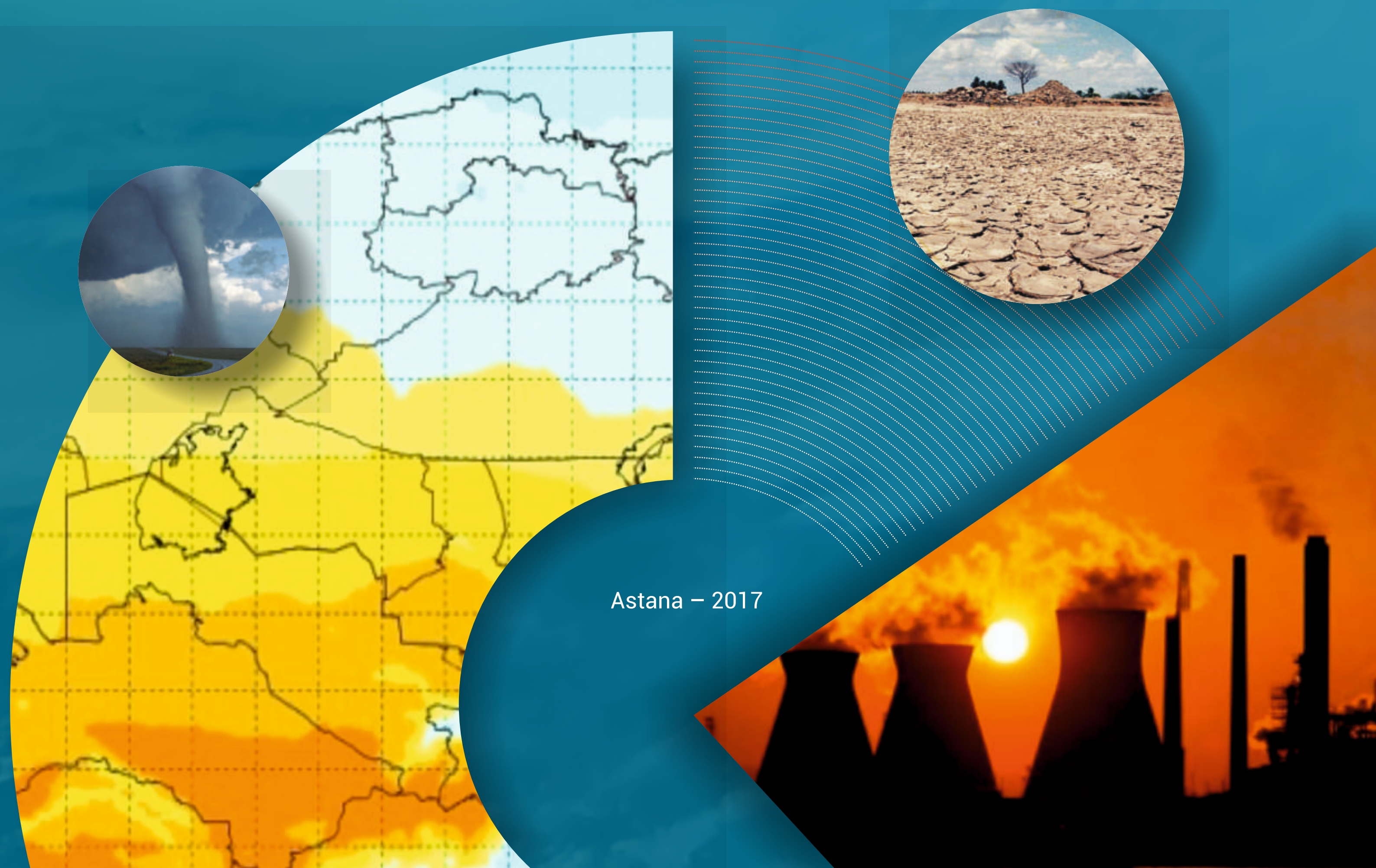
Ministry of Energy of the Republic of Kazakhstan
United Nations Development Programme in Kazakhstan
Global Environment Facility

SEVENTH NATIONAL COMMUNICATION AND THIRD BIENNIAL REPORT OF THE REPUBLIC OF KAZAKHSTAN TO THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE



Astana – 2017

Ministry of Energy of the Republic of Kazakhstan
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Seventh National Communication and third Biennial report of the Republic of Kazakhstan to the UN Framework Convention on Climate Change

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CONTENTS

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FOREWORD

Dear Colleagues,

The Republic of Kazakhstan is pleased to present you its Seventh National Communication and Third Biennial Report to the UN Framework Convention on Climate Change (UNFCCC).

Kazakhstan is an active contributor to the climate agreements. Since 1995, the country has engaged in activities to implement commitments and mechanisms of the international climate agreements, which have always been considered by our country as a comprehensive and global mechanism, aimed at creating incentives to improve legislation, adopt new technologies and know-how, and ultimately achieving the global goal of addressing climate change.

From 2013 to 2015, together with our international and national partners we were piloting and improving the emission-trading scheme (ETS). This system helped us to create opportunities for modernization of our economy, preventing rapid increase in greenhouse gas emissions and pollutants. The next stage would be creation of new indicators based on best available technologies in order to increase capacity of the country to reduce greenhouse gas emissions in manufacturing and oil-and-gas sectors. However, we do understand that industrial complex alone cannot be held responsible for all emissions in the country and enterprises should not become the only operators in achieving the goal of reducing GHG emissions. In this regard, measures have been taken in the country to reduce greenhouse gas emissions.

A new tool for nation-wide reduction of greenhouse gas emissions was created and developed in the country. Emission trading scheme has been advanced, in 2018 and onwards allocation of allowances will be done with due consideration of the best available technologies, which will support us in creating incentives for upgrading the energy complex and in creating conditions necessary to transform industry towards green economy.

Much has been done to improve legislation on GHG emissions regulations, on providing support for the use of renewable energy sources, and achieving energy saving and energy efficiency. We believe that it will enable us to create incentives to strengthen our efforts to address climate change. The Ministry of Energy has carried out commendable work to include new sections into the legislation, namely those related to climate change adaptation. A series of devastating floods on normally not flood-prone territories, which were considered rather safe in terms of possible flooding, has shown that adaptation works should be implemented across the country to ensure greater degree of safety for the people, infrastructure and food security.

We are constantly monitoring state programs and strategies to include adaptation and mitigation issues. However, still a lot remains to be done. It is important to find common action points, which will be beneficial to both the business community and society, as well as to the future generations.

An important step in this direction was organizing and hosting International exhibition EXPO-2017 “Future Energy” in Kazakhstan, with more than 3.8 million visitors. Through this lens, we have demonstrated latest global technologies and we hope to create opportunities for a paradigm shift in Kazakhstan. The Republic of Kazakhstan has gone a long way from traditional energy mix with large emissions and inefficient technologies to a state, which turns towards new innovative technologies, including those in coal and oil sectors. We are continuing to work on retrofitting the industrial complex, trying to create high-value-added along with introduction of high environmental standards.

We would like to thank all our international partners for the assistance provided to the country on this important path.

I. EXECUTIVE SUMMARY

Background information

The Republic of Kazakhstan is a unitary secular state with the presidential government system[1]. The administrative territorial system includes 14 regions, 2 cities with a republican status (Astana and Almaty), 177 administrative districts, 87 towns, 30 townships and 6693 rural settlements[2].

The area of the Republic of Kazakhstan is 2,724.9 thousand sq. km. Length of the country's state border is 13394 km.

Population of the Republic of Kazakhstan in May 2017 reached 18 million people. In 2012-2017 population grew by 1 million 341 thousand people.

Country's average population density in 2016 was 6.5 people per square kilometer.

Arid natural zones - desert, semi-desert and dry steppe zone- cover most of the territory of Kazakhstan. Only its northern part's conditions are more favorable in terms of humidity: steppe and forest-steppe.

Policy directives

In the Republic of Kazakhstan the most important decisions on climate policy are made by the President, the Parliament and the Government. The Ministry of Energy (ME RK) is responsible for climate policy administration in the country and climate negotiations on an international level. In its activity ME RK adheres to the adopted laws and planning documents in accordance with the state planning system. The interdepartmental coordinator for sustainable development is the Council for transition to green economy under the President of the Republic of Kazakhstan headed by the Prime Minister of the Republic of Kazakhstan.

The Government of the Republic of Kazakhstan introduced several «strategic plans» that set priorities and quantitative targets for the country development until 2050. «Concept for transition of the Republic of Kazakhstan to green economy», adopted by the President of the Republic of Kazakhstan in 2013, sets ambitious goals on reducing energy intensity of GDP, improving air quality, increasing the share of alternative energy sources and gasification of the country.

Under the current system of state planning (SSP)[3] that operates since 2010, strategic directions of government bodies and organizations are defined within five-year strategic plans.

In 2013, the emissions trading scheme (ETS) was launched in Kazakhstan. The pilot phase began in 2013 and covered 178 companies from the energy, oil and gas, mining and chemical industries that were responsible for 55% of GHG emissions. During its pilot phase, allocation of allowances was based on a historical approach. In 2016, a proposal was made to allocate allowances using best available technologies' benchmarks and where it is impossible - a historical basis. The updated ETS will enter into force in 2018.

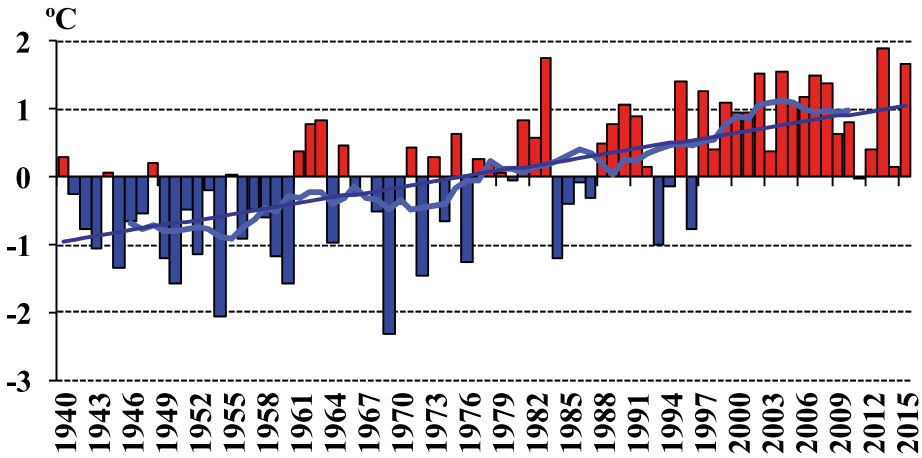
Kazakhstan signed the Paris Agreement on August 2, 2016 and ratified it on December 6, 2016. On September 28, 2015 Kazakhstan announced its nationally determined contributions (INDC - Intended Nationally Determined Contributions) stating that by 2030 Kazakhstan intends to achieve an unconditional reduction of greenhouse gas emissions at the level of minus 15% from the 1990 baseline.

1 Constitution of the Republic of Kazakhstan
2 Kazakhstan in numbers, Committee on statistics of the Ministry of national economy of the Republic of Kazakhstan (hereinafter referred to as Committee on statistics of RK), 2016.
3 http://adilet.zan.kz/rus/docs/U090000827_

Climate profile

The average annual temperature increase rate in Kazakhstan is by 0.28 °C every 10 years, temperature in Kazakhstan grows faster in spring and autumn – by 0.30 and 0.31 °C/10 years, in winter – by 0.28 °C/10 years, while the slowest temperature growth rate is registered in summer – by 0.19 °C/10 years. In accordance with the linear trend of air temperature anomalies (against the base period of 1961 ... 1990) for the year (Figure 1.1), all trends in the series of annual and seasonal values of surface air temperature are positive and statistically significant, indicating a steady increase in air temperature in Kazakhstan from 1941 to 2015).

