„Association of Environmental Organizations
of Kazakhstan“ ALE

Konrad-Adenauer-Stiftung

training manual

Environmental Policy in Kazakhstan: Outlines and Prospects

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The book is a comprehensive training material on the subject of „environmental policy“. Great attention is paid to the development of new schemes and concepts, analysis of domestic and foreign experience in this area. A large number of legislative documents and normative legal acts, including confidential ones, are presented, more than ten tables and figures are given.

The teaching aid is intended for students, graduate students, research theorists and practitioners working in the field of environmental policy.

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DEAR READERS!

Kazakhstan's educational fund has been enriched by a new textbook „Environmental Policy in Kazakhstan: Outlines and Prospects", which is an unconventional environmental education solution in terms of the volume and breadth of topics covered, and most importantly - brimming with the enthusiasm and devotion of the specialists working on the publication.

These authors are recognized social activists and experts in the theory and practice of environmental policy. Suffice to remind you that this is the first textbook dedicated to the subject of environmental policy in Kazakhstan.

The latest work by the Association of Environmental Organizations of Kazakhstan is not merely a tribute to fashion; it is evidence demonstrating an active development and reflection on environmental policy in Kazakhstan, whereby it shifts from compiling foreign experience to creating such theories and technologies for environmental policy processes that adequately take into account domestic specifics.

Instead of limiting themselves to theoretical arguments, the authors have succeeded in describing and summarizing the experience of applied environmental policy.The topics presented and outlined in the handbook encompass a wide range of issues, from basic information on environmental policy in Kazakhstan, air, water and land pollution problems to climate change. Biodiversity status and management systems, pathways to fulfilling commitments under the Paris Agreement and achieving carbon neutrality are touched upon, as well as novelties and features of the new Environmental Code.

The handbook has sections on political, economic and social aspects of environmental policy. But the focus is on a theoretical view of the global environmental situation that provides the necessary information for practical application.

The analysis of approaches to the formation of an effective system of environmental policy in public authorities also deserves attention. Studying various aspects of the

functioning of environmental structures in public administration would help their employees to better perceive their place in building effective cooperation with different target groups, to optimize forms and methods of work.

The textbook is made explicit. All things are called by their proper names without excessive scientism, that some scientists, including humanitarian scholars, sometimes obfuscate simple, in general, facts and phenomena, concealing in such a way paucity of thought and complete detachment from the real practice.

The handbook presents itself as pragmatic in a good way. On the one hand, it debunks the idea of Kazakhstan's environmental policy as some kind of „thing in itself," which does not logically explain anything, and on the other, by revealing the mechanisms and technologies of the environmental policy, it makes it clear that there is no need for the environmental policy to be colored in any negative directions. The handbook provides positive examples of environmental policy in accordance with the norms of law and morality, and at the same time it does not cease to be effective.

The work of the Association of Ecological Organizations of Kazakhstan is designed primarily for a student audience; it is an academic textbook. However, the authors' approach to the material, the abundance of examples taken from official sources and practice make the manual very useful for mature professionals and all those interested in this relatively new for Kazakhstan and very promising area of human activity.

I hope that it will serve as a healthy impetus for the formation of an ecological culture, a common approach in the identification of common environmental problems and their effective solution. I would like to express special thanks to the long-standing partner of the Association, the Konrad-Adenauer-Stiftung and to all those who took part in the preparation of the handbook. I wish you all the best wishes for the inspiration for the knowledge and ongoing dedication to the ideas of nature conservation.

Aliya Nazarbayeva,
Chairperson of the Presidium
of the Association of Ecological
Organizations of Kazakhstan

Current global economic and political turbulence is caused, in part, by factors such as the changes and tendencies already established in the world as well as new threats, risks and contradictions that are now almost constantly being generated. Objectively, many of these factors are also linked to the social sphere and to environmental issues. All of these factors create a need for a better understanding of new models and scenarios for economic development in the post-pandemic period. Indeterminacy and increasing imbalance (which applies to the sphere of development and decision-making, as well as to the sphere of public consciousness and perception) are often due to a lack of systematic and broad understanding and perception of the paradigm of „green“ economy, sustainable development and clean environment, which have become leading today for all mankind in the XXI century.

Achievements of science and technology today are already determining the rapid change not only in production, but also in the non-productive sphere, in all aspects of society and each person as well as influencing the formation of the culture of relations between society and the environment and nature in general.

Education is the initial basis of both the worldview, which necessarily includes ecological literacy, and culture, which is the moral responsibility of each person for everything that happens around us.

The growing level of anthropogenic impact on the environment is forcing the world community to change the parameters of its life activity, in particular by adopting the concept of sustainable development and approving the transition of some countries to a so-called „green economy“. In many ways, a civilized future is linked to the level of ecological culture and precaution of the individual and of society as a whole.

In this context, education comes to the fore, as it can provide a solid foundation for ecological thinking. As part of the reform of the various sectors of production, the area of „green“ technology, one of the most important, includes environmental attitudes consistent with the principles of best available practices and the introduction of a circular economy.

The concept for the transition to a „green“ economy is a motivational impetus to promote Kazakhstan’s educational reform in the direction of ecologization, an active introduction of innovative technologies. It highlights several main provisions and tasks.

Training new personnel with new skills, such as improving the efficiency of resource use and management: water, land, biological and others, modernizing existing and creating new infrastructure, improving the quality of life, improving the environment and increasing national security, is one of the priorities. For this reason, the training of relevant specialists in higher education institutions and the necessity to include the issues of rational use of natural resources and environmental protection in the curricula come to the forefront. Today there is a significant need for engineers with relevant qualifications, which can be met by adjusting curricula and introducing additional courses in environmental education.

I am confident that the manual, recommended by the Association of Ecological Organizations for students of higher and secondary educational institutions, will be a valuable book for profile specialists as well.

The content is up-to-date and presented in the form of materials of both theoretical and practical nature. The basics of Kazakhstan's environmental policy are of basic value, and much attention is paid to the dynamics of its legislative support.

I believe that the educational approach, which is an absolutely necessary element in the ecologization of human activity is disclosed in this textbook in a sufficiently profound and informative manner.

Especially noteworthy are the materials devoted to international environmental law and its implementation into the legal system of our country, the ratification of the relevant international documents and Kazakhstan's international obligations in this area.

Other sections of the book are also worth noting, as they cover all areas of the ecosystem, mechanisms of impact on reduction of emissions into the environment in order to achieve sustainable development with conservation of the eco-balance.

Essential parts of the textbook are dedicated to the concepts and development of the circular economy, global climate change and climate policy of the Republic of Kazakhstan.

All sections of the textbook are backed up by practical cases and constructive discussions, which is quite important for readers and learners.

In conclusion I would like to note that the book „Environmental Policy in Kazakhstan: Outlines and Prospects" as a whole contributes to the formation of a careful attitude towards the environment among students, which in their future professional activities will promote the Republic of Kazakhstan towards clean ecology and rational use of natural resources.

Bakytzhan Zhumagulov,
Member of the Senate of the Parliament of the Republic of Kazakhstan,
Chairman of the Scientific and Technical Council of the International Centre for Green Technologies and Investment Projects, Academician

On behalf of the Konrad-Adenauer-Stiftung it's a pleasure to present our new textbook on ecology for bachelors, masters, doctoral students and subject specialists.

In the spring of this year, our Foundation decided to support the initiative of the Association of Ecological Organisations of Kazakhstan to co-publish this unique textbook. It includes the most fundamental chapters of ecology, such as atmospheric air, water and land resources, biodiversity, circular economy, renewable energy and climate change; in-depth analysis of the current state of ecology in Kazakhstan. The main idea behind the creation of this textbook was the lack of scientific and material base required for subject matter experts and students of higher education institutions.

Since the first environmental UN-conference in Stockholm in 1972, many countries have reflected on the importance of environmental issues for the first time and the urgency of developing an action plan to address them. Since independence Kazakhstan's commitment to environmental improvement has been evident. To date Kazakhstan has ratified up to 30 international environmental conventions. In 2021 a new Environmental Code was adopted, which has served as the country's main legal environmental event. Also this year the national strategy for low-carbon development by 2050 was announced in the President's Address to the Nation. This book will shed light on the foundations of Kazakhstan's environmental policy and evaluate the effectiveness of existing legislation. Given the current environmental situation in Kazakhstan a comprehensive and systematic approach is required to address the current situation. This textbook aims to contribute to building a functional framework for the development of an effective environmental policy.

Let us express a huge gratitude to our partner, the Association of Ecological Organizations, and in particular to Aigul Sagadibekovna Solovyova, Chairperson of the Board of the Association, as well as to all the authors of materials and articles for our textbook for the work they have done!

Johannes D. Rey,
Representative
of the Konrad-Adenauer-Stiftung
in Kazakhstan

Chapter 1

ENVIRONMENTAL POLICY FRAMEWORK IN KAZAKHSTAN

1.1 Global Environmental Policy

In today's world, ecology is not only an area of the science of interactions between living organisms and their environment; it has become more widespread and is a key element of socio-economic, scientific and technological development.

Today, global environmental policy has a clear objective of ensuring sustainable development that includes issues of conservation, restoration and effective use of components of the natural environment. Solving issues of equitable satisfaction of the needs of present and future generations, creating a favorable environment for human life and health, preventing environmental degradation and taking measures to prevent global environmental disasters, as well as creating conditions aimed at economic development through minimizing negative impact on the environment.

One of the first to reveal the term „ecology" was the German philosopher and thinker Ernst Heinrich Haeckel. In his book, published in 1866, „General Morphology of Organisms", Haeckel defined ecology as „the study of the environment, including the relationship between organisms and each other and their environment".

The word „ecology" means „οἶκος" from the Greek language - dwelling, residence and „λόγος" - teaching. Ecology describes the relationship between living organisms and their environment, the interaction of organisms with each other, as well as the regularity and cause for the abundance and distribution of organisms in nature.

To be sure, the environment includes both the natural and built environment. The components of the natural environment are atmospheric air, surface and groundwater, the earth's surface and soil layer, subsoil, flora and fauna, and other organisms, all layers of the Earth's atmosphere, including the ozone layer, as well as the climate that enables them to interact in a manner conducive to the existence of life on Earth. At the same time, the anthropogenic environment includes anthropogenic objects, which are the daily human habitat.

Ecology, as a science, tries to answer questions about how nature works. The different types of physical, chemical and biological processes that occurs in ecological systems involve complex interactions between different components of the system. To study these interactions, ecologists involve interdisciplinary sciences such as physiology, biochemistry, genetics, geology, hydrology, meteorology, etc. Ecology has become an experimental rather than a philosophical subject and helps to understand how our actions affect the environment, and shows the degree damage caused by people to the environment. Unfortunately,

lack of understanding of ecology has led to the destruction of ecological systems, depletion of natural resources and increased harm to human health.

The global ecological crisis has completely changed the attitude towards the ecology of developed countries. Today, the environmental policy of most countries of the world and Kazakhstan is aimed at ensuring environmental security, both regionally and internationally. A coherent international environmental policy that responds to the interconnectedness and interdependence of today's world is the order of the day. Environmental security, survival and prosperity of humanity can only be ensured by joint implementation of the global environmental policy.

1.2 Channels and the degree of environmental impact on the economy

Considering the impact of the state of the environment on the economy, many economists refer to Environmental Kuznets Curve[1]. The original work of the Nobel laureate Simon Kuznets was devoted to the analysis of income distribution among different population groups. Kuznets hypothesized that in countries at the early stages of economic development, income inequality first increases, but tends to decline as the economy grows. This assumption later formed the basis for the so-called Kuznets curve. Later, this approach was developed in the study of the relationship between ecology and economics[2].

Considering the channels and the degree of environmental impact on the economy, one can note quite a lot of work on this topic. For example, we can note the work of a group of Greek scientists who studied and systematized 27 works on the economic assessment of the influence of environmental factors on the health of the population between 1997 and 2009[3]. Considering the following years, we can note the work of a group of international scientists from the United States and Chile[4], who studied the impact on the health of the population of the consequences of climate change. The study logic is as follows:

Degree of air pollution -> Asthma occurrence and level -> Healthcare expenditure and employee quality / performance.

1 Economic Growth and the Environment, T Everett, M. Ishwaran, G.P Ansaloni and A. Rubin, March 2010, Department for Environment, Food and Rural Affairs, UK Government.

2 Shkiperova G.T., Ecological Kuznets Curve as a tool for studying regional development, 2013 [Electronic resource]. - Access mode: https://cyberleninka.ru/article/n/ekologicheskaya- krivaya-kuznetsa-kak-instrument-issledovaniya-regionalnogo-razvitiya/viewer.

3 Environmental Effects on Public Health: An Economic Perspective, K. Remoundou, Ph. Koundouri, Int J Environ Res Public Health. 2009 August; 6(8): 2160-2178 [Electronic resource]. - Access mode: https: // www.ncbi.nlm.nih.gov/pmc/articles/PMC2738880/.

4 Ancillary human health benefits of improved air quality resulting from climate change mitigation, M. L BellEmail, D.L.Davis, L. A. Cifuentes, A.J. Krupnick, R.D. Morgenstem and G.D. Thurston, Environmental Health periodical, July 31, 2008. [Electronic resource]. - Access mode: https://ehjourmal.biomedcentral.com/articles/10.1186/1476-069X-7-41.

In their work, they cite data from the European Environment Agency that limiting the increase in global average temperature to 2°C will result in annual savings in the implementation of existing European air pollution measures in the amount of EUR 10 billion and will avoid annual health costs in the amount of EUR16-46 billion.

A study of three cities in Latin America found significant health benefits from reductions in greenhouse gases, including about 64,000 cases of preventing premature deaths over the 20-year study period. It is estimated that a 20% reduction in methane concentrations starting in 2010 will prevent more than 30,000 deaths worldwide by 2030.

Indian researcher Usha Gupta[5] studied the impact of air pollution on the lost work days (RAD - restricted activity days), costs due to illness (COI – cost of illness) logically:

Degree of air pollution -> Active days reduction -> cost of illness, willingness to pay (WTP – willingness to pay).

According to this study, by improving air quality, it is possible to reduce the number of lost working days by 0.41 per worker in Kolkata, 0.75 in Delhi, 0.82 in Taiwan and 0.63 in Kanpur. It is also possible to reduce the number of bed days in Kanpur by 1.88 days or by 1.3 in Taiwan for each hospitalized patient.

These results are consistent with data from studies in Taiwan and the United States, where the ratio of willingness to pay to the cost of illness varied between 1.61 and 2.26, depending on the level of air pollution. This suggests that the population and firms are willing to pay for the cleaner air.

Thus, it can be noted that ecology affects economic growth through four channels:

1. not going to work (the number of working days lost due to illness of citizens - restricted activity days) - lost GDP;
2. health care costs - due to the increased incidence of the population;
3. quality of work - decision making by the elite (top management of the state and quasi-state sectors, etc.);
4. tourist attraction.

One can note the work of a group of Spanish scientists on the materials of the fastest growing European cities during the crisis of 2009-2010 assessing the degree of influence. The analysis presented in the article „The Effects of Environmental and Social Dimensions of Sustainability in Response to the Economic Crisis of European Cities“[6] – „Effects of environmental and social factors of sustainability in response to the economic crisis of European cities“, for a group of 119 European

[5] Valuation of urban air pollution: A Case Study of Kanpur City in India, U. Gupta, South Asian Network for Development and Environmental Economics (SANDEE), PO Box 8975, EPC 1056, Kathmandu, Nepal, May 2006.

[6] The Effects of Environmental and Social Dimensions of Sustainability in Response to the Economic Crisis of European Cities, D Nevado-Peña, V-R López-Ruiz, J-L Alfaro-Navarro, 26.06.2015. [Electronic resource].: www.mdpi.com/journal/sustainability.

cities, shows a high level of influence of environmental and social factors on economic growth.

In particular, according to the calculations of these scientists, environmental factors determine 20.2% of GDP per capita growth in 119 European cities. Social factors account for 14.6% of GDP per capita growth in 119 European cities. Among these groups of factors, the most significant environmental factors are „Waste and their processing" with a share of 36.4%, and among social factors - health care (40.7%) and education (12.9%).

1.3 Formation of a global environmental policy

The XX century is one of the most significant periods of change and transformation. The scientific and industrial revolution has led to rapid economic growth combined with increasing pressure on the environment, which had led to various biological, geophysical, climatological, meteorological and hydrological disasters.

Global environmental policy is a relatively new area of research in international relations that focuses on issues related to the interaction between man and the natural world. As early as the middle of the 19th century, scientists wrote about the role of natural resources in global security and political economy. However, much of the literature prior to the eighties dealt specifically with resource extraction and development. It was not until the 1980s and 1990s that global environmental policy began to establish itself as a separate field, with its own specialized journals and publishing houses, and the field of research expanded to include global environmental issues such as ozone depletion, climate change, biodiversity, deforestation, desertification and others. It has developed into a center for interdisciplinary work that brings together research from a number of areas, including geography, economics, history, law, biology and many others. The interdisciplinary approach makes it difficult to define boundaries in this rather vast area of research.

Since the middle of the XX century, the world has accelerated the process of adopting the necessary regulatory and legal framework to ensure environmental regulation. For example, in 1952[7], the „great London smog" covered London for five days (December 5-9), caused by a combination of industrial pollution and high pressure weather conditions. At the time, the city used cheap coal for everything from power generation to house heating. The combination of smoke and fog almost stopped the city and led to thousands of deaths.

Initial reports indicate that approximately 4,000 people died prematurely immediately after the smog. Many experts estimate that the event claimed at least 8,000 to 12,000 lives. Four years later (1956), its consequences led to the adoption of the Clean Air Act, which marked a turning point in the history of environmental protection.

From 5 to 16 June 1972, one of the first and most important conferences on environmental issues was held in Stockholm under the auspices of the United Nations.

[7] Deadly poisons in London's air, 2016 [Electronic resource]. - Access mode: https: // www.bbc.com/russian/uk/2016/01/160114_vert_fut_lethal_effects_of_london_fog.

Participants adopted a number of principles for rational environmental management, including the Stockholm Declaration[8] and Action Plan for Environmental Protection, as well as several resolutions.

The Stockholm Declaration, containing 26 principles, brought environmental issues to the forefront of international concerns and heralded the beginning of a dialogue between industrialized and developing countries on the relationship between economic growth and environmental pollution.

The Stockholm Conference encouraged countries around the world to monitor the state of the environment and to establish environmental ministries and agencies. For example, over the next 10 years, about 100 ministries of environmental protection have been created. Despite these institutional advances, including the creation of UNEP, the failure to implement much of its program of action prompted the UN to hold follow-up conferences.

A new international environmental action plan was discussed in 1992 in Rio de Janeiro at the subsequent United Nations Conference on environment and development (Earth Summit).

The Earth Summit concluded that the concept of sustainable development was an attainable goal for all the world's population, regardless of whether they are at the local, national, regional or international level. It also recognized that integrating and balancing economic, social and environmental concerns while meeting our needs is vital to sustaining human life on the planet, and that such an integrated approach is possible.

The main outcome of the conference was the adoption of Agenda 21[9], a bold agenda calling for new strategies for investing in the future to achieve a common sustainable development in the XXI century. Its recommendations ranged from new teaching methods to new ways of conserving natural resources and new ways of participating in a sustainable economy.

The following documents were adopted:

- Rio de Janeiro Declaration and its 27 universal principles of sustainable development;
- United Nations Framework Convention on Climate Change (UNFCCC);
- Convention on Biological Diversity;
- Declaration on the principles of forest management.

In 1997, at a special session of the UN General Assembly dedicated to the environment (Earth Summit + 5) the implementation of Agenda of XXI century had been considered and a program for its further implementation had been proposed. Three years later, in 2000, the Millennium Summit set eight Millennium Development Goals (MDGs)[10].

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[8] Declaration of the United Nations Conference on the Human Environment, 1972. [Electronic resource].- Access mode: https://www.un.org/ru/documents/decl_conv/declarations/declarathenv.shtml.

[9] The Rio Declaration on Environment and Development, adopted at the UN Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992 [Electronic resource]. - Access mode: https://www.un.org/ru/documents/decl_conv/declarations/riodecl.shtml.

[10] United Nations Millennium Declaration, Adopted by General Assembly resolution 55/2 of September 8, 2000 [Electronic resource]. - Access mode: https://www.un.org/ru/documents/decl conv/declarations/summitdecl.shtml.

The World Summit on Sustainable Development in Johannesburg adopted a new Action Plan in 2002. The Millennium Development Goals were discussed at high-level meetings in New York in 2005, 2008 and 2010.

Twenty years after the Earth Summit in Rio de Janeiro (1992), the 2012 United Nations Conference on Sustainable Development in Rio, well known as Rio + 20, led to the adoption of a document containing clear and practical steps to implement sustainable development.

At the conference, member states decided to begin the process of developing a set of Sustainable Development Goals (SDGs), building on the Millennium Development Goals (MDGs) and moving closer to the post-2015 development agenda.

In 2015, the UN Sustainable Development Summit adopted the 2030 Agenda and its 17 Sustainable Development Goals. It is underpinned by 17 Sustainable Development Goals (SDGs)[11], which urge all countries, developed and developing, to act in a global partnership.

1.4 Green Economy as a factor of sustainable development

Most of the tasks set within the framework of the Sustainable Development Goals until 2030, adopted at the meeting of the 70th UN General Assembly, are aimed at developing a Green Economy and are complex and indivisible, provide a balance of all three components of sustainable development: economic, social and environmental.

In its simplest sense, a Green economy is a low carbon economy that uses resources efficiently and serves the interests of the whole society.

In a Green economy, income and employment growth is driven by public and private investments that reduce carbon emissions and pollution, increase energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services. These investments need to be catalyzed and supported through targeted public spending, policy reforms and regulatory changes.

This path of development should preserve, increase and, where necessary, restore natural capital as an essential economic asset and a source of public goods, especially for the poor, whose sources of income and security depend on nature.

As defined by the United Nations Environment Program (UNEP), a Green Economy is the result of increasing human well-being and social justice while significantly reducing environmental risks and environmental scarcity (limitation).

[11] The Sustainable Development Goals are a kind of call to action, emanating from all countries-poor, rich and middle-income. It aims to improve the well-being and protect our planet. States recognize that measures to eliminate poverty must be taken in parallel with efforts to enhance economic growth and address a range of issues in education, health, social protection and employment, as well as climate change and environmental protection [Electronic resource].- Access mode: https: //www.un.org/sustainabledevelopment/ru/sustainable-development-goals/.

By the Organization for Economic Co-operation and Development (OECD), the term Green Economy[12] refers to a model of economic development based on sustainable development and knowledge of environmental economics.

The main elements of the Green Economy concept include:

1. government support and private investment aimed at disseminating knowledge, implementing initiatives, creating technologies and industries that help reduce carbon emissions and pollution;
2. on the basis of Green technologies, implying deeper recycling of waste, reduction of energy consumption or the use of alternative energy, new Green sectors of the economy and Green jobs are emerging.
3. increasing energy efficiency by reducing the need for burned fuel and reducing carbon emissions.
4. increasing resource efficiency, which leads to a decrease in waste generation, a decrease in the level of environmental pollution, ensures the sustainable existence of this sector of the economy for a long period, preserves conditions for maintaining biodiversity, conducting an organic household, increasing access to local natural resources and reducing poverty, development of ecosystem services.

Thus, the concept of a Green Economy emphasizes the importance of improving the resilience of the global economy.

The Green Economy Guidebook, which was published in September 2012, provides an overview of the six principles of a Green Economy:

- fairness and objectivity, both within one generation and between generations;
- consistency with the principles of sustainable development;
- a preventive approach to social and environmental impacts;
- assessment of natural and social capital, for example, internationalization of external costs, Green accounting, life-cycle costs and management improvements;
- sustainable and efficient use of resources, consumption and production;
- the need to achieve existing macroeconomic goals through the creation of Green jobs, poverty eradication, increased competitiveness and Green growth in key sectors[13] [14].

In early 2012, the Coalition for a Green Economy worked with various organisations to draft the following nine Green Economy principles, which were further refined through various consultations:

1. Principle of Sustainable Development - ensuring sustainable development;
2. Principle of equity - ensuring equity;

[12] Green Economy and Sustainable Development Goals for Russia / Collective Monograph, edited by S.N. Bobylyov, P.A. Kiryushin O.V. Kudryavtseva, 2016. - p.13.

[13] The Green Economy Coalition is a diverse set of organisations, including NGOs, research institutes, UN organisations, enterprises and trade unions, working to accelerate the transition to the Green Economy.

[14] A Guidebook to the Green Economy Issue 2: exploring green economy principles, United Nations Division for Sustainable Development [Electronic resource]. / UNDESA, 2012. [Electronic resource]. - Access mode: https://sustainabledevelopment.un.org/content/documents/743GE%20Guidebook%202%-20-%20Principles_final. pdf.

3. Principle of dignity - creating true prosperity and well-being for all;
4. Principle of precaution, integrity of the Earth and planetary boundaries - improving the natural world;
5. Principle of inclusion - inclusive and involved in decision-making;
6. Principle of governance - accountability;
7. Principle of sustainability - increased economic, social and environmental sustainability;
8. Principle of efficiency - ensuring sustainable consumption and production;
9. Principle of interaction between the generations - investing in the future.
10. The principles are generally based on the work of the International Trade Union Confederation, the Nordic Alliance for Sustainable Development and others.

In May 2013, by the decree of the President, the Concept for the transition of the Republic of Kazakhstan to a Green economy[15] was adopted. According to the developers, the aggregate amount of investments required for the implementation of the Concept from now until 2050 will average 3-4 billion US dollars annually. The largest annual investment volume will be equivalent to 1.8% of GDP in the period from 2020 to 2024, and on average until 2050, investments will amount to about 1% of GDP.

To date, a regulatory and legal framework for the implementation of the principles of a Green Economy that meet international standards has been created.

Table 1. **Goals and target indicators of the Green Economy**

Sector	Description of the goal	2020	2030	2050
Water resources	Eliminating water scarcity at the national level	Provide water to the population	Provide water for agriculture (by 2040)	Solve water supply problems once and for all
	Eliminating water scarcity at the basin level	The fastest possible coverage of the deficit by basin as a whole (by 2025)	No deficit for each basin	
Farming	Labor productivity in agriculture	3x magnification		

[15] Concept for the Transition of the Republic of Kazakhstan to a Green Economy, Decree of the President of the Republic of Kazakhstan dated May 30, 2013 No. 577 [Electronic resource]. - Access mode: https://adilet.zan.kz/rus/docs/U1300000577.

	Wheat yield (t / ha)	1,4	2,0	
	Irrigation water consumption (m^3 / t)	450	330	
Energy efficiency	Decrease in energy intensity of GDP from the level of 2008	25% (10% to 2015 r.)	30%	50%
Electric power engineering	Share of alternative sources [1] in electricity generation	Solar and wind: at least 3% by 2020	30%	50%
	Share of gas-fired power plants in electricity generation	20% [2]	25% [2]	30%
	Gasification of regions	Akmola and Karaganda regions	Northern and Eastern regions	
	Reduction in relation to the current level of carbon dioxide emissions in the electric power industry	2012 level	-15%	-40%
Air pollution	Emissions of sulfur and nitrogen oxides into the environment		European emission level	
Recycling	Covering the population with the removal of solid household waste		100%	
	Sanitary waste storage		95%	
	Share of recycled waste		40%	50%

Note: additional targets have been set.

Astana Initiative Green Bridge

Efficient use of natural and energy resources is a priority for each country in terms of economic and energy security, and the Green Economy is one of the main

mechanisms for sustainable development. One of the initiatives of the Republic of Kazakhstan, approved by all states of the United Nations as an interregional initiative for sustainable development, is the Green Bridge Partnership Program. The International Green Bridge[16] Partnership Program (GBPP) is an initiative of Kazakhstan for the transition of countries to a Green Economy based on multilateral partnerships with business, the public and international cooperation. The program was put forward by the President of the Republic of Kazakhstan N.A. Nazarbayev at the III Astana Economic Forum in May 2010 and approved at the 6th ESCAP conference of the countries of the Asia-Pacific region in October 2010. in Astana, and later, at the 7th Ministerial Conference „Environment for Europe" in September 2011 in Astana and was included in the final document of the world summit on sustainable development Rio + 20 „The future we want".

The goal of the Green Bridge Partnership Program (hereinafter referred to as the GBPP) is to unite the efforts of states, international organizations, public and business sectors in the region of Europe, Asia and the Pacific for the transition to a Green Economy.

The main principles of the GBPP are the leading role of the state in creating favorable conditions for the transition to a Green Economy, a long-term and multilateral approach to programs and projects, as a prerequisite for innovation and investment in the „green" economy and ecosystem services, the interest of business circles.

The need for the program is justified by the following factors:

- The inability of many countries to independently make the transition to a „green" economy and the lack of practical mechanisms, expert potential.
- Ineffectiveness of short-term and fragmented actions.
- The need for a professional, neutral and long-term framework to support reform, investment and innovation.
- Lack of mechanisms for lobbying Green Projects and industries.
- Lack of strong environmental media and education.

The principles of the GBPP are as follows:

- the leading role of the state in Green Reforms;
- partnership of the parties: governments, parliaments, local governments, international organizations, business, innovators, consumer protection societies, etc.;
- long-term interests for investors in Green Business, development of multilateral long-term agreements with business;
- contribution to the increase in productive employment and poverty reduction;
- Extraction of direct and indirect effects from increasing the ecosystem productivity;

[16] Outcome document of the United Nations Conference on Sustainable Development (RIO + 20), 2012 [Electronic resource] - Access mode: https: // undocs.org/ru/A/66/L.56.

- reorientation of government subsidies from brown industries to Green industries;
- focus on the production of ecological products that are missing on the world market and are not subject to intense competition between countries (organic products and fertilizers, mariculture, shubat, biofuels of the 2nd and 3rd generations for Euro-5, etc.);
- facilitating the reorientation of capital of large companies in the brown industries to advanced „green“ technologies and investment programs such as Exxon Mobil;
- support for new environmental technologies entering the market through sustainable procurement.

1.5 Development of environmental legislation in the Republic of Kazakhstan

Ehe Kazakh SSR began to independently establish the procedure for organizing the protection of the ecological environment, the use of natural resources, providing the people with environmental security and determined the right to prohibit the construction and stop functioning on its territory of any enterprises, institutions, organizations, other facilities that are a source of environmental danger with the adoption of the Resolution of the Supreme Council of the Kazakh SSR dated October 25, 1990 No. 307-XII „On the Declaration of State Sovereignty of the Kazakh Soviet Socialist Republic“[17].

Over the 30-year period of independence, legislative instruments and political strategies in the field of environmental protection have been modified in the direction of strengthening environmental regulation and compliance with international treaties signed by Kazakhstan.

The central state body provides guidance and cross-sectoral coordination of state policy in the field of environmental protection. Since 1988, the name of the Ministry has changed eight times (Fig. 2). During the reorganization, functions in the field of forestry, fishing and hunting, water resources were either transferred or excluded from the competence of the environmental ministry.

It should be noted that Kazakhstan has now ratified[18] [19] 29 international conventions in the field of environmental protection, which demonstrates its foreign policy commitment to improving the environment (Appendix 1). Every international treaty is to some extent harmonized into national legislation.

[17] On the Declaration on State Sovereignty of the Kazakh Soviet Socialist Republic, Approved by Resolution of the Supreme Soviet of the Kazakh SSR dated October 25, 1990, No. 307-XII [Electronic resource]. - Access mode: https://adilet.zan.kz/rus/docs/B900001700_.

[18] List of International Conventions in the field of environmental protection ratified and signed by the Republic of Kazakhstan [Electronic resource]. - Access mode: https:// ecogosfond.kz/orhusskaja-konvencija/ dostup-k-jekologicheskoj-informacii/haly-araly-yntyma-tasty/ aza-stan-respublikasymen-ratifikacijalan-an-ol-ojyl-an-orsha-an-ortany-or-au-salasynda-y-haly-araly- konvencijalardy-tizimi/.

[19] On Environmental Protection in the Kazakh SSR, Law of the Kazakh Soviet Socialist Republic dated June 18, 1991. Repealed by Law of the RK dated July 15, 1997, No. 161 - Z970161 [Electronic resource]. - Access mode: hptts://adilet.zan.kz/rus/docs/Z910003500.

Figure 2. **The history of the formation of the central state body in the field of environmental protection**

One of the first legislative acts adopted in 1991 was the law „On environmental protection in the Kazakh SSR". This law is stated in a wide range, without specifying small details although it contains all the necessary principles of environmental protection.

A number of codified legislative acts were adopted that regulate the use and protection of certain types of natural resources to fill this gap, (Table 2).

Table 2. **Codified legislative acts regulating the use and protection of selected natural resources**

No.	Year of acceptance	Name of the legislative act
1	1992	Code „On Subsoil and Processing of Mineral Raw Materials"; Laws „On social protection of citizens affected by nuclear tests at the Semipalatinsk test site" and „On social protection of citizens affected by the environmental disaster in the Aral Sea region".
2	1993	Forest and Water Codes; Law of the Republic of Kazakhstan „On the protection, reproduction and use of the animal world".

3	1994	Law of the Republic of Kazakhstan „On Sanitary and Epidemiological Welfare of the Population“.
4	1995	The Law of the Republic of Kazakhstan „On Oil“.
5	1996	The Law of the Republic of Kazakhstan „On Subsoil and Subsoil Use“.

A new Law of the Republic of Kazakhstan „On Environmental Protection“[20] was adopted in 1997, which determined in the best way the modern legal, economic and social foundations of environmental protection in the interests of the present and future period, ensured environmental security, prevention of harmful effects of economic and other activities on natural ecological systems, conservation of biological diversity and the organization of rational use of natural resources.

The law contains important points as the rights and obligations of citizens and public associations in the field of environmental protection, the competence of state and local authorities in the field of environmental protection, natural resources and nature management.

Among the most important conditions for the use of nature management are the following:

- limits and quotas, permits for nature use;
- government regulation;
- state structure of nature management and schemes for the integrated use of reproduction and protection of natural resources;
- state registration and state cadastres of natural resources;
- individual elements of the state legal mechanism of environmental management;
- the economic mechanism of environmental protection;
- regulation, standardization and certification in the field of environmental protection;
- environmental requirements for economic and other activities;
- environmental assessment;
- objects of environmental protection of particular ecological, scientific and cultural value;
- international cooperation in the field of environmental protection, etc.

According to the experts who drafted the first environmental performance review of the Republic of Kazakhstan (2000)[21], this law does not include provisions on liability for environmental damage, but is a part of an administrative procedure, civil and criminal law.

[20] On Environmental Protection, Law of the Republic of Kazakhstan dated July 15, 1997, No. 160, Repealed by the Code of the Republic of Kazakhstan dated January 9, 2007, No. 212. [Electronic resource]. - Access mode: https://adilet.zan.kz/rus/docs/Z970000160.

[21] The Environmental Performance Reviews (EPRs) for countries of transition economy were initiated by Ministers for Environment at the Second „Environment for Europe„ Conference in Lucerne, Switzerland, in 1993. As a result, the UNECE Committee on Environmental Policy decided to make EPRs part of its regular programme. The first cycle of reviews started in 1994 and continued until 2004 in 23 countries of the UNECE region.

Environmental Code of 2007

The Environmental Code is the main comprehensive legislative act that regulates public relations in the environmental sphere.

The level of environmental security in the Code of 2007 is brought in line with international standards that are focused on advanced technologies. It establishes a list of natural objects subject to legal protection, indicates the main environmental requirements for economic and other activities, it contains all aspects of environmental protection, such as environmental education, provisions that consolidate the system of public authorities and management in the field of environmental protection etc.

The laws „On Environmental Protection", „On Protection of Atmospheric Air", „On Ecological Expertise" and a number of by-laws became invalid in connection with the adoption of this Code.

At the same time, the Environmental Code contains novelties regarding:

- competence of state bodies in the field of environmental protection and nature management;
- EIA;
- state regulation in the field of greenhouse gas emissions and removals;
- economic assessment of damage to the environment;
- forms of state and industrial environmental control;
- state cadastres of natural resources (production and consumption waste, disposal of hazardous substances, radioactive waste and wastewater discharge into the subsoil);
- state system for assessing emissions and absorption of greenhouse gases;
- environmental requirements for the use of land, subsoil, waters, forests and other vegetation, wildlife, for the protection, reproduction, breeding in captivity and semi-free conditions, limited economic use of rare and endangered species of animals, in the implementation of economic and other activities in the state protected area in the northern part of the Caspian Sea, to the use of radioactive materials, atomic energy and radiation safety, in the production and use of potentially hazardous chemical and biological substances, genetically modified products and organisms, in determining the ownership of production and consumption waste, when handling with production and consumption waste, to radioactive waste storage and disposal facilities;
- state regulation of activities in the field of emissions of greenhouse gases and ozone-depleting substances.

Environmental Code of 2021

The need to develop a new edition of the Environmental Code of the Republic of Kazakhstan is due to the execution of the instructions of the Head of State N.A. Nazarbayev, given in the Address of the President of the Republic of Kazakhstan - Leader of the Nation N.A. Nazarbayev to the people of Kazakhstan Strategy „Kazakhstan-2050": a new political course of the established state" (Astana, 14 December 2012); Strategic development plan of the Republic of Kazakhstan until 2025 approved by the Decree of the President of the Republic of Kazakhstan dated

February 15, 2018 No. 636; Message to the people of Kazakhstan „New opportunities for development in the context of the fourth industrial revolution" dated January 10, 2018, which defines new transition trends of Kazakhstan towards a „green" industrial and innovative economy and environmental protection; Concept for the transition of the Republic of Kazakhstan to a Green Economy approved by the Decree of the President of the Republic of Kazakhstan dated May 30, 2013 No. 577.

An in-depth analysis of one of the four key issues for the successful development of Kazakhstan in the medium term, carried out by OECD experts: the effectiveness of environmental regulation, also indicates a number of inconsistencies of the current legislation with the criteria of the OECD approach. The experts recommended reforming the environmental legislation.

The program document (Concept of environmental security of the Republic of Kazakhstan for 2004-2015), adopted during the period of the Environmental Code (2007-2017), aimed at creating a system of environmental protection that complies with the principles of sustainable development and ensures a qualitative improvement in the state of the environment, achievement of regulatory indicators the quality of environmental objects and a favorable level of environmentally sustainable development of society, ensuring the reduction of environmental impact, the formation of an environmental quality management system - was not implemented, the set goals were not achieved. The amendments introduced (at different times - 82) also did not create conditions for achieving the set goals.

In this regard, the current Environmental Code, having fully realized the historical mission entrusted to it on environmental regulation and control over the observance of environmental legislation, needed to be replaced by new, more progressive legislation that meets modern challenges, corresponding to international policy in environmental protection, creating an effective governance structure with specific mandates.

The task of the environmental protection agency should be to create conditions in which consumers of natural resources will benefit from investment in modernization of production and environmental protection measures aimed at reducing the impact on the environment, thereby improving the country's environmental health. The task of local executive bodies is to become jointly and severally responsible, together with the users of natural resources and the population of the region, for improving the quality of the environment of the region headed.

Environmental Code innovations of 2021[22]:

1. the „polluter pays" principle - the application of pollution prevention and control measures, as well as responsibility for the restoration of the damage caused to the environment;
2. integrated environmental permits (hereinafter - IEP) and the best available technologies (hereinafter - BAT) - the most hazardous polluting activities are

[22] Environmental Code of the Republic of Kazakhstan / Code of the Republic of Kazakhstan dated January 2, 2021 No. 400-VI [Electronic resource]. - Access mode: https: //adilet zan.kz/rus/docs/K2100000400.

classified in the first category, which implies stricter regulation. So, for objects of the first category, a mandatory transition to IEP is provided with the condition of introducing BAT. At the first stage, -it is planned to transfer to BAT 50 of the largest enterprises of the oil and gas, mining and metallurgical, chemical and electric power industries, which account for 80% of pollution;

3. environmental payments and targeted spending - for operators of new facilities that have received IEP and have implemented BAT, appropriate amendments are proposed to exempt from payments for emissions. The same mechanism is envisaged for operating enterprises, but for them to be exempted from payments for emissions, it is necessary to develop and implement a program to improve environmental efficiency and introduce BAT;
4. Environmental Impact Assessment (EIA) - the procedure will become mandatory only for enterprises of the first category, while objects of the second category will be subject to screening to determine whether an EIA is necessary or not;
5. waste management - a licensing procedure is being introduced to minimize waste generation, reuse of generated waste, recycling, utilization and burial at landfills. For transportation, a notification procedure is introduced for companies carrying out these types of activities.

List of International conventions in the field of environmental protection, ratified, signed by the Republic of Kazakhstan

No.	Name of the convention, agreement	Document of the Republic of Kazakhstan on accession / ratification
1	World Meteorological Organization Convention, October 11, 1947.	Resolution of the Supreme Council of the Republic of Kazakhstan on accession from 18.12.1992. No. 1791-XII.
2	Convention on Biological Diversity. Rio de Janeiro, June 1992.	Resolution of the Cabinet of Ministers of the Republic of Kazakhstan on approval from 19.08.1994. No. 918.
3	International Convention on Civil Liability for Oil Pollution Damage. Brussels, November 29, 1969r.	Resolution of the Cabinet of Ministers of the Republic of Kazakhstan on accession from 4.05.1994. No. 244.
4	Convention concerning the Protection of the World Cultural and Natural Heritage. Paris, November 16, 1972.	Accession 29.04.1994.
5	International Convention for the Prevention of Pollution of Ships.	Resolution of the Cabinet of Ministers of the Republic of Kazakhstan on accession from 4.05.1994 No. 244.

6	Convention on the prohibition of military or any other hostile use of means of influencing the natural environment.	Resolution of the Supreme Council of the Republic of Kazakhstan on accession from 20.02.1995 from No. 301-XIII.
7	Energy Charter Treaty. Lisbon, December 17, 1994.	Decree of the President of the Republic of Kazakhstan on ratification of October 18, 1995 No. 2537.
8	United Nations Framework Convention on Climate Change (UNFCC). Rio de Janeiro, June 11, 1992.	Decree of the President of the Republic of Kazakhstan on ratification of 04.05.1995. No. 2260.
9	UN Convention to Combat Desertification.	Law of the Republic of Kazakhstan on ratification of 07.07.1997 No. 149-1.
10	Montreal Protocol on Substances that Deplete the Ozone Layer. Montreal, September 16, 1987. Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London, June 27-29, 1990. Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted in Copenhagen on November 23-25, 1992, and the Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted in Montreal on September 15-17, 1997. On the ratification of the Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted in Beijing on December 3, 1999.	The Law of the Republic of Kazakhstan on accession dated 30.10.1997. No. 176. Law of the Republic of Kazakhstan on accession dated 07.05.2001. No. 191-II. Law of the Republic of Kazakhstan dated April 6, 2011 No. 426-IV. Law of the Republic of Kazakhstan dated April 23, 2014 No. 198-V of the Law of the Republic of Kazakhstan.
11	Vienna Convention for the Protection of the Ozone Layer. Vienna, 22 March 1985.	The Law of the Republic of Kazakhstan on accession dated 30.10.1997. No. 177-I.
12	Convention on International Trade in Endangered Species of Wild Fauna and Flora. Washington, March 3, 1973.	Law of the Republic of Kazakhstan on accession of April 6, 1999 No. 372-1.
13	Convention on Environmental Impact Assessment in a Transboundary Context. Espoo (Finland), February 25, 1991.	The Law of the Republic of Kazakhstan on accession dated 21.10.2000. No. 86-II.
14	Convention on Long-range Transboundary Air Pollution. Geneva, November 10, 1979.	Law of the Republic of Kazakhstan on accession from 23.10.2000. No. 89-II.
15	Convention on the Transboundary Effects of Industrial Accidents.	Law of the Republic of Kazakhstan on accession from 23.10.2000. No. 91-II.

16	Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters.	Law of the Republic of Kazakhstan on ratification of 23.10.2000. No. 92-II.
17	Convention on the Protection and Use of Transboundary Watercourses and International Lakes. Helsinki, 17 March 1992. On ratification of the Amendments to Articles 25 and 26 of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes.	Law of the Republic of Kazakhstan on accession of 23.10.2000 No. 94-II. Law of the Republic of Kazakhstan dated January 28, 2015 No. 282-V of Law of the Republic of Kazakhstan.
18	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. Basel, 20-22 March 1989.	Law of the Republic of Kazakhstan on accession dated 10.02.2003. No. 389-II.
19	Convention on Wetlands of International Importance Primarily as Habitat for Waterfowl (as amended by the Paris Protocol of December 3, 1982, and amended at Regina, May 28, 1987).	Law of the Republic of Kazakhstan on accession from 13.12.2005. No. 94-III.
20	Framework Convention for the Protection of the Marine Environment of the Caspian Sea (Tehran, November 4, 2003).	The Law of the Republic of Kazakhstan on ratification of December 13, 2005 No. 97-III.
21	On the signing of the Protocol on the protection of the Caspian Sea from pollution from land-based sources and as a result of activities carried out on land to the Framework Convention for the Protection of the Marine Environment of the Caspian Sea.	Decree of the President of the Republic of Kazakhstan dated January 28, 2013 No. 486.
22	On signing the Protocol on Environmental Impact Assessment in a Transboundary Context to the Framework Convention for the Protection of the Marine Environment of the Caspian Sea.	Decree of the President of the Republic of Kazakhstan dated July 19, 2018 No. 718.
23	On the ratification of the Protocol on Regional Preparedness, Response and Cooperation in the Event of Oil Pollution Incidents to the Framework Convention for the Protection of the Marine Environment of the Caspian Sea.	Law of the Republic of Kazakhstan dated March 18, 2016 No. 474-V of Law of the Republic of Kazakhstan.
24	Stockholm Convention on Persistent Organic Pollutants. Stockholm, 22 May 2001.	Law of the Republic of Kazakhstan dated June 7, 2007 No. 259.

25	Rotterdam Convention on the Application of the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.	The air defense missile system was ratified in 2007.
26	Convention on the Conservation of Migratory Species of Wild Animals. Bonn, 23 June 1979.	Law of the Republic of Kazakhstan on accession of 13.12.2005 No. 96.
27	Cartagena Protocol on Biosafety to the Convention on Biological Diversity.	Law of the Republic of Kazakhstan dated June 17, 2008 No. 43-IV.
28	Kyoto Protocol to the United Nations Framework Convention on Climate Change. Kyoto, December 11, 1997. Amendment to Annex B to the Kyoto Protocol to the United Nations Framework Convention on Climate Change. On the signing of the Paris Agreement.	Law of the Republic of Kazakhstan dated March 26, 2009 No. 144-IV. Decree of the President of the Republic of Kazakhstan dated August 25, 2011 No. 145. Decree of the President of the Republic of Kazakhstan dated July 20, 2016 No. 301.
29	On the ratification of the Protocol on Pollutant Release and Transfer Registers to the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters.	Law of the Republic of Kazakhstan dated December 12, 2019 No. 279-VI of the Law of the Republic of Kazakhstan.

Conclusion

Within the context of the everyday world, the environmental agenda is set as a priority to ensure sustainable economic development. Many scientists and researchers are looking for ways to develop humanity while minimising the impact on the surrounding world. Notably, the 2018 Nobel Prize in Economics is awarded to William Nordhaus (W. D. Nordhaus), as noted in a press release from the Royal Swedish Academy of Sciences, for integrating climate change into long-term macroeconomic analysis. Also in 2021 the Nobel Prize in Physics was awarded to a team of scientists from Syukuro Manabe, Klaus Hasselmann and Giorgio Parisi for studying „complex systems" and climate change modelling. The evolutionary development of Kazakhstan's environmental policy is directly linked to the state's international commitments under ratified international environmental agreements. It should be noted that the conducted reform of the environmental legislation has clear objectives with fixed instruments aimed at ensuring the necessary level of environmental quality.

In general, studying the basics of environmental policy, on the one hand it is possible to understand the vector of a country's development, and on the other hand to see the government's priorities in ensuring environmental security.

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Chapter 2

ATMOSPHERIC AIR

2.1 Value of atmospheric air

Atmosphere (atmospheric air) is an integral part of the natural environment, and an important part of ecosphere, and it is connected with it by biogeochemical cycles that include gaseous components. Significance of atmospheric air is undoubtedly enormous.

Atmospheric air contains oxygen necessary for breathing of living organisms, is a source of carbon dioxide for plant photosynthesis, protects living organisms from harmful cosmic rays, contributes to the Earth's heat preservation and regulates the climate, transforms gaseous products of metabolism. And, at the same time, it is a reservoir of accumulation of harmful substances, a source of water and soil pollution.

Atmospheric phenomena (rain, snow, hail, drought, etc.) have excited the consciousness of people since ancient times. The recognition process was very slow. The book of Aristotle (IV century BC) was a great achievement in exploring the atmosphere and contributed to the turn from mythology to reality[1]. Scientific justification attempts about the occurring meteorological phenomena did not begin until the 18th century after invention of measuring instruments and discovery of physical laws that determine gases' behavior. After all, the atmosphere is a gaseous mantle of Earth. Even today, people continue to believe in omens, trying to predict changes in weather conditions.

Atmospheric composition

Gas composition of the atmosphere includes nitrogen (≈78%) and oxygen (≈21%). The share of other gases (carbon dioxide, argon, neon, radon, helium, krypton, hydrogen, methane, nitrous oxide and ozone), gases of man-made origin (freon) are about 1%. Suspended particulate matters (dust, water droplets, ice crystals, aerosols) play an important role. They enter the atmosphere both naturally (weathering) and as a result of human activities.

Atmospheric air pollution problem is one of the most serious global problems faced by mankind. Air pollution has been associated with humans for thousands of years, starting with the use of fire for cooking and heating. Threateningly high levels of air pollution became a problem during the industrial revolution, when the mass use of coal led to numerous cases of serious urban air pollution.

Atmospheric pollution is not only dangerous in that it releases harmful substances into the clean air that are destructive to living organisms, but also in pollution-induced change to the Earth's climate. The Great London Fog of 1952, for example, was an extreme form of air pollution, with a dramatic increase in mortality within a single

[1] Ugryumov A.I. Fragments of the book „According to the Hydrometeorological Center." [Electronic resource].- Access mode: https://meteoinfo.ru/ugryumov.

week. Air pollution caused by the open burning of coal in homes and power plants, as well as the use of „dirty“ fuels in transportation and industry, coincided with weather events that trapped pollutants over London, resulting in over 12,000 deaths in a few of days. The resulting public outcry led to the Clean Air Act (1956) in Britain[2]. Other fatal air pollution incidents, in the United States Donora (1948)[3] and the Meuse Valley in Belgium (1930)[4], have prompted similar actions to combat air pollution in other countries.

Human air pollution has increased the concentration of carbon dioxide by nearly 30% over the last 200 years. The process is so massive that it is causing global environmental problems. Air pollution is also taking a toll on the economy. It costs lives, it reduces the ability of people to work, it makes it more difficult to produce important goods for society such as food, it reduces the ability of ecosystems to perform the functions people need, and it costs money to recover and compensate for the damage.

Calculations by the World Health Organization (WHO) and the Organization for Economic Cooperation and Development (OECD) show that air pollution costs society about $1.6 trillion in monetary terms. The obtained data show the scales of the problem[5].

Pollutant characteristics

Air pollution comes from many sources, both natural and anthropogenic. Natural sources include volcanic eruptions, marine aerosols, soil dust, plant fires, and lightning. The most common anthropogenic sources include: electricity generation, transportation, industry, residential heating and cooking, agriculture, solvent use, oil and gas extraction, waste incineration, and construction. Some sources, such as forest and savanna fires and wind-blown mineral dust, occur naturally but are exacerbated by human activities.

Much of the air pollution to which much of the world’s population is exposed is the result of human activity.

The main pollutants affecting human health are particulate matter, ground-level ozone (O_3) and nitrogen dioxide (NO_2). Particulate matter harmful to human health is known as $PM_{2.5}$ (particulate matter less than 2.5 μm in diameter). These fine particles are invisible to the human eye and are forty times smaller than the thickness of a human hair. They are capable of causing significant harm to the human body. These particles are small enough to penetrate deep into the lungs, where they cause inflammation of sensitive lung tissue and can enter the bloodstream, affecting organs such as the heart and brain.

2 wiki2.info: wikipedia free encyclopedia [Electronic resource]. / The Great Smog of London. - Access mode: https://wiki2.info/Great_Smog_of_London, free. - Head. from the screen.

3 wiki2.info: wikipedia free encyclopedia [Electronic resource]. / The Donora Smog, 1948. - Access mode: https://wiki2.info/1948_Donora_smog, free. -Head. from the screen.

4 Wikipedia (1930) Meuse Valley fog [Electronic resource].

5 UNECE Report: Clean Air for Life.

WHO estimates that exposure to $PM_{2.5}$ causes 7 million premature deaths per year[6]. Ozone (O_3) is an important secondary pollutant. It is a potent lung irritant and plant growth retardant. Ozone is also a potent greenhouse gas (GHG). O_3 is formed in the troposphere near the Earth's surface when certain air pollutants „precursors" react with each other when exposed to sunlight. Much of the O_3 is produced by emissions of such a potent greenhouse gas as methane (CH_4) into the atmosphere. O_3 has an indirect effect on the climate by slowing tree growth, reducing the ability of forests to absorb carbon dioxide, and reducing their potential to regulate climate change.

Nitrogen oxides (NO_x) are a group of chemical compounds that pollute the air, and they include nitrogen dioxide (NO_2) and nitrogen oxide (NO). NO_2 is the most harmful of these compounds and is produced by human activities. It affects human health, reduces the transparency of the atmosphere and, at high concentrations, can play a significant role in climate change. At the same time, it is the most important precursor to formation of O_3. Sulfur dioxide (SO_2) and nitrogen oxides (NO_x) react with water in the atmosphere to form sulfuric and nitric acids, which come back to earth as „acid rain". Acid rain affects the environment by damaging leaves of plants, thereby reducing their productivity. Acidification of groundwater and river water can kill fish and insects, affecting other species that feed on them. Acid rain is also known to damage buildings and monuments. Acid rain has decreased significantly in Europe and North America due to stricter controls on SO_2 and NO_x emissions, such as the Clean Air Act of 1970 in the United States, the 1991 Canada-U.S. Air Quality Agreement, and similar measures adopted in Europe[7].

Close correlation between pollution and atmospheric clarity was clearly evidenced when industrial production and traffic shutdowns, which contributed to lower pollutant emissions due to the COVID-19 pandemic, reduced air pollution levels.

The International Agency for Research on Cancer (IARC), which operates under the WHO aegis, has determined that air pollution is a carcinogenic factor[8].

2.2 Policies and problems in the field of atmospheric air pollution

In September 2015, as part of the new sustainable development agenda, countries around the world adopted goals to overcome poverty, protect our planet, and ensure the well-being of all people[9]. Each goal includes specific targets to be achieved over the next fifteen years. Objectives related to air quality and its impacts are reflected in 11 of the 17 Sustainable Development Goals (Table 1).

