

Challenges and prospects of the green ecology in Kazakhstan based on international experience

Ainur Seilkhan^{1*}, Akbota Beken¹, Zhang Shicheng², Gau Siyau Jiang², Madina Yussubaliyeva³, Zhanat Idrisheva³, Manira Zhamanbayeva³, Almira Bukunova³

1. Abai Kazakh National Pedagogical University, Faculty of Natural Sciences and Geography, Almaty, Kazakhstan

2. Department of Environmental Science and Engineering, Fudan University, Research Associate, Kazakhstan

3. D. Serikbayev East Kazakhstan Technical University, Ust-Kamenogorsk, Kazakhstan

* Corresponding author's E-mail: Ainus.seilkhan@mail.ru

ABSTRACT

From the point view of sustainable development, there is no conflict between economic growth and the preservation and improvement of the environment. In fact, the realization of the goals of sustainable development by institutionalizing a wise and sustainable view of activities in different economic, social, cultural and political dimensions, including paying attention to the sustainability of planning in the environmental sector is realized in the light of optimal consumption of resources and environmental protection. Therefore, the creation of suitable platforms for improving productivity, quality, competitiveness, creativity, and innovation in the use of optimal materials and benefiting from the favorable environment along with economic and social growth indicators can be achieved through the establishment of the green management system at the country level and finally, the implementation and it is possible to implement a green government. Achieving sustainable and economic development goals emphasizes the necessity of carefully consuming the country's natural resources. According to the studies conducted to establish the green government system in institutions and organizations, the existing challenges can be examined from three general aspects: managerial problems and obstacles at the country level, technical and cultural issues, and obstacles. The establishment of the green government in the country's management system has not been followed seriously, and the need to implement it and provide correct management solutions at the macro level of the country and the micro level in the institutions and organizations has yet to be considered. From a technical point of view, the lack of required knowledge in optimizing material and energy consumption, especially in the implementation sector, and the lack of sufficient specialists in this field are important limitations. At the end, the managers' lack of vision and accountability regarding the need to preserve the country's resources and reserves as well as the lack of necessary knowledge and training in establishing the mentioned system play an essential role in the lack of access to the abovementioned goals. The obtained results show that the concept of green ecology is a multidisciplinary research field, using the planning method supported by decision-making tools capable of modeling green infrastructure as an ecological network formed by natural and semi-natural areas to equally distribute public services for increasing the quality of life as well as a wide range of ecosystem services and sustainability in communities.

Keywords: Green Ecology, Sustainable development, economic growth, environment and ecosystem.

Article type: Review Article.

INTRODUCTION

In the 21st century, cities must coordinate people with the nature around them and make it possible to achieve sustainable development. In recent decades, the growth and expansion of cities has been in contradiction with the development concepts of sustainable habitats. This process has caused an increase in the volume of traffic, pressure on the environment, such as the intensification of pollution caused by the consumption of fossil fuels or

