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Digital and Economic Transformation in the Public Administration System

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ABSTRACT

In the context of rapid development of digital technologies and economic changes, the relevance of the research is emphasized by the need to adapt the public administration system to the new challenges and opportunities brought by digital transformation, aimed at improving the efficiency of economic processes and ensuring sustainable development, requiring a comprehensive understanding by researchers to propose holistic strategies that contribute to the development of both public administration and the economy as a whole. In this direction, Kazakhstan is actively developing and implementing geoinformation systems for accounting, monitoring and analyzing natural resources, which allow collecting and storing geospatial data on natural objects, including mineral deposits, water resources, natural reserves and others. Digitalization in the sphere of natural resources of the Republic of Kazakhstan is aimed at improving management efficiency, reducing risks and increasing transparency in the use of natural resources, contributing to the strategy of sustainable economic development and conservation of the country's natural resources. Digital and economic transformation in the public administration system is closely related to the economy, providing new opportunities for more efficient management and stimulating the growth of economic activity, requiring not only the introduction of technology, but also appropriate legal regulation to ensure the sustainability and efficiency of processes. The purpose of the study of digitalization of public administration in the context of transformation of the economy of the Republic of Kazakhstan is to assess the impact of digitalization on sustainable development, including analysis of economic, environmental and social indicators, identification of best practices and recommendations for

INTRODUCTION

In the context of transformational change, the introduction of digital technologies, in particular in the field of environment and natural resources, has a great impact on the economy, contributing not only to sustainable development, but also to increasing efficiency, stimulating innovation and the formation of new environmentally oriented markets. The development of digital tools contributes to better forecasting of environmental risks and to shaping public strategies for sustainable development. The creation of digital platforms and technologies can stimulate the emergence of new, greener technologies and solutions, which in turn can create new economic opportunities and improve production efficiency. The use of digital monitoring and reporting systems ensures the availability of information for society and business, which contributes to the formation of a responsible approach to the digitalization of public administration in the context of economic transformation.

Sustainable development and increased transparency in the context of digitalization of public administration in the field of ecology, geology and natural resources is relevant and strategically important for many countries in the modern world. In this context, digitalization, as the use of modern information technologies and digital solutions, plays a decisive role in achieving sustainable development and improving transparency in these areas. The relevance of studying the digitalization of public administration in the field of ecology, geology and natural resources is undeniable in the modern world and this is due to a number of factors: a) Growth in environmental consumption. Increasing population and growing consumer demands require more efficient use of natural resources and environmental protection; b) Climate transformation. Changing climate conditions challenge countries to adapt and mitigate impacts, which requires accurate information and analysis; c) Transparency and openness. The public demands greater transparency and participation in natural resource management and environmental protection processes; and d) Technological capabilities. Modern digital technologies allow information to be collected, analyzed and disseminated more efficiently, creating unique opportunities for improved management (Kiselakova et al. 2022; Kurniawati et al. 2022). This study is to assess the impact of digitalization on sustainable development and increasing transparency in the field of ecology, geology and natural resources using the example of the Republic of Kazakhstan and is aimed at considering the following tasks:

- study of experience and examples of successful digitalization in these areas;
- analysis of the impact of digital solutions on natural resource management processes;
- assessment of changes in transparency and accessibility of information to the public;
- formulating recommendations for further improvement of management processes in these areas.

Research on this topic helps to assess the impact of digital technologies on achieving sustainable development and improving transparency in the management of natural resources and the environment. This is important not only for strategic planning, but also for ensuring the well-being of current and future generations and preserving the environment.

1. LITERATURE REVIEW

Foreign research in the field of digitalization of public administration in the field of ecology, geology and natural resources as a principle of sustainable development and an element of increasing transparency plays an important role in expanding knowledge and experience in this area and contributes to more efficient use of resources and environmental protection on a global scale. J. Poore and T. Nemecek, (2018) assesses and analyzes greenhouse gas emissions associated with agriculture and provides information on the importance of agriculture as a source of greenhouse gas emissions, suggesting methods and strategies to reduce these emissions. M. Springmann et al. (2018) discusses environmental obligations and measures that can be taken to fulfill them, which include reducing greenhouse gas emissions and other actions aimed at environmental sustainability. Both sources are related to the issue of agriculture and its impact on the environment. The results of such research can be useful in developing policies and practices to reduce the impact of agriculture on climate change and other environmental issues.

These publications highlight the importance of considering different greenhouse gases and their impact on climate change when developing strategies to reduce emissions and achieve environmental commitments. Many studies that examine the impact of agriculture on climate change often miss or incorrectly account for important principles, one of which is that greenhouse gases such as methane (CH₄) and nitrous oxide (N₂O) have different impacts on climate compared to carbon dioxide (CO₂). For example, methane is a more powerful greenhouse gas, but its climate impact period is shorter. Understanding these differences helps develop more precise emission reduction strategies: a) significant attention to the problems of climate change has led to many countries and organizations making commitments to reduce greenhouse gas emissions. These commitments could include both CO₂ emissions reductions and CH₄ and N₂O emissions reductions, taking into account their different impacts; b) the Paris Climate Conference agreement sets a goal of limiting global warming to below 2 °C above pre-industrial levels, preferably 1.5 °C. Understanding the differences in the impacts of greenhouse gases helps design policies to achieve this goal; c) the need to achieve net-zero CO₂ emissions by 2050 and reduce global emissions by 45% by 2030 underscores the urgency and ambition of action. This requires not only reducing CO₂ emissions, but also taking other greenhouse gases into account; and climate change is already leading to catastrophic consequences such as extreme weather events, rising sea levels and loss of biodiversity. Action to reduce greenhouse gas emissions today can mitigate these impacts and protect people and ecosystems.

Research and analysis of data on emissions of various greenhouse gases play an important role in developing science-based strategies and policies to combat climate change and achieve environmental commitments. This provides the basis for making informed decisions that can have a real impact on improving the environment and reducing the impact of climate change. Sustainable development has long been a key topic of research and discussion in the world's scientific literature and public debate. Researchers such as A. Carman (2019), V. Strezov et.al. (2018) are actively developing the concept of sustainable development and considering it as an alternative to the traditional concept of economic growth. Such studies typically consider several key aspects, including: a) Integrative approach – considers sustainable development, which implies an integrative approach to development and takes into account economic, environmental and social aspects. Researchers emphasize the need to balance these requirements and suggest ways to integrate these aspects into development strategies; b) Reducing environmental impact considers a key aspect of sustainable development - reducing negative environmental impacts, including reducing greenhouse gas emissions, reducing environmental pollution and preserving biodiversity. Researchers propose methods and technologies that help achieve these goals; c) Economic efficiency - sustainable development does not exclude economic growth, but emphasizes the need for more sustainable and resource-saving forms of development. Researchers are analyzing cost-effectiveness models that take into account the cost of environmental damage; d) Social equality and justice, where an important aspect of sustainable development is ensuring social justice and taking into account the interests of all segments of society. Researchers study the social dimensions of development and propose strategies that promote sustainability and equity; and e) Sustainable development is also seen in the context of global challenges such as climate change, declining natural resources and threats to biodiversity. Researchers are developing strategies to adapt to and mitigate such challenges.