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6 Frequently Asked Questions About Air Pollution [Electronic resource] / International Day of Clean Air for blue skies. - Access mode: https://www.cleanairblueskies.org/ru/vy-znali/chasto-zadavaemye-vo-prosy-o-zagryaznenii-vozdukha, free. Head. from the screen.

7 Ibid. p.31.

8 Stop air pollution - prevent 50,000 deaths in Europe [Electronic resource] /Noosphere. – 2021. Access mode: https://www.who.int/ru/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health.

9 Sustainable Development Goals [Electronic resource]. - Access mode: https://www.un.org/sustainable-development/en/sustainable-consumption-production/.

Table 1. **Sustainable Development Goals**

Goal 2 Ending Hunger	Reducing the amount of nitrogen emitted into the air and using it in a more ecologically balanced way has a direct impact on the state of soil.
Goal 3 Good health and well-being	Reducing air pollution decreases the risk of a number of non-communicable diseases (e.g., respiratory and cardiovascular diseases), including cancer.
Goal 6 Clean water and sanitation	Water pollution is largely related to the precipitation of pollutants out of the air. Therefore, one way to reduce pollutants in the aquatic environment is to reduce air pollution.
Goal 7 Affordable and clean energy	Since energy production, consumption, and transportation represent a major source of air pollution, increasing the share of renewable energy and improving energy efficiency under this goal will help reduce air pollution. Investments in clean energy technologies, also envisioned in this goal, will also reduce air pollution.
Goal 8 Decent work and economic growth	One of the goals of „green economy“ is to create new jobs and improve existing ones by developing cleaner production and environmentally sustainable technologies, particularly in industries that are less polluting, such as those related to renewable energy or modern transportation, and this is envisaged by this goal.
Goal 9 Industry, innovation and infrastructure	Old production facilities and processes are a significant source of air pollution, so the improvement and modernization of many industrial facilities envisioned for this purpose will significantly reduce air pollution. Investments in research and innovation will also improve industrial production, reduce waste and air pollution.
Goal 11 Sustainable cities and communities	SDG 11 sets a specific goal related to improving air quality: „By 2030, reduce negative per capita environmental impact of cities, including by focusing on air quality, storage and disposal of municipal, and other wastes. Reducing air pollution nationwide helps improve urban air quality”.
Goal 12 Responsible consumption and production	Improved management of chemicals throughout their lifecycle and with all types of waste will help reduce air and water pollution. Improved compliance by enterprises with international and national regulations will also help reduce the amount of pollutants released into the air.
Goal 13 Climate action	Because greenhouse gases and some of the major air pollutants share common sources, combating climate change will improve air quality. In turn, reducing air pollution will contribute to positive climate outcomes.

Goal 14 Life below water	Reduction of air pollution, especially nutrients (nitrogen), will reduce pollution of the seas from land-based sources.
Goal 15 Life on land	Reduction of air pollution will reduce adverse impacts on ecosystems and biodiversity.

Atmospheric air plays an important role in human life and health and the environment, and this can be seen by specific examples.

Air quality and health

Each year, seven million people die prematurely from air and indoor air pollution worldwide, an amount equal to the population of Bulgaria[10]. This is ore than from the main high mortality diseases - malaria, tuberculosis and AIDS - combined.

Air pollution and environment

By 1984, nearly half of the trees in the majestic Black Forest of Germany had been damaged by acid rain. Thirty years later, the forest looks healthier, but the damage has not been completely eliminated, and the forest is still being treated with lime-containing preparations to reduce acidity levels[11]. Sulfur and nitrogen emissions, as well as the formation of ground-level ozone, affect the ability of ecosystems to function and grow. Sulfur dioxide and nitrogen oxides, when released as acid rain into water, soil and plants, increase their acidity and have harmful effects on flora and fauna. Ultimately, acidification affects the ability of ecosystems to provide such services as nutrient and carbon cycling and the provision of water, without which human life on the planet is impossible.

Air pollution and food production

By 2050, air pollution could reduce food production by 10% (Bloometal., 2014)[12], even though the global population will increase by 50% during that time. Food insecurity has increased the need for food while reducing food production due to climate change, changing energy costs, and air pollution. Particularly dangerous in this regard are air emissions of substances involved in the formation of ground-level ozone (nitrogen oxides and volatile organic compounds), which penetrate plant tissues and slow down their development processes.

[10] „at the level of individual countries and at the global level System, indicators and goals May 2014 WHO/HIS/HIA/14.1 Authors of the World Health Organization Ties...“ [Electronic resource] / WHO, 2014. [Electronic resource]. WWW.NEW.Z-PDF.RU.

[11] Guidance document on methods for controlling emissions of sulphur, nitrogen oxides, volatile organic compounds and particulate matter substances (including PM^{10}, $PM^{2.5}$ and black carbon) from stationary sources [Electronic resource] / the United Nations of ECE/EB.AIR/117. -Access mode: https://unece.org/sites/default/files/2021-06/Clean-air-for-life_rus.pdf.

[12] Bloometal., 2014.

Air pollution and industry

One of the main sources of air pollution is electricity production. Coal-fired power plants make a significant contribution to air pollution. A growing concern is the use of diesel generators in areas not connected to the general power grid. Industrial production processes and use of solvents in chemical and mining industries also pollute the air.

Policies and programs aimed at improving energy efficiency and expanding renewable electricity generation have a direct impact on air quality in various countries. To date, 82 of 193 countries around the world have implemented incentive measures that promote greater investment in renewable energy and cleaner production processes, as well as energy efficiency and/or pollution control.

Air pollution and transport

Nearly a quarter of energy-related carbon dioxide emissions come from the global transportation sector, and this share continues to grow. These transportation emissions are closely linked to about 400,000 premature deaths. Nearly half of all deaths due to vehicle air pollution are due to diesel engine emissions, and those who live in close proximity to transportation highways are 12% more likely to be diagnosed with dementia.

Reducing transportation emissions is an important step to improve air quality, especially in cities. Policies and standards requiring cleaner fuels and stricter standards for vehicle emissions can reduce transportation emissions by 90% and more[13].

Air pollution and waste

Open burning of garbage and disposal of organic waste in landfills releases harmful dioxins, furans, methane and black carbon into the atmosphere. Approximately 40 percent of waste worldwide is incinerated outdoors. The problem is most acute in regions that are rapidly urbanizing and in developing countries. Open burning of agricultural and/or municipal waste is practiced in 166 of 193 countries[14].

Improvements in solid waste collection, sorting and disposal methods reduce the amount of waste that is sent to incineration or landfill. Separating organic waste and turning it into compost or biofuel improves soil fertility and represents an alternative energy source. Reducing about one-third of all food that is lost or wasted can also improve air quality.

Air pollution and economic development

Air contamination costs lives, it reduces the ability of people to work, it makes it more difficult to produce important goods for society, such as food, it reduces the ability of ecosystems to perform the functions people need, and it requires the cost

[13] Causes of air pollution [Electronic resource] / International Day of Clean Air for blue skels. - Access mode: https://www.cleanairblueskles.org/ru/vy-znall/prichiny-zagryazneniya-vozdukha.

[14] Ibid p. 34.

of remediation and reparation. The economic costs of premature deaths due to air pollution, especially particulate matter, have increased in many countries in Eastern Europe, the Caucasus and Central Asia[15], in large part due to the increasing number of cars.

Air pollution and climate change

In December 2015, world leaders met in Paris to agree on measures to combat climate change. Until recently, the scientific and policy debates on air pollution and climate change were largely independent of each other, but it is becoming increasingly clear that these issues are intrinsically linked (WMO, 2012). For example, dispersant concentrations in the air are known to vary with seasonal factors and environmental phenomena such as temperature, wildfires, winds, and storms[16]. Forecasts for the USA (Mickleyetal., 2004) indicate that by 2052, as a result of climate warming, air pollutant concentrations in the Northeast and Midwest of the USA could increase by 5-10% during the summer months[17].

In 1967, Svante Oden, a Swedish scientist, drew the world's attention to the fact that acidity of rainfall was linked to the release of sulfur into the air from the burning of fuels, particularly coal at the time.

Twelve years later, in 1979, countries, realizing the transboundary nature of air pollution, joined together to address the problem with the first legally binding international instrument on air pollution, the Convention on Long-range Transboundary Air Pollution (Air Pollution Convention).

The Air Pollution Convention now brings together 51 countries, from the United States and Canada in the west to Kazakhstan (Law of the Republic of Kazakhstan of October 23, 2000 N 89-II On Accession to the Convention in the East. The Convention is supplemented by eight protocols, the main ones are shown in Table 2.

Table 2. **Protocols to the Air Pollution Convention**

Protocol	Principal obligations
The 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol) and its text as amended in 2012	Commitments to reduce air emissions of sulfur dioxide, nitrogen oxides, ammonia, volatile organic compounds, PM 2.5 by 2020 and beyond; application of emission limit values for sulfur, VOCs and NOx and special measures to limit ammonia emissions. Application of emission limit values for mobile sources and limit values for VOC content in products; application of best available techniques to mobile and stationary sources, taking into account relevant guidance documents; reporting.

[15] WHO issues best practices for naming new human infectious diseases [Electronic resource] / WHO and OECD, 2015. [Electronic resource]. www. who.int.

[16] WHO and OECD, 2015.

[17] Mickleyetal. 2004.

The 1998 Protocol on Heavy Metals and its text as amended in 2012	Reduction in air emissions of mercury, lead and cadmium from baseline year levels; application of limit values and best available techniques for large stationary sources; application of regulatory measures for products (unleaded gasoline, mercury in food items); reporting.
The Protocol on Persistent Organic Pollutants and its text as amended in 2009	Cessation of production or use of 21 types of pesticides, restriction of use of two industrial chemicals; reduction of air emissions of four polycyclic aromatic hydrocarbons, dioxins/ furans, hexachlorobenzene and polychlorinated biphenyls and application of best available techniques to their major sources; Reporting.
The Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)	The EMEP program is funded by mandatory contributions from the Parties to the Protocol. The EMEP budget includes the costs of coordinating observation network, collecting data on emissions, developing concentration and deposition models, and integrated assessment models.
Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes, 1988	A protocol to limit emissions of nitrogen oxides and their transboundary fluxes was adopted. Entering into force in 1991, the protocol requires parties to ensure that emissions of nitrogen oxides (NOX) or their transboundary fluxes at the end of 1994 do not exceed 1987 emissions, and requires the establishment of critical loads and corresponding reduction targets with an action schedule.
Protocol on Further Reduction of Sulphur Emissions	The Protocol on Further Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30% was adopted as the first substantive protocol requiring Parties to develop national programs to reduce sulfur emissions. As a result of this protocol, Europe has recorded significant reductions in its emissions.
Convention's Long-Term Strategy	The Convention's updated long-term strategy highlights priorities for 2020-2030, including remaining work on reducing emissions of ozone precursors, particulate matter; implementation of protocols, especially in Eastern Europe, the Caucasus and Central Asia; work on linkages between air pollution, biodiversity and climate change; and cooperation beyond the UNECE region[18].

[18] Convention on Long-range Transboundary Air Pollution (CLRTAP). The 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (known as the Gothenburg Protocol) and its text as amended

The Republic of Kazakhstan joined the Geneva Convention on Long-Range Transboundary Air Pollution on 30 November 1979 (Law of the Republic of Kazakhstan of 23 October 2000, No. 89-II), but is not a party to any of its protocols. This circumstance limits the possibilities for Kazakhstan to participate in UNECE cooperation programmes and to receive financial and technical support for the implementation of programmes under the Convention. Kazakhstan is currently reporting data for the Inventories Information Report and submitted emissions data to the Centre on Emission Inventories and Projections (CEIP) in 2017.

Reference: The Convention was previously signed on behalf of the USSR on November 13, 1979. It was ratified by the Presidium of the Supreme Soviet of the USSR on April 29, 1980. Instrument of ratification of the USSR was deposited with the Secretary General of the UN on 22 May 1980. Pursuant to its Article 16, paragraph 1, the Convention entered into force for the USSR on March 16, 1983. „Vedomosti Verkhovnogo Soveta SSSR", 1983, No. 23.

However, despite the measures taken, the process of increasing emissions globally and their movement between continents exceeds the background levels of pollutants controlled by the Convention's protocols. This means that transboundary air pollution outside the UNECE region has a growing impact on air quality inside the region. In this regard, precursors of ground-level ozone, such as methane, are of serious concern. At the same time, it is becoming increasingly clear that local air pollution, including in cities, is strongly influenced by distant and transboundary transport of pollutants, and that the urban environment itself is also a powerful source of air pollution. Therefore, the challenge is to establish relationship between measures taken at different levels of government in order to identify appropriate different pollution control strategies. In addition, air pollution is a major link in relationship between ozone, nitrogen, climate change and ecosystems, which also requires an integrated approach to environmental policymaking, including beyond the UNECE region. Impacts of air pollution on health also continue to be a serious problem.

Finding the right policy response is becoming increasingly difficult, especially when public awareness is low and citizens expect government action. In the European Union, for example, a recent public opinion survey on the environment showed that air pollution is the problem citizens are most concerned about after climate change.

UNEP's Global Review of Air Quality Policies and Programs shows that the number of countries implementing policies for all key polluting industries has

in 2012. The 1998 Protocol on Heavy Metals. Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP). The 1988 Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes. Protocol on the Reduction of Sulphur Emissions or Their Transboundary. Long-term strategy for the Convention. Law of the Republic of Kazakhstan dated October 23, 2000 No. 89-II.

increased over the past five years[19]. However, significant gaps in implementation, funding, capacity and monitoring indicate that air pollution levels remain high. These data are published on International Clean Air Day for Blue Skies, a new report from the United Nations Environment Program (UNEP).

Clean Air Action: Global Summary of Policies and Programmes to Reduce Air Pollution is based on the results of recent studies in 195 countries. The report evaluates policies and programs in the key air-polluting sectors: transportation, power generation, industrial emissions, solid waste management, household air pollution, and agriculture. It also examines air quality monitoring, air quality management, and air quality standards as key policy tools for mitigating air pollution effects.

As at 2020, 124 countries (about two-thirds of the countries) had introduced national ambient air quality standards, 17 more than reported in 2016. However, only 9 percent of them meet the World Health Organization (WHO) recommended standards[20].

According to the report's findings, while low-income countries suffer more from air pollution, action to reduce air pollution has many development benefits, including climate change mitigation, agricultural productivity, energy security, and economic growth.

Although new policies to protect clean air around the world and a steady decline in the number of illnesses caused by household air pollution in some regions, health statistics show that outdoor and indoor air pollution remains the world's leading health risk factor. Improvements in air quality will require more effective measures to enforce existing policies and standards, substantial increases in funding, and greater monitoring and capacity strengthening.

Meanwhile, jurisdictions of OECD member states have established a number of regulatory tools: obtaining environmental permits, and other permits which establish restrictions on emissions into the environment, on the use of raw materials (natural resources), energy, materials, requirements for the implementation of the best available technologies. Mandatory monitoring of emissions, energy and resource efficiency of the enterprise, compliance with environmental quality standards, which allow to predict the impact, prevent and regulate them[21].

A new study's authors concluded that air quality, which largely depends on human activities, is closely linked to climate change. They confirmed that during the 2019-2020 economic crisis associated with the pandemic, anthropogenic emissions of air pollutants decreased significantly. But at the same time, extreme weather events became more frequent, many of which caused sand and dust storms and wildfires. This trend continues in 2021. Already this year, large-scale wildfires in North America, Europe and Siberia have affected the air quality that millions of people breathe. Sand and dust storms swept through several regions and continents.

[19] Press release. - Air [Electronic resource] / UNEP.org . 07 SEP 2021.

[20] UNEP - UN Environment Programme [Electronic resource]. - Access mode: https://www.unep.org/.

[21] The Sixth Environment Action Programme of the European Community 2002-2012 (6EAP).

2.3 Implementation of the Sustainable Development Goals in Kazakhstan

In order to achieve the goals of sustainable development, Kazakhstan has adopted a number of strategic documents and legislative acts and developed a set of measures aimed at reducing and controlling pollutant emissions, greenhouse gas emissions, and achieving improvements in air quality.

A concept for Kazakhstan to become one of the thirty most developed countries in the world (2014 Decree No. 732 of the President of the Republic of Kazakhstan as of January 17, 2014). Such indicators as reduction of average carbon dioxide (CO_2) emissions during production of 1 kWh of electricity from 1000 g/kWh to 350 g/kWh by 2050 are defined. This must be achieved by modernization of generating capacities and increasing to 50% the share of alternative energy in meeting domestic demand for electricity[22]; halving of the energy intensity of GDP from 0.4 c.t,/thous. USD to 0.2 c.t,/thous. USD This must be achieved by implementation of comprehensive measures to improve energy efficiency.

Kazakhstan's concept of transition to a „green" economy (2013) was implemented in three stages from 2013 to 2020. In this period, the state' s main priority was to optimize the use of resources and improve the efficiency of environmental protection activities, as well as the creation of a „green" infrastructure. On the basis of the formed „green" infrastructure in 2020-2030 will begin the transformation of the national economy, focused on the careful use of water, promoting and stimulating the development and widespread introduction of renewable energy technologies, as well as construction of facilities based on high energy efficiency standards[23].

Measures for the transition to a „green" economy, according to the Concept, are distributed in the following areas:

- sustainable use of water resources;
- development of sustainable and highly productive agriculture;
- energy saving and energy efficiency;
- development of electric power industry;
- waste management system;
- air pollution reduction;
- conservation and efficient management of ecosystems.

It is estimated that by 2050, the transformation of the „green" economy will further increase GDP by 3%, creating more than 500 thousand new jobs, creating new industries and services, and ensuring universally high standards of quality of life for the population.

[22] WHO issues best practices for naming new human infectious diseases [Electronic resource]/ WHO and OECD, 2015. [Electronic resource]. www.who. int.

[23] Government Decree of the Republic of Kazakhstan dated July 31, 2013 No. 750 „On approval of the Action Plan for the Implementation of the Concept for the Transition of the Republic of Kazakhstan to a „Green Economy" for 2013 – 2020". Government Decree of the Republic of Kazakhstan dated July 29, 2020 No. 479 „On approval of the Action Plan for the Implementation of the Concept for the Transition of the Republic of Kazakhstan to a „Green Economy" for 2021 - 2030".

Concept of fuel and energy complex development of the Republic of Kazakhstan until 2030 is currently being updated in connection with the commitments to reduce greenhouse gas emissions. In accordance with the strategic objectives of the country's development, the policy of regional gasification is being successfully implemented. In 2019, the Saryarka main gas pipeline was built, which is laid through the coal-mining Karaganda region, which contains huge reserves of coalbed methane. A legal basis for stimulating the capture and utilization of coalbed methane and the effective use of associated petroleum gas has been established. The Code on Subsoil and Subsoil Use regulates methane handling (Articles 146,153 of the Code on Subsoil and Subsoil Use)[24].

State program for agro-industrial complex of the Republic of Kazakhstan for 2017-2021. The program task is:

- provision of food security;
- improvement of land use efficiency;
- increase in water resources use efficiency;
- increase in technical equipment and intensification of production in the AIC;
- increase in satisfaction with living conditions of the population living in rural areas.

State program of healthcare development of the Republic of Kazakhstan for 2020-2025. Mechanisms and tools for implementation of strategic documents are set out in new edition of the Environmental Code of the Republic of Kazakhstan dated January 2, 2021 No. 400-VI ZRK (hereinafter - the Code), as well as in other legislative acts.

Low-carbon economic development concept of the Republic of Kazakhstan: goals and ways of transformation until 2050. In 2009, Kazakhstan ratified the Kyoto Protocol, and in 2016 the Paris Agreement, introduced an emissions trading system (cap and trade system) (KazETS), which regulated domestic CO_2 emissions and stimulated low-carbon technology development. However, in 2016, KazETS was suspended until January 2018. KazETS suspension did not have a positive impact in terms of encouraging large emission sources to take steps to consistently reduce their emissions. However, during the KazETS suspension, monitoring, reporting, and verification systems were improved. The country has set ambitious goals that may conflict with each other: to become one of the 30 most developed countries in the world by 2050 and to ensure unconditional reduction of GHG emissions by 15% by the end of 2030 compared to 1990.

Kazakhstan has great potential to reduce its ecological footprint as a global source of GHG emissions. Energy sector is the main source of CO_2 emissions, accounting for the lion's share of GHG emissions (in average of 82.4% between 1990 and 2015). Transition from coal and oil to gas and renewables will reduce GHG emissions and, at the same time, reduce oil and coal refining pollution.

Climate change is cross-sectoral in nature, it is still perceived as a separate topic to be dealt with by a specific body designated as responsible for climate change issues. This is affected by the lack of reflection of climate change aspects

[24] WHO and OECD, 2015.

in various policy documents and limited coordination on climate change issues. President of the Republic of Kazakhstan Kassym-Jomart Kemelevich Tokayev at the 76th session of the UN General Assembly stated Kazakhstan's intention to achieve carbon neutrality by 2060. This topic is covered in Chapter 8.

The Environmental Code of Kazakhstan as of January 2, 2021, No. 400 - VI ZRK (hereinafter - the Code) is harmonized with OECD best practices and meets new trends and challenges of the modern world in the field of environmental protection[25].

For the first time the concept of atmospheric air quality and atmospheric air quality standards were introduced at the legislative level. Environmental standards for atmospheric air quality are established:

- for chemical indicators of atmospheric air state in form of maximum permissible concentrations of pollutants in the atmospheric air;
- for physical indicators of atmospheric air state in form of maximum permissible levels of physical impacts on the atmospheric air.

In order to ensure atmospheric air protection, the state establishes standards of permissible anthropogenic impact on atmospheric air:

- standards of permissible emissions are set in the environmental permit, and are defined as the maximum mass of a pollutant or mixture of pollutants allowed (permitted) to be emitted into the atmosphere;
- technological standards of emissions;
- standards for permissible physical impacts on the atmospheric air.

The Code obliges local executive bodies to develop target indicators of environmental quality. It defines mandatory indicators for which quality target indicators are set:

- quality of atmospheric air;
- quality of surface and underground water;
- quality of land and soils;
- total area of forests and greenery, taking into account climate and soil conditions in each region;
- reduction of land degradation and desertification;
- total volume of emissions by type of pollutants;
- total volume of discharges by type of pollutant and by each individual water body and basin;
- by types of municipal waste - the share of separate collection, preparation for reuse, recycling, utilization and disposal (destruction and (or) burial);
- cumulative reduction of greenhouse gas emissions.

The Code determines the right of local representative bodies of regions, cities of republican significance, the capital to provide for the introduction of special environmental requirements in the field of air protection in the territories of certain administrative-territorial units in cases where on such territories the established environmental standards for air quality are not complied with within their regulatory

[25] Environmental Code of the Republic of Kazakhstan dated January 2, 2021. No. 400-IY. Directive 2010/75/EU on industrial emissions.

legal acts in coordination with the authorized body in the field of environmental protection; to impose restrictions on the entry of vehicles and other mobile vehicles or their individual types into settlements or separate zones within settlements, on the territory of places of recreation and tourism, specially protected natural territories, as well as to regulate the movement within them of transport and other mobile vehicles in order to reduce the anthropogenic load on the atmospheric air.

For the purpose of real-time control of pollutant emissions, operators of Category I facilities are required to monitor using automated systems, and to transmit information on the emissions carried out to the Unified State System for Monitoring the Environment and Natural Resources. For the failure to comply with these requirements, the environmental permit may be suspended, the operator of the installation may be deprived of the environmental permit in connection with the failure to comply with the environmental conditions of the permit. For the entities that obtained comprehensive environmental permits and were exempted from environmental emission fees, the full amount is to be refunded on a regressive basis, taking into account the coefficient established for the respective period. For facilities commissioned before July 1, 2021, the requirement of the Code on the mandatory presence of an automated emission monitoring system applies from January 1, 2023.

Comprehensive environmental permit, is an environmental permit which contains a set of measures of the best available techniques for the reduction of waste, energy consumption, resource conservation, monitoring of noise, vibration, odor, prevention of emissions and discharges of pollutants, which allow to achieve environmental quality. Operators of facilities whose activities are included in the list of areas of best available techniques (Schedule 3 to the Code) are required to obtain this document, thereby undertaking responsibilities to implement the best available zero-waste, innovative technologies.

The best available techniques are the most effective and advanced stage of development of activities and methods of their implementation, which indicates their practical suitability to serve as the basis for the establishment of technological standards and other environmental conditions aimed at preventing or, if it is not practicable, minimizing the negative anthropogenic impact on the environment. At the same time, techniques mean both the technologies used and the methods, techniques, processes, practices, approaches and solutions applied to the design, construction, maintenance, operation, management and decommissioning of a facility.

Techniques shall be deemed available if the level of their development allows the introduction of such techniques in the relevant sector of production on economically and technically feasible terms, taking into account costs and benefits, regardless of whether such techniques are used or produced in the Republic of Kazakhstan, and only to the extent that they are reasonably available to the plant operator.

The „best“ refers to those available techniques that are most effective in achieving a high overall level of environmental protection as a whole.

Such plant operators, in accordance with the Tax Code of the Republic of Kazakhstan, are exempt from payment for emissions to the environment. Emissions are releases, discharges of pollutants into the environment. Transition to the best

available techniques principles will minimize the anthropogenic load (in terms of industry) on the environment, and in turn is a tool for industrial enterprises to improve the competitiveness of their products, in line with global trends. The main pollutants affecting the quality of atmospheric air defined by WHO are included in the list of marker substances and are subject to real-time monitoring. Such as carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NO_x), ozone (O_3), hydrocarbons, lead (Pb), industrial dusts PM^{10}, $PM^{2.5}$ (mechanical dust, combustion gases, fly ash and industrial soot).

Also, the authorized body in the field of environmental protection approved the list of pollutants the emissions of which are subject to environmental regulation (hereinafter - the list of pollutants) (Order of the Minister of Ecology, Geology and Natural Resources of the Republic of Kazakhstan No. 212 as of June 25, 2021). Real-time monitoring using automated monitoring systems is required for all operators of Category I plants. Data from automated systems will be sent to the Unified State System of Environment and Natural Resources Monitoring. For non-compliance with the requirements for installation of such systems, the environmental permit is subject to suspension, revocation due to non-compliance with the environmental conditions of the permit. For the subjects who received complex environmental permits and were exempted from payment for emissions into the environment, the full amount will be refunded on a regressive basis, taking into account the coefficient established for the relevant period.

A standard list of environmental protection measures has been approved, which contains a separate section „Atmospheric Air“ of 17 areas:

1. commissioning, repair and reconstruction of dust and gas treatment plants designed to capture, neutralize (utilization) of harmful substances emitted into the atmosphere from technological equipment and aspiration systems;
2. installation work related to the rationalization of heating systems, including heat recovery, flue gas recirculation with discharge into the burner, domestic production of power equipment with a high efficiency factor and the use of alternative, environmentally friendly energy sources;
3. implementation of measures to prevent and reduce pollutant emissions from stationary and mobile sources;
4. implementation of the best available techniques at municipal thermal power plants and combined heat and power plants;
5. introduction of equipment, plants and treatment devices for utilization of associated gases, neutralization of exhaust gases, suppression and neutralization of emissions of pollutants and their compounds into the atmosphere from stationary and mobile pollution sources;
6. installation of catalyst converters for cleaning exhaust gases in vehicles using unleaded gasoline as fuel with fuel additives that reduce toxicity and „smokiness“ of exhaust gases, equipping vehicles operating on diesel fuel with exhaust gas neutralizers, transfer of motor vehicles, increased use of electric traction;
7. measures to prevent environmental pollution during transportation, storage and use of chemical agents for plant protection, mineral fertilizers and other preparations;

8. optimization of the technological process, ensuring reduction of pollutant emissions during mining, blasting operations, placement and operation of waste heaps, dumps and landfills;
9. works on dust suppression at mining and heat power enterprises, subsoil and construction sites, including tailing pits, sludge reservoirs, open pits and in-field roads;
10. introduction and improvement of technical and technological solutions (including transition to other (alternative) types of fuel, raw materials), which allow reducing the negative impact on the environment;
11. purchase of modern equipment, replacement and reconstruction of main equipment ensuring efficient cleaning, utilization, neutralization, suppression and neutralization of pollutants in gases, discharged from emission sources, dismantling of outdated boilers with high concentration of pollutants in flue gases;
12. introduction of technological solutions to optimize fuel combustion modes (changing the quality of fuel used, the structure of the fuel balance), reduction of toxic substances (including lead compounds, nitrogen oxides) in air pollutant emissions, including for mobile sources;
13. measures aimed at reducing greenhouse gas emissions and (or) increasing greenhouse gas absorption;
14. reduction of the use of ozone-depleting substances through the use of ozone-friendly substances;
15. introduction of systems of automatic monitoring of pollutant emissions at sources and the quality of atmospheric air on the border of the residential sanitary protection zone;
16. improvement of the efficiency of existing dust and gas collectors, including their modernization, reconstruction, and equipping them with control and measurement devices with the introduction of automatic control systems;
17. construction and modernization of observation posts for atmospheric air conditions with the expansion of the list of pollutants monitored through the purchase of modern equipment and the introduction of a local network for transmitting information to the authorized body for environmental protection and its territorial subdivisions.

Kazakhstan has also established regulatory instruments to hold emissions of pollutants into the atmospheric air by legislative acts. New edition of the Environmental Code is harmonized with OECD best practices. Regulation is performed by:

- authorized body in the field of environmental protection. Develops environmental quality standards, which are established in accordance with the Code separately for atmospheric air.

Environmental standards for atmospheric air quality are established:

1. for chemical indicators of atmospheric air state - in form of maximum permissible concentrations of pollutants in the atmospheric air;
2. for physical indicators of atmospheric air state - in form of maximum permissible levels of physical impacts on atmospheric air.

Provides public access to environmental information on the state of atmospheric air, climate change, water and land resources, biodiversity, energy situation, waste management, surface and groundwater, soils and land.

Climate Policy and Green Technologies Department of the authorized body in the field of environmental protection develops the State Regulation of emissions and absorption of greenhouse gases, which is performed using the following tools:

1. establishment of carbon budget;
2. carbon quota;
3. administration of plant operators.

Develops the Carbon Budget, the National Carbon Plan, manages the reserve of the National Carbon Plan, the distribution of carbon units among the quota subjects, the approval of the carbon offset and the granting of offset units, monitors the volume of quota emissions of greenhouse gases of the administered installations.

The Committee for Environmental Regulation and Control establishes limits on emissions into the atmosphere through environmental permits. It monitors and controls the implementation of the requirements defined in the environmental permit for compliance with legislation in the field of environmental protection.

Authorized body in the field of standardization and certification defines the legal basis of the state system of standardization in the field of environmental protection, human protection from environmental impact and safety. In particular, the implementation of environmental management system ST RK ISO 14001-2006, as the object of the best available techniques, is a mandatory requirement for operators of facilities of category I. Goods, products, processes, services are subject to standardization.

Authorized body in the field of sanitary-epidemiological welfare establishes hygienic requirements for the atmospheric air in urban and rural areas, in the territories of industrial organizations; the air of industrial, residential and other premises. Exercises control.

RSE Kazhydromet conducts environmental monitoring in residential areas, meteorological and hydrological monitoring using the state observation network. Forms and maintains the state climatic cadastre and a systematic set of data based on meteorological information about the totality of atmospheric conditions, including air temperature, cloudiness, atmospheric phenomena, wind direction and speed, precipitation and other characteristics of the atmosphere and underlying surface, typical for certain territories, and formed on the basis of the climate database of meteorological data for a multi-year period.

Local executive bodies provide informing the population about the state of the atmospheric air, and the local representative bodies approve the environmental quality targets for the quality of atmospheric air in the region.

Environmental quality targets are determined taking into account the environmental problems of the region and provide indicators of the state of atmospheric air with the development of a set of measures to reduce pollution. Regional indicators of the atmospheric air quality are taken into account when issuing environmental permits.

Tax authorities exercise control over timely payment within the limits of permitted emissions into the environment, the object of taxation is the actual volume of emissions into the environment, including those established by the results of inspections by the authorized body in the field of environmental protection and its territorial bodies on compliance with environmental legislation of the Republic of Kazakhstan (state environmental control), as emissions of pollutants (Article 595 of the Tax Code of RK).

Fee rates for emissions of pollutants from stationary sources are (Table 3):

Table 3. **Fee rates for emissions from stationary sources**

No.	Types of pollutants	Fee rates per ton (MCI)	Fee rates per kilogram (MCI)
1	2	3	4
1.	Sulfur oxides	10	
2.	Nitrogen oxides	10	
3.	Dust and ash	5	
4.	Lead and its compounds	1,993	
5.	Hydrogen sulfide	62	
6.	Phenols	166	
7.	Hydrocarbons	0.16	
8.	Formaldehyde	166	
9.	Carbon oxides	0.16	
10.	Methane	0.01	
11.	Carbon black	12	
12.	Iron oxides	15	
13.	Ammonia	12	
14.	Hexavalent chromium	399	
15.	Copper oxides	299	
16.	Benz(a) pyrene		498.3

Kazakhstan has ratified the Protocol on Pollutant Release and Transfer Registers to the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Kiev Protocol) by the Law of the Republic of Kazakhstan No. 279-VI ZRK as of December 12, 2019. Pollutant Release and Transfer Register (PRTR) established in Kazakhstan provides a solid basis and significant opportunities for the country to use positive examples of PRTRs developed by other countries, including OECD member countries, to improve the use of the PRTR instrument. It is important that the PRTR covers the latest technological developments and effectively serves as a „one-stop shop" for industry and governments in fulfilling their various national reporting obligations and Kazakhstan's reporting obligations under the MEAs and the Sustainable Development Goals, thereby reducing the overall reporting burden on governments and businesses. It is also important that PRTRs allow the results of reporting to be used in a comprehensive manner for a variety of purposes. Since PRTR systems are highly dependent on technological developments, it is essential that new PRTR projects and activities related to PRTRs in Kazakhstan take into account the latest technological developments, anticipate possible future program/technical updates and are sustainable over a long period of time. However, PRTR systems are in the process of formation. The current PRTR system is a collection of scanned data submission forms of various enterprises. This does not allow ranking emissions in real time in the context of their types (in air, water, soil). The information is presented only by area. And some enterprises in some regions are not presented in the PRTR system at all. There is no information on some regions at all (Pavlodar and Turkestan regions). Thus, the existing PRTR system is not able to demonstrate a transparent picture of the state of the environment.

Aarhus Convention

Aarhus Convention has a great importance for the regulation of relations in the field of nature management and environmental protection. As it is known, this convention was signed by 38 countries in Aarhus, Denmark, on June 25, 1998 at the 4th Conference of European Environment Ministers within the framework of „Environment for Europe" process. Ten countries from the post-Soviet territory (Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Ukraine) were among the countries that ratified it. It should be noted that at the time of the Convention ratification none of these countries was ready to comply with the provisions of this international legal act. Meanwhile, the Aarhus Convention played an important role in regulation of relations, which were not regulated by national legislation, as well as in improvement of environmental legislation of these countries by means of implementation of norms of the Convention into legal acts of these countries. At least, the Aarhus Convention allowed the Republic of Kazakhstan to develop and introduce amendments and additions into the legislative acts regulating relations in the field of ecology and nature management.

Basic principles of the Aarhus Convention are, first of all:

- provision of active public access to information;
- involvement of the public in decision-making process of ecologically significant

decisions, in development of state ecological policy, programs and action plans;
- provision of public access to justice on issues related to the environment;
- support of public organizations engaged in environmental protection and ensuring compliance of national legislation with this principle.

Ecological information available on the websites of the main state bodies responsible for organizing work in the field of environmental protection (Ministry of Ecology, Geology and Natural Resources, Ministry of Agriculture) leaves much to be desired. The Information and Analytical Center for Environmental Protection (hereinafter - IAC EEP) under the Ministry of Ecology, Geology and Natural Resources, provides access to environmental information online through several specialized websites. Although this practice in itself is not a disadvantage (due to the fact that environmental information is actually provided by the IAC EP), poor visualization of environmental information and the lack of opportunities for the public to access it through the websites of ministries, indicates an insufficient level of attention paid by them to environmental issues. Websites of local executive bodies contain small amount of environmental information. An additional problem that needs to be addressed is the low quality of the information provided.

Kazakhstan ratified the Aarhus Convention, Law of the Republic of Kazakhstan of October 23, 2000 No. 92-II ZRK as of 23 October 2000.

Despite the introduction of rather stringent measures, there are problems that do not allow to effectively create conditions for the quality of atmospheric air.

As mentioned above, environmental quality monitoring on the territory of the country is carried out by RSE Kazhydromet of the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan. At the moment, the overall network of atmospheric air monitoring of RSE Kazhydromet includes 70 settlements and 170 environmental posts, which allowed to achieve 100% coverage of the territory of Kazakhstan with atmospheric air monitoring.

Taking into account the recommendation of the Joint Economic Research Program (JERP) - Kazhydromet since 2013 has gradually included monitoring of atmospheric air quality for priority substances, such as suspended solids $PM^{2.5}$, PM^{10}, sulfur dioxide, nitrogen dioxide, carbon monoxide in all observation points. Since 2021 ozone is measured in Nur-Sultan, Almaty, Shymkent, Atyrau, Ust-Kamenogorsk, Karaganda, Kostanay, Kyzylorda, Aktau, Taraz, Uralsk, Pavlodar, Petropavlovsk, Turkestan, Schuchinsk-Borovoye resort area.

As of 2021, at the state network of atmospheric air quality monitoring, $PM^{2.5}$ measurements are performed at 101 automatic posts. However, so far Kazhydromet posts are not equipped with analyzers for PM^{10} measurements.

Determination of benzopyrene concentrations in the air of Almaty began in 2020, benzopyrene is determined in Nur-Sultan in 2021, and measurements of volatile organic compounds in the air of Nur-Sultan, Atyrau and Almaty are planned from 2022.

RSE Kazhydromet launched a mobile application „Airkz“, which integrates data from all environmental posts. The mobile application by the experts of the Environmental Performance Assessment (EPA) is noted as a positive experience

in Kazakhstan to raise public awareness of air quality. Monitoring results are also available online hourly on the Interactive Map on the website of RSE Kazhydromet.

New application „AirKz“ developed by Kazhydromet offers users basic information on both monitored parameters and the impact of air pollution on human health. LED screens in the cities of Almaty, Aktau, Atyrau, Kostanay, Pavlodar, Petropavlovsk, Taldykorgan, Uralsk and Ekibastuz are displaying data from the AirKZ mobile application to monitor air quality. For the other cities of Kazakhstan the work is ongoing.

However, the app does not provide users with recommendations on what to do at specific levels of air pollution, nor does it contain health risk maps or other health-related information, as this is the responsibility of the Ministry of Health of Kazakhstan.

2.4 Air quality standards

As a unit of air quality measurement in Kazakhstan, levels of maximum permissible concentrations (MPCs) of pollutants are used. Air quality standards are based on maximum single and average daily values, but special indices are used to assess the state of air pollution, which are indirectly related to MPCs. Indices can be used as indicative tools and for comparative assessment of cities, but in practice the use of indices does not allow to get a clear idea of the real air quality to assess the risks to human health, which can be provided in case of using the internationally accepted standards for determining concentrations.

Issue of necessity to develop national standards on the basis of WHO and European standards recommendations has been raised for a long time. However, to date, MPC standards have not been revised. Consequences: irrelevant standards do not allow to assess air quality by such important for Kazakhstan indicators as the sum of hydrocarbons and methane, the average annual content of hydrogen sulfide, etc. Importantly, air quality has a long history of deterioration. This suggests that MPC standards set for plant operators are very lenient, and this leads to a significant accumulation of pollutants in the air. There are differences between the Kazakh air quality standards and the WHO standards. As mentioned above, the WHO uses average daily and annual limit values for PM^{10}, $PM^{2.5}$, and NO_2 particles to assess air quality, whereas in Kazakhstan, maximum single MPC values are used. For example, the one-time MPC for $PM^{2.5}$ used in Kazakhstan is 16 times higher than the average annual WHO standard.

Established emission limits

Emission limits are set as part of the MAE and EIA on the basis of MPC standards. MPC standards are outdated and set without taking into account the current conditions in Kazakhstan. Emission limits themselves have not been reviewed for a long time. Methods for setting emission limits do not take into account the increased impact on atmospheric air pollution of a set of emission sources, including vehicles, private sector, sewage facilities, etc. This leads to the fact that industrial

emission sources contribute pollution to the atmosphere in excess of urban pollution. Consequently, there is a picture of long-term deterioration of air quality.

Statistical compilations compare air quality with national air quality standards, with no comparison with WHO standards. Emissions of various pollutants are summed up, without taking into account toxicity levels.

Chaotic urban development

Recently, there has been a lack of planning of urban development, taking into account the wind rose, the ventilation of the city, the location of sources of air pollution. Thus, chaotic development in Almaty, Nur-Sultan and other cities of Kazakhstan have led to a decrease in average wind speeds, disturbance of the direction of air flows, respectively, a significant accumulation of pollutants in the atmosphere and the formation of acrid smog.

Lack of inventory of all emission sources

To date, there has been no inventory of all sources of emissions, including emissions from motor vehicles, the private sector, small businesses (cafes, saunas, shashlik houses, etc.), livestock farms, landfills. Consequently, this leads to the inability to regulate them. As a consequence, the atmospheric air is largely polluted by uncontrolled volumes of emissions of pollutants.

Lack of processing of data received from the operators of installations as part of the implementation of plans of environmental protection measures. The Committee for Environmental Regulation and Control does not process the data. In this regard, regional population does not have access to information on the implementation of environmental measures by plant operators, which causes a negative reaction and distrust on the part of residents.

Local executive bodies (LEAs) are not involved in the process of regulation of air pollution. In international practice, local executive bodies are responsible for environmental pollution on a par with the operators of installations. In case of failure to take measures to improve, LEAs receive sanctions from the Government, which is a good incentive for active participation of local authorities in improving the condition of atmospheric air quality.

List of environmental problems of Kazakhstan's regions is quite large, one of which is atmospheric air pollution. According to the results of environmental monitoring of atmospheric air, in 2020, out of 45 industrial cities and megacities, 10 cities belong to a high level of atmospheric air pollution. These cities are Nur-Sultan, Almaty, Karaganda, Temirtau, Atyrau, Aktobe, Balkhash, Ust-Kamenogorsk, Zhezkazgan and Shymkent. Overall pollutant emissions amounted to 2.5 million tons.

The RK Ministry of Ecology, Geology and Natural Resources has signed memorandums with large industrial enterprises, such as Samruk-Energy JSC in Almaty (must modernize CHP-2 and CHP-3 to switch to gas) in addition to the measures being taken. In Karaganda Region, Arcelor Mittal Temirtau JSC is committed to reducing atmospheric emissions by 30% by 2025. In the East Kazakhstan region

Kazzinc LLP is committed to reducing atmospheric emissions by 20%. Also, the existing landfills will be brought into compliance.

Where does Kazakhstan rank in the global air pollution ranking?
32/ 106 countries in ranking for 2020.
In harmful zone, for sensitive groups

Prospects for improvement of atmospheric air quality

The world community is concerned about the state of atmospheric air quality, because this issue is not a local one, or a problem of one city or country. This problem has a global scale. Efforts by European countries to improve air quality are gaining momentum. „The European Green Deal" sets new priorities for achieving zero air pollution. Politicians, the media and the public are increasingly interested in air quality issues, and public support for initiatives is growing. The development of guidelines and projects to reduce air pollution is based on continuous monitoring of urban air quality. For example, CAMS consolidates observations at local, national and European levels and provides air quality forecasts based on satellite observations, ground-based measurements and digital models. This allows local authorities and policymakers to target the specific cause of pollution, be it transport, industry, or a dust cloud from the Sahara.

Air quality monitoring tools demonstrate the effectiveness of day-to-day measures to reduce air pollution, such as showing how limiting traffic flow on a given day can reduce the amount of particulate matter in the air. Health experts, too, are using this information to stimulate action against air pollution.

A study by King's College London, for example, showed that having good data could help reduce the impact of air pollution by as much as 50 percent through small changes in daily activities. In Helsinki, scientists are consolidating air quality data from urban communities and citizens, who carry mobile sensors that transmit more accurate information about pollution zones. The goal of HOPE project is to provide basic information about air quality and its impact on city residents in an accessible form, with a focus on what city residents can do to improve local air quality.

Experts from Zaragoza, Santiago de Compostela, Florence, Modena, Livorno and Pisa are linking traffic data to weather forecasts and toxic levels to reduce air pollution from road vehicles. TRAFAIR's project uses low-cost sensors placed throughout the city to monitor pollutant content, and then uses traffic data and pollutant dispersion patterns to predict air quality.

An innovative approach to solving the problem of air pollution costs the city of London 4.1 billion euros a year. The Breathe London project aims to create the world's largest air quality monitoring network. As part of the project, 100 sensor modules have been installed on lampposts and buildings of the city, which measure the level of air toxicity in real time, and GoogleStreetView vehicles equipped with mobile sensors travel in central areas of the city and take one-second measurements. City

residents also participate in the project, who will use portable sensors to measure air quality in their neighborhoods.

Research carried out by the Netherlands Bureau for Economic Policy Analysis has demonstrated the effectiveness of combined measures to reduce CO_2 and particulate matter, which are much cheaper. By combining measures to reduce air pollution and mitigate climate change, it is possible to reduce CO_2 emissions in Western Europe by 15% more than by implementing measures from just one of these programs[26].

In a changing climate, there is a need to combat both air pollution and greenhouse gas emissions at the same time. This is a win-win situation that will have a direct impact on public health.

In Central Asian countries supported by the World Bank, such as Uzbekistan, research is being completed on planting saxaul, a tree native to Central Asia that could reduce air pollution from sand and dust storms coming from the bottom of the Aral Sea. The basin of this body of water has degraded to the point that today it is mostly a salt desert. Strong winds generated there carry 15 to 75 million tons of salt and dust annually, which negatively affects air quality and human health. In the Kyrgyz Republic, the World Bank is supporting the development of a master plan to improve air quality, including the preparation of pre-feasibility studies that will lead to priority measures to improve air quality in Bishkek. This study is part of a broader land reclamation initiative that has been launched throughout Central Asia.

Conclusion

In his Address to the People of Kazakhstan, the President of the Republic of Kazakhstan instructed to pay special attention to environmental problems in the country, especially air quality. In the medium term, 10 of the most polluted cities must be gasified and converted to alternative energy sources.

New edition of the Environmental Code of the Republic of Kazakhstan gives positive prospects for improving air quality in Kazakhstan.

Implementation of the best available techniques principles by large industrial enterprises will effectively influence the environment, and the atmospheric air in particular. A set of measures on resource conservation (water, energy, fuel), energy efficiency and energy conservation, the use of industrial waste generated in the economy, and their subsequent reduction, the modernization of existing facilities, the introduction of innovative low-carbon technologies, real-time monitoring of major pollutants, all together, will give a significant reduction of pollutants in the environment. It should also be noted that the environmental regulation of large industrial enterprises is carried out according to the sectoral principle. This means that sectoral state bodies will have to „green“ the industry's development.

As a result of implementation of BAT principles in the EU a significant reduction

[26] European cities in pursuit of clean air [Electronic resource] / Euronews. - Access mode: https://ru.euronews.com/green/2020/09/09/yevropeyskiye-goroda-v-pogone-za-chistym-vozdukhom.

of pollutant emissions was achieved: sulfur dioxide was reduced by 94%, nitrogen oxides by 69%, dust and particulate matter by 94%[27].

Local executive and representative bodies must develop and approve environmental quality targets within which to monitor the state of the environment in the region, and be responsible for their implementation. Plan the development of the region taking into account the target indicators. Target the use of funds received in the budget for environmental emissions for environmental protection measures in the region.

Thus, provisions of the Environmental Code formed a comprehensive approach to pollution prevention involving all interested state and local executive bodies to achieve environmental quality in Kazakhstan.

The European Union experience shows effectiveness of air quality control tools, which demonstrate effectiveness in day-to-day measures to reduce air pollution.

RSE Kazhydromet needs to increase the number of tools to monitor air quality.

Local executive bodies have established control over the condition of atmospheric air in the cities of Nur-Sultan, Almaty, Temirtau and Ust-Kamenogorsk, through automated monitoring systems. The installation of such systems throughout the country will provide additional information and allow the consolidation of observation results at the local and national level. However, the Code does not provide for the inclusion of such data in the Unified State System of monitoring of the environment and natural resources. To consolidate data, it is also necessary to integrate data of sanitary and epidemiological monitoring of the environment with the Unified State System of Monitoring of Environment and Natural Resources.

Consolidated data will allow us to understand the situation and effectively address issues of air pollution. For the RK Ministry of Health, consolidated information will allow to control the level of morbidity associated with exposure to pollutants.

Ratification of protocols of the Convention on Air Pollution by Kazakhstan will allow to participate in the cooperation programs of UNECE and receive financial and technical support for the implementation of programs under the Convention.

As it was mentioned above, Kazakhstan adopted strategic documents The Concept of Transition of the Republic of Kazakhstan to Green Economy and The Concept of Low-Carbon Economic Development of the Republic of Kazakhstan: Goals and Ways of Transformation till 2050. The world community raises the issue of ensuring consistency of policies to improve air quality and reduce greenhouse gases. Unification of efforts and consistency of the adopted Concepts will improve quality of the environment.

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Chapter 3

WATER RESOURCES OF KAZAKHSTAN

3.1 Water is Blue Gold

Water is the simplest chemical compound of hydrogen and oxygen (H_2O), made by nature itself, has been and remains the greatest value on earth. It is a key component of natural ecosystems, an important factor of economic development, and access to it is a basic human right.

As of today, Kazakhstan is a state rich in natural resources, but comparatively poor in water resources. Mean multi-year runoff is estimated at 100 km3 per year, of which 44% comes from transboundary and 56% from domestic sources. Country's climate is arid, characterized by uneven territorial and seasonal distribution of water resources and precipitation. Main feed sources are glacier and snow melt water, rainfall, as well as groundwater reserves in several areas.

The country's territory can be divided into eight water basins, seven of which are transboundary. The level of dependence on transboundary sources varies throughout the country, with its highest degree in the Aral-Syrdarya basin, where up to 90% of all resources flow in from neighboring countries.

According to Malin Falkenmark's classification,[1] Kazakhstan is not one of the countries experiencing water stress (when water per capita is 1,700 m^3) or water scarcity (when water per capita is 1,000 m^3). In 2017, the total amount of renewable water resources was 5,955 m^3 per capita.[2] However, this figure does not reflect significant territorial heterogeneity. The main problem in Kazakhstan is that in some basins volume of water is sufficient to meet the water needs of both natural ecosystems and population and economic activities. In other regions, however, the level of pressure on water ecosystems is significant due to both limited water resources and developed water-intensive economic activity.

Country's economy as a whole is water-dependent, with 66% of all water used in agriculture, 30% in industry and the remaining 4% for municipal purposes. At the same time, Kazakhstan exports virtual water. Virtual water is the volume of water consumed per unit of production. For example, production of one kilogram of cotton requires more than twenty thousand liters of water, and production of one gigajoule of oil requires 28 to 72 liters of water. Thus, between 2000 and 2016, the volume of virtual water contained in agricultural output in Kazakhstan ranged from 55.61 to 83.98 billion m^3 of water per year. At the same time, the main water consumer was wheat, and the main destinations for export of virtual water were Russia and

[1] According to Malin Falkenmark, countries with water availability within 1,000 m^3 per capita are chronically water stressed and those within 1,600 m^3 per capita are water stressed. For details, see Falkenmark, Malin, and Carl Widstrand. „Population and water resources: a delicate balance." Population bulletin 47, no. 3 (1992): 1-36. and Falkenmark, Malin, Gunnar Lindh, Roger G. Tanner, Yahia Abdel Mageed, and Ven Te Chow. Water for a starving world. Routledge, 2019.

[2] UN-Water. Kazakhstan [Electronic resource]. - Access mode: https://sdg6data.org/country-or-area/ Kazakhstan#anchor_6.4.2.

Azerbaijan. Such large-scale export of virtual water leads to significant pressure on local natural and water resources.[3]

This section will introduce the main issues of water resources management in the country. It will first give a brief overview of the implemented reforms in water resources management, followed by an analysis of the main aspects of water security in the country, both in transboundary and national contexts. Separately, analysis and discussion of the current situation in water management and protection will be presented and recommendations on further improvement of the situation will be given.

3.2 Main aspects of water resources management in Kazakhstan

Water sector reform in Kazakhstan started after independence and was closely connected with the land reform. This was due to the fact that agriculture was and still is the main water consumer in the country - it accounts for up to 66% of all water consumed in the country.

The first important legislative act in the field of water management was the Water Code adopted in 1993. It was aimed at introducing a new principle - water management-basin principle along with administrative-territorial principle. The first principle stipulated that water resources should be considered, first of all, within the boundaries of water management basins, even if the basins passed through the territory of different provinces and districts. It was aimed at more integrated management and distribution of water resources among water users. Thus, the basin as a unit was the basis for formation of the country's water policy. The Water Code also created an opportunity for joint water use of people, e.g. farmers, and laid the foundation for the development of water users associations (WUAs).

Introduction of the basin principle of management in Kazakhstan reflected the global agenda. As far back as 1992, the so-called Dublin Principles of Water Resources Management were adopted at the Conference on Water and Environment in Dublin, which read as follows:

- Freshwater is a finite and vulnerable resource, vital to support life, development and the environment;
- Water development and management should be based on a participatory approach including users, designers and decision makers at all levels;
- Women play an important role in water provision, management and conservation;
- Water has an economic value in all competing water uses and should be recognized as an economic commodity.[4]

These principles were a significant contribution to Agenda 21 in Rio de Janeiro and laid the foundation for the Integrated Water Resources Management (IWRM) approach.

[3] Ding, Y. K., Y. P. Li, and Y. R. Liu. „Spatial-temporal assessment of agricultural virtual water and uncertainty analysis: The case of Kazakhstan (2000-2016).“ Science of the Total Environment 724 (2020): 138155.

[4] Global Water Partnership. Integrated Water Resources Management. Thematic publication of the Technical Committee 4.