neglecting climate issues. As a result of this pattern, resources such as land, energy, and water, which must be preserved for the next generations, are being consumed with increasing trends (Diyar *et al.* 2014; Onyusheva *et al.* 2018; Economy 2018). For some time now, the country's cities have maintained their traditional and authentic characteristics, and new and scientific principles have not ruled over their environmental development and future growth (Reznikova *et al.* 2019; Turgel *et al.* 2019). So, the urban environment has become a major challenge in planners' minds since the beginning of the last century and with numerous environmental crises. It has become a city. Such a process has created several movements, each of which has emerged in various biological schools in different parts of the world. They try to use theoretical concepts and background in their analysis. In the meantime, the common denominator of all these theories is the emphasis on the concept (sustainable urban development). One of the theories proposed in this field is the ecological city theory (Karatayev & Clarke 2016). Some of the important researchers in the ecological and green city introduced a society that makes its way to the "urban landscape" through walking, using bicycles and public transport, and changing everyday human behaviors. Some of the researchers in the field of urban ecology (Bespalyy *et al.* 2023), as an architect and urban designer, in their research on urban form & ecosystem dynamics, considered urban growth and the transformation of land into a city as a major threat to ecology and system knowledge and effective factors. It examines the relationship between urban patterns and the ecological system. It suggests features in urban planning to preserve the ecological conditions of the region in the development of cities. Research on advances in urban ecology is considered one of the most important challenges for scientists and future researchers in learning how to evolve urban areas regarding the interaction between ecological and human processes. Tikhonova *et al.* (2021), in their research related to the environment and society in urban design, considering the criteria of protection, environmental quality, and energy efficiency in development and design, found a comprehensive solution that is also responsible for solving the cultural and social needs of Jacobs' opinion. According to their results, if traditional urbanization and sustainable urban development can reduce dependence on fossil fuels, limit air pollution and greenhouse gases, and create coherent and stable social places, this type of urbanization will be desirable. Filippov *et al.* (2015), in an article entitled "The role of urban parks in a sustainable city", while pointing out the importance of urban green spaces and the lack of international studies in this field, have tried to show the importance of city nature for the well-being of citizens and urban sustainability. These studies show that the natural experience in the urban environment is the source of positive feelings and useful services that fulfill important non-material and spiritual needs. In an article on analyzing and evaluating the distribution and sustainable development of inner-city green spaces (Jan *et al.* 2015), they investigated and quantitatively analyzed the spatial distribution of parks and green spaces in the city and introduced the per capita corresponding to the social-environmental characteristics. Today, in many cities of the country, due to global developments and the implementation of various urban plans, the economic factor has become the main determining factor, and instead of creating an environment that is harmonious with ecological conditions, along with a sense of comfort, a sense of belonging to a place, security, and freshness, we are dealing with a dry and soulless environment. A city's construction is alien and unfamiliar to its surrounding environment. The developments of the current century and the oil-based economy have resulted in excessive population density, the concentration of activities and the frequency of constructions, the physical growth and expansion of urban centers, and the destruction of the natural ecosystem of the country's cities (Aithal & Aithal 2016; Kovalchuk & Kravchuk 2019; Kurpayanidi & Khamdamova 2024). Kazakhstan's diverse ecosystems are home to a wealth of medicinal plants that have been utilized for millennia for their therapeutic properties and nutritional benefits. However, the rapid pace of deforestation, urbanization, and the overexploitation of domesticated plant varieties pose significant threats to the rich biodiversity of these natural resources. Studies have highlighted a concerning decline in the genetic diversity of wild plants, leading to the extinction of several species and an endemism crisis (Akhmetova *et al.* 2015; Akhmetova *et al.* 2018; Seilkhan *et al.* 2018; Bukenova *et al.* 2019; Seilkhan 2024). This decline underscores the urgent need for sustainable practices to protect and enhance the region's ecological integrity. One promising solution is the cultivating medicinal plants in controlled environments, such as botanical gardens and specialized fields, which can provide a steady supply of raw materials while conserving wild populations (Seilkhan *et al.* 2016; Seilkhan *et al.* 2021). Additionally, the innovative practice of hydroponics offers a modern approach to vegetable production, allowing for year-round cultivation irrespective of climatic conditions. By integrating advanced chemistry and biology, hydroponics not only enables the efficient growth of crops like chard but also promotes environmentally friendly practices that can significantly reduce production costs (Ydyrys *et al.* 2020a,b). Prioritizing education in the context of green ecology in

Kazakhstan is essential for developing a knowledgeable and engaged society capable of addressing environmental challenges. By investing in education, Kazakhstan can sustainably leverage its rich natural resources, ensuring ecological resilience for future generations (Ydyrys *et al.* 2021). In developing countries, including Kazakhstan, urban development has been associated with greater growth and speed, and today, one of the major challenges facing the cities of Kazakhstan is its ecological and environmental issues. Developments in planning show that until the middle of the 20th century, the emphasis of planning was on growth and development without considering the limits for using ecological powers and environmental capabilities. Based on this view, the planning system has been applied in Kazakhstan. In the grand goals of the social and economic development programs of the country, the correct and sustainable exploitation of existing natural resources has been emphasized to improve the quality of life of the present and future generations (Adams 2008; Seilkhan *et al.* 2022). For this purpose, planning to create balance and equilibrium in the environment of the regions and equipping the development centers through the expansion of the infrastructure and production capacities of the environment according to the capabilities, conditions, and environmental considerations as one of the important policies of the economic development of different regions are recommended to the country. Unfortunately, the indiscriminate development of human economic activities, the increase in population, and the immediate reliance of a large segment of people on the exploitation of nature, day by day, create more restrictions and bottlenecks for the survival of nature and resources (Kudelas *et al.* 2018; Chatzimentor *et al.* 2020; Zhhexenbay *et al.* 2020; Alpysbayev *et al.* 2021; Porfiriev 2022). Therefore, the main concern of this research is the necessity of creating a green ecology in Kazakhstan and how it can be achieved.