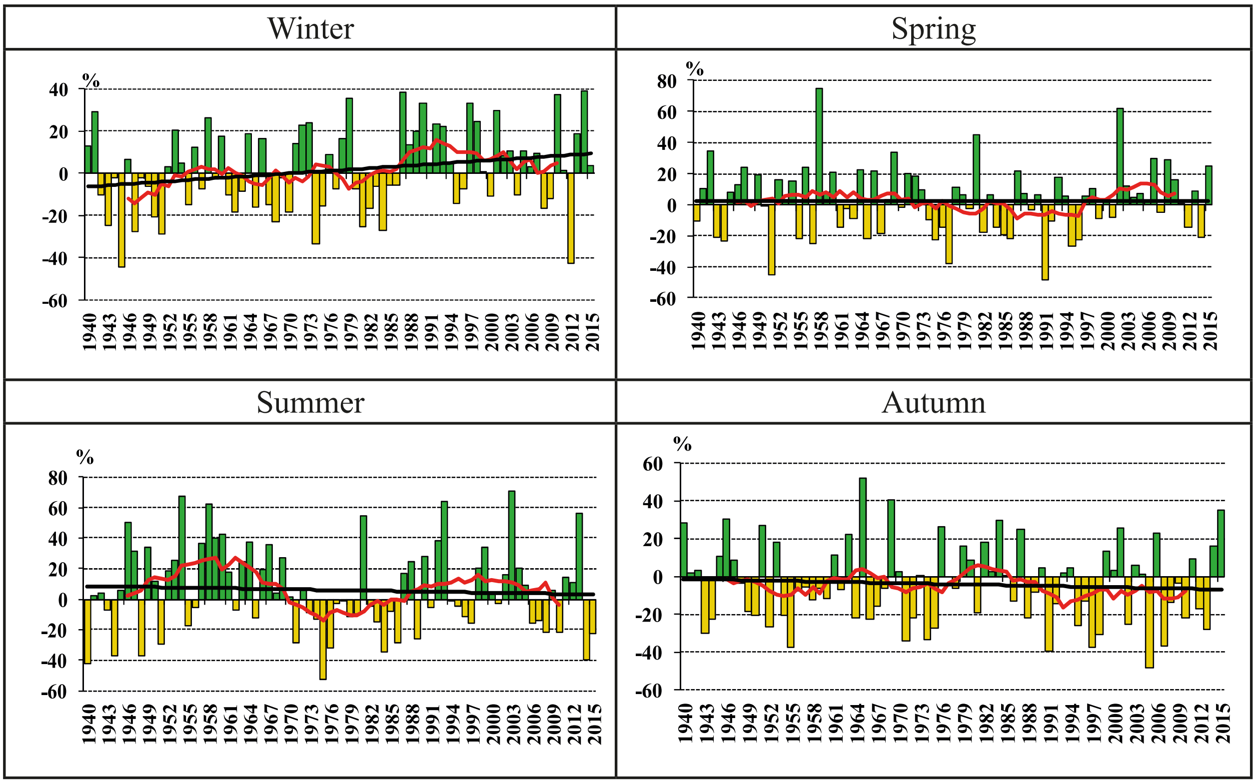
Figure 1.1. *Time-series and linear trend of annual average air temperature anomalies over the period of 1940...2015, spatially averaged over the territory of Kazakhstan.*



In contrast to air temperature, the change in the regime of atmospheric precipitation on the territory of Kazakhstan for the studied period presents a heterogeneous picture. In some areas of Kazakhstan, there is a slight increase in precipitation, and in others – a decrease.

On average for the period of 1940 ... 2015 annual precipitation values have fallen slightly in Kazakhstan – by 0.2 mm/10 years. On average for all seasons in Kazakhstan, a weak (statistically insignificant) trend of precipitation decrease by 0.7 mm/10 years can be observed in all seasons except winter when precipitation is increasing by 1.5 mm/10 years and the trend is significant. Thus, over the period under consideration a significant increasing trend is observed in winter time and a decreasing one is seen in other seasons.

Figure 1.2. *Time-series and linear trend of seasonal precipitation anomalies over the period of 1940 through 2015, spatially averaged over the territory of Kazakhstan. Anomalies are calculated in% against the base period of 1971-2000. Fitted curve formed with 11-year moving averaging.*



In the 21st century, further significant climate warming should be expected in all scenarios under consideration (Table 1.1).

Table 1.1. *Probable changes of annual and seasonal air temperature on the territory of Kazakhstan in 2030-s, 2050-s, 2070-s and 2090-s against the base period of 1980-1999 for two scenarios*

Scenario	Year	Winter	Spring	Summer	Autumn
			2020-2039		
rcp4.5	1.7	1.7	1.6	1.8	1.6
rcp8.5	1.9	2.0	1.9	1.9	1.8
			2040-2059		
rcp4.5	2.4	2.4	2.6	2.6	2.2
rcp8.5	3.1	3.0	3.1	3.2	2.9
			2060-2079		
rcp4.5	3.0	3.2	3.0	3.1	2.6
rcp8.5	4.6	4.8	4.4	4.8	4.3
			2080-2099		
rcp4.5	3.2	3.5	3.3	3.2	2.9
rcp8.5	6.0	6.4	5.8	6.1	5.6

In the 21st century Kazakhstan will see an insignificant increase in annual precipitation in all the considered scenarios. Precipitation may be going down in summer starting from 2050-s (Table 1.2).

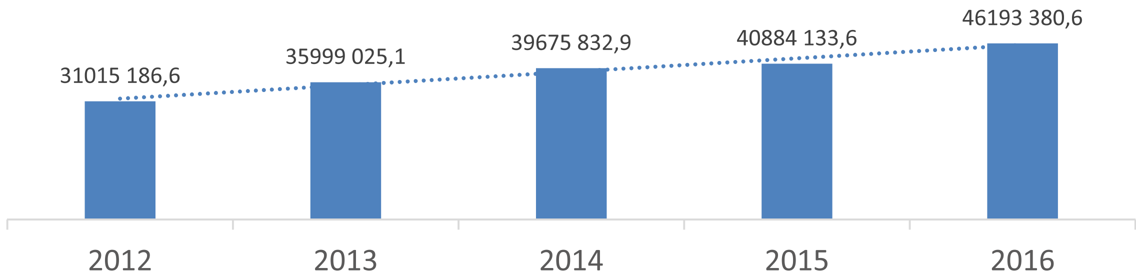
Table 1.2. *Probable changes in annual and seasonal precipitation (%) on the territory of Kazakhstan in 2030-s, 2050-s, 2070-s and 2090-s against the base period 1980-1999 for two scenarios*

Scenario	Year	Winter	Spring	Summer	Autumn
2020-2039					
rcp4.5	8.37±21.69	12.54±5.74	9.59±7.96	6.96±12.11	5.81±7.21
rcp8.5	4.94	9.47	6.04	4.40	0.76
2040-2059					
rcp4.5	9.26	15.81	10.82	5.33	7.53
rcp8.5	5.98	14.28	9.77	-0.43	2.76
2060-2079					
rcp4.5	12.70	20.91	16.58	8.51	7.71
rcp8.5	8.20	22.06	13.54	-1.88	2.75
2080-2099					
rcp4.5	13.21	21.85	17.91	7.99	7.50
rcp8.5	11.77	32.68	17.69	-2.07	4.76

Economy

Gross domestic product (GDP) of the Republic of Kazakhstan has demonstrated stable growth in 2012-2016 (Figure 1.3).

Figure 1.3. *Gross domestic product, million KZT*



Source: Main socio-economic indicators of the Republic of Kazakhstan. Committee on Statistics of the RK, 2017

Speaking of industrial development, the Country attaches special importance to the Manufacturing industry. The highest growth is expected in petrochemical, automotive, agrochemical, electric engineering and railroad rolling stock manufacturing.[4] According to the State program of industrial and innovative development for 2015-2019, by the end of 2019 the value of manufacturing industry's export is expected to grow by 19 percent. Therefore, manufacturing industry will probably see an increase in cumulative GHG emissions with reduction of emissions per unit of output.

Given the goals, stipulated in the Concept for transition of the Republic of Kazakhstan to green economy, aimed at increasing the efficiency of water resources use and energy efficiency in various sectors, as well as modernization of the existing infrastructure and construction of the new one, one can expect reduction of GHG emissions.

[4] Indicators of the State program for industrial and innovative development of the Republic of Kazakhstan for 2015-2019, Committee on Statistics of the RK.

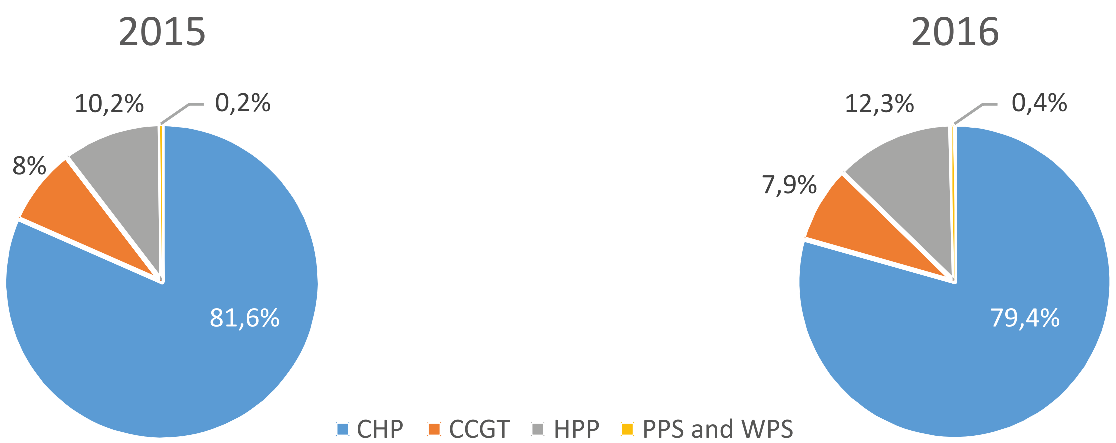
Energy

In 2015, 76 power plants with various forms of ownership generated electric energy. Total installed capacity of power plants in Kazakhstan is 21307.2 MW, available capacity — 17 500.1 MW.[5]

In 2015, Kazakhstan produced 90,976.6 million kWh. Electricity generation in 2016 increased by 3.6% and amounted to 94076.5 million kWh.

Mineral fuels, coal in particular, are predominant energy resources generated and consumed in Kazakhstan. Plans on expansion of coal and oil production indicate that dependence on conventional energy sources will continue. Meanwhile, there are efforts to upgrade coal-fired power plants to support reduction of greenhouse gas emissions. By 2020, wind and solar energy are expected to reach 3 percent of the total electricity generation in the country as of August 2017, their share is about 1%.[6]

Figure 1.4. *Electric energy generation by sources*



Source: Committee on Emergency Situations, MIA

Transition of existing coal-fired power plants and CHP plants in Astana and Almaty cities and other cities with a population of more than 300 thousand people to gas is part of the Action Plan of the Concept for transition of the Republic of Kazakhstan to green economy for 2013-2020[7]. To gasify central and northern regions, gas mains are under construction to connect them to the western part of the country[8]. These projects are expected to supply gas to about 3 million people. Thus, Kazakhstan reduces greenhouse gas emissions by replacing coal with gas, reduces atmospheric air pollution in cities, connects main gas pipelines into a unified gas transportation system and creates conditions for the export of Kazakh gas.

Kazakhstan considers nuclear energy as an alternative energy source as well. Currently a feasibility study is being prepared for construction of a Nuclear power plant (NPP). It is expected that by 2050, half of electric energy in the country will be generated by renewable or alternative energy sources.