Today, IWRM is an internationally recognized approach in water resources management that provides for „coordinated development and management of water, land and related resources to maximize economic and social benefits based on the principles of equity without compromising ecosystems" resilience.[5] It is based on six principles, including (1) water should be managed within river basins, (2) basin water and land resources should be managed in an integrated manner, (3) social, economic and environmental factors should be considered in water resources planning and management, (4) surface and groundwater resources are linked and should be integrated into the management system, (5) public participation is essential for effective decision-making on water resources management, as well as (6) transparency and accountability in decision-making are important components in effective water management.[6]

Thus, the very first Water Code of Kazakhstan envisaged implementation of international water management principles. It created a basis for basin water management through basin councils, united different components of water resources, such as surface water, groundwater, glaciers and waters of the Caspian Sea and Aral Sea into one water fund, as well as outlined the role of public in implementation of control over water use and protection and participation in decision-making process.[7]

In spite of the fact that the Water Code has laid the foundation for wider participation of water users in the management of on-farm irrigation infrastructure, the situation has not significantly changed at the initial stages. This was due to difficulties in reforming the former collective and state farms, as well as some legal requirements for water users. [8] These issues were solved by amending the Civil Code in 1995 and by adopting the Decree of the President of the Republic of Kazakhstan having the force of the law on land. The Law on Bankruptcy was adopted in 1997 and the Law on Peasant and Farm Enterprise in 1998, which also facilitated further transfer of irrigation infrastructure management to the level of water users.[9] [10]

In 2003, the new Water Code was adopted, which is in force up to now. The aim of the new water legislation was „to achieve and maintain ecologically safe and economically optimal level of water use and protection of water resources, water supply and sanitation for preservation and improvement of living conditions of population and the environment". (Article 3). It provides for „integrated and rational water use" as well as payment for special water use (Article 133).

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5 Ibid. p.57.

6 Kazakhstan National Integrated Water Resources Management and Water Efficiency Plan. Draft, November 2005 [Electronic resource]. - Access mode: https://caresd.net/iwrm/new/en/doc/doc_plan.pdf.

7 Water Code of the Republic of Kazakhstan, 31 March 1993: https://adilet.zan.kz/rus/docs/K930003000_.

8 Wegerich, Kai. „Blueprints for water user associations' accountability versus local reality: evidence from South Kazakhstan." Water International 33, no. 1 (2008a): 43-54.

9 Toleubayev, Kazbek, Kees Jansen, and Arnold van Huis. „Knowledge and agrarian de-collectivisation in Kazakhstan." The Journal of Peasant Studies 37, no. 2 (2010): 353-377.

10 Wegerich, Kai. „Coping with disintegration of a river-basin management system: multi-dimensional issues in Central Asia." Water Policy 6, no. 4 (2004): 335-344.

The Code has established that water resources will be managed at several levels, including interstate, state, basin, and territorial levels (Article 33).[11] Thus, within the country, water resources are currently managed according to the basin principle within 8 water basins. At the same time, the establishment of basin inspections is envisaged, and the implementation of water use is performed within the framework of a basin agreement, which is concluded between the basin inspections, local executive bodies and other entities. Separately, work is being performed on the foreign policy field to ensure sufficient flow through transboundary rivers.

New water legislation, as well as adoption of the Law on Rural Water Users' Cooperative in April 2003, allowed continuing the gradual transfer of water management functions in the part related to irrigation to water users. This was performed in order to improve the efficiency of water resources use and ensure wider participation of water users in the water management and decision-making process. However, underfunding of WUAs further resulted in dilapidation of irrigation systems, but in no way improved the efficiency of water use. Part of the infrastructure was later returned under the management of state organizations.

Gradually, the established water management system continued to change and fragment, resulting in a complex polycentric system, where eight ministries and 172 structural units started to deal with water issues in one or another context.[12] On the other hand, consultative status of the basin councils also did not allow to fully implement the basin principle of water management, which eventually led to inefficient water use.

3.3 Water Security in Kazakhstan: Ensuring Water Quantity and Quality

What is water security and what does it mean for Kazakhstan? As defined by UN: Water, water security involves ensuring sustainable access to an adequate quantity of water of acceptable quality for livelihoods, well-being and socio-economic development; to provide protection against pollution and water-related disasters; and to maintain ecosystems in a climate of peace and political stability. [13]

Consequently, for Kazakhstan, ensuring water security implies two main directions: reducing pollution and maintaining water quality, as well as ensuring sufficient supply of water resources through domestic and transboundary sources.

One of the important directions of ensuring water security is to guarantee sufficient water resources from both internal and transboundary sources to maintain natural ecosystems, socio-economic development of the country and well-being of the population.

Today, Kazakhstan receives up to 44% of the total annual runoff from neighboring countries. At the same time, in some basins, for example, in the Aral-Syrdarya basin,

[11] Water Code of the Republic of Kazakhstan, 9 July 2003: https://adilet.zan.kz/rus/docs/K030000481_.

[12] Industry Leaders, Water Resources Team, Task: Institutional Transformation of the Water Resources Industry, MS Power Point presentation.

[13] UN-Water, Workingdefinition, 2013.

this figure reaches up to 90%. Therefore, the issue of efficient water diplomacy with neighbors is an important aspect of ensuring the country's security.

Water diplomacy of Kazakhstan is mainly performed in four main directions. These are water sharing along the Syrdarya River, cooperation along the Shu-Talas Basin, river cooperation with China, and cooperation with Russia. Below we will consider each of the directions separately.

Water apportioning along the Syrdarya river

Syrdarya is the longest continental river in Central Asia. It starts at the confluence of the Naryn and Karadarya rivers, and the basin covers up to 219 thousand km^2. The average long-term runoff of the river is about 36 km^3, which is formed on the territory of the Kyrgyz Republic (74.2%), Kazakhstan (12.1%), Uzbekistan (11.1%) and Tajikistan (1.1%). The main feed sources of the river are melted waters of snow and glaciers, as well as rainfall. The basin's climate is arid, characterized by inconstant rainfall, cold winters and hot summers. This leads to the fact that the water availability of the river is uneven both during the year and in different years.

The flow is almost entirely regulated by a cascade of reservoirs of multi-year and seasonal regulation, built between 1965 and 1985. The main reservoirs on the river are the Toktogul Reservoir (in the Kyrgyz Republic) with up to 19.5 km^3, the Kayrakkum Reservoir (in Tajikistan) with 3.4 km^3, the Charvak and Andijan Reservoirs (in Uzbekistan) with 2 km^3 and 1.75 km^3 respectively, and the Shardara Reservoir (in Kazakhstan) with 5.2 km^3. In 2010, Kazakhstan completed construction of the Koksarai counter-regulator to solve the problem of winter releases from the upstream river, which led to floods, and to provide irrigation water in summer time.

In order to build a mechanism for interaction with Central Asian countries, Kazakhstan together with other states of the region signed in 1992 an Agreement on cooperation in joint management of use and protection of interstate water resources (or the Almaty Agreement) and in 1998 an Agreement on use of water and energy resources of the Syrdarya River. These agreements were based on such principles as the commonality and unity of water resources in the region, equal rights to use and the obligation to ensure rational use and protection of waters (Article 1), and not to cause damage to other States (Article 3).[14]

Based on the Almaty Agreement, the Interstate Commission for Water Coordination (ICWC) was established to manage the shared rivers and was charged with developing and defining regional water policies and developing and approving water use limits.[15] In 1993, the Interstate Council on the Aral Sea Problems was established, which was later merged with the International Fund for Saving the Aral Sea (IFAS). In 1999, IFAS became an umbrella institute for regional cooperation that included the ICWC, the ICWC Scientific Research Center (SIC ICWC) and two basin

[14] Agreement between the Republics of Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan and Turkmenistan „On Cooperation in the Sphere of Joint Management of the Use and Protection of Water Resources of Interstate Sources", 18 February 1992 [Electronic resource]. - Access mode: http://www.icwc-aral.uz/statute1_ru.htm.

[15] Ibid. p.60.

water organizations - BWO Syrdarya and BWO Amudarya established back in the 1980s. The main focus of water cooperation in region was determination of water limits for each state in the region, as well as cooperation to solve the Aral Sea and Aral Sea zone crisis.

Some experts noted that the conclusion of the above agreements can be regarded as a successful framework for cooperation on water and environmental issues in the Aral Sea basin,[16] but the issue of water allocation is still one of the burning issues. In Kazakhstan, this issue occupies a special place because „Kazakhstan, being the most willing to cooperate, is in the most vulnerable position: vulnerable to winter releases from the Kyrgyz Republic and vulnerable to the strategy of hydro-independence of Uzbekistan. [17]

So, why and how have modern water management issues developed? In order to answer this question, it is necessary to consider the history of these issues, since they are the historical legacy and result from the water management system established back in the Soviet period.

During the Soviet Union, the Central Asian region was seen as the most suitable in the whole Union for growing the strategic crop, cotton. This necessitated large-scale irrigation infrastructure projects that began as early as 1918.[18] This work became especially extensive with the beginning of land development in 1950-1960s. Both traditional oases, such as Bukhara oasis, Fergana valley, lower reaches of Amudarya and Syrdarya, and new lands in Hungry and Karshi steppes were to be developed.[19] This all required „taming“ the flow of large rivers and creation of infrastructure for irrigation - reservoirs, canals, pumps.

The constructed reservoirs were aimed at regulating the flow of rivers to meet the water requirements of irrigated land. At the same time, in order to maximize the use of river flow, the construction of infrastructure projects was implemented in an integrated manner, which also provided for the associated construction of cascades of hydroelectric power plants (HPPs), such as the Naryn cascade of reservoirs in Kyrgyzstan.[20] Thus, water releases in summer in the upstream countries - Kyrgyzstan and Tajikistan - also generated electricity, which was distributed among the countries of the region through the United Energy System of Central Asia (UES CA). The winter deficit of electricity and heat in upstream countries was then covered by fuel supplies from downstream countries, i.e. Kazakhstan, Turkmenistan and Uzbekistan, and from the CAPS.[21] [22]

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16 Weinthal, Erika. State making and environmental cooperation: Linking domestic and international politics in Central Asia. MIT Press, 2002.

17 Wegerich, Kai. „Have your cake and eat it too: Agenda-setting in Central Asian transboundary rivers“. In Water, Environmental Security and Sustainable Rural Development, pp. 191-206. Routledge, 2009.

18 O'Hara, Sarah L. „Lessons from the past: water management in Central Asia.“ Water policy 2, no. 4-5 (2000): 365-384.

19 Micklin, Philip P. Managing Water in Central Asia. Royal Institution of International Affairs, 2000.

20 The Naryn reservoir cascade includes Toktogul reservoir of multi-annual regulation, as well as Kurupsai HPP, Tashkumir HPP, Shamaldysai HPP and Uchkurgan HPP.

21 Ibatullin, Sagit. Water resources in Central Asia: current status, problems and perspectives of use. 2013

22 Libert, Bo, Erkin Orolbaev, and Yuri Steklov. „Water and energy crisis in Central Asia.“ In China Eurasia Forum Q, vol. 6, no. 3, pp. 9-20. 2008.

Water allocation, at the same time, was implemented on the basis of quotas, which were established taking into account applications of the republics. Thus, water allocation in the Syrdarya basin was regulated by Protocol No 413 of 7 February 1984, which stipulated water allocation in the following volume: Uzbekistan 46% of all surface runoff, Kazakhstan - 44%, Tajikistan - 8%, and Kyrgyzstan - 2%. At that, 75% of all releases were to be realized during vegetation period (April-September) and only 25% during non-growing season (October-March).[23]

After the collapse of the Soviet Union, the concluded agreements were aimed at preserving the above-mentioned Soviet scheme. However, it became obvious that emerged needs and national priorities of the states, contradicted directly the principles and mechanisms laid in the agreements. As a consequence, shortly after the conclusion of the 1992 Almaty Agreement, Kyrgyzstan transferred the operation mode of the Toktogul Reservoir from irrigation to hydropower. The transfer of the hydropower regime meant that water releases were made in winter, when the demand for electricity in Kyrgyzstan was greatest, leading to floods in the lower reaches of the Syrdarya River, and in summer releases were reduced to accumulate water, leading to a shortage of irrigation water.

It was obvious that without solving water and energy issues in tandem, water allocation issues in the region could not be solved. This led to an agreement on the Syrdarya in 1998, which prioritized the restoration of the former water-energy exchange mechanism. Alongside the agreement, however, the Council of Prime Ministers of the three countries (Kazakhstan, Kyrgyzstan and Uzbekistan) decided to establish a water and energy consortium. This decision provided for the establishment of a system for the mutually beneficial use and development of water and energy resources in the region.[24] Already in 2002, during the Summit of the Heads of States of the Organization of Central Asian Cooperation (OCA) it was decided that the World Bank would develop a feasibility study for an economic mechanism and develop a proposal for regulating cooperation in the use of water and energy resources.

However, the 1998 agreement lasted only a few years from 1999 to 2002. Such a fleeting fate was due to several aspects - the agreement did not regulate the entire Syrdarya basin and did not take into account the water years. This created loopholes in the exchange mechanism itself. Thus, tributaries of the Syrdarya within Uzbekistan, which were downstream of the Naryn cascade, were not subject to the regulation of this agreement. As a consequence, in high water years Uzbekistan did not need to participate in the water and power exchange mechanism because it was sufficiently provided with necessary water resources.[25]

Moreover, subsequent high-water years after signing the agreement resulted in no need for additional releases from Toktogul, and consequently there was no interest to direct fuel and energy resources to Kyrgyzstan according to the concluded agreement.

[23] World Bank. „Water energy nexus in Central Asia: improving regional cooperation in the Syr Darya Basin. „ The World Bank, 2004.

[24] Kazakhstan, Kyrgyz Republic, Uzbekistan, Decision on International Consortium, March 17, 1998 [Electronic resource]. - Access mode: http://www.cawater-info.net/library/rus/gov1.pdf.

[25] Wegerich, Kai, 2004.

As noted by SIC ICWC, „it is enough to give an example of water growing season of 1998 when water volume allowed avoiding additional releases from Toktogul in violation of annual agreements that were based on forecasts".[26] As a whole, the policy of increasing hydro-independence through construction of additional water storage capacities (for example, construction of water control structures in the Arnasay depression and Razaksay, Kangulsay and Karmanaksay reservoirs) in Uzbekistan resulted in „reduced dependence of Uzbekistan on timely releases from the Toktogul reservoir and low need in making agreements on seasonal regulation of releases makes it uninterested in new agreement in the frame of the water-energy exchange concept".[27]

At the same time, Kazakhstan's policy with respect to the current complex water allocation situation in the basin was based on two pragmatic approaches.

On the one hand, Kazakhstan has been and remains consistent in its approaches to promoting mechanisms of cooperation with neighboring countries. Thus, within the framework of the study on the water-energy consortium, the World Bank in 2004 submitted a report with economic calculations of benefits obtained under different forms of cooperation and operation regimes of the Toktogul reservoir. In spite of the fact that the document was criticized by some countries and the proposed mechanism was not supported, Kazakhstan, understanding the importance of developing joint approaches to water management and addressing the issue of energy security in upstream countries, requested the World Bank to continue work on finalizing the economic mechanism. To this day, Kazakhstan promotes the need for a consortium, which would allow settling the issues of mutually beneficial exchange and joint use of water and energy resources in the region.

On the other hand, measures have been taken to reduce the negative impact from winter releases from the upstream river. Thus, in the early 2000s, a project aimed at alignment of the Syrdarya river channel to increase the flow capacity and reduce flood risks was implemented.[28] Construction of the Koksarai counter-regulator started in 2008 and was completed in 2010. The need for this facility was justified by the high risks from winter releases from upstream countries. For example, in 2004 uncoordinated actions of the states in the region led to an emergency situation when high releases from the Toktogul reservoir (reaching 560 m^3 against the agreed less than 500 m^3 per second) and additional releases from the Tajik Kayrakkum reservoir for power generation (up to 1200-1400 m^3 per second), as well as restrictions related to discharge of excess to the Arnasay depression resulted in overflowing of the Shardara reservoir and threat of breaching of protection dams.[29]

At the same time, Kazakhstan, being a downstream country, faces significant water allocation problems. Despite the annual agreement on water use limits, water allocation today is not based on limits, but „on the fact" of water availability. Thus, there has been a shift in the volumes of water received by the countries - today

[26] SIC ICWC, Bulletin No. 26, April 2001.

[27] SIC ICWC, Bulletin No. 39, November 2004.

[28] Ryabtsev, Anatoly, Water as a Source of Future Development in Kazakhstan, 2014 [Electronic resource]. - Access mode: http://www. cawater-info. net/bk/iwrm/pdf/ryabtsev-0414.pdf.

[29] Dadabaev, Timur. Japan in Central Asia: Strategies, Initiatives, and Neighboring Powers. Springer, 2016.

Uzbekistan accounts for 50% to 84% of all water in the Syrdarya basin.[30] Despite the emerging situation, Kazakhstan continues constructive interaction with neighboring countries to solve the existing problems of water cooperation.

Water allocation in the Shu-Talas basin

The Shu-Talas basin is shared between Kazakhstan and Kyrgyzstan and includes three major rivers - the Shu, Talas and Asa. The volume of the Shu River is 6.64 m^3 per year and the Talas River about 1.616 m^3 per year.[31] The rivers support irrigation of an area of up to 800 thousand ha.

Previously, water allocation in the basin was performed according to a protocol signed in 1983 between the two republics. According to this protocol, for the Shu River Kazakhstan received 42% and Kyrgyzstan 58% of the total annual flow, and for the Talas River the distribution was performed in equal shares.[32] [33] Kazakh share of the Talas River consisted of two components, including 716 million m^3 from the Kirov reservoir and 92 million m^3 from internal tributaries.

After independence, previously agreed water allocation quotas were retained under the 1992 Almaty Agreement, including in the Shu-Talas basin. However, in subsequent years, it became evident that water inflows from the Kirov reservoir became less sustainable, which had a negative impact on irrigated agriculture in Kazakhstan. At the same time, in water relations Kyrgyzstan increasingly began to raise issues of the need for more „equitable“ distribution of costs of maintaining interstate water management facilities, which are located on the territory of the Kyrgyz Republic.

In January 2000, the two countries signed an Agreement on the Use of Water Management Facilities of Inter-State Use on the Shu and Talas Rivers, which provides that „the use of water resources, operation and maintenance of water management facilities of inter-State use shall be aimed at achieving mutual benefit on an equitable and reasonable basis“ (Article 1). Thus, the countries have agreed to share the costs of maintaining the water management facilities „in proportion to the volume of water received“ (Article 4). In addition, the Kyrgyz side received the right to be compensated by the Kazakh side for costs ensuring the safe and reliable operation of the water management facilities (Article 3).[34]

In order to implement the provisions of the agreement, it became necessary to establish a bilateral commission, for which States requested the assistance of the United Nations Economic Commission for Europe (UNECE) and the United Nations

[30] SIC ICWC, Water Intakes from Transboundary Rivers and Local Sources in the Syrdarya River Basin, b.d. [Electronic resource]. - Access mode: http://www. cawater-info. net/syrdarya/pdf/vodozab_transgr_mest-n_r. pdf.

[31] United Nations Economic Commission for Europe. Second Assessment of Transboundary Rivers, Lakes and Groundwaters. New York and Geneva, 2011.

[32] Wegerich, Kai. „Passing over the conflict. The Chu Talas basin agreement as a model for Central Asia? „Central Asian Waters (2008b): 117.

[33] Ibid. p.64.

[34] Agreement between the Government of the Republic of Kazakhstan and the Government of the Kyrgyz Republic on the Use of Water Management Facilities of Intergovernmental Status on the Rivers Chu and Talas, March 7, 2002 [Electronic resource]. - Access mode: https://adilet.zan.kz/rus/docs/Z020000301_.

Economic and Social Commission for Asia and the Pacific (UNESCAP). With the assistance of the Organization for Security and Co-operation in Europe (OSCE) and two UN regional commissions, a bilateral commission was established in 2006. The mandate of the Commission included joint decision-making on topical issues of water allocation and technical maintenance of water management facilities, information exchange, as well as prevention and rapid resolution of problematic situations.

At the same time, to date, one of the important issues on the agenda of this commission remains the issue of the environmental dimension of sustainable development. In particular, the agreement and mandate of the Commission are aimed at ensuring water allocation and maintenance of water management facilities, but no provision is made for the protection of natural ecosystems in the basin.[35] [36] Recent years, water quality and pollution issues have increasingly been raised within the Commission, but the full integration of this work into the Commission's mandate is still an open question.

Conclusion of agreement and creation of bilateral commission was of practical importance for Kazakhstan, because during the years of independence regime of Kirov reservoir changed. Releases during the non-growing season became regular, and during the growing season releases were reduced, resulting in water shortage for irrigation in Kazakhstan. As consequence financial participation of Kazakhstan in technical maintenance of water structures was forced to increase significantly, and grew from 7 to 190 million US dollars or 3 to 71% between 1998 and 2003. In this context, it is important to note that the total amount of water resources allocated for maintenance of the basin's waterworks facilities has increased from US$ 7 million to US$ 190 million between 1998 and 2003.[37]

Water cooperation with China

Kazakhstan and China together share 24 watercourses, among which the important rivers are Yertis and Ile.

The largest river in Kazakhstan, the Yertis is shared by Kazakhstan, China, Mongolia and Russia. Up to 90% of the total flow of the Yertis is formed by right bank tributaries from the Kazakh Altai. At the same time, the Kara-Yertis, which forms on the territory of Mongolia and China, is a relatively abundant tributary and may account for 10 km^3 of the total inflows from China to Kazakhstan.[38] [39] On the Kazakhstan side the river is regulated by three reservoirs, including Ust-Kamenogorsk reservoir

[35] Libert, Bo. „The UNECE Water Convention and the development of transboundary cooperation in the Chu-Talas, Kura, Drin and Dniester River basins." Water International 40, no. 1 (2015): 168-182.

[36] Libert, Bo, and Annukka Lipponen. „Challenges and opportunities for transboundary water cooperation in Central Asia: findings from UNECE's regional assessment and project work." International Journal of Water Resources Development 28, no. 3 (2012): 565-576.

[37] Wegerich, Kai, 2008b.

[38] In total more than 40 km3 of water flows into Kazakhstan due to transboundary rivers. For details see Baizakova, Zhulduz. „The Irtysh and Ili transboundary rivers: The Kazakh-Chinese path to compromise." Voices from Central Asia 21 (2015): 1-12.

[39] Ho, Selina. „China's transboundary river policies towards Kazakhstan: issue-linkages and incentives for cooperation". Water International 42, no. 2 (2017): 142-162.

(volume 0.655 km^3), Bukhtarma reservoir (volume 50 km^3), and Shulba reservoir (volume 3 km^3), constructed in 1953, 1960 and 1988 respectively. In the Omsk-Semey section, the river is navigable. In the Kazakh part, water is diverted through the Yertis-Karaganda canal, which supplies water to the capital city.

The Ile River forms on the Muzart glacier of Central Tanirtau, passes through the territory of China and returns to Kazakhstan in high water. The flow forming part of the river is located in China; up to 30% of the flow is formed in Kazakhstan. The largest man-made reservoir in the basin is the Kapshagai Reservoir, constructed during the Soviet era for energy and irrigation purposes.[40] The river is an important artery for maintaining the balance of Lake Balkhash.

Today, the main problem in this basin for Kazakhstan appears to be increased water withdrawals from rivers on the Chinese side. According to data, before 2005 the amount of water withdrawn by China from the Yertis Basin was not more than 1.8 km^3 per year. From 2006 to 2008, however, this volume grew to 2.5-3.5 km^3 per year, reaching 5.5 km^3 in 2009. However, to date there is no reliable data on the exact volume of water withdrawn as well as the total flow of the Kara-Yertis River.[41] In the Ili River, the situation is similar. According to some reports, while water abstraction on the Chinese side was not more than 1.2-1.5 km^3 per year until the 1970s, in recent years the volume of water abstracted has increased to 3.5 km^3 per year.[42] This led to a catastrophic drop in the level of Lake Balkhash. In view of necessity of maintenance of its level not lower than 341 meters - the critical mark for survival of the lake, the Decree of the Cabinet of the Republic of Kazakhstan dated May 12, 1992 No. 423 On Measures to Address Environmental Problems in the Ili-Balkhash Basin decided to fix the limiting upper level of the Kapchagay reservoir at 479 meters, with the design level of 485 meters, aimed at provision of appropriate water releases to Balkhash lake.[43]

Issues on institutionalization of cooperation with China on transboundary rivers have been raised by Kazakhstan since 1992 after establishment of diplomatic relations. However, the Chinese side's interest in solving issues of joint river use at that time remained at a low level. Only in May 1999, China sat down at the negotiating table on joint rivers.[44] In the opinion of some experts, such a step was connected to the fact that Kazakhstan was an important partner in combating the „three evils" (i.e., terrorism, separatism and extremism) and in energy cooperation.[45] [46] In addition, the Kazakh media began to report on the construction of the Kara Yertis-Karamai canal to supply water for the industrial development of the Xinjiang Uygur Autonomous Region, which acted as a trigger for the start of negotiations.[47]

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40 Libert, Bo, and Annuka Lipponen, 2012.

41 Baizakova, Zhuldyz, 2015.

42 Ibid. p.66.

43 Decree of the Cabinet of Ministers of the Republic of Kazakhstan No. 423 On Measures to Address Environmental Problems in the Ili-Balkhash Basin, 12 May 1992: https://adilet.zan.kz/rus/docs/P920000423_.

44 Ho, Selina, 2017.

45 Ibid. p.66.

46 Laruelle, Marlene, and Sebastien Peyrouse. Globalizing Central Asia: Geopolitics and the challenges of economic development. Routledge, 2015.

47 Sievers, Eric W. „Transboundary jurisdiction and watercourse law: China, Kazakhstan, and the Irtysh." Tex.

Concerned about maintaining productive cooperation with Kazakhstan on the above-mentioned strategic issues, China agreed to negotiations, which were marked by the signing in 2001 of an Agreement on Cooperation in the Use and Protection of Transboundary Rivers, which provided the legal basis for the formation of a joint commission. Meetings of the bilateral commission led to development of legal base of cooperation through signing of a number of agreements, including on emergency notification in case of natural disasters,[48] exchange of hydrological and hydrochemical information of border gauging stations,[49] joint management and operation of „Dostyk" hydrostructure on Khorgos river [50], water quality protection,[51] cooperation in field of environmental protection,[52] etc.

However, despite the outwardly dynamic and productive relationship between Kazakhstan and China, Lake Balkhash nevertheless remains in a „tense state"; many points to the threat of the lake being divided into two parts as a result of shallowing.[53] This has necessitated the start of negotiations on water-sharing issues. In 2015, an ad hoc working group was established to negotiate a water-sharing agreement between the two states. As of 2021, the agreement is still under negotiation and the details of the negotiation process are closed.

In general, the problem of water allocation between Kazakhstan and China is related, among other things, to different conceptualization of water. Thus, Kazakhstan sees water use from transboundary rivers in the light of one of the main principles of international water law - „doing no harm", linking increased water diversion upstream with a possible „ecological disaster" downstream, including the shoaling of the unique Lake Balkhash. China, on the other hand, takes the opposite position, applying the principle of „territorial sovereignty" in relation to water resources - i.e. the state, on whose territory water resources are formed, is in a position to use them as it needs.[54]

Int'l LJ 37 (2002): 1.

48 Agreement between the Ministry of Agriculture of the Republic of Kazakhstan and the Ministry of Water Resources of the People's Republic of China on emergency notification of the parties on disasters on transboundary rivers, 1 July 2005 [Electronic resource]. - Access mode: https://adilet.zan.kz/rus/docs/P050000677_.

49 Agreement between the Ministry of Environmental Protection of the Republic of Kazakhstan and the Ministry of Water Resources of the People's Republic of China on mutual exchange of hydrological and hydrochemical information (data) of border gauging stations of major transboundary rivers, 20 December 2006 [Electronic resource]. - Access mode: https://adilet.zan.kz/rus/docs/O0600000008.

50 Agreement between the Government of the Republic of Kazakhstan and the Government of the People's Republic of China on the Management and Operation of the Dostyk Joint Venture on the Khorgos River, 29 August 2013 [Electronic resource]. - Access mode: https://adilet.zan.kz/rus/docs/P1300000898.

51 Agreement between the Government of the Republic of Kazakhstan and the Government of the People's Republic of China on Protection of Water Quality of Transboundary Rivers, February 22, 2011 [Electronic resource]. - Access mode: https://adilet.zan.kz/rus/docs/P1100001114.

52 Agreement between the Government of the Republic of Kazakhstan and the Government of the People's Republic of China on Cooperation in the Field of Environmental Protection, 11 June 2001 [Electronic resource]. - Access mode: https://adilet.zan.kz/rus/docs/P1100000651.

53 Bologov, Peter, Aral number two. How China is turning Kazakhstan into a desert, 23 January 2013, Lenta.ru [Electronic resource]. - Access mode: https://lenta.ru/articles/2013/01/23/irtysh/.

54 Zheng, Chenjun. „Sino-Kazakhstan transboundary water allocation cooperation study: analysis of willingness and policy implementation." Water International 46, no. 1 (2021): 19-36.

While water allocation issues remain unresolved between the two countries, the issue of reducing incoming water resources continues to be high on the agenda, and the further fate of Balkhash Lake is hazy. At the same time, it is necessary to take into account the fact that the consequences of increased water withdrawal by China were not so acutely felt in Kazakhstan until now due to the high-water cycle. However, the current low-water cycle and the effects of climate change on water resources may aggravate the current situation.

Water cooperation with Russia

Kazakhstan and Russia have the world's longest border, which is crossed by a number of river basins, including the basins of the Yertis, Tobol, Zhaiyk (Ural) and Esil rivers. In bilateral water cooperation, the most topical issue is regulation and cooperation in the Zhaiyk-Caspian basin.

Zhaiyk River originates on the eastern slope of the Uraltau ridge and represents the main watercourse of the basin.[55] It has several transboundary tributaries, including the Yelek, Or, Khobda, Orta Borte and Shagan rivers. The main source of feeding (up to 80%) is snowfall with an insignificant share of rainfall feeding. The total volume of surface runoff in Russia is about 10.6 km^3 a year, and in Kazakhstan 12.6 km^3 a year, including 4.1 km^3 from internal sources and 8.7 km^3 from the transboundary flow. There are also significant groundwater reserves in the basin, which amount to 1.03 km3 per year in the Kazakh part.[56]

The river has a large number of hydraulic structures and reservoirs, the most significant of which is the Iriklinsky Reservoir in Russia with a usable volume of up to 2.7 km^3, built in the 1950s. The reservoir is capable of seasonal regulation and is intended for energy, water supply, flood protection, irrigation, water quality regulation and fisheries requirements.

Other important rivers in the basin are the rivers Zhem, Oyil and Sagiz. The basin covers an area of 415 thousand km^2 with 240 lakes, most of which (201) are located in Atyrau and West Kazakhstan regions, containing mainly bitter-saline and saline water.

In 1992, Kazakhstan and Russia signed an agreement on the joint use and protection of transboundary water bodies, in which the countries recognized „equal rights" to use and equal responsibility for the rational use of water resources (Article 2).[57] Based on the agreement, a bilateral commission was established to agree on schedules of reservoirs intended for joint use, as well as the establishment of water withdrawal limits.[58] The agreement was extended twice, and in 2010 a new agreement

[55] Burlibayev, M., Amirgaliev, N., Schoenberger, I., Skolsky, V., Burlibayeva, D., Uvarov, D., Smirnova, D., Yefimenko, A., Milyukov, D. Pollution problems in major transboundary rivers of Kazakhstan. Vol. I. Kazakhstan Agency for Applied Ecology. 2014. Kaganat Publishers.

[56] UNECE, 2011.

[57] Agreement between the Government of the Russian Federation and the Government of the Republic of Kazakhstan on the Joint Use and Protection of Transboundary Water Bodies, 27 August 1992 [Electronic resource]. - Access mode: http://base.spinform.ru/show_doc.fwx?rgn=31129.

[58] Food and Agriculture Organization of the United Nations. AQUASTAT Country Profile - Kazakhstan. 2012.

was signed,[59] which was based on the principles stipulated in the Convention on the Protection and Use of Transboundary Watercourses and International Lakes or the so-called Helsinki Convention of 1992, to which both States acceded.

At the same time, in recent years, intensive shoaling of the basin's rivers, as well as the main artery - the river Zhaiyk, has been observed. This raises issues in the context of bilateral cooperation. At present, the river and basin problems are twofold: on the one hand, there is high water regulation by reservoirs and plans for further construction of reservoirs in the upper reaches of the river, and issues of significant water pollution by industrial wastes (especially in Magnitogorsk and the Orenburg region) and domestic wastewater (Uralsk and Atyrau cities).[60] a special report of the Preliminary Findings on the river Zhaiyk (Ural), up to 20 billion tons of industrial wastes have accumulated in the river basin. As a consequence, „chemical pollution of air and water, depletion of soil resources, contamination of food and the nutrient environment, together with global climate change have a negative impact on all living nature, including humans".[61]

At the end of 2020, Kazakhstan and Russia adopted programs of joint measures for the conservation and restoration of the ecosystem of the transboundary river basins Zhaiyk and Yertis. Thus, the activities included the development of science-based proposals for the restoration of ecosystems, identification and inventory of pollution sources, reconstruction of culverts, cleaning and restoration of water bodies in the basin.[62]

Obviously, the issue of shallowing of rivers in the basin has intensified after the beginning of low-water years, supplemented by negative consequences of climate change and degradation of aquatic ecosystem. This actualizes the issues of ecological conservation in the context of ensuring and protecting water security and, consequently, national security of the country.

Protection of internal water sources

Conservation of inland water sources is another important component of the country's water security. It has two components - maintaining the quality of aquatic ecosystems by reducing pollution of water bodies and adaptation to climate change.

Ensuring sufficient water resources in a country is closely linked to maintaining acceptable quality of aquatic ecosystems. It is important to understand this thesis in

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[59] Agreement between the Government of the Russian Federation and the Government of the Republic of Kazakhstan on the Joint Use and Protection of Transboundary Water Bodies, 7 September 2010 [Electronic resource]. - Access mode: https://docs.cntd.ru/document/902240034.

[60] UNECE, 2011.

[61] Kenshimov, A., Shortanbaev, M., Nesterenko, Yu. Preliminary results of studies on the Zhaiyk River (Ural). Edited by Akhmetov, S., 2017 [Electronic resource]. - Access mode: https://unece.org/fileadmin/DAM/env/water/meetings/Water_Convention/2016/Projects_in_Central_Asia/Transboundary_Rivers_Study_in_Kazakhstan_Ural_River_Feb_2017.pdf.

[62] „Kazakhstan and Russia Adopted Programmes of Joint Measures for the Conservation and Restoration of the Ecosystem of the Ural and Irtysh Transboundary River Basins," December 4, 2020, Committee on Water Resources, Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan [Electronic resource]. - Access mode: https://www.gov.kz/memleket/entities/water/press/news/details/134211?lang=ru.

the context of cause-effect relationships that they represent. Thus, increasing pollution of aquatic and natural ecosystems leads to decreasing the ability of ecosystems for rehabilitation and changes in the water cycle, which, in turn, can affect the volume of water resources. The issue is extremely relevant for water-deficient Kazakhstan.

To date, surface waters of the country are polluted and their hydrochemical, hydrobiological and sanitary regimes are changing. Pollution of groundwater by municipal and industrial facilities takes place.

Regulation of water quality protection in the country as a whole has not changed since the times of the Soviet Union and is based on compliance with Maximum Permissible Concentrations (MPC) while setting Maximum Permissible Discharges (MPD). Today, water bodies are mainly polluted as a consequence of discharges of untreated industrial and municipal wastewater. According to the microbiological and sanitary-chemical surveys conducted in 2019, non-compliance with sanitary requirements was found in 4% and 13% respectively in category 1 water bodies and in 7.1% and 13.4% respectively in category 2 water bodies.[63]

However, it is noted by some experts that the current MAC system is not fully effective. This is due to the fact that the MPC approach itself assumes „a sufficiently complete study of the nature of environmental impact and requires reliable information for its assessment".[64] This sometimes leads to situations where nature management companies can take advantage of data gaps as well as a lack of consideration of regional characteristics of surface water runoff formation and obtain over- or underestimation of wastewater discharge standards. In addition, the system does not stimulate these enterprises to technological innovation.[65]

Another factor is the issue of wastewater treatment. According to a study by the Organization for Economic Cooperation and Development (OECD), in cities in Kazakhstan with populations over 50,000, the coverage of the wastewater treatment system is approximately 70%. Almost all of this wastewater is treated. In cities with population between 20 and 50 thousand people, about half of the wastewater is collected in the city sewer system, but treatment is extremely limited. However,[66] the total amount of sewage collected by the centralized system is only 62% nationally, including 84% in large cities. The condition of sewage treatment plants (STPs) today is not entirely satisfactory, with one third of all systems requiring technical upgrading. Moreover, out of 540 sewage collectors, most are filled up to a critical level.[67]

Therefore, it is important to solve the problem of pollution of water bodies in Kazakhstan in a step-by-step and systematic manner. It should be understood that

63 Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan. National report on the state of the environment and use of natural resources of the Republic of Kazakhstan for 2019.

64 Jumagulov, A., Nikolayenko, A., Mirkhashimov, I. Water quality standards and norms in the Republic of Kazakhstan. Regional Environmental Center of Central Asia. 2009.

65 Ibid. p.70.

66 Organization for Economic Co-operation and Development, Danish Environmental Protection Agency/ Danish Cooperation for Environment in Eastern Europe, Municipal Water Services, Kazakhstan. Background Analysis for the Financing Strategy, 2001: https://www.oecd.org/env/outreach/33721258.pdf.

67 Andraka, Dariusz, Kairat Ospanov, and Menlibai Myrzakhmetov. „Current state of communal sewage treatment in the republic of Kazakhstan. Journal of Ecological Engineering 16, no. 5 (2015).

intoxication by discharges of natural ecosystems and objects leads to a reduction in the amount of available water resources of acceptable quality. In addition, sanitary releases from water bodies potentially lead to inefficient operation of reservoirs and negatively affect the availability of water resources, especially during the busy summer months.

Therefore, environmental and water legislation should be based on incentives to reduce pollution of water bodies, as well as to increase the coverage of wastewater treatment. The new Environmental Code 2021 should stimulate the reduction of negative impacts on water resources through increased accountability, including through the „polluter pays and remedies“ principle, as well as incentives for more sustainable practices and technologies.

Another factor is climate change. The consequences of a changing climate on water resources are already evident today. As discussed earlier, Kazakhstan's rivers are largely dependent on snow and glacier melt water as well as rainfall.

For example, climate change is accelerating the melting of glaciers. At the same time, while melting glaciers may lead to a short-term increase in runoff in high mountain rivers, in the medium and long term their degradation leads to a drastic reduction in water resources. For example, the Intergovernmental Panel on Climate Change (IPCC) Special Report on the Ocean and the Cryosphere noted that past decades have witnessed widespread shrinkage of the cryosphere, with loss of glacier mass and glaciers, reduction in snow cover and increased permafrost temperature; lands previously covered by ice have appeared, leading to disruption of ecological balance and ecosystem functioning; and thawing of permafrost has occurred. All this will further adversely affect both the quantity and seasonality of river flows and crop productivity and food security, as well as change the structure of ecosystems and consequently the loss of unique biodiversity.[68]

In Kazakhstan, glaciers are the most vulnerable to climate change. According to domestic glaciologists, Ile-Alatau glaciers have been decreasing by an average of 0.73-0.76% per year in area and about 1% per year in volume of ice since the 1960s.[69] Given that up to 40% of the total runoff is formed precisely by glaciers, this potentially threatens the very irrigation system that has evolved in the country.

Climate change also leads to changes in precipitation patterns. For example, according to the Seventh National Communication of the Republic of Kazakhstan, there is a change in precipitation patterns with an overall decrease throughout the year. Only in winter time there is an increase in precipitation, which as a consequence leads to increased risks of spring floods.[70]

Thus, the issue of providing the economy, population, and natural ecosystems

[68] Intergovernmental Panel on Climate Change. IPCC Special Report on the Ocean and Cryosphere in a Changing Climate. 2019.

[69] Seversky, Igor, Glacier of Our Alarm, Kazakhstanskaya Pravda, interview by Brusilovskaya, Elena, September 11, 2020 [Electronic resource]. - Access mode: https://www.kazpravda.kz/fresh/view/lednik-trevogi-nashei.

[70] Ministry of Energy of the Republic of Kazakhstan, United Nations Development Programme, Global Environment Facility. Seventh National Communication and Second Biennial Report of the Republic of Kazakhstan to the UN Framework Convention on Climate Change. 2017.

with sufficient water resources determines the issue of further development in Kazakhstan. It is closely intertwined with both ecological aspects of maintaining ecosystems and issues of ecologization of industry and economic activity, reducing pressure on natural ecosystems and resources, as well as the political dimension of water resources management and agreeing the acceptable water allocation regime with neighboring states. All this requires an interdisciplinary approach to considering water issues, as well as building and maintaining appropriate human capacity.

3.4 Discussion

So, what can we say about current water policy of the country and in what direction should we move further? I will try to outline some ideas in this regard.

Firstly, today in the country we observe how water policy has become excessively fragmented. It is important to remember that the issue of water resources management is a complex and integrated task. It requires clearly built system of interaction between different stakeholders, established mechanisms of resource protection and response to emerging situations. A large number of structural subdivisions that deal with those or other aspects of water policy complicates decision-making processes on water. At the same time, despite the introduction of the basin principle of water management, the Basin Councils are actually an advisory body with weak influence mechanisms. Water policy is also negatively affected by the fact that the main Water Resources Committee is often transferred from one ministry to another.

Secondly, unfortunately, the reflection of the ecosystem approach remains weak. But what is the ecosystem approach with respect to water resources? Surface water is closely connected with groundwater and vice versa. They interact and form a single organism. Thus, without groundwater health it is difficult to speak about surface water health. However, today there is actually no unified mechanism for managing these two complex components of one system. Often the main focus of water protection measures remains on eliminating the consequences of problems but not their causes. This subsequently leads to loss of supplying, regulating and supporting ecosystem services of water bodies and reduction of the ability of ecosystems to recover.

Thirdly, climate change issues as a new factor require more systematic integration into the country's water policy. The consequences of climate change are already tangible in Kazakhstan today. This requires us to intensify adaptation measures and improve relevant capacities. The new Environmental Code adopted in 2021 includes a separate chapter on adaptation to climate change. Effective implementation of its provisions should reduce risks both for the economy and population, as well as for the country's natural ecosystems, avoid economic losses and damage, and help create a resilient economy for a sustainable future.

Fourthly, it is important to introduce an integrated and systematic approach to ensure that existing water sector challenges are best addressed in achieving sustainable development. At the same time, sustainable development implies a balanced approach in its three main components - economy, people and nature. In sustainable development, success in one dimension depends on success in the other two. Thus, economies and

societies cannot develop without natural ecosystems. The Sustainable Development Goals, adopted in 2015, seek to answer the question: „how to ensure a thriving economy that aims to improve the quality of life of people and maintain the sustainability of ecosystems?“. Thus, water is at the core of sustainable development, and is central to the implementation of the 17 Sustainable Development Goals. The Water and Sanitation Goal in this context is both a mechanism for ensuring economic development and maintaining natural ecosystems, as well as a driver for sustainable development and human well-being.[71] Consequently, consideration of water issues requires effective integration of aspects that are in one way or another related to it.

Conclusion

Water is a strategic resource for the Republic of Kazakhstan. In this regard, water resources are considered comprehensively - as an important component of maintaining sustainability of natural ecosystems, as a production factor in the economic development of the country, and as an element for ensuring social well-being. Water is the key to preserving national security of the state.

The established water management system in the country has allowed integrating basic international water management principles and regulating water demand and supply during three decades of independence. The basin principle of water management has been introduced, opportunities for public and water users participation in decision-making have been expanded, and major water allocation and water use agreements have been concluded with neighboring countries (water allocation negotiations with China are ongoing at the time of writing).

At the same time, today the whole world, including Kazakhstan, is entering a new era. The climate on the planet is changing, the state of natural resources is also changing, significant anthropogenic load in recent years has led to changes and degradation of natural ecosystems, which, in turn, directly or indirectly affects water resources. Therefore, it is obvious that new legislation is required, as well as implementation of updated approaches to this limited resource. It is important to rethink the very approaches, goals and objectives. For example, if the priority is to provide drinking water to the population, then perhaps the goal should be the preservation of long-term sustainability of aquatic ecosystems to maintain their supply functions, including the supply of sufficient water of acceptable quality to the population and economy.

Consequently, solving current problems and challenges requires the application of systems thinking as the basis for solving the problems of the present and the challenges of the future.

[71] United Nations Economic and Social Commission for Asia and the Pacific. Analytical Framework for Integration of Water and Sanitation SDGs and Targets Using Systems Thinking Approach. Working Paper. 2016. Bangkok, United Nations.

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Chapter 4

LAND RESOURCES OF KAZAKHSTAN

4.1 Land fund of Kazakhstan

Land resources are the combined natural resource of the land surface as the spatial basis for settlement and economic activity and the basic means of production in agriculture and forestry.

The importance of the sustainable use and protection of land predetermines its well-balanced use for equitable satisfaction of the needs of present and future generations, while emphasizing habitat and ecological values.

The Republic of Kazakhstan is the world's ninth largest country by total area (272.5 million ha), second largest by arable land per capita, and third largest by land availability following Australia and Canada. It consists of forest-steppe, steppe, semi-desert and desert zones. The variety of soils in Kazakhstan is due to horizontal zonality, geological and geomorphological features of different parts of the territory, increasing climate aridity west-to-east.

The area of land resources of Kazakhstan is 270.1 million ha, of which 82% are suitable for agricultural use. Irrigated cropping is developed in the large river-valleys. There is enough heat to mature a variety of agricultural crops. The plains in the central and south-western parts of the country are mainly used for pasture due to the low rainfall. It is worth noting that the Republic is the sixth-largest by arable land in the world.

Territorial zoning

The totality of natural conditions has determined the necessity of singling out ten natural-climatic territories[1]. According to the State Land Cadastre, the highest share is in the desert and semi-desert part of the territory - 54.8%, forest-steppe and dry-steppe - 32.6%.

In its turn, the land fund is divided into the following land categories in accordance with its designation purpose:

1. agricultural designation;
2. human settlement;
3. industry, transport, communications, for the needs of space activities, defense, national security and other non-agricultural purposes;
4. specially protected natural territories, land for healthcare, recreational, historical and cultural purposes;
5. forestry fund;
6. water fund;
7. stock.

[1] Land Code of the Republic of Kazakhstan of June 20, 2003 No. 442-II.

As a result of land legal relations, the land fund is redistributed every year, changing from one category to another. Significant changes have taken place in the category of agricultural land, the area of which has decreased by half compared to 1990. There has been an almost nine-fold decrease in lands for industry, transport, communications and other non-agricultural purposes (from 7.3% to 0.8%). At the same time, there has been an eleven-fold increase in the lands of human settlement, an almost ten-fold increase in the lands of specially protected natural territory, a 2.3-fold increase in the lands of forestry funds, and a five-fold increase in the lands of water funds. Their form of ownership has become more varied: state and private. Most of the land in human settlements is privately owned - 2.7 million ha, and leased from the state - 21.4 million ha. There are 1.4 million ha of land for agricultural purposes under private ownership and 107.1 million ha under long-term lease, and 0.09 million ha and 2.1 million ha of land for industrial, transport, communications and other non-agricultural purposes respectively. With such a demand for land, it is logical to assume that the rational and efficient use of land resources should become the main driver of economic growth and social well-being of the population.

However, at the turn of the third millennium, Kazakhstan faced with the challenge of overcoming a systemic crisis that has enveloped all spheres of social relations, exacerbating problems of land and environmental degradation. By nature of impact, the issue of land use has become a complex one, interlinked with economic, social and environmental conditions. At the same time, new challenges of high adaptation to climate change and the transition to a green economy have become dominant for sustainable development.

4.2 Earth as a spatial basis

It is generally accepted that the problem of land use as a spatial operational basis by nature of anthropogenic impact has become complex. High demands on the level of protection of land resources from adverse influences in the field of mining and construction are now becoming the dominant factor in the territorial basis.

In the aggregate, these requirements are universal and applicable to all types of production areas. Their content may vary depending on the specification. However, the zoning principle is one of the initial and effective tools for regulating land relations in urbanized areas and its main advantage is that it allows for a comprehensive approach to the task.

With the introduction of zoning, the principle of multiple use of a land plot changes completely to the principle of exclusivity, i.e. only those activities that are explicitly provided for in the regime of its designated use are allowed. Without aiming for full coverage of all zoning mechanisms, here are only those that may be characteristic to be understood in an overall context.

When using water fund lands

The establishment of water protection zones and, within these zones, of water protective belts with the status of water fund lands is envisaged in order to achieve

and maintain an environmentally sound and economically optimal level of water use and protection of water fund lands[2]. Prohibitions on economic and other activities, construction and operation of buildings and structures shall be imposed within the water protective belt, except those expressly provided for in the water legislation. A special regime of land use in the water protection zone prohibits the construction, reconstruction of facilities, as well as the extraction of minerals and laying of communications without the approval of the basin inspectorates and environmental authorities. The protected characteristics of these areas are reflected in cadastral systems, which is important in terms of recording and monitoring.

Air transport lands

The list of requirements for them and for the aerodrome environs affects the placement of facilities that constitute a threat to flight safety. Particularly with electromagnetic, light, acoustic and other types of radiation and impairing flight visibility. Areas with food waste, construction of fur farms, slaughterhouses and other facilities with the involvement and mass gathering of birds are prohibited within a distance of at least fifteen kilometers. These conditions are derived from the Law of the Republic of Kazakhstan „On use of the airspace of the Republic of Kazakhstan and the aviation activities“[3] [4], as well as from construction regulations and rules.

On transport, communications and energy lands

Special legislation for this category of land use is established by special legislation, taking into account industry-specific and technical requirements. For example, the Law on Main Pipelines, which applies to technical regulations and conditions for safe operation, defines the situation of protected areas with a special use regime without the need to take land from landowners, land users.

Communication and energy land also has established protection zones along electrical power network facilities with minimum allowable parameters depending on the energy to be transmitted. There are also special conditions for land use within their boundaries[5]. The size of the protection zones of heat networks facilities depends on the pipeline diameters and varies from 5 to 25 metres[6]. Generally, infrastructural facilities that constitute a threat to animal migration should include ecological corridors in their construction design, which is important for the conservation of habitats[7].

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2 Order of the Minister of Agriculture of the Republic of Kazakhstan of May 18, 2015 No. 19-1/446 „On approval of Rules for establishment of water protection zones and bands“.

3 Law of the Republic of Kazakhstan of July 15, 2010 No. 339-IV „On the Use of Airspace of the Republic of Kazakhstan and Aviation Activities“.

4 Law of the Republic of Kazakhstan „On Main Pipeline“.

5 Order of the Minister of Energy of the Republic of Kazakhstan of September 28, 2017, No. 330 „On approval of Rules for Establishment of Protected Zones of Electrical Network Facilities and Special Conditions for the Use of Land Plots Located within the Borders of Such Zones“.

6 Order of the Minister of Energy of the Republic of Kazakhstan of September 28, 2017, No. 331 „On approval of the Rules for the Establishment of Protected Zones of Heating Network Facilities and Special Conditions for the Use of Land Plots Located within the Borders of Such Zones“.

7 Law of the Republic of Kazakhstan of July 9, 2004 No. 593 „On Protection, Reproduction and Use of Animal World“.

The boundaries of zones and the land use regime for zones with special land use conditions (for industrial facilities, mudflow-, landslide- and other hazardous areas) shall be determined by the authority which took the decision on granting land ownership or land use.

Sanitary and epidemiological requirements for cemeteries and funeral facilities do not allow residential and public buildings to be located closer than three hundred metres from the cemetery fence, and one hundred metres for closed ones[8].

The category of historical and cultural lands provides for restrictions on all types of works in the protection zones determined by the authorised body for the protection and use of historical and cultural heritage facilities. Here the parameters of protection zones are taken to be equal to several values of the distance from the land to the highest points of urban planning and architecture monuments, monumental art constructions.

The zoning is regulated on human settlement lands: building development and land use regime. At the same time, special importance is given to urban planning and land use regulations. For example, nine types and forty four types of functional territorial zones have been established in the territory of Almaty city, which are reflected in the plot and design plan of functional zoning of the city. The boundaries of these units are red lines, rivers and other natural and artificial boundaries (administrative districts). In accordance with the schemes of regulation of city-building activity, planning restrictions are set for:

1. conditions for the reconstruction of territories;
2. ecological zoning;
3. landscape zoning (landscape conservation);
4. construction zoning by types of seismic zones and building floors;
5. specially protected natural territory;
6. water protection zones;
7. objects of historical and cultural heritage;
8. engineering-geological conditions (seismicity, rupture, soil types);
9. transport and engineering communication isolation space.

Such use of land plots is considered permitted if it will comply with city planning regulations, restrictions on environmental conditions, conditions for protection of monuments and other planning restrictions. The general elements of compliance with the land use regime are: the minimum size of the land plot; the payment for property development; the maximum parameters of buildings on the plot.

Only those activities explicitly provided for in the list of uses are allowed, while conditionally allowed uses have „caveats“ in terms of the application of fire, sanitary, environmental, construction and other mandatory rules.

[8] Order of the Minister of Health of the Republic of Kazakhstan of August 19, 2021, No. ҚР ДСМ-81 „On approval of Sanitary Rules „Sanitary and Epidemiological Requirements for Cemeteries and Funeral Purposes Facilities“.

4.3 Land resources as a basic asset in agriculture

The heterogeneity of land plots by quality determines the economics and organization of agricultural production. Agricultural land is 97.2%, including 23.8% arable land, 0.1% perennial plantation, 1.7% fallow land, 2.0% hayfields and 69.6% pasture in the structure of lands of agricultural designation[9].

Protecting land from degradation and soil exhaustion

The scientifically defined land assessment system should be based on the study of soil properties according to V.V. Dokuchayev, the founder of the world science of soil science. Soil should be assessed as a natural body, irrespective of human relations to it and time conditions.

This conclusion he stated in his book „Russian chernozem“[10] (1883, selected works, Moscow city, 1948, vol.1). At the same time the fundamental conclusion of V.V. Dokuchayev was that: „to a certain extent the chernozem is more expensive than oil, coal, gold and iron ores, it contains eternal and inexhaustible national wealth“.

The formation of soil science in the Kazakh steppe began with the active participation of his students and close associates. In 1908-1916 they initiated before the Resettlement Department of the Russian Empire the assessment of lands for peasants from small - land areas.

In the Soviet period, during the first five-year periods, the soils of the first state and collective farms were studied. The first soil map at scale of Kazakh SSR was made in 1935 and 1948 - the second.

Further soil research was linked to the conversion of virgin lands, the natural-economic zoning of lands suitable for irrigation, and the study of methods and techniques for reclamation of saline and solonetzic lands.

At the same time, other areas of research were launched: agro-soil, agro-physical, appraising, mathematical modelling, erosional-preventive, recultivation, etc.

As a rule, all soil-amelioration studies concluded with recommendations for farming practices, taking into account the level of soil knowledge and assessment.

There are now many indicators of the composition of agricultural land in terms of soil types and sub-types. Among this diversity, dark-chestnut soils of the dry-steppe zone are the most suitable, accounting for only 26.8%, while common chernozems account for 7.6% of all soil types.

