karagandinskoj oblasti [Socio-economic indicators by districts and single-industry towns of Karaganda region].* (In Russian). Retrieved from https://stat.gov.kz/api/iblock/element/region/291821/file/ru/

27. BNS. (2025o). *Innovacionnaja aktivnost predprijatij [Innovative activity of enterprises].* (In Russian). Retrieved from https://stat.gov.kz/api/iblock/element/region/42174/file/ru/

28. BNS. (2025p). *Statistika okruzhajushhej sredy Karagandinskoj oblasti [Environmental indicators of Karaganda region].* (In Russian). Retrieved from https://stat.gov.kz/ru/region/karagandy/dynamic-tables/1523/

29. Cao, Y., Zhang, R., Zhang, D., & Zhou, C. (2023). Urban agglom-

erations in China: Characteristics and influencing factors of population agglomeration. *Chinese Geographical Science, 33,* 719-735. https://doi.org/10.1007/s11769-023-1368-7

30. Caprotti, F. (2019). Spaces of visibility in the smart city: Flagship urban spaces and the smart urban imaginary. *Urban Studies, 56*(12), 2465-2479. https://doi.org/10.1177/0042098018798597

31. Chen, H., Li, Z., Cui, X., Zhao, M., Shi, Y., Lin, H., & Zhu, T. (2025). Analysis of sustainable spatial structure of cities under the framework of "Economy-Society-Environment": A case study Beijing–Tianjin–Hebei urban agglomeration. *Ecological Indicators, 173,* Article 113416. https://doi.org/10.1016/j.ecolind.2025.113416

32. Chen, S., Jin, H., & Lu, Y. (2019). Impact of urbanization on CO2 emissions and energy consumption structure: A panel data analysis for Chinese prefecture-level cities. *Structural Change and Economic Dynamics, 49,* 107-119. https://doi.org/10.1016/j.strueco.2018.08.009

33. Chen, X., Li, F., Li, X., Hu, Y., & Wang, Y. (2020). Mapping ecological space quality changes for ecological management: A case study in the Pearl River Delta urban agglomeration, China. *Journal of Environmental Management, 267,* Article 110658. https://doi.org/10.1016/j.jenvman.2020.110658

34. Chen, Y., Liu, Z., & Zhou, B. (2022). Population-environment dynamics across world's top 100 urban agglomerations: With implications for transitioning toward global urban sustainability. *Journal of Environmental Management, 319,* Article 115630. https://doi.org/10.1016/j.jenvman.2022.115630

35. Cheng, C., Yan, X., Fang, Z., Zhou, Q., Tang, Y., Li, N., & Tang, D. (2024). Proposing carbon reduction strategies for mega-urban agglomerations – A cluster analysis based on carbon emission intensity. *Ecological Indicators, 166,* Article 112336. https://doi.org/10.1016/j.ecolind.2024.112336

36. Di Giacinto, V., Micucci, G., & Tosoni, A. (2020). The agglomeration of knowledge-intensive business services firms. *Annals of Regional Science, 65,* 557-590. https://doi.org/10.1007/s00168-020-00995-3

37. Dijkstra, L., Garcilazo, E., & McCann, P. (2013). The economic performance of European cities and city regions: Myths and realities. *European Planning Studies, 21*(3), 334-354. https://doi.org/10.1080/09654313.2012.716245

38. Ding, J., Liu, B., & Shao, X. (2022). Spatial effects of industrial synergistic agglomeration and regional green development efficiency: Evidence from China. *Energy Economics, 112,* Article 106156. https://doi.org/10.1016/j.eneco.2022.106156

39. Eccleston, R., Verdouw, J., Flanagan, K., Warren, N., Duncan, A., Ong, R.V.J., Whelan, S., & Atalay, K. (2018). *Pathways to housing tax reform* (AHURI Final Report No. 301). https://doi.org/10.18408/ahuri-4111001