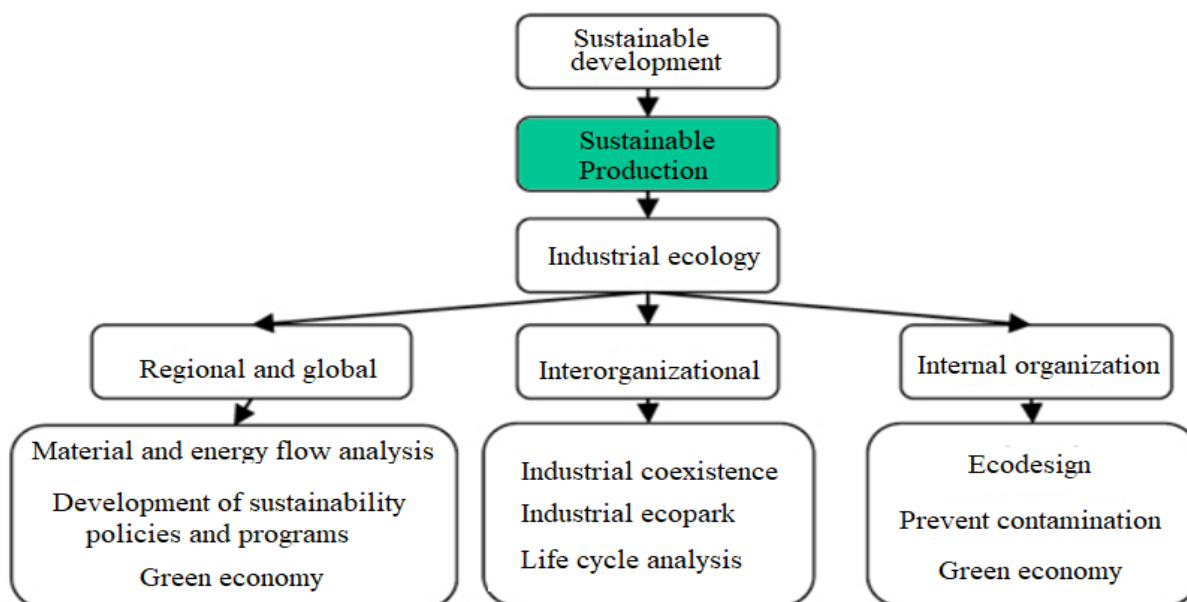


Fig. 1. The structure of green ecology in sustainable development.

Theoretical foundations of research

During the past years, the issue of how to plan and build your environment with productivity and livability and without any damage to the ecological environment has always been one of the issues emphasized by experts and scientists (Rashid & Uddin 2018; Onyusheva *et al.* 2018; Pratikno *et al.* 2023), which led to the formation of the concept of green ecology. Urban planners and managers have raised the need to create alternative environments following the problems that have arisen for communities, especially issues related to public health.

Green ecological development strategies

To achieve green ecology, the combination of the following strategies is needed:

1. Sustainable shipping

A sustainable transportation system is a system that provides access to basic needs in a safe and healthy manner while respecting intergenerational and intergenerational justice. Also, sustainable transportation supports a dynamic economy, reduces pollution and non-recyclable waste, and minimizes the consumption of non-renewable resources and land use. In the World Bank report 1009 sustainable transportation and its elements are as follows.

-Economic pillar of appropriate organizational structure and investment for transportation infrastructure.

- The environmental and ecological component includes a study on how to invest in transportation, emphasizing reducing energy consumption and the emission of environmental pollutants.
- The social pillar emphasizes the adequacy and proper access of all sections of society to transportation services.