High energy intensity of manufacturing is one of the main features of Kazakhstan's economy[9], however the country makes efforts to reduce it. In 2012, energy intensity of the GDP decreased by 13.6 percent compared to 2008. Reduction of energy intensity of the manufacturing industry (by at least 15 percent by 2019) is defined as one of the key objectives to ensure competitiveness of Kazakhstan's economy.[10]

[5] "Electric energy" (note), Ministry of Energy of RK, 5 April 2017.
[6] Information on the Concept for transition of Kazakhstan to green economy, 31 July 2017, Ministry of Energy of the Republic of Kazakhstan.
[7] Resolution of the Government of RK of 31 July 2013, № 750 'On approval of the Action plan to implement the Concept for transition of the Republic of Kazakhstan to green economy for 2013 – 2020'.
[8] "KazTransGas" JSC has presented report on activities in the first half of 2017, 4 August 2017, website of the national operator in the field of gas and gas supply KazTransGas.
[9] State program for accelerated industrial and innovative development of the RK for 2010-2014, approved by the order of the President of RK of 19 March 2010, № 958.
[10] State program for industrial and innovative development of the RK for 2015-2019, approved by the Act of the Government of the RK of 9 June 2014, № 627.

Table 1.3. *Plans to reduce energy intensity of the GDP of Kazakhstan against 2008*

Year/ Goals	Concept for transition of the Republic of Kazakhstan to green economy	Concept for development of fuel and energy complex of the RK by 2030
2015	Not defined	-10%
2020	-25%	-25%
2030	-30%	-30%
2050	-50%	Not defined

"Energy conservation-2020" program[11]. was adopted in 2013. Under this program, an annual 10% reduction of energy intensity of the GDP was foreseen for 2013–2015 with a total reduction by 40% to 2020 against the level of 2008.

"Energy conservation-2020" program was repealed in July 2016, but its main principles were preserved in the current State program for industrial and innovative development for 2015–2019.

Strategic plan of the Ministry of Energy of the Republic of Kazakhstan for 2017-2021 was approved on 28 December 2016. This plan's mission is to improve quality of the environment and ensure transition of the Republic of Kazakhstan to low-carbon development and green economy in order to satisfy the needs of the current and future generations.

Strategic dimension "Improvement of the quality of environment" talks about minimizing emissions to the environment by improving state environmental control and regulation, as well as by achieving targets of the Concept for transition to green economy on carbon emissions and by fulfilling commitments under the UN Framework Convention on Climate Change and other agreements. In order to implement the Nationally determined contributions[12] (INDC), as specified in the Paris agreement under the UN Framework Convention on Climate Change (UNFCCC), the following measures will be implemented: 1) regulation of emissions and removal of greenhouse gas through the market mechanism –emissions trading scheme (ETS); 2) increasing the share of renewable energy sources in energy mix of the country; 3) modernization of heating and power plants and boiler houses; 4) implementation of energy efficiency and energy conservation projects.

The Concept for development of fuel and energy complex (FEC) defines a range of objectives, which can indirectly reduce GHG emissions: development of renewable energy sources; reduction of equipment wear and tear; increasing the reserve of electric capacity and capacity of the power transmission equipment; development of flexible gas-fired generation in Western energy zone to ensure supply of capacities to Southern and Northern energy zones and to cover the peak demand in the South and North; increasing energy efficiency in the Republic of Kazakhstan.

Table 1.4. *Expected outcomes in electric energy sector*

Description	2020	2030
Share of wind and solar power plants in electricity generation	3%	10%
Share of gas-fired power plants in electricity generation	20%	25%
Reduction of carbon dioxide emissions in the electricity sector	Level of 2012	-15% (against the level of 2012)

According to the subparagraph 5-2), Article 6 of the Law of the Republic of Kazakhstan "On supporting the use of renewable energy sources:", "Target indicators for development of the renewable energy sources sector" (№ 478) were approved on 7 November 2016.

[11] Act of the Government of the Republic of Kazakhstan of 29 August 2013, № 904 «On approval of the «Energy conservation-2020» program. Repealed on 25 July 2016 in line with the Act of the Government of the RK № 434.
[12] http://www4.unfccc.int/Submissions/INDC/Published%20Documents/Kazakhstan/1/INDC%20Kz_eng.pdf

Table 1.5. *Target indicators for development of the renewable energy sources sector*

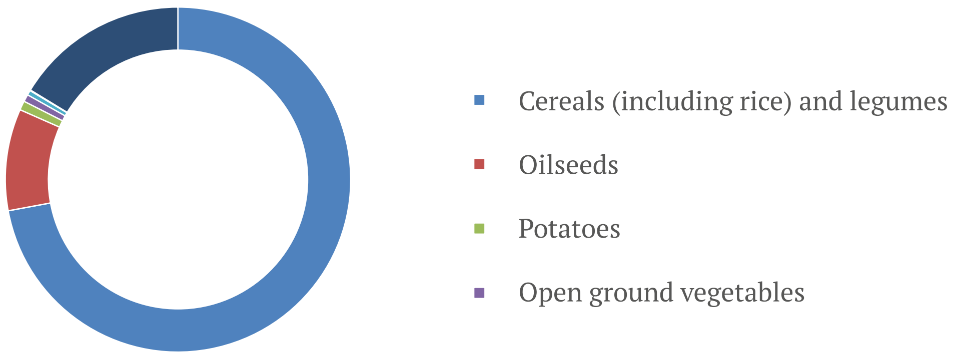
№	Indicators	Targets
1	Share of electric energy generated by renewable energy sources in the total amount of energy generated by 2020	3%
2	Cumulative installed capacity of renewable energy facilities by 2020 including:	1700 MW
	Wind power plants	933 MW
	Solar power plants, which use photovoltaic solar energy converters	467 MW
	Hydro power plants	290 MW
	Biogas plants	10 MW

Feed-in tariffs are established in Kazakhstan for supply of electric energy generated by renewable energy sources[13].

Agricultural economy

One sixth of the employed population works in agriculture, forestries and fisheries in Kazakhstan.[14] However, agricultural production (including forestries and fisheries) takes only 4.6 percent in GDP structure[15]. Forty-three percent of the population lives in rural areas. Total area of cultivated lands (Figure 1.5) is 21.5 million ha.[16] Northern regions specialize in growing grain and forage crops; southern region, where irrigation is important, have diversified crops (grain, oilseeds, fruit and berries, vegetables, cotton). [17]

Figure 1.5. *Main agricultural crops in 2016*



Source: Corrected area under agricultural crops in 2016, Committee on Statistics of the RK.

Kazakhstan's agriculture is a source of methane and nitrogen emissions[18]. These two sources emit about 88% of all GHGs of the sector.

Adverse changes in natural and climate conditions and weather instability are identified as threats to the agro-industrial complex development in Kazakhstan.[19] Due to unfavorable climate conditions in 2012 and 2014, large areas of crops died – about 1407 thousand ha (or 15 percent of insured crops area)

[13] By Act of the Government of the RK № 645 of 12 June 2014.
[14] Employed population by types of economic activities and by regions, 2010-2016, Committee on Statistics of the RK.
[15] Employed population by types of economic activities and by regions, 2010-2016, Committee on Statistics of the RK.
[16] Total corrected area of agricultural plants, Committee on Statistics of the RK.
[17] Agrometeorological forecasting in Kazakhstan, Project 'Improving the Climate Resiliency of Kazakhstan Wheat and Central Asian Food Security' UNDP.
[18] GHG emissions inventory in Kazakhstan, 2017
[19] State program for agro-industrial complex development for 2017-2020.

and 369 thousand ha (or 8 percent) respectively. In fact, total area of insured crops in 2015 decreased 40 times compared to 2012, when about 9320 thousand ha were insured in total.[20]

Strategic plan of the RK Ministry of Agriculture for 2017–2021[21] and RK State program for development of agro-industrial complex stipulates a range of measures which contribute to adaptation to climate change.

Forestry sector

Forest cover amounts to 12,627 thousand ha or 43% of the total forest fund area. Country's forest cover has not increased in the last four years and still remains at the level of 4.6 percent.[22]

Emissions and removals in the forestry sector in Kazakhstan, which have been cumulatively calculated for the native pastures, forests, trees and shrubs, arable lands, wetlands and perennial plantations in the period from 2013 to 2015, have increased 1.9 times (or by 6643 thousand tons of CO_2 equivalent, Table 1.5).

Table 1.5. *Emissions/removals of greenhouse gas in forestry sector in thousand tons of CO_2 equivalent*

Year	Forest lands	Arable lands	Pastures	Wetlands	Perennial plantations	Total
2013	-10938.88	46405.33	-26718.13	11.88	-1409.10	7351.11
2014	-11018.75	51010.67	-27750.44	0	-1592.43	10649.05
2015	-11092.54	55618.20	-28763.84	0	-1767.88	13993.93

Source: Greenhouse gas emissions inventory in Kazakhstan, 2017.

The number of forest fires has increased significantly from 2013 to 2015 –1.7 times (or by 202 cases), total area of forest fires has increased 8.3 times (or by 8.5 thousand ha). Frequency of forest and steppe fires is expected to increase as the climate becomes dryer.

Sustainable development of forests (continuous increase of forest cover) is one of the principles of forestry legislation in the RK.[23] Increase of forest cover in water catchment basins is planned as one of the measures to reduce water deficit.

Waste

In 2016, 2813.6 thousand tons of municipal waste were collected in Kazakhstan, which is 20.7 percent less compared to 2013 (Table 1.6).

Up to 90 percent of municipal wastes are not sorted for further processing or recycling. This amount goes for permanent landfilling (storage of waste) at the waste landfills. The rest is sent for sorting and further recycling and/or disposal.[24]

The amount of per capita waste has decreased by 24% in the reporting period.

[20] Ibid
[21] Approved by the Order of the Deputy Prime-Minister of the RK, Minister of Agriculture of the RK of 30 December 2016, № 541.
[22] Forest resources, Committee on Statistics of the RK.
[23] Code of the RK of 8 July 2003, № 477 «Forest code of the RK», Article 3.
[24] On collection, transportation and storage of municipal waste from 2013 to 2016, Committee on Statistics of the RK.

Table 1.6. *Waste generation and recycling rates*

	Units	2013	2014	2015	2016
Generation of municipal waste	Tsd tons/year	3547,7	3446,3	3235,5	2813,6
Generation of hazardous waste	Tsd tons/year	382 214,30	337 414,8	251 565,6	-
Recycling of municipal waste	Tsd tons/year	16,0	383,0	372,5	346,2
Recycling of hazardous waste	Tsd tons/year	3580,0	3124,3	5456,10	-
Population of the country*	Mln people	17, 160	17, 417	17,670	17, 670
Per capita generation of municipal waste	Kg per capita	206,7	197,9	183,1	159,2
Per capita generation of hazardous waste	Kg per capita	22 272,6	19 372,0	14 236,4	-

* RK population from 2004 to 2016, Committee on Statistics of the RK

Source: Green economy indicators of the RK, Waste generation and recycling rates, Committee on Statistics of the RK

Modernization program for the municipal solid waste (MSW) system was initiated in 2016. Measures taken thereunder have significantly contributed to waste processing – amount of processed waste has increased 22 times in 2016 compared to 2013.

Total amount of emissions in this sector in 2015 was 6115 thousand tons of CO_2 equivalent, which is 5 percent more compared to 2013 (Table 1.7).

Table 1.7. *Greenhouse gas emissions in municipal waste and municipal waste waters management sector in thousand tons of CO_2 equivalent*

Year	MSW	System of waste water discharge and treatment	Healthcare waste incineration	Total for the sector
2013	3830,3	1981,0	3,4	5814,8
2014	3906,0	2070,0	7,1	5983,0
2015	3996,1	2111,6	7,5	6115,2

Source: Greenhouse gas emissions inventory in Kazakhstan, 2017.