The qualitative condition of land is also influenced by land amelioration groups, which are subdivided into uncomplicated with negative properties, highly rubbled, saline, solonetzic, washed away, deflated, etc.

Uncomplicated negative features account for only 41.5 million ha or 19.4% of the total area of agricultural land, while the effective use of the remaining groups on an area of 172.8 million ha (80%) requires amelioration measures related to the improvement of their chemical and physical properties so that their natural fertility becomes economic.

[9] Consolidated Analytical Report „On the State and Use of Land of the Republic of Kazakhstan for 2020“.

[10] V.V. Dokuchayev „Russian chernozem“ (1883, selected works, Moscow city, 1948, vol.1, p.476).

State of land use in agricultural production

The current reality in AIC is that it is extremely difficult to improve the efficiency of agricultural land without the necessary economic and financial tools[11]. According to the results of the land inventory, pasture and hayfields (78%) account for the largest share of the total unused lands. At the same time, about 70.6 % of pasture was not used due to the lack of water supply. 6.8 % of the irrigated arable land is completely out of use of hydraulic structures and irrigation systems.

The following factors were the main reasons for the reduction in irrigated land. All previously constructed infarm systems have changed their status to interfarm canals, thereby leaving them without proper control, repair and management and have become in an unsatisfactory technical condition or have fallen out of use. As a result, some have lost their connection to irrigation sources.

Financial resources are needed for rehabilitation of the irrigation network, purchase of irrigation engineering and equipment. Therefore, traditional surface irrigation prevails, which is not conducive to economical water use. Water losses reach up to 35%, and the absence of a collector arterial drainage network or its poor technical condition causes a rise of the groundwater level, which leads to waterlogging and salinization of soils.

The fertility of irrigated land is sharply deteriorating and the productivity of estuary irrigated land is decreasing. This situation is exacerbated by irregularities in crop farming techniques, and crop rotation is practically not used.

The next problem resulting from the non-use of crop rotations is the high weed infestation of crops and soil with weed seeds. They increase the infestation of agricultural crops with diseases and pests. Cultivation of monocultures has become the norm. It is known that different crops leave unequal amounts of organic matter in the soil, with a decrease in the accumulation of organic residues there is a decrease in humus content, and it is one of the main indicators of soil fertility.

According to agrochemical service of the Ministry of Agriculture, humus content in bogharic agriculture soils was determined as high only on 2.2% of arable land, average - 36.1%, low - 61.7%. In soils of irrigated farming high humus content accounted for only 0.2% of the area, average - 1.6%, low - 98.2%. Mineral and organic fertilizer use has been low in the presence of such indicators. For example, since the level of 1986, the application of mineral fertilizers has been reduced by thirteen times and the volume of organic fertilizers has been reduced by almost three hundred times.

The processes of degradation and erosional feature of lands have started to intensify due to non-observance of agrotechnical measures for soil treatment. Thus, of the total area of agricultural land 214.3 million ha of eroded and erosion-hazardous lands, 50.3% or 107.7 million ha.

Since 2000, the area of eroded arable land has increased from 1.6 million ha to 1.8 million ha or by 0.2 million ha, including the area of washed-out arable land

[11] Law of the Republic of Kazakhstan of July 8, 2005 No. 66 „On State Regulation of Development of Agro-industrial Complex and Rural Territories“.

from 1.03 million ha to 1.22 million ha or by 0.2 million ha. The area of pasture has decreased from 182.0 million ha to 179.1 million ha, i.e. by 2.9 million ha. At the same time, the quality characteristics of pasture are also deteriorating. The area of pasture with broad-leaved cat-tail increased from 7.6 million ha to 7.7 million ha (by 0.13%), the area of churned up pasture from 26.6 million ha to 27.1 million ha (by 1.9%).

It has been established that the economic entities have not practically improved the pasture for many years. Many of the pasture areas that were considered to be improved have become overgrown with natural and weed vegetation. There is practically no accounting of improved pasture.

The withdrawal of a large part of the pasture land from agricultural use has had a negative impact on its quality (overgrowth with non-edible weeds). In turn, the concentration of livestock around human settlements has led to the degradation of adjacent pasture land. These processes, although recorded in the primary inventory, and changes in the quality composition occurring at intervals of every five years, but their updating and actualization is hampered by problems with insufficient financing. The economic valuation of land was only carried out in 2010-2011 based on the results of geo-botanical and soil surveys carried out in the previous ten years.

The materials of soil surveys in the country cover surveys of various periods, where the main volumes fall only for the period up to 1990 – 104.25 million ha or 56.3% of the surveyed area. Between 1991 and 2016, annual soil surveys were conducted from 2 million ha to 3.2 million ha, the results of which revealed: the dynamics of an increase in the area of saline lands from 34.3 million ha to 35.8 million ha or by 1.5 million ha (by 4.3%), waterlogged lands from 0.9 million ha to 1.1 million ha, i.e. by 0.14 million ha (by 13%).

Starting in 2017, the volume of soil surveys began to increase, reaching 5.15 million ha in 2017 and 7.4 million ha in 2020. The situation is similar for geobotanical surveys, which were mainly carried out in the pre-1990 period at 93 million ha or 56.4% of the area of forage land. From 2006 to 2020, geobotanical surveys were carried out on an area of 39.2 million ha, or 23.7% of the natural forage area.

Objectives of the sectoral management programme of land resources

The State Programme for the Agro-industrial Complex provides target indicators for the achievement of the sector's objectives[12]. It attaches particular importance to the system of reproduction of agricultural land fertility. It is planned to cover 33.0 million ha with soil surveys by the end of 2021, 33.0 million ha with geobotanical surveys, and 27.0 million ha according to the definition of soil bonitet.

The measures of the state response have been to tighten the policy for unsustainable land use, by increasing the basic tax rates tenfold[13]. A twentyfold increase is already being considered as part of the draft law on taxation and improvement

[12] Government Resolution of the Republic of Kazakhstan of July 12, 2018 No. 423 „On Approval of the State Programme for the Development of the Agro-industrial Complex of the Republic of Kazakhstan for 2017 - 2021".

[13] Code of the Republic of Kazakhstan of December 25, 2017 No. 120-VI „On Taxes and Other Obligatory Payments to the Budget (Tax Code)".

of the investment climate, as well as the adoption of the Land Management Rules, which set standards for identifying conditions for land degradation, crop rotation, pasture pressure, etc[14].

At the same time, the sectoral non-economic nature of management may not affect the rapid achievement of objectives. Non-sustainable use of land will continue to dominate. Already today, space monitoring has identified an additional 7.7 million ha of unused land with a significant predominance of pasture land in the country.

Evidently, the real reasons do not lie only in the field of tighten the legislation. Much depends on economic and financial tools. Global growth in the agricultural economy over recent decades has been achieved mainly through active protectionism - subsidies, price supplements, guarantees for directed loans, quotas, customs and tax preferences. These are provided by the World Trade Organization (WTO) with state support measures for agriculture, including:

1. food subsidies and subsidies within the permitted level of state support;
2. the full cancellation of direct payments (subsidies) with a focus on insurance plans;
3. programmes aimed at reducing production in order to increase competitiveness;
4. measures to allocate funds for rural infrastructure development, agricultural research, environmental programmes, soil fertility improvement.

This support is not subject to regulation and can be allocated in any amount. As it is understood that our country has retained the possibility of subsidizing during the transition period of accession to the WTO: direct subsidies to economic entities for the purchase of agricultural engineering, machinery and equipment; for the creation of infrastructure for pasture watering, fattening facilities and others that stimulate the growth of labour productivity.

However, the global trend towards sustainable development demonstrates strategic priorities for transforming resource management policies through new economic approaches. These already include solutions for maintaining land fertility through the development of a „green“ economy, and land use through renewable energy technology, as well as the strengthening of carbon regulation. These issues will mean application of incentives for the country, e.g. for certain types of pesticides and fertilisers that improve soil conditions. Subsidies for fertility assessment and conservation measures will become more oriented, without excluding them from the overall biodiversity system.

Preparing for the coming changes will trigger the identification of strategic conceptual decisions on them. Strengthening the role of research works based on international practices to support „green“ technologies, risk insurance programs aimed at infliction of damage as a result of excess pollution, the introduction of tax incentives; investment subsidies for the modernization of production in accordance with the requirements for the protection of natural resources, sustainability standardisation, eco-production and eco-labeling certification systems; financial

[14] Order of the Minister of Agriculture of the Republic of Kazakhstan of January 17, 2020 No. 7 „On approval of the Rules for the rational use of agricultural land and on amendments and additions to some orders of the Minister of Agriculture of the Republic of Kazakhstan“.

instruments for adaptation and climate change, „green“ lending; pilot testing of the economic assessment of resources and the creation of extra-budgetary mechanisms to cover the funding gap.

4.4 Policy on sustainable land use and protection

Development of land relations

The social form of land use historically prevailed in the Kazakh steppe, until 1731 land relations were reduced to simple patrimonial land usage. It was based on „squatting“ right which was the actual possession of pasture by an individual clan or group of clans. The population perceived the land as pasture resources, which were not permanently owned by one clan or another. But already in 1868, after the accession of territory to the Russian Empire, the Tsarist government approved a temporary regulation on the administration of the Steppe Territory (as modern Kazakhstan was then called). According to this act, all lands were declared the property of the Russian state. Following this, the withdrawal of the most valuable pasture lands and their inclusion in the resettlement fund began. The traditional livestock industry has been severely damaged, and breeders have been forced to migrate from their traditional nomadic areas to semi-desert and desert lands, where pasture is very scarce. As a result, the number of indigenous population in the land which had been seized gradually declined. This was in general terms the situation until the October Revolution of 1917.

As known, the Decree on Land was the second official document of the Soviet government in terms of adoption. It was full of grand conceptions - it liquidated landlordly ownership of the land, which going forward should belong to those who cultivate it. But collectivization in essence condemned the villagers to „rural enslavement“ - no easier than the serfdom that was abolished by the Tsar’s Manifesto of 19 February 1861.

With regard to land use in the former USSR, the Second All-Union congress of members of a collective farm held in 1935 approved the „Model charter of the agricultural artel“. It stipulated that the land occupied by the agricultural artel would be granted free of charge and in unlimited use, i.e. in perpetuity.

During the socialist period the regulation of land relations was carried out in accordance with the Fundamentals of Land Law of the USSR and the Union republic. The Land Code of the Kazakh SSR adopted at that time fixed the priority of large-scale state agricultural land use. State farms became the predominant form of management during the development of virgin and fallow lands, which began in 1954.

For all the benefits that virgin land has brought to Kazakhstan’s famous billions of pounds of grain, it is impossible not to regret that as a result of a thoughtless, all-out approach, traditional pastureland has been put under plowing.

Stages of land reform

Kazakhstan attained state sovereignty on October 25, 1990 and became independent of the „centre“. The formation of a national legal system began thereafter, particularly in relation to land relations.

Starting from this period, one after another the laws that can be called the first stage of the land reform were adopted: „On Land Reform“[15], „On Peasant Farm“ and „On Land Tax“. These acts have played their role in the creation of new forms of land management. Citizens began to have the right to receive land plots for lifelong inherited possession for farming, personal subsidiary farming. The transfer of land for lease was also allowed. However, at this stage of the land reform, the ways of transferring land to efficient users have not been determined. Moreover, the tendency to wasteful attitude has begun to increase.

Investments in agricultural chemicalization, land reclamation and erosion control measures have been drastically reduced, if not halted, in the context of a systemic economic crisis. The material and technical equipment of agricultural production began to deteriorate. The state stopped fulfilling the paternalistic function that was normal under socialism, and this had an immediate impact on attitudes to land and the quality of work on it. Consequently, the issue of land denationalization became objectively unavoidable. A decisive step in this direction was necessary. During 1994-1995 the President of the Republic of Kazakhstan signed decrees having the force of law: „On certain issues of land relations regulation“ and „On further improvement of land relations“. With their adoption, it became possible to sell and donate land, to lease it and to mortgage it. In other words, the right of lifetime ownership of land and the right to use land became subject to civil law transactions. In that way, the land sector was turned towards market relations. A land market began to emerge, and a system for assessing the market value of land plots began to take shape.

However, the main property issue was still unresolved. Land continued to be the exclusive property of the state. The existing system of social relations and attitudes in different layers of society at that time all indicated that the transition to new land relations should not be made by radical measures, but by evolutionary means.

The possibility of private ownership of land needed to be legally secured so that the idea did not fall victim to profanity and become a apple of discord in society. Remarkably, during the widespread discussion of the draft Second Constitution, the people of Kazakhstan expressed their support for the introduction of private land ownership. This provision was entrenched in the text of the Constitution adopted by referendum on August 30, 1995. According to the 1995 Constitution, land may be both publicly and privately owned on the grounds, conditions and limits prescribed by law. This normative legal act was not long in coming. Also in 1995, the President of the Republic of Kazakhstan issued a decree having the force of law on land, which introduced private ownership of private subsidiary farming, horticulture and construction.

But it has to be said that there was no large-scale objective of a complete transfer of land to private ownership at that time. The social and economic conditions of the time, especially the agro-industrial sector of the economy, which was

[15] Law of the Kazakh Soviet Socialist Republic of June 28, 1991 „On Land Reform in the Republic of Kazakhstan“.

unprofitable, could not be ignored. It was not necessary to involve political scientists for the predictive analysis to conclude that the introduction of private ownership of agricultural land in those conditions would not only provoke a negative reaction from the population, but could also lead to a shattering of domestic political stability.

With the adoption of the Land Law in 2001[16], the next stage in the implementation of land reform began. It should be noted that the right of non-state land users to permanent land use was replaced by the right to temporary long-term land use on lease terms for forty-nine years. Temporary restrictions were set for holders of rights to conditional land shares regarding their disposal, which did not improve the situation of peasants.

As this law began to roll back the course of land reform, the issue of restoring the pre-existing institution of permanent land use was raised.

But everyone realized that such a return would contradict the Constitution, as the content of land ownership and the right to permanent land use would in practice be no different.

The fact of the matter is that law cannot fail to take into account all the components of social consciousness. Particularly eclectic, where there were still ideals of egalitarianism, lack of initiative and paternalism, nurtured by decades of ideological conditioning in the spirit of Marxist-Leninist teaching.

Private ownership: pros and cons

Realising that the Gordian knot could not be cut with a single legislative stroke, work began on a draft law on the phased in introduction of private ownership of agricultural land. It was even put up for all-people's discussion, but due to the acute polarization of opinion, the draft law was withdrawn from Parliament and swept under the carpet for several years.

Again, the social aspect and the consideration of public opinion were extremely important in land use and farming. The sociological research conducted has shown that the negative attitude of many people towards private land ownership had a sketchy and not objective assessment. The participants in the surveys generally did not have a clear, let alone a systematic understanding of the basics of land legislation. Even about such a concept as the „land market". The strongest argument „con" proved to be the mentality of „spiritual first principle", which has an inextricable connection with the land.

For others, the phenomenon of private land ownership had a clear negative connotation due to ideological ideas - „Land for the people!" but the idea of „selling land" was slammed as blasphemous. Many denied buying and selling land simply because they were financially insolvent. In the mass of the population, this part did not even want to get into the core of a problem, but in advance and categorically spoke to the contrary.

The question of land was seen as self-sufficient, determining and decisive, and independent of the whole set of problems of agricultural and rural development in

[16] Law of the Republic of Kazakhstan of January 24, 2001 No. 152 „On Land".

general. At the same time, this attitude was not uniform in the mass consciousness. The people who lived and worked on fertile land regarded private ownership as an objective reality. Those who worked on poorer lands considered it best when the land was owned by the state, which was obliged to support the workers in agricultural production. In the public discussion on land, there were assessments of different forms of land relations. Particular emphasis was placed on leasing, with reference to foreign experience. Can lease be an alternative to private land ownership?

Features of foreign practices

In modern states, different models of land use are being implemented. In many countries land may be privately owned. For example, agricultural relations are based on private land ownership in Bulgaria, Hungary, Poland, the USA, Croatia, the Czech Republic and others. The Land Code and the Federal Law „On the agricultural land transactions“ have been adopted in Russia.

In some European countries land was held as a kingly gift. So, the Latin American latifundia did not come about through the market. As in Europe, land was donated to local landowners by colonial authorities representing, for example, the Portuguese monarchy in Brazil and the Spanish crown in other countries. A different model is used in other countries around the world. For example, in Israel, China, land remains in state ownership, but the sale of land use rights or the leasing of land with extended terms, donation and inheritance rights, as well as its pledging for bank loans, are allowed. That is, market-oriented mechanisms are used.

Land issues in South-East Asia are influenced by factors such as limited land resources with overpopulation. However, international practice shows examples of high profitability of state-owned land. At the same time, it shows inefficient management of private land holdings.

Thus, we can make the conclusion that the land issue is nowhere in the world given over to the private owner in principle. Issues such as the addressee of the sale of a land plot, its size and the purpose of acquisition are determined by law at different levels. Some issues belong to political powers, others to executive ones. States are able to put barriers to all kinds of abuses and negative phenomena in this area, such as land plot speculation, monopolism in their concentration or fragmentation. The maximum and the minimum size of plots when they are sold, inherited or leased are subject to regulation to combat such phenomena. To a certain extent, the individual characteristics of the persons applying for the purchase of land plots are taken into account. For example, local authorities grant permission for establishing and farming based on the educational qualifications of the applicants, their level of agricultural training and production experience. Sometimes the criterion is professional experience (at least 3-5 years) or a vocational diploma. If society and the state regulate land use, then the land market becomes an object of regulation, with a special focus on it. No country has a completely „free“ land market. In a number of countries, the state acquires a specific land plot itself, reimbursing the selling party for its market price, and then resells it on more acceptable terms or leases it, using the right of veto. Lease relations strictly determine the mode of

cultivation of the land and the application of measures to ensure soil conservation. It should be added that in many countries the methods, forms and intensity of land use are in direct dependence on the level of development of their productive forces and the balance of political trends. However, the main objective of society remains unchanged - the protection of the benefits and privileges involved in the right of private land ownership.

Features of the Land Code

The Land Code as amended in 2003 sets out the conditions for the introduction of private ownership of agricultural land. It provided an opportunity for all willing citizens and non-state legal entities to purchase land plots into private ownership. But it was not about compulsory repurchase. The following principles were enshrined in it:

1. voluntary choice of land use form;
2. legal personality;
3. limit of private property rights.

In addition, the issues of ownership of the lands of the forest and water resources of the Republic of Kazakhstan were clarified. Before focusing on the institution of private ownership of agricultural land, it should be borne in mind that the limits of private ownership of land affected primarily only those allocated for private subsidiary farming, individual residential construction, horticulture, and development of industrial and nonindustrial buildings and structures in accordance with the Decree „On Land“ of December 22, 1995. This was done deliberately to change the psychology of the people, who had always been oriented towards exclusive state ownership of land.

However, it would be untimely and unjustified to extend the institution of private ownership of agricultural land at the start of land reform. Since then, transformation of state agricultural organizations and the reform of collective farms have been completed. Almost all the villagers, which is more than two million citizens, received the right to a conditional land share. Thus, they were given equal starting conditions for entering into real legal relations regarding the land market.

Today, based on the principle of voluntariness, more than 90% of agricultural land is owned by non-state organizations, which were established on the basis of disbanded state farms or former collective farms. Persons who received land for farming could also work on it on a temporary, long-term basis for up to forty-nine years. Foreigners and persons without citizenship could only obtain plots for temporary land use on a lease basis and for up to ten years. In cases where private ownership belonged to an individual and he lost his citizenship, the plot was either subject to re-registration as temporary land use for up to ten years, return to state ownership, or be alienated to another Kazakh citizen.

The secondary use right for agricultural land was abolished by the transitional provisions of this Code as of January 1, 2005, i.e. only the owner of the land plot may hold the lease right. It is considered fair that the lessee himself should work on the land leased from the state, rather than sub-lease it to someone else. This legal provision was aimed at preventing the appropriation of land rents.

The principle of fee-based provision of private property provided for the sale, both at their full estimated value and at a discounted price, according to the cadastral (estimated) value of the land plot. The instalment sale was allowed for a period of up to ten years. In the case of a land plot sold at a discounted price, restrictions were imposed on the right to dispose of it. The moratorium on sales was set at ten years for such purchase, and the moratorium on instalment sales was set for the installment period. The money received from the sale was used by the National Fund only for the purpose of agricultural production and improvement of land fertility.

Current stage

The need for privatization of agricultural land was stated by the country's leadership based on the results of the 2012-2014 land inventory, when the level of unused and withdrawn land from agricultural circulation reached significant proportions and the guaranteed opportunity to purchase land leased from the state into private ownership was not massively used. The consumer attitude towards leased land did not include preservation of soil fertility, and ineffective regulation of land relations limited the land's potential as a factor of production growth. This initiative was later included in the Nation's Plan „100 steps to implement the five institutional reforms" with the need to amend the Land Code and other legislative acts to include agricultural land in the market turnover for its efficient use; simplify the procedure for changing the land designation, transfer of all unused land to the state fund for further privatization. In this connection, a law was passed in 2015 that provided for the implementation of the provisions of the Nation's Plan. The amendments related to the purchase of land exclusively in private ownership and only on the basis of tenders (auctions) and they applied not only to residents of the country, but also to foreigners and persons without citizenship. However, these amendments were not adopted due to a wide response and public protests. A special Land Reform Commission was established to clarify and develop proposals. According to the results of its work, the Head of State imposed a moratorium, then a specially adopted Law suspended the validity of these norms, and later when the five-year moratorium expired, it was extended until 2027[17].

On the inter-relations between land law and other law branches

First of all, it should be noted that a country's entire legal system is closely interconnected with each other. In matters of the use and protection of land, this relationship results from the nature of land relations, which constitute one of the most complex branches of law. Here are the challenges of economics, social welfare and environmental protection. For example, the norms of land legislation regarding the legal regime of land use complement all sectoral legislation by land category with regard to related legal relations.

[17] Law of the Republic of Kazakhstan of December 23, 2016 No. 32-VI „On introduction of amendments to the Law of the Republic of Kazakhstan „On Suspension of Certain Norms of the Land Code of the Republic of Kazakhstan and Implementation of the Law of the Republic of Kazakhstan of November 2, 2015" On Introduction of Amendments and Additions to the Land Code of the Republic of Kazakhstan".

Legal regime term as a whole has a particular focus on the regulation of relations at a higher level, the content of rights and obligations regarding the use of land. It is also of great importance in planning, management, and control of land resources conservation and valuation. Assessment of the land in its significance requires consideration of standards for hazardous substance maximum allowable concentration, harmful microorganisms and other pollutants. Sources of such impacts can generally be identified in the siting and operation of production, utility, storage and other facilities.

The legal regime for the use of land resources is resolved in general plans, projects for their detailed planning, rules for land use and development, land use projects, and the establishment of protection zones. Regulatory resolutions of the Supreme Court play a special role in the understanding and application of a rule of land law in conjunction with other law branches, as they refer to existing law in accordance with the Constitution. Such regulatory decrees now have clarifications on issues of contesting the legality of acts of state authorities, the granting of land plots, their withdrawal, assessment and compensation for losses, damage.

4.5 Land resources issues in cities

Transformation of property rights

It makes sense to outline the main directions of land policy at the stages of land reform in the first place. In the initial stages, the reform was aimed at transforming the rights to land plots that were individually owned by citizens. It began with the granting of the right of lifetime inheritable possession to run a private subsidiary farming, horticulture, construction and maintenance of a dwelling house. Later (since 1995), this right of ownership was transformed by granting land plots to citizens for free in private ownership. The change of rights has also affected the legal relations in development, and built-up industrial and other facilities with the adoption of the Land Act in 2001. Land for these purposes was provided on a fee-paying basis for private ownership or on a fee-paying lease from the state. The situation at that time with the granting of rights to land plots was not „smooth“, there were „ravines“ in the form of illegal social phenomena of unauthorized land-grabbing, which also had a long chronology. The most characteristic of these were the requirements for the allocation of land for individual residential construction. The grounds for their free of charge provision were then perceived by some categories of citizens as a state guarantee of immediate satisfaction of their needs. The latter’s dissatisfaction has spurred the unauthorized land-grabbing.

In Almaty the first attempts of unauthorized land-grabbing took place back in 1991, when groups of young workers from among those living in dormitories staged rallies demanding immediate provision of housing. They seized undeveloped territory, divided it into plots and allocated them to each other. To give their actions some semblance of legitimacy, they organized public associations. In order to break the social tensions that had arisen, the executive authorities were forced to grant land plots to representatives of these associations. About 10 thousand land plots were

allocated only in one microdistrict. But this did not solve the problem, on the contrary, it created other problems, because the housing was built spontaneously, without proper designs, with materials at hand and did not meet seismic requirements and other regulations. Issues of subsistence have arisen and become aggravated due to the lack of engineering infrastructure and utilities. No landscaped passageways have been laid, no territories have been reserved for the construction of schools and kindergartens.

Two more squatting followed the first stage. In 1997-1998, some land of nearby districts of Almaty region was included in the city boundary. Some of this land was misappropriated by a number of rural district officials, for which they were later punished accordingly. The development of the plots allocated to them was also carried out without approved detailed planning and development designs. Houses were built non-seismic, roads were not constructed.

The third stage of squatting took place in 2003 and continued for several more years. The squatters include territories that are part of the city's land reserve of specially protected territories: the protection zones of gas pipelines, areas with energy and social facilities. More than 900 plots, about 300 power lines, 1,182 water facilities, 320 cemeteries in total are within the gas pipeline's protection zones. About 1,600 plots in the territories are located with a close groundwater occurrence, in places where streets are punched. Nevertheless, the consequences of squatting have been resolved, including legalization of their amnesty.

The reality of land squatting has required solutions in other cities of regional significance.

Forms and procedures for granting land

Territorial limitation predetermined the forms and procedures for granting land. For commercial purposes it became possible only through auctioning, as it was necessary to equalize opportunities in access to them on the principles of openness and competitiveness.

Auction form does not apply to public construction projects for public needs, engineering and communication networks, public planning system and others, according to the list of legislation, and is regulated by a special procedure.

Land plots are provided in the form of state grants in kind for investment projects that meet the conditions of the investment[18]. The conditions of the grant are the fulfilment of obligations under investment contracts. The grant is provided by the authorized investment body, in agreement with the central land management authority and the local executive body for temporary royalty-free use or with compensation-free transfer of ownership or land use.

The conditions also include proof of the market value of the land plot. Another possibility is for participants in a free economic or industrial zone for import substitution, export-oriented or industrial-innovative projects. If these requirements are met, the land is subleased and then registered for private ownership after the

[18] Law of the Republic of Kazakhstan of January 8, 2003 No. 373-II „On Investments".

operational commissioning of the facility[19]. The participant is entitled to tax benefits in the form of full exemption from corporate income tax, land tax and property tax. In addition, it is granted the lease or sublease of the infrastructure created wholly or partly with budgetary funds.

High density of construction during implementation in public projects are known to take the form of forced seizure of land plots[20]. Although compulsory acquisition is carried out in exceptional cases, the conditions of equal compensation for value in each case are accompanied by claims. Finding the compensation threshold value, taking into account the balance of interests of parties: from plot owners, investors and city authorities is difficult. Some parties consider that the assessment is not sufficiently objective and fair, i.e. not adequate to the market value. The amount of compensation for the demolished property on the land is not satisfactory.

Conducting a reliable and fair valuation formed the basis of legislation on state property on valuation activities. The basic principles are legality, objectivity, authenticity, independence and confidentiality.

There are three components to determining market value: regulatory, methodological and informational. All of them must be thorough, specific and reliable.

Compensation components include the market value of the land plot and the immovable property on it, including perennial plantations; losses caused by acquisition, including losses incurred by plot owners to third parties; and loss of benefit (this category of compensation is not the subject of the evaluators, but is part of the conciliation process). In the event of a dispute, the issue of loss of benefit is subject to judicial review.

In the general structure of compensation payments, the determining amount is the value of the land itself, which can be 80% or more of the total amount. This value analysis is based on monitoring sales prices on the free market, and the price contingency is not constant and changes due to supply and demand.

While the return on investment in construction activity was quite high due to the so-called „housing bubble“ in 2005-2006, the trend in demand reached a climax in 2007, and consequently there was a price increase. Investment activity declined significantly in 2008 due to the global financial crisis, lack of funding sources. As a result, prices on the secondary market decreased by an average of 58.5%. The tendency to equalize the inter-relationship between supply and demand was noted in the period from 2009 to 2010, and since 2010, an increase in prices has been triggered in places provided for the seizure of land for state needs. Thus, valuation methods should be based on integrated approaches, including the processing of comprehensive information.

[19] Law of the Republic of Kazakhstan of April 3, 2019 No. 242-VI „On Special Economic and Industrial Zones“.

[20] Law of the Republic of Kazakhstan of March 1, 2011 No. 413-IV „On State Property“.

Agglomeration model

In the context of limited territory, the neighbouring parts of suburban lands are the reserve, which constitute a single social, natural and economic territory with the city. Therefore, the procedure and regime for the use of land included in the suburban zone of the capital and cities of republican significance shall be determined by the Government[21].

The agglomeration model is now recognised as the main strategic direction, as it opens up new opportunities[22]. The core of agglomeration is to create a supporting framework for the strategic development of the country's productive forces. In comparison with ordinary urban development projects, agglomeration aims at a broader scale by creating a system of human settlements with a center of economic development. The city has a clear advantage here. The solution to urban problems is the removal of part of production, the creation of transport and municipal infrastructure, the development of recreational facilities and a suburban environment, a higher level of engineering, socio-cultural services and life quality. The objectives of agglomeration development will be achieved by well-managed specific land use, the establishment of special regulation zones. The formation and development of agglomerations as long-term growth „poles" of the country has been defined in the Prognostic scheme for the territorial and spatial development of the country.

The current Message of the Head of State again emphasizes the importance of agglomeration development. Now the largest city of Almaty is already at the stage of completing all the designs for large-scale urbanization. The result will be the formation of „countermagnet cities", drawing in external migration flows and thus helping to relieve the megacity from overpopulation; the transformation of large agglomeration human settlements into „mini-countermagnet cities" with a developed network of modern production facilities - places of employment, intercepting internal pendulum migration flows into the megacity.

Advanced experience in land resources management

Another example of an urban problem solving is Singapore's advanced land management model, which is recognized as one of the best in the world. It focuses on four main components: analysis, geographic information system, data management, Internet access.

There, the land services procedure is carried out in real time and consists of analysis of the incoming application, control analysis of the status, cadastral definition of the land plot, entry into the database (land plot plan), preparation of the document (land plot deed), certification.

The so-called data hub contains information about the land plot, traffic infrastructure, urban development plan, environment, taxation and etc. is lectronically

[21] Decree of the Government of the Republic of Kazakhstan of December 18, 2003 No. 1269 „On Approval of the Rules and Land Use Regime included in the Suburban Zone of the Capital and Cities of National Significance".

[22] Decree of the Government of the Republic of Kazakhstan of June 6, 2013 No. 581 „On Approval of the Interregional Action Plan for the Development of the Almaty Agglomeration until 2020".

accessible for all interested parties. Each piece of the information is controlled and updated by the corresponding public authorities.

Within a generation, Singapore went from an underdeveloped state to one of the developed countries of the world. In 1960, 50% of Singapore's citizens had the worst housing conditions. In the seventies, a time of crisis, the construction of low-cost typical houses began. In the eighties, with the economy development and people's well-being improving, the Concept of Urban Areas was developed to improve housing conditions. In order to gain access to all services in each urban area (4,000 to 6,000 flats), the creation of industrial zones for work, linking up with shopping and recreational centres, health and education facilities has begun. Flat areas have increased in size. In the whole country, one apartment was rented in eight minutes. This was facilitated by the use of block construction with prefabricated flights of stairs and modern technology.

In the nineties the problems of houses built in the sixties were solved by renovating them in a modern way. For this purpose, the state bought back old flats, relocating their inhabitants to new flats. Houses have grown in size as a result of using typical standard technology after reconstruction.

The millennium was a period of combination, i.e. creating mixed styles in architecture and design, combining the old with the new. Integration of transport systems, shopping complexes, new job formation so that people do not leave their areas. Since 2010, the identification of citizens' needs began, with a review and revision of everything that had been done. Each house became accountable to the city authorities.

Based on the noted stages of the development of housing construction, it becomes clear why in Singapore the plot plan of development is reviewed every ten years. The logic here is that initial planning, then design and commissioning, and finally management of the finished facility. This cycle is repeated in a new ten-year stage.

4.6 Ensuring land resources management

Regulatory and methodological frameworks for the provision of land resources management are fundamentally developed and define the scope of application along thematic orientations. The main list of methodological and procedural frameworks includes implementation and production procedures:

1. land organization;
2. soil and geobotanical surveys;
3. maintenance of the state land cadastre and land monitoring;
4. zoning and valuation of lands;
5. recultivation of disturbed land.

Land organization

It is a system of measures to ensure compliance with land legislation and is aimed at regulating land relations and organizing the rational use and protection of land. Land organization is carried out on land of all categories independent of

ownership and form of management. Whether it is a specific plot of land or an administrative-territorial unit. Its formation begins with a land organization[23], which includes the process of:

1. initiation of proceedings;
2. preparatory works;
3. development of forecasts, schemes and projects of land organization;
4. review, coordination and approval of land management documents;
5. execution of the land organization project.

Land organization is most closely linked to agriculture. Without it, the very creation and organization of land use with the intra-economic organization of the area for agricultural production is unthinkable[24].

The main feature of land organization is that the designation, regime of land use and protection, restrictions and encumbrances, borders of land plots, data on the quality and quantity of land, established based on its results, are binding. The entire cycle of land organization activities is technologically linked to the state land cadastre.

The state land cadastre also plays an important role in land resources planning and management processes. Its maintenance and formation is ensured by carrying out topographic-geodesic, aerospace, cartographic, land surveying works, soil, geobotanical surveys and investigations, land monitoring works, quantitative and qualitative land registration, preparation of land cadastre file for a specific land plot, production of land cadastre maps and land identification document for a land plot.

The content of the above-mentioned types of work is defined by their specifications in accordance with the regulations of the central authority responsible for land management and protection[25]. As part of the maintenance of the land cadastre, the following activities are also carried out:

1. state cadastral valuation of land;
2. drawing up schemes of boundaries of evaluated zones with the establishment therein of correction coefficients to the basic rates of payment for land plots;
3. calculation of basic rates of payment for land plots;
4. determination of agricultural production losses in the event of seizure of agricultural land for non-agricultural purposes;
5. accumulation, processing and maintenance of a data bank on land plots and their subjects, as well as other land cadastral information;
6. maintenance of the automated information system of the state land cadastre;

[23] The textbook „Land Planning Design“ 1999, edited by Professor, Doctor of Economics M.A. Gendalman.

[24] Order of the Minister of Agriculture of the Republic of Kazakhstan of January 17, 2020 No. 7 „On approval of the Rules for the rational use of agricultural land and on amendments and additions to some orders of the Minister of Agriculture of the Republic of Kazakhstan“.

[25] Order of the Minister of National Economy of the Republic of Kazakhstan of December 23, 2014 No. 160 „On Approval of the Rules of Maintaining the State Land Cadastre in the Republic of Kazakhstan“.

7. production and maintenance of land cadastre maps, including digital;
8. maintaining the land cadastre register and the unified state land register.

The automated land cadastre information system provides:

1. integration with „e-government“ information systems and public databases;
2. „e-government gateway“;
3. „Register of taxpayers and taxation objects“;
4. „Address register“;
5. „Real estate register“;
6. „Legal entities“;
7. „Natural entities“;
8. Law enforcement and special authorities' system of exchange General Prosecutor's Office (through this system it has become possible to provide public services in the field of land relations electronically).

Creation of a unified land and real estate cadastre is currently being completed. At the same time, tthe potential of this system with greater efficiency can be extended for integration with other natural resource cadastres.

Cadastral valuation

The cadastral (estimated) value of a specific land plot is determined by the State Corporation „Government for Citizens“, which maintains the state land cadastre. It is calculated according to the base rates of the fee with the application of correction (increasing or decreasing) coefficients to them and is documented in a valuation report. It is primarily needed to determine the fees for land plots when they are provided by the state to private ownership or lease. It is also applicable in establishing the resource potential of land's natural resources in the structure of total national wealth. In general, it plays an important role in planning and management processes and in controlling the use and protection of land, because it allows to find answers in relation to each specific land plot.

The evaluation of natural soil and plant properties is of primary importance for the protection of land fertility. In addition, the results of the assessment are used to determine:

1. compensation costs in cases where agricultural and forestry land is seized for other non-agricultural and non-forestry purposes[26];
2. replacement of losses for the restoration of land with the amount of fertile soil layer applied;
3. actual damages compensation from loss of benefit.

It is achieved through soil surveys, geobotanical surveys, soil rating, land monitoring, i.e. with combined methods and techniques for analysing the

[26] Land Code of the Republic of Kazakhstan of June 20, 2003 No. 442-II.

composition, physical-mechanical, agrochemical and biological properties of soil and plants.

The result determines:

1. control indicators of soil and plant conditions, distribution of areas with degrading properties;
2. sources of negative impact and the causal link of their degradation;
3. salinity, solonetzicity and other soil properties affecting land fertility;
4. crop-engineering state, plant chemistry and nutrition, crop yield, fodder quality, forage capacity, composition of medicinal, technical, threatened and endangered species, non-edible and poisonous plants.

In view of the increase in land transactions, it is possible to assume an increase in requests for determining their market value. Consequently, there is a need to pay attention to this valuation as well.

Market value is the process of determining the price (value) of a land plot, carried out by independent appraisers, within the framework of legislation on valuation activities[27]. Methods based on market, income and cost approaches are used, which are independent of each other to determine it. In the end, they are designed to give one close to the market value of the land.

The scope of application of the market value of land is very diverse and can be carried out in the following operations:

1. purchase and sale of a land plot;
2. contribution of the right to a land plot into the property complex or the authorized capital of an economic entity;
3. provision of a land plot for investment;
4. evaluation in determining the amount of compensation or damages;
5. collateral security;
6. other operations within the scope of applicable law.

Some specifics on determining the market value of land for compulsory seizure for state needs are given in the section on land resources of human settlements.

Monitoring of lands

The efficient use of land resources cannot be achieved without a permanent system of control and monitoring of the qualitative and quantitative condition of the land fund and its use, i.e. monitoring of lands.

[27] Law of the Republic of Kazakhstan of January 10, 2018 No. 133-VI „On Valuation Activities in the Republic of Kazakhstan".

The content of monitoring[28] consists of systematic observing the state of land at stationary semi-stationary points, which enables the identification of the nature of changes, assessment and formation of an appropriate forecast and recommendations for the prevention and elimination of the consequences of negative impacts on land resources.

The existing monitoring network covers all natural and economic zones of the country. Space-based monitoring is currently being developed. However, information on the state of the land was outside the unified monitoring system, obtained through monitoring by other agencies. The issue of monitoring urban land, where the focus should be on the environmental aspects of pollution, remains relevant. The densification of the surveillance network with full territorial coverage of all zones therefore becomes necessary. Maintaining land monitoring should be integrated with monitoring of all other natural resources in the long term.

4.7 Law violations and legal responsibility

With the emergence of property or other real right to a land plot, which extends not only to the plot itself, but also to the surface soil layer, landlocked bodies of water and plantations within its boundaries, the owner of the land plot has corresponding responsibilities. In the event of non-compliance with such obligations, legal consequences may arise, including compulsory enforcement. Current legislation attaches[29] particular importance to obligations to prevent adverse impacts on soils, valuable agricultural land and the conditions of the land use regime. Signs of a breach of obligations are:

1. destruction or illegal removal of fertile soil layer;
2. pollution or other deterioration of land with agrochemicals, pesticides, fertilizers and other dangerous biological and radioactive substances;
3. pollution of land resulting in environmental damage;
4. unsustainable use or non-use of land;
5. use of land not for its intended purpose, and on lands of human settlements not in accordance with the functional zone;
6. failure of land protection measures;
7. failure of measures for bringing temporarily occupied land into a condition suitable for further use;
8. works in the protection zones of power and heat supply lines, gas supply systems, water protection zones and water bodies' lanes.

Such violations are detected by bodies exercising state control over the use and protection of land:

1. central competent body for land resources management;

[28] Order of the Minister of National Economy of the Republic of Kazakhstan of December 23, 2014 No. 159 „On Approval of the Rules of Land Monitoring and Use of its Data in the Republic of Kazakhstan".

[29] Code of the Republic of Kazakhstan of July 5, 2014 No. 235-V „On Administrative Offences".

2. authorized bodies for monitoring the use and protection of land of local executive bodies;
3. state bodies:
4. in the field of environmental protection, architecture, urban planning and construction;
5. agriculture, forestry, hunting and fishing industries, specially protected natural territory, protection of water resources and subsoil protection.

Conclusion

In this chapter, the analysis of the state of land use is carried out, the main approaches to land management are revealed, and the specifics and features of the approaches and evaluation methods for the qualitative parameters of the productive capacity of land are identified.

The author's main sources for writing the chapter were personal experience, knowledge of the subject from the results of the exchange of experience in international seminars and conferences.

The data of the state land cadastre was used in determining the quantitative and qualitative characteristics of land resources. The ways of solution are indicated. The main directions that should be paid attention to are:

1. the development of a Concept for the development of land resources, since the activities of the authorized body in the field of land resources management are concentrated exclusively on agricultural land;
2. integration of the state land cadastre with natural resource cadastres;
3. alternative methods and models for surveying the resource potential of land with planning, financing and evaluation according to international standards;
4. analysing advanced experience to create transformative new land resources management policies.

This chapter can be used in the training of students with an environmental background.

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57. Decree of the Government of the Republic of Kazakhstan of December 18, 2003 No. 1269 „On Approval of the Rules and Land Use Regime included in the Suburban Zone of the Capital and Cities of National Significance".
58. Resolution of the Government of the Republic of Kazakhstan of January 5, 2005, No. 3 „On the Programme for the Rational Use of Agricultural Land for 2005-2008".
59. Order of the Minister of National Economy of the Republic of Kazakhstan of December 23, 2014 No. 160 „On Approval of the Rules of Maintaining the State Land Cadastre in the Republic of Kazakhstan".
60. Order of the Minister of National Economy of the Republic of Kazakhstan of December 23, 2014 No. 159 „On Approval of the Rules of Land Monitoring and Use of its Data in the Republic of Kazakhstan".
61. Decree of the Government of the Republic of Kazakhstan of September 29, 2003, No. 990 „On Approval of the Rules of State Control over the Use and Protection of Land".
62. Decree of the Government of the Republic of Kazakhstan of June 6, 2013 No. 581 „On Approval of the Interregional Action Plan for the Development of the Almaty Agglomeration until 2020".
63. Consolidated Analytical Report „On the State and Use of Land of the Republic of Kazakhstan for 2020".

Chapter 5

BIOLOGICAL DIVERSITY

5.1 Concept of Biological diversity

The concept of „biological diversity“ (hereinafter referred to as „biodiversity“) only came into wide circulation in 1972 at the UN Stockholm Environment Conference, where ecologists were able to convince political leaders of the world community that protection of wildlife should be a high priority in all human activities on Earth. For short, biodiversity is the totality of natural and ecological resources. At the same time, we now have several definitions of biodiversity, but in this publication, we will use the definition given in the UN Convention on Biodiversity. Thus, biodiversity means the diversity of living organisms from all environments, including terrestrial, marine and other aquatic ecosystems, and their constituent ecological complexes, diversity within species, between species and ecosystems.

There are three levels of biodiversity in nature - genetic, species and ecosystems[1]. Genetic diversity refers to the multiplicity (or genetic variability) within a species. The enormous diversity of genes determines the ability of an individual or an entire population to offset the unfavorable effect of an external factor. From an ecological perspective, *species diversity* refers to both the number of species and the distribution of the number of individuals or their biomass between species, i.e. the degree of uniformity of the distribution. The species level of diversity is usually regarded as the basic level and species are the reference unit of biodiversity records. Species inventories are extremely difficult, taking into account their huge numbers and dynamics. The total number of the currently known species is approximately 2.5 million, of which almost 1.5 million are insects, mammals - no more than 4 000, fish - 40 000, birds - 8400, amphibians - 4000, reptiles - 8 000, molluscs - 130 000, protozoa - 36 000, various worms - 35 000 species. More than 300,000 flowering plants have been described, and just over 30,000 algae, around 70,000 fungi, less than 6,000 bacteria and around 1,000 viruses are known. In recent decades, the number of identified species has increased due to the development of modern technology and the instrumental base, which allows the study of inaccessible places of the planet, such as the deep-water zones of the seas and oceans, hydrothermal vents and others.

Ecosystem biodiversity

It represents the totality of the planet’s ecosystems at all levels. The diversity of ecosystems can be classified by either functional or structural features. Ecosystem diversity is often evaluated through the diversity of the species component. It can be an evaluation of the relative abundance of different species, the overall diversity of an area or biotope, the biomass of species of different size classes at different

[1] Primack R. Fundamentals of biodiversity conservation/Translated from English, Yakimenko O.S., Zinoviyeva O.A., Moscow: Publishing house of Scientific and Educational Methodological Centre, 2002. p. 256.

trophic levels or different phylum. The informativeness of ecosystems, the balance of matter and energy flows and the efficiency of self-regulation mechanisms depend on species richness. When the number of species is halved, ecosystem production declines by an average of 13%.

The current rate of species extinction exceeds that of previous epochs by a factor of 100 to 1000. It is estimated that, if this rate remains at current levels and does not increase, the planet will lose from 25% to 50% of current species diversity in 50-100 years. The International Union for the Conservation of Nature has estimated the rate of species extinction from available historical records and other materials. Thus, 63 species and 44 subspecies of mammals, 74 species and 87 subspecies of birds disappeared from 1600 to 1975. Since the 20th century, the rate of extinction has increased rapidly, when from one to ten animal species (including vertebrates and invertebrates) disappear every day, one plant species per week, and more than 20 thousand plant and animal species are under threat.

It is important to develop and implement effective evaluation mechanisms to ensure that society has a full understanding of the state of biodiversity and that interested parties are able to make constructive decisions related to the use of biodiversity.

The world community has come to realize that it is impossible to implement a sustainable development model without prioritizing the value of wildlife as the most important environmental and economic indicator at regional, national and global level. This requires the valuation of natural resources based on the ecosystem approach, the formation of the concept of „natural capital and the concept of ecosystem services“. The semantic content of the term „ecosystem services“ means benefits received by society from nature, emphasizes the dependence of human welfare on the condition of ecosystems.

At present, 178 countries out of 196 have adopted an effective National Biodiversity Strategy and Action Plan (NBSAP) as a policy tool for implementing an ecosystem approach to natural resource management as well as for implementing the 20 global targets adopted at the tenth meeting of the Conference of the Parties to of the CBD in Nagoya (Aichi Prefecture, Japan) in 2010. Unfortunately, the Republic of Kazakhstan is not on the list of countries having NBSAP.

5.2 Current status of biodiversity and management system

Flora species diversity

The flora of Kazakhstan according to a number of evaluations includes more than 13 thousand species, including more than 5754 species of higher vascular plants, about 5000 species of fungi, 485 species of lichens, over 2000 species of algae and about 500 species of mosses. Among plants 14% of species are endemics[2].

[2] Draft Concept for the Conservation and Sustainable Use of Biological Diversity in Kazakhstan until 2030,

The vegetation of Kazakhstan is very diverse. The largest area is occupied by steppe and desert types of vegetation. Tundra, meadow, forest, shrub and marsh types are also characteristic of the country. Rare indigenous types associated with arid regions of Central Asia include Juniperus seravschanica woodland, umbelliferous, savannoid, phryganoid (thorn-bush and mountain-grassland) types, while in the mountains of continental Asia, cryophyte-pulvinatedl types predominate.

So called by scientists, the centres of endemism of flora are located in Kazakhstan (Karatau mountains, Western Tien Shan). These are unique natural complexes - pine forests on sands (Arakaragai, Naurzum), forest and steppe complexes of lowlands of Central Kazakhstan, original in floristic composition desert communities of Betpakdala, South Pribalkhash and Ili basin and set of forest, shrub and steppe communities of Southern Altai, Kalba Mountains and Tarbagatai, middle mountains of Dzungarian Alatau and Tien Shan with coniferous spruce forests and fragments of apple forests, as well as floodplain forests (tugai) of Syrdarya, Ili, Irtysh and Zhaik.

The forest plant communities include more than 108 species of kind of wood and 310 species of shrubs.

Coniferous forests in the north of the republic are represented by pine forests. Fir, larch, spruce and cedar predominate in the east and south-east. Softwoods are dominated by birch and hardwoods by saxaul. Forests in the forest-steppe zone are predominantly birch forests with a mixture of aspen and willow, with steppe meadows and meadow steppes in non-forested areas. Forests in the steppe zone are predominantly birch and aspen, while in the sandy pine strip - predominantly pine. Floodplain forests in Kazakhstan are represented by poplar forests, oak forests, maple forests, willow forests and others. Desert forests mainly consist of black and/ or white saxaul. Mountain forests of Altai, Saur, Northern Tien Shan, Dzungarian Alatau and Western Tien Shan are characterized by high biodiversity. The lower belt of these mountains is covered with deciduous forests, while the middle mountains are covered with coniferous forests - fir, cedar, larch and spruce forests, with juniper and alpine meadows at higher altitudes.

Fauna species diversity

The modern fauna of Kazakhstan is rich and poorly studied. It suffice to say that at least 80,000 species of the invertebrate animals, including at least 50,000 species of insects, live here presumably. By now only about 100 families have been studied out of the 550 insect families represented in the fauna of Kazakhstan and no more than 40% of the species composition has been identified. No elementary species lists exist for many other invertebrate classes. There are about 890 vertebrate species with varying degrees of knowledge and with varying degrees of conservation or use (Table 1).

Table 1. **Number of vertebrate species in Kazakhstan**

Class	Number of species			
	Total	Are listed in the Red Book of Kazakhstan	Are listed in the IUCN Red List	Hunting
The cyclostomes	3	1	-	
The fishes	147	17	15	
The amphibia	12	3	1	
The reptile	50	10	-	
The birds	500	57	32	59
The mammals	178	40	31	34

It should be noted that Kazakhstan has vast areas with unique steppe ecosystems that have been virtually destroyed elsewhere in Eurasia, so most steppe species populations have found refuge here. These are globally important species such as saiga, gazelle and others, of birds - steppe harrier, gyrfalcon, steppe pratincole, oxyura and a number of others.

There are species of vertebrates that are the „ancestors“ of domestic animals on the territory of the Republic. For example, among mammals - mouflon, argali, wild boar, kulan, wolf, caffre cat, and others; among birds - mallard, gray goose, quail, etc.; among amphibians and reptiles as a genetic resource are important, primarily species of poisonous snakes: steppe and common viper, copperhead snake, and species used in traditional oriental medicine: Semirechye salamander, Tatary sand boa, etc. An example of commercial demand for reptiles is the Central Asian tortoise, which is an important export item.

The total number of fish and fish-like organisms in Kazakhstan according to recent evaluations is around 145 species, but this evaluation may need to be confirmed. 19 fish and fish-like species are included in the List of objects of environmental conservation, as having the status of special ecological, scientifically important and culturally significant. The commercial ichthyofauna of water bodies in Kazakhstan is represented in most cases by acclimatized species. Originally, the aboriginal ichthyofauna in Kazakhstan was represented by no more than 100 species, but has been significantly enriched by acclimatization activities (including occasional immigrants).

Approximately 5-8 forms from the entire species diversity of fish and cyclostomes, including hybrids, are currently being cultured. These include sturgeons in the Caspian Sea, whitefish in Northern and Eastern Kazakhstan, far-eastern phytovorous (grass carp and silver carp) mainly in southern regions and carp almost everywhere, as well as a number of hybrids.

As a genetic fishery resource, herring, nelma, inconnu, grayling, taimen, pike, Caspian roach, Black sea roach, tench, barbel, marinka, Balkhash perch are of interest.

As aquarium breeding objects, the species of Kazakhstan's ichthyofauna include primarily small carp and loach species, among which there are endemic and sub-endemic forms. The most suitable in this regard are Salvelinus, adequate to South-East Asian representatives of the genus Acanthophthalmus, and limnophilic endemic species of minnows. Potentially this group could include tench and stickleback.

Endemic fish species from Kazakhstan's water bodies represent unique genetic material, the loss of which is assessed as an ecological disaster. Many endemic species are treated as commercial species, some species are used as delicacies. Most of the endemic species are listed in the Red Book of Kazakhstan.

In this regard, the introduction of endemics into aquaculture is very perspective. Artificial reproduction of aboriginal and endemic species has a high scientific and practical potential with high relevance to the topic. Development of aquaculture of aboriginal and endemic species will reduce anthropogenic pressure on their wild populations and enable the reintroduction of species to their native habitats.

The most prospective endemic species for aquaculture are Aral spike, Urals and Turkestan barbel, Balkhash perch and marinka, Caspian salmon, Aral salmon, taimen, nelma and inconnu. Aboriginal species such as naked and scaly Osman, minnow and Chatkal bullhead can also serve as aquaculture targets for sport fishing, aquarium husbandry and commercial farming.

Diversity of ecosystems and existing systems for their conservation

Natural ecosystems are defined as natural-territorial complexes that have a common lithogenic basis and consist of two interrelated parts: the abiotic environment and biota. All abiotic factors including climate are regarded as life-supporting factors for biota. Ecosystems are characterized by spatial and temporal dynamics, a special mode of functioning, external and internal circulation of substances and energy.

The spatial differentiation of ecosystems is related to the nonhomogeneity - circulation processes, heat and moisture supply, topographic features, soils, hydrological conditions, which determine their differences and structural and functional features, as well as the diversity of biota. The main differentiating factors of spatial distribution of ecosystems are ground features and climate. At the macro-structural level, taking into account the macro-forms of ground features, two main classes of ecosystems are distinguished on the territory of Kazakhstan: ecosystems of plains and ecosystems of mountains. The distribution of ecosystems across latitudinal zones in the plains and high-altitude zonal belts in the mountains depends on climatic parameters[3].

Kazakhstan's natural ecosystems are characterized by the following features:

- The Plain territory includes a significant part of the zonal spectrum of temperate zone of Eurasia. The main, major zonal associations of plains ecosystems are forest-steppe, steppe and desert. Zonal and subzonal differentiation of major ecosystems when moving from north to south occurs primarily due to changes in climate (balance of heat and moisture);

[3] Ogar N.P., III-IV ecosystems Section of the National Communication of the Republic of Kazakhstan to the UN Framework Convention on Climate Change (UNFCCC), Astana, 2013.

- Mountains of Kazakhstan represent an exceptionally wide range of ecosystem diversity (tundras, dark coniferous, light coniferous and deciduous forests, arid sparse forests, cryophytic meadows, mountain steppes, shrub thickets, savannoids). The composition of the belts in the mountains is determined primarily by the latitudinal-zonal position of each mountain system;
- Diverse intrazonal water-swamp and grassland ecosystems confined to the coasts of large and small lakes, river valleys and inner enclosed basins of seas, lakes and rivers.