A study conducted by K. Stamkulova and M. Stamkulova (2022), assessing anthropogenic pressure on the atmosphere and water resources in agricultural production, represents an important contribution to the field of ecology and assessment of the impact of human activities on the environment. The work analyzes equivalent indicators, which makes it possible to assess the impact of various stages of agricultural production on the environment. The results of such a study are of practical importance, since they can be used for: a) decision making - the data obtained can serve as the basis for decision-making in the field of agriculture and ecology. Human impact assessments can help identify vulnerabilities and consider alternative methods and technologies for agricultural production; b) planning and management - the results of the study can be included in strategies and plans for resource and environmental management in agriculture. This can help agricultural businesses and authorities make more informed decisions; c) compliance with norms and standards - the study can help assess the compliance of agricultural operations with environmental safety norms and standards and suggest measures for compliance; d) forecasting and planning of environmental safety - the study can be used to predict changes in the environmental safety of agriculture and develop measures to improve it; and e) environmental conservation - analysis of anthropogenic pressure can help identify the most environmentally efficient approaches to agricultural production and ways to reduce negative impacts on the atmosphere and water resources.

These findings and recommendations have the potential to improve agricultural sustainability and promote more environmentally friendly production of food and resources. As a result, the influence of innovation policies, where environmental protection is an important factor, is increasing. One of the factors for ensuring the sustainable development of industrial enterprises in modern conditions is the identification, support and stimulation of their environmental and innovative projects, since many industrial enterprises pay insufficient attention to environmental measures and the introduction of environmental innovations, constantly faced with a choice between economic efficiency aimed at maximizing profit, and environmental feasibility associated with compliance with existing regulations and obligations. In his research A. Semin (2018) considers institutional mechanisms for increasing the productivity of scientific research in the field of developing innovative products, which consists in improving environmental protection, since the environment affects not only the number of aspiring entrepreneurs at the population level, but also cultural, economic and market factors that collectively enhance or inhibit entrepreneurship (Busenitz et al., 2023). N. George et al. (2018) show how environmental conditions create and moderate the relationships between individual behavior and opportunity recognition.

Innovation factors have indeed become key in the economies of many countries in recent decades. This is due to a number of factors and trends that have updated and strengthened the role of innovation:

- the rapid development of information technology, biotechnology, artificial intelligence and other areas has become the driving force of innovation. These technologies provide enormous opportunities to create new products and services, optimize production processes and improve the quality of life;
- growing concerns about climate change and the depletion of natural resources have created a need to develop environmentally efficient technologies and production methods. Greening has become an important factor in innovative development;
- digitalization of all aspects of society and the economy has created enormous opportunities for improving management processes, communication and service provision, as a result of which it has stimulated innovation in the digital sphere, including the digitalization of public administration in the field of ecology.

The mentioned studies by J. Huang and Z. Wu (2022), as well as the study by X. Shi et al. (2018) highlight the important role of strong environmental regulation in stimulating enterprise innovation and improving trade competitiveness. This is a key to achieving a triple win-win situation that promotes sustainable development, environmental sustainability and foreign trade growth. Due to different levels of economic development in different countries, developed countries are paying more attention to sustainable development and implementing stricter and better environmental regulations Tanaka et al. (2022). An increasing number of countries are including environmental factors in an important part of the state regulation process (Baghdadi et al. 2022; Usman and Hammar, 2021; Kot, 2023). Improving state policy in the field of innovative development and its direction towards the creation and active implementation of innovations in the field of greening and environmental protection are of key importance for the sustainable development of Kazakhstan and its participation in global competition. In the context of the Republic of Kazakhstan, the development of digital solutions in the field of ecology and management natural resources can help the country more effectively solve environmental problems, ensure sustainable environmental management and strengthen the transparency of government processes, which, in turn, contributes to the sustainable development of the Republic of Kazakhstan.

2. METHODOLOGY

Digitalization of public administration in the field of ecology, geology and natural resources is key to achieving sustainable development and increasing transparency in this area. The example of the Republic of Kazakhstan illustrates how digital innovation can positively impact natural resource management and environmental protection (Figure 1). According to Figure 1, the impact of digitalization on natural resource management and environmental protection is manifested as follows: a) Effective management of natural resources. Kazakhstan is actively implementing digital technologies to monitor and manage its natural resources, such as oil, gas, coal, minerals and water resources. This includes the use of geographic information systems (GIS), sensor networks and cloud technologies to collect and analyze data on the state of natural resources; b) Increased transparency. Digitalization promotes more open and accessible dissemination of data on the state of the environment and the use of natural resources. This helps combat

corruption and provides citizens with the means to monitor the activities of government agencies and corporations; c) Sustainable development. Digitalization helps balance economic growth with environmental protection. Data analysis and modeling make it possible to predict the impact of natural resource exploitation on the environment and develop measures to eliminate negative consequences; d) Process optimization. Digital solutions automate and streamline routine processes such as issuing permits and licenses for natural resource extraction, reducing bureaucratic burdens and increasing efficiency; e) Data collection and analysis. Digital tools provide the ability to continuously collect and analyze data on environmental parameters, allowing you to quickly respond to changes in the environment and make decisions based on evidence; f) Promoting innovation. Digitalization of the natural resources and environmental sector promotes innovation in clean technologies, energy conservation and environmental sustainability; and g) Electronic services for citizens and enterprises. The introduction of electronic services, such as online application for permits and obtaining information on the state of the environment, makes the interaction of citizens and businesses with government agencies more convenient and efficient.

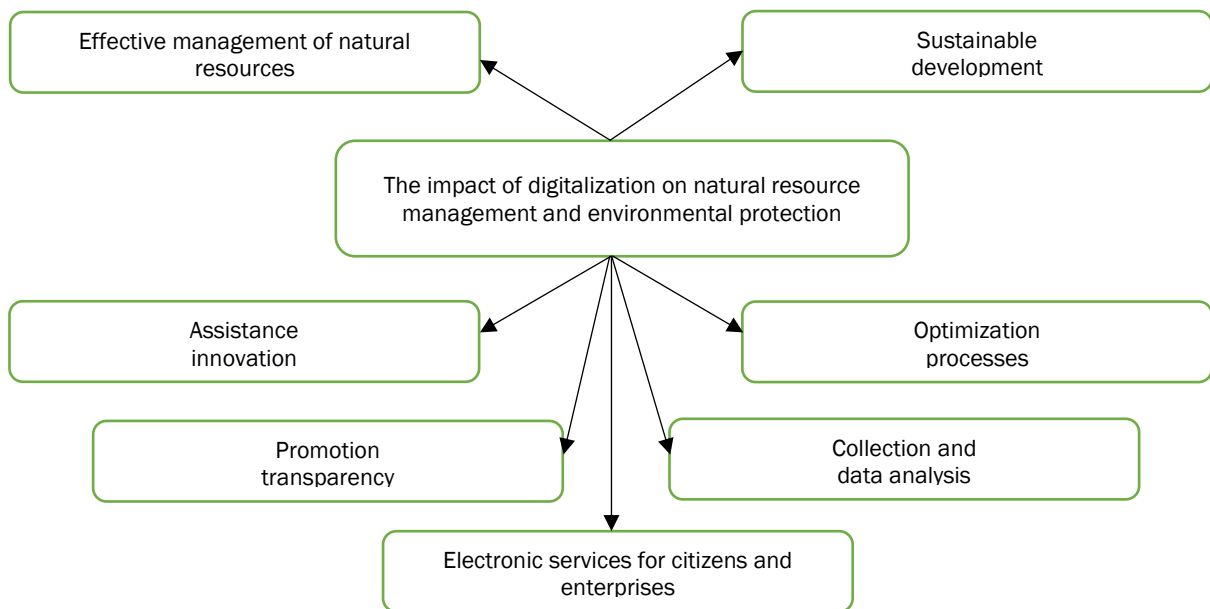


Figure 1. Impact of digitalization on natural resource management and environmental protection
Source: compiled by authors