The process of creating a sustainable city in the future requires fundamental changes in people's culture, which for many means a change in their way of life. A method that is no longer dependent on the use of personal transportation means, one of the characteristics of this cultural change is the perspective of societies on the urban area, its residents, and the necessary technology to support the essential social, economic, political, and physical infrastructure sustainability. The new trend of looking at the city as a set of interconnected systems, if successful, leads to the creation of planning mechanisms that include sets of related policies that support each other. Sustainable transportation requires the support of a balanced combination of pricing methods to support public transit, plus changes in the type of administration and improvements in transportation technology, including material recycling, as well as innovations in the design and implementation of future development plans. Using bicycles, pedestrians, and public transportation are sustainable solutions in ecological cities.

2. Development of renewable energy

One of the cheapest and easiest ways to preserve energy reserves is to increase energy efficiency; changing behaviors and intelligent energy control in buildings and homes can reduce the need for additional energy. Studies show that improvement in matters such as insulation, effective water heating, and using devices with appropriate energy consumption can quickly bring benefits and economic benefits to homeowners. Cities can move towards the combination of heat, energy, environmental heat, and energy networks. In order to provide their own energy, cities can use garbage and waste as energy and use secondary bio-fuels to produce energy and products, creating a solar building, living room and dining room in the southern part (sunny), kitchen and the bathroom and services of the building located in the north part. Walls, ceilings with 400 mm wool, glass, or polyurethane insulation, triple-glazed windows, and LED street lights with solar energy are examples of renewable energy development in the ecological city. Attracting climate-friendly technologies, strengthening urban green space, using local initiatives, and using renewable energy techniques and technologies from the construction level to the regional level are among the things that can be used in developing renewable energy.

3. Mixed use

The degree of sustainability of a city is related to its shape, size, density, and uses. Today, the discussion of how to use land plays an influential role in achieving sustainable city development, which can be implemented by following the model of a dense mixed-use city (Rakhimberdiev *et al.* 2024). Mixed-use has the concept of diversity in urban activities, including the presence of commercial functions and local industries in residential areas or the presence of residential places in industrial and commercial areas. Some of the advantages of mixed-use in the ecological city include easy access to local facilities, the need to have a car. It reduces people and increases the number of short trips to buy daily necessities. The placement of shops and recreational facilities in nearby and adjacent areas leads to a decrease in the desire to use a car, and many government facilities and organizations are located at a close distance.

4. Creating carbon-free cities

One of the main goals of the carbon-free cities approach is to ensure that all homes, neighborhoods, and commercial buildings are carbon-free. Optimally using energy and reducing the consumption of fossil fuels reduces their impact on the environment, actually reduces their ecological footprint, and provides the basis for the restoration of the environment. The use of biomass energy, absorption of landfill gas, photovoltaic solar heating, wind, and dry air conditioning systems with the help of the sun and, micro-hydro and wind, as well as biological refineries are among the measures that can be taken in this field.

5. Increasing urban green infrastructure

The most important effect of green spaces in cities is their environmental function, which has made cities meaningful as the environment of human society and countered the impact of industrial expansion and improper use of technology, increasing the quality of life in cities. The components of urban development works can disrupt the biological system of cities in various ways. Appropriate green spaces in cities are one of the influential factors

in reducing these effects, especially dust and air pollution. Forest-like green spaces are considered the breathing lungs of cities. The most crucial impact of green spaces in cities is to regulate temperature and increase relative humidity in air softness and dust absorption (Susilowati *et al.* 2023). From the point view of environmental protection, urban green space is a vital part of the physical construction of cities. At the same time, green infrastructure includes photosynthetic resources, renewable energy, food supply, and local fiber. There are two approaches to strengthening the green infrastructure in cities: first, increasing the green space per capita by creating vast and large-scale areas in the city and suburbs, and second, developing the city based on its natural structure. Strengthening the natural elements of the city, although small, will strengthen the sustainable presence of nature in the city. In this approach, it is essential to pay attention to social, cultural, and historical conditions and the role of these factors in planning people's minds and thoughts. Approaches such as green roofs, urban parks, green spaces of urban roads, green belts, and urban agriculture are among these measures emphasized by the ecological city, which, if followed and implemented by city managers, will transform a city from a global perspective. Greening the city includes the possibility of easy access to public parks, the creation of so-called green jobs for citizens, the formulation of laws that lead to the construction of sustainable buildings, and the use of new methods of material recycling.