The diversity of ecosystems in Kazakhstan and the diversity of biota are due to the influence of cross-border territories. The mountain-taiga ecosystems of the Siberian type adjoin the Altai Mountains. Desert ecosystems of the North-Turanian type in the intermountain basins of Zaisan, Ili and Alakol border on Central Asian desert ecosystems, in southern Ustyurt and Kyzylkum border on the South-Turanian deserts. The semi-arid Central Asian mountain ecosystems are represented in the mountains and foothills of the Western Tien Shan. Kazakhstan plays a special role in the conservation of steppe ecosystems on the Eurasian continent, as it has significant areas of still preserved distinctive steppes, while the steppe biome of Eurasia is critically endangered.

The territory of the Republic of Kazakhstan, due to its unique combination of natural complexes of steppes, deserts, mountains, large intracontinental water bodies with rivers flowing into them and well-developed deltas, is characterized by the greatest diversity of ecosystem types in Central Asia (Fig. 1).

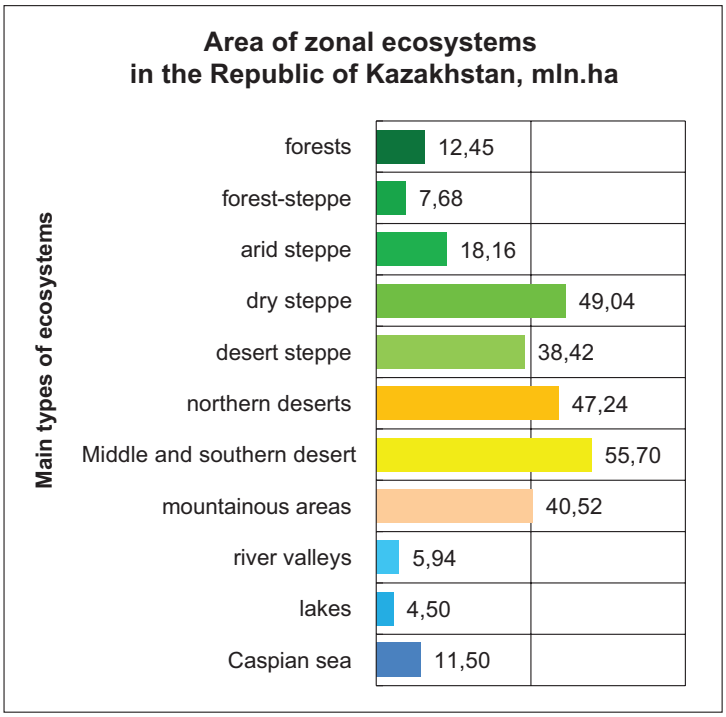

Figure 1. **Area of zonal ecosystems in the Republic of Kazakhstan (mln. ha)**

Significant measures have been taken in Kazakhstan since the end of the last century to promote real environmental conservation outcomes. Development of a series of major conservation projects began during these years, with the approval of the National Strategy for the Conservation and Sustainable Use of Biodiversity in Kazakhstan (1999). This document, although not approved as a legal instrument, was the main reference point for long-term planning, defining the principles, priorities and main directions of Kazakhstan's biodiversity conservation policy.

On the basis of the Concept of Development and Location of Specially Protected Natural Territories (hereinafter referred to as SPNT), approved by Resolution of the Government of the Republic of Kazakhstan of November 10, 2000 No. 1692, the areas of SPNT in Kazakhstan were significantly increased from 2000 to 2010, which are the main element of the ecological network of Kazakhstan.

The SPNT system, as part of the ecological network, becomes a nodal element of the ecological network, conserving the most valuable and vulnerable habitats. More soft limitations on natural resource use of a permanent or seasonal nature are imposed on adjacent areas and migration routes.

As of 01.01.2021, the SPNT system includes 10 state nature reserves on the area of 1.6 million ha, 13 state national nature parks (2.7 million ha), 6 state nature reserves (3.1 million ha), 50 state nature-sanctuary of national importance (5.8 million ha), 5 state preserved area (11.3 million ha), 26 state natural monuments of republican significance (6.5 thousand ha, including 272.7 ha outside the SPNT), 6 national botanical gardens (470.3 ha) and one dendropark (365.43 ha).

In addition, there are 3 regional natural parks of local significance (189,000 ha), 18 state nature-sanctuary of local significance (1.5 million ha) and 22 state natural monuments of local significance (1,767.6 ha).

Overall, the total area of sustainably managed SPNTs with legal entity status is 7.6 million ha, or 2.8% of the country's total area.

Conservation of the forest fund is carried out by 120 state forestry agencies, which manage more than 29 million ha of state forest land. Well-managed forest institutions can be classified as IUCN VI category „Managed Resource Territory", whose main functions are the maintenance of biological and landscape diversity, maintenance of local economies, development of safe natural resource use directions, scientific research and environmental monitoring, development of recreation and environmental education.

One of the components of the ecological network is sustainably managed hunting areas, it is a small part of the existing more than 700 hunting farms of Kazakhstan, which cover 117.7 million ha[4].

Fishery water bodies of international and republican significance that are provided with conservation and reproduction measures are also potentially elements of the ecological network.

[4] Draft Concept for the Conservation and Sustainable Use of Biological Diversity in Kazakhstan until 2030, Nur-Sultan, 2019.

Ecological corridors (Yrgyz-Torgai-Zhylanshyk, Kapshagai-Balkhash) providing spatial links between elements of the ecological network provide the basis for ensuring conservation of migration routes and habitats of rare migratory species (saigas, Persian gazelle).

The establishment and maintenance of ecological network functions cannot be ensured only through the activities of environmental structures. This requires the integration of a number of socio-economic sectors, as it affects water supply and use issues, land-use planning, development of agriculture, forestry and other natural resource management.

5.3 Legal and institutional frameworks for the management of biological resources

Legal framework

The basic provisions in the field of environmental protection are set out in the Constitution of the Republic of Kazakhstan. In accordance with the Constitution, the state has set the goal of conserving an environment conducive to human life and health. The Constitution also stipulates that citizens of the Republic of Kazakhstan are obliged to conserve nature and take good care of natural resources.

The Kazakhstan-2050 Strategy defines a new political course for the state and sets clear directions for building a sustainable and efficient economic model based on the country's transition to a „green" path of development.

The Concept for the Transition of the Republic of Kazakhstan to a „green" economy is the main program document setting priorities for the reform of major sectors of Kazakhstan's economy, such as energy, agriculture, waste management and the water sector, with the aim of ensuring the country's sustainable development. The concept also raises issues of conservation and effective management of forest ecosystems, fisheries and ecological tourism in accordance with the principles of sustainable development. With a planning horizon until 2050, the Concept lays the foundation for the efficient use of natural resources and the improved well-being of the citizens of Kazakhstan through economic diversification, balanced regional development and new job formation, strengthening the health of the nation through the improvement of the environment[5]. At the same time, there is a need to supplement the concept with provisions on ecosystem services, their economic valuation and the introduction of an ecosystem services accounting system into the national system of accounts and the natural resources cadastre.

The main legislative acts regulating public relations, fundamental principles and norms in the field of conservation and sustainable use of biodiversity also include the Civil Code (1994, 1999), the Land Code (2003), the Environmental Code (2021), the Forest Code (2003), Water Code (2003), Code of Administrative Offences (2014), Criminal Code (2014), Law of the Republic of Kazakhstan „On Protection, Reproduction

[5] The Concept for transition of the Republic of Kazakhstan to Green Economy, approved by Presidential Decree of May 30, 2013, № 577.

and Use of Animal World“ (2004), „On Specially Protected Natural Territories“ (2006), „On Subsoil and Subsoil Use“ (2010) and „On Tourist Activities“ (2001) [6] [7].

The Republic of Kazakhstan is a party to a number of international agreements relating the conservation and sustainable use of biological diversity, including the Convention on Biological Diversity (1994), Convention on International Trade in Endangered Species of Wild Fauna and Flora (1999), Convention on the Conservation of Migratory Species of Wild Animals (2005), Convention on Wetlands of International Importance Especially as Waterfowl Habitat (2007), Cartagena Protocol on Biosafety to the Convention on Biological Diversity (2008), and Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (2015).

Between 2010 and 2014, the Zhasyl Damu sectoral programme was implemented, aimed at creating conditions for the conservation and restoration of natural ecosystems, which identified measures for the further development of international relations, scientific support for environmental protection and natural resource management, environmental and natural resource monitoring systems, issues of environmental education, education and raising public awareness.

Institutional framework

State management in the field of biodiversity is carried out by the Government of the Republic of Kazakhstan, central executive bodies and their territorial subdivisions, local representative and executive bodies of regions.

For 2021, the functions of the state executive body responsible for governance and inter-sectoral coordination in the implementation of state policy in the field of environmental protection and natural resources are assigned to the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan (hereinafter - MEGNR RK). The Ministry competence also includes the implementation of international agreements of the Republic of Kazakhstan in the field of biodiversity conservation. The Forestry and Wildlife Committee of the MEGNR RK is the agency responsible for the implementation of obligations and reporting to international agreements. The National Biotechnology Centre of the Committee of Science of the Ministry of Education and Science of the Republic of Kazakhstan plays the role of coordination center for the Clearing House Mechanism of the Cartagena Protocol. Local executive bodies are empowered to manage forest, water and biological resources[8].

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[6] Legislative acts containing systematized norms by industry: the Code of the Republic of Kazakhstan on Administrative Offenses, the Criminal Code of the Republic of Kazakhstan, the Land Code of the Republic of Kazakhstan, the Water Code of the Republic of Kazakhstan, the Environmental Code of the Republic of Kazakhstan, the Budget Code of the Republic of Kazakhstan, the Forest Code of the Republic of Kazakhstan.

[7] Laws of the Republic of Kazakhstan: „On Protection, Reproduction and Use of Wildlife“, „On Specially Protected Natural Territories“, „On Tourist Activities in the Republic of Kazakhstan“, „On Legal Protection of Breeding Achievements“, „On Pastures“, „On Production of Organic Products“.

[8] Draft Concept for the Conservation and Sustainable Use of Biological Diversity in Kazakhstan until 2030, Nur-Sultan, 2019.

A special role in the system of conservation and sustainable use of biological diversity belongs to environmental non-governmental organisations (hereinafter referred to as NGO). More than 100 of NGOs in the Republic of Kazakhstan are involved in biodiversity reproduction and restoration, environmental education and the development of foundations for ecological tourism.

5.4 Threats to biodiversity and management challenges

The challenge of biodiversity conservation and sustainable use has become one of the world's top priorities, due to the need to conserve biodiversity for the survival and further development of humanity in connection with the exacerbation of the global anthropogenic crisis of the biosphere.

One of the most dangerous expressions of this crisis is the trend towards irreversible reductions in biodiversity and ecosystems, leading to irreversible instabilities in the biosphere, declining environmental quality and impoverishment of the genepool of wildlife. In spite of the successes achieved in the conservation and sustainable use of Kazakhstan's biodiversity, negative impacts on natural ecological systems and populations of wildlife species and wild plants continue.

Major threats to Kazakhstan's biodiversity include factors leading to total habitat destruction or degradation and include habitat loss or damage, overfishing, pollution, invasive species and climate change. Such direct threats are the result of more distant, indirect forces of impact on biodiversity loss that come from resource consumption and waste production (Table 2).

The absolute drivers of threats to biodiversity are human needs for food, fibre, wood, water, energy and space for infrastructure development. As human populations and the global economy grow, so do the pressures exerted on biodiversity.

Table 2. **Main threats to biodiversity**

Habitat loss or damage	Climate change	Invasive species	Overexploitation (overhunting)
Construction of traffic highways (roads, railways, gas and oil pipelines, electricity transmission lines, hydroelectric power stations, channels with a hard coating, border barriers, residential and industrial complexes)	Changing water regimes and drought	Invasive vertebrate species	Fish overhunting
Intensive forest management		Invasive fish species	Overhunting of hunted species
Intensive agriculture		Invasive plant species	Overgrazing and pasture degradation

Mining operations		Invasive bird species	
Irrigation and drainage of water areas			
Changing the natural channels of rivers and other freshwater bodies			
Natural disasters			
Fires			
Loss of species			
The spread of animal and plant diseases			
Poaching			
Genetic erosion			

Indirect threats

1. Transformation of habitat destruction

Increasing construction in forests, mountains, lakeshores and other ecosystems is reducing habitat diversity and loss of species and genetic biodiversity. Urbanization increases air and water pollution, the destruction of vegetation on construction sites leads to soil erosion, and ground ablation increases the siltation of rivers, lakes and other water bodies. The natural ability of areas with natural ecosystems, as they decrease, reduces the retention of pollutants, water cleaning, the maintenance of the biological cycle of matter and energy.

2. Natural environment pollution

Pollution or poisoning of soil, water and air as a result of overuse of mineral fertilizers and pesticides in agriculture, as well as the activities of energy and industrial plants, vehicles, facilities and processes, are serious problems of today.

3. Introduction and acclimatisation of alien species

Plants and animals introduced to this ecosystem may displace local species. To some extent, invasion by species of new (for that species) areas, waters and ecosystems is a natural process. However, human activity makes it much more intense. These are both relocation and unintentional relocation of species, e.g. animals can move many thousands of miles from one ocean to another with tanker ballast water, and intentional relocation of species, or acclimatization, aimed at

commercial gain and increased production or other products. Often, in competition for resources, alien species overtake local species and occupy a large part of the habitat. Examples include nutria, muskrat, Canada goose, algae (Caulerpataxifolia), old-ladies ointment clothespins and ragweed.

4. Unorganized tourism and recreation

The development of tourism activities is often oriented towards maximum growth in the number of tourists visiting a tourist area for one season. Large hotel complexes are built for this purpose, destroying natural areas and creating sources of domestic waste and waste water. Plants or animals often die on and near trails, when camping, kayaking, etc.

To this date, the challenges of managing Kazakhstan's biodiversity include:

1. Lack of a long-term strategy/concept for the conservation and sustainable use of biodiversity;
2. Lack of medium-term state programmes for the conservation and sustainable use of biodiversity;
3. Insufficient level of financing for environmental conservation measures;
4. Lack of a system of retraining and professional development;
5. Insufficient activity and low level of involvement of civil society in natural resource management;
6. Lack of a system for evaluating the economic value of biodiversity and ecosystem services;
7. Imperfect record-keeping, monitoring and cadastre system for forests, SPNTs and wildlife.

5.5 Principles and approaches for the conservation and sustainable use of biodiversity

Basic principles of biodiversity conservation

The organization of conservation of natural areas must implement a number of principles for biodiversity conservation, as biosystems at different levels are characterized by different structural and functional organization of development. It follows herefrom the principle of taking into account the hierarchical structure of biodiversity objects: organism, population, species, community, ecosystem, territorial and contiguous complex of ecosystems and the biosphere as a global ecosystem[9].

1. Organism-based principle

This principle is related to the fact that organisms, as the smallest units of life that exist independently in the environment, are carriers of hereditary information. The main objectives in this area are the conservation of organisms and ensuring

[9] Primack R. Fundamentals of biodiversity conservation/Translated from English, Yakimenko O.S., Zinoviyeva O.A., Moscow: Publishing house of Scientific and Educational Methodological Centre, 2002. p. 256.

their reproduction. Particular attention should be paid to large organisms that require large spaces for their full existence. Such organisms, due to their limited territory, may be represented by single specimens.

2. Population-based principle

Population-based principle due to the fact that populations are a form of existence of a species, elementary units of the evolutionary process, possessing a unique genepool. The main objectives are the conservation or restoration of the sizes and ranges of natural populations, the conservation of intra-population genetic diversity and the genetic uniqueness of the population and the diversity of its structure. Population size is great important because its decline increases the probability of random population extinction and is accompanied by a reduction in intra-population genetic diversity.

The work in this area includes:

2.1 conservation of populations of rare and threatened with extinction species;
2.2 regulating the harvesting of populations of exploited species;
2.3 habitat conservation and restoration and biotope reconstruction;
2.4 population conservation in specially protected natural territories;
2.5 technological and organizational measures to protect species from mortality on engineering and linear structures, amelioration and other anthropogenic impacts.

3. Species-based principle

Considering that a species is the smallest genetically closed system with a unique genepool, the species-based principle represents a system of interconnected local populations, intraspecific forms and subspecies. The main objectives are to maintain the numbers and ranges of species, the spatial and genetic population structure of the species and intraspecific forms. It is necessary to maintain the spatial and genetic structure of the species by maintaining the degree of isolation of populations and forms that is characteristic of undisturbed natural areas.

The work in this area includes:

3.1 conservation of rare and threatened with extinction species;
3.2 regulating hunting of exploited species;
3.3 conservation and restoration of species' habitats and biotope reconstruction;
3.4 conservation of species in SPNTs;
3.5 recreating lost populations.

4. Biocenotic principle

This principle is determined by the fact that species in nature exist in close functional relationship with other species in the form of communities. The main objectives in this area are the conservation and restoration of communities, maintaining their species diversity, and maintaining the natural processes of composition and structure formation. Loss of species and reduction of species

diversity leads to degradation of communities. The introduction of alien species into the community, both as a result of their introduction by humans and during independent placement, can also disrupt the structure of natural communities. Sustainable communities require the maintenance of the inherent species composition, including the characteristic proportions of different species and the structure of cenotic relationships; the control and management of the species composition of organisms removed from natural ecosystems; the reintroduction of extinct species from biocenoses where the structure has not changed substantially; the control and management of self-distribution and acclimatization of alien species and the restoration of biocenoses.

5. Ecosystem-based principle

It takes into account the totality of functionally interconnected organisms (biocenosis) and abiotic components of the environment, constituting a single ecological system. The main objectives in this area are the conservation and restoration of natural ecosystems, the maintenance of their environment-forming functions.

The full and long-term conservation of species and communities is only possible as part of natural ecosystems, while maintaining their typical abiotic environment. The normal existence and development of ecosystems involve a natural succession of seral stages. The conservation of ecosystems can only be ensured if the diversity of communities representing different stages of succession is maintained.

The work in this area includes:

5.1 control and regulation of the use of territories within the buffer action range of ecosystems, creation of SPNTs with different protection regimes;

5.2 biotope conservation and restoration as a condition for the conservation and restoration of biocenoses and ecosystems;

5.3 maintenance of traditional economic activities necessary for the conservation of natural and cultural complexes.

The specific nature of ecosystems makes an impact on the conservation strategy for biodiversity conservation. For example, the conservation of rare species associated with water bodies is made more difficult by the diversity of their ecological characteristics, including dependence on several habitats or long-distance migration. It should be noted that changes affect the aquatic ecosystem as a whole, and attempts to locally conserve rare species in individual habitats are ineffective.

Ecosystems conservation as „key“ natural objects for biodiversity conservation can be carried out at different hierarchical levels of the landscape structure of the territory. Unfortunately, most national and regional biodiversity conservation schemes focus predominantly on zonal ecosystem conservation. Far less attention is paid to the conservation of territorially contiguous complexes of catchment ecosystems.

6. Territorial principle

The territorial principle and its application in the organization of SPNTs is connected with the fact that the territorially contiguous natural complex consists of interconnected ecosystems and is formed within an area unified by physical and geographical conditions and history of development.

The main objective is the conservation of territorial complexes of ecosystems and their diversity.

The work in this area includes:

6.1 territorial planning that takes into account the objective of biodiversity conservation;

6.2 planning for the conservation and sustainable use of biodiversity;

6.3 creation and development of a network of specially protected natural and historical-cultural territories with different protection regimes.

7. Biosphere-based principle

Diversity of species and ecosystems supports biosphere processes and the functioning of the biosphere as an entire ecosystem.

The main objectives in this area are the conservation of the global ecosystem, global species diversity and global ecosystem diversity.

Under the auspices of UNESCO and IUCN, a network of biosphere reserves was formed in 1976 and aims to preserve representative areas of all types of biomes and biogeographical provinces of the world and to conduct scientific research based on a unified programme of background environmental monitoring.

The best strategy for long-term protection of biodiversity is *in situ*, i.e. conserving natural communities and populations in the wild. The process of evolutionary adaptation to a changing environment can only take place here. It is necessary to conserve ecosystems and natural habitats, and to maintain and restore viable populations of species in their natural environment. Particular attention is paid to the conservation of the structure of relationships in species' habitats[10].

The *exsitu* strategy refers to the maintenance of the species under artificial conditions in case of signs of extinction of the species. This strategy refers to a system of measures aimed at conserving genetic and species diversity by maintaining population and species genotypes of individuals outside their natural habitats. Animal conservation is carried out in laboratories, zoos and special farms as part of animal captive breeding programmes. Technology is being developed to breed and keep rare fish species in order to release them into the wild, or reduce the necessity of entrapment of wild species. The role of oceanariums in the conservation of endangered cetaceans is particularly important. Plants are conserved in botanical gardens, arboretums and seed banks.

[10] Draft Concept for the Conservation and Sustainable Use of Biological Diversity in Kazakhstan until 2030, Nur-Sultan, 2019.

5.6 Formation of a representative ecological network

As previously mentioned, elements of the ecological network, in addition to SPNT, potentially include state forestry agencies, fishery bodies of national and international importance, hunting farms, ecological corridors. However, the environmental network should include those institutions that comply with the principle of sustainable management according to a management effectiveness evaluation involving economic valuation of natural resources.

Taking into account the pace of the country's economic development and the increasing extraction of all kinds of natural resources, the issue of sustainable development of SPNT as the basis for conserving the country's biodiversity remains the most relevant. According to Objective 7 of the Strategic Plan 2025 „Conservation of Biodiversity for the Conservation of Endemic, Rare and Endangered Species, Unique Standard Sites and Natural Ecosystems" (hereinafter - Objective 7 of Strategy 2025) by 2030 the area of SPNTs with legal entity status should be increased from 2.8% to 5%[11].

Conservation of rare and endangered species

Objective 7 of Strategy 2025 provides for a policy of biodiversity conservation by conserving objects of the state natural reserve fund, preserving and increasing the number of wild animals, including rare and endangered animals, developing game breeding in captive and semi- captive conditions, and conserving the population of fish species.

In 2021, scientific research has started, taking into account the positive international experience on the list of rare and endangered plants and animals of Kazakhstan.

However, there is a need to improve the legal framework, including the adoption of the Law of the Republic of Kazakhstan „On Plant World", rare animal reintroduction programme, implementation of the „Green Book" system, updating the Red Book species list according to the International Union for Conservation of Nature (IUCN) categories, definition and implementation of the „Species Management Action Plan" status, amendments to existing acts defining responsibility for the management of particularly hazardous infrastructure sites.

For the conservation of rare animal and plant populations, it is necessary to develop action plans for the management of the following species on the basis of common methodology:

1. Flora - Asian wild apple, White poplar (Turanga sizolistny), black saxaul, Sogdian ash-tree (Fraxinus sogdiana), etc.;
2. Fauna - snow leopard, saiga, gazelle, Przewalski's horse, Bukhara deer, Turanian tiger, Caspian seal, sturgeon fish, etc[12].

[11] Strategic Development Plan of the Republic of Kazakhstan until 2025, approved by Presidential Decree No. 636 of February 15, 2018.

[12] Draft Concept for the Conservation and Sustainable Use of Biological Diversity in Kazakhstan until 2030, Nur-Sultan, 2019.

With regard to rare tree species, this work was initiated at the Kazakh selective and seed centre of the Committee of Forestry and Wildlife of the MEGNR RK with the support of the United Nations Development Programme in Kazakhstan (UNDP); in particular, the laboratory for cultivation of rare plant species through microclonal propagation (Asiatic poplar, Asian wild apple, Sogdian ash-tree (Fraxinus sogdiana) and others) was expanded. The grown seedlings are acclimatized in the tree nurseries of this Centre, located in mountain and desert conditions.

The implementation of a project to restore habitat for the Turanian tiger on the southern shore of Balkhash Lake in Almaty region is planned in Kazakhstan. The territory of the newly created state reserve „Ile-Balkhash“ in 2018 under the UNDP Project is a suitable site. World Wildlife Fund (Russia, Netherlands), UNDP and the Committee of Forestry and Wildlife of the MEGNR RK are key partners in this project. Deer resettlement in the Ili River delta continues on World Wildlife Fund reintroduction of Bukhara deer. Their introduction is carried out within the framework of the Reintroduction Programme for the Turanian Tiger in Pribalkhash area.

It is necessary to implement a programme to introduce Przewalski's horses from Europe to Almaty and East Kazakhstan region in order to create their sustainable population of about 500 horses.

In the framework of international cooperation, reintroduction activities continue for houbara bustards, falcons, included in the list of rare and endangered species of animals of Kazakhstan through breeding in special nurseries and introduction from Arab countries with subsequent release into the nat ural environment of the country.

The results of effective work on the conservation and reproduction of saigas will allow to form an action plan for the species, allowing to achieve ambitious goals based on scientific developments on disease prevention and monitoring information.

One important way of conserving rare and endangered species is equipping particularly dangerous sections of power lines, above-ground and under-ground pedestrian crossings and transport infrastructure with safe technologies to ensure free migration and the safety of wild animals.

In order to conserve certain rare and endangered animal species, measures should be taken to:

- equipping high-voltage lines with protective devices to prevent bird deaths;
- Creation of at least 20 wild animal crossings (wildlife crossing, tunnels) in migration areas and ungulate concentrations;
- expanding and strengthening the network of nurseries of various forms of ownership for captive breeding and conservation of rare and endangered animal species, including for the rescue of detained and confiscated animals, as well as their inclusion in programs for the reintroduction and relocation of individual species;
- ensuring habitat system continuity for rare and endangered species within the range in territorial planning, especially at the local level;
- developing a unified system of International Union for Conservation of Nature categories and criteria, taking into account regional specificities to identify and classify rare and endangered animal species, operational evaluation of their

status and setting priorities for their conservation;
- developing technologies for the conservation of rare and endangered animal species in artificial environments and natural habitats;
- improving the scientific and methodological basis for inventories, monitoring the status of key wildlife habitats, and creating an information system database.

Conservation of genetic resources

The issues of conservation of genetic resources are regulated in accordance with the Decree of the President of the Republic of Kazakhstan of 17.03.2015 No. 1025 „On Accession of the Republic of Kazakhstan to the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity“[13]. At the same time, it is necessary to create a legal framework, such as the Law of the Republic of Kazakhstan „On Genetic Resources“ and subordinate acts. These documents should take into account the principles providing for potential users of genetic resources to obtain the prior consent of Kazakhstan to implement the conditions of access to the resource by concluding mutually agreed agreements. As a consequence, ensuring access to genetic resources of Kazakhstan will require identification of a designated authority for genetic resources, establishment of a national focal point, competent national bodies and control points for monitoring, a state-budget approved and supported training programme in the field of genetic resources, etc[14].

In order to conserve genetic resources, it is recommended to:
- evaluate the genetic diversity of wild plant species, local breeds, hybrids, agricultural plant lines, wild animal species with the identification of rare and endangered species;
- Establish/strengthen forest breeding centres, financed from mixed funding sources, to protect breeding and genetic facilities, botanical gardens, arboretums, zoological parks for ex-situ conservation, a genetic bank for the main plant species forming the republican network;
- establish a genetic seed bank of particularly valuable and rare tree species;
- create an archive of clones of valuable tree species;
- establish a wildlife germplasm bank for conservation and, if necessary, restoration in natural ecosystems;
- establish laboratories at the Institute of General Genetics and Cytology of the Ministry of Education and Science of the Republic of Kazakhstan to analyze blood and biomaterials of large mammals using DNA markers.

The effectiveness of these objectives will depend, among other things, on developments to determine the impact of invasive species of different groups on biodiversity, on harm reduction actions and on controlling their introduction. For this purpose, lists and databases of alien vertebrate and invertebrate species by level of

[13] Ibid p.122.
[14] Ibid p.122.

threat to biodiversity should be created and habitat maps of invasive species should be drawn up.

Sustainable forestry

The Republic of Kazakhstan is a sparsely wooded and forest-deficient region. For this reason, forest resources have great ecological, protective, scientific and cultural value. The importance of forest resources is evidenced by Objective 7 of the Strategy 2025, which provides for an increase in the forest cover of the territory to 12%[15].

Sustainable use of forest resources and forest ecosystems should be organized in the long term prospects in the following direction:

1. Improving management efficiency;
2. Creating conditions for forest conservation and protection;
3. Creation of a forest certification system;
4. Increasing in forest cover of the territory;
5. Development of private forestry.

Improvement of management efficiency can be realized through approval of state forest policy focused on improving management efficiency in the context of climate change. And it is necessary by 2030 to develop a set of measures and mechanisms for the conservation, sustainable use and restoration of forest resources. In order to implement the principle of sustainable management, the forest management system of the country should provide for optimal separation of powers between the authorized body in the field of forests and local executive bodies based on the evaluation of forest management efficiency[16].

Economic and financial incentives are needed to support the principles of sustainable forest management, including:

- improving the material and technical base of environmental institutions, the forest aviation conversation facility, and the forest inventory management facility;
- issues of development of small and medium businesses engaged in harvesting and in-depth processing of forest products;
- improving the concession and public-private partnership system in the forest sector;
- Recovery design system in terms of forest restoration and forest breeding;
- establishment of a permanent forest health monitoring;
- measures to support the establishment of private forest plantations and nurseries.

These measures will allow to increase the volume of development of the forest fund for primary use up to the stage of advanced processing of forest raw materials, will create conditions for the protection and conservation of forests in order

[15] Strategic Development Plan of the Republic of Kazakhstan until 2025, approved by Presidential Decree No. 636 of February 15, 2018.

[16] Draft Concept for the Conservation and Sustainable Use of Biological Diversity in Kazakhstan until 2030, Nur-Sultan, 2019.

to neutralize the impact of negative factors - forest fires, illegal felling and forest diseases. The protection system should include the development of a general fire-fighting scheme for the country's forests, use Earth remote sensing data, introduce optical-sensor systems for early detection of forest fires and tighten standards and regulations that make users more responsible for the damage caused. The material and technical base of existing forest fire stations will need to be strengthened, and new stations and towers equipped with a fleet of aviation forest fire protection and extinguishing units, modern machinery and fire-fighting equipment will need to be opened.

Establishment of the Centre of forest health monitoring in Almaty city with a regional network of branches in East Kazakhstan, North Kazakhstan, Kyzylorda and West Kazakhstan regions will enable timely detection of pest and forest disease outbreaks and rapid response.

The establishment of a forest certification system in accordance with international standards will simplify the process of developing NLA, approving standards and certifying forest management and entities.

Implementation of Objective 7 of Strategy 2025 contributes to an increase in forest reproduction and forest breeding, the creation of green areas around regional centres, and the development of private forest breeding. It requires forest nurseries that meet modern requirements. If in 2013 there were 156 forest nurseries in the country to ensure forest cultivation work, with a design capacity to grow up to 200 million standard seedlings of various species annually with a capacity to create forest cultures on an area of about 80,000 ha, this is clearly not enough, taking into account the planting of 2 billion trees within 5 years according to the instructions of the President of the Republic of Kazakhstan. The first reason for the low planned yield of planting material is insufficient seeds of tree and shrub species, another reason is that nurseries are not equipped with modern machinery and irrigation systems due to lack of funds to renovate nurseries and introduce advanced, innovative methods of cultivation of planting material.

Work to increase the forest cover in Kazakhstan can be carried out in the following ways:

- the introduction of effective forest restoration on forest fund land;
- by developing protective green areas around human settlements, protective and sanitary zones around large industrial facilities and compensatory planting at the expense of natural resource users;
- forming agro-forestry landscapes by establishing protective plantations on pasture and arable land and afforestation of damaged areas;
- conducting an inventory of unrecorded forests with subsequent reclassification of these areas to public and private forest fund land;
- forest breeding on forested lands on the dried Aral Sea bed and other most erosion-dangerous lands;
- development of private forest plantations.

These measures will increase forest reproduction and forest breeding, green areas around regional centres and develop private forestry.

Private forestry is one prospective direction, creating alternative sources of wood raw material for industries, reducing the exploitative pressure on natural forests[17]. Therefore, the establishment of private forest plantations on agricultural and other purpose land by entrepreneurs and individuals is a priority. The green building works carried out by the local executive bodies also provide for the involvement of private forest owners and other non-governmental organizations to create public green areas in cities and human settlements.

Climate change adaptation measures in the forest sector relate to the identification and conservation of reference and unique ecosystem sites, as well as forest restoration. Management decision-making on them should be based on monitoring data identifying the mechanisms of climate change impacts on ecosystems, taking into account microclimatic parameters with short- and long-term forecasts of the dynamics of vulnerable ecosystems and indicator species of flora and fauna. In this context, the role of monitoring is important to assess the existence risk of populations, species and communities that are threatened, to develop schemes for the sustainable and non-unsustainable use of biological resources and to adjust traditional systems of accounting for them.

Sustainable management of animal resources

The processes of conservation, reproduction and sustainable use of wildlife resources should be carried out at the regulatory, institutional and individual levels. In order to achieve the objectives of conservation, reproduction and sustainable use of wildlife resources, the following activities are required:

1. improving the legislative framework;
2. creating the technical conditions for the formation of the cadastre;
3. determining the economic value of game species;
4. creating conditions for attracting private investment in hunting, wildlife conservation and use.

The updated legal framework will create favourable conditions both for the conservation and reproduction of wildlife and for the development of entrepreneurship in the field of hunting, farming hunting and game breeding[18].

This process involves:

- improving the legal and regulatory framework for recognizing wildlife resources as an important sector for „green development“, recognizing hunting as an economic activity;
- creating a legal framework for the assignment of land for game breeding;
- reviewing the structure of the biological substantiation for wildlife taking limits and ensuring that it is linked to the wildlife cadastre;
- adoption of NLA that expand the rights of game management owners and strengthen their responsibility for the decisions made and damage caused to wildlife;

[17] The Concept for transition of the Republic of Kazakhstan to Green Economy, approved by Presidential Decree of May 30, 2013, № 577.

[18] Draft Concept for the Conservation and Sustainable Use of Biological Diversity in Kazakhstan until 2030, Nur-Sultan, 2019.

- determination of the procedure for compensation of losses to hunting farms in the event of allocation of land plots of assigned hunting lands for state needs;
- automation of administrative processes for regulating wildlife management activities;
- transfer of the issuance of approval documents for hunters, distribution of quotas for the seizure of wildlife objects in electronic format, etc.

The system of measures and mechanisms to stimulate the sustainable use of wildlife resources includes:

- revision of territorial planning to optimize hunting lands, the internal hunting management system and the re-assignment of hunting lands;
- establishment of a service-digital database of hunting farms and game species;
- developing methodologies for evaluating the efficiency of hunting farm management and evaluating the economic value of game species;
- establishment of data collection and monitoring system for rare and game species based on updated methodologies, including their habitats, diseases, etc. based on geoinformation technology (geoportal on wildlife);
- creation of the wildlife cadastre on the information base of the conducted state accounting of the wildlife;
- establishment of a Wildlife Resettlement Centre for the adaptation and reintroduction of wild ungulate threatened animals to their historic habitats, conservation of the gene pool, development of hunting farms;
- creation of public councils for the conservation, reproduction and sustainable use of wildlife under local executive bodies;
- prioritization of the transfer from extensive to intensive hunting farm, development of game breeding and hunting farms;
- development of hunting tourism - ensuring cultural and safe hunting for the public and foreign hunters, development of hunting services;
- using funds gained from hunting tourism for the development of hunting farms, trophy and recreational hunting;
- development of breeding of hunting dogs and national types of hunting;
- implementation of measures to detect, monitor and prevent the emergence and spread of wildlife diseases that threaten public health, damage agriculture and species diversity, including rare and endangered animal species;
- subsidizing game breeding;
- introduction of compensatory measures for biodiversity losses;
- development of public-private partnerships to attract external investment.

Sustainable fisheries

Conservation of fish species populations and development of commercial fish farming and aquaculture are also included in Objective 7 of Strategy 2025, the implementation of which requires the development of subsidy rules for the purchase of alternative energy generating installations (solar panels and wind turbine generators), capital amelioration of ponds in full-system pond farms, purchase of medicines to combat fish diseases and preventive work, and introduction of new

technologies for the cultivation of valuable fish and domestic formulations of special feeds[19].

The stable functioning of aquatic ecosystems, largely determined by the condition of breeding grounds (spawning grounds), wintering holes and migration routes, depends on hydrological conditions. In this context, it is important to determine the optimum volume of water releases required for fisheries and fisheries amelioration of water bodies. Depending on the prevailing situation, it is necessary to apply measures to prevent the depletion of fish productivity in water bodies and to establish appropriate fishing regimes - prohibitions and restrictions in breeding grounds, migration routes and wintering grounds[20].

In order to ensure the conservation, reproduction, management and sustainable development of fisheries resources in the long term, the following activities should be carried out:

1. development of fisheries within safe limits to conserve fish stocks;
2. fisheries reproduction;
3. development of aquaculture and commercial fisheries;
4. conservation of the biodiversity and ecosystem of the Caspian Sea.

To support the fisheries sector, it is necessary to improve legislative norms in accordance with international agreements in the field of fisheries, including the following issues:

- the principles of sustainable fisheries and aquaculture developed in accordance with the Code of Conduct for Responsible Fisheries as recommended by the Food and Agriculture Organization of the United Nations (FAO);
- regulations on the division of water bodies into fishing areas, in compliance with the principles of biodiversity conservation and effective and profitable fisheries;
- fish resources cadastre, taking into account the economic value of biodiversity;
- the list of species of hydrobionts prohibited and restricted to enter the territory of Kazakhstan, according to the degree of threat to biodiversity;
- measures taken jointly with neighboring water-basin countries on invasive alien fish species;
- Automated recording (traceability) systems for the catch, transport and sale of fish products;
- rules for granting land plots on the basis of an easement for the needs of fisheries.

The Agreement on the Conservation and Rational Use of Biological Resources of the Caspian Sea, signed during the Fourth Summit of the Heads of the States bordering the Caspian Sea of September 29, 2014 (Astrakhan city, Russia) includes the definition of agreed measures to improve the habitat and natural reproduction of fish resources, including combating illegal fishing.

[19] The Concept for transition of the Republic of Kazakhstan to Green Economy, approved by Presidential Decree of May 30, 2013, № 577.

[20] Draft Concept for the Conservation and Sustainable Use of Biological Diversity in Kazakhstan until 2030, Nur-Sultan, 2019.

In order to reduce the negative impact on the ecosystems of the Caspian Sea, it is necessary to zoning the water areas of the Kazakh part of the Caspian Sea, defining preserved, recreational and technogenic zones with different sustainability and vulnerability, establishing a special regime of water resources use. These measures will lead to an increase in Caspian seal and sturgeon fish populations. Creation of a reserve area in the Caspian seal habitat in the Kazakh part of the Caspian Sea is one of the priority objectives.

Economic valuation of biodiversity

The importance of economic valuation of biodiversity/ecosystem services is determined by the fact that the level of biodiversity is an indicator of the state of ecosystems, which in its turn determines the productivity of those ecosystems and their ability to meet the needs of society and human well-being. Biodiversity is evaluated in two ways: richness (diversity) and abundance (quantity). Therefore, three main types of biodiversity evaluation are used in biology:

1. biodiversity index is a measure of the abundance of species at a particular monitoring site;
2. species abundance index compares the number of individuals of a species (group of species) in relation to other species or groups of species in the same community. For example, the population size of a species is relatively stable but initially low; relatively high, but steadily declining; initially small and continues to decline;
3. regular species distribution index combines indicators of diversity and abundance in one value[21].

Economic valuation of ecosystem services also plays an important role in planning and management processes, as it allows to find answers to many questions about individual natural resources:

1. What is the value of conserving the forest, including contribution to GDP, value for the local population, value for commercial use, for tourists, for water balance, agricultural needs, etc.?
2. Who is the owner and beneficiary of the benefits and damages?
3. What are the economic consequences of biodiversity loss/degradation for key sectors of the economy and human well-being?
4. What level of funding is needed for effective biodiversity conservation?
5. What are the possible measures of incentives for the sustainable use of natural resources, taking into account the benefits and costs of their loss/reduction?
6. How can we influence planning, management and decision-making processes?

A simplified definition of valuation could be as follows: „an attempt to determine the value of ecosystem goods and services in monetary form“. The theory of the issue and specific methods are based on the neoclassical theory of welfare economics,

[21] The economic value of natural of environmental resources, TME, Institute for Applied Environmental Economics, Jochem Jantzen et al., 2006.

that is, public choice theory, which provides a positive analysis of how different societal preferences are formed and realized. The main purpose of assessment is to determine societal preferences by measuring their readiness to pay or to accept compensation for changes in certain benefits of environmental characteristics and functions of biodiversity[22].

It should be understood that the object of economic valuation of biodiversity is not the „stock of goods and services" of biodiversity. Economic valuation measures the value of changes in the „stock of goods and services". That is, when we talk about the economic value of biodiversity, we mean the economic value of biodiversity change. Accordingly, the purpose of economic valuation is not to determine the real value of biodiversity or the ecosystem. The initial and practical aim is to estimate the cost of biodiversity change and compare it with alternative opportunities. The practical solution to this approach is based on compensation schemes or equivalent alternatives[23].

It is important to note that in biodiversity valuation the term economic value should be interpreted more broadly, as biodiversity values can have various additional reasons and motivations beyond making a quick profit from the use of the resource. Furthermore, a definition of the economic value of resources and functions at all levels of biodiversity does not in any way imply a requirement for payment by the end-user for the cost of ecosystem products and services, which can be assumed in a narrow understanding of economic relations. In this case, a certain economic value of a biodiversity resource or function indicates the degree of their importance to society and that degradation or loss of a certain resource or ecological function would cause significant harm to human well-being. Thus, determining economic value helps to select the optimal scenario.

The results of the economic assessment can be important for forming policy frameworks for development, planning and management at national and local levels. The results of the economic valuation can be used to:

- demonstrating the value of biodiversity and increasing awareness;
- making decisions on changing land use regimes;
- development of priorities of national policy in the field of environmental conservation within a limited budget;
- biodiversity impact evaluation of investment projects;
- damage assessment of biodiversity loss or degradation;
- restrictions or bans on extraction and trade;
- national accounts audits.

The economic valuation of natural resources is based on the basic model of market relations, where supply and demand determine the price of a good or service in monetary form, i.e. the price that people actually pay for the opportunity to buy/consume a particular product or service[24].

[22] The economic evaluation of biodiversity / Medvedeva O.E. [etc.] - 1999.

[23] The economic value of natural of environmental resources, TME, Institute for Applied Environmental Economics, Jochem Jantzen et al., 2006.

[24] Klimanova O. N.: Review of international experience of economic valuation of natural resources and biodiversity, Astana, 2015. p. 52.

But in the case of valuation of biodiversity, the theory of supply and demand also applies to products and services that are not traded on the market, for example most of the ecosystem services do not have a market value. The reason is that most ecosystem services have the characteristics of public goods and services, that is, people by birth have a legally guaranteed right to use them.

Therefore, the laws of the self-regulating market do not fully work in the case of public goods and services. And as a consequence, many of the goods and services produced by resource exploitation and biodiversity functions have an undervalued value that does not include the value of the numerous ecological processes involved in their production. This in its turn leads to a wrongheaded view of the real value of these goods and services, both by producers and consumers.

Thus, conducting economic valuation of biodiversity/ecosystem services not only raises the level of awareness and understanding of the „latent“ benefits of conserving biodiversity and maintaining vital ecosystem services, economic valuation also provides opportunities for improving decision-making and reforming legal frameworks.

With regard to economic valuation, it is important to understand the difference between the market price of a good or service and their value for ensuring the well-being of people in terms of willingness to pay. We can assume that if a person purchases some product at the price of eight dollars, this price indicates the value of that item to that person, which may not correspond to reality. In fact, it is quite possible that a person is willing to pay more, e.g. $10. In this case, the economic value of this good will be represented by the consumer's additional (net) profit, which is equal to the difference between the price the consumer is willing to pay for this good and the actual market price or consumer surplus.

The same principle of economic value applies to goods and services that do not have a defined market price. For example, consider the case of an fisherman who is willing to pay thirty dollars a day for the opportunity to go sport fishing on a particular lake. But his actual costs for transport and other expenses are twenty dollars a day. The consumer surplus of the fisherman or the economic value of this lake to the fisherman will be ten dollars, which is the difference between his willingness to pay and the actual price. If, for example, as a result of the implementation of an infrastructure project near this water body, a fisherman loses the opportunity to do sport fishing in this place, then this person will lose the satisfaction of fishing on this particular lake, which he estimates at ten dollars. Therefore, the economic recreational value of this lake to this person is ten dollars.

The same applies to the operating costs of the producer. The subject of economic evaluation is the producer's net profit, i.e. the difference between the selling price and the production cost per unit of a good or service, rather than the total cost. Meanwhile, the total economic value according to the willingness-to-pay principle in this case would be the sum of the net profit of the consumer and the net profit of the producer.

As noted above, biodiversity is in the form of biological resources for society. Although the presence of biological resources is only a final result, visible and

tangible to humans. But the formation of each component of biological resources was preceded by many interrelated biochemical and biophysical processes operating in tandem, each of which has some economic value. The sum of the maximum number of different types of biodiversity values constitutes its total economic value[25] [26].

According to the concept, total economic value is made up of use and non-use values (Fig. 2). Use values, in turn, consist of values of direct use, values of indirect use and deferred values. Non-use values include inheritable and existence values.

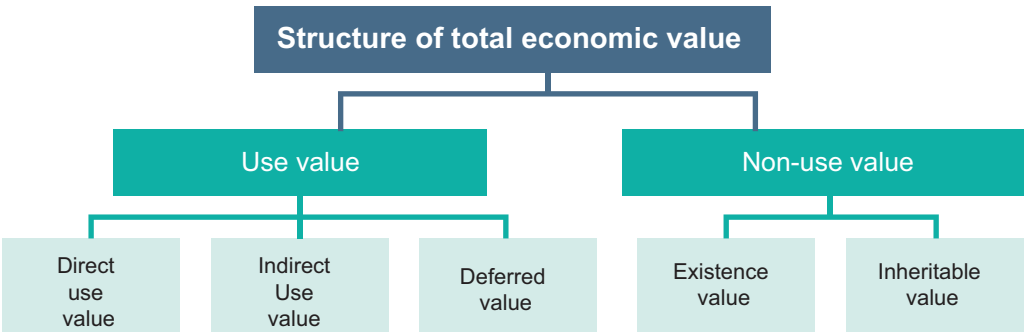

Figure 2. **Structure of total economic value**

Direct use values - values obtained from the use of natural territories in the following activities: recreation, tourism, extraction of natural resources, hunting, conservation of the genepool, education and scientific research. These activities may be commercial in nature, i.e. put on the market (natural resource extraction, tourism and scientific research), or non-commercial, i.e. where for some goods and services there is no formal market in which to sell them (e.g. firewood collection or grazing by informal arrangement). The value of commercial uses is usually determined very simply by identifying the market price. However, if prices are set administratively, they may not reflect the true value of the product. Measuring the value of non-commercial uses is a more complex process, involving a number of methodologies by which approximate market analogues of the true value of goods and services are found.

Indirect use values are values obtained from the use of ecological functions, such as: water catchment protection, conservation of breeding sites for migratory species, climate stabilization and absorption of carbon dioxide from the atmosphere. Natural areas can serve as breeding sites for insects that pollinate local crops or as habitats for predators that regulate rodent populations. Indirect use values are usually distributed over a large territory and are therefore difficult to establish in a market way. Alternative methodologies are needed to evaluate them, which will be described below.

[25] Phillips A. The economic value of protected areas. - IUCN, 1998.

[26] An exploration of tools and methodologies for valuation of biodiversity and biodiversity resources and functions, CBD Technical Series No. 28, 2007.

Deferred values are values that can be derived from the use of a natural area in some way or another in the future. These can be both direct and indirect values that contain potential resources or valuable information that can be obtained in the future. Potential information is often considered particularly important for biodiversity conservation, as unexplored genes may be used in the future in the agriculture, pharmaceutical or cosmetics industries.

Non-use values are values that are not related to the use of the natural territory. The two most obvious examples are inherited values and existence values. Inherited values mean the benefits of a natural territory for future generations. Existence values reflect the benefit of having a natural area, even if a person is unlikely to visit it and cannot use it. Non-use values are particularly difficult to measure. The concept of total economic value (TEV) is based on a holistic approach, but it must be taken into account that:

1. The TEV is anthropocentric in the sense that the values considered within its framework are important for people. This system does not take into account the intrinsic values of biodiversity. Endless debates continue in the conservation community about whether individual species and nature as a whole have an independent value unrelated to humans, and it is recognized that the economy is not able to fully take into account all the values associated with protected territories.
2. With a high probability, it can be expected that the TEV will reveal mutually antithetical values. That is because different people evaluate goods and services associated with a SPNT using different criteria, and these evaluations may be contradictory. One person will appreciate the opportunity to observe animals in their natural habitat, while another person will appreciate the opportunity to hunt animals. Calculating the actual total economic value of biological resources is likely to face the problem of unrecorded values, conflicting values or double counting.
3. Calculation of the full economic value using the TEV methodology is usually not required. Such a full-scale analysis is very expensive, difficult and time-consuming.

In international practice, three main approaches to the economic valuation of natural resources and biodiversity are widely used (Table 3):

- revealed preference approach, i.e. using official data on market prices and other variables to determine the value of ecosystem goods and services;
- stated preference approach, where calculations are based on willingness to pay for ecosystem goods and services identified through subjective surveys;
- using theoretical and practical experience in evaluating certain ecosystem goods and services described in scientific publications.

Table 3. **Main methods used in international practice of economic evaluation of biodiversity and ecosystem services**

Evaluation approach	Evaluation methods	Type of value/expense
Stated preference approach	Contingent evaluation method / questionnaire method	All values of use and non-use
	Preference modelling method	All values of use and non-use
Revealed preference approach	Market price analysis method: - the direct market price method - the method of prices for similar goods and services (alternative prices)	Value of direct use; Value of indirect use
	Preventive cost methods: - the non-allowable cost method (preventive cost) - the no loss method - the replacement cost method	Value of indirect use
	Productivity change method	Value of indirect use
	Travel cost method	Value in use, implying travel costs
	Environmental media comfort method/ hedonistic method	Value associated with environmental quality change
	Human capital method	
Approach of using existing cost evaluations	Method of using data from previous empirical evaluations	All values of use and non-use

In a modern market economy, with limited government resources to maintain conservation institutions and finance biodiversity conservation goals, alternatives are needed to provide them with additional financial resources by demonstrating the economic value of biodiversity[27].

[27] Valentine P. Sustainable financing of SPNT, a review of international experiences, methodologies and approaches. - IUCN, 2007.

The first pilot project to conduct an economic valuation of ecosystem services was the Karkaraly State National Natural Park (hereafter, Karkaraly SNNP), where all types of ecosystems are represented, respectively the variety of ecosystem goods and services[28] [29].

The assessment process included several stages, including a workshop on identification of ecosystem services of Karkaraly SNNP with the participation of interested parties, collection of materials from the database of state institutions of the Karkaraly region and other organizations that maintain data on natural resources of Karkaraly region, interviewing tourists in the winter period, cameral treatment and analysis of collected data, preparation of calculations and recommendations for further integration of practices of economic evaluation of ecosystem services of SPNT into the management process The types of ecosystem services to be prioritised for economic valuation were identified with the participation of all interested parties (Tables 4 and 5).

Table 4. **Ecosystem services of Karkaraly SNNP**

TOTAL ECONOMIC VALUE OF ECOSYSTEM SERVICES OF THE KARKARALY SNNP				
Use value			**Non-use value**	
Direct use values	**Indirect use values**	**Deferred values**	**Existence values**	**Inherited values**
Tourism and recreation	Conservation of animal and bird habitats	Unexplored species of biodiversity to be reported in the future	The benefits of having a Karkaraly SNNP for people in other regions who do not use its services directly, namely the conservation of the country's biodiversity and cultural heritage	All consumer and non-consumer values for future generations
Fuel (fuelwood)	Absorption of carbon dioxide from the atmosphere and climate stabilization			

[28] Methodological guide for economic valuation of ecosystem services of SPNT, Astana, 2014.

[29] Emerton L. Guide to Conducting an Economic Evaluation of SPNT in Kazakhstan. - Astana, 2012.

Food (mushrooms, berries, fish) Water supply Construction materials (industrial wood) Forage base (pastures, hayfields) Health resources, pharmaceuticals (medicinal plants) Education, enlightenment and scientific research (wild animals, plants, birds, fish)	Groundwater conservation Conservation of surface water sources Producing oxygen (photo-synthesis) Soil formation Erosion control			

Table 5. **Ecosystem services, selected for economic valuation**

Ecosystem services	Forest ecosystem	Water ecosystem	Hayland
Carbon sequestration and climate stabilization	+		
Tourism and recreation	+	+	
Water supply		+	
Mushrooms	+		
Hay			+
Wood products of the forest	+		

The economic value of the ecosystem services of Karkaraly SNNP selected for evaluation was more than 12 billion tenge, which reflects only a small part of the real value of the national park, which can be multiplied and transferred to future generations if it is constantly accounted for and managed effectively.

The economic evaluation of the ecosystem services of Karkaraly SNNP focuses on demonstrating the economic evaluation mechanism itself, based on the TEV using several ecosystem services of the national park as an example. The economic value of those ecosystem goods and services that have historically been produced in SPNT and have a market value is reflected in the study, but their role in the growth of the local economy remains 'overlooked'.

As a result of the work carried out, the following conclusions were made:

1. A comprehensive vision of the values of ecosystem goods and services is needed in planning payment schemes for ecosystem services, a vision that ensures a balance of carbon dioxide sequestration, biodiversity conservation, sustainable forest management and watershed protection;
2. A transition from the modern economic paradigm, which views economic sector efficiency and nature conservation as independent issues to a holistic environmental-economic approach, integrating nature and the economy as two interconnected component of the socio-ecosystem, is needed. Any decisions at the macroeconomic level must produce positive environmental effects under such approach;
3. the economic value of wildlife should be included in the assessment of national wealth and macroeconomic indicators of the republic's development;
4. comprehensive measures need to be taken to determine the economic value of ecosystem services and biodiversity as part of the national wealth of the country and to account for them as an asset of Kazakhstan in international economic reciprocal payments from the perspective of conservation and restoration of biosphere functions;
5. economic valuation of ecosystem services should be included in national policy documents and funding allocated to it;
6. conducting a targeted information campaign on the economic value of ecosystem services, since the evaluation of ecosystem services and the comparison of benefits associated with the conservation of biodiversity and its use is useful for establishing policy priorities.

Conclusion

Kazakhstan is the world's ninth largest country by total area of 2.72 million km^2 and has a unique range of landscape complexes: from deserts to highlands and land-locked sea ecosystems. However, dry and sub-humid lands occupy more than 75% of the country's territory.