The Republic of Kazakhstan is actively developing and implementing digitalization programs in the field of ecology, geology and natural resource management, which contributes to sustainable development and improved transparency in this area. These efforts help to better manage natural resources and ensure their conservation for future generations. Sustainable development is a strategic approach to development that takes into account the needs of current and future generations, as well as the impact of economic growth on the environment and social well-being. In the field of ecology, geology and natural resources, sustainable development includes the following aspects (Figure 2). Achieving “digital maturity” of the industry is impossible without improving the public administration system, increasing the efficiency of accounting for natural objects as objects of property rights and their characteristics, studying and reproducing natural resources, increasing the efficiency of government supervision based on the development of domestic industry software systems and information technologies, creating a unified digital platforms for integrating domestic software into a single information space and involving industry specialists in the digital transformation of the industry. According to Figure 2, sustainable development in the field of ecology, geology and natural resources includes the following aspects: a) Sustainable development considers the needs of current and future generations, as well as the impact of economic growth on the environment and social well-being; b) Digitalization of public administration implies the use of modern digital technologies and tools to improve decision-making processes and the provision of public services; and c) Increasing transparency in natural resource and environmental management means ensuring the availability of

information, open decision-making processes and public involvement. The introduction of modern digital solutions and the development of information technologies in this area can bring many benefits (Table 1).

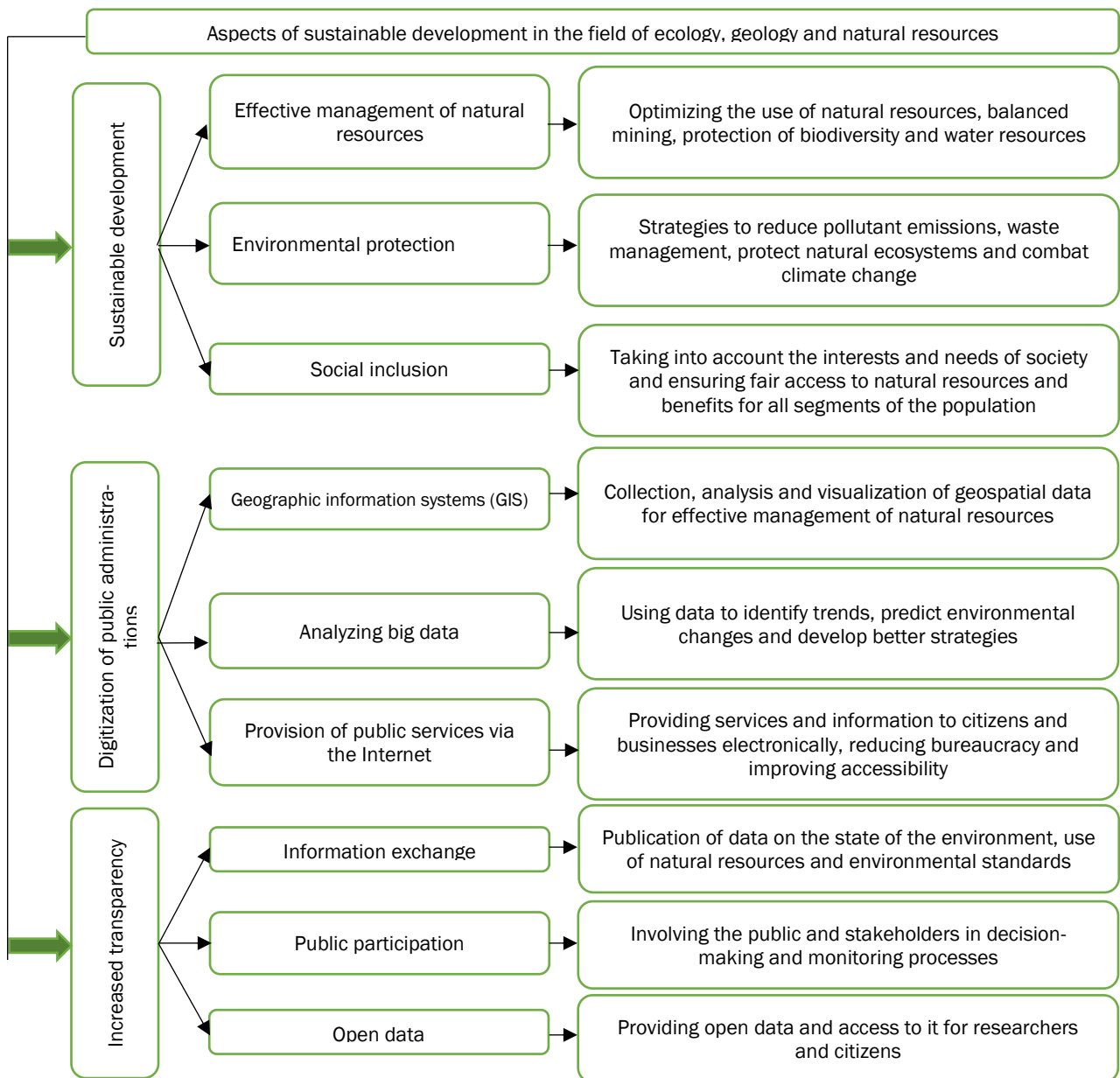


Figure 2. Aspects of sustainable development in the field of ecology, geology and natural resources
Source: compiled by authors

Table 1. Introduction of modern digital solutions and development of information technologies in natural resource management

<i>Nº</i>	<i>Digital solutions</i>	<i>Rationale</i>	<i>Opportunity</i>
1	Improved resource management	digital systems and tools allow for more accurate and efficient accounting of natural resources, their condition and use	provides better planning and resource management
2	Increased transparency	digital transformation can make all processes related to natural resources and ecology more transparent and accessible to society	citizens and stakeholders can receive up-to-date information on the state of the environment and resource use