40. Estoque, R. C., Ooba, M., Seposo, X. T., Togawa, T., Hijioka, Y., Takahashi, K., & Nakamura, S. (2020). Heat health risk assessment in Philippine cities using remotely sensed data and social-ecological indicators. *Nature Communications, 11,* Article 1581. https://doi.org/10.1038/s41467-020-15218-8

41. Fang, C., Yu, X., Zhang, X., Fang, J., & Liu, H. (2020). Big data analysis on the spatial networks of urban agglomeration. *Cities, 102,* Article 102735. https://doi.org/10.1016/j.cities.2020.102735

42. Feng, P., Lu, T., Yu, Y., Gao, R., & Ni, T. (2023). Effects measurement and spatial differentiation in synergy between pollution and carbon reduction in national urban agglomerations. *PLoS ONE, 18*(9), Article 0289801. https://doi.org/10.1371/journal.pone.0289801

43. Gao, C., Chang, S., & Wang, Y. (2024). From global to national: The role of urban agglomerations in China's new development paradigm. *PLoS ONE, 19*(6), Article 0305594. https://doi.org/10.1371/journal.pone.0305594

44. Giannakis, E., & Bruggeman, A. (2020). Regional disparities in economic resilience in the European Union across the urban–rural divide. *Regional Studies, 54*(9), 1200-1213. Retrieved from https://ideas.repec.org/a/taf/regstd/v54y2020i9p1200-1213.html

45. Guan, X., Wei, H., Lu, Sh., Dai, Q., & Su, H. (2018). Assessment on the urbanization strategy in China: Achievements, challenges and reflections. *Habitat International, 71,* 97-109. https://doi.org/10.1016/j.habitatint.2017.11.009

46. Guo, Y., Li, B., & Han, Y. (2020). Dynamic network coupling between high-speed rail development and urban growth in emerging economies: Evidence from China. *Cities, 105,* Article 102845. https://doi.org/10.1016/j.cities.2020.102845

47. Gurran, N., Rowley, S., Milligan, V., Randolph, B., Phibbs, P., Gilbert, C., James, A., Troy, L., & Van Den Nouwelant, R. (2018). *Inquiry into increasing affordable housing supply: Evidence-based principles and strategies for Australian policy and practice* (AHURI Final Report No. 300). https://doi.org/10.18408/ahuri-7313001

48. He, Q., Zeng, C., Xie, P., Tan, Sh., & Wu, J. (2019). Comparison of urban growth patterns and changes between three urban agglomerations in China and three metropolises in the USA from 1995 to 2015. *Sustainable Cities and Society, 50,* Article 101649. https://doi.org/10.1016/j.scs.2019.101649

49. He, S. Y., Wu, D., Chen, H., Hou, Y., & Ng, M. K. (2020). New towns and the local agglomeration economy. *Habitat International, 98,* Article 102153. https://doi.org/10.1016/j.habitatint.2020.102153

50. Hodges, P. E., & Carson, S. A. (2012). The triumph of the city: How our greatest invention makes us richer, smarter, greener, healthier, and happier. *The Social Science Journal, 49*(4), 558-560. https://doi.org/10.1016/j.soscij.2012.11.003

http://dx.doi.org/10.21511/ppm.24(3).2026.27

51. Huang, H.-J., Xia, T., Tian, Q., Liu, T.-L., Wang, C., & Li, D. (2020). Transportation issues in developing China's urban agglomerations. *Transport Policy, 85,* A1-A22. https://doi.org/10.1016/j.tranpol.2019.09.007

52. Huang, J., Nitivattananon, V., Lin, D., & Gong, W. (2023). Integrated assessment for Sustainable Development Goals of metropolitan regions: A case study of the Pearl River Delta region, China. *Environmental and Sustainability Indicators, 20,* Article 100299. https://doi.org/10.1016/j.indic.2023.100299

53. Jacobs, A. J. (2016). The city as the nexus model: Bridging the state, market, societal, and geospatial contexts. *Cities, 51,* 84-95. http://dx.doi.org/10.1016/j.cities.2015.11.018