GHG inventory

Cumulative emissions of GHG in the base year 1990 in Kazakhstan without LULUCF were 389.104 million tons of CO_2 equivalent, and GHG emissions in 1990 including LULUCF were 371.831 million tons of CO_2 equivalent (Table 1.8). As of 2015, total GHG emissions including LULUCF were 314.9 million tons and 300.920 without LULUCF, therefore, total national GHG emissions were below the base year of 1990 by 15.3% with LULUCF, and by 22.7% excluding LULUCF.

Table 1.8. *Dynamics of total national greenhouse gas emissions in 1990-2015 by economic sectors in the Republic of Kazakhstan in thousand tons of CO_2 equivalent*

Years	Energy activities	IPPU	Agriculture	LULUCF	Waste	Total emissions with LULUCF (net emissions)	Total emissions without LULUCF
1990	318195,02	23885,04	42249,08	-17273,21	4775,28	371831,25	389104,47
1991	300299,82	22548,28	41135,86	-13732,32	4829,70	355081,34	368813,66
1992	275111,44	19767,95	42052,82	-9795,97	4662,80	331799,03	341595,00
1993	242410,94	14718,05	39869,65	-7504,06	4521,07	294015,65	301519,71
1994	206839,48	9658,86	32410,43	-2516,46	4599,74	250869,27	253385,73
1995	190464,06	10403,75	28432,39	2574,30	4490,76	236365,25	233790,95
1996	175710,77	8998,94	23476,36	5931,78	4506,42	218624,27	212692,49
1997	162285,94	11126,27	20772,53	9988,14	4557,88	208730,75	198742,62
1998	157853,82	9843,19	20338,99	12882,08	4496,22	205414,30	192532,22
1999	126584,92	12118,79	22017,40	15052,39	4497,71	180271,21	165218,82
2000	152332,76	13305,46	23005,29	17094,15	4593,92	210331,57	193237,43
2001	140698,15	13486,50	24294,77	16040,18	4572,31	199091,91	183051,73
2002	159491,52	13979,72	23769,94	14736,75	4581,16	216559,09	201822,34
2003	178454,16	14889,00	24515,49	14043,93	4636,12	236538,70	222494,76
2004	186775,49	15539,58	25145,20	13798,45	4741,92	246000,64	232202,19
2005	200005,97	14698,04	25660,05	13606,98	4782,76	258753,80	245146,82
2006	223766,67	15293,41	26318,47	12399,53	4992,24	282770,32	270370,79
2007	229809,49	17557,77	26797,79	11118,81	5176,49	290460,35	279341,54
2008	233408,90	16373,82	26745,72	9640,18	5188,07	291356,69	281716,51
2009	228816,66	16333,41	26999,30	5937,54	5314,66	283401,83	277464,29
2010	257527,46	19072,43	26786,70	2599,92	5455,48	311442,00	308842,07
2011	247991,17	19740,37	26220,88	4121,11	5609,81	303683,33	299562,22
2012	257136,57	18806,54	26139,52	5916,81	5699,29	313698,73	307781,92
2013	261269,79	18461,93	26791,12	7351,11	5814,76	319688,70	312337,59
2014	264317,47	18974,04	27794,39	10649,05	5983,01	327717,96	317068,91
2015	246874,79	19177,99	28752,57	13993,93	6115,15	314914,43	300920,50
Difference in 2015 compared to 1990 in%	77,6	80,3	68,1	-81,0	128,1	84,7	77,3
Difference in 2015 compared to 2014 in%	93,4	101,1	103,4	131,4	102,2	96,1	94,9

GHG projections

To obtain GHG emissions projections and assess an overall effect from fuel burning and fugitive emissions, three GHG emissions scenarios were developed (without measures (WOM), with current measures (WCM) and with current and additional measures (WCAM)) to assess the impact of policies and measures. All scenarios assume annual GDP growth at an average rate of 3.5% until 2020 and 3% after 2020.

The figure below presents GHG emissions projection without LULUCF.

Figure 1.6. *GHG emissions forecast without LULUCF*

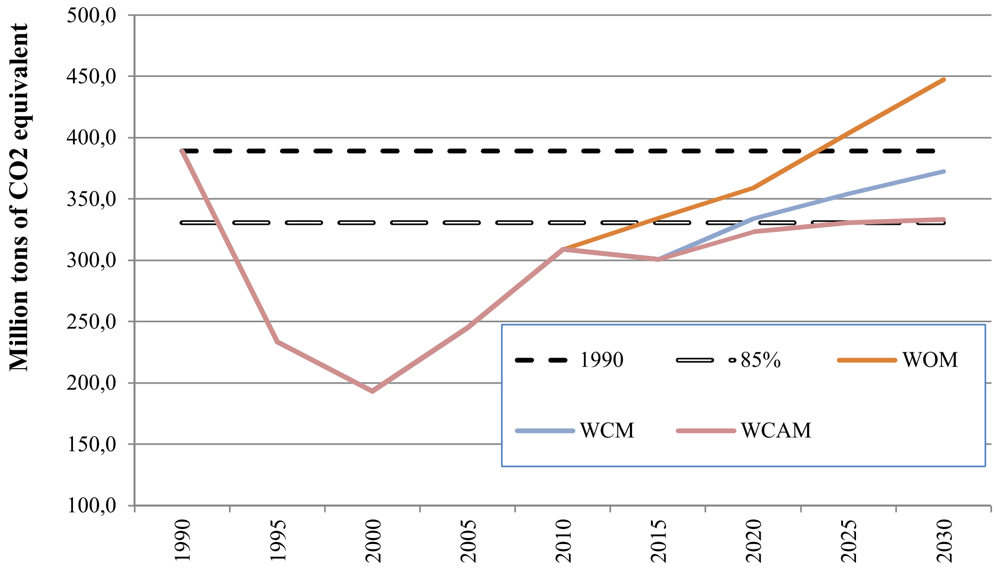


Figure 1.6 shows that emissions decreased by 75 million tons of CO_2-equivalent in 2030 in the scenario with current measures. Scenario with additional measures further reduces emissions by 40 million tons of CO_2 equivalent in 2030.

The table below reflects the cumulative effect of current and additional measures.

Table 1.9. *Cumulative effect of the current and additional measures*

Scenario	Emission values. Million tons of CO_2 equivalent		
	2020	2025	2030
Scenario without measures	359,3	404,0	447,6
Scenario with current measures	334,1	354,3	372,8
Effect from applying current measures	25,2	49,6	74,8
Scenario with additional measures	323,5	330,6	333,4
Effect from applying additional measures	10,7	23,8	39,4

Without measures scenario (WOM)

This scenario reflects possible changes in the amount of greenhouse gases when no measures are taken to reduce them. Further economic growth is generated by cheap coal as fuel for energy generation. This scenario assumes that GHG emissions depend on the general GDP and population growth rate.

Scenario with measures – WM (in this report is equivalent to Scenario with current measures (WCM))

This scenario takes into account taken and planned measures and policies addressing reduction of GHG emissions directly or having an indirect effect on GHGs reduction.

Scenario with additional measures - WAM (in this report is equivalent to Scenario with current and additional measures (WCAM))

This scenario includes measures and policies which can possibly be taken to address reduction of GHG emission directly.

Extreme hydrometeorological events

Kazakhstan is largely exposed to natural disasters related to climatic or weather conditions.

Year 2015 was a record year in terms of hydrometeorological emergencies (mostly heavy precipitation, river floods and mudslides). Number of such events in 2015 was almost twice as high as in the previous 4 years (Table 1.10).

Table 1.10. *Hydrometeorological emergencies in Kazakhstan*

Year	Amount of emergencies	Number of aggrieved persons	Number of casualties
2011	43	12	5
2012	39	20	15
2013	36	12	3
2014	43	19	9
2015	75	8	-

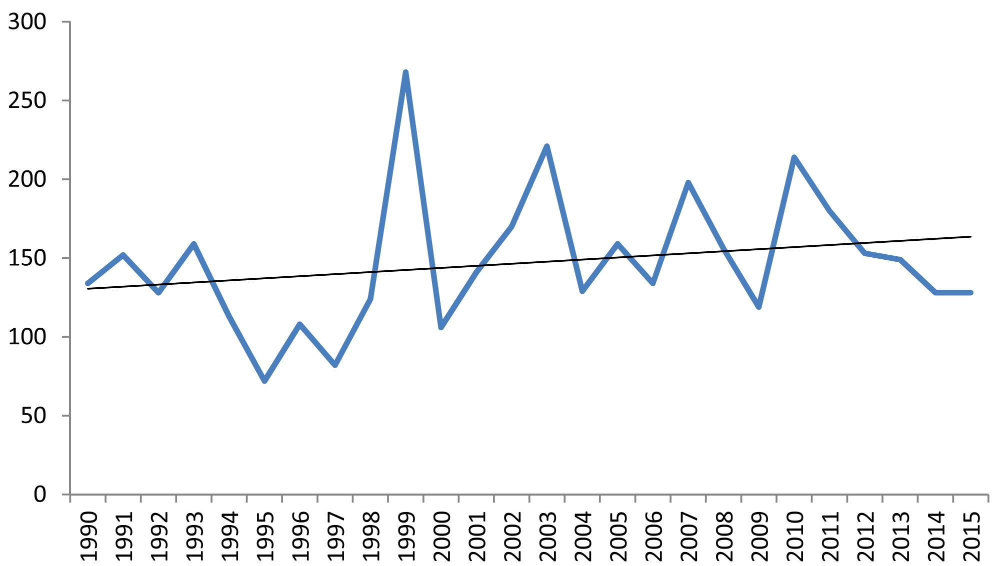
Kazhydromet's early weather alerts and concerted efforts of the Committee for Emergency Situations and other emergency response teams enabled evacuation of over 10,000 people from danger areas in 2015 (Table 1.11) with no human casualties.

Table 1.11. *Emergency response in Kazakhstan (data of the Committee for Emergencies of the MIA RK)*

Year	Number of people evacuated		Number of vehicles rescued
	Total	of them, children	
2013	1759	59	491
2014	6154	232	2121
2015	9588	327	3187

The frequency of extreme weather events and their overall intensity are gradually increasing (Figure 1.7) and it poses a threat to the country in terms of higher pressure on the environment and potentially adverse effect on the economy.

Figure 1.7. *Dynamics of the total number of days with extreme weather events in Kazakhstan in 1990-2015*



The country pays special attention to spontaneous hydrological events (SHE).

In the period 1991-2015, against the previous period of 1967-1990, number of spontaneous hydrometeorological events like river floods on mountain rivers, ice jams, mud slides and low water levels has increased. Number of floods in lowland rivers has slightly decreased (Table 1.12).