6. Increasing ecological efficiency

Most of the phenomena on the planet are affected by non-linear behavior and follow this rule. None of the ecological developments are calm, unchanging, and continuous. These phenomena follow the law of non-linear communication instead of following the law of simple linear behavior. Therefore, we deal with circular systems or closed loops in cities. Cities with high efficiency in environmental and local fields reduce their adverse environmental effects by reducing consumption and waste materials. According to the principle of balance of materials, the problem of garbage and waste materials in urban areas is only possible through reducing the number of waste materials and waste as well as establishing a balance in the ecological cycle to the extent of the range capacity. Recycling only mitigates the problem to a certain extent and that delays it in terms of time or moves it from one place to another. Therefore, paying attention to the issue of waste and waste material recycling in ecological cities is particularly important.

RESULTS

Global experiences of ecological cities

According to the studies conducted and the experiences of ecological cities in the world and based on various domestic and foreign sources and paying attention to the reasons for the success and failure of projects in different regions, it shows that among the Asian countries, China, Japan and Singapore pay special attention to have had this approach; In particular, China has had a comprehensive program in this regard since 2020. Also, attention to this approach is being seriously pursued in Europe and America. In the Middle East region, especially in the Persian Gulf countries, particular emphasis has been placed on the construction of ecological cities. The results show that in the areas and countries where the environmental town has been done or is being done, it has had a positive effect in the direction of improvement and ecological efficiency and sustainability and has played the role of a catalyst. In addition, the active participation of citizens can also play an essential role in the success of the environmental city. There are also concerns in this field that the ecological model cannot achieve its goals, and economic and market incentives may play a role in it, or the wishes of the local people may not be considered in its construction. Nowadays, most environmental problems and bottlenecks are not considered local or national issues but due to the interdependence and mutual effects of the modern human environment with macro-human topics such as economy, culture, development, politics, and many others, human life's material and spiritual aspects are a problem for the whole world and humanity. For this reason, several formal and informal meetings have been held in recent years to prevent environmental destruction and damage worldwide.

The need to create ecological cities in Kazakhstan

Due to its climatic capacities and unique geographical location, Kazakhstan has special environmental conditions that are unique among the countries of the world. However, unfortunately, in the last few decades, it has witnessed the destruction of its environmental elements, in a way that the country's environmental worrying factors such as the destruction of forests and pastures, water pollution, air pollution, soil destruction have caused many crises (see Fig. 2). On the other hand, the rapid growth of the country's urban population and the increase in the number of

cities, consumerism, rural-to-city migration, and preparing urban plans with minimal attention to environmental issues have accelerated the destruction of the urban environment. With the current spreading destruction process in the country, it is not far from the expectation that the environmental situation will turn into a dangerous and uncontrollable situation in the near future. The fate of the future depends on how we look at the environment and the extent to which the ecological balance is restored. If environmental crises are not managed and the country's ecological balance is not restored, it can threaten national security.

Table 2. Sample ecologic cities.

Ecological city	The necessity and purpose of design	Considered approach	Challenges
Dongtan China	China's population growth, increasing urbanization, increasing demand for a better life, central government policies, lack of resources (water and energy)	Development of urban green spaces with a green approach, increasing biodiversity by preserving wetlands around the city, attention to energy utilization, use of clean energy (solar and geothermal), water purification, use of public transportation, waste management, environmental modernization of the city	Little opportunity for local experts in the decision-making process, top-down planning in China, conflict between the interests of national administrations, difficulty in attracting investment, difficulty in attracting population, city marketing has not been successful, insufficient support of local governments for cultural studies
NEOM Saudi Arabia	Using smart technologies and creating an attractive tourist destination	Rae is a new model for sustainable living, work activities, and economic growth, the first city without streets, cars, and traffic, using artificial intelligence and using clean energy sources, the favorable climate of the city of Neom, using renewable energy at a competitive price, from Through solar and wind potential	Absence of culture of use and very fast transformation without creating cultural infrastructure, high cost for building a new city in a hot and dry climate region.
Dubai, United Arab Emirates	To become the global leader of technology, to become the standard of sustainable development of the world	Using clean solar energy, not using cars, electric and solar transportation systems, using waste to produce electricity and heat, zero carbon city, using the Internet of Things, underground transportation	The impossibility of achieving a zero carbon and zero waste city in the world of realities, failure to respect the emotional and social aspects of the city, a city that only responds to demand and the market, the suspension of the city's identity, the ambitiousness of the plan, the global economic crisis and weakness Real estate market in the Middle East, financial and budgetary issues
Freiburg, Germany	Scattered growth, increasing use of private cars and high emissions of CO ₂ environmental pollution	Using solar energy, use of biomass energy, photovoltaic design, emphasis on public transport, combined heating, cycling and walking, minimal car use, direct participation of citizens in housing planning, collaborative approach with social creativity. Realization of social justice	Imbalance in regional stability between the municipality of Freiburg and the regions outside the city