54. Jiang, J., Zhang, X., & Huang, C. (2022). Influence of population agglomeration on urban economic resilience in China. *Sustainability, 14*(16), Article 10407. https://doi.org/10.3390/su141610407

55. Jin, Y., & Ou, G. (2023). The impacts of high-speed rail on producer service industry agglomeration: Evidence from China's Yangtze River delta urban agglomeration. *Sustainability, 15*(4), Article 3581. https://doi.org/10.3390/su15043581

56. Kaliyeva, S., Rakhmetova, R., Maxyutova, A., Kabylkairatkyzy, R., & Sadykov, I. (2025). Impact of energy factors and digitalization advancement on employment: Evidence from mining, industry and electricity labor markets. *International Journal of Energy Economics and Policy, 15*(5), 480-489. https://doi.org/10.32479/ijeep.20323

57. Kim, S. (2020). Inter-municipal relations in city-region governance. *Cities, 104,* Article 102771. https://doi.org/10.1016/j.cities.2020.102771

58. Kourtit, K., Nijkamp, P., & Steenbruggen. J. (2017). The significance of digital data systems for smart city policy. *Socio-Economic Planning Sciences, 58,* 13-21. http://dx.doi.org/10.1016/j.seps.2016.10.001

59. Lawson, J., Denham, T., Dodson, J., Flanagan, K., Jacobs, K., Martin, C., Van Den Nouwelant, R., Pawson, H., & Troy, L. (2019). *Social housing as infrastructure: Rationale, prioritisation and investment pathway* (AHURI Final Report No. 315). https://doi.org/10.18408/ahuri-5314001

60. Lin, Y., Chen, Y., Nie, H., & Peng, L. (2024). Sustainable development of urban agglomeration based on material metabolism: A case study on Fujian Delta, China. *Environment, Development and Sustainability*, *26*(4), 10533-10555. https://doi.org/10.1007/s10668-023-03160-w

61. Lopez-Aparicio, S., Grythe, H., Drabicki, A., Chwastek, K., Toboła, K., Górska-Niemas, L., Kierpiec, U., Markelj, M., Strużewska, J., Kud, B., & Sousa Santos, G. (2025). Environmental sustainability of urban expansion: Implications for transport emissions, air pollution, and city growth. *Environment International, 196,* Article 109310. https://doi.org/10.1016/j.envint.2025.109310

62. Lovinskaya, A., Kolumbayeva, S., & Suvorova, M. (2022). Screening of natural surface waters of the Almaty region of the Republic of Kazakhstan for toxic and mutagenic activity. *Science of The Total Environment, 849,* Article 157909. https://doi.org/10.1016/j.scitotenv.2022.157909

63. Makhrova, A. G., Safronov, S. G., & Abilov, A. Zh. (2023). Urban agglomerations of Kazakhstan: Trends in socioeconomic development. *Izvestiya Rossiiskoi Akademii Nauk. Seriya Geograficheskaya, 87*(1), 16-28. (In Russian). https://doi.org/10.31857/S2587556623010119

64. Mora, C., Dousset, B., Caldwell, I. R., Powell, F. E., Geronimo, R. C., Bielecki, C. R., Counsell, C. W. W., Dietrich, B. S., Johnston, E. T., Louis, L. V., Lucas, M. P., McKenzie, M. M., Shea, A. G., Tseng, H., Giambelluca, T. W., Leon, L.R., Hawkins, E., & Trauernicht, C. (2017). Global risk of deadly heat. *Nature Climate Change, 7,* 501-506. https://doi.org/10.1038/nclimate3322

65. Mukayev, A., Satpayeva, Z., Kangalakova, D., Doskeyeva, G., & de Matos Pedro, E. (2023). Assessment of the population's quality of life in Kazakhstan during COVID-19: The effectiveness of public policy. *Problems and Perspectives in Management, 21*(3), 69-83. https://doi.org/10.21511/ppm.21(3).2023.06