Table 1.12. *Number of various types of SHE in 1967-1990 and in 1991-2015*

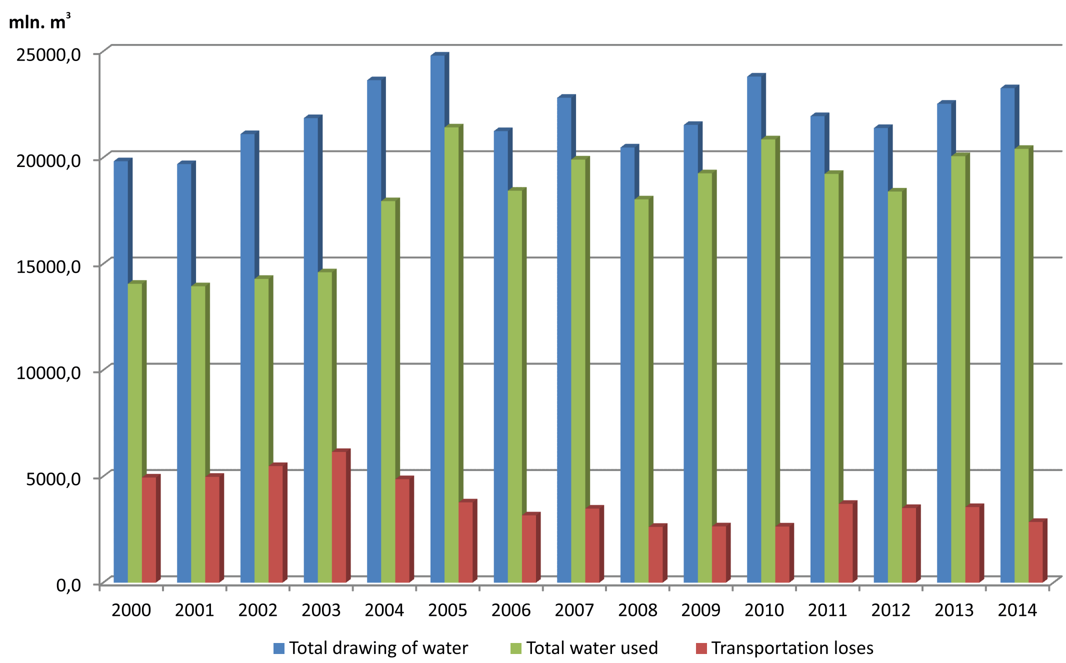
Types of SHE \ periods	1967-1990	1991-2015
river floods on mountain rivers	54	96
floods in lowland rivers	66	52
ice jams	12	23
mud slides	11	20
low water levels	9	19
TOTAL	**54**	**96**

Water resources

Total perennial riverflow and intermittent water streams are estimated at the level of 100.58 km^3 per annum, of which 55.94 km^3 (55.6%) is formed on the country's territory, and the rest– 44.64 km^3 (44.4%) are formed outside. Thus, average water supply on the country's territory is 37 thousand m3/km2 or 370 m^3/ha, which is one of the lowest levels in the CIS.

In the reporting period from 2000 to 2014, withdrawal of fresh water in the Republic of Kazakhstan has increased from 19,830.1 million m^3 in 2000 to 23,265.5 million m^3 in 2014, i.e. by 17.3%. At the same time, water withdrawal from surface waters has increased by 23.1% from 18,040.7 million m3 in 2000 to 22,214.5 million m3 in 2014, whereas water withdrawal from ground waters has decreased slightly (by 6.4%). Total number of water consumed by all water users in the reporting period has grown from 14,058.8 million m3 in 2000 to 20,410.9 million m^3 in 2014 and has increased by 45.2%. (Figure 1.8).

Figure 1.8. *Water withdrawal, consumption and transportation losses in Kazakhstan*



Source: Committee for Water Resources of the Ministry of Agriculture of the RK.

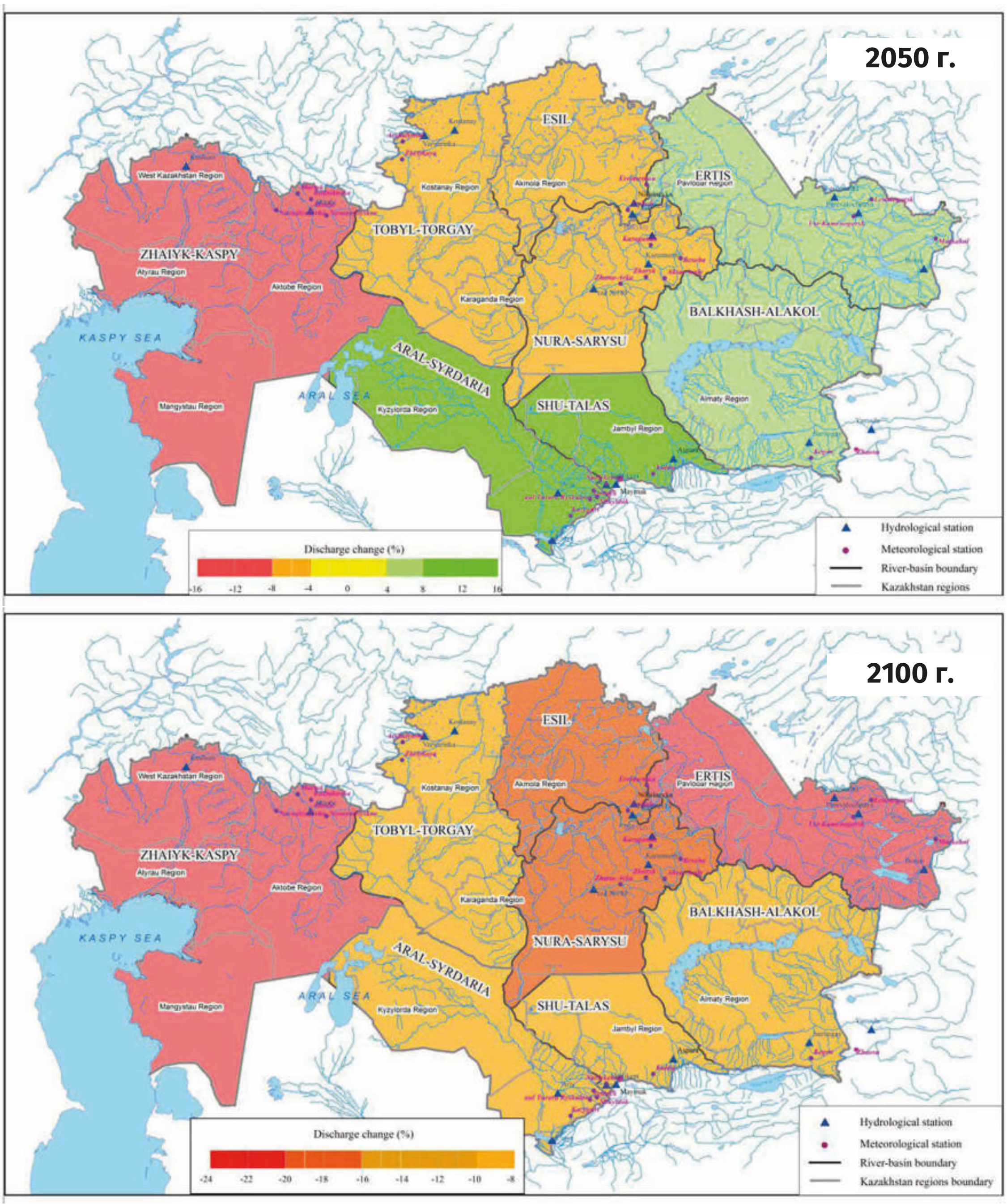
Table 1.13 shows the projection of natural water resources affected by the climate change in 2025, 2030, 2050 in% against the perennial flow rate.

Table 1.13. *Flow value projections for various future periods and changes against the perennial flow rate.*

	Section of the catchment basin	Perennial flow rate, m^3/sec	Average annual flow, m^3/sec		Changes against the flow rate,%	
				2071-2100	2050	2100
1	Yessil r.– Turgenevka village	3.8	3.5	3.1	- 8.7	- 18.0
2	Moyildy r.– village Nikolayevka	1.1	1.0	0.9	- 9.5	- 19.1
3	Tobol r. – Kostanay city	16.3	15.6	14.8	- 4.3	- 9.2
4	Ayat r. – Varvarinka village	6.0	5.8	5.4	- 3.7	- 10.0
5	Nura r. – Romanovka village	20.6	18.6	18.3	- 9.7	- 11.2
6	Sherybainura r. – Karamuryn village	5.2	4.7	4.6	- 9.4	- 12.8
7	Sarysu r.– crossing No 189	3.0	2.6	2.3	- 14.5	- 23.7
8	Assa r.– railway station Maymak	10.8	11.8	9.3	9.3	- 13.9
9	Ters river – Nurlykent village	6.0	6.7	5.4	12.0	- 10.0
10	Kuragaty r. – railway station Aspara	3.9	4.5	3.3	15.4	- 15.4
11	Keles r. – mouth	13.0	14.6	11.1	12.3	- 14.6
12	Arys r. – railway station Arys	11.7	13.7	10.1	17.1	- 13.7
13	Ural r. – Kyshym village	353	300	283	- 15.0	- 19.8
14	Yelek r. – Aktobe city	17.2	15.0	14.1	- 12.8	- 18.0
15	Kara Yertis – Boran village	301	326	234	8.3	- 22.3
16	Ulba r. – Perevalochnaya village	104	116	86.0	11.5	- 17.3
17	Oba r. – Shemonaikha city	165	186	141	12.7	- 14.5
18	Ile r. – Yamadu village	360	396	301	10.0	-16.4
19	Sharyn r. p – Sarytogai village	36.8	39.0	33.1	6.0	- 10.1

Data from the table above demonstrates that if the climate change will follow scenario RCP4.5, then by 2050 water resources in mountain basins of Kazakhstan could increase on average by 6% – 17%, whereas by 2100 on the contrary there is a decrease, on average by 10% - 22.3% in the basins of Keles, Kuragaty, Assa, Ters, Ile, Oba, Ulba, Ertis, Arys, Sharyn rivers. The increase of water resources by 2050 will happen mostly due to southern basins, where glaciers take part in the formation of runoff, whereas decrease by 2100 will happen due to the depletion of these glaciers. Glaciological studies show that in the past decade there has been a downward trend in glacier runoff and by the end of the century there is a risk of the glaciers' disappearance. In the lowland rivers of western, northern and central Kazakhstan, water resources tend to decrease by 3.7% -15% by the middle of the century, and by the end of the century by 9.2% - 23.7% compared to the past runoff rate. Decrease in the runoff of the lowland rivers of Kazakhstan is connected with the latitudinal dependence of the runoff, i.e., it is arising from the prevailing influence of the increasing average annual air temperature. Water stress by basin by 2050 is shown in Figure 1.9

Figure 1.9. *Forecast of water resources in RK in 2050 and 2100*



Adaptation of agriculture

Agriculture, predominantly crop farming, has a significant share in Kazakhstan's economy. Out of the total gross output in agriculture, crop growing takes 55%, livestock farming – 45%[25].

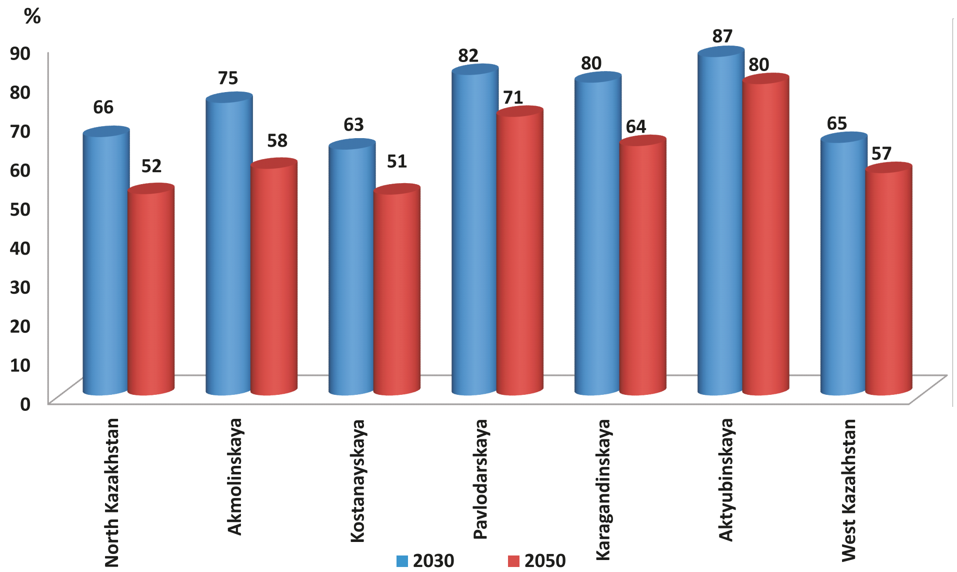
Currently there are over 21 million ha of lands designated for agriculture in the country. Of them over 1.0 million ha are irrigated lands (about 5%), i.e. on 95% of agricultural lands crops are cultivated with natural humidification.