3	Optimization of supervision and control processes	the use of digital technologies allows you to automate the processes of supervision and control in the field of natural resources and ecology	increases efficiency and reduces the risk of violations
4	Data Integration	digital transformation allows you to combine data from different sources and systems	promotes more comprehensive analysis and informed decision making
5	Stakeholder participation	involvement of specialists and the public in digital platforms and systems	allows to gather expert opinion and attention to important environmental issues
6	Development of domestic information technologies	digital transformation of the natural resources and ecology industry	promotes the development of domestic IT companies and innovative solutions
7	Promoting sustainable development	digital transformation in this area helps to achieve a balance between economic interests and preservation of the natural environment	promotes sustainable development

Source: compiled by authors

The creation of a unified digital platform and the integration of industry software systems are important steps towards the digital transformation of the sphere of natural resources and ecology. This allows you to optimize the use of resources and ensure more efficient management. Forming a digital maturity strategy in the ecology and environmental management industry implies the development and implementation of an action plan to enhance digital transformation and increase the level of readiness of this industry for the effective use of modern information technologies and digital solutions. The definition of the ecology and environmental management sector in this strategy may include the following aspects: a) study, use, reproduction and protection of natural resources; b) land relations related to the transfer of lands of the water fund, forest fund and lands of specially protected territories and objects; c) area of the forest complex; d) tasks of state hunting supervision in terms of identifying, preventing and suppressing violations of requirements in the field of hunting and conservation of hunting resources; e) development of state policy and legal regulation in the field of treatment of animals; f) activities in the field of hydrometeorology and related areas, monitoring the state and pollution of the environment; g) state environmental monitoring; h) development and implementation of state policy and legal regulation in the field of environmental protection and environmental safety; i) management of production and consumption waste, including in the field of municipal solid waste management; j) protection of atmospheric air; and k) preservation and development of the system of specially protected natural areas, increasing the efficiency of public administration in this area, protecting and ensuring the functioning of specially protected natural areas. Thus, the process of managing the digitalization of ecology and environmental management can be outlined as follows (Table 2).

Table 2. Management process of digitalization of ecology and environmental management

<i>№</i>	<i>Digital solutions</i>	<i>Rationale</i>
1	Goals and objectives of the digital maturity strategy	improving the efficiency of natural resource management
		improvement of environmental monitoring and control
		reducing the negative impact on nature and others
2	Scope	environmental protection
		natural resource management, protection of the diversity of living organisms, geological research
		compliance with environmental standards
3	Current state	assessment of the level of use of digital technologies
		availability of modern information systems
		data availability, etc.
4	Defining the potential for digital transformation	benefits that can be achieved through digital innovation
5	Strategic directions	development of geographic information systems
		creation of digital platforms for environmental monitoring
		improving data collection and analysis processes and much more
6	Infrastructure and resources	investment in information technology
		personnel training, database creation, etc.
7	Monitoring and evaluation	mechanism for monitoring and assessing progress in implementing the strategy

		indicators to measure the digital maturity of the industry
8	Stakeholder Engagement	government agencies, enterprises, society and environmental activists
9	Social inclusion	fair access to digital solutions in this industry
10	Risk management	cybersecurity and data privacy

Source: compiled by authors

The goal of a digital maturity strategy in the environmental and environmental management industry should be to create fundamental changes in the way natural resources and environmental protection are managed using modern digital technologies and innovative approaches.

The information that the United Nations Development Program in Kazakhstan in 2022 has a portfolio of 45 projects, including global and regional initiatives aimed at maintaining the environmental situation and environmental protection, indicates the significant activity of the organization in this country in areas of sustainable development and environmental protection. Such projects may include a number of initiatives, for example: a) Protection of biodiversity. Projects aimed at preserving and restoring biodiversity in various regions of Kazakhstan. This may include the creation of nature reserves, protected areas and programs to protect vulnerable species; b) Reduction of greenhouse gas emissions. Projects that aim to reduce greenhouse gas emissions and combat climate change include supporting alternative energy sources and improving energy efficiency. c) Control over water resources. Projects to improve water resources management, including water conservation, protection of aquatic ecosystems and ensuring access to clean drinking water; d) Promoting sustainable rural development. Initiatives aimed at supporting rural communities in the Republic of Kazakhstan, including the development of sustainable agriculture and the protection of rural nature; and e) Education and awareness. Projects aimed at educating and informing society about the importance of environmental protection and sustainable development.

Such projects can help improve the environmental situation, reduce negative impacts on the environment and contribute to sustainable development in Kazakhstan (Figure 3).

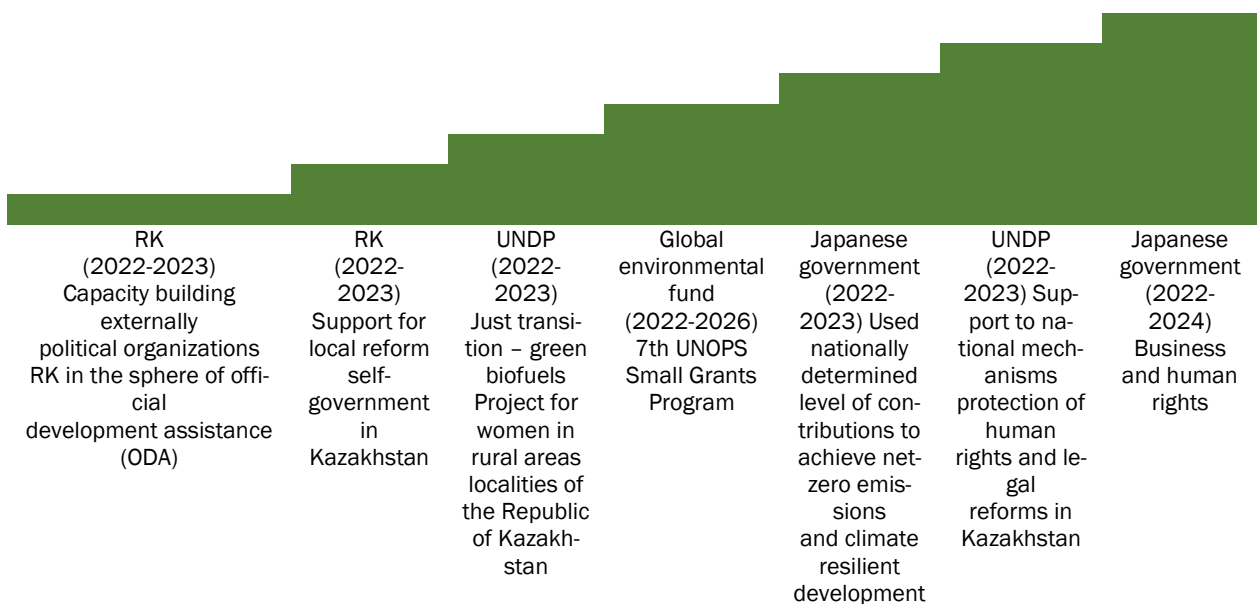


Figure 3. Development of programs to support ecology and environmental protection

Source: compiled by authors according to <https://www.undp.org/>

The UN Development Program actively cooperates with the government of Kazakhstan and other interested stakeholders to implement such projects.

