

Original Research Paper

Economic Impact of Climate Change: Elaborating the Policy for Sustainable Development of Central Asia

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Abstract: The article deals with the theoretical and practical aspects of the impact of global warming on the sustainable economic development of the Republic of Kazakhstan and Central Asia. In particular, we touch upon the impact of climate change on water resources, agriculture, ecosystems, etc. and propose measures to minimize, prevent and reduce economic losses from the lack of water resources, pollution and depletion of water bodies and ecosystems.

Keywords: Climate Change, Global Warming, Sustainable Development, Natural Resources, Central Asia, Strategy of Socio-Economic Development

Introduction

Changing the environment and all systems of mankind life support (environmental, social, political, economic and cultural) caused by global warming enables us to see the strong interrelation of climate change and economic growth.

In all countries, regardless of the recognition of global warming, scientists are conducting research and trying to predict the effects of climate change: Environmental, economic and social. Governments in many countries are developing strategies and programs to respond to possible threats and challenges of nature.

The World Bank in its report “Adapting to Climate Change in Europe and Central Asia” came to the conclusion that the countries of Europe and Central Asia are subjected to a significant threat due to the climate change despite the fact that some of the most serious factors had previously become a reality. In Europe and Central Asia, there is an increase in the average temperature by 0.5 and 1.6° in southern Siberia. The global nature of the changes in the environment requires a coherent strategy for the future economic and social development (WBR, 2009).

Problems of sustainable economic development in terms of climate change are studied in the works of scholars such as Aydaraliyev A.A., Bokonbayev K.D.,

Vaschekin N.P., Delokarov K.H., Evseyenko A.V., Krasnova M.A., Nesterov A.V., Ursul A.D., Fomin V.M., Chistyakov V.M., etc.

Many scientist gave their view how to protect environment and avoid negative consequences of climate change. For example, some researchers emphasize, that forest is “playing a key role in mitigating climate change through the capture and storage of carbon” and “considered a major asset for the socio-economic growth of rural areas” (SgROI *et al.*, 2016). Authors propose to create new mechanisms of managing forest that human can properly use natural resources and can pay for it. As a result, this innovation can bring more positive impact on climate change and economic development of some regions (SgROI *et al.*, 2016).

The main purpose of the work is to determine the nature of the concept “global warming”, to identify factors associated with climate change, defining the sustainable development of the Republic of Kazakhstan and the Central Asian countries and to develop practical recommendations for their minimization and prevention as well as reduction of economic damage.

Materials and Methods of Research

The theoretical basis of the research is represented by works of the domestic and foreign scientists on climate

change and its impact on sustainable economic development. There are abstract-logical and judgment-based methods in justifying the theoretical assumptions and economic-statistical and monographic methods in the assessment of factors affecting the sustainable development of the Central Asian economies.

Results

The results of global climate change cause a widespread concern of the world community and this is understandable, since environmental change may lead to a number of fundamental and, for some regions, disastrous effects.

In the world, regardless of the recognition of the presence of global warming, studies are carried out to timely predict climate change impacts (environmental, economic and social) and concepts and strategies for responding to them are developed.

The issue of global warming is the subject of many works, by both domestic and foreign scholars who address various aspects of the designated problem. One of the first scientists who studied the problem of global warming is a Russian scientist V.I. Vernadsky, who studied climate change as early as 1927 in his "Essays on Geochemistry" (Vernadsky, 1927). Since in the early XX century warming took place not as active as at the present stage, this subject did not deserve enough attention. Currently, many scientists are conducting research dedicated to identifying the causes of global warming, due to the intensification of these processes and the need for practical measures to mitigate the harmful effects of challenges and threats. Among them are A.A. Averchenkov, S.A. Glazyrin, A.A. Golubev, V.G. Gorshkov, A.N. Dronin, B.V. Lukutin and other scientists.

The review of latest researches and our own investigation allowed us to sum up the following main features of climate change and economic of global warming:

1. Mountains and hills occupy one-fifth of the land surface and are a major environmental Earth system. About 10% of the world's population live in mountainous areas and more than half use mountain resources and because the majority of the world's rivers originate in the mountains, they perform the function of fresh water collection.

Neglect of humanity to natural resources including mountains has led to the fact that at the beginning of the XX century socio-economic situation of mountain areas has worsened, which resulted in negative problems (ethnic tensions, poverty, land and ecosystems degradation, etc.).