Main crop in Kazakhstan is spring wheat. Biggest spring wheat acreages are located in Kostanay, North-Kazakhstan and Akmola regions.

The crop yields depend on the level of farming practices (cultivation technology) and weather conditions. Long-term analysis (1991-2016) of spring wheat yields showed that in the northern regions of Kazakhstan in the period of 1991-1998 the level of farming practices was decreasing, and afterwards - it was improving. The farming practices have been improving since 1998, but the share of agricultural technologies in the yield formation has shifted to a positive balance only in 2006-2007. Consequently, 2006 can be considered as the beginning of the high farming standards development due to the introduction of advanced agricultural technologies

Under the projected climate conditions in 2030, spring wheat yield in 8 grain producing regions is expected to be 63-91% of the current level, and in conditions projected for 2050 – 51-87% (Figure 1.10). It means that if there are no changes in current farming practices, spring wheat yield will decrease by 13-49% by 2050. Biggest changes are expected to occur in three northern regions.

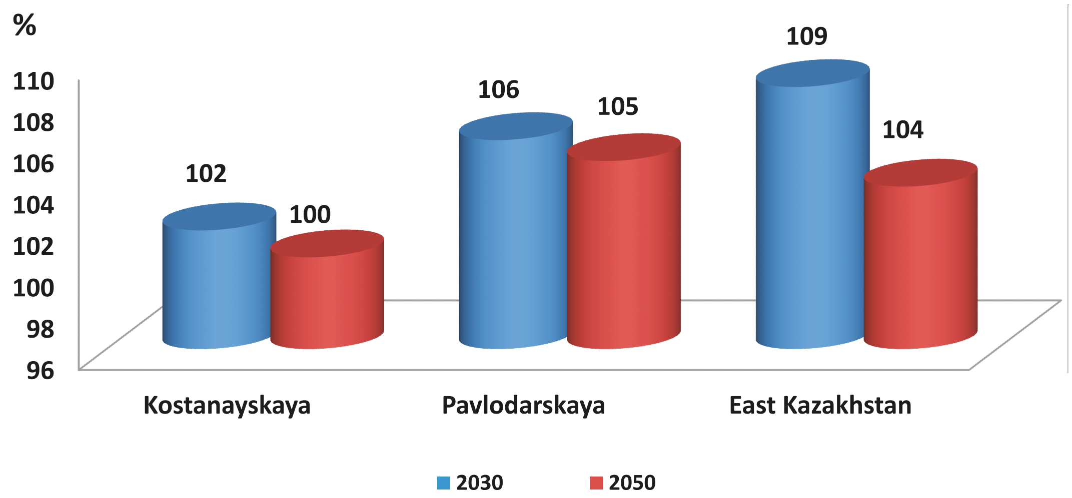
Figure 1.10. *Projected spring wheat yield by 2050 (Y, in percentage of the present level), according to the rcp4.5 climate change scenario*



However for some other crops climate change is seen as a significant advantage. Under projected climate conditions in 2030, sunflower seeds yield by regions will be 102-109% of the current level, and under 2050 projections – 100-105% (Figure 1.11). It means that if there are no changes in current farming practices, sunflower seeds yield by 2030 can increase by 2-9%, and by 2050 – up to 5%, against the current yields. It indicates the need to expand thermophilic crops in northern and eastern regions of Kazakhstan.

[25] Official website of the Committee on statistics of the Ministry of national economy of the Republic of Kazakhstan [website]. – 2016. – URL:http://www.stat.gov.kz/faces/wcnav_externalId/homeNumbersAgriculture?_afrLoop=2799360813148923#%40%3F_afrLoop%3D2799360813148923%26_adf.ctrl-state%3 D57nxjwcne_50 (last accessed 20.09.2016).

Figure 1.11. *Projected yield of sunflower seeds by 2050 (Y, in percentage of the current level), according to the rcp4.5 climate change scenario*



Livestock breeding is one of the key economic sectors in Kazakhstan and the main source of employment and livelihood for the rural population. Farm livestock in Kazakhstan is presented by cattle, sheep and goat, horses, camels and pigs.

The leading livestock breeding sub-sectors in Kazakhstan are currently sheep and cattle breeding. By 2016, the number of sheep and goats has reached almost 18.0 million animals, and cattle – 6.2 million animals. Population of horses exceeds 2.1 mln. animals.

Farm animal mortality in Kazakhstan's livestock breeding sector is mainly associated with adverse weather conditions. Climate factors, which cause mortality, are as follows – hard frost, strong snowstorms, high snow cover, ice layers in the snow cover, cold weather recurrence after sheep shearing, heat wave and drought etc.

The timeline for such important activities as grazing, kidling, cattle drive, insemination, shearing and washing of sheep is closely linked to local climate and weather conditions. For sheep breeding, it is important to assess probability of favorable weather conditions for the animals in warm and cold seasons, during shearing and transfer of sheep to summer pasture.

With the further climate warming, it is anticipated that by 2030 the livestock wintering conditions in the south of Kazakhstan will gradually alleviate by 20-30%, and by 30-40% – by 2050. In the Kyzylkum sandy massif, where winters are very mild, it is anticipated that the number of non-grazing days in winter will be reducing by 1-2 days until 2050. In Betpak-Dala and in the south of the Saryarka steppe non-grazing period is on average about 20 days, it is anticipated that this period will be reduced by 3-4 days by 2030, and by 5-6 days – by 2050.

Spring shearing start date will shift to earlier periods everywhere, by 2 days – by 2030, and by 3-5 days – by 2050.

Steady heat wave (SHW) for sheep is anticipated to last longer by 10-15% – by 2030, and by 15-25% – by 2050, and that will negatively affect the summer sheep pasturing. For example, with an average duration of SHW for fine-wool sheep of about 100 days (Moyinkum sands), by 2030 it is anticipated to increase by 10-12 days, and by 2050 – by 16-18 days (Table 1.14).

Table 1.14. *Changes in the duration of steady hot waves for fine-wool sheep till 2050 (in days), according to the RCP4.5 and RCP8.5 climate change scenarios*

Oblast	Location	Current climate	2030s		2050s	
			RCP4.5	RCP8.5	RCP4.5	RCP8.5
Almaty	Saryesik-Atyrau sands	80	+10	+12	+16	+18
	Taukum Sands	90	+10	+12	+16	+18
	Ile and Zhetysu Alatau foothills	70	+8	+10	+14	+16
Zhambyl	Betpak-Dala	85	+8	+10	+14	+16
	Moiynkum Sands	100	+10	+12	+16	+18
	Northern Karatau foothills	90	+10	+12	+16	+18
	Kirghiz Range foothills	80	+8	+10	+14	+16
South Kazakhstan	Southern Karatau foothills	100	+8	+10	+15	+17
	Kyzylkum sands	120	+8	+10	+15	+17
Kyzylorda	Aral Karakum	85	+7	+9	+13	+15
	Kyzylkum sands	110	+8	+10	+15	+17
Mangystau	Ustyurt Plateau	115	+8	+10	+14	+16
Aktobe	Bolshiye Barsuki sands	85	+7	+8	+14	+16
Karaganda	Sary-Arka South	60	+8	+9	+12	+14

It is also anticipated that the sheep drive to summer pastures will be starting earlier by 3-5 days by 2030, and by 7-9 days by 2050. The smallest change is anticipated in the Kyzylkum Desert, in Ustyurt Plateau, in Betpak-Dala and in Sary-Arka South, where timeframe of the sheep drive will be shifted to earlier dates, by 3 days – by 2030 and by 2050 – by 7 days. In the other areas of the southern parts of Kazakhstan, the time frame of cattle drive to summer pastures will be starting earlier by 4-5 days in 2030, by 8-9 days in 2050.

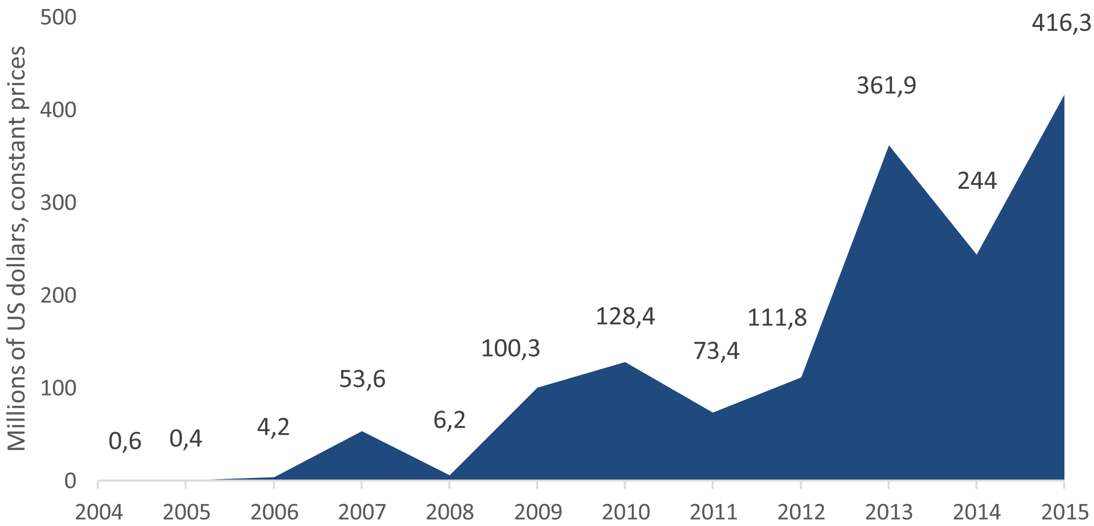
Adverse impact of warmer climate on agriculture can be compensated by introduction of adaptation measures. Therefore, in order to reduce adverse impact of climate change, we suggest key adaptation measures in grain crops planting and livestock breeding in the Republic of Kazakhstan.

Financial resources and technology transfer

According to the statistical database of the Organization for Economic Cooperation and Development (OECD/DAC), in the reporting period (2012-2015) Kazakhstan has raised 1134 million USD for climate related development projects. Biggest share of those funds (about 95 percent) was allocated for GHG reduction projects, and the rest – for adaptation projects.

Funding, which Kazakhstan allocated for climate related projects in 2015, amounted to 416.3 million USD. About 97 percent of the funding was raised in the form of loans and about 3 percent in the form of grant assistance. Loans were provided by the European Bank for Reconstruction and Development (EBRD), grants were provided by the Global Environment Facility (9.66 million USD.), as well as by some individual countries (United States of America – 1.83 million USD, Japan – 30 thousand USD, Korea – 22 thousand USD).

Figure 1.12. *Funding of climate related development projects (mitigation and adaptation) in Kazakhstan*



Source: OECD/DAC

Climate funding in 2015 was provided for the following sectors – transport and storage, energy, mineral resources and mining and agriculture. When looking at the whole reporting period (2012–2015), one will see that in addition to the abovementioned sectors, significant funds were provided for climate activities in water supply and sanitation, construction and environment protection sectors.

In addition to the humanitarian aid, which in 2016 was about 1.362 million USD[26], Kazakhstan provides assistance to the developing member countries.

In 2015, an initiative was launched on 'Africa–Kazakhstan Partnership for the SDGs'.[27] The goal of the program is to provide assistance to 45 African countries for implementation of sustainable development goals; program budget is 2 million USD.[28]

In 2016, Kazakhstan and Caribbean Community (CARICOM) have signed an agreement on supporting the CARICOM member-states in the area of climate change and sustainable development. According to the agreement, Kazakhstan has allocated a grant to CARICOM in the amount of 770 thousand USD for strengthening capacity of CARICOM member-states in climate negotiation processes, as well as to support the regional dialogue.[29]

Environment protection and climate is identified as one of the four principles of country's policy in the area of official development assistance.[30] Since 2013,[31] work is underway in the country to create Kazakhstan's agency for development and technical assistance KazAID. It is expected that the aid from Kazakhstan to developing countries in the framework of UNFCCC will increase.