3. ANALYSIS AND RESULTS

The historically established administrative-territorial structure of the republic and non-uniform natural and climatic conditions determine to varying degrees the combination and structure of the land fund by category of land in the regions of the country. The changes that have occurred in the areas of land categories are explained by the transfer of land from one category to another - in connection with the provision of land plots for various purposes and the clarification of their areas as a result of ongoing inventories and clarification of lands (Table 3).

Table 3. Distribution of land by category by region

Region	Land category							Total lands
	Agricultural purposes	Settlements	Industry, transport, communications and other non-agricultural purposes	Specially protected natural areas	Forest Fund	Water Fund	Stock	
Akmola	10914,0	1371,5	109,0	519,0	514,8	200,8	982,9	14612,0
Aktuibinsk	12552,6	4024,7	196,5	1177,5	221,0	13,1	11399,7	29585,1
Almaty	8623,8	723,0	251,8	1642,7	3750,6	192,1	7173,2	22357,2
Atyrau	3057,2	677,2	230,7	156,5	56,0	20,5	7540,0	11738,1
East Kaz.	12256,5	2947,1	138,3	1688,2	2153,9	571,1	8591,5	28346,8
Zhambyl	4693,0	672,2	175,0	11,6	4429,1	356,1	1601,2	11938,2
West Kaz.	7755,8	2288,3	47,3	12,4	217,0	81,5	3267,9	13670,2
Karaganda	18037,0	4121,4	181,2	550,3	190,2	50,0	13127,4	36257,5
Kyzylorda	2922,3	838,3	262,5	163,5	6510,5	2285,9	11124,8	24110,8
Kostanay	10838,0	1626,7	108,6	742,3	456,7	67,9	5759,9	19600,1
Mangystau	3422,6	1085,6	239,4	223,4	254,2	11,8	11327,2	16564,2
Pavlodar	7124,4	1832,6	121,0	357,9	126,0	78,9	2829,7	12470,5
North Kazakhstan	7287,5	1016,4	66,2	134,9	545,2	142,4	611,7	9804,3
Turkestan	4475,7	799,4	108,6	430,5	3009,7	134,4	2652,0	11610,3
Shymkent city	-	116,3	-	-	-	-	-	116,3
Almaty city	-	68,3	-	-	-	-	-	68,3
Astana city	0,8	79,7	-	-	0,4	-	-	80,9
Total	113961,4	24288,7	2239,1	7810,7	22435,3	4206,5	87989,1	262930,8

Source: compiled by authors according to <https://www.gov.kz/>

Industrial facilities of transport, communications, defense and other non-agricultural purposes in many cases have a negative impact on the condition of lands, causing their pollution and deterioration of the environmental situation in the country. In this regard, it is necessary to constantly monitor changes in the condition of the lands of industrial enterprises, military training grounds, oil and gas pipelines, and surrounding areas, and to promptly carry out reclamation of disturbed lands. Agriculture is the third largest contributor to total emissions of gases that negatively affect the greenhouse effect. At the beginning of 2022, agriculture generates two types of gases: methane and nitrogen oxide (Figure 4).

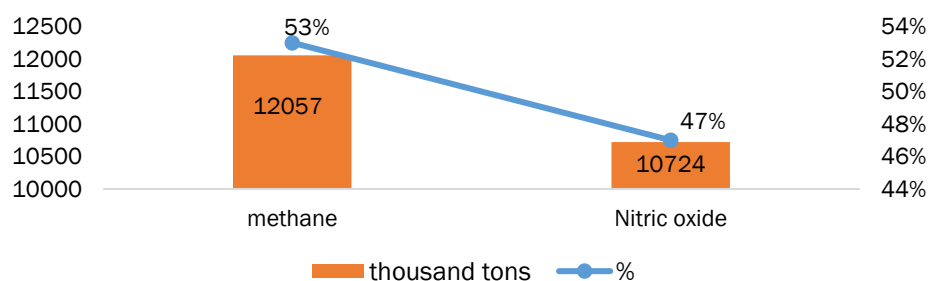


Figure 4. Contribution of agriculture to total gas emissions

Source: compiled by authors according to <http://www.kazhydromet.kz>

In the structure of methane emissions at the beginning of 2022, livestock production has the largest share (96%). The remaining 2% of methane emissions in agriculture, come from rice fields and from burning crop residues in the fields. As for nitrogen oxide emissions, agricultural activities related to soil management play the main role (97% of total N2O emissions). Manure and crop residue burning account for 1.9% and 0.7%, respectively (Figure 5).

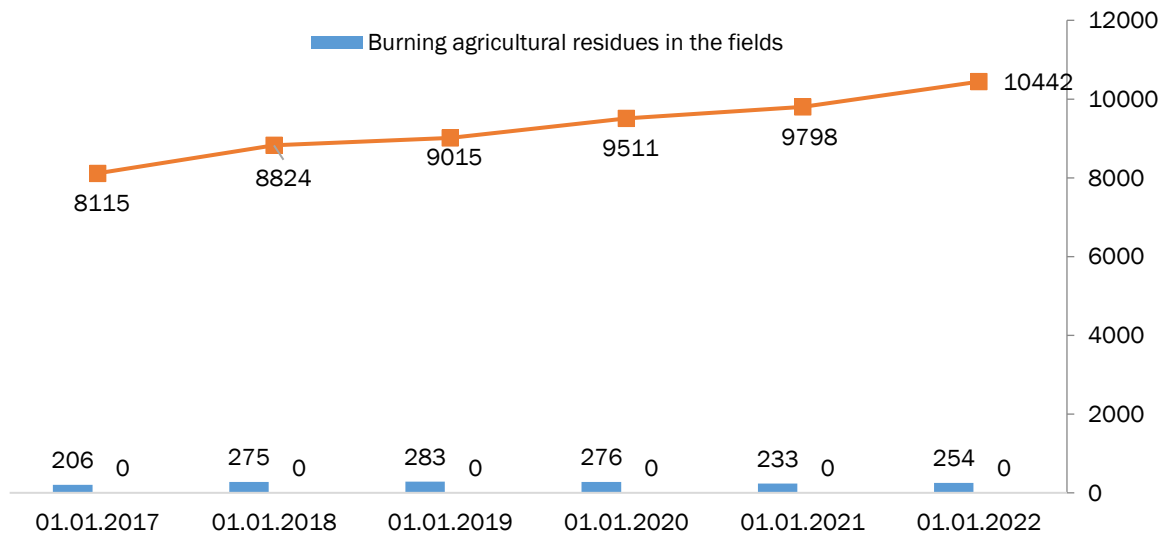


Figure 5. GHG emissions from the “Agriculture” category, thousand tons of CO2 eq.

Source: compiled by authors according to <http://www.kazhydromet.kz>

Recent changes in land use have led to both increases and decreases in CO2 emissions. At the beginning of 2022, net carbon sequestration in this sector was 1,431 thousand tons, which is only 0.6% of the total greenhouse gas emissions in the country. A graphical representation of the estimate of carbon emissions and sequestration from land use and land use change can be seen in Figure 6.