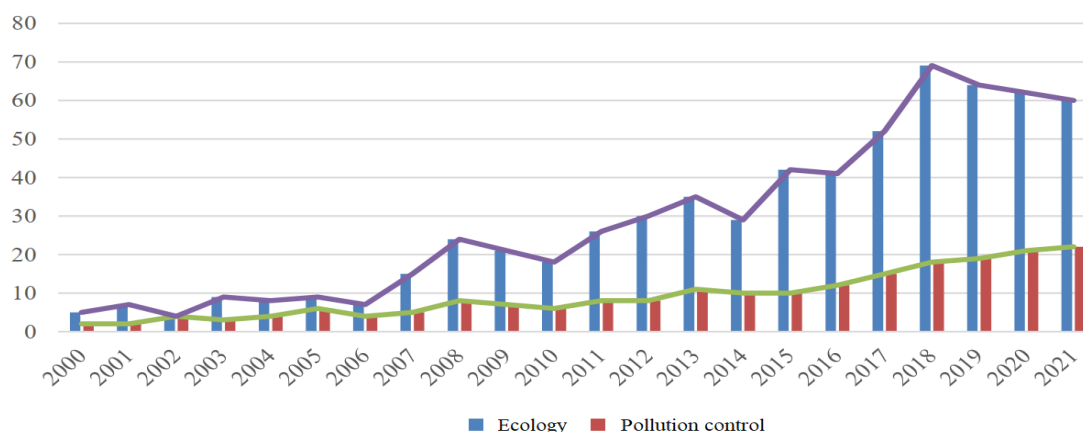


Fig. 2. Trends of ecology and pollution control prediction.

CONCLUSION

Vegetation and its role in ecological and environmental structure is paramount. Meanwhile, the forest society is the most developed and beautiful society of nature. Different sub-communities, such as trees, shrubs, bushes, plants, grasses, other birds and fungi, and water and soil, can form the links of the chain of nature. By analyzing the results of the present study, which was carried out using the tool of synonym analysis, it was determined that the most crucial gap and challenge in this research in the field of the concept of the urban green network is the connection between the concept of the urban green network as well as the dimensions and concepts of related environmental sciences. This research has paid attention to the gap and challenges of this issue and finally led to a comprehensive model in this field. Meanwhile, in this process, a set of essential and valuable information that will help entirely and comprehensively to reach this conceptual model has been investigated. In addition, by using this information, bases, dimensions, and concepts have been obtained. From the studied environmental sciences, a good understanding of the concept of the urban green network is obtained. Moreover, by using this knowledge, the high capacities and potentials of this concept can be used to improve the level of utilization of ecological and green areas and also to create optimal sustainability in cities. It is clear that the findings of this research can be applied in various geographical and climatic contexts, as well as in countries and cities with diverse environmental conditions. The future of urban ecology could be shaped by the practical approaches and solutions based on the dimensions and concepts of the urban green network. These findings could pave the way for feasible solutions to the challenges of contemporary urban development, offering reassurance for the strengthening and development of urban green infrastructures in an experimental and practical manner.

ACKNOWLEDGEMENTS

This research was funded by “Abai University in collaboration with foreign higher educational institutions grants for the implementation of international scientific projects. Order No 05-04/554 dated 07/30/2024.