The problem of global warming has affected the Central Asian states as well. Currently, many researchers have attempted to find a way out of the crisis by developing various strategies and socio-economic

development programs. However, not all of them take into account the seriousness of the problems that may arise due to climate change.

2. Today, all over the world, scientists are actively studying problems related to the impact of climate change on the vulnerability of the economy and population, taking into account the possible scenarios of the consequences and the methods which allow to adapt to them.

Intense climate change is observed in all countries of Central Asia and all the studies of water resources in the region attest to the fact that we should not expect any enhancement of available water resources. According to the calculations of the Eurasian Development Bank (EDB), by 2050 the volume of river flow in the Amu Darya River basin will be reduced by 10-15% and in the Syr Darya by 6-10% (Ibatullin *et al.*, 2009).

Furthermore, according to an industry survey by EDB in the mountainous regions of the Republic of Kazakhstan and the Central Asian countries there is a progressive degradation of land resources, which entails desertification, salinization and waterlogging and environmental pollution leads to a reduction of forests and biodiversity (Ibatullin *et al.*, 2009).

3. The Republic of Kazakhstan is located in the center of Eurasia. A large part of its territory belongs to the arid zone, represented by steppes, semi-deserts and deserts. According to the World Bank report "Review of the Activities in the Field of Climate Change" (WBR, 2013) the average temperature ranges from -18°C in the north to -3°C in the south (in January) and from 19°C in the north to 29°C in the south (in July). The daily difference in temperature reaches 20-30°C. The rates of warming observed since 1936 indicate that the climate of Kazakhstan is becoming warmer and the temperature rise is recorded almost everywhere, at any time of the year. From 1936 to 2014 the average annual air temperature every 10 years increased by 0.31°C (WBR, 2013).

Since Kazakhstan is land-locked, this fact creates a sharply continental climate with an almost countrywide lack of precipitation. The level of precipitation in the foothill areas ranges from 500 to 1600 mm per year, in the steppe zone—from 200 to 500 mm, in deserts—from 100 to 200 mm. According to the World Bank, changes observed in the period from 1936 to 2014 do not have a clear trend of change in the regime of annual and seasonal precipitation in Kazakhstan (WBR, 2013).

In many regions of the country there is an increased annual amount of precipitation and the most significant growth has been observed in the southern mountainous part of the Urals, as well as in the foothills and mountains of southern Kazakhstan. In winter, almost the entire territory of Kazakhstan observes an increase of the daily maximum rainfall, while the reduction of the maximum duration of low-water period (lack or faint) is observed almost all over Kazakhstan, with the most

noticeable reduction observed in the north and southeast of Kazakhstan (WBR, 2013).

According to many scientists, there are already serious risks of global warming. For example, hot summers with periods of intense heat creates a large load on the transmission network of the country and frequent natural and emergency situations relating to climate change entirely threaten the existing network capabilities, which cannot function properly (WBR, 2013).

In addition, all of these changes can create a huge burden on natural ecosystems. Serious problems are expected in the shortage of water resources and their impact on the agricultural sector and all these climate changes will affect human health (CAN Report, 2009).

Thus, the possible trends of climate change in Kazakhstan in the World Bank report can be characterized as follows:

- A further increase in temperature in the country and the increase in average temperature will be by 1,4°C-by the year 2030, by 2,7°C-by the year 2050 and by 4,6°C-by the year 2085
- An expected increase in the amount of precipitation in winter (9%) and spring (5%), as well as an expected increase in precipitation intensity and variability, but it is expected by mid-century. However, some models predict an increase in annual rainfall by 2%-by the year 2030, 4%-by the year 2050 and 5%-by the 2085, while other models project a decline in the rainfall by the year 2085 by an average of 11%
- A possible reduction in the number of frost days. In this case the expected weather conditions are unfavorable for the production of cereals, particularly winter wheat, for example, in Kostanai, Akmola and Pavlodar regions of Kazakhstan (Astana, 2009)
- Under a scenario of extremely high levels of GHG emissions, a projected shift by the year 2085 of the wet zone by 250-300 km to the north. In the latter case, all the northern regions of Kazakhstan will turn into a semi-desert zone (WBR, 2009)
- An expected climate change will increase water resources in mountain areas and, conversely, reduce them in the plain, which would entail substantial negative consequences for water resources

The shrinkage of glaciers will affect the river resources in the Lake Balkhash basin-one of the largest and most densely populated areas of Kazakhstan. While the results of the research indicate that the runoff of mountain rivers will significantly be reduced due to the shrinkage of glaciers there can be expected an additional transitional water flow into some rivers due to the rapid melting of glaciers and the melting of glaciers in the North Tien Shan that started in the XIX and XX centuries will continue due to climatic changes (Abakumova and Podovalova, 1999).