There are 5,754 species of higher plants on the territory of the Republic. There is a high level of endemism, which is up to 14%. The list of rare and endangered species

includes 387 plant species. There are 890 vertebrate species including mammals - 178 species, birds - 500 (388 of them nest in Kazakhstan, others come only for wintering or leave in spring and autumn), reptiles - 49, amphibians - 13, fish - 147 and cyclostomes - 3. Also, there are about 100 thousand species of invertebrates, including at least 50 thousand species of insects.

Kazakhstan is a party of five priority interstate agreements, directly applicable to conservation and sustainable use of biodiversity: the Convention on Biological Diversity, the Convention for the Protection of the World Cultural and Natural Heritage, the Convention on the Conservation of Migratory species of Wild Animals (Bonn Convention), the Convention on Wetlands of International Importance (Ramsar Convention), the Convention on International trade of Endangered Species of Wild Fauna and Flora (CITES), as well as the United Nations Convention to Combat Desertification.

There is no single strategic document directly providing for the implementation of the Strategic Plan for Biodiversity Conservation and Sustainable Use based on the global targets for the conservation and sustainable use of biodiversity adopted in 2010 through the CBD in Japan.

The sectoral programme „Zhasyl Damu“, approved by the Decree of the government of the Republic of Kazakhstan No. 924, of September 10, 2010, and planned for implementation during 2010-2014, included a block of forestry, wildlife and SPNTs.

The Strategic Development Plan of the Republic of Kazakhstan till 2025 includes issues of biodiversity conservation and ecological culture. However, the strategic plan of ministries and regional programme documents do not fully define national goals and objectives directly or indirectly equivalent to the CBD targets[30].

In order to fill that gap, this chapter presented: the current status, existing threats, principles and strategic vision for the long-term conservation and sustainable use of Kazakhstan's biodiversity. However, it should be noted that achieving the goals of sustainable development of conservation and restoration of terrestrial ecosystems and promoting their sustainable use, sustainable management of forests, combating desertification, stopping and turning back the tide of land degradation and stopping the loss of biodiversity depend on such objectives as ensuring the conservation and restoration of water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes. Kazakhstan still needs to take a number of measures to prevent the introduction of invasive alien species and significantly reduce their impact. It is necessary to clarify the impact of invasive species of different groups and effectively control their import by conducting an evaluation of the impact of alien species on the state of local species and natural ecosystems.

The objectives in Chapter 3 on the conservation of rare and endangered species, genetic resources, forests, fisheries and wildlife resources focus on the twenty global Aichi targets adopted by the parties to the Convention on Biological Diversity in 2010 in Japan.

[30] Strategic Plan of the Ministry of Ecology, Geology and Natural Resources for 2017-2021, approved by Order of the Minister of EGaNR RK dated 10.09.2019 No. 26.

Economic valuation of ecosystem services provides the basis for equitable accounting of renewable resources and the implementation of new approaches to greening the System of National Accounts in accordance with the UNECE Recommendations for implementation of the System of National Accounts in Eastern Europe, the Caucasus and Central Asia.

Despite the apparent diversity of methods applied and the wide coverage of natural resources, most of the valuation indicators are non-economic in nature, i.e. do not allow to determine the true market value of the object being valued. The methods for estimating natural resources are not virtually linked and are an industry-specific in nature. This is primarily due to the underdevelopment of market mechanisms in Kazakhstan to determine the real market value of natural and public resources, as well as a narrow-departmental approach to valuation.

In the transition to new management methods in Kazakhstan's economy, there is a real need to determine the market value of sites and the total economic value of biodiversity in order to evaluate the share of ecosystem services in natural capital, a cadastral valuation of resources, taking into account all explicit and latent benefits of biodiversity in an integrated manner.

Theoretical developments and practical application of new methods in Kazakhstan will contribute to changing the paradigm of the resource-economic approach to the economic evaluation of ecosystem services and the maximum accounting of the entire range of products and services of genetic, species and ecosystem diversity.

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Chapter 6

THE CIRCULAR ECONOMY AS A TOOL FOR SUSTAINABLE AND LOW-CARBON DEVELOPMENT

6.1 Relevance of the issue

Currently, achieving sustainable economic growth has become an important item on the global agenda. Harmonious reconciliation of the components of sustainable development that ensures economic growth, social stability and long-term ecological balance can be ensured through the concept of „green" economy, which has recently received increased attention all over the world. The transition from the traditional model of economic growth to „green" growth is becoming a global global trend, where the green economy is a tool for achieving sustainable development. Increasing air, soil and water pollution on the world scale has led to global climate problems and threatened the existence of life on Earth.

During the late 19th and early 20th centuries, the global community recognized the problem of global warming and began to take action to solve it. The documents adopted in Rio de Janeiro, Kyoto, Paris and ratified by UN Member States set new trends and a new development paradigm. Seventeen sustainable development goals were developed in 2015. The sustainable development goals related to the „green" economy made up one third of all targets (56 out of 169) and more than half of all indicators.

The decision of the 12th goal of sustainable development is the transition to a circular economy expressing responsible consumption and production with maximum resource efficiency, zero waste generation and minimization of external negative effects on the environment.[1]

Main challenges:

12.1 to implement the ten-year strategy for action on transition to sustainable consumption and production patterns involving all countries, with developed countries being the first to start it, and taking into account the development and potential of developing countries;

12.2 to achieve the sustainable utilization and efficient use of natural resources by 2030;

12.3 to reduce by half, on a per capita basis, the global amount of food waste at retail and consumer levels by 2030 and reduce food losses in the trade and value chains, including post-harvest losses;

[1] Wilts, H. The digital circular economy: can the digital transformation pave the way for resource-efficient materials cycles? In Brief: Sustainability Impulses from Wuppertal 04/2017 / H. Wilts, H. Berg, Wuppertal Institut // Wuppertal Institut. - 2017. - URL [Electronic resource] - Access mode: https://wupperinst.org/fa/redaktion/downloads/publications/In_Brief_2017-4_en.pdf (Дата обращения: 05.09.2021).

12.4 to achieve the environmentally sustainable use of chemicals and all wastes throughout their life cycle by 2020, in accordance with internationally agreed principles, and to significantly reduce their release into air, water and soil so as to minimize their negative impact on human health and the environment;

12.5 substantially reduce the volume of waste by 2030 through measures for waste formation, reduce, recycle and reuse.

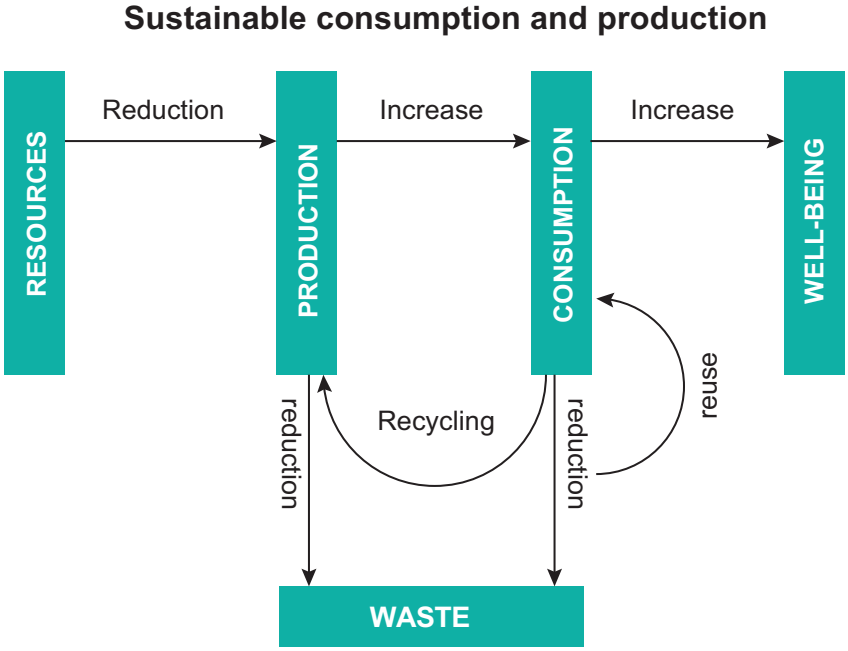

Figure 1. **Life cycle or systems approach to sustainable consumption and production**

Deciding on the 12th goal enables the achievement of 6,7,11,13,14,15 goals, i.e. will positively influence the decision of the others.

Socio-economic progress over the last century has been accompanied by environmental degradation that threatens the same systems on which future development, and in fact the survival of humanity itself, depends.

In 2009, a team of Earth systems and environmental scientists led by Johan Rockström from the Stockholm Resilience Centre and Will Steffen from the Australian National University formulated a list of planetary boundaries in 9 regions, enabling safe operational limits for human activities to be defined and quantified.

Planetary boundaries are a concept that includes Earth system processes that contain environmental boundaries.

The group of scientists wanted to define a „safe working space for humanity“ for the international community, including all levels of government, international

organizations, civil society, academic community and the private sector, as a prerequisite for sustainable development. Violation of one or more planetary boundaries could be detrimental or even catastrophic because of the risk of cross-thresholds that would cause sharp changes in the environment of planetary-scale continental systems. At the moment, humanity has already crossed three boundaries: climate change, biodiversity loss and partly biogeochemical change.

The consequence of this has been the application of the traditional linear model of the economy based on the principle of obtaining raw materials, creating a product and waste disposal - „extract-produce-dispose". However, this model has become unsustainable in the face of environmental and economic constraints and challenges, and has already gone beyond the world's limited resources. Environmental pollution and destruction have expanded on a scale never seen, in this regard, the quality of life has significantly decreased, entire species of animal and plant life have disappeared, the environment leaves much to be desired.

As noted by experts, the only economic model that will allow living within planetary boundaries is the circular economy model that has been evolving since the 1960s as a tool for sustainable development, with the goal of restoring natural, productive, financial and human capital, as well as renewing resources. This type of economy is also considered to be part of the „Fourth manufacturing revolution". At the 2016 World Economic Forum in Davos, one of the main topics of discussion was the Fourth manufacturing revolution, characterized by the blurring of boundaries between physical, digital and biological technologies (Schwab K., 2016), as a result of which, in general, the rationality of the use of resources, including natural ones, should increase, the economy will become more transparent, predictable and its development will be rapid and systematic. The first President of the Republic of Kazakhstan N.A. Nazarbayev spoke about new development opportunities in the contex of the fourth manufacturing revolution in January 2018 in his address to the people of Kazakhstan[2].

6.2 Principles of Circular Economy. Development of models

The aim of the circular economy is to separate economic growth from the use of primary raw materials by creating a circular system of production and consumption with a minimum of losses. Resources need to be managed efficiently throughout their life cycle, from production and consumption to disposal and recycling, creating additional value on the basis of available resources while reducing the volume of waste produced. In addition to reducing environmental impacts, the effective implementation of circular economy principles enables facilities to cut costs, increase growth potential and improve their corporate image. That is why the transition to a resource efficient circular economy is important in the interests of competitiveness and sustainable economic growth.

[2] Message of the President of the country N.A. Nazarbayev to the people of Kazakhstan „New development opportunities in the context of the fourth industrial revolution" 10.01.2018. [Electronic resource] / LAWYER. [Electronic resource] - Access mode: https://online.zakon.kz/Document/?doc_id=38416707#pos=2;-116.

The circular approach is based on the Three R's principle, a resource-conserving way of managing waste[3]:

1. Refuse+Reduce - refusal, reduced use of resources and priority of renewable materials;

2. Reuse+Repair - maximum efficient use of products, reuse;

3. Recycle - recovery of by-products and waste for further use in the economy.

The transition to a circular economy requires changes along the entire product value chain, from product design to new business models and the formation of consumer habits. In the case of new and existing products, the emphasis is on full life-cycle development with a focus on the choice of green materials, product quality (long life, repairability), optimisation of the distribution chain, recycling and reuse (universality, component separation capability). Environmental innovation and technology development play an important role, contributing to a change in the direction of the economy.

It should be noted that there is no unique and universal definition in the available literature, but a general consensus on the basic concepts and objectives of the circular economy is reflected. There are two main types of definitions.

The first type is a resource-based definition, where the emphasis is on ensuring a closed circulation of material resources and on reducing the introduction of new, untapped resources.

The second type is the definition that apply not only to material resource management, but also to other aspects such as changing patterns of consumption (Rizosetal, 2017).

In practice, the actions required for this transition include: recycling; resource management; renewable energy use; secondary manufacture, restoration repair and reuse of products and their components; extending the life of products; the perception of products as a type of service; product sharing[1]; waste prevention, including innovations at the design stage ensuring the elimination of the inevitability of waste; changing consumption patterns (Rizosetal, 2017; EMF, 2015a).

The principles of circular economy cover all areas of activity.

To summarize, the following positive factors can be identified for the circular economy: the economic benefits, which are expressed in terms of reduced consumption of raw materials and energy, and the resulting reduced volatility of resource prices. Thanks to the circular economy, new sectors of the economy linked to recycling are emerging, which leads to an increase in the number of jobs (Beuren F., Gomes F., 2013). The introduction of the practices of recycling, recovery and other elements of circular production increases innovation and creates additional competitive advantages for businesses, new sources of profit are created, customer loyalty is improved and relationships with counterparties along the entire value chain are strengthened (Firnkorn J., Müller M., 2016; Shafiee A., Stec T., 2014). Development

[3] Directive 2008/98/EC [Electronic resource] - Access mode: https://google-info.org/7110947/1/1direktiva-2008-98-ec.html.

of a new type of agriculture. There is an important link between agricultural and environmental policy. The EU farm-to-fork strategy aims to create a fair, healthy and environmentally sound food system; for the consumer, the benefits of the circular economy are expressed in the use and consumption of environmentally friendly products, as well as lower costs; for the environment reduction of greenhouse gas emissions and pollutants, zero waste generation, reduction of landfills and dumping, reduction of discharge into water bodies, as well as reduction of consumption of limited resources, reduction of land degradation, conservation of biodiversity.

6.3 Circular economy models

Circular economy models vary in scope and complexity.

The 1st model. A simple circular concept that describes a cycle involving production, consumption and reuse/repair/disposal.

The 2nd model developed by EMF (2015a), which details the following principles:

1. preservation and augmentation of natural capital by controlling ending stocks and coordinating the flow of renewable resources;
2. optimizing the use of resources by circulating products, components and materials with maximum utility;
3. increasing the efficiency of the system by identifying and excluding negative externalities (at the design stage).

For example, EMF uses a „regeneration-sharing-optimisation-circuiting-virtualization - replacement“ (ReSOLVE) scheme, which involves six types of actions that can be taken by business structures and governments of countries. Such schemes provide a transition process that requires an integrated effort by various interested parties. At the same time, the role of the state is to determine the strategy and set the regulatory and fiscal rules, as well as to finance certain measures, such as research and business support. The latter plays a crucial role in implementing the principles of the circular economy, including through innovation. Public organizations and business associations are also involved in this scheme, supporting this process by actively promoting and disseminating knowledge[4].

6. 4 „Circular“ approaches

Refuse+Reduce - refusal, reduction of consumption or the „goods-as-a-service“ philosophy

Refusal, reduction of consumption is at the top of the list. The reduction of consumption refers to everything: conservation of electricity, hot and cold water, gas, room heat, food, reduction of things. This principle calls to begin for himself or herself.

[4] Circular economy and health: opportunities and risks. Copenhagen: WHO Regional Office for Europe, 2019. License: CC BY-NC-SA 3.0 IGO.

The eBay marketplace, for example, adheres to this principle and offers restored, damaged or defective but fully functional devices at discounted prices on a special website. Obolon Concern sells agricultural companies by-products of beer production, which become animal feed.

The „goods-as-a-service“ philosophy involves replacing traditional sales models with sales of services. For example, Power-by-the-Hour Company offers customers in the aviation industry, instead of buying aircraft engines, to pay for their use based on a fixed rate per 1 hour of operation. The service approach increases the life cycle of an engine by 25%.

The successful launch of a car subscription by Volvo. The customer can choose a model through the website and subscribe with a fixed monthly payment. This model is an alternative to leasing or buying a car.

Reuse+Repair - The „second hand“ philosophy

The circular economy is more than just waste disposal. It is a whole philosophy of reusing and profiting from what used to be considered unnecessary and scrapped within the triad of the traditional linear economy.

For example, sports shoe manufacturer Nike launched the NikeGrind initiative almost 30 years ago. Old sneakers, collected all over the world, were used as a material for the manufacture of coverings for sports grounds. Since the launch, around 28 million pairs of shoes have been recycled for sports ground surfaces. General Electric Company uses 3D printing to make parts to save material quantities. Canon Inc. takes back products at the end of their life cycle and uses the components in new devices, without reducing the functional characteristics of the materials.

Thus, it is reuse in production, where used products or components become part of new products.

Recycle - waste recycling

Recycling includes changing the physical form of an object or material and creating a new product. It does not lead to the complete destruction of waste. The aim of recycling is to turn waste into secondary raw materials, energy or products with specific consumer properties. As practice demonstrates, the great part of household waste comes from numerous supermarket packages: tetra bags, cardboard boxes, glass and aluminium cans, and several types of plastic. For example, the recycling of aluminium cans requires 80% less energy than the production of a new one.

It should be noted that the recycling system in the USSR has existed for a long time. In the 1920s, at the start of the first five-year plans, the ideology of careful resource use developed. The rudiments of integrated waste collection were established. After a while, five groups of recyclable resources were identified: glass, waste paper, textiles, tyres and polymer materials.

The entire path of the transition of raw materials into a product before processing and disposal was carefully calculated and thought out. Processing costs were included in the cost of production of the relevant industries. Collection standards for the main types of secondary raw materials were developed and

further planning took place on this basis. In 1986, the CPSU Central Committee adopted a resolution under which organizations developing new products were to work simultaneously on developing technology for the reuse of that product after its useful life had expired.

An important input to the overall system was the infrastructure. Numerous collection points and industrial recycling facilities for basic types of secondary raw materials were set up all over the country.

As noted by experts, in 1987 more than 70 per cent of recyclable materials were circulating.

Waste recycling and reuse is an important element of the circular economy.

6.5 National initiatives for the development of the circular economy

The prospects for the development of the circular economy in the countries are evaluated quite highly.

China has adopted legislation to promote a closed-cycle economy (circular economy). The transition to a circular economy in China is supported at the state level and regulated by the relevant law. The country is developing alternative energy (solar, wind), developing low-carbon city projects, and introducing nanotechnology. South Korea has adopted a „Green Development Strategy", which forms part of a national strategy. Economic development aims to create alternative transport and engines, harmless waste treatment, fresh water treatment and the involvement of businesses and the public in the state's environmental projects. Japan's circular economy combats air pollution, reduces methane emissions from recycling, farming activities. Safe methods of disposal of this substance and new materials are being developed to reduce the use of methane in production. A „Sound Material-Cycle Society" is being created in Japan. The contribution of the Japanese government to the protection of the biosphere from methane and black carbon emissions in developing Asian countries is noted[5] [6] [7] [8].

[5] On the Promotion of the Circular Economy: Law of the People's Republic of China, 2009. China Circular Economy Development Strategy Action Plan, 2013. The concept of „green gold" (Japan). Waste Management and Sanitation Act (1970). Recycling of Packaging and Packaging Act (1997). Concept in the field of resource management and waste management based on the „3R" principle. Sustainable Material Cycle Society Act (2000). Household Appliances Recycling Act (2001). Car Recycling Act (2005). [Electronic resource]/Circular Economics//Article from Wikipedia, free encyclopedia [Electronic resource]. - Access mode: https://ru.frwiki.wiki/wiki/%C3%89conomie_circulaire.

[6] European Union. European Circular Economy Stakeholder Platform [Electronic resource]. – Access mode: https://richwater.eu/circular-economy-stakeholder-platform/.

[7] Towards a circular economy. [Electronic resource]/ IndustryWired January 7, 2021. [Electronic resource]. - Access mode: https://industrywired.com/towards-a-sustainable-future-circular-economy-in-2021-and-beyond/.

[8] European companies on the way to a closed-loop economy [Electronic resource] /. Euronews: 25/01/2016. [Electronic resource]. – Access mode: https://ru.euronews.com/next/2016/01/25/cradle-to-cradle-powering-europe-s-circular-econome.

The world's first circular economy plan for Europe was presented in Finland in September 2016. Since then, nine EU countries have followed Finland's lead with similar action plans[9].

The European Commission has published a comprehensive package and action plan for the transition to a closed-cycle economy. Their aim is to stimulate the transition to a circular economy, increase global competition, ensure sustainable economic growth and create new jobs. The package contains measures applicable to the entire product life cycle: from production and consumption to waste disposal - a total of 54 different measures that can benefit both the environment and the economy, contributing also to social well-being.

Such a powerful financial institution as the European Investment Bank is behind the development of the circular economy in the EU today. It has invested 15 billion euros in various projects over the last ten years and plans to spend 40 billion euros on solid waste management alone in 2020[10]. In recent years, the circular economy financial platform has focused, among other things, on the following three objectives: popularization of best practices in order to attract potential investors and other interested parties to relevant projects; analysis of specific projects and their financial needs; financial consulting; coordination of the activities of facilities operating in the circular economy; promotion of circular economy projects and organization of their financial support; crediting of business organizations involved in the circular economy, especially medium- and long-term projects.

Central Asian countries have also adopted a number of institutional instruments to facilitate the implementation of circular economy principles.

Kyrgyzstan has adopted a Green Economy Development Programme in the Kyrgyz Republic for 2019-2023. „Kyrgyzstan - the country of „green" economy", the Ecological Security Concept of the Kyrgyz Republic, Sustainable Development Goals until 2030 in the field of waste management, the State Programme on Sustainable Waste and Secondary Resources Management for 2019-2023. State support is envisaged for users of natural resources implementing waste-free and low-waste technologies, stimulating the introduction of biogas production technologies from domestic and municipal organic waste and wastewater, encouraging the development of bio-fertilizer production using biomass, organic and food waste, large-scale recycling and the use of improved consumption and production systems.

The Republic of Tajikistan has adopted programme documents: the Ecological Security Concept in the Republic of Tajikistan, approved by the Government of the Republic of Tajikistan on December 31, 2008 (No. 645), National Concept for the rehabilitation of tailing dumps of uranium ore processing waste for 2014-2024.

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[9] The circular economy. Greening of business. [Electronic resource]. - Access mode: https://richwater. eu/circular-economy-stakeholder-platform/.https://www.fincyte.com/circular-economy-and-opportunities-for-small-businesses/.

[10] Circular economy is the key to prosperity in the future [Electronic resource] / This is Finland. [Electronic resource]. - Access mode: https://finland.fi/ru/biznes-i-innovatsii/tsirkulyarnaya-ekonomika-za-log-protsvetaniya-v-budushhem/.

Tajikistan encourages collection and recycling of fluorescent lamps, waste reduction and its disposal, as well as safe storage.

The Republic of Uzbekistan has adopted strategic documents: Strategy for Solid Waste Management in the Republic of Uzbekistan for the period of 2019-2028, Environment Concept until 2030, Strategy for transition of the Republic of Uzbekistan to „green" economy for the period of 2019-2030. Four large PET bottle recycling plants have been commissioned in the country, with up to 30% of the resulting polyester fibre used in the production of carpets in Uzbekistan. Geosynthetics like geotextiles made from PET bottle waste are used for dramatically improvement in the quality of roads.

Legislative acts have also been adopted in Turkmenistan: the Law of Turkmenistan „On Nature Protection" (2014), the Law of Turkmenistan „On Waste" (2015), the Sanitary Code of Turkmenistan. Legislative acts are aimed at developing the introduction of non-waste, low-waste and resource-saving technologies and productions, and the creation of advanced low-waste technological processes.

The institutional basis for the transition from a linear to a circular economy is also established in Kazakhstan. Strategic documents have been adopted: The Concept of Development of the Republic of Kazakhstan until 2050, the Low-Carbon Development Strategy of Kazakhstan until 2050, and the Concept of the Republic of Kazakhstan for the transition to a green economy, Environmental Code of the Republic of Kazakhstan (new version).

Table 1. **Overview of typical policy options in the circular economy**

Types of policies	Examples
Regulation mechanisms	National strategies of States, indicating targets, for example, the EU action plan for the introduction of a closed-cycle economy. Standards and regulations governing the production of products, for example, the Regulation for Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH). Waste management regulations, for example, the EU Waste Framework Directive. The EU Directive on waste electrical and electronic equipment and relevant national legislation, regulations and rules related to individual industries and consumer protection, for example, on food safety.
Economic instrument	Incentives for consumers, e.g. reduced value-added tax (VAT) for products manufactured in compliance with the principles of a closed-cycle economy. Changing the tax burden from labour to resources, for example, a landfill use tax. Financial support for business, for example, in the form of subsidies or financial guarantees.

Education, information and awareness-raising	Public communications and information campaigns. Business cooperation platforms to exchange information and best practices. Business technical support in the form of advice, training and demonstration projects. Information and education initiatives by social organizations.
Research and innovation policy	Research and development programmes, for example, Horizon 2020 - EU Projects on the circular economy, the European Cooperation in Science and Technology (COST) programme, the EU Circular Impacts project, international development bank projects.
Public procurement	Public investment in circular economy facilities, for example, waste disposal, collection and recycling facilities. Circular economy standards in legislation or guiding principles on procurement, for example, the Danish government's strategy for sustainable public procurement.

These new national development concepts provide for a radical change in waste management systems, aiming to maximize the recovery of secondary resources from waste and their use in industrial production instead of natural minerals.

Problems of circular economy development in Kazakhstan

Transition to a circular economy is a necessary priority for Kazakhstan, as the country's economic development is currently highly concentrated on the principles of a linear economy. In most sectors of the economy, there is a relatively high level of energy intensity and pollution, energy efficiency and a high level of waste generation.

This section focuses on the key risks, challenges and barriers to the development of a „green" economy that facilitates the transition to a circular economy in Kazakhstan, and also offers recommendations and measures to solve existing problems for the transition to a circular economy. Let's review the basic directions of the circular economy.

Renewable energy in Kazakhstan

Renewable energy sources include solar and wind power plants, small HEP, biofuel power plants, geothermal and some other types of power plants. Given the geographical location and climatic conditions of Kazakhstan, small HEP, solar and wind energy are the most prospective renewable energy sources. According to official estimates, the hydropower potential of medium and large rivers is 55 billion kWh per year, and that of small rivers is 7.6 billion kWh per year. At the same time, the potential for solar and wind energy is estimated at around 2.5 billion kWh per year and 1.820 billion kWh per year, respectively. Thus, the total renewable energy potential is 1,885 billion kWh per year, which is equivalent to a total power capacity of 4.3 GW[11].

[11] The EIB in the circular economy – European Investment Bank. [Electronic resource] / [Electronic resource].-

The key factors for the development of renewable energy projects in Kazakhstan are:

1. The government's commitment to achieving environmentally sound sustainable economic growth.
2. Mechanical ageing of the electricity generation infrastructure, which suffers from relatively high transmission and distribution losses (6%). Development of renewable energy sources can reduce losses by reducing power transmission distances.
3. Kazakhstan has a relatively high rural population (43%), which currently accounts for about 10% of the country's total electricity consumption. RES can be a convenient source of energy for outlying villages and regions.
4. High emissions of pollutants and carbon dioxide, high energy waste generation, due to heavy dependence on coal for electricity generation. The low intensity of emissions into the atmosphere, as well as the absence of generation of energy waste by renewable energy sources, are an attractive option for investors.

The issue of renewable energy development in Kazakhstan is described in Chapter 7.

„Green" building

Most of the available real estate in Kazakhstan is outdated, and many residential and business centres in the country use outdated energy-saving technologies, leading to significant energy losses. At the same time, the residential sector is the third largest consumer of electricity in the country after the mining and industrial sectors. Real estate, primarily residential, accounts for 13.5% and 24% of electricity and heating demand, respectively[12]. Therefore, improving energy efficiency in the residential sector becomes a national strategic priority for Kazakhstan. Like other countries with emerging-market economies, Kazakhstan is increasingly interested in introducing „green" building. „Green" housebuilding (also known as „green building" or green construction), means using processes based on the principles of environmental responsibility and resource conservation during the entire construction period: from location to building design, construction, operation, maintenance and modernization, down to demolition. Despite the fact that new technologies are constantly being developed to complement existing ones, the overall aim of „green" housebuilding is to reduce the negative impact of constructed facilities on human health and the environment through the efficient use of electricity, water and other resources; protecting public health and increasing employee productivity; reducing waste, levels of pollution and environmental degradation.

Within the past 40 years, „green" building has been gaining popularity all over the world, with the construction of efficient and energy-saving buildings has become a real trend.

Access mode: www.eib.org/attachments/circular_economy_en.pdf.

[12] Ibid p.150.

Despite significant economic, social and environmental benefits, „green“ building is not well developed in Kazakhstan. The Kazakhstan Green Building Council (KazGBC) was established in 2013 to support „green“ building. Kazakhstan's first projects in the field of „green“ construction are Greenville cottages and a new academic building of the Kazakh-British Technical University in Almaty city, as well as TalanTowers and the Green Quarter in Astana city. Modernization of buildings is envisaged, which will be assigned the status of a „green building“.

Table 2. **Opportunities and obstacles to the development of „green“ building**

Opportunities	Obstacles
Low operating costs, for example, utility costs and total life-cycle costs. The cost of most „green“ buildings at a premium of <2% and the profit is 10 times more during the entire life-cycle of the building.	High initial costs. New installations and modern technology tend to be priced higher than average.
High property value.	Lack of political support, incentive programmes. „Green“ growth is a relatively new direction, and requires special attention from the public.
A favorable environment for people.	Lack of demand in the market.
High rent rates.	Lack of public awareness.
High occupancy rates.	Lack of trained professionals in the field of „green“ construction.
Environmental benefits.	Access to capital.

Green transport

Kazakhstan is the largest source of pollutant and greenhouse gases in Central Asia, and the transport sector is the fastest growing source of emissions. The government has taken a number of measures aimed at limiting the harmful environmental impact of the growing number of cars and other vehicles.

Reducing the growth in emissions from the transport sector in the largest cities, while improving urban environmental conditions, is implemented through better

management of public transport and air quality. Car manufacturers in Kazakhstan have started producing electric cars in limited quantities. At the end of 2014, the Ust-Kamenogorsk plant Asia Auto produced the first KIA Soul EV. In July 2016, the Saryarka Avtoprom plant in Kostanay produced a pilot batch of electromobiles of the Chinese brand JAC. In 2017, Asia Auto presented the LADA Vesta EV at EXPO-2017. Local production of electromobiles can reduce the cost of electromobiles to the public.

Legislation provides support measures - a zero customs value rate for electric transport. It is valid from January 1, 2020 to and including December 31, 2021. The recycling fee for electric transport owners and the motor vehicle tax have been abolished since May 13, 2021. Other incentives are provided, such as the right of free entry to Shymbulak, Kok-Tobe in Almaty city.

Nickel and cobalt deposits were discovered in eastern Kazakhstan in the 1950s, and are used in the production of batteries, particularly for electromobiles. This will create production of batteries in Kazakhstan and recycle them, including for other countries.

However, the infrastructure is not sufficiently developed to change for electromobiles. Changes in building regulations and road infrastructure are required. There are two types of charging: fast and long. A long charge will allow the car to travel easily for 300 km, while a fast one charges the vehicle by 20%. So the driver should have a clear understanding of where he or she can charge the vehicle. The concept of low-carbon economic development envisages a gradual transition to environmentally sound modes of transport.

EPR operator implements a pilot project to develop electromobiles production and establish the necessary infrastructure. Road Map is approved by the Ministry of Infrastructure Development of the Republic of Kazakhstan. Electronic ignition systems (EIS) are currently installed in Nur-Sultan city (52) and Almaty city (50). The underdeveloped infrastructure does not allow efficient development of the electromobile industry.

Waste management

Waste management in Kazakhstan is regulated by the Environmental Code of Kazakhstan. Targets set by the Conception of Kazakhstan on transition to „green“ economy are the share of waste recycling to 40% by 2030 and 50% by 2050, and the storage of residual volumes of SMW in landfills will increase to 100% by 2050.

According to the information of the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan, more than 125 million tons of municipal solid waste (hereinafter referred to as MSW) are accumulated in Kazakhstan, and annually 4.5-5 million tonnes of MSW are generated, the rate of MSW processing reaches up to 15.8%.

The main reasons for the significant accumulation of waste are ineffective management, lack of economic incentives for the development of historical and newly generated waste.

According to the World Bank (2017), the main challenges of Kazakhstan in MSW management are:

1. increase in MSW growth and accumulation;
2. inefficient waste collection and transport;
3. Insufficient environmental management of landfills (open dumping);
4. no waste separation;
5. low level of MSW disposal.

Table 3. **Main findings of the World Bank on MSW management**

Category	Main findings
Tariffs	Low tariffs do not cover the full costs of solid waste management. Households pay only 0.33-0.44% of average disposable income, while the internationally accepted norm is ~1-1.5%. The state does not intend to raise tariffs.
Funding	Closing dumps and unsanitary landfills will be expensive. Tariffs cannot cover these costs, the funding is the responsibility of the state. Landfill is a low-cost option for the final disposal of waste and is a frequently used practice. If the fees charged for receiving waste in landfills do not increase significantly, it will be difficult to implement alternative waste management options (with the exception of source-stage separation).
Private sector	The private sector is represented by more than 130 companies operating primarily in waste sorting and recycling. There is a national policy to privatize municipal waste collection facilities to reduce the financial burden on the state budget.
Responsibility of municipal bodies	Collection and dumping of MSW in Kazakhstan is mainly carried out by municipal companies (100% owned by the municipality). Not being a municipal organization, the company will face an increase in costs, since VAT and profit margin must be included in the tariff calculation of the company.

EPR operator LLP is an organization authorized by the Government of the Republic of Kazakhstan responsible for implementing the principle of extended obligations of producers (importers) in Kazakhstan. In accordance with the functions

stipulated by the Environmental Code of the Republic of Kazakhstan, it reimburses the costs of entities that collect, transport, sort and dispose of MSW, eliminate dumps, as well as provide financial support for the development of separate collection of consumption waste. With the support of the EPR operator, 12,196 containers for separate MSW collection were installed in 10 regions of the country, 147 collection points in 8 regions, and 28 specialized vehicles were purchased. 2,321 containers for mercury-containing lamps and chemical food sources were also installed in 11 regions.

In accordance with the Environmental Code of the Republic of Kazakhstan, waste must be sorted before being disposed in landfills. However, there are a number of challenges in this area, such as the lack of a convenient system of waste collection in yards, low public awareness, lack of effective communication between waste processors and the population of the country. In this regard, due to the lack of an effective sorting system, about 160 recycling facilities are forced to purchase almost all major types of waste: paper, transparent glass, plastic, rubber (car tyres), aluminium and tin cans from outside the country. The only things that are not recycled in the country are textiles and food waste. However, it is a question of time.

According to a study (2018) initiated by the National Chamber of Entrepreneurs of the Republic of Kazakhstan „Atameken", the depth of sorting and processing of MSW in 2017 varied from 0.23% in Pavlodar region to 24.77% in Almaty region, in Atyrau region sorting was performed with a depth of 44.33%. The average sorting value for all regions and cities of Nur-Sultan and Almaty cities was 8.67%.

With the participation of the EPR operator, a car recycling system has been created, which allows to solve several problems at once: the withdrawal of outdated vehicles that are harmful to the environment, human life and safety from the domestic car fleet; formation of the necessary incentive for the development of the auto-recycling industry; creating an additional contribution to the development of the national automotive industry and one of the important aspects is the reuse of the obtained raw materials. High-tech plant built in Karaganda region with the ability to get up to 90% of components extracted from vehicles.

In order to solve existing problems related to MSW pollution and effective MSW management, the following measures should be taken:

1. use of standard methods and techniques such as planning, subsidies, design, etc.;
2. use of innovative solutions, such as payments for ecosystem services, geoinformation systems, etc.;
3. implementation of a regional waste management approach across the entire technological network from separate collection at the source to MSW disposal in landfills;
4. application of a particular waste management model should be complemented by behavioural changes in society;
5. introduction of economic incentive measures, tax incentives for goods obtained by recycling waste.

Industrial waste

About 31.6 billion tonnes of industrial waste have accumulated in the country. About 1 billion tonnes are generated each year. According to the information of the Ministry of Ecology, Geology and Natural Resources, the main share is formed by technogenic mineral formations (TMF), including overburden rock and ash slag (70% of the total amount), waste from manufacturing industry (10% of the total amount) and other activities (20%). The share of recycled and disposed industrial waste for the 3rd quarter of 2020 is 29.7%.

The implemented reform of legislation in the field of industrial waste management complies with international best practice and the principles of the circular economy. The new edition of the Environmental Code of RK[13] defines the main approaches of the circular economy, taking into account the modern waste management model proposed by the EU in the 5-R concept, which is a hierarchy of stages and forms of management of used and waste products, taking into account the priorities of the circular economy:

1) Refuse+Reduce - waste prevention (a set of measures to reduce the amount of waste produced);

2) Reuse+Repair - reuse (secondary use of items without recycling);

3) Recycle - recycling (turning waste into secondary raw materials for reuse);

4) Rot - composting, recovery (incineration with generating energy, biogas collection in landfills, etc.);

5) Disposal - disposal (landfill and incineration without generating energy).

In accordance with the Environmental Code of RK, certain types of waste in the waste classifier can be defined at the same time as hazardous and non-hazardous with assignment of different codes („mirror“ types of waste) depending on the concentration levels of hazardous substances contained in them or the degree of influence of hazardous characteristics of the type of waste on the life and (or) health of people and the environment. Thus, the large part of the waste can become a raw material for other sectors of the economy.

In addition, the development of waste reduction and minimization can lead to the introduction of BAT principles that integrate the technological, environmental and economic aspects of the methods and equipment used.

The BAT mechanism, including technology standardization and integrated environmental permits, if the state properly applies it, can act in the direction of reducing the minimum quality level of minerals at which its industrial processing will remain economically viable. The same effect can be achieved with regard to increasing the comprehensiveness of the use of natural or technogenic minerals. In world practice, for example, mining and milling wastes, metal ores and mining and chemical raw materials, waste of metallurgical production have significant potential for the recovery of rare earth metals. Waste from mining facilities is an important

[13] The EIB in the circular economy – European Investment Bank [Electronic resource]. - Access mode: www.eib.org/attachments/circular_economy_en.pdf.

source of raw materials in the construction industry for the production of crushed stone, cement and ceramic wall materials, and most of the overburden rocks from iron ore deposits are also suitable.

From the waste left after the incineration of coal, some states produce up to 20 kg of gold from 100,000 tons of ash. In Germany, waste ash from CHP plants is an excellent material for the production of concrete (concrete without ash is no longer produced there). In Poland ash slags are used for the production of construction materials and cement, for road construction and mining. For example, the Indian authorities have obliged builders undertaking their projects near CHP plants to use ash slag materials in their work. In China ash is used to make burned bricks, expanded clay, concrete and cement additives, fertilizer for agriculture, and ash is used for land improvement. Approximately 15% of the waste is used for mine filling. Products based on ash slags for Kazakhstani thermal power plants are a source of investment for technical re-equipment. Despite the obvious benefits and prospects of wide application of ash slag waste, the volume of their use in our country does not exceed 10%, and ash slag utilization requires solving a set of issues, such as development of technical specifications for their use, technological lines for their processing, transport and loading and unloading means[14].

Waste from the chemical industry can be used in agriculture, for example, phosphogypsum waste is an effective ameliorant. Phosphogypsum is very valuable in practical terms for maintaining favourable physical, chemical and biological soil properties. Its composition contains useful substances such as calcium and sulphur, which increases crop yields.

The inclusion of industrial waste in the circular process and its subsequent reduction requires the involvement of all line ministries, local executive bodies. These examples speak for themselves.

Medical waste

An evaluation of waste level data from around the world indicates that hospitals produce around 0.5 kg of waste per hospital bed daily. However, this amount and the basic composition of waste varies greatly according to local conditions. For example, high income countries produce much more waste and plastic, which often accounts for more than half of all medical waste. Because of this huge difference, there is no single best solution for medical waste management.

However, in reality, there is a huge amount of medical waste around the world, including waste generated as a result of the pandemic, either improperly treated with inappropriate technologies or not treated at all.

Medical waste is thought to generate around 2% of total consumption waste annually in Kazakhstan. Waste from medical facilities presents significant epidemiological and environmental hazards. Problems in the area of medical waste management are raised in the media by residents, where spontaneous dumps of

[14] Koptev D. Ecological paradox of fossil fuels [Electronic resource] / Independent military review [Electronic resource]. - Access mode: https://nvo.ng.ru/ng_energiya/2020-10-12.

medical waste have been found, even in the courtyards of houses. Around three tons of test tubes and syringes containing the blood of coronavirus patients were found in the suburbs of Nur-Sultan city[15]. The situation in Kazakhstan is complicated by the fact that control in the field of ensuring national biological safety and environmental conservation is „somewhat relaxed". There are no unified approaches, requirements or even tariffs for implementing this activity. As a consequence, health care facilities can choose contractors to provide services according to tenders and quotations, whereby tariffs for these services differ for different types of waste: the higher the hazard class, the higher the cost. This provides a wide field of manoeuvre, for example, particularly hazardous types of waste can be written off to mutual satisfaction as „non-hazardous" or „less hazardous" in order to reduce the overall cost. This situation demonstrates a lack of legislation and approaches to medical waste management, which needs to be seriously reformed.

The problem of environmental pollution by medical waste in the modern world is solved by introducing innovative technologies for the decontamination of hazardous medical waste. The World Health Organization (WHO) calls on all countries for the safe management of medical waste and opposes its incineration on the territory of health care facilities, but in specialized landfills or in innovative installations.

The United Nations Environment Programme (UNEP) International Environmental Technology Centre (IETC) located in Osaka, Japan, has produced the Handbook of medical waste recycling/disposal technologies, a scientific and practical publication covering all aspects of medical waste.

Persistent organic pollutants

There is no production of persistent organic pollutants (hereinafter - POPs) in Kazakhstan. The main sources of pollution are outdated and unusable pesticides, including pesticides with POPs properties. In agriculture, POPs-containing equipment, and in industry, use of technologies leading to unintentional emission of dioxins and furans (formed in the process of open combustion).

The problem of outdated and unusable pesticides and their chemical identification is acute in the agricultural sector of the country. 4,100 litres of outdated, banned, unusable pesticides, 3,700 tonnes of landfilled pesticides, 13,500 pieces of pesticide containers are in warehouses and storage facilities of the country. Some of them are stored in inappropriate and dilapidated facilities without proper order. Only 20% of pesticides with POPs properties are inventoried in the country. Previously landfilled pesticides also need to be retrieved and destroyed. Soil contamination by pesticide wastes belonging to POPs is numerous, which will require large clean-up efforts in areas contaminated by pesticides with POPs properties.

[15] Several tons of tubes and syringes with blood were found near Nur-Sultan [Electronic resource] / Times.kz, October 27, 2020. [Electronic resource]. - Access mode: https://timeskz.kz/76083-neskolko-tonn-probirok-i-shpricov-s-krovyu-nashli-pod-nur-sultanom.html.

Polychlorodiphenyls

There are no stocks of pure polychlorodiphenyls and oils on their basis (sovol, sovtol, etc.) in the Republic. Polychlorodiphenyls (hereinafter referred to as PCBs) were used in industrial production from 1968 to 1990 at the Ust-Kamenogorsk Capacitor Plant (UKKZ) as a liquid for filling capacitors. The problem is PCB-containing equipment and PCB-polluted territories. Currently there are about 40,300 PCB-containing oil transformers and PCB-polluted capacitors in Kazakhstan. In the case of depressurization as it reaches the end of its useful life, the equipment represents a potential hazard to workers. In addition, 9 areas have been identified in Kazakhstan that are polluted with PCBs to varying degrees. The Republic of Kazakhstan ranks second among Eastern and Central European countries in terms of POPs waste stocks after the Russian Federation[16]. Trichlorodiphenyl residues at the Ust-Kamenogorsk Capacitor Plant and production wastes after the banning of PCB use in production in 1990 were landfilled in a storage pond at the plant, together with the removed heavily polluted soil in the area of the plant. Thus, the UKCZ storage pond is currently one of the most dangerous pollutants of air and especially of groundwater, as the storage pond has no screening layer on the bottom.

PCB-containing materials can be divided into two categories: equipment (transformers, capacitors) and PCB-polluted soil and subsoil. There are different destruction technologies for each category. At present, several methods of recycling various types of PCB-containing materials have been developed and successfully applied all over the world that allow destroying hazardous highly toxic polychlorinated or polyfluorinated hydrocarbons and rehabilitating polluted areas without the threat of secondary formation of highly toxic dioxins and furans.

Analysis of international experience has indicated that all technologies for neutralization of POPs wastes can be divided into three groups: thermal, chemical and biological. It has been established that the most universal is the technology of hazardous waste incineration in furnaces. However, this method is expensive because of the high demands on furnace design, technological process and flue gas cleaning system, and when the temperature drops during the decomposition of organochlorine products, highly toxic dioxins can be produced. The chemical decomposition of polychlorodiphenyls is of interest, which involves oxidation, reduction, dechlorination, hydrogenation, thermal decomposition and other chemical processes, producing harmless compounds like methane, carbon monoxide, water and hydrogen chloride or sodium chloride, seldom hydrocarbons. These technologies are mostly suitable only for clean POPs or heavily polluted soils. Unfortunately, it is impossible to destroy PCB-polluted equipment, such as capacitors, polluted pipes or concrete[17].

Biological methods are of great interest and are a promising area, as they allow for the disposal of PCBs without high temperatures and harmful emissions. The main

[16] Guidelines for the identification of PCBs and materials containing PCBs. UNEP, Geneva, p.199, 34.

[17] Beybitova A.D. Inventory of PCB-containing equipment in the Republic of Kazakhstan. Report at the Second Seminar of UNPD/GEF in the framework of project „Initial Assistance to Republic of Kazakhstan for fulfillment of obligations under Stockholm Convention on persistent organic pollutants“ UNDP, Astana, 2005, p.5.

area of bioremediation is polluted soils, while it is possible to decompose PCBs by microorganisms directly at the site of pollution, which saves money due to the fact that there is no need to remove polluted soil, transport it to the disposal site.

Another promising area is the plasma chemical decomposition of wastes containing PCBs. The use of high plasma temperature (1200-3000°C) leads to the complete decomposition of polychlorodiphenyls to methane or carbon monoxide, water and hydrogen chloride. There are several varieties of plasmatrons that are intended for destroying different types of waste: solid or liquid[18].

The Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan plans to receive free of charge facilities for the destruction of hazardous waste in 2021 as part of a UNIDO project, in order to fulfil Kazakhstan's obligations under the Convention.

The Republic of Kazakhstan signed the Stockholm Convention on POPs on May 23, 2001, ratified it by the Act of the Republic of Kazakhstan of June 7, 2007 No. 259 „On Ratification of the Stockholm Convention on Persistent Organic Pollutants" and became a Party to the Convention on September 9, 2007. The main objective of the convention is the restriction or elimination of the production and use of all intentionally produced POPs (i.e. chemicals and pesticides), the gradual minimization and, if possible, the eventual elimination of emissions of unintentionally produced POPs such as dioxins and furans. The use of equipment containing PCBs is permitted until 2025. Destruction of PCBs and such equipment is foreseen until 2028. The Conference of the Parties reviews the destruction process every 5 years.

Legislation adopted in the field of production and consumption waste management makes it possible to include waste in the circulation. This requires an inventory of the industrial wastes that can be used, identification of the branches of the economy to which they will be directed in the form of raw materials (fertilisers), development of building regulations and sanitary and epidemiological requirements, and other regulations. It is also necessary to maintain requirements for the inclusion of goods obtained from secondary raw materials for public „green" procurement, to establish an inter-ministerial commission on circular economy under the Government of the Republic of Kazakhstan. A moratorium on the extraction of common minerals should be established in order to conserve resources. An important aspect for a successful transition to the principles of a circular economy are measures of economic incentives, establishment of preferential taxation and subsidies for companies of closed value chain to minimise prices of recycled products and raw materials obtained from processing; indirect measures to create institutional conditions and change behaviour patterns not only of producers but also consumers in favour of choosing environmentally clean and safe products suitable for recycling.

Development of sustainable and efficient organic agriculture

Given the growing demand for organic products in European countries and the USA, organic agriculture could be one of the attractive sectors for Kazakhstan

[18] Krapivina S.A. Plasma-chemical technological processes, Leningrad: Chemistry, 1981.

(OECD, 2015). Organic farming is regulated by the Law on Organic Production. Kazakhstan has great potential in developing organic agricultural production due to the availability of significant land, natural resources and traditional farming culture without the use of synthetic fertilizers and pesticides. At present, there are no official data on the production of organic products and farms engaged in organic farming. However, according to the Food and Agriculture Organization (FAO), there are 29 producers and 19 processing facilities on the market, mainly in Akmola, Almaty and Kostanay regions.

Lack of standardization, certification, management systems and labelling requirements currently restricts the development of domestic and export markets of organic products. However, there are several active international certification bodies on the market, and some private companies are also developing such systems (FAO, 2016).

Table 4. **The main advantages and challenges of of the transition to organic farming**

Advantages	Challenges
The possibility of selling organic products at a higher price.	Increasing competition in the domestic market after accession to the World Trade Organization.
Increasing competitiveness through improved quality.	Low access to funding.
Export potential due to increased demand for organic products from foreign markets.	Low sustainability of the agricultural sector due to the high level of debt burden on farms.
Using a wide range of leguminous crops in crop rotations, which allows to solve the problem of forage and maintain nitrogen levels in the soil.	Lack of technology and experience in production and processing of organic products.
More rational use of labor and increased profits of facilities.	Psychological difficulties of the transition to new farming methods after many years of traditional farming.
Environmental and health care.	Due to the fact that organic farming is more complex than traditional agriculture, there is a high probability that the farmer can be wrong by significantly reducing crop yields, increasing disease incidence, leading to weed and pest infestations.
High cost of mineral fertilizers and pesticides.	Low level of information and knowledge of organic farming methods and approaches.

	Additional certification costs. A ban on the use of synthetic preservatives in food could significantly reduce its period of use.

Conclusion

The modern global economic system is largely a linear economy. The transition to a circular economy will allow reorienting towards maximum savings in the value of products, materials and resources (returning them after use into the production cycle) and a minimum amount of waste and polluting emissions generated in the process. Cyclicality allows the economy to become more sustainable and competitive.

The development of a circular economy should be phased in with short, medium and long-term measures, as currently the country has not developed a base of best available techniques, infrastructure and institutional environment for a rapid and qualitative transition to a circular economy.

Kazakhstan has great potential and the necessary tools to develop a circular economy, which will create conditions for the development of innovative entrepreneurship - „green“ business. The circular economy can develop independently of the economic growth and the volume of natural resources. This is achieved through the optimal use of available funds and assets, materials and reserves, i.e. by reducing the consumption of raw materials and reducing the amount of waste generated.

The circular economy strategy for Almaty city and region is given as an example[19]. The Strategy project was developed by Emerging Markets Sustainability Dialogues (EMSD), the Mayor's office of Almaty city, some individuals and legal entities who worked on the report as consultants, as well as interviewed seminar participants and experts. The strategic directions for creating a circular economy and the tools for their implementation are explored. Opportunities of closing of the loop in agriculture through the use of renewable materials between the food and agriculture cluster are reviewed. It is considered how the principles of circular economy will be implemented in these sectors of the city and region. It is suggested to develop the principles of passive design and engineering, combining traditional and modern architecture in construction. The industry assumes reuse of goods and materials.

In implementation of a future circular economy strategy organic waste generated by agriculture and the food industry in the production and processing of food, as well as by households, can be collected and used for recovery of soil, production of new food products or alternative packaging materials.

[19] Metabolic analysis and circular economy strategies for Almaty, Kazakhstan [Electronic resource]. shifting paradigms, 5 July 2019. [Electronic resource]. – Access mode: www.shiftingparadigms.nl/projects/almaty

Kazakhstan seeks to strengthen its food security and import substitution through local food products. The use of available organic resources, including waste, will enable Almaty city to produce domestically what is currently being imported. The commercial viability of this approach is that local products have a competitive advantage over imported products due to lower transportation costs. Innovations starting from hydroponic cultivation of tomatoes and cucumbers in greenhouses heated with gas to the use of poultry dung and straw to grow mushrooms already demonstrate the high potential of using waste and more resource-efficient production methods.

The national government is supporting Almaty city to double its agricultural and processing capacity, and additional facilities will generate even more organic waste by 2020. The material needs of new farms and factories should be mapped and coordinated with future waste streams from third parties within and outside the sector. Only in this case the agricultural cluster will be able to function as a system initially designed for resource efficiency. Additionally, by making optimum use of natural processes at farm level, the need for synthetic materials can be minimized. Production (industrial) symbiosis is the concept that allows linking the waste streams of one company to the resource needs of another. If there is no direct demand for specific organic materials, they can be recycled into biodegradable packaging materials, biofuels and/or substances for soil enrichment. When working within an integrated cluster, ensuring short- and long-term profits becomes a common and mutually beneficial goal for farms and food processing facilities. Composting food processing residues to produce soil improvers and/or forming organic fibres from farms into packaging materials are examples of how farms and processing facilities can mutually beneficial add value.

Part of the materials for new buildings, when introducing circular economy methods in the construction sector, can be provided by demolished buildings and existing buildings can be preserved and used as long as possible, so that their demolition becomes the most extreme measure and is resorted to last. Where new and additional building materials are needed, the city's growth can be secured through the use of secondary raw materials, and adaptive and modular construction methods can be favoured in tenders. This approach will stimulate design and construction companies to develop and implement projects with the lowest environmental impact throughout the life cycle of buildings. The construction industry is characterized by a significant carbon footprint. Most „industry" greenhouse gases are emitted to the atmosphere outside Almaty city from cement kilns and blast furnaces in the production of building materials. As the city grows, new construction is inevitable. Sustainable building methods and materials can help reduce the carbon footprint arising from urban expansion and the necessity to meet the needs of a growing urban population. The use of secondary raw materials (e.g. wood) will not only contribute to a more pleasant living space, but may also turn the urban environment into a net carbon sink.

With the implementation of circular economy principles in Almaty's industrial sector, companies can retain ownership and take responsibility for their goods

throughout their lifecycle, maintaining the maximum duration and convenience of their operation, including through scheduled maintenance, energy efficiency and reuse and/or recycling after their end of life. The last phase of the „life" of goods may not be their removal to landfills in the form of waste, but rather recycling, and only if the cost of the full configuration of a particular product is less than the cost of its components. Industrial facilities in Almaty city recycle around 113 thousand tonnes of materials (or 13% of all solid waste produced). In addition to reducing the demand for raw materials, it will allow avoiding the generation of about 173 thousand tonnes of CO_2-equivalent emissions.