REFERENCES

- Adams, B 2008, Green development: Environment and sustainability in a developing world. Routledge.
- Aithal, PS & Aithal, S 2016, Opportunities & challenges for green technology in 21st century. *International Journal of Current Research and Modern Education (IJCRME)*, 1: 818-828.
- Akhmetova, A, Mukhitdinov, N, Ydyrys, A 2015, Anatomical indicators of the leaf structure of *Ferula iliensis*, growing in the eastern part of Zailiyskiy Alatau (Big Boguty Mountains). *Pakistan Journal of Botany*, 47: 511-515.
- Akhmetova, AB, Mukhitdinov, NM, Ydyrys, A, Ametov, AA, Inelova, ZA, Öztürk, M 2018, Studies on the root anatomy of rubber producing endemic of Kazakhstan, *Taraxacum Kok-Saghyz* L.E. Rodin. *Journal of Animal and Plant Sciences*, 28: 1400-1404.
- Alpysbayev, KS, Gridneva, YE & Kaliakparova, GS 2021, “Green” Economy: Realities and Prospects in Agriculture. *The Problem in the Agricultural Market*, 3: 44-50.
- Bespalyy, S, Gridneva, Y & Kaliakparova, G 2023, Study of the current state, problems and potential of the waste management system affecting the development of the green economy of Kazakhstan. *Journal of Environmental Management & Tourism*, 14: 32-43.
- Bukenova, EA, Bassygarayev, ZM, Akhmetova, AB, Altybaeva, NA, Zhunusbayeva, ZK & Ydyrys, A 2019, Development of the method of obtaining the endogenic biostimulator from wheat green spike glumes. *Research on Crops*, 20. <https://doi.org/10.31830/2348-7542.2019.030>.
- Chatzimentor, A, Apostolopoulou, E & Mazaris, AD 2020, A review of green infrastructure research in Europe: Challenges and opportunities. *Landscape and Urban Planning*, 198: 103775.
- Diyar, S, Akparova, A, Toktabayev, A & Tyutunnikova, M 2014, Green economy–innovation-based development of Kazakhstan. *Procedia-Social and Behavioral Sciences*, 140: 695-699.
- Economy, G 2018, Realities and Prospects in Kazakhstan. World Bank Group, 32 p.
- Filippov, S, Mikova, N & Sokolova, A 2015, Green energy prospects: Trends and challenges. *International Journal of Social Ecology and Sustainable Development (IJSESD)*, 6: 1-20.
- Ivakhiv, A 2016, Green pilgrimage: Problems and prospects for ecology and peace-building. In: Pilgrims and Pilgrimages as Peacemakers in Christianity, Judaism and Islam. pp. 85-104. Routledge.