66. Mukhametzhan, S. O., Junusbekova, G. A., & Daueshov, M. Ye. (2020). The management of urban development for the regional economic growth: The example of Kazakhstan. *EoR, 16*(4), 1285-1301. https://doi.org/10.17059/ekon.reg.2020-4-19

67. Nichol, J. E., King, B., & Ding, X. (2013). Sustainable urbanization. *International Journal of Remote Sensing, 34*(3), 755-758. https://doi.org/10.1080/01431161.2013.721284

68. Nurlanova, N. K., Alzhanova, F. G., & Satpayeva, Z. T. (2023). Sustainable development of cities: Rating assessment methodology and risk analysis (using Kazakhstan as an example). *Economy of Regions, 19*(2), 343-354. https://doi.org/10.17059/ekon.reg.2023-2-4

69. Nurlanova, N. K., Omarov, A. K., & Satpayeva, Z. T. (2020). Methodological approaches to estimation of economic growth and sustainable development: Kazakhstan's experience. *Journal of Asian Finance, Economics and Business, 7*(4), 317-324. https://doi.org/10.13106/jafeb.2020.vol7.no4.317

70. Nyussupova, G., Kenespayeva, L., Tazhiyeva, D., & Kadylbekov, M. (2022). Sustainable urban development assessment: Large cities in Kazakhstan. *Urbani Izziv, 33,* 70-81. https://doi.org/10.5379/urbani-izziv-en-2022-33-01-01

71. Peng, D., Elahi, E., & Khalid, Z. (2023). Productive service agglomeration, human capital level, and urban economic performance. *Sustainability, 15*(9), Article 7051. https://doi.org/10.3390/su15097051

72. Razia, S., & Abu Bakar Ah, S. H. (2023). A call to action: Unpacking the challenges to implement-

ing social sustainability initiatives in a developing country city. *Heliyon, 9*(8), Article 19085. https://doi.org/10.1016/j.heliyon.2023.e19085

73. Ren, J., Bai, H., Zhong, S., & Wu, Z. (2023). Prediction of CO2 emission peak and reduction potential of Beijing–Tianjin–Hebei urban agglomeration. *Journal of Cleaner Production, 425,* Article 138945. https://doi.org/10.1016/j.jclepro.2023.138945

74. Rustiadi, E., Pravitasari, A. E., Setiawan, Y., Mulya, S. P., Pribadi, D. O., & Tsutsumida, N. (2021). Impact of continuous Jakarta megacity urban expansion on the formation of the Jakarta-Bandung conurbation over the rice farm regions. *Cities, 111,* Article 103000. https://doi.org/10.1016/j.cities.2020.103000

75. Shao, Y., Han, W., Jin, M., & Wang, L. (2025). Indicators and methodologies for assessing urban agglomeration sustainability. *IScience, 28*(7), Article 112927. https://doi.org/10.1016/j.isci.2025.112927

76. Takano, T., Morita, H., Nakamura, S., Togawa, T., Kachi, N., Kato, H., & Hayashi, Y. (2023). Evaluating the quality of life for sustainable urban development. *Cities, 142,* Article 104561. https://doi.org/10.1016/j.cities.2023.104561

77. Tian, J., Tian, Y., & Yi, H. (2023). The influence of industrial Synergy Agglomeration on economic resilience: Based on the comparison between Yangtze River Delta Urban Agglomeration and Central Yunnan Urban Agglomeration. *Journal of Innovation and Development, 2*(3), 70-77. https://doi.org/10.54097/jid.v2i3.7279

78. Tiwari, A. K., Antoniuk, V. S., Lapo, A. S., & Vansovich, E. R. (2024). Managing urban agglomeration processes in Russia in the context of agglomerative and socio-economic development. *Heliyon*, *10*(7), Article 28654. https://doi.org/10.1016/j.heliyon.2024.e28654