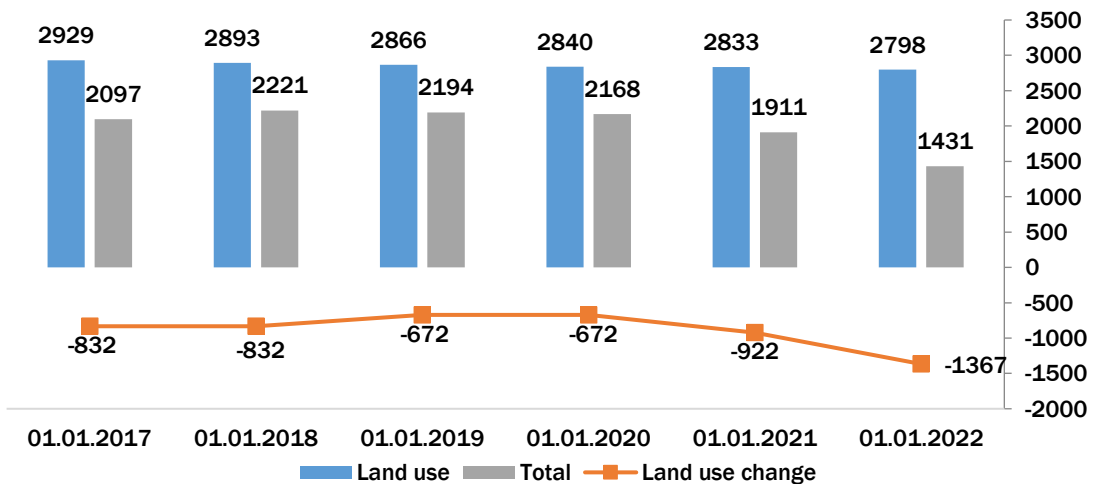


Figure 6. Emissions/sinks from categories of pollutants in Kazakhstan, thousand tons of CO2

Source: compiled by authors according to <http://www.kazhydromet.kz>

The increase in carbon sequestration is positive (+) and negative (-). The main decrease in carbon dioxide accumulation is due to the cutting of orchards, and changes in the use of agricultural land for pasture have also led to a small decrease in carbon sequestration. Kazakhstan needs a clear climate change adaptation strategy and a specific chapter in the country's commitments under the Paris Agreement. This means that adaptation measures should be prioritized in the national programs and legislation of

Kazakhstan. Thus, for information, as of January 1, 2022, organizations and private entrepreneurs engaged in agriculture attracted loans totaling 385.3 billion tenge, which is 52.1% or 132 billion tenge more than in the same period of the previous year (Figure 7).

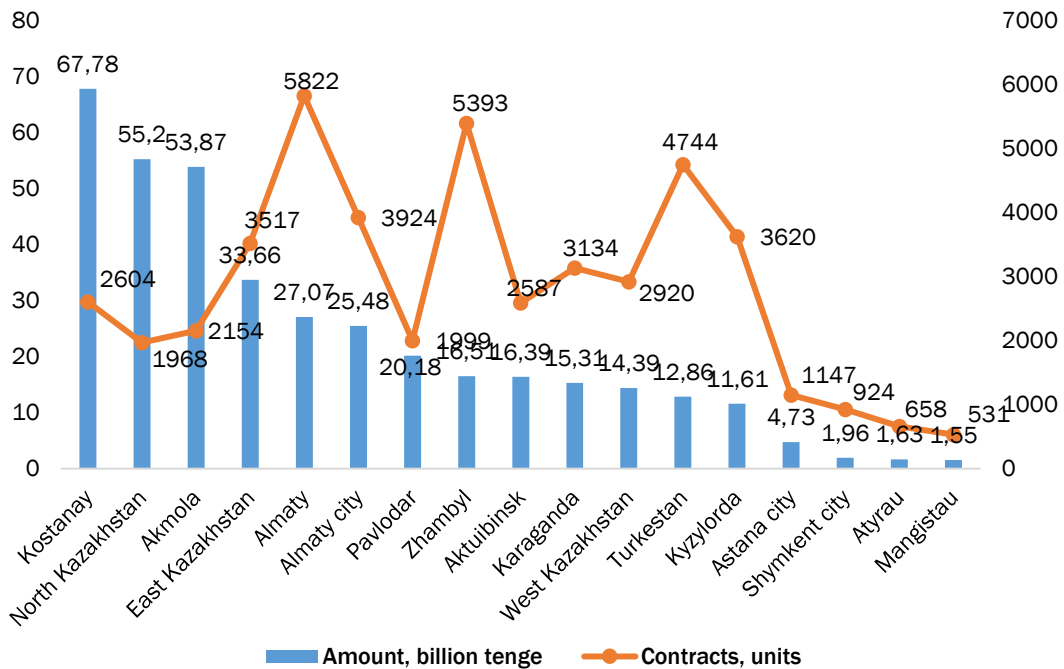


Figure 7. Financing for agricultural needs of SMEs of the Republic of Kazakhstan in the regional aspect

Source: compiled by authors according to [www.https://www.1cb.kz/](https://www.1cb.kz/)

Financing through the Agrarian Credit Corporation, the Fund for Financial Support of Agriculture and subsidiaries KazAgro and Baiterek is a common practice in supporting agriculture and agricultural projects. These organizations provide various types of financial support, including loans, subsidies, guarantees and other support measures for agricultural enterprises. As a result, we can observe an increase in budgets and results of programs implemented through the Damu Fund (Figure 8).

Excessive pressure on the environment can cause serious environmental problems, and investments in environmentally sustainable projects and agriculture can help mitigate these impacts and promote sustainable development. Key to the successful implementation of such programs is the effective management of financial resources, monitoring and evaluation of results, and collaboration with stakeholders, including agricultural producers, community organizations and the academic community. The growth of budgets and results of programs implemented through the Damu Fund (National Development Fund of the Republic of Kazakhstan "Samruk-Kazyna"), aimed at agricultural needs and maintaining the level of environmental conditions and environmental protection, can have a significant positive impact on the development of the country in several aspects: a) Investments in agriculture help increase food production and provide the country's population with high-quality and affordable products. This is important for food security; b) Supporting environmentally sustainable agricultural practices and environmental conservation helps conserve natural resources and reduce negative impacts on ecosystems; c) Investment in agriculture can help develop infrastructure and services in rural areas, which improves quality of life and promotes rural retention; d) Agricultural development and support for environmentally sustainable projects can contribute to economic growth and job creation; e) Supporting agricultural producers and products can contribute to the export of agricultural goods and strengthen the country's position in the world market; and f) Agricultural development and support for rural communities contribute to social stability and help improve the living conditions of the population.