Kazakhstan is also a recipient of technologies in the framework of financial assistance. In turn, Kazakhstan has presented two significant initiatives on technology transfer and best practices exchange.

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26 According to the data of the Financial tracking tool of the United Nations office for coordination of humanitarian affairs (https://fts.unocha.org/donors/4795/flows/2016).

27 Kazakhstan and UNDP have adopted a new program to support African countries, 29 September 2015, official website of the MFA RK (http://www.mfa.kz/ru/content-view/kazakhstan-i-proon-prinyali-novuyu-programmu-pomoshchi-stranam-afriki)

28 D. Sultanoglu, Introductory remarks at Astana Economic Forum, 26 May 2016, official website of UNDP in Kazakhstan (http://www.kz.undp.org/content/kazakhstan/ru/home/presscenter/speeches/2016/05/26/-.html).

29 «CARICOM, Kazakhstan sign support grant agreement», 14 March 2016, CARICOM web site (http://today.caricom.org/2016/03/14/caricom-kazakhstan-sign-support-grant-agreement/)

30 Decree of the President of the RK of 31 January 2017, № 415 «On approval of the main dimensions of state policy of the RK in the area of official development assistance for 2017 – 2020».

31 Decree of the President of the RK of 9 April 2013, № 538 «On approval of the Concept of the RK in the area of official development assistance».

'Green bridge' partnership program is aimed at development of international cooperation to ensure green economic growth by transferring technologies, exchanging knowledge and providing financial support to implement investment projects.[32] The program was initiated by the Republic of Kazakhstan in 2012 at the 66th Session of the UN General Assembly and has been endorsed at the UN conference on sustainable development as an interregional sustainable development initiative.

Kazakhstan has hosted the international exhibition **Astana EXPO-2017 «Future Energy»** in June-September 2017, which received over 3.8 million visitors. Ministry of Energy has selected 28 domestic projects on renewable energy sources, waste management, improvement of energy efficiency to be demonstrated in the Kazakhstan's pavilion. It is expected to implement best technologies which were showcased during Astana Expo-2017 in the pavilions of other countries. For this purpose Ministry of Energy of the RK has created an expert task force which consists of the representatives of national companies and analytical experts.

Studies and systematic observations

The Republican State Enterprise (RSE) Kazhydromet, which is a structural subdivision of the RK Ministry of Energy, conducts systematic climate observations in Kazakhstan,. The RSE includes 15 branches, which are located in all regional centers of Kazakhstan and in Almaty city.

Hydrometeorological network of Kazakhstan includes 328 meteorological stations and 307 hydrological stations (in 2011 their number was 260 and 298, respectively). 86 meteorological stations (out of the existing ones) send daily information to the Global observation network of the World meteorological organization (WMO). 66 meteorological stations are part of Regional basic synoptic network of the WMO, 44 – are part of the Regional basic climate network of the WMO.[33] Moreover, RSE Kazhydromet provides information on agrometeorological and ecological conditions of the environment.

Adoption of the modernization program for RSE Kazhydromet for 2017-2020 is expected, in the framework of this program, methodological framework of hydroforecasting will be expanded and technical coverage of the observation network will be improved for ecological, meteorological and hydrological monitoring. For instance, there is a plan to install 25 meteorological radiolocators in the country to provide greater accuracy of the forecasts.

Education, outreach and training

Education and development of environmental culture among businesses and population is defined as one of six main principles for transition to green economy in the Concept for transition of the Republic of Kazakhstan to green economy[34], which was adopted in the country in May 2013. To achieve the goals, it is necessary to improve current and develop new educational programs to ensure sound use of resources and environment protection in education and training system.

Meanwhile, ecological education has not been reflected in the law 'On education'[35] and State program for education and science development for 2016-2019[36].

It is worth noting that teachers, who organize extra-curricular activities or classes, initiate in-depth study of the climate change issues in public schools. State Compulsory Standard of Education with the changes, introduced by the Law of the RK of 13 November 2015, № 398-V, does not provide for a specific course to study climate change issues.

32 http://gbpp.org/
33 Surface and upper-air stations, Kazakhstan Country Profile, WMO (https://www.wmo.int/cpdb/kazakhstan).
34 Decree of the President of the Republic of Kazakhstan 'On the Concept of transition of the Republic of Kazakhstan to green economy' of 30 May 2013, № 577.
35 Law of the Republic of Kazakhstan «On education» of 27 July 2007, № 319-III.
36 Decree of the President of the Republic of Kazakhstan 'On approval of the State Program for education and science development for 2016-2019' of 1 March 2016, № 205.

Deeper study of environment and climate change issues is offered in Nazarbayev intellectual schools (NIS), which focus on education of children with chemistry and biology specialization. Such work takes place in 9 out of 20 regional branches of the autonomous educational institution (AEI) 'NIS'.

Climate change issues are included into two classes in college programs on "Agriculture, veterinary and environment", in 2015 33578 people were enrolled in these programs[37].

Access to environmental information

Changes were made in Kazakhstan's legislation related to provision of environmental information, including information on climate change, in the reporting period (2012-2016). Environmental code of the RK was amended in the part of provisions related to environmental information. In particular, it envisages development of State emissions and pollutants transport register (Article 160), information contents of the State fund of environmental information were expanded (Article 160), annual preparation and publication of the National report on environmental situation and natural resources use is envisaged. A standard of public service on 'Provision of environmental information'[38] and the procedure for public service 'Provision of environmental information'[39] were developed.

The biggest information campaign was the aforementioned Astana EXPO-2017, which was held in June-September 2017 in Astana themed 'Future energy'.

In general, most awareness raising campaigns in Kazakhstan are initiated by civil society organizations. Target groups for such campaigns are pre-school children, school, college or university students, public, which also includes the cooperatives of apartment owners (CAO). Campaigns are organized in forms of promotions, contests, competitions, distribution of information materials.

There are some resource and information centers in Kazakhstan, focused on awareness raising on climate change.

Currently, state support is provided in the Republic of Kazakhstan for non-government organizations' activities through the mechanism of state social order. Given the scale of NGO-run climate change activities, this support is limited.

[37] Secondary education in Kazakhstan: current state and prospects. Analytical collection, Astana, 2015.
[38] Approved by the Order of the Minister of Energy of 23 April 2015, № 301.
[39] Approved by the Order of the Minister of Energy of 22 May 2015, № 369.

II. NATIONAL CIRCUMSTANCES RELATED TO THE GREENHOUSE GASES EMISSION AND REMOVAL

2.1. Political structure

The Republic of Kazakhstan is a unitary, secular state with the presidential system of government[40]. The administrative and territorial system includes 14 regions, 2 cities of republican status (Astana and Almaty), 177 administrative districts, 87 towns, 30 townships and 6693 rural settlements[41].

The power is distributed between three independent branches. Legislative functions are entrusted to the Parliament, which consists of two chambers: Senate (upper chamber) and Majilis (lower chamber). Executive power is in hands of the Government, which governs the system of executive bodies. Judicial functions are performed by the judicial system, which includes the Supreme Court, local (regional, city, and district) courts, and specialized courts (military, juvenal, economic).

Public governance reform was done in September 2014 in Kazakhstan, during the reform 18 ministries and agencies were disbanded, mandate of the remaining ones was expanded, additional five ministries were created. The reform has affected public governance in the area of environment protection and sustainable development.

In particular, Ministry of Environment Protection and Water Resources of the Republic of Kazakhstan was disbanded, which was responsible for these issues before 2014. The functions of the Ministry were divided between two bodies.

Ministry of Energy of the Republic of Kazakhstan became responsible for the matters of developing and implementing state policy in the area of protection, control and supervision over the sound use of natural resources, municipal solid waste handling, renewable energy sources development, and control of state policy in the area of green economy development. Additionally, the Ministry of Energy develops and implements state policy, coordinates management processes in oil and gas, petrochemistry industry, transportation of hydrocarbons, state regulation of production of oil, gas products and gas supplies, main pipelines, energy, heat supply, coal industry and nuclear energy.

Functions and powers in the area of developing and implementing state policy in fisheries, water, forest and wildlife resources management are given to the Ministry of Agriculture of the Republic of Kazakhstan. This Ministry includes Committee for Water Resources and Committee for Forestry and Wildlife.

Ministry of Energy has the following departments: Department of climate change, Department for waste management, Department for green economy, Department for environmental monitoring and information, and Committee for environmental regulation and control. The latter has territorial subdivisions – departments of environment, which are located in each region of the country.

In relation to regulation of greenhouse gas emissions, the Ministry develops a methodology for calculation of emissions, reductions and removals, identifies monitoring and control procedures for GHG inventory, procedure for converting units of local project mechanisms in the area of GHG emissions or removal into the quota units, procedure for handling the state register of carbon units and procedure for development of internal projects for GHG emissions reduction, as well as defines the list of economic sectors, where these can be implemented. The Ministry of Energy identifies the operator of the carbon units and upon approval of the authorized body for state statistics, identifies the list of organizations, which conduct statistical observations of climate and ozone layer in the relevant territories[42].

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[40] Constitution of the Republic of Kazakhstan.

[41] Kazakhstan in numbers, Committee on statistics of the Ministry of national economy of the Republic of Kazakhstan (hereinafter referred to as Committee on Statistics of the RK), 2016.

[42] Resolution of the Government of the Republic of Kazakhstan of 19 September 2014, № 994 'Issues of the Ministry of Energy of the Republic of Kazakhstan'.

2.2. Demographic situation

In May 2017, population of Kazakhstan has reached 18 million people. In 2012-2017 population increased by 1 million 341 thousand people. The growth was dominated by growing urban population, which has increased more than by 1.1 million since 2012. In the same period increase of rural population was insignificant – it grew by slightly more than 90 thousand people.[43] Reduction in the share of rural population is caused primarily by movement of the rural population to the cities.

Main indicators, which characterize natural population growth in 2012-2016, did not change significantly. Birth rate fluctuated from 22.66 to 23.13 births per thousand people. Mortality rate decreased from 8.51 to 7.44 deaths per thousand people. Infant mortality indicators have also decreased significantly (from 14.93 in 2011 to 8.6 in 2016 per thousand births) and maternal mortality (from 17.40 per hundred thousand births in 2011 to 12.7 in 2016). Cumulative birth rate in 2016 was 2.8 children per one woman.[44]

However, along with the factors, which have a positive effect on the population, there are also adverse factors. Namely, in 2012–2016, negative balance of emigration is recorded. It is worth mentioning a growing trend in emigration: in 2012 migration balance was minus 1426 people, in 2013 – minus 279, in 2014 – minus 12162, in 2015 – minus 13466 and in 2016 – minus 21618[45].

Average population density in the country in 2016 was 6.5 people per square kilometer. Major part of the population is located in the south of the country – in South-Kazakhstan, Almaty and Zhambyl regions. The same regions also have predominantly rural population. Karaganda and East-Kazakhstan regions have also relatively big population, and the share of urban population exceeds the rural population.

Life expectancy at birth in 2016 was 72.3 years, which is by 2.39 years more than in 2012 (or by 4.7 years compared to the same indicator of 1991). In particular, life expectancy for men is 67.9 years, and for women – 76.9 years.[46]

Age composition of the population in the Republic of Kazakhstan in 2015 was as follows: below employable age – 28.4 percent (or 5 019.4 thousand people), employable age – 60.8 percent (10747.4 thousand people), above employable age – 10.8 percent (1903.8 thousand people)[47].