3. Currently, there are 2724 glaciers in Kazakhstan; the territory of a neighboring country Kyrgyzstan has 45% of glaciers (8200) with a total area of 8,000 square meters of Central Asia. It should be noted that the area of glaciers in Central Asia has declined by 25% compared to 1957 and in recent years more than 2,000 of them have already melted. The average speed of the retreat of glaciers is 8 meters per year. It must be emphasized that, since the 70 s of the last century, the rate of melting of glaciers has a pronounced tendency to increase. Melting of glaciers has a negative impact on the region's two main rivers, the Syr Darya and the Amu Darya, Kazakhstan is largely dependent on. For example, a fairly well-known Tuyuksu glacier in the past two decades has decreased by a kilometer and Syr Darya water flow has decreased by 7% in recent years.

For example, according to the "Second National Communication of the Kyrgyz Republic on the UN Framework Convention on Climate Change" (Bishkek, 2009) for Kyrgyzstan in general there is an expected reduction of glaciation from about 64 to 95% between 2000-2100 depending on the adopted variants of the climate scenarios.

Thus, we can assume that in mountain regions, climate change will lead to their disappearance and because the glaciers are the main water resources, this can lead to serious consequences in the whole Central Asian region, both socio-economic and political.

Over the past 40 years, the area of mountains covered with forests has reduced, for example, in the Kyrgyz Republic, by half. The few forests in Kazakhstan are also endangered. The area covered by forest is only 4.5% of the country. The total forest area of the Republic of Kazakhstan is 26 446 thousand hectares, of which covered with forests-12 284 hectares. Natural regeneration of forest does not take place. The area of cultivated land (about 7% of the territory) is dramatically reduced due to desertification, water logging or construction. Soil erosion has covered 70% of the land in the mountains. The area of glaciers and eternal snows has also reduced. There is a decrease in the number of surface water and groundwater and their quality is deteriorating. Because of soil erosion and man-made impact on the hillsides we can witness (especially in the last 50 years) an increase in the number of landslides, avalanches, floods and other disasters. The efforts of government agencies to address the problems of the forestry sector are unsystematic and episodic. The destruction of the natural environment and mountain resources can become irreversible.

Largely due to the impact of the above factors, the level of poverty of the Kyrgyzstan and Kazakhstan population, although tending to decrease, still remains very high. For example, according to the National Statistical Committee of the Kyrgyz Republic the overall poverty rate in 2013 was 31.7% and the extreme poverty

rate-6.1% (Fig. 1). The poverty line set by the regulatory legal act in Kazakhstan in 2012 amounted to 38% of the subsistence minimum which amounted to 40% in 2013. This indicator is characterized primarily by the economic capabilities of the state in the provision of targeted social assistance.

However, the most acute remains the problem of poverty in rural areas of the Kyrgyz Republic, the majority of which is located in foothill and mountain areas of the country. For example, if the number of people with consumer spending below the poverty line in urban areas is on average 1/5 of the population (22.6%), in rural and mountain areas the number of the poor is more than 1/3 of the population -36.8% (Table 1).

The low level of investment in mountain areas, low income, unemployment due to the closure of many state-owned industrial and agricultural enterprises, low yields, etc. have led to a mass migration of the population of mountains to valleys or other countries. Weak and unpopular is the system of secondary specialized vocational education: No more than 10% of young people

choose to study in vocational high schools. The quality of school teaching has degraded and many families cannot send children to school because of poverty.

Opportunities for self-realization of the citizens are better shown by the Human Development Index (HDI)-the main integrated indicator summarizing the indices which characterize the level of life expectancy, education and income, calculated on the basis of Gross Domestic Product (GDP) per capita at Purchasing Power Parity (PPP) in US dollars.

As can be seen from Table 2 the literacy rate in Kazakhstan for the period from 1990 to 2015 has been steadily growing. If in 1990 this figure was 97.7%, in 2015 it changed to 99.7%. The latter figure is the ratio of the total number of students at all levels of education, regardless of their age to the total population aged between 6 and 24. This indicator reflects the results of the education system. The percentage of total enrollment decreased by 7% during the period from 1990 to 1995 and in subsequent years we can see a gradual increase: From 81.0% in 2000 to 90.0% in 2015.