At present, citizens, unfortunately, rarely see the results of their efforts on separate collection of household waste. Obtaining permits for communities and workshops to produce their own goods or create materials from secondary resources, recycle them and/or change their functional purpose is getting more and more widespread and is attracting interest among the population. Special labelling is proposed for goods made from recycled materials.

Almaty's transition to more circular and low-carbon development principles will open up new horizons for the food industry, production and the construction sector. Other sectors can play an important role in this process. The government sector itself can be another positive factor and instrument for the implementation of business models based on the principles of the circular economy. The country's government can, for example, take active steps to improve resource efficiency, potentially coordinating relevant measures with targeted policy initiatives in the EU and China. Both government revenue, especially taxes, and costs should be consistent with national sustainability goals. Revenues from environmental taxes can, for example, be used to reduce labour taxes. Often business models built according to circular economy methods are labour-intensive. Reducing the labour tax could facilitate their introduction, and at the same time encourage the use of domestic rather than imported resources.

Implementing circular economy strategies often requires innovative financial approaches. Service models, for example, imply larger primary financing compared to business models, where the sale of goods is the main source of income. And yet service models are not new to the financial sector - usually the bank experts working in other sectors have the necessary knowledge and skills. Research institutions of Almaty city have already contributed to the restoration of the Aral Sea and the development of competitive and sustainable brands, including in the dairy sector. In the process of developing an agricultural cluster based on the principles of the circular economy, scientists can help to develop compost with the right balance of carbon and bound nitrogen, and support the industry in introducing the principles of production symbiosis and initial resource efficiency design.

The field of education offers society fundamental tools and cognitive models that future generations will be able to apply to address the challenges of the next decades. Schools and universities are already promoting young people's awareness of environmental issues and circular methods of solving them by deploying equipment to recycle plastics of their own manufacture, participating in UNDP's e-waste

initiatives and teaching children about the „Doughnut Economy“. Simple ‘household’ kits for growing mushrooms on coffee press cake in your kitchen are a good way of demonstrating the value of organic waste, and children’s playgrounds made from secondary raw materials prove that rubbish and waste can be turned into children’s joy.

The Draft Opportunity Strategy for the introduction of a circular economy in Almaty city clearly demonstrates the benefits and opportunities of the circular economy.

It should be noted that the implementation of circular economy principles affects all areas of the economy. A consolidated policy is needed for this. As noted above, many countries have adopted specific strategies for the transition to circular economy. For Kazakhstan, the adoption of such a document would exclude the adoption of particular documents on environmental impact reduction, in this case the development of the Waste Management Programme. Since the development of this direction requires serious financial costs.

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Chapter 7

RENEWABLE ENERGY SOURCES

7.1 Relevance

The whole world around rapidly moves towards the renewable energy sources (hereinafter - RES), that is, clean, and theoretically inexhaustible environmental energy sources. This process is represented in the 17 global Sustainable Development Goals (SDGs) of the UN as Goal No.7 „Ensure universal access to affordable, reliable, sustainable and modern energy sources.“ This goal includes three objectives by 2030: ensure universal access to affordable, reliable and modern power supply; significantly increase the share of renewable sources in the global energy balance; double the global energy efficiency rate (energy savings).

That is caused with the negative climatic changes on the planet, related by the most experts with greenhouse gas emissions, primarily CO_2, that is combustion of traditional hydrocarbon fuels - coal, oil, gas. Based on the UN, „energy is the dominant driver of climate change, contributing about 60 percent of total global greenhouse gas emissions“[1]. Toxic combustion emissions are also harmful for the health. For example, „air pollution from cooking and heating using combustible fuel claimed 4.3 million lives in 2012“[2].

Carbon dioxide, methane, water vapor, nitrogen oxides and other greenhouse gases coming to the atmosphere prevent the solar heat dissipation into outer space, disturbing the established temperature balance and creating greenhouse effect, therefore causing the slow but sure warming of the planet. In August 2021, the UN's Intergovernmental Panel on Climate Change (IPCC) presented a comprehensive and disturbing report on global warming and Earth's climate change.[3] The conclusions are extremely disappointing: the climate is subject to irreversible changes that have not happened for hundreds of thousands of years, and largely due to anthropogenic impact. Experts say that optimistic forecasts have not come true, and the planet is warming up faster than they predict a decade ago. Upon the data report, the average temperature of the Earth will continue to rise, and even the largest reduction of carbon dioxide emissions will not reach the Paris Climate Agreement goals, the main goal of which is to prevent the average annual temperature on the planet from exceeding the industrial level by 2°C by 2100 and do all the best to keep warming within 1.5°C. „The average temperature may rise by more than 2°C by the end of the century if no immediate and dramatic reduction in emissions are reached“ – has been stated in the document.

„But carbon, as the basis of life, existed on the planet before?“ - you can say, and you will be right. However, in prehistoric time, it was actively assimilated from

1 Sustainable development objectives UN, ЦУР 7 [Electronic resource]. – Access mode: https://www.un.org/sustainabledevelopment/ru/energy/.

2 Ibid. p 166.

3 IPCC Sixth Assessment Report „Climate Change 2021 The Physical Science Basis“ [Electronic resource]. - Access mode: www.ipcc.ch/report/ar6/wg1.

the atmosphere by flora (oceans of blue-green algae, huge primeval forests), and then by fauna (all herbivorous and carnivorous animals), thereby assuming to stay in the solid, organic form. All this tremendous organic mass was subsequently buried in the geological sediments and turned into the oil and gas bearing zone lens and coal layers under the high earth's crust pressure. Extracting and burning the mined resources, thereby we return carbon from the depths to the surface, but in the gaseous form unsafe for the climate. This primitive, dirty, but cheap fuel once upon the time made the mankind capable to carry out industrial production and transport revolution and construct modern energy system. Now, when the prospect of global warming threatens the melting of glaciers and freshwater icebergs, flooding of a number of sea countries and desertification of others, the extinction of many species and resettlement of entire peoples, it is time to review our energy approaches and turn to the renewable sources the Sun generously provides our planet with.

Yes, it is the energy of our luminary that is the primary source of the most energy alternatives to fossil fuels. So, wind energy is the transfer of air masses caused by uneven heating of the earth's surface with the sun. The energy of rivers is the same energy of the sun's rays, evaporating the surface of the seas and oceans and thereby creating clouds, which then feed our river flows and rotate the turbines of the hydroelectric power station. The biomass energy as it was said above, is again the radiation of our luminary, which the flora absorbs through the amazing photosynthesis process for its growth and reproduction. Even the radioactive elements for modern nuclear reactors originated in the depths of previous suns completed their life billions of years before the Earth.

The unique role of solar energy in the planet's ecosystem has been realized by the eminent scientists already at the beginning of the twentieth century. Thus, the world-famous sage V. Vernadsky compared the life with a „green fire" on the planet body and special fluid mineral set the sun in motion. Scientist-cosmist A. Chizhevsky numerically linked the activity of our luminary with all processes on the Earth - from accident statistics to massive epidemics, wars and economic cycles. The historian L. Gumilev was looking for the prerequisites for epoch-making events in the cosmic rays „whipping" the planet. Even our distant ancestors, being sun worshipers long before the first world religions, intuitively guessed this important link. Learning to capture effectively and utilize usefully the bottomless ocean of inexhaustible, „green" cosmic energy around us is our challenge and duty as a new generation of people responsible for the future fate of the planet. This chapter is devoted to these new energy technologies.

7.2 Overview of the main types of renewable energy

Conventional energy sources operate with oil, natural gas and coal. After combustion, carbon dioxide is released to the air, causing the growth of greenhouse effect and global warming. This has become the main reason to search for the alternative energy sources. An alternative energy source is a renewable source potential to replace the conventional ones.

Based on the Law of the Republic of Kazakhstan to support the renewable energy sources, the renewable energy sources mean the sources that are continuously renewable due to naturally occurring natural processes, including the following: solar radiation energy, wind energy, hydrodynamic water energy; geothermal energy: heat from soil, groundwater, rivers, water reservoirs, as well as biomass, biogas and other fuel of organic waste used to generate power or heat.

Alternative or renewable energy sources have been quite important to human being since the beginning of civilization. For centuries in various ways biomass has been used for heating, cooking, steam production, and power generation. Energy of water and wind was used for transportation, and later for power production.

Renewable energy sources typically depend on the energy flows passing through the Earth's ecosystem, solar radiation and the Earth's geothermal energy. The following types of renewable energy sources can be distinguished:

- biomass energy;
- wind energy;
- direct solar energy;
- hydropower (river energy);
- geothermal energy.

Let's take a look at the three most popular ones today.

Biomass energy

The Earth's surface gets solar energy at the rate of 3.8 × 1024 J annually that is equivalent to about 120,000 TW of power. Less than 0.1% of this energy is converted to the plant by photosynthesis, and yet this tiny percentage is more than six times of total energy consumed by humans annually. The term „biomass" is used to describe energetically valuable organic matter. Mineral fuel contains the energy of ancient vegetable material, but unlike biomass, mineral fuel is not renewable. Thus, the terms „biomass" and „biofuel" usually exclude mineral fuel. Another important advantage of biofuel over the mineral fuel is that it almost does not pollute the atmosphere with carbon dioxide, since biomass while growing removes much more carbon dioxide from the atmosphere than it is released during combustion. In this context, biofuel would be described as carbon neutral or negative throughout its life cycle.

From the other hand, it mainly consists of primitive fuels such as wood and dung, the world's population has been used for heating and cooking for a long time. In fact, in some developing countries, firewood makes 96% of their total energy consumption. Therefore, with such use, biofuel can hardly be called renewable and can be even hazardous for environment, as trees usually turn into firewood without replanting.

Two modern biofuels are bioethanol and biodiesel, which are produced using edible crops such as corn, sugarcane or sugar beet. Since 1975, bioethanol production has dramatically increased, reaching recently over 100 billion liters annually. About 90% of all bioethanol in the world is produced in two countries: Brazil and the United States, whereas the most of the world's biodiesel is produced in the European Union (EU).

Biomass energy can be produced and utilized in various ways shown in the figure below.

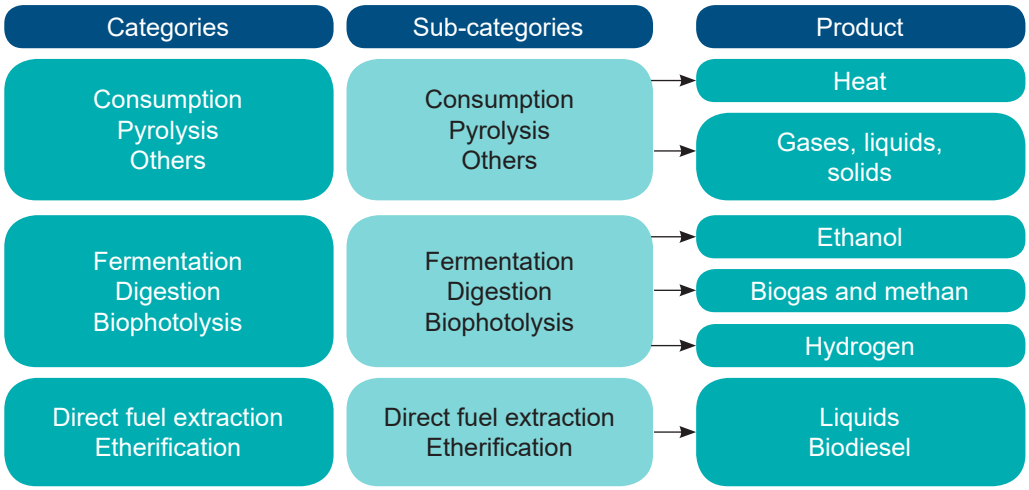

Figure 1. **Categories of biofuel production processes**

Most biofuel is used in the transport sector, where it can offset a certain rate of oil consumption, either as an additive to gasoline or diesel, or in some cases as substitute in adapted engines. Biodiesel and bioethanol currently make just under 3% of the fuels used for road transport globally, whereas the International Energy Agency estimated that it could provide more than 25% of global demand by 2050 (EIA, 2011).

Thus, the use of biofuels is growing rapidly and is expected to continue in the future.

7.3 Wind energy

Wind energy means the kinetic energy of moving air. The energetic wind appears in course of uneven atmosphere heating by the sun, unevenness of the earth's surface and Earth rotation. Wind speed determines the amount of kinetic energy can be converted into mechanical energy or power. Wind is one of the oldest energy forms used by humans. Evidence of the wind use for agricultural purposes comes back to around the 7th century BC and has been found in the Middle East and Asia. Mechanical wind power has been historically used to grind the grain and pump the water, but today it is essential for the „wind turbines" operations that generate power.

The global resource of the wind energy is huge indeed, but most of the wind energy is difficult to obtain, since it is located far out in the sea or at high altitudes, where strong winds blow constantly. The technically available volume has been estimated at about 300 million GWh per year that is about 20 times the current power demand.

The average wind speed varies greatly depending on location, and the winds strength is even more dependent on space and time. Figure 2 shows the global wind resources. It is shown that regions with high potential (about 9 m/s) are located in the middle and high latitudes, as well as in the region of huge plains and deserts of the central part of North America, Russia, Central Asia and North Africa (about 6 m/s). The wind speed necessary to generate the power shall be between 3 m/s to 15 m/s.

As of 2021, 743 GW of wind power capacity has been installed worldwide. This avoids over 1.1 billion tones of CO_2 emissions equivalent to the annual carbon emissions of all South America. In Denmark, this figure has already reached 49% - the highest rate in the world. The top five countries in terms of installed wind power capacity are China, the United States, Germany, Spain and India, where there is 82% of the world's total scope together [4].

Direct solar energy

The sun radiates a power flux equivalent to 4·10kW [23] to the surrounding space. The area of the Earth's surface irradiated by the Sun is about 5·10km^2. [8] The solar radiation flux reaching the Earth, by the scientists, is up to 1,2·10kW that significantly exceeds the resources of all other energy sources, for instance the total capacity of all power plants in Kazakhstan exceeds 20,000,000 kW)[14]. Thus, thanks to our luminary, we live in the ocean of energy, and we do not face any shortage of it even in the remotest future. They believe that the world's energy needs could be completely covered by using only 0.5% of the Sun's energy.

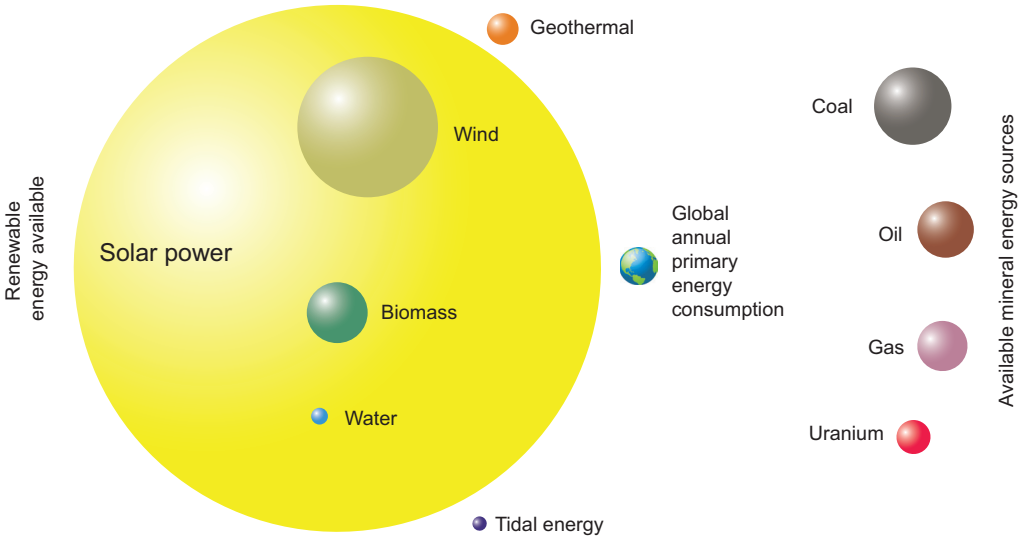

Figure 2. **Side-by-side comparison of**

[4] Global wind report GWEC for 2021 [Electronic resource]. – Access mode: https://gwec.net/global-wind-report-2021/.

Solar energy is used in everyday life by means of solar thermal and electrical installations. There are also tower and parabolic solar concentrators (CSPs) for the industrial solar turbine steam generation. Currently, in the world and in Kazakhstan, two types of solar installations are the most popular:

- solar collectors to heat the water;
- photoelectric or photovoltaic - PV panels.

The familiar PV batteries represent the method of direct conversion of solar energy to the electrical energy using the photovoltaic effect. It means that light coming to the semiconductor silicon material generates an electric current. The size of the typical modern monocrystalline solar panel is 1x2 meters, its efficiency is over 20% and output power is over 400W.

The solar energy trap is capable to convert the solar radiation into hot water, and thereby replace electrical and stove heating. Unlike photoelectric panels, the optical efficiency of solar energy trap exceeds 90%. Such a panel of $2m^2$ area placed in the southern latitude of Kazakhstan generates up to 2000 kWh of clean heat energy annually. In the shinny day, it is heated up to over 100°C, providing up to 150 liters of hot water daily or heating support for up to $15m^2$ of the floor area.

7.4 Renewable Energy Capabilities in Kazakhstan

In view of the global paradigm changes of hydrocarbon energy in favor of renewable energy sources, individual specialization of developed and developing countries can be noted that seek to occupy a leading place in the specific technologies corresponding to their climatic, scientific and technical capabilities. Thus, Denmark has obtained the leading status in scope of wind energy, Brazil - in biofuels, China is the photovoltaic leader, Spain was the first to test and implement the tower-type solar concentrator technology. Last century Israel introduced requirements to use hot water collectors, the UAE is actively promoting the solar cooling concept, India is majoring in the agricultural solar solutions.

The steppe wides of Kazakhstan are traditionally associated with the sun and wind. Each of these resources is theoretically capable of more than covering all the country's needs for clean energy. The power engineers of the future shall realize the colossal capabilities of clean energy in our country. The Ministry of Energy of the Republic of Kazakhstan estimates the total national capabilities of the renewable energy sources as follows:

- wind energy - 920 billion kWh/year;
- hydro capabilities - 62 billion kWh/year;
- solar energy - 2.5 billion kWh/year;
- thermal capabilities of geothermal waters - 4.3 GW.

Capabilities of these energy sources will be reviewed in more detail later.

Wind capabilities of Kazakhstan

The wind speed necessary to generate power by the modern blade turbines shall be in the range of 3 m/s to 25 m/s. Wind speed of 14 m/s is deemed as optimal

one for generation. Many areas on the Earth are not suitable for wind turbines, but significant part of the Earth's surface is described with an average annual wind speed exceeding 4.5 m/s, when wind energy is commercially profitable.

It is a challenging task to assess the wind resources of specific area demanding the extensive data. In general, capabilities of the wind power generation depends on the following four factors:

- latitude and prevailing wind conditions;
- relief and height;
- reservoirs;
- vegetation and building development.

Kazakhstan has rich resources necessary for the wind energy development as well as the free land for the wind farms construction. Based on the concept of the fuel and energy complex development in the Republic of Kazakhstan until 2030, the wind capabilities of Kazakhstan take 1,820 billion kWh annually. As part of the initiative to develop the wind energy market in Kazakhstan, a wind atlas of Kazakhstan has been developed and the wind potential in various regions of the Republic of Kazakhstan has been studied, annual wind measurements have been carried out at 15 sites. The values of the long-term average wind speeds at the altitude of 80 m from the earth's surface with 9 km resolution for most regions and 100 m for nine particularly promising regions have been shown in the atlas. Weak wind areas are marked in green, stronger wind areas are in red. Stronger speed periods have not been included. Studies have shown that wind speeds in the republic are higher in the period from December to January.

According to the wind atlas, high wind potential areas (7-8 m/s) cover about 50,000 km^2 and they are located in 9 out of 14 regions of Kazakhstan. The wind speed is 4-5 m/s at 30 m altitude in about 50% of the territory of Kazakhstan. The highest wind potential is noted in the Caspian Sea region - Atyrau and Mangistau regions, as well as in the North and South Kazakhstan. Based on the concept of fuel and energy complex development in the Republic of Kazakhstan till 2030, the wind potential of Kazakhstan is 1,820 billion kWh per year. The lowest capabilities for the wind power farms are in the eastern regions of Kazakhstan, where average wind speed is 5 m/s.

Wind capabilities of the three most favorable regions of Kazakhstan are presented in the Table 1 (Af-Mercados EMI, 2013).

Table 1. **Wind energy generation capabilities in the Republic of Kazakhstan**

Transmission network region	Capabilities of RES (MW)
Western	2200
Northern	11878
South	3162
Total	**17240**

In view of the country's wind energy capabilities and growing power demand, the Ministry of Energy and Mineral Resources of Kazakhstan, supported with the United Nations Development Program, has developed a wind power plants development program. Based on this program, as well as a number of other initiatives, the government has identified the actions and targets necessary to develop the national wind energy in the period from 2015 to 2030, therefore it is planned to construct wind turbines of total capacity up to 2,000 MW by 2030.

After successful implementation of this program, the volume of wind power will make up to 5 TWh by 2030. Favorable conditions for the successful implementation of the wind energy projects in Kazakhstan are determined by the proximity of existing transmission networks to the areas of high wind potential and presence of the clear correlation between the wind seasonality and peak electricity demand periods in wintertime.

Implementation of the wind energy projects in the southern regions of the country can help to resolve the overloading problem of power transmission lines (PTL) connecting the north and south regions of the country with. Although power overproduction is typical for the northern regions, the construction of the wind power plants (WPPs) will enable to decrease the power import from Russia. Power shortage can be also noted in the western (isolated) network sector in the volume of over 100 MW. In this regard, the wind energy projects implementation will also help to decrease the dependence of the west part of the country on Russian imports.

Solar capabilities of Kazakhstan

The unit rate called intensity or insolation is used (measured in kW/m^2 annually) in order to quantify the solar radiation. This is the power of radiant energy per second per square meter of area perpendicular to the sun's rays. While passing the atmosphere, sunlight is attenuated mainly due to some radiation absorption by water vapor, ozone, dust particles and aerosols scattered in the air. On the Earth surface, the solar radiation flux is uneven and reaches maximum of over 2200 kWh/m^2 annually in the equator.

In this regard, Kazakhstan is also located in the favorable zone, where intensity of solar radiation is from 1100 to 1800 kWh/m^2 annually according to the electronic solar atlas.[5] The central location of the country on the continent away from the humid sea air and relative height of its territory above sea level enables the republic to obtain excess solar radiation. The average number of sunshine hours daily ranges from 6.5 to 6.8 hours, and the daily solar insolation ranges from 3.5 to 4.6 kWh/m^2. At the same time, the duration of sunshine in Kazakhstan ranges from 2000 to 3000 hours annually. The southern regions of the country, especially the Aral Sea region and the

[5] Initial data on annual solar irradiation for specific city / region of the country are available from the electronic solar atlas of the Republic of Kazakhstan at www.atlassolar.kz. The Atlas of Solar Resources of Kazakhstan was created within the Project of the Ministry of Energy of the Republic of Kazakhstan and the United Nations Development Program, and includes maps of solar radiation indicators (direct, scattered, total, etc.) necessary to calculate the solar radiation indicators based on the climatic bases of NASA SSE, Sustainable Buildings, SARAH-E.

Kyzylorda region are the most favorable areas for the solar energy use where duration of sunshine hours reaches 3000 annually, whereas maximum values on the Earth are more than 3600 hours annually.

Annual solar energy capabilities of the various regions of Kazakhstan (Methodological guide to SNiP 2.01.01-82 „Construction climatology and geophysics“) are presented in the Table 2.

Table 2. **Annual solar energy capabilities of RK (E)**

Region	E, kWh/m²	Region	E, kWh/m²
Nur Sultan	1302	Almaty	1411
Kostanay	1224	Aktau	1427
Petropavlovsk	1227	Aktyubinsk	1352
Karaganda	1335	Shymkent	1477
Ust Kamenogorsk	1285	Uralsk	1251
Ekibastus	1284	Turkestan	1476
Semey	1373	Taraz	1373
Pavlodar	1307	Kyzylorda	1620
Kokshetau	1227	Taldykurgan	1420

At the same time, Kazakhstan is ahead of many other countries in terms of insolation. Values of horizontal insolation for known world cities and countries in shown in the Table 3 in comparison with similar indicator for different cities of Kazakhstan (Data from the international report Solar Heat Worldwide 2019 and the solar atlas of the Republic of Kazakhstan).

Table 3. **Comparison of the solar capabilities of the regions of the Republic of Kazakhstan and countries all over the world**

City of RK	Insulation (kWh/m², annum)	Similar cities all over the world
Petropavlovsk, Kokshetau	1200 - 1250	Seoul, Tokyo, Bulgaria
Nur-Sultan, Karaganda, Semey, Aktobe	1300 - 1350	Shanghai, Canada, Romania

Atyrau, Aktau	1350 - 1400	Italy, New Zealand
Almaty,Taraz	1450 - 1500	Uruguay, Taiwan
Kyzylorda, Turkestan	1500 - 1550	Greece, Portugal
Shymkent, SKR	1650 - 1800	Australia, Mexico, Turkey

Thus, solar energy supplied to the entire territory of the country is several times higher than the potential of all national resources of oil, gas, coal and uranium for a year.

REFERENCE ON THE CALCULATION METHOD:

A) The annual power generation of the typical PV module of 2m^2 area for southern Kazakhstan is estimated as:

1540 kWh per year per m^2 x 2 m^2 x 0.21 = 647 kWh per year

where 1540 kWh / m^2 is the annual insolation for this region (according to the Solar Atlas of the Republic of Kazakhstan www.atlassolar.kz);
2 m² - area of the typical PV-module with dimensions of 1x2 m;
0.21 - efficiency of the solar module.

B) The annual thermal energy generation of typical solar collector of 2m^2 area for southern Kazakhstan is determined as:

1540 kWh per annum per m^{2}x 2 m^{2}x0.7 = 2,156 kWh per annum

Where 1540 kWh / m^2 is the annual insolation for this region (according to the Solar Atlas of the Republic of Kazakhstan www.atlassolar.kz);
2 m² - the area of a typical flat collector with dimensions of 1x2m;
0.7 - efficiency of the solar collector, subject to losses for the southern region.

C) Planned CO_2 emissions reduction based on the recommended ratio of the European Bank for Reconstruction and Development (0.919 tons of CO_2 per 1 MWh) for Kazakhstan in 2020 will be:

0.65 MW x 0.919 = 0.6 tons of CO_2 per annum for PV panel;
2.15 MW x 0.919 = 1.9 tons of CO_2 per annum for the solar collector.

Hydropower capabilities of the Republic of Kazakhstan

Hydropower is the second largest source of the power generation in Kazakhstan, making about 10.9% of all generating capacity in Kazakhstan, according to data of 2017. In terms of absolute indicators of potential hydro resources, Kazakhstan ranks the third within the CIS countries. The hydraulic power potential of Kazakhstan is estimated at about 170 billion kWh per year, technically feasible is 62 billion kWh.

The hydraulic power of the medium and large rivers is 55 billion kWh, small rivers - 7.6 billion kWh per year. Meanwhile, technically feasible capabilities of the small

hydropower plants is about 8 billion kWh. Waterpower resources are distributed throughout the country, but it is worth noting three particularly large areas among them: the Irtysh river basin with the main tributaries (Bukhtarma, Uba, Ulba, Kurchum, Kalzhyr), the South-Eastern area with the Ili river basin and the Southern area - the Syrdarya, Talas and Chu river basins. According to the figures of 2017, power generation of the small hydropower plants is 649 million kWh.

Capabilities of geothermal waters

Kazakhstan is also potentially rich in geothermal resources. Natural hydro geothermal resources of Kazakhstan with temperature from 40°C to more than 100°C are estimated at 10275 billion m³ in water scope and 680 billion Gcal in heat stock that is equivalent to 97 billion tons of fuel equivalent (ton of equivalent fuel) or 2.8 billion TJ and comparable to the heat resources. For reference: the forecasted hydrocarbon reserves in Kazakhstan are about 12 billion tons of oil and condensate (17.2 billion tons of fuel equivalent) and about 6-8 trillion cubic meters of gas (7-9.2 billion tons of fuel equivalent). The total geological coal reserves and forecasted resources in the republic are estimated to 150 billion tons (101.0 billion tons of fuel equivalent). Geothermal sources are mainly located in Western Kazakhstan - 75.9%, in South Kazakhstan - 15.6% and in Central Kazakhstan - 5.3%. The artesian basins of South and South-East Kazakhstan: Aryssky, Almaty and Zharkentsky are the most promising for the heat-and-power underground waters extraction with mineralization up to 3g/dm3 and temperature up to 70-100°C.

7.5 Main aspects of the RES use in Kazakhstan

The development of the renewable energy sources in Kazakhstan has been commenced after adoption of the PK Law „On Supporting the Use of Renewable Energy Sources“ dated July 4, 2009. In 2013, the Concept for Kazakhstan transition to the „green“ economy was adopted with ambitious goals, based on that the structure of generating capacities shall consist of 50% alternative energy sources by 2050, including nuclear power plants and renewable energy sources. The Government of the Republic of Kazakhstan intends to achieve it via gradual decommissioning of the aging coal plants and their replacement with renewable energy sources, as well as via installation of energy-efficient process equipment and compliance with strict environmental standards. Thus, the Concept of Transition to Green Economy and the Strategic Development Plan of the Republic of Kazakhstan until 2025, approved by the Decree of the President of the Republic of Kazakhstan dated February 15, 2018 No. 636, defines the following strategic goals for the renewable energy development in Kazakhstan:

- 3% of the renewable energy sources share in the total volume of power generation by 2020;
- 10% of renewable energy sources share in the total volume of power generation by 2030 (revised to 15% in 2021);
- 50% share of low-carbon alternative and renewable energy sources.

In addition, in 2016, Kazakhstan signed the Paris Climate Change Agreement and accepted the commitment thereof to decrease the greenhouse gas emissions by 15% by 2030 in regards of 1990 emissions. In December 2020 Head of State Kassym-Jomart Kemelevich Tokayev announced Kazakhstan's intentions at the UN Climate Ambitions Summit to achieve carbon neutrality by 2060. In this regard, target indicators of RES development have been revised in the country's strategic documents, actively involving RES. Among the measures announced to achieve the carbon neutrality by 2060 are the following:

- Implementation of the greenhouse gas emissions regulation by environment restoration by the users of natural resources.
- The need to implement the best available technologies (BAT), the mechanism of which is provided for by the new Environmental Code of the Republic of Kazakhstan in 2021.
- Requirements for the mandatory integrated environmental permit (IEP) from the beginning of 2025.
- Introduction of the clean technologies, designated with the rational use of resources and minimum economically justified emissions.
- Comprehensive technological audit and transfer of 50 major contaminating plants to BAT by 2025.

The first step was the instruction given by the Head of State at the meeting on the power industry development in May 2021, to achieve the renewable energy sources share up to 15% by 2030 in the total energy balance of the country (instead of the previously adopted 10%). To start the renewable energy sources development in Kazakhstan, high feed-in tariffs for „green" energy have been approved for 15 years by the Resolution of the Government of the Republic of Kazakhstan No. 645 dated June 12, 2014. The auction mechanism has been introduced in July 2017, subject to the international experience to replace fixed rates for the renewable energy projects within the annual regional quotas of the country. This would enable, on one hand, to make the process of selecting the projects and investors transparent and clear, and, on the other hand, devoting the more efficient technologies and projects minimizing the tariff impact for the end users upon renewable energy facilities commissioning. Electronic auction international bids of 2018-2020 have been held for renewable energy projects with total capacity of 1,505 MW.

172 companies from 12 countries took part in the auction: Kazakhstan, China, Russia, Turkey, Germany, France, Bulgaria, Italy, UAE, Netherlands, Malaysia, Spain. Upon the auction, 58 companies concluded the contracts with the Accounting and Financial Center (AFC) for 15 years for the total capacity of 1218.77 MW. Therewith, the tariffs reduction for individual projects amounted to 64% for the sun, 30% for wind and 23% for hydroelectric power plants.

The fixed rate mechanism at the initial stage of RES development made it possible to launch the RES market quickly and implement wind and solar energy projects, and the auction mechanism reduced the tariffs of the „green" energy purchase significantly due to competition among the participants. Thus, renewable energy in the country has grown almost 10 times - from 178 MW in 2014 to 1,634.7 MW in 2020.

Currently, there are 120 RES facilities in the Republic with installed capacity of 1806 MW:

- 29 wind power plants, capacity of 511.3 MW;
- 47 solar power plants, capacity of 1031.6 MW;
- 39 hydroelectric power plants, capacity of 255.08 MW;
- 5 bioelectric power plants, capacity of 7.82 MW.

Based on the information of the Ministry of Energy of the Republic of Kazakhstan, power generation by the renewable energy sources in the country by the end of 2020 has been 3.24 billion kWh (wind - 1,076.7 million kWh; solar - 1,349.7 million kWh; hydroelectric power plants - 812.1 million kWh ; biomass stations - 6.6 million kWh).

Thus, the renewable energy targets have been fulfilled for 2020 at the rate of 3% (3.24 billion kWh of the annual volume of 108 billion kWh). Power generation increase by the renewable energy plants is 74% in 2020 versus to the same period of 2019. It was scheduled to commission 22 renewable energy facilities in 2021 with total capacity of 382 MW (5 HPPs - 44.59 MW, 4 SPPs - 76.95 MW, 13 WPPs - 259.65 MW), 6 facilities out of them have been commissioned with total capacity of 171 MW . The total capacity of renewable energy facilities is scheduled to be increased from 1806 MW (120 facilities) to 2015 MW (138 facilities) by the end of 2021.

The renewable energy facilities are placed in the regions subject to the resource potential, power needs, maximum permissible capacities in the zones of the Unified Electric Power System (UES) as well as infrastructure readiness.

Whereas the development of the large grid RES stations is well underway and it is nationally supported but the RES household use by the population is just beginning. The UNDP analysis in Kazakhstan, carried out in 2020, demonstrates the great potential for the use of renewable energy technologies by households, small and medium-sized businesses in terms of Kazakhstan. For example, it is already economically justified to use solar collectors, heat pumps and biomass boilers for hot water supply and heating, both for individual housing and multi-story buildings. So far, we are not talking about competing with the existing central heating networks, however, if we take into account the high wear and tear of the latter and the investments necessary for modernization, the experts can predict a further annual increase in the cost of heat and electricity provided by the central networks.

Quite interesting outcomes have been found while modeling the power distribution network of the Turkestan region: connecting so-called home solar power installations to the electrical network in the regional scale will improve the network reliability as a whole, unload the overloaded nodes and decrease the power losses.

5–10% potential of the households is equivalent to the construction of the large 500–1000 MW CHP plant. Despite the lack of technical barriers to use renewable energy technologies by the population, small and medium-sized businesses, peasant farms, the tariff setting system in the energy sector is the main barrier in Kazakhstan that in general does not motivate both the widespread use of renewable energy technologies and implementation of energy-saving measures in the infrastructure facilities, housing and transport as well.

Summing up, there are several promising areas for the household renewable energy use. Among them, it is worth to note the solar thermal collectors for hot water supply and heating. This is especially relevant for the rural areas where there is no central heating networks (the share of central heating and hot water supply there is 3.7% and 1.9%, respectively).

Concerning the small and medium-sized businesses and peasant farms, the use of renewable energy is relevant already now, since the cost of electricity per 1 kWh for these entities is more expensive than for other categories of consumers.

7.6 Problems and challenges of green energy in Kazakhstan

The climate agenda becomes one of the most important challenges for the energy industry around the world and a new culture for the humankind. Ambitious decarbonization targets, tougher CO_2 emissions regulations, and business focus shifted towards sustainable development will significantly affect the fuel and energy industry of many countries.[6]

Kazakhstan did not stand back and set its targets to achieve the carbon neutrality, consequently ensured the importance of green energy development in the country.

The outcomes of the PwC Kazakhstan study show that the renewable energy sources stimulating mechanisms at the early stage showed their effectiveness - the capacity of renewable energy plants increased from 94 MW (2011) to more than 1800 MW (2020) providing the scheduled 3% share of renewable energy sources in the total electricity portfolio of Kazakhstan.[7] However, there are a number of fundamental issues demanding the systemic solution for the further RES growth.

The experts interviewed in the course of present study identify the following key barriers to the renewable energy sources development in Kazakhstan:

- The need to finalize the legislation in the field of renewable energy.
- Investment risks.
- Lack of reserve capacity.
- Non-competitive rates.
- Lack of microgeneration support.
- Problems of the renewable energy sources integration to the national Grid.

Meanwhile, the experts note that consistent solution of these barriers and further growth of renewable energy sources can bring significant positive socio-economic effect to the economy of Kazakhstan in the short term, including new jobs created to replace the traditional energy occupations losing their relevance and reduce the population morbidity related to the soot and toxic gases emissions, create a number of new advanced technological production facilities. All related industries can benefit from the widespread introduction of renewable energy sources.

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[6] ESG- Environmental, Social, and Corporate Governance - set of parameters of the company management when solution of environmental, social and management problems is achieved.

[7] PwC Kazakhstan, „RES Market in Kazakhstan: Potential, Challenges and Prospects“, first issue, 2021.

In the next example, we can assess the potential effect of RES use in such important industry as greenhouse agriculture, the success of which directly depends on the relevant and affordable power supply.

7.7 Case study: solving the energy shortages problems in the greenhouse facilities using renewable energy sources

According to statistical agencies, heat consumption in the country will increase by about 20% in the period up to 2030 compared versus to 2014. Introduction of the energy efficient and renewable energy technologies is determined by the heat energy demand growth keeping the current state of the market (depreciation of assets, high level of heat losses, etc.) the.

The energy supply issue is especially critical for the agricultural industry, its needs for the technology proposed is relevant and measurable. The introduction of modern technologies in agricultural enterprises is extremely important, since it is the rural areas in the country where centralized heating and gas networks are quite poor. For these facilities, the best way is to introduce renewable energy technologies, among them the proposed solution can be distinguished, enabling to reduce the costs of heating and power supply of autonomous greenhouses and farms significantly, the reduced cost causes the competitiveness of agricultural enterprises with imported products.

Industry Needs Analysis

Based on the information provided by the Association of Greenhouses of Kazakhstan, heating and supplementary lighting takes up to 80% of all scheduled expenses in the greenhouse. Scheduled yield with the use of such technologies enables to get 40-45 kg/m^2 without supplementary lighting and with supplementary lighting and heating up to 70 kg/m^2, based on two cycles annually.[8] At the same time, farmers are informed that the greenhouse maintenance is more expensive, since the temperature inside must be maintained at 24 degrees, plus the cost of additional lighting from 700 to 1800 kW/h per hectare of greenhouse. Due to energy costs, market participants have to raise the prices for vegetables, thereby decreasing their competitiveness in relation to cheap import. Industry experts provide the following figures: the energy consumption of 1 hectare of a greenhouse is about 1 MW of power and 2 MW of heat. Subject the high specific power cost in the product price, significant reduction in the product cost and profitability increase can be achieved only by the energy rate reduction. According to the Chairman of the Association of Greenhouses of the Turkestan region and Shymkent, Mr. Myrzakhmet Snabaev, the current cost of early vegetables makes them inaccessible to most Kazakhstanis, the cost of 1 hectare of greenhouses per each winter month in the region is 9-10 million

[8] The state of development of a typical industry in the Republic of Kazakhstan [Electronic resource]. - Access mode: https://foodindustry.kz/sostoyanie-razvitiya-teplichnoj-otrasli-v-rk/.

tenge. 3 thousand cubic meters of gas are consumed daily only for heating, when the cost of one cubic meter is 36 tenge, the monthly expenses amount to 3-3.5 million tenge. In addition to that the cost of power, mineral fertilizers, wages, supplementary lighting due to decrease of daylight hours, etc. According to him, the share of import of greenhouse vegetables in the Kazakhstan market now reaches 80%. Most of them comes from Uzbekistan and Turkmenistan.[9]

Russian experts provide the similar data - „The power and heat costs of greenhouse farms are in average at least 50% of total costs. In some greenhouses, the share of power and heat costs can reach up to two-thirds of the total costs. All this predetermines the need of alternative and cheaper energy sources for these purposes“[10].

In accordance with data provided by the Committee on Statistics of the Ministry of National Economy: „The area of greenhouses in the agricultural enterprises where vegetables were grown was 1803 hectares in 2018 (for reference: in 2016 the area was 1061 hectares).[11] As a rule, these are the large industrial greenhouses of the area more than one hectare, they are constructed by the foreign companies. The area of greenhouses in the farms was 6176 hectares, in private households - 3658 hectares“.

The total area of greenhouses in the country as of 2018 was 11,637 hectares. The main part of greenhouses (94%) is located in the south regions (Turkestan region - 894 hectares, Almaty region - 95 hectares, Zhambyl region - 29 hectares) and western regions (Mangystau region - 32 hectares, Aktobe region - 18 hectares, Atyrau region - 13 hectares), that corresponds to the regions of maximum annual solar irradiation.[12]

At the same time, the greenhouse market is capable of paying due to state support instruments. The Ministry of Agriculture of the Republic of Kazakhstan developed the rules to subsidy the protected ground in the Republic of Kazakhstan in 2010. For six years, the Ministry of Agriculture of the Republic of Kazakhstan allocated funds by means of local regional administrations to compensate the costs of greenhouse complexes, farm greenhouses and glass houses, at the rate of 1,300,000 tenge per 1 hectare.

According to the agribusiness development program in Kazakhstan (AB) „Agribusiness-2020“, the estimated amount of subsidies granted to grow vegetables in greenhouses will be 16.127 billion tenge[13] in seven years. Therefore, greenhouse complexes for the total area of 139 hectares have been commissioned by funds of KazAgro for the period from 2010 to 2017, the value of investments amounted

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9 Greenhouse conditions. Why imported vegetables are cheaper than Kazakhstani ones in winter [Electronic resource]. - Access mode: https://forbes.kz/finances/markets/teplichnyie_usloviya_pochemu_zimoy_importnyie_ovoschi_stoyat_deshevle_kazahstanskih/.

10 A. Kupriyanov Energy of the greenhouse economy [Electronic resource]. - Access mode: https://www.agbz.ru/articles/energetika-teplichnogo-hozyaystva/.

11 Greenhouse business: development continues [Electronic resource]. - Access mode: https://agrosektor.kz/agrotema-online/teplichnyj-biznes-razvitie-prodolzhaetsya.html.

12 One of the largest greenhouses in the RK was launched in WKO [Electronic resource]. - Access mode: http://www.greenhouses.kz/news?page=2#.

13 Everything about the food industry [Electronic resource]. - Access mode: https://foodindustry.kz/sostoyanie-razvitiya-teplichnoj-otrasli-v-rk/.

to 44.4 billion tenge. The Agriculture Department of the Turkestan region reports that the region plans to increase the area of greenhouses by 200 hectares in 2020. 179.3 hectares of greenhouses were built in the region in 2019, finally, the total area reached 1114.1 hectares as of January 1, 2020. According to the head of the Association of Greenhouses of Kazakhstan, the difficulty in the south, where they grow on soil, where the yield is low, supplementary lighting systems are not available and there are no heating systems, there is no stove heating, that is, where the technology is not observed, they cannot receive any subsidy.

Thus, the analysis provided enables to estimate the following energy demand of the greenhouse market alone, excluding the needs of other industries:

- the total area of greenhouse farms in the country as of 2018 is 11,637 hectares, more than 94% of them are located in the southern and western regions of the country where annual solar irradiation is maximum and energy tariff is maximum as well;
- energy costs for heating and supplementary lighting take from 60% to 80% of the domestic greenhouses production cost making them less competitive comparing to the similar products of neighboring countries since the energy tariffs are quite high (in the south of the country) and connection to gas networks is complicated.

The total thermal demand of greenhouses in the country is 23,274 MW when average specific demand of greenhouses heating is 2 MW/ha.

The total power demand of greenhouses in the country is 11 637 MW if average specific power demand for supplementary lighting of greenhouses is 1 MW/ha.

7.8 Estimate of potential benefits from the RES use

In line to estimate the benefits from the RES use in the greenhouse agriculture sector, let us refer to the UNDP study within the project „Calculation of the potential renewable energy sources use for the hot water supply and heating at the various civil construction sites for domestic needs, subject to the gender aspects“ for 2020. The levelized cost of 1 kWh of thermal energy from various sources (traditional - central heating, coal, gas and diesel boilers, and alternative - heat pumps and solar collectors) is compared in the study for various cities of Kazakhstan within 5-10 years, subject to the climate and local energy tariffs.[14]

The Levelized Cost of Electricity (LCOE) is widely used in the investment analysis of renewable energy projects to calculate and compare the unit energy cost over the entire life of generation station. This indicator correlates the revenue value from the power generated to the current worth value of the capital and operating costs of generation station. It enables to compare the projects with different technologies, lifetime, scale, capital cost, and capacity.

[14] Levelized cost of electricity (LCOE) is the cost per unit of energy over the life of generating station that equates the present revenue value from the power generation and selling to the current worth construction and operating cost of the power plant.

In general, following formula id used to calculate this indicator:

It = Capital expenditures per year t
Mt = Operating costs per year t
Ft = Fuel costs (if any) per year t
Et = Annual power generation t
R = Discount rate
n = Project lifetime

The conclusions of UNDP study showed that with current tariffs, in the vast majority of cases, heat energy from district heating is cheaper than from any other possible energy sources in each city. At the same time, the cost of heat energy generated from the alternative sources (solar collectors, heat pumps) for 5 years term, in some cases, can be comparable and even more profitable versus to the traditional sources. Comparing the heat production specific indicators, it was recommended to use RES for the hot water supply (HWS) and heating of civil construction facilities in the cities of the Republic of Kazakhstan.

In the regions of the highest greenhouse farms concentration (south and west regions of the country), the specific heat energy cost from solar collectors over 5 years term is 28-33 tenge per 1 kWh that is lower than the cost of coal heating (32-37tg / kWh) and diesel heating (35-39 tg / kWh) used for these purposes today.

Savings of the greenhouse facilities for the first five years of solar systems operation is made of the difference in the specific cost of thermal energy generated by the traditional sources and solar collectors at the rate of 6 tenge per 1 kWh in average. Further savings will be even greater, since solar equipment is purchased once for 30-40 years term and further operation costs for it are relatively small. Annual operating costs of traditional boilers, related to the purchase and storage of fuel (coal, diesel, gas), maintenance (technical staff, ash handling), environmental payments for emissions are quite high despite the lower capital costs. Moreover, the service life of traditional boilers is about 20-30 years. Thus, solar collectors can be compensated eight times since service life of them is up to 40 years.

Conclusion

Climate change has become one of the greatest threats of the 21st century to the environment, health, well-being of nations and global security. Over the past decade, CO_2 emissions from the energy sector have increased by 1% annually in average, if the current average growth rate continues, the global warming is expected by the end of the century by more than 3°C versus to pre-industrial levels. The Paris Agreement aims to limit the global temperatures rise to „significantly below“ 2°C, and ideally to 1.5°C (versus to pre-industrial levels) this century. Current and expected government policies will reduce emissions by 2050 to the values similar to today’s, but this still will bring temperature rise of about 2.5°C. A profound transformation of the global energy landscape is therefore required to achieve the Paris climate target.

The current energy supply system, primarily founded on the mineral fuels, shall be soon reformed in favor of carbon-neutral technologies based on the renewable energy sources, nuclear energy or hydrogen. The top countries have recognized the urgency of action and committed r the carbon-free future. The Republic of Kazakhstan did not stand back and adopted ambitious goals to achieve carbon neutrality by 2060.

The sustained increase of renewable energy capacities recent years is related from one hand, to the cheaper technologies and from the other hand, ambitious climate targets. Solar PV and wind power plants have reached price parity in many markets, while other renewable energy sources (geothermal energy, biomass) will be fully cost competitive in the future till 2030. Distributed energy resources such as solar photovoltaic panels on the roofs, batteries and electric vehicles are becoming promising solutions that can be also successfully applied for domestic needs, including oil and gas fields.

All time high rate of the new capacities commissioning based on renewable energy sources has been recorded in 2020, the share of renewable energy sources reached 29% in global power generation, more than 256 GW of renewable energy-based capacities have been commissioned during 2020. However, the share of renewable energy sources in the total energy balance is still relatively small and makes 11.2% (excluding traditional biomass use), while the share of conventional fuels accounts 84% as of 2019 (Fig. 3).

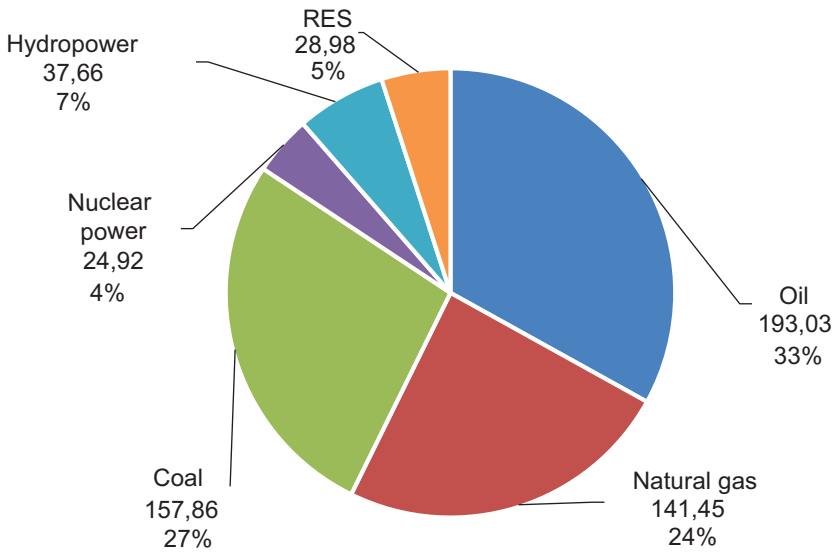

Figure 3. **Distribution of primary energy in the world in 2019 British Petroleum (BP) data**

It shall be clear that despite its outstanding advantages, RES also has a number of disadvantages, including:

- pronounced daily and seasonal fluctuations in generation and its unpredictability from year to year;
- high cost and complexity of generated power accumulation in order to align the generation and loading peaks;
- high energy consumption and related CO_2 emissions during equipment production (for instance, crystalline silicon smelting for PV panels);
- large areas occupied by the stations due to low energy density of these sources versus to the traditional ones.

Therefore, in addition to the increase of the renewable energy sources share within the global climate agenda recent years, the development of new associated technologies has been noted:

- CO_2 capturing and storing technologies (Carbon Capture and Storage, CCS), capable to capture the atmospheric carbon in the solid form and store it in the Earth's interior;
- generation of hydrogen and hydrogen energy infrastructure as an environmentally friendly method of energy transportation and storage;
- laboratory research on the controlled thermonuclear fusion of energy, enabling to „ignite" a compact analogue of the Sun on the Earth in the future.

The hydrogen energy is the most established and promising one. Hydrogen that makes up to 90% of the universe mass, is a key fuel resource as well, the demand for it will be increased in the coming years. In accordance with British Petroleum forecasts, the global consumption of hydrogen will be from 7% to 16% of the global energy balance by 2050, and its share will reach 18% in the industry, and 10%[15] in the transport sector. The global Hydrogen Council initiative has similar forecasts expecting the hydrogen to provide up to 69GW of global energy consumption by 2030[16]. According to Bloomberg NEF 24% of the world's energy needs will be covered by hydrogen by 2050, the industry will attract about $ 11 trillion in investment, and annual sales of hydrogen fuel in the world will reach $ 700 billion[17].

Zero carbon footprint (the water is formed after combustion of hydrogen), coupled with the power conversion to fuel, storage and transportation, make hydrogen an on dispensable alternative to oil and gas. Moreover, hydrogen can be used both in existing internal combustion engines (ICE) powered by gasoline, natural gas, and in the fuel cells converting chemical energy to the power. High energy density (3 times higher than that of gasoline, 2 times higher than that of natural gas) makes hydrogen fuel the cost-effective one even at the market price (1.5 - 5 USD/kg).

Significant growth of the hydrogen demand is expected in the oil refining industry – it will be used to improve the oil quality. Hydrogen is already used to

[15] Energy Outlook | Energyeconomics | Home | bp global [Electronic resource]. - Access mode: https://www.bp.com/en/global/corporate/energy-economics/energy-outlook.html.

[16] Hydrogen Insights An updated perspective on hydrogen investment, market development and momentum in China [Electronic resource]. - Access mode: https://hydrogencouncil.com/wp-content/uploads/2021/07/Hydrogen-Insights-July-2021-Executive-summary.pdf.

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extend the processing depth, improve the oil properties, refine the oil products from the sulfur, and produce a wide range of oil products: fuel, oils and lubricants.

There are three ways to produce hydrogen: the so-called „gray", „blue" and „green". „Gray" hydrogen is produced from the petroleum products, gas or coal by steam reforming with the associated carbon dioxide CO_2 production. „Blue" hydrogen is produced with the same method from methane, but CO_2 is recovered. „Green" hydrogen is produced by electrolysis - water splitting to hydrogen and oxygen by electric current obtained from the renewable energy sources. This method is deemed as the most preferred.

The main types of hydrogen units are so-called fuel cells (efficiency up to 83%), gas turbines (efficiency up to 74%) and internal combustion engines (efficiency up to 35%). Thermal energy of hydrogen combustion is used in the gas turbines and internal combustion engines, and chemical energy converted to the power directly is used in the fuel cells. Due to its high efficiency, the fuel cell can be used both in transport and power plants to provide power to individual buildings, industries and large cities. More often hydrogen is used in the independent power sources. The potential hydrogen consumers are portable devices and batteries, backup generators, power supply systems for auxiliaries of various power plants, robotics, unmanned aerial vehicles, power plants, generators for the permanent heat and power supply to private houses.

The national strategies of the top countries include 4 main objectives of the hydrogen energy development:

- development of hydrogen transport;
- development of hydrogen production capacities;
- hydrogen infrastructure (distribution, storage and transportation);
- development of hydrogen power plants.

In the USA, Japan and the Scandinavian countries, large business centers, hospitals, and residential buildings are powered from the hydrogen fuel cells power plants (capacity of more than 1 MW). There is a state program to produce independent household hydrogen stations In Japan - there are already several thousand of stations in the country. Also, the Japanese are engaged in the large-scale use of hydrogen, primarily via energy sector modernization and increase the number of the hydrogen power plants. However, the main difficulty of hydrogen use as a fuel is its storage systems. It can be stored in the special cylinders at very high pressure of 700 cl. atm. or in the cryogenic liquid at the temperature of minus 253°C. But already now, the ways have been found how to store this gas in the safe form associated with other chemical elements, including solid forms and traditional ammonia feed.