- Jan, WD, Justyna, K, Obid, T & Siew, QT 2015, August, Integration of local eco-innovation with global problems of protection of the natural environment and bio-based green economy. In: 2015 AASRI International Conference on Circuits and Systems (CAS 2015), pp. 25-28. Atlantis Press.
- Karatayev, M & Clarke, ML 2016, A review of current energy systems and green energy potential in Kazakhstan. *Renewable and Sustainable Energy Reviews*, 55: 491-504.
- Kovalchuk, S & Kravchuk, A 2019, The impact of global challenges on “green” transformations of the agrarian sector of the eastern partnership countries. *Baltic Journal of Economic Studies*, 5: 87-95.
- Kudelas, D, Domru, E, Stoianov, A & Peters, D 2018, International Experience, Principles and Conditions for the Transition to a “Green Economy”. In *E3S Web of Conferences*, 41: 04023. EDP Sciences.
- Kurpayanidi, K & Khamdamova, S 2024, Macroeconomic prospects and challenges: international business and green economy. In *E3S Web of Conferences*, 531: 05025. EDP Sciences.
- Onyusheva, I, Ushakov, D & Van, HT 2018, The eco-problems and green economy development in Kazakhstan: An analytical survey. *International Journal of Energy Economics and Policy*, 8: 148-153.
- Onyusheva, I, Ushakov, D, & Van, HT 2018, The eco-problems and green economy development in Kazakhstan: An analytical survey. *International Journal of Energy Economics and Policy*, 8: 148-153.
- Porfiriev, B 2022, Green economy: Realities, prospects, and limits to growth. Carnegie Endowment for International Peace.
- Pratikno, Yu, Soesilo, R, Prayoga, R, Endrawati, T & Limakrisna, N 2023, The integrated green supply chain and human resource management for sustainability. *Economic Annals-XXI*, 206: 36-40.
- Rakhimberdiev, IU, Urakov, RF, Artikova, RA, Ismatullaeva, NN & Seytbekova, ST 2024, Efficiency of the Green Economy: Monitoring Based on International Experience and Prospects for Improvement in Uzbekistan. In: Development of International Entrepreneurship Based on Corporate Accounting and Reporting According to IFRS, 33: 225-233. Emerald Publishing Limited.
- Rashid, MHU & Uddin, MM 2018, Green financing for sustainability: analysing the trends with challenges and prospects in the context of Bangladesh. *International Journal of Green Economics*, 12: 192-208.
- Reznikova, N, Zvarych, R, Zvarych, I & Shnyrkov, O 2019, Global circular e-chain in overcoming the global waste. *Procedia of Environmental Science, Engineering and Management*, 6: 641-647.
- Seilkhan, A 2024, An overview of green applications of natural products for pharmaceutical, biofuel, and rubber industries: Case study of Kazakh Dandelion (*Taraxacum kok-saghyz* Rodin.). *Energy & Environmental Science Journal*, 25. <https://doi.org/10.30919/esee1171>.
- Seilkhan, A, Abdrassulova, Z, Erkaebaeva, M, Soltan, R, Makhambetov, M, & Ydyrys, A 2022, Problems of distance education in Kazakhstan during the COVID-19 pandemic. *World Journal on Educational Technology: Current Issues*, 14: 380-389. <https://doi.org/10.18844/wjet.v14i2.6913>.
- Seilkhan, A, Mirzadinov, R, Aksoy, A, Abulgaziye, A & Kanat, G 2018, Assessment of recovery of medicinal plants of the Kurti district of the Almaty region, Kazakhstan. *Ecology Environment and Conservation*, 24: 1653-1658.
- Seilkhan, A, Syraiyl, S, Turganova, G, Satbayeva, E & Erkenova, N 2021, March, Determination of laboratory seed yield of *Artemisia schrenkiana* Ledeb and *Chorispora bungeana* Fisch. In: IOP Conference Series: *Environmental Earth Sciences*, 699: 012014.
- Seilkhan, R, Mirzadinov, IR, Mirzadinov, MA & Kizdarbekova 2016, Degradation of lands in central Asia. International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM.
- Susilowati, D, Lambe, KHP, Farid, M, Jumintono, & Dampa, D 2023, Investigating the parameters which influence green supply chain management in agricultural industry. *Economic Annals-XXI*, 206: 30-35.
- Tikhonova, I, Guseva, T, Averochkin, E & Shchelchikov, K 2021, Best available techniques and best environmental management practices: collaboration between industries and regions. *Procedia of Environmental Science, Engineering and Management*, 8: 495-505.
- Turgel, I, Bozhko, L, Ulyanova, E & Khabdullin, A 2019, Implementation of the smart city technology for environmental protection management of cities: The experience of Russia and Kazakhstan. *Environmental and Climate Technologies*, 23: 148-165.

- Ydyrys, A, Abdolla, N, Seilkhan, A, Masimzhan, M & Karasholakova, L 2020a, Importance of the geobotanical studying in agriculture (with the example of the Sugaty region) E3S Web of Conference, 222 04003. DOI: https://doi.org/10.1051/e3sconf/202022204_003.
- Ydyrys, A, Serbayeva, A, Dossymbetova, S, Akhmetova, A & Zhuystay, A 2020b, The effect of anthropogenic factors on rare, endemic plant species in the Ile Alatau. E3S Web of Conferences, 222. https://doi.org/10.1051/e3sconf/202022205_021.
- Ydyrys, A, Zhaparkulova, N, Aralbaeva, A, Mamataeva, A, Seilkhan, A, Syraiyl, S & Murzakhmetova, M 2021, Systematic analysis of combined antioxidant and membrane-stabilizing properties of several Lamiaceae family Kazakhstani plants for potential production of tea beverages. *Plants*, 10: 666, <https://doi.org/10.3390/plants10040666>.
- Zhexenbay, N, Akhmetsadykova, S, Nabiyeva, Z, Kizatova, M & Iskakova, G 2020, Using pectin as heavy metals detoxification agent to reduce environmental contamination and health risks. *Procedia of Environmental Science, Engineering and Management*, 7: 551-562.

Bibliographic information of this paper for citing:

Seilkhan, A, Beken, A, Shicheng, Z, Jiang, GS, Yussubaliyeva, M, Idrisheva, Z, Zhamanbayeva, M, Bukunova, A 2024, Challenges and prospects of the green ecology in Kazakhstan based on international experience, *Caspian Journal of Environmental Sciences*, 22: 971-979.