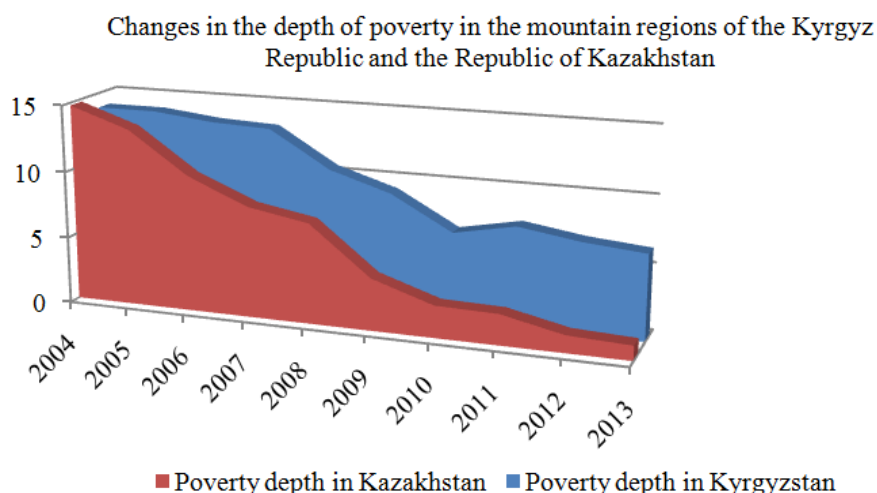


Fig. 1. Changes in the depth of poverty in the mountain regions of the Kyrgyz Republic and the Republic of Kazakhstan

Table 1. The number of population of the Kyrgyz Republic with consumer spending below the poverty line (in %)

	1996	1997	1998	1999	2000	2005	2006	2007	2008	2009	2010	2011	2012
Total	43.5	43.0	54.9	55	62.6	56.4	54.8	49.9	45.9	43.1	39.9	35.0	31.7
Urban	36.3	23.1	42.2	42	53.3	45.4	44.5	35.7	28.3	29.8	26.7	23.2	22.6
Rural	49.6	55.3	62.4	60	67.6	62.3	60.3	57.4	55.5	50.8	47.7	41.7	36.8

Table 2. Basic indicators and indices of human development in Kazakhstan in 1990-2015

	1990	1995	2000	2005	2010	2015
Life Expectancy (LE) at birth, years	68.1	63.5	65.4	65.3	65.91	68.41
Literacy rate, %	97.7	98.7	99.5	99.5	99.6	99.7
The total coverage of education, %	80.0	73.0	81.0	81.3	86.0	90.0
GDP per capita, USD, at PPP	6283	4508	5867	6378	8090	12769
LE index	0.718	0.642	0.673	0.671	0.682	0.724
Income index	0.691	0.636	0.679	0.707	0.733	0.809
HDI	0.650	0.620	0.614	0.657	0.696	0.714

The HDI dynamics in Kazakhstan for the period from 1990 to 1995 there was a decrease for 30 thousandth of points. The main reason of the HDI deterioration was a decrease in life expectancy by 4.6 years, GDP production per capita by \$1775 at PPP and total enrollment by 7 percentage points.

In 2000, HDI decreased from 0.620 to 0.614; although there is a growth in the rates compared to 1995, still a number of indicators of life expectancy and GDP per capita have not reached the level of 1990.

In the subsequent stage between 2000 and 2015 the human development indicators in Kazakhstan are gradually improving. HDI for this period increased by 10 hundredths of points. At the same time we can observe increased indicators in life expectancy at birth for 3.01 years, GDP per capita for \$ 6902 at PPP, the level of literacy by 0.2 percentage points and the total enrollment by 9 percentage points.

Thus, the main factor in the deterioration of the HDI in Kazakhstan at the stage of the transitional period was the GDP per capita, the second main is the total coverage of education and life expectancy at birth is the third factor.

In Table 3, according to the National Human Development Report (UNDP, 2010) there are data describing the dynamics of the Human Development Index and its components in the Kyrgyz Republic. According to research “in general the HDI in 2007 increased by 5.7 percent compared to 1993. In 1994-1998, there was a decrease in HDI, due to a slower growth in GDP per capita consumption. The maximum drop in the HDI was observed in 1995, when it was 0.642 and in 2007 it reached a level of 0.704.