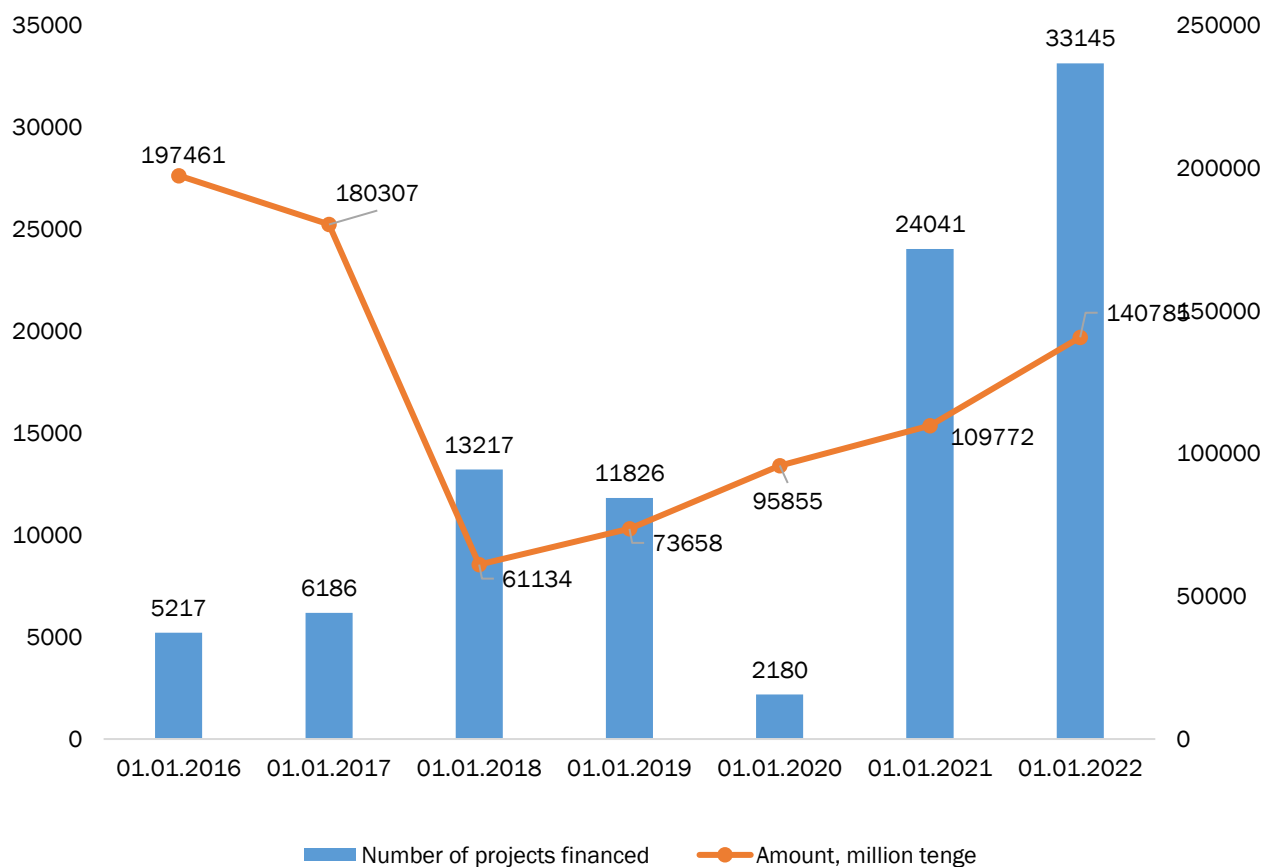


Figure 8. Growth of budgets and results of programs implemented through the Damu Fund

Source: compiled by authors according to <https://damu.kz/>

To achieve sustainable and successful development of large enterprises in new geopolitical conditions, it is important to pay special attention to the development of industries in which these companies actively operate. This includes improving technology, innovation, improving the quality of products and services, increasing productivity and efficiency, and the environmental impact of production. However, there are serious problems that agricultural production constantly faces (including climatic conditions), as well as its specific features, which increase the lag of enterprises in the application of modern management tools.

Land productivity and land use in the Republic of Kazakhstan are important for the sustainability of natural resources and the environment (Figure 9).

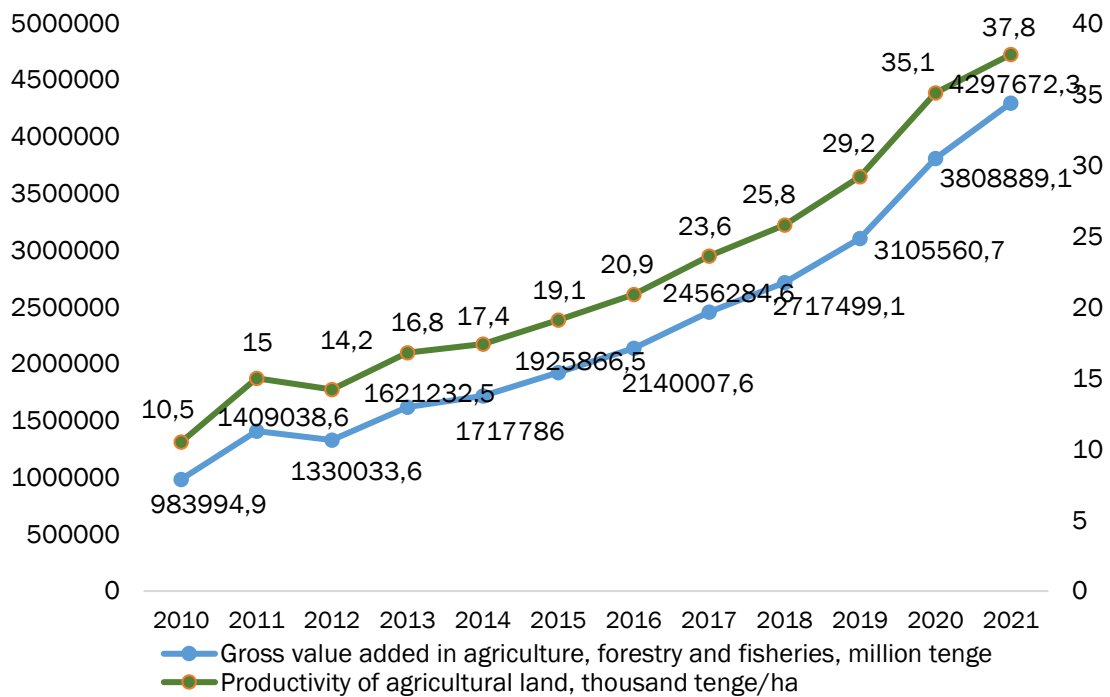


Figure 9. Indicators characterizing land productivity in the Republic of Kazakhstan

Source: compiled by authors according to <http://www.stat.gov.kz>

Changing land productivity and its impact on natural resources and the environment requires a balance between economic needs and environmental sustainability. This can be achieved through sustainable land management, compliance with environmental standards and the development of sustainable practices in agriculture and construction.