79. Valente, R. (2024). Urban routines, spatial occupancy, and their effects on outdoor crime in Barcelona. *European Journal of Criminology, 21*(5), 754-773. https://doi.org/10.1177/14773708241251629

80. Venter, Z. S., Figari, H., Krange, O., & Gundersen, V. (2023). Environmental justice in a very green city: Spatial inequality in exposure to urban nature, air pollution and heat in Oslo, Norway. *Science of The Total Environment, 858*(3), Article 160193. https://doi.org/10.1016/j.scitotenv.2022.160193

81. Vij, A., Connor, J.D., & Beer, A. (2021). The negative effects of urban agglomeration on housing affordability in Australia. *The Australasian Journal of Regional Studies, 27*(1), 26-46. Retrieved from https://www.anzrsai.org/assets/Uploads/PublicationChapter/AJRS-27.1-pages-026-to-046.pdf

82. Wang, C., Chen, J., Wang, Q., Li, D., Zhu, M., Gan, Z., & Zhang, Y. (2025b). Investigation of the influence and mechanism of urban population agglomeration on carbon emission efficiency. *Journal of Urban Management, 14*(4), 1269-1290. https://doi.org/10.1016/j.jum.2025.05.006

83. Wang, S., Sun, Q.C., Huang, X., Tao, Y., Dong, C., Das, S., & Liu, Y. (2023). Health-integrated heat risk assessment in Australian cities. *Environmental Impact Assessment Review, 102,* Article 107176. https://doi.org/10.1016/j.eiar.2023.107176

84. Wang, X., Xu, S., & Wang, Y. (2025a). A framework for quantifying the resilience of urban agglomeration under multidimensional association rule. *Sustainable Futures, 9,* Article 100550. https://doi.org/10.1016/j.sftr.2025.100550

85. Wu, H., Zhao, C., Zhu, Y., & Pan, Y. (2024). A multiscale examination of heat health risk inequality and its drivers in mega-urban agglomeration: A case study in the Yangtze River Delta, China. *Journal of Cleaner Production, 458,* Article 142528. https://doi.org/10.1016/j.jclepro.2024.142528

86. Yang, H., Wang, Y., Tu, P., Zhong, Y., Huang, C., Pan, X., Xu, K., & Hong, S. (2024). Evaluating the effects of future urban expansion on ecosystem services in the Yangtze River Delta urban agglomeration under the shared socioeconomic pathways. *Ecological Indicators, 160,* Article 111831. https://doi.org/10.1016/j.ecolind.2024.111831

87. Ye, Z., Li, J., & Chen, J. (2025). The promotion mechanism of financial agglomeration and human capital on urban economic resilience: Based on the moderating effect of industrial structure. *International Review of Economics and Finance, 97,* Article 103764. https://doi.org/10.1016/j.iref.2024.103764

88. Zhang, M., Wu, Q., Li, W., Sun, D., & Huang, F. (2021). Intensifier of urban economic resilience: Specialized or diversified agglomeration? *PLoS ONE, 16*(11), Article 0260214. https://doi.org/10.1371/journal.pone.0260214

89. Zhang, Q., Kong, Q., Zhang, M., & Huang, H. (2024). New-type urbanization and ecological well-being performance: A coupling coordination analysis in the middle reaches of the Yangtze River urban agglomerations, China. *Ecological Indicators, 159,* Article 111678. https://doi.org/10.1016/j.ecolind.2024.111678

90. Zheng, S., & Du, R. (2020). How does urban agglomeration integration promote entrepreneurship in China? Evidence from regional human capital spillovers and market integration. *Cities, 97,* Article 102529. https://doi.org/10.1016/j.cities.2019.102529

91. Zhou, J., Chen, H., Liu, J., Shen, Q., & Zang, D. (2024). Does environmental regulation promote urban economic resilience? A case of China's Yangtze River Economic Belt. *Sustainable Futures, 8.* Article 100391. https://doi.org/10.1016/j.sftr.2024.100391

http://dx.doi.org/10.21511/ppm.24(3).2026.27