In comparison with 1995 there was a steady increase in the income index due to a real GDP growth: In 1995 -0.384, in 2007 -0,498. Educational level index for the period under review remained virtually at the same level and amounted in 1995 to 0.859 and in 2007 to 0.897. Life expectancy index has fallen from 0.725 in 2000 to 0,715 in 2007. Some decline in the index is due to the transition of the country (since 2004) to the live birth criteria recommended by the World Health Organization and, accordingly, to infant and child mortality” (WHOR, 2013).

In general, it should be noted that the major components of the HDI income index and life expectancy index still continue to remain very low, as well as the quality of education in the country.

Our forecast of the time series for 2 forthcoming years in life expectancy at birth in Kyrgyzstan and Kazakhstan was carried out using a logarithmic trend in EXCEL package (Fig. 2).

The forecasting equation of LE trend for RK is as follows:

$$Y = 0.23 \ln(x) + 67.8$$

While the forecasting equation of LE trend for KR:

$$Y = -0.19 \ln(x) + 68.3$$

Where:

X = Year forecast

Y = Life expectancy (years)

Thus, life expectancy in the Republic of Kazakhstan in 2016 will amount to 69.5 and will reach 69.55 in 2017 and in Kyrgyzstan -68.85 and 68.8 years 0 Fig. 2).

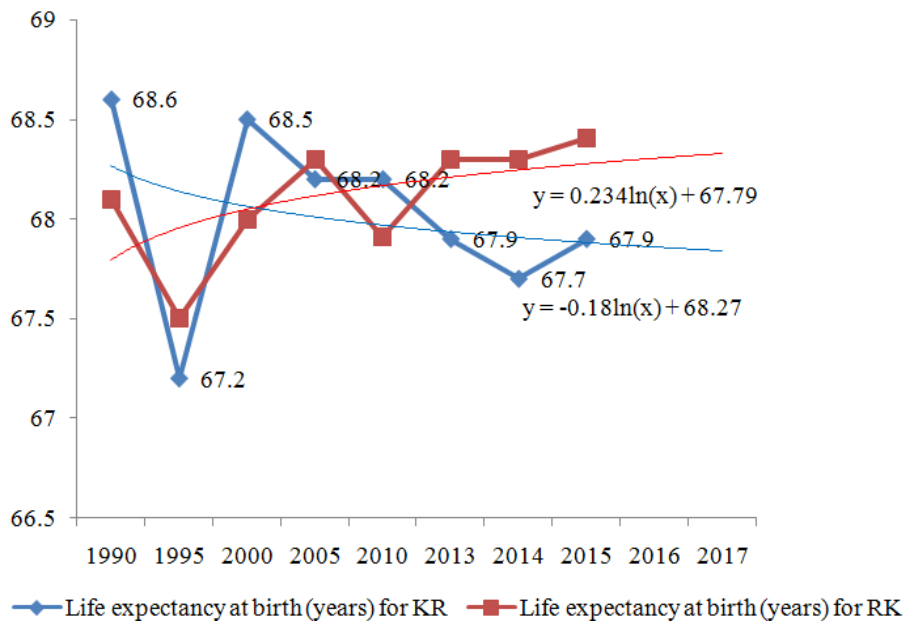


Fig. 2. Projected LE trends in Kyrgyzstan and Kazakhstan

Table 3. The components of the human development index in the Kyrgyz Republic

Index	1993	1995	2000	2003	2004	2005	2006	2007
Life expectancy at birth (years)*	67.3	66.0	68.5	68.2	68.2	67.9	67.7	67.9
Adult literacy rate (%)	97.3	97.3	98.7	98.7	98.7	98.7	98.7	98.7
The aggregate share of students in primary, secondary and higher education institutions (% among the population aged 7-24)	66	63	71	71	71	71	71	72
Real GDP per capita (PPP in 2005, \$)	1282	1000	1332	1558	1697	1728	1813	1980
Life expectancy index	0.705	0.683	0.725	0.720	0.720	0.715	0.712	0.715
The index of the level of education	0.867	0.859	0.895	0.896	0.895	0.896	0.895	0.897
Income index	0.426	0.384	0.432	0.458	0.473	0.476	0.484	0.498
Human development index	0.666	0.642	0.684	0.692	0.696	0.696	0.697	0.704

Experts of the International University of Kyrgyzstan, the International Institute of Mountains and the National Centre for the development of mountain regions of the Kyrgyz Republic, under the auspices of the Asian Development Bank developed “National and Regional Strategies and Action Plans for Sustainable Development of Mountain Regions of the Kyrgyz Republic, Kazakhstan, Uzbekistan, Tajikistan, Turkmenistan and Xinjiang (China)-National Strategy and Action Plan (NSAP) and Regional Strategy and Action Plan (RSAP)”.