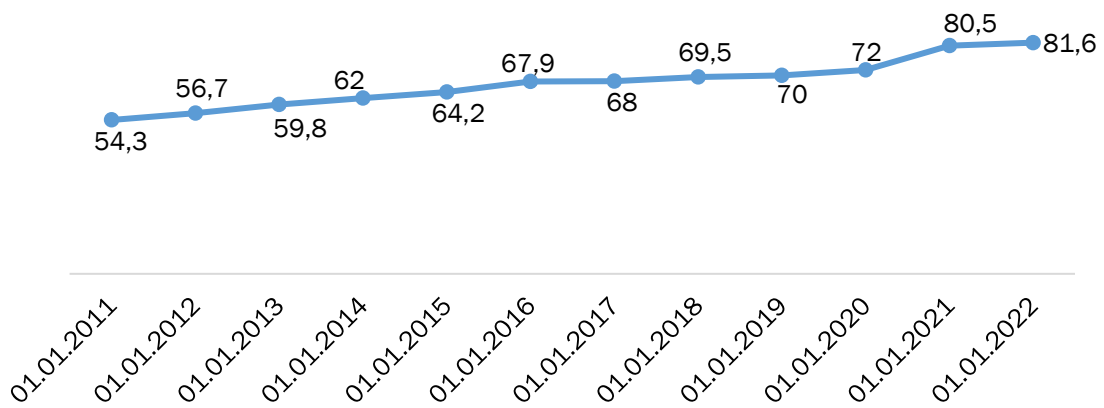


Figure 10. Final electricity consumption by agriculture/forestry, thousand tons of oil equivalent

Source: compiled by authors according to <http://www.stat.gov.kz>

The development of a methodology for classifying regions according to the level of technological development and the introduction of digital technologies aimed at improving the environmental situation would make it possible to develop and implement various packages of measures to promote technological and scientific modernization in regions with different levels of technological equipment. This will help determine which regions require more active implementation of modern technologies to solve environmental problems, and what measures can be most effective. The creation of an environmentally friendly agricultural waste recycling system combined with an updated process is a breakthrough in the field of energy efficiency, as evidenced by data on electricity consumption in agriculture (Figure 10).

4. APPLICATION FUNCTIONALITY

To determine the forecast values of the indicator “Final consumption of electricity in agriculture/forestry” for 2023-2025 a trend model was built.

Table 4. Checking for anomalous observations in a time series

Year	Observed value of Irwin's criterion	Calculation formulas
01.01.2011		Observed value of Irwin's criterion $\lambda_t = \frac{ y_t - y_{t-1} }{\sigma_y}, t = \overline{2, 11}$
01.01.2012	0,397	
01.01.2013	0,513	
01.01.2014	0,364	
01.01.2015	0,364	Critical value of Irwin's criterion $\lambda_{0,05} = 1,5$
01.01.2016	0,612	
01.01.2017	0,017	
01.01.2018	0,248	
01.01.2019	0,083	
01.01.2020	0,331	
01.01.2021	1,407	
01.01.2022	1,497	

Source: compiled and calculated by authors

During the analysis, it was found that the time series under consideration contain a trend component.

a) the summary presentation of the criterion for “ascending” and “descending” sequences (to identify a trend, it is enough to violate at least one inequality) is formulated as follows:

$$v(n) > \left[\frac{2n-1}{3} - 1,96 \sqrt{\frac{16n-29}{90}} \right] \text{ near } 1 < 4, K_{\max} < [K_0(n)] \text{ near } 10 > 5$$

b) the parameters of the selected growth curve were estimated using the least squares method:

$$y_t = 52,722 + 2,196t$$

c) results of residual series analysis to test the model (Table 6).

d) confidence interval at significance level $\alpha = 0,05$.

Table 6. Checking the adequacy of the model

Statistics used		Border	Result
Name, calculation formula	Received value		
Criterion for “peaks” (turning points) $p > \left[\frac{2}{3}(n-2) - 1,96 \sqrt{\frac{16n-29}{90}} \right]$	4 > 3	3	adequate
RS-criterion: $RS = \frac{e_{\max} - e_{\min}}{S}$	3,52	2,80-3,91	adequate
t-Student's t-statistic: $t_{\text{observ.}} = \frac{ e }{S} \sqrt{n}$	0	2,23	adequate
average relative approximation error: $E_{\text{rel.}} = \frac{1}{n} \sum_{i=1}^n \frac{ e_i }{y_i} \cdot 100\% = 1,84\%$			adequate

Source: compiled and calculated by authors

Indicators of technical equipment, energy supply, energy intensity, fertilizer, variety and species composition, labor intensity, average carrying capacity of vehicles and age structure allow us to draw conclusions about the level of digitalization of public administration in the field of ecology, geology and natural resources as a principle of sustainable development and an element of increasing transparency of the Republic of Kazakhstan.

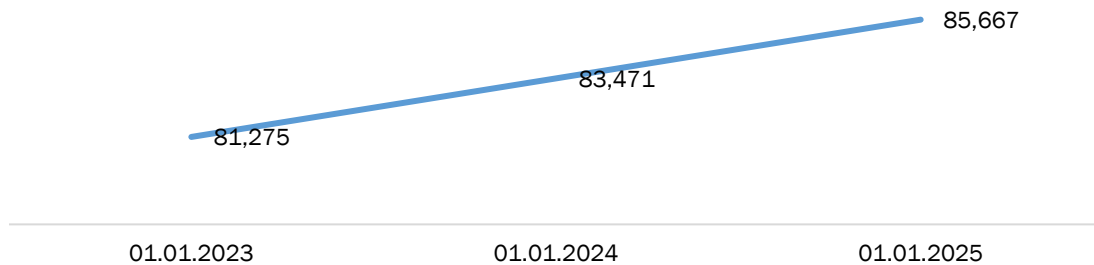


Figure 11. Point forecast of final electricity consumption in agriculture/forestry in the context of digital technologies

Source: compiled and calculated by authors

All this, of course, contributes to technical development, decision-making on the structure and direction of state support and technical modernization of farms in the context of digitalization.

CONCLUSION

Digital technologies and innovation policies focused on greening and environmental protection not only help solve environmental problems, but also create new opportunities for economic growth and development, as well as for participation in global processes and competition. During the research, the author found that:

- The development of innovative technologies and methods in the field of ecology helps to reduce the negative impact on the environment, reduce greenhouse gas emissions, reduce water pollution and combat other environmental problems. This is important for improving the country's environmental sustainability.
- Environmental innovations can help improve production efficiency and reduce energy and resource costs. This can make the economy more competitive and sustainable.
- Attention to the environment and sustainability of products and services is growing in the global economy. Going green is becoming an important factor for international trade and investment.
- The development of innovation and support for start-ups in the field of ecology and sustainability contributes to the emergence of new ideas and technologies that can be successfully commercialized and exported.
- Kazakhstan's participation in global research and innovation initiatives in the field of ecology and sustainability can facilitate the exchange of knowledge and experience with other countries and organizations.

In developed countries, there is a trend towards a "green" economy and adherence to the concept of sustainable development based on balancing environmental, economic and social aspects of development. It focuses on overcoming environmental constraints and ensuring equitable distribution of public resources, which contributes to more effective economic development.

The Republic of Kazakhstan has also seen the introduction of the concept of sustainable development, which is applied to ensure the harmonious development of the country, taking into account priorities in the areas of environmental protection, equitable distribution of resources and social well-being. This allows Kazakhstan to move towards sustainable and balanced development by implementing environmental standards, supporting social programs and stimulating economic growth based on sustainable practices.

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