Kazakhstan also has unique opportunities to develop hydrogen energy. Therefore, the President of the country Kassym-Jomart Tokayev instructed in June 2021 to develop domestic hydrogen energy as one of the priorities of the competence center in new technologies. Experts refer the following factors to prerequisite the hydrogen energy development:

- excess capacity of power plants in Kazakhstan (total installed capacity of power plants in Kazakhstan is about 20 GW, regular excess capacity is about 3 GW);
- low cost of power generation for the hydrolysis process in the number of regions of the country;
- well-established hydrogen production for own needs at the state district power station of Pavlodar region and MAEK in Mangistau region;
- significant reserves of the rare earth metals necessary to produce the catalysts and components for fuel cells;
- production and scientific base for the production of catalysts, hydrogen storage and delivery facilities, fuel cells at the national enterprises[18].

Thus, the experts estimated the hydrogen production capabilities in Kazakhstan up to 1 million tons annually under existing capacities of power plants by electrolysis without any loss of the main operation. This is sufficient to resolve the peak load problems of all power plants in the country or refuel 270 thousand city buses daily.

The hydrogen energy development in the country will afford to realize the advantages of Kazakhstan and diversify the hydrocarbon sector, ensure the advanced transformation of economy in the new process mode and obtain large-scale benefits necessary for the dynamic socio-economic development of the country. Therefore, national strategy of the hydrogen energy development will be drafted in Kazakhstan.

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Chapter 8

CLIMATE CHANGE AND CLIMATE POLICY

8.1 Global climate change

Global climate change[1] becomes the dominant factor threatening the well-being and security of all peoples living on the planet.

Natural disasters are on the increase and increase in frequency (sudden changes in ambient air temperatures, an abnormal amount of precipitation in a short time, floods, droughts, wild forest and steppe fires, accelerated melting of glaciers, etc.), which lead to large-scale destruction of economic infrastructure and housing in vast territories, ruin crops and animals cause premature human death.

What is causing the global climate change?

According to the accumulated scientific knowledge, the planet's climate has changed before. Warming and cooling phases were observed. The results of many natural scientific studies indicate that global climate change is a natural inevitable cyclical process that proceeds very slowly over millennia and depends on many factors.

We are now living in a warming phase. This means that the average temperature of the atmosphere, the oceans and the earth's surface on the planet is gradually increasing.

Currently, the global temperature of the atmosphere is 1.1 higher than the pre-industrial level (1850)°C. Scientists-climatologists are already observing irreversible catastrophic phenomena in different parts of the planet, therefore they recommend not to allow an increase in the average temperature of the atmosphere, the world's oceans and the earth's surface by more than 2°From until the end of the XXI century, but it is better to keep the temperature rise by no more than 1.5°C.

Can humans influence the future climate? Is it possible to anticipate and prevent damage and reap economic benefits from climate change? If yes, then how to properly build climate policy? We will try to answer these and other questions in this chapter.

On the danger of an increase in the average ambient temperature by 1.5 ° C and above

To explain the danger of a temperature rise of 1.5° From and above for all life on the planet, a parallel can be drawn with human well-being, since the human body is a protein form of life[2].

[1] Climate change, depending on the scale, can be local and global (planetary). You can read about the climate and climate-forming factors in an easily accessible form on the Internet resource of the popular scientific meteorological project „Meteorologist and Me", link to the e-book [Electronic resource]. - Access mode: https://meteo59.ru/book/index.php...

[2] All human organs are composed of proteins, proteins are involved in metabolic processes in the body. Thanks to them, we grow, move and look in a certain way, since collagen and elastin, which form the basis of the skin, are also proteins.

Every adult knows that at a body temperature of 38°The person shivers, he feels unwell. But 38°C is just an excess of 1.4°C. At a temperature of 40°Death can occur, as the living protein folds and dies. Therefore, doctors first of all knock down a patient with a high temperature if it exceeds 38°C.

Living organisms that form biota[3], can perfectly exist only in a certain temperature environment. When the ambient temperature rises above the optimal range (norm), living organisms experience physiological stress. The mechanism of self-regulation of body temperature is automatically triggered. For example, the human body, when overheated through perspiration, gets rid of excess heat. But long-term extreme temperature exposure for the body can lead to metabolic disorders, diseases, irreversible negative consequences for health and even death.

With hypothermia, the body also experiences physiological stress, the body shivers (the body tries to generate heat), all metabolic processes slow down (the body saves energy). Prolonged hypothermia as well as overheating can lead to undesirable irreversible consequences and death.

In this regard, climatologists have introduced terms such as „heat waves“ and „cold waves“ or „heat waves“ and „cold waves“, which characterize the extreme temperature parameters of the environment for humans, lasting more than five days in a row.

The main parameter of the comfort of the habitat for living organisms is the temperature, the sensation of which also depends on the humidity of the air and the speed of the wind. The higher the air humidity, the stronger the effect of the ambient temperature on the body. The drier the air, the easier the body tolerates temperature deviations, for example, in Almaty, where the air humidity is higher than in Nur-Sultan, -17°C is more difficult to transfer than -30°C in Nur-Sultan.

The higher the speed of the wind that blows over the body, the faster the heat removal. Therefore, in hot weather, the wind lightens the temperature load on the body, in cold weather, it aggravates. In this regard, forecasters, when predicting air temperature, add information about how it might feel, taking into account humidity and wind.

Climate forcing

Currently, according to scientists, aerosols save us from overheating.[4] That enter the atmosphere due to forest fires, volcanoes, military operations, etc. They have a cooling effect on the climate.

Objectively, the climate is influenced by many factors, which can be conditionally divided into external and internal - it is difficult for a person to influence them. That is why the opinions of scientists and politicians have been divided for almost three decades. Some believed that the reason for the acceleration of climate change could be anthropogenic activities (extraction and combustion of fuel, intensive farming and

[3] Biot (from others - Greek βιοτή - life) is a historically formed set of species of living organisms, united by a common habitat (distribution) [Electronic resource]. - Access mode: https://ru.wikipedia.org/wiki/%D0%91%D0%B8%D0%BE%D1%82%D0%B0...

[4] Aerosols are particles of a solid or liquid suspended in the air (in a gaseous medium).

deforestation), which change the composition of the atmosphere, others that this issue was highly politicized in order to impose on the post-Soviet and developing countries strict environmental requirements, and thus, increase discrimination in international trade. While the discussions were going on, the process of global warming began to accelerate. Stanford climatologists estimate that the climate is changing 10 times faster than ever before.[5] Not only the atmosphere is warming up, but also the ocean and land.

Temperature rise is monitored and recorded using precision measuring instruments installed around the planet [6], that is, warming is an objective reality.

In Kazakhstan, global warming is manifested more intensely than the world average

According to the RSE „Kazhydromet" for 1976-2020. the average rate of increase in surface air temperature in Kazakhstan was 0.32°C.

Many people ask the question - why are we talking about global warming, while winters in most of Kazakhstan are getting harsher, and summers unbearably hotter? The fact is that warming leads to an acceleration of the circulation of air masses in the atmosphere, ocean currents change directions. Scientists report that the warm Gulf Stream in the cold Atlantic Ocean changes direction and will soon stop washing the shores of Europe, as a result of which the mild warm climate in Europe will change to a cold one.

The temperature at the poles of the Earth is rising faster than at the equator. This leads to the fact that the Arctic cold air masses are forced onto our continent, therefore, in some places there is a significant cooling (cold waves), and in some places - prolonged heat (heat waves). In Kazakhstan, winters became colder, and the other three seasons are warmer (Dolgikh S.A.[7], RSE „Kazhydromet", Fig. 1).

Also, there are uneven temperature changes throughout the year in the context of regions.

Why are there floods where there has never been a precedent? The fact is that the annual rainfall in Kazakhstan has increased over the past 20 years: mostly in winter and spring, to a lesser extent in summer. At the same time, autumn precipitation has decreased significantly, as evidenced by observations RSE „Kazhydromet".

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5 K. Ranks. Global warming in Russia and the world: six myths [Electronic resource]. - Access mode: https://republic.ru/posts/1424.

6 Hydrological posts, meteorological and agrometeorological stations around the world more and more often record and transmit to the servers of national hydrometeorological services and the World Meteorological Organization (WMO) anomalous deviations from the usual temperature standards air, the amount of precipitation, the level of reservoirs and river flows, soil moisture and other important basic physical and climatic parameters. The observational network of the hydrometeorological service of Kazakhstan (RSE „Kazhydromet") has 328 meteorological stations, 83 of which are included in the global network of WMO, and 377 hydrological posts on rivers and lakes, of which there should be at least 800, in order to timely and accurately warn about the expected hazardous hydrological phenomena, for which you need to prepare in order to timely prevent possible damage and loss of life [Electronic resource]. - Access mode: https://www.kazhydromet.kz.

7 Presentation „Kazakhstan: Impacts of Climate Change and Adaptation" at the XVII Forum of Interregional Cooperation between Kazakhstan and Russia, September 28, 2021.

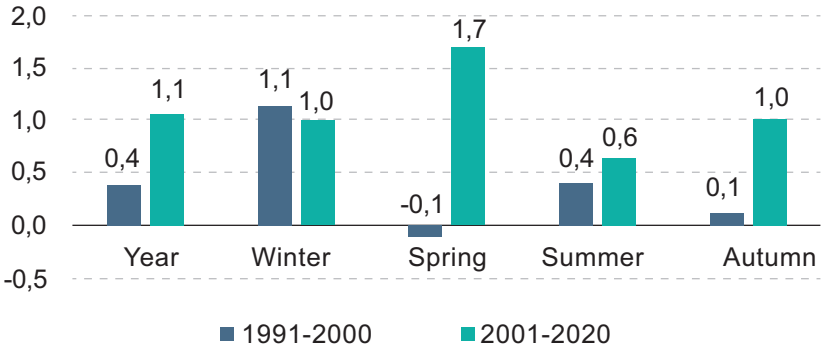

Figure 1. **Comparison of changes in seasonal temperature in Kazakhstan for 1981-2000 and 2001-2020, ° C**

The final word in science on climate change and the role of people

In August 2021, the Intergovernmental Panel on Climate Change (hereinafter - IPCC) published the 6th Assessment Report „Climate Change 2021: The Physical Science Basis“, which, for the first time in the history of scientific research, categorically states that the acceleration of climate change is due exclusively to anthropogenic activities. The influence of natural factors, such as increased activity of the sun, volcanoes and other factors, on the acceleration of climate change, has been reduced to zero.

According to the 6th IPCC Assessment Report, by the end of this century, the average global temperature will rise by at least 2.7°C, maximum 5.7°C, which will lead to irreversible catastrophic phenomena such as extremely high temperatures in some regions of the world, melting of the Arctic ice, the disappearance of ice from the surface of the Arctic Ocean, the disappearance of forests, an increase in the level of the World Ocean by 2-3 meters until the end of the century.

The IPCC says the battle is 1.5°C has already been lost. Mark 1.5°C will be completed in 2040. Even if all developed countries reach carbon neutrality by the middle of the century, humanity has no chance of keeping the temperature rise within 1.5° from to the end of the century. In 30 years (until 2050), such a volume of greenhouse gases will enter the atmosphere, which will lead to a catastrophic overheating of the atmosphere until the end of the century.

With prolonged heat waves, there is an increase in mortality among vulnerable segments of the population, especially those suffering from kidney disease and cardiovascular pathologies.

What is the reason for this unprecedented rate of acceleration of warming in millions of years? Anthropogenic impact on climate

Scientific and technological progress has allowed humanity to enter the phase of industrial development, develop highly productive industrial and agricultural technologies, and improve social and industrial infrastructure. And all this thanks to

modern energy technologies, constantly converting a huge amount of fossil energy resources into electrical and thermal energy.

Billions of tons of greenhouse gases (hereinafter - GG) are annually released into the atmosphere during the extraction, transportation, storage, combustion of hydrocarbon fuels in various industrial processes in all countries. GGs are also released into the atmosphere during intensive farming and animal husbandry, as well as in the formation of municipal biodegradable waste. Since one of the main GGs is carbon dioxide (CO_2), trees, fertile soil, and organic farming contribute to its absorption. When trees are destroyed, deep plowing and soil depletion, they are not absorbed, but released into the atmosphere (emissions).

Greenhouse gases, entering the atmosphere and accumulating in its upper layers, live a long time until they completely decay. Depending on their molecular weight, they are capable of retaining different amounts of the sun's energy during their life, reflected back into space from the planet's surface. This leads to an increase in the average temperature of the lower atmosphere on the planet, that is, a greenhouse effect is created. Due to the increase in the average temperature on the planet, all hydrometeorological processes are accelerating, which teaches anomalous natural phenomena in the form of: sudden temperature changes, the fall of huge amounts of precipitation in a short time, snow drifts, floods, increased and more frequent heat waves causing droughts, steppe and forest fires etc. Thus, an increase in the concentration of GG in the upper atmosphere leads to an increase in the frequency and intensification of natural disasters, to an increase in the scale of material and humanitarian damage. Gradually, climatic zones are shifting in the direction from the equator to the poles, from the lowlands to the upper reaches. The shift of climatic zones poses a real threat to the loss of biodiversity. The invasion of exogenous insects, the penetration and more rapid spread of pathogens, displace or destroy endemic plant and animal species. Farmers' crops and crops are increasingly dying, and natural ecosystems do not have time to adapt. displace or destroy endemic plant and animal species. Farmers' crops and crops are increasingly dying, and natural ecosystems do not have time to adapt. displace or destroy endemic plant and animal species. Farmers' crops and crops are increasingly dying, and natural ecosystems do not have time to adapt.

Thus, the reason for the acceleration of climate change was the rapidly growing concentration of greenhouse gases in the upper atmosphere, that is, a change in the composition of the atmosphere.

International Climate Policy

In 1992 the world community [8] agreed to work together to combat climate change. The UN Framework Convention on Climate Change (hereinafter - UN FCCC) was developed and opened for signature, which was signed and ratified by 197 countries of the world, including Kazakhstan.[9]

[8] Member States of the United Nations.

[9] The UN Framework Convention on Climate Change dated June 11, 1992 (UNFCCC) was ratified by the

The main goal of the UN FCCC is to consolidate the efforts of developed and developing countries to prevent dangerous anthropogenic impact on the climate system, so that the rate of climate change allows ecosystems to naturally adapt to new conditions. The preservation of ecosystems (and, accordingly, and biodiversity) is important to prevent a threat to the food security of all peoples.

One of the main principles of international cooperation in the fight against climate change has become the principle of „universal but differentiated responsibility". This principle means that developing countries have the right to economic growth and an increase in the standard of living of the population, respectively, the requirements for them in terms of GG emissions should be softer than for developed countries that have already achieved a high standard of living. According to the UN FCCC, developed countries are obliged to provide assistance to developing countries to accelerate their transition to low-carbon technologies. Since it was recognized that by the beginning of the 90s, 70% of the accumulated greenhouse gases in the upper atmosphere were emitted by developed countries during the post-war economic recovery.

All country parties to the UN FCCC meet annually for a two-week conference for negotiation and decision-making. Between conferences, implementation of the provisions of the UN FCCC and decisions of the parties is ensured by the Convention Secretariat and its subsidiary bodies.

Parties annually, by April 15, submit to the Secretariat reports on the national inventory of emissions and removals GG in the form of national reports (Status Reports) and duly completed unified data tables (CRF)[10]. Kazakhstan has been submitting reports to the UN FCCC Secretariat since 2009. Zhasyl Damu JSC has been preparing national reporting on GG for 12 years in a row. The reports are prepared according to the guidelines developed by the IPCC. National reports are annually checked by international experts for the reliability of the data used and the correctness of the calculations. All received comments should be eliminated in time and, if necessary, the data should be recalculated for the entire time series since 1990.

In pursuance of the UN FCCC, the Kyoto Protocol was developed in 1997, which entered into force only in 2005. He offered UN FCCC parties three flexibility mechanisms for mutually beneficial reductions in GG emissions. However, the Kyoto Protocol procedures were heavily bureaucratic. This made it difficult to register projects and certify emission reductions. Kazakhstan too late ratified the Kyoto Protocol by the Law of the Republic of Kazakhstan dated March 26, 2009 No. 144-IV. This did not give Kazakhstan anything other than difficulties in preparing national reports on the GG inventory, which must meet the strict requirements for reports of developed countries.

In 2015, the Paris Agreement was developed. It entered into legal force in 2016 and replaced the Kyoto Protocol from January 2021.

Decree of the President of the Republic of Kazakhstan dated May 4, 1995 No. 2260.

[10] The UNFCCC Secretariat publishes on its website all national reports of the parties on GHG emissions [Electronic resource]. - Access mode: https://unfccc.int/ghg-inven (data to be recalculated) tories-annex-i-parties / 2021...

Purpose of the Paris Agreement (temperature) - until the end of the XXI century, keep the overheating of atmospheric air by no more than 2°C, or better - no more than 1.5°C relative to the temperature that was observed before the industrial period, that is, until 1850. In this regard, the parties to the Paris Agreement are recommended to develop national strategies for low-carbon development until 2050.

The Paris Agreement defines the international legal framework for global efforts to reduce greenhouse gas emissions. According to the Decree of the President of the Republic of Kazakhstan dated July 20, 2016, the Paris Agreement was signed by Kazakhstan, and on October 27, 2016 it was ratified by the Parliament of the Republic of Kazakhstan. Thus, Kazakhstan joined the Paris Agreement and its provisions became legally binding for the country at the international level.

According to In Article 3 of the Paris Agreement, the parties should expand their ambitions in the fight against climate change over time. This means that previously declared national obligations cannot be reduced, but should only increase. If the country wants to reduce or abandon its obligations, then it withdraws from the Paris Agreement with the deprivation of access to any international donor assistance provided for the decarbonization of the economy and adaptation to the effects of climate change.

According to Article 4, the parties should strive to peak GG emissions as soon as possible and begin to reduce GG emissions as soon as possible in order to achieve carbon neutrality by the middle of the century, balancing anthropogenic emissions and removals. Currently, more than 120 countries have declared their intention to achieve carbon neutrality by the middle of the century, China and Kazakhstan by 2060.

Without modeling and continuous improvement of tools, databases, methodology and interaction with all stakeholders, Kazakhstan will not be able to plan when it will peak in emissions and how to achieve carbon neutrality by 2060.

The Conference of the Parties to the UN FCCC, serving as the Meeting of the Parties to the Paris Agreement, will regularly take stock of the global results of the implementation of the Paris Agreement: (1) on the actual emissions of countries; (2) to increase the ambition of countries to reduce GG emissions; (3) on collective progress towards the 2030 and 2050 targets.

Countries report actual GG emissions and removals annually.

From 2020, every five years, all parties to the Paris Agreement must update their NDCs (Nationally Determined Contributions to the Paris Agreement Temperature Target), striving to regularly expand national ambitions, and submit the updated NDCs, to the UN FCCC Secretariat, including NDC implementation plan and a Roadmaps for the next five years and adjusted long-term strategies for low-carbon development. It is noted that the parties can adjust their NDCs at any time in order to increase their levels of ambition.

From 2023, all parties to the Paris Agreement will report on progress in implementing the planned decarbonization and adaptation measures. Reporting forms uniform for all countries are still being developed. At the global level, the results of countries' implementation of their Roadmaps will be regularly summed

up, based on the national GG inventory reports submitted to the UN FCCC Secretariat.

The requirements for national reporting under the Paris Agreement, as expected by international experts, will become more complicated (in terms of detailing the data submitted by the country and providing a high-quality evidence base). In this regard, it is important for Kazakhstan to improve its national statistics as soon as possible so that it meets the needs of preparing high-quality national reporting on GG emissions and removals. Also, it is important to improve the national monitoring, reporting and verification (MRV) system, bring it in line with ISO international standards in the field of GG management.

Before the start of the 26th UN FCCC Conference of the Parties, which will be held on October 31-November 12, 2021 in Glasgow (UK), Kazakhstan intends to submit to the UN FCCC Secretariat the Updated NDC of the Republic of Kazakhstan until 2030, the Roadmap for the implementation of the NDC for 2021-2025 and the Doctrine of Achieving Carbon Neutrality by 2060. Further, it will be necessary to constantly report and adjust plans.

In decisions on the implementation of the Paris Agreement (FCCC / PA / CMA / 2018/3 / add.1) adopted by the 24th Conference of the Parties to the UN FCCC, which is considered the Meeting of the Parties to the Paris Agreement, held in Katowice, Poland in December 2018, indicated that the parties to the Paris Agreement should regularly provide information to ensure clarity, transparency and understanding not only of global GG emissions, but also of the national contributions of countries to the achievement of the temperature target of the Paris Agreement.

It is stated that the parties should avoid underestimating and overestimating projected GG emissions and removals by sinks. A dedicated interactive platform of experts has been created that collects and discusses new knowledge, experience, information to recommend to countries the tools and modeling methodologies needed to develop specific actions.

Necessary when developing (1) plans to reduce climate impact and (2) adapt to climate change, assess all costs and benefits, not only economic, but also social, not only direct, but also accompanying (indirect), assess the needs and availability of investments for the implementation of plans.

It is recommended to set GG emission reduction (absorption) targets for each sector in relative and absolute units. In this case, it is necessary to be guided by the methodological principles of the IPCC. In specific country-specific issues, the applied methodologies should be justified and accepted (agreed upon) by the IPCC.

This suggests that research and preparation of such documents as updated NDCs, five-year roadmaps for NDC implementation, Strategies for achieving carbon neutrality, the National Climate Change Adaptation Plan, etc., as well as the preparation of implementation reports, should be carried out on an ongoing basis. to develop professionalism and appropriate quality to be accepted by the IPCC and the UN FCCC Secretariat. Otherwise, the parties (countries) receive comments that need to be resolved in a timely manner.

The flexibility of the Paris Agreement lies in the fact that all countries are given the right to independently determine their feasible contribution to the achievement of the temperature target of the Paris Agreement, taking into account national development interests.

As noted above, within the framework of the UN FCCC and the Paris Agreement, the principle of common but differentiated responsibility of countries in the fight against climate change operates. All countries must do their utmost to combat climate change. At the same time, developed countries have financial and other obligations to help developing countries accelerate the decarbonization of their economies.

A Green Climate Fund has been established along with many other global and government funds from developed countries that can finance mitigation and adaptation projects for vulnerable countries. The main condition is the presence of more ambitious plans to combat climate change than before. Developing countries are deprived of access to international aid and to „green" international investment when (1) an insufficiently ambitious updated NDC, (2) refusal to implement the previously announced NDC and / or (3) its non-implementation.

What should a national climate policy include?

According to the UN FCCC and the Paris Agreement, countries' climate policies should include two main components: mitigation and adaptation.

Mitigation - means the mitigation of human impact on the climate, which is achieved through a reduction in emissions and an increase in the absorption of greenhouse gases.

Adaptation - presupposes the timely identification of climatic risks for vulnerable sectors of the economy, vulnerable groups of the population and ecosystems, assessment of expected damages and potential benefits, development and implementation of an appropriate National Adaptation Plan to prevent expected damages and extract emerging benefits by increasing their resilience to external influences.

The phrase „combating climate change" should not be interpreted literally. This is not a „fight with the mills". In the context of the UN FCCC and the Paris Agreement, „combating climate change" implies climate mitigation and adaptation to the effects of climate change.

8.2 State climate policy of Kazakhstan

An authorized state body that forms, improves and implements the state climate policy in Kazakhstan

The state climate policy of Kazakhstan is formed and implemented by the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan (MEGNR), which has in its structure the Department of Climate Policy and Green Technologies.

Expert support in the formation, improvement and implementation of state climate policy in Kazakhstan

Zhasyl Damu JSC provides expert support to the authorized state body in the development, improvement and implementation of climate policy, which generates official statistics on GG emissions and removals.

Zhasyl Damu JSC, the operator of the National Emissions Trading System (ETS), helps the MEGNR Department of Climate Policy and Green Technologies to calculate the carbon budget and the National Plan for the allocation of free quotas to emitters whose emissions exceed 20 thousand tons of CO_2-eq per year. Accordingly, it maintains the GG State Emissions Inventory, into which verified and validated reports of companies on GG emissions are uploaded, and also maintains the State Register of Carbon Units, in which market participants have their carbon accounts.

Zhasyl Damu JSC develops changes in legislation, regulations in the field of GG emissions regulation.

Also, the company provides modeling, analysis and forecasting services, evaluates, on the basis of modeling, the impact of various policies, market and regulatory instruments on GG emissions, the parameters of economic development and individual sectors of the economy that have a significant impact on national GG emissions.

Legal framework for climate policy

The fundamental basis of the climate policy is the Environmental Code of the Republic of Kazakhstan dated January 9, 2007, which contains the relevant definitions and sections on the regulation of greenhouse gas emissions on the territory of the republic and provisions related to adaptation to climate change.

There are a number of by-laws that govern the emissions trading system.

Key indicators of state climate policy (mitigation)

State climate policy indicators are defined by the country's declared commitments under the Paris Agreement.

Strategic goal until 2060 - achieving carbon neutrality, that is, achieving a zero balance of GG emissions and removals.

Goals for 2030 are fixed in the updated NDC:

- the unconditional goal is to reduce net GG emissions by 15% compared to 1990 emissions;
- a conditional goal (with the assistance of the international community for decarbonization) - bringing the reduction of net GG emissions to -25% relative to the 1990 level.

Paris Agreement transforms the terms of international trade and investment attractiveness of countries

Three shocks await the economy of Kazakhstan, which will be difficult to cope with if we continue to implement the policies and indicators recorded in the current documents of the State Planning System.

The three shocks are: (1) the impact of the carbon border adjustment mechanism (CBAM) that the EU intends to introduce [11]; (2) a two-fold decline in the price of oil and other fuels by 2050 due to lower demand as more than 120 countries of the world have decided to achieve carbon neutrality by 2050[12]; (3) the impact of climate change on agriculture.

A number of states are negotiating with the EU on the introduction of a CBAM, similar to the EU. These are the USA, Canada, Japan, South Korea. China also announced the introduction of its SWAM. Thus, if the Kazakhstani economy does not reduce its carbon intensity, the exported goods become uncompetitive, the state budget will lose a significant part of its revenues, and the situation with external debt will worsen.

Figure 2 shows the comparative dynamics of the GDP of the three scenarios. The line of the Baseline Scenario corresponds to the situation of maintaining the existing sectoral policies and development indicators, taking into account the above shocks. We see that in the baseline scenario, GDP grows much slower than the Ministry of National Economy of the Republic of Kazakhstan expects - only by 89% instead of 200% over the next 39 years. The expected losses from the three major shocks for the economy will amount to 3.7 trillion. USD (in comparison with the expectations of the Ministry of National Economy of the Republic of Kazakhstan).

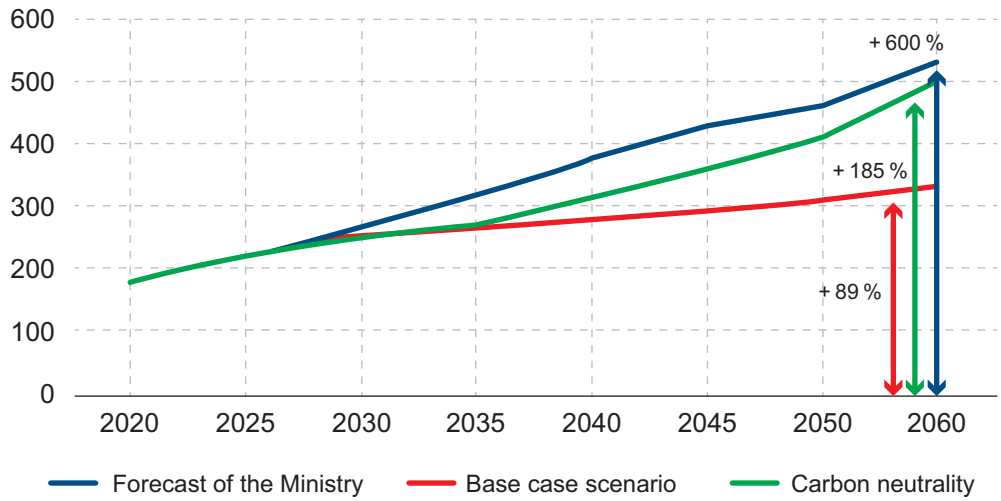

Figure 2. **Dynamics of Kazakhstan's GDP until 2060, billion USD (2017)**

Note: The result of modeling obtained during the development of the Doctrine of achieving carbon neutrality of the Republic of Kazakhstan until 2060.

[11] CBAM is introduced to replenish the EU budget, to protect domestic producers from dumping of external competitors, whose production is localized in countries with more lenient GHG regulation, and to prevent the movement of carbon-intensive industries from the EU to countries with weak GHG regulation or where there is no such regulation at all. The structure of this mechanism provides for an import duty on carbon-intensive imports, and most likely it will be agreed by the World Trade Organization. The taxable base will be direct and indirect GHG emissions, which took place along the entire value-added chain of external suppliers, from mining to the production of this product.

[12] According to the forecast of the International Energy Agency at the OECD.

Implementation of the Carbon Neutrality (CN) scenario will reduce the expected total damage from the above three shocks by 2.4 times by 2060. In 2060, the GDP in the CN scenario will exceed the GDP of the baseline scenario by 50% and will amount to USD 504 billion (for comparison: in 2020, the GDP was USD 177 billion).

With regard to GG emissions (Fig. 3), the CN scenario will achieve not only the notional 2030 target, but also a zero balance of GG emissions and removals by 2060. Compared to the baseline scenario, the CN scenario will prevent release to the atmosphere during 2022-2060. 9.3 billion tons of CO_2-eq. This will be the „contribution" of Kazakhstan to curbing the growth of the global temperature of the atmosphere on the planet.

International financial institutions refused to finance projects related to coal (World Bank, European Bank for Reconstruction and Development, Asian Development Bank, etc.). Moreover, all projects related to the flaring of oil, gas and nuclear power plants are also considered dirty. In some cases, projects to replace coal with natural gas may be supported, since burning gas produces fewer greenhouse gases than burning coal to generate that amount of energy.

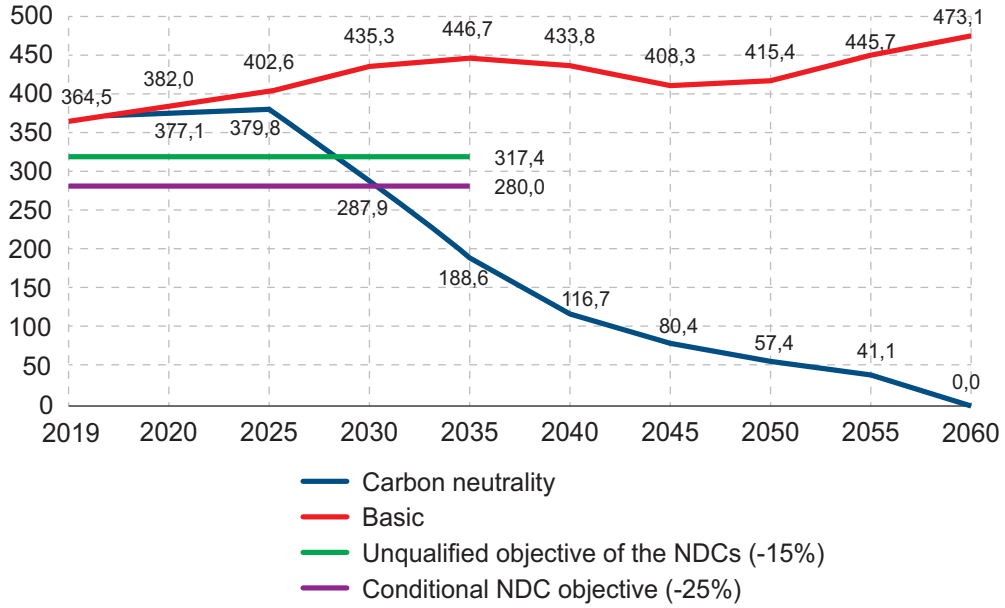

Figure 3. **Dynamics of net GG emissions in Kazakhstan until 2060 under the baseline scenario and the „Carbon neutral" scenario**

Note: The result of modeling obtained during the development of the Doctrine of achieving carbon neutrality of the Republic of Kazakhstan until 2060.

For a quarter of a century, the driver of economic growth of independent Kazakhstan has been the export of natural resources, that is, participation in international trade in raw materials and energy-intensive goods.... The inflow of foreign direct investment (hereinafter - FDI) is due precisely to the attractiveness of the natural resource sector in Kazakhstan.

Strengthening international climate policy leads to the fact that investments in energy-intensive and resource-intensive projects may very soon turn into „locked“ assets. Removing the carbon price from carbon-intensive goods at the border of importing countries, if it is not paid in the country of origin of the goods, will lead to a decrease in the income of investors. Only an active policy of deep decarbonization of the Government of Kazakhstan can affect the expected unfavorable forecast of a decrease in FDI inflows to the economy and FDI outflows from Kazakhstan.

A decrease in exporters' incomes and, accordingly, a decrease in state budget revenues will reduce the possibility of financing education, health care, transport systems, and the potential for creating new jobs and economic growth will decrease. Therefore, it is necessary to take immediate action during 2021-2022. The state should not support investments in carbon-intensive (fuel-intensive) projects. This is the road to stuck assets. The state supporting such investments faces severe economic problems.

Current situation with GG emissions

GG's national net emissions in 2019 amounted to 364.5 million tons of CO_2-eq., Which is 2.4% below the 1990 level.

79.9% of national GG emissions are associated with the extraction, processing, transportation, storage and combustion of fuels. Emissions from this source category in 2019 are 8.5% lower than the 1990 level (Table 1).

The second most important source of national GG emissions in Kazakhstan is agriculture, its share is 10.2%. Due to the fact that the livestock population has significantly decreased compared to the 1990 level and the use of nitrogen fertilizers by farmers has decreased, the absolute volume of emissions from this source category is 15.5% less than in 1990.

Non-fuel emissions from industry are 5.9%. The absolute volumes of emissions exceeded the 1990 level by 11.7% due to an increase in the production of steel, ferroalloys, non-ferrous metals, cement and other mineral products.

The category of emission sources and sinks GG „Land use, land use change and forestry“ (hereinafter - LULUCF), which includes arable land, pastures, human settlements and forestry, became a net emitter in 2019, that is, emissions exceeded absorption, in while in 1990 the net absorption was 11.6 million tons of CO_2.

Table 1. **Change in GG emissions and removals by GG source and sink categories, thousand tonnes of CO2-eq**

GG Source and Sink Categories	1990	2018	2019	Change in 2019 to 1990,%
Energy activity	317963.5	312761.0	291084.5	-8.5
Industrial processes and product use	19405.9	21697.5	21678.1	11.7

Agriculture	43869.0	36217.4	37089.3	-15.5
LULUCF	-11629.8	12437.1	9613.4	-182.7
Waste	3783.7	4906.0	5017.6	32.6
TOTAL net emissions	373392.2	388019.1	364483.1	-2.4

Three main greenhouse gases account for 99.56% of the total GG emissions. This is carbon dioxide (CO_2), which is mainly released when organic hydrocarbon fuels are burned. CO_2 emissions and removals also occur in LULUCF. In 2019, the share of CO_2 in GG's national emissions was 83.8%. The second place is occupied by methane (CH4) with a share of 11%. The third is nitrous oxide (N2O) with a share of 4.8%. The remaining greenhouse gases total less than 0.5%: hydrofluorocarbons (HFCs) - 0.31%, perfluorocarbons (PFCs) - 0.18% and sulfur hexofluoride (SF6) - 0.00054% (Fig. 4).

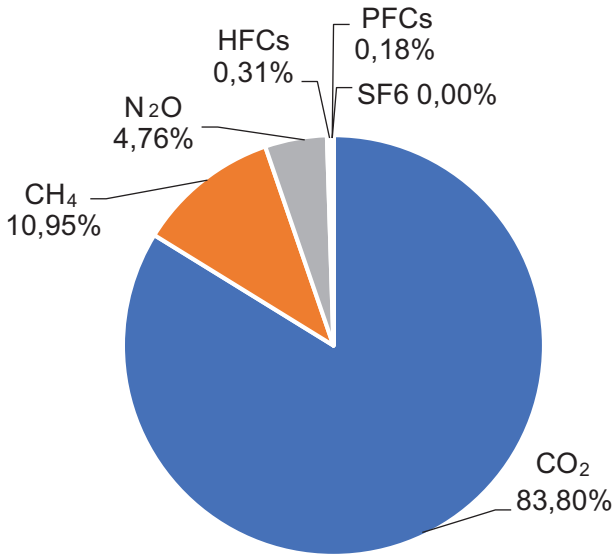

Figure 4. **Structure of GG emissions by gas type for 2018**

Note: GEIsmagulova, National Emission Inventory 2021 Zhasyl Damu JSC.

Two-thirds of GG emissions in Kazakhstan are somehow related to coal, that is, they are released into the atmosphere during the extraction, transportation, storage, processing and combustion of coal in all sectors of the economy.

68.9% of electricity in Kazakhstan is generated from coal... More than 50% of the fixed assets of power plants are worn out.

If all the necessary measures are not taken in a timely manner at the country level, the aforementioned new global development challenges will lead to a significant decrease in the competitiveness of Kazakhstani exporters in the medium term, to

a significant decrease in their marginal revenues, respectively, to a decrease in tax revenues to the state budget and a reduction in investment in the economy.

Zhasyl Damu JSC has developed a Roadmap for the implementation of NDC for 2021-2025, the implementation of which will create resilience to exogenous uncertainties, which will minimize risks and optimize economic benefits.

In the face of an inevitable reality, the Government of the Republic of Kazakhstan should find compromise (balanced) solutions that support not only „green" projects in various sectors of the economy, but also allow existing „brown" companies to adapt until 2023 and then until 2030.

The doctrine of achieving carbon neutrality

The doctrine defines the main directions and indicators of transformation of economic sectors that make a significant contribution to national GG emissions.

The main purpose of the document is to provide strategic (ultra-long-term) step-by-step planning for achieving carbon neutrality by 2060, taking into account national interests, that is, not to the detriment of economic development in general and the well-being of the nation. Some sectors, such as coal and coal power generation, blast furnace steel production, will have to shrink significantly. Reducing the carbon intensity of the economy will help maintain the competitiveness of the national economy in the international trade system.

Achieving carbon neutrality requires a technological transformation of sectoral policies in sectors that greatly contribute to a country's carbon status. According to „The Global Carbon Atlas, 2019" (http://www.globalcarbonatlas.org), Kazakhstan ranks twenty-first in carbon dioxide emissions among 221 countries, eleventh in per capita emissions and fifth in carbon intensity of GDP. However, it is important to note that Kazakhstan's contribution to global carbon dioxide emissions in 2019 was only 0.86%. According to the given data, Kazakhstan looks very bad in the world carbon rating, therefore, increased attention of international development institutions is now directed to Kazakhstan.

Achieving carbon neutrality means that all emissions that may still occur in the economy in 2060 must be completely captured from the atmosphere and absorbed by soils and vegetation, that is, ecosystems. If the economy is still emitting more GG in 2060 than our ecosystems can absorb, then there must be sufficient industrial carbon capture and storage technologies to capture carbon dioxide before the exhaust gases are released into the atmosphere and safely buried. ... Thus, by balancing GG emissions and removals, Kazakhstan will be able to achieve carbon neutrality.

In 2060, the economy may still emit 76.6 million tons of CO_2-eq., Of which 45.2 million tons will be absorbed by ecosystems, 31.4 million tons of CO_2-eq. to be compensated for by carbon capture and storage technologies (hereinafter referred to as CCS), which are not yet commercialized (it is assumed that they will be available on the market by that time).

The largest source of GG in 2060 will be agriculture, with emissions of 42.4 million tons of CO_2-eq. Livestock emissions will increase due to the increase in livestock numbers, but will be less than in the baseline scenario. Kazakhstan has a

huge potential for the production of organic agricultural products. Organic products are significantly more expensive than products obtained by traditional agricultural methods. The global organic market is growing despite the COVID-19 pandemic. Agriculture can become a growth driver. Crop production stops emitting GG and increases absorption capacity due to 100% organic farming.

The absorption of GG by pastures and forest plantations will increase. In general, LULUCF in 2060 will ensure the absorption of 45.2 million tons of CO_2-eq. Thus, emissions from agriculture are fully offset by LULUCF. LULUCF can also fully offset emissions from transport, which can be reduced by more than 10 times through electrification and the use of hydrogen fuel.

The second large emitter will be industry (ferrous and non-ferrous metallurgy, production of cement and other mineral products). Emissions will amount to 21.6 million tons of CO_2-eq., Difficult to reduce. 3.9 million tons of CO_2-eq. Associated with fuels in industry must be neutralized by CCS technologies.

In the electricity generation sector 19 million tons of CO_2-eq. compensated by CCS technologies.

Coal mining is stopped and emissions are reduced to „0".

The oil and gas sector will emit 6.1 million tons of CO_2-eq.

In the HUI sector and the service sector, direct emissions will be reduced to „0" due to electrification, district heating, use of distributed RES sources.

The economy's demand for electricity will increase by about six times by 2060 in the CN scenario. In the structure of power generation, the share of RES capacities, including large HEPs, will increase from the current 11% to more than 83% in 2060. All coal-fired power plants must be decommissioned by 2050 (natural disposal). Nuclear energy remains uncompetitive until 2060, since after 2035 Kazakhstan will be able to import cheaper natural gas due to a decrease in global demand for it.

Table 2. **Electricity production by type of primary fuel and energy resources, billion kWh**

	2020	Base				Carbon neutrality			
		2030	2040	2050	2060	2030	2040	2050	2060
Coal	74.5	71.7	58.1	29.5	31.4	33.5	13.3	0.2	0.0
Gas and hydrogen	21.6	44.3	58.1	80.4	100.8	39.8	70.7	78.6	102.6
Fuel oil	0.6	0.9	1.8	1.6	1.6	0.3	0.2	0.1	0.0
Hydro	9.5	11.5	19.0	25.0	19.1	23.2	25.4	25.4	19.5

Wind	1.1	1.0	6.0	8.6	10.6	21.0	97.3	173.3	201.7
The sun	1.3	1.3	2.3	4.8	8.2	12.6	48.8	157.6	283.5
Biomass	0.005	0.0	0.0	0.0	0.0	1.6	1.6	3.2	4.5
Total	108.1	130.7	145.3	149.9	171.8	132.1	257.3	438.3	611.8

In the CN scenario, hydrogen fuel (H2) appears. It will be produced in Kazakhstan mainly from RES, but also from gas. There will be domestic demand for H2, mainly from industry, energy and transport (Table 3).

Table 3. **Expected domestic demand and supply of hydrogen as an energy resource**

H_2 consumption (demand for hydrogen fuel in the following sectors), ktoe								
	2025-2030	2031-2035	2036-2040	2041-2045	2046-2050	2051-2055	2056-2060	2021-2060
Power generation	43,8	0,0	0,0	1534,9	3789,5	6936,6	10482,8	22787,6
Industry	399,5	856,2	3057,5	4169,3	4890,4	5748,9	5491,9	24613,6
Population	0,0	0,0	0,0	0,0	0,0	20,6	0,0	20,6
Commercial sector	0,0	0,0	28,7	0,0	0,0	0,0	0,0	28,7
Transport	39,9	49,7	97,2	154,4	284,5	408,6	369,3	1403,6
Total demand	443,4	856,2	3086,2	5704,2	8679,9	12706,1	15974,7	48854,2

H_2 production (the possibility of hydrogen production from the following types of fuel and energy resources), thousand toe								
from coal	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
from biomass	0,0	58,8	34,8	0,0	0,0	0,0	0,0	93,7
from RES	96,0	127,1	2428,7	5279,3	8964,4	13114,8	16344,0	46354,2
from natural gas	387,2	719,9	719,9	579,2	0,0	0,0	0,0	2406,3
Total offer	483,2	905,8	3183,4	5858,6	8964,4	13114,8	16344,0	48854,2
Deficit (-) / surplus (+)	39,9	49,7	97,2	154,4	284,5	408,6	369,3	0,0

The doctrine will be implemented through five-year roadmaps for the implementation of the NDC.

Updated NDC until 2030 and the Roadmap for the implementation of the updated NDC of the Republic of Kazakhstan for 2021-2025

The updated NDC of the Republic of Kazakhstan until 2030 contains the main goals for reducing GG emissions, which the country undertakes to achieve in time. The document will be transferred to the UN FCCC Secretariat and will be kept by the depositary - the UN Secretary General.

The document contains new sections such as „Ambition and Fairness of Purpose“ and „Risks of Non-Implementation of the NDC“.

In addition, the updated NDC, in addition to the mitigation section, now contains an adaptation section.

All parties to the Paris Agreement are required to update their NDCs (Nationally Determined Contributions to the Paris Agreement Temperature Target) every five years starting in 2020, with the revised targets extended over the next five years. The world community expects from all countries with each update of the NDC to increase the previously announced ambitions.

Accordingly, for each forthcoming five-year period, roadmaps for the implementation of the NDC with the corresponding investment plans should be carefully developed.

Updating the NDC, developing five-year Roadmaps may require a corresponding updating of the Doctrine (adjusting long-term indicators and technological priorities).

Why do we need to increase our ambition every five years when updating the NDC?

1. The climate is changing so rapidly that it requires a faster rate of reduction in global emissions.
2. New technologies appear, technologies become more accessible, new barriers may appear on the way to the intended goal and new opportunities open up. All this requires updating the calculations and adjusting the previously outlined action plans.

The roadmap for the implementation of the updated NDC for 2021-2025 was developed as a Technical Guide for the Government of the Republic of Kazakhstan to achieve the goals of the NDC.

The first Roadmap was developed with broad stakeholder involvement. It provides for the achievement of the 2030 goal in three stages. 9 institutional and 44 sectoral decarbonization measures have been developed.

Ideally, the Roadmap will reduce emissions by more than 15% relative to 1990 emissions (down to about -23%). But given the risks that the Government needs to cope with, remove barriers that restrain business, and invest in projects to reduce GG emissions, the Development Team of the updated NDC and the Roadmap recommended leaving the quantitative commitments at the previously announced level, despite numerous pressures from external forces. Towards 2025, it will be clear whether Kazakhstan can quantitatively increase its ambitions.

Achieving carbon neutrality on time with minimal economic losses requires a notional target (-25) by 2030. The developed Roadmap does not contradict the Doctrine.

In the Roadmap for the implementation of the updated NDC of the Republic of Kazakhstan for 2021-2025. describes how to change industry policies if they interfere with the implementation of the NDC. Also, it presents 9 cross-sectoral (institutional) and 44 sectoral decarbonization measures in sectors of the economy, which make a significant contribution to national GG emissions.

List of institutional measures to be implemented in the next 2 years:

- gradual and sequential tightening of the ETS and the revitalization of exchange trading in carbon units;
- introduction of carbon taxation to regulate emissions of all emitters not covered by the ETS, to protect domestic producers and to minimize exogenous risks associated with the introduction of CBAM;
- Creation of the Kazakhstan Economy Decarbonization Fund to invest in low-carbon projects;
- formation of the Bank (portfolio) of mitigation projects ready for implementation;
- introduction of a system of green certificates;

- change in the technological structure of electricity production towards an increase in the share of RES and less carbon-intensive maneuverable gas TPP;
- improvement of the national MRV system;
- preparing the ground for a gradual rise in prices and tariffs for energy carriers;
- integration of all target indicators and decarbonization measures of the Roadmap into the state planning system.

The Roadmap presents the ranking result of all selected sectoral decarbonization measures. The set is segmented into four groups at the cost of reducing a GG unit. The first segment grouped the twenty cheapest measures at a cost of reducing a GG unit to USD 30, the second segment - 10 measures at a cost from USD 30 to USD 90, in the third segment - 10 measures at a cost of USD 90 to USD 212.5 and finally, in the last segment, there are four measures at a price higher than USD 212.5 per 1 tonne of CO_2-eq. Within each price segment, the measures were ranked according to the totality of all factors (according to the complex index).

The description of each sectoral measure (in a unified tabular format) sets out:

- key indicators by industry measure;
- potential to reduce GG emissions as a result of the implementation of this measure;
- what indicators need to be monitored to prove emission reductions;
- the need for investments (from what sources they are expected);
- accompanying economic, environmental and social effects;
- risks of not implementing each specific measure.

For each risk of non-implementation of sectoral measures, the following are spelled out:

- problem statement (barrier / risk);
- which government agency is responsible for removing this barrier;
- the form of removing the barrier;
- the term for removing the barrier.

That is, within the framework of the five-year Roadmaps, all policy issues and measures are carefully worked out.

All government agencies and other stakeholders can work closely with the permanent Project Office for the implementation of the NDC, or the Project Office for the implementation of obligations under the Paris Agreement, which will be created in 2022.

8.3 Adapting to climate change

What will happen to the climate in Kazakhstan in the current century?

Climatologists predict a further increase in air temperature in Kazakhstan until 2100 in all seasons. The average increase in air temperature by 2050 will be 2-3°C,

and by 2100 - 3-6° From a relatively pre-industrial level. In general, the number of hot days with temperatures above + 30-35 ° C will increase, and the frequency of frosty days will decrease.

The duration of the growing season in Kazakhstan will increase, which will allow more than one harvest to be taken in one season. Many countries have already adapted to these changes, including those in Central Asia, and are benefiting accordingly.

Annual precipitation up to 2050 may increase by 0-10%, by 2100 - by more than 10%. In the summer, in the southern regions, a decrease in precipitation is likely. Winters will be warmer and wetter. This is especially true for the northern, foothill and mountainous regions.

Global climate models show that water-rich regions of the world will experience more rainfall and flooding, and dry climates will become drier.

Global warming leads to an increase in the frequency of extreme (dangerous) natural and climatic events in Kazakhstan, in particular:

- the duration and frequency of hot days increases (above +30°C);
- dangerous meteorological phenomena such as heavy rains, snowfalls, winds and hail are becoming more frequent;
- with rapid melting of snows, heavy and prolonged rains, the frequency of floods and floods increases;
- with sharp jumps in temperature in the spring, the frequency of river jams increases;
- in the absence of precipitation for a long time, there is a threat of drying up of small streams and reservoirs;
- Mudflow and landslide danger in mountainous areas is growing due to (1) increased frequency of wet precipitation in large volumes, (2) degradation of glaciation and thawing of permafrost massifs, the emergence of new periglacial and moraine lakes.

Priority sectors for adaptation policies

On July 1, 2021, the new Environmental Code of the Republic of Kazakhstan entered into force, which provides for Chapter 22. Public administration in the field of adaptation to climate change. According to Article 313.2. priority areas for adaptation to climate change are: agriculture, water management, forestry, civil protection.

Current policy

The process of developing a state policy for adaptation to climate change has started. International donors help Kazakhstan build up competencies, build models for assessing climate risks, expected damages and benefits. Based on the results obtained, a National Adaptation Plan will be developed, and experience in the development, improvement and implementation of adaptation policies will be gained.

The adaptation is planned and autonomous. Planned adaptation is implemented through the state planning system. Autonomous is an independent response of market entities (the state must create conditions in the market, ensure the availability of technologies).

Cities will experience strong heatwaves due to the urban „heat island“, which retains heat in them more strongly than rural settlements. Therefore, mayor's offices should have adaptation action plans to minimize damage to the economy, public health and ecosystems.

8.4 Modeling as a tool for assessing the impact of various policies and measures on GG emissions and socio-economic development parameters

The development of climate policy and the adoption of appropriate decisions by the Government of the Republic of Kazakhstan require highly qualified expert support based on modeling, interpretation of the results obtained, analysis and forecasting of the development of industry and financial markets.

There are very few modellers specializing in reducing greenhouse gas emissions and increasing adaptive capacity to climate change in Kazakhstan. Given that decarbonization and adaptation are closely related to sectoral and territorial development plans, universities need to pay attention to the training of relevant specialists.

With the financial support of the German Government in the framework of the GIZ projects[13] several high-quality models were developed for the Kazakh Government and transferred to the use of Zhasyl Damu JSC[14], as well as JSC „Economic Research Institute“ of the Ministry of National Economy of the Republic of Kazakhstan.

The simulation results became the basis for the development of the Doctrine of achieving carbon neutrality by the Republic of Kazakhstan until 2060. Adaptation modeling results will form the basis of the National Adaptation Plan.

Zhasyl Damu JSC will on an ongoing basis develop the developed models and use them to advise not only the Government represented by the authorized state body, but also all stakeholders, including businesses, ministries and mayor's offices.

Simulation for mitigation

The following models are used to assess the feasibility of declared commitments under the Paris Agreement in Kazakhstan:

TIMES - is a high-tech bottom-up model generator that uses linear programming to optimize the future power system that requires the lowest cost and meets the constraints and development opportunities introduced into the model. The TIMES energy model used by Zhasyl Damu JSC considers about 190 thousand equations. In

[13] German Society for International Cooperation.

[14] Zhasyl Damu JSC is one of the oldest scientific-consulting subordinate structures of the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan, the authorized body in the field of environmental protection and is responsible for the implementation of the Paris Agreement, and 2021 will mark the seventieth anniversary of it. Zhasyl Damu is currently merging with the non-profit „International Centre for Green Technologies and Investment Projects“ JSC.

it, 17 regions of the country are grouped into 4 climatic zones. This is a technological model of production and use of energy resources „from the bottom up“, contains information on the technologies used for each sector, types of energy sources with their prices, and so on. A total of 43190 variables were collected and entered into the model. The model allows an in-depth analysis of energy development and climate impacts in the medium and long term. The model covers all sectors of the economy, mining,

CGE is a computable macroeconomic general equilibrium model that allows one to assess the impact of various regulatory policies on various parameters of the development of a market economy, for example, GDP, GVA of industries, government and household revenues, investments, employment, as well as total GG emissions, including, along with GG emissions from energy activities, emissions not related to fuel handling. The CGE model is built from top to bottom, assuming that the markets in the model are balanced. 3425 nonzero parameters and 3317 variables were collected and introduced into the used CGE macroeconomic model. CGE allows you to simulate the impact of different policies on the main economic and selected social and environmental parameters of development.

For the five sectors most sensitive to the impact of decarbonization policies: coal mining, HUI with a focus on heating buildings, vehicles, agriculture and the waste management sector, an SD (System Dynamics) model was built to assess the impact of proposed policies on the economic, environmental and social parameters of the development of these industries, but above all, in terms of socio-economic consequences.

Based on the dynamic CGE model, by linking it with the TIMES and SD models, a hybrid model has been built and used.

It should be noted that in the future, the range of models used to develop the GG emission reduction policy will expand, including LEAP / WEAP, GAINS and others.

Conclusion

To develop a state policy for adaptation to the consequences of climate change, it is necessary to have access to the results of modeling scenarios for the development of climate change in the country. Currently, Kazakhstan does not have its own climate model, but has access to the results of open global climate models. It is desirable to have your own climate model.

An E3.kz model is being developed and will be shared with Zhasyl Damu JSC and other stakeholders for the economic assessment of vulnerability and modeling of climate resilient scenarios under the GIZ Global Policy Recommendations for Climate Resilient Economic Development (CRED) program.[15]

[15] E3 stands for „Economy, Ecology, Greenhouse Gas Emissions“.

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Content

teaching aid

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