The documents give comprehensive information about the destruction of nature, flora and fauna of the mountain. In the NSAP environmental and social problems of mountain areas are not simply listed. There is a deep and systematic analysis of their relationships, their level of hierarchy and dependence on environmental, economic, social and political conditions. Experts from different fields of life have developed schemes called “problem trees” (agriculture, protected areas, energy, forests, mineral resources, tourism, water).

These schemes allow visually seeing the interrelation and hierarchy of problems and levels and priorities for their solutions. Resolution of the “lower” level problems contributes to solving the problems of the next level, up to the “upper” level. These “problem trees” allow understanding which problems brook no delay and in what sequence they should be resolved.

Discussion

In summary, it can be noted that at present there is an intensive economic development of the mountains, degradation of mountain resources which increases from year to year and all this calls for a change in the development of mountain regions.

In the Republic of Kazakhstan there have currently been developed a number of key strategies, concepts, action plans to address the strategic areas of adaptation and mitigation of occurring climate changes.

So Strategy “Kazakhstan-2050” is aimed at the development of the energy sector; it considered the

development of alternative energy sources in the country, namely wind and solar. The document was developed in order to discharge the energy consumption by half, so that in 2050 they (alternative and renewable energy sources) accounted for at least half of the total energy consumption in the country.

Another important document is the “Second National Communication under the UN Framework Convention on Climate Change in Kazakhstan” (Astana, 2009). It contains issues of the impact of climate change on forest resources, debris flow activity, changing of glaciers and, of course, human health.

In addition, the Republic of Kazakhstan in the light of the transition to “green economy” adopted a concept in 2013 which reflects identified priorities: Increasing resource productivity, namely, water, land, biological resources (WBR, 2009).

Conclusion

In terms of global climate change in Central Asian countries, as we see it, very important is the development, institutionalization and implementation of policies that would enhance the effectiveness of water resources management, namely:

- Identification of the main areas which form the main water streams of the country in highly protected areas
- Introduction of innovative technologies contributing to the saving and improvement of the existing water supply and irrigation systems
- Expansion of the country’s forest resources
- Reconstruction and construction of new irrigation systems in mountain areas

The development of the hydropower sector in the country remains a major priority for the sustainable development of the country’s economy. To do this we need:

- Energy efficiency and conservation
- Use of renewable energy sources
- Improvement of tariff policy

The development of agriculture remains a priority for the development of the country's economy and creation of conditions for the rapid growth of production in the agricultural sector will contribute to the growth of employment and reduction of poverty in rural areas.

In order to build a modern state policy in the sphere of agriculture in the country there is a need for:

- Creation and development of a modern legislative and regulatory framework of the industry;
- Creation, development and operation of the system of secondary land market and formation of farming producing enterprises
- Development of the financial and monetary system in the agricultural sector of the country
- Institutional development of the industry (creation and development of farmers' (territorial and sectoral) associations
- Structural and functional restructuring of the Ministry of Agriculture of the Kyrgyz Republic and its regional and district departments
- Development of a civilized market chain: Producer (farmer)-buyer (procurement system)-processor-Distributor (trade)-consumer (population)
- Development of training and consulting services, information supply industry, transfer of new knowledge and Innovative technologies
- Development of science in the industry
- Sector integration into the regional economy and its appropriate positioning
- Formation and development of a fully functioning market infrastructure in the industry, etc

To ensure food security of the state it is necessary to address three key issues-problems related to the production of food, solvency of the population, as well as issues related to the protection of nature.

Thus, a systematic approach to the study of the environmental and social problems of mountain areas, developed in Kazakhstan and Central Asian countries should enter into a planetary information field of the concept of Sustainable Development.

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Author's Contributions

Assem Yessenbekova: Contribution to the writing of the Abstract, Introduction and section "Results."

Ainura Adieva: Data collection, contribution to writing the sections "Discussion", "Results" and "Conclusion."

Syrym Sharipkhanov: Contribution to the Literature review, writing the sections "Discussion", "Conclusion."

Ethics

The authors have read and approved the paper and no conflicts of interest in the publication of the paper.

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