Population aging index (number of people over 65 years per 100 children below 15 years) in the Republic of Kazakhstan in general in 2015 was 25.7.[48] The highest population aging index is seen in the north, east and central part of the country (North-Kazakhstan region – 53.1, Kostanay region – 51.1, East-Kazakhstan region – 46.2, Pavlodar region – 43.3, Karaganda region – 40.2, Akmola region – 38.4). On the contrary, in southern and western regions this indicator is lower than the country average (Mangystau – 11.4, South-Kazakhstan – 21.1, Kyzylorda – 14.9, Atyrau – 15.2, Zhambyl – 17.9). Given that the lowest risk of aging, and consequently reproduction capacity is seen on the territories with the highest population, one can expect further growth of population through natural processes in the southern regions of the country. According to the forecasts, country population by 2050 will reach 24.5 million people. By 2050, if the current trend continues, the population of northern regions will decrease by 0.9 million people, whereas the population in the southern regions will grow by 5.3 million people. Thus, the population density in the southern region will be four times higher than in the northern region.[49]

To eliminate the disproportion in the population, the government has adopted a voluntary resettlement program from the labor-excessive regions (mostly southern) to labor-deficit region (northern) in 2016.[50]

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43 'On demographic situation in the Republic of Kazakhstan', Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan, 2017.
44 Ibid
45 'Population migration', Committee on Statistics of the RK, 2017.
46 Dynamics of demographic indicators in 1991-2016, Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan
47 Ibid
48 Population aging index, Committee on Statistics of the RK, 2016.
49 Resolution of the Government of the RK of 29 December 2016, № 919 «On approval of the productive labor and mass entrepreneurship program for 2017 – 2021…».
50 In the framework of the productive labor and mass entrepreneurship program for 2017 – 2021.

Growing trend of increasing urban population can affect the demand for higher energy generation, because urban population has a higher energy consumption level. Given that biggest share of energy in Kazakhstan is generated by coal firing, such demographic trend can lead to increase in GHG emissions..

2.3. Geography

Kazakhstan is located at the juncture of two continents – Europe and Asia. The territory of the Republic of Kazakhstan is 2724.9 thousand km^2. Length of state border is 13394 km.

Kazakhstan is the world's ninth largest country by the territory. Kazakhstan is the largest land-locked country in the world.

Territory terrain is predominantly flat, over 90 percent of the territory is flatland. High mountains are only located in the southeast and eastern part of the country. Leveled plains, exacerbated by significantly deteriorated ancient rocks.

Big part of the country is occupied by arid natural zones: deserts, semi-deserts, dry steppe. More favorable humid steppe and forest-steppe is located only in the north.

Land use structure in the Republic of Kazakhstan did not change significantly over the reporting period (Table 1, Figure 1). Only two categories of land use had changes, which exceed one percent. Namely agricultural lands have increased by 2.8 percent (or 7434.2 thousand ha), and reserve lands have decreased by 3.2 percent (or 8261.7 thousand ha).[51]

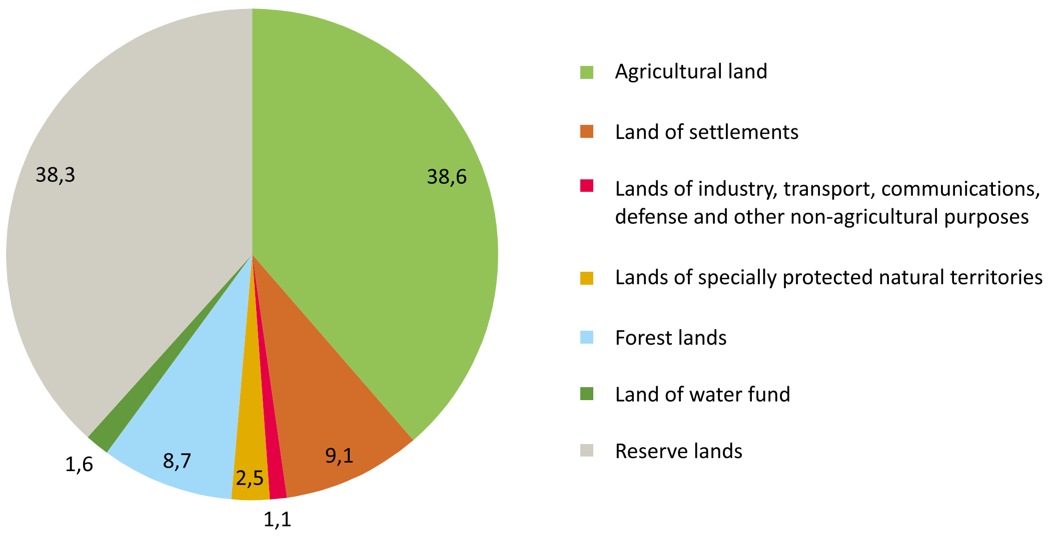
Table 1. *Dynamics of land use changes, in thousand hectares*

Land category. in thousand ha	2012	2013	2014	2015
Agricultural lands	93 428,2	96 278,3	98 580,2	100 835,4
Settlement lands	23 789,8	23 749,7	23 804,8	23 751,5
Industrial, transport, communication, defense and other non-agricultural lands	2 620,8	2 726,4	2 778,7	2 826,0
Lands of the specially protected natural areas	5 776,5	6 515,2	6 634,3	6 613,4
Forest fund lands	23 059,9	22 934,6	22 850,6	22 899,6
Water fund lands	4 113,2	4 112,9	4 120,9	4 124,2
Reserve lands	108 385,4	104 847,7	102 404,3	100 123,7

Source: 'Indicators of green economy of the Republic of Kazakhstan. Land resources', Committee on Statistics of the Ministry of national economy of RK (hereinafter – Committee on statistics of RK), 2017.

[51] Indicators of green economy of the Republic of Kazakhstan. Land resources. Committee on Statistics of the RK, 2017.

Figure 1. *Structure of land resources of the Republic of Kazakhstan, 2015.*



Source: 'Indicators of green economy of the Republic of Kazakhstan. Land resources', Committee on Statistics of RK, 2016.

The area taken out of productive use, which is occupied now by facilities, has increased in 2012-2015 by 0.1 percent (or from 264.1 thousand km2 to 265.7 thousand km2), which comprises 9.8 percent of the total area of the country.

Based on the study's results, which are conducted every five years, the share of lands under water erosion in total area of agricultural lands from 2010 to 2015 has reduced slightly – by 38.9 thousand hectares (which in total is 2.2 percent of the total area of agricultural lands). The share of lands under wind erosion has also decreased from 25493.1 thousand hectares in 2010 to 24168.1 thousand hectares in 2015.

So, in the context of land use and land conditions, the factors which cause an increase of GHG emissions and which prevent their removal can include increase of agricultural lands by 7.4 million hectares and persistence of 24 million hectares of eroded soils. Risk of land degradation can be increased as the result of dryer climate and use of non-sustainable practices of land use and agricultural activities, in particular.

2.4. Climate situation

National hydrometeorological service has been issuing an annual bulletin on climate condition in Kazakhstan since 2010.
When comparing the processes in Kazakhstan with global trends, it is worth mentioning that distribution of extremely warm years in Kazakhstan is slightly different from the ranking of average global temperature of ground air (Table 2).

Table 2. *Ranking of the warmest years on global scale (in 1850-2015) and Kazakhstan (in 1941…2015) and the respective average annual temperature anomalies for ground air, averaged over the territory of Kazakhstan*[52]

Rank	Worldwide	Kazakhstan	Anomaly of average annual temperature averaged over the territory of Kazakhstan, ° C
1	2015	2013	1,89
2	2014	1983	1,76
3	2010	2015	1,66
4	2005	2002	1,53
5	1998	2004	1,45
6	2003	2007	1,48
7	2002	1995	1,41
8	2013	2008	1,38
9	2007	1997	1,26
10	2006	2006	1,19

Source: Annual bulletin on monitoring of climate change and climate condition of Kazakhstan, RSE Kazhydromet, 2015.

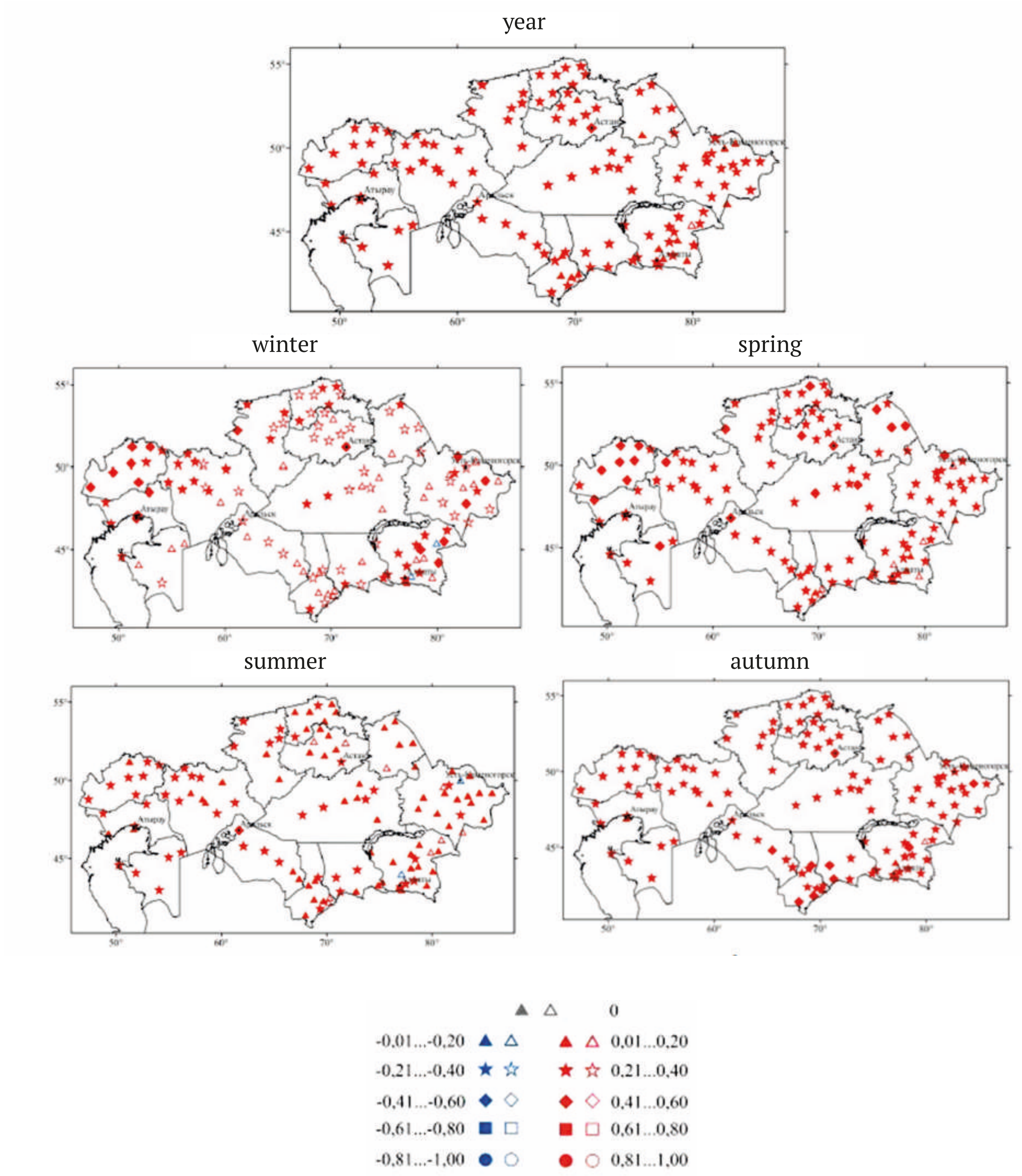
The average annual temperature rate, averaged for the territory of Kazakhstan, is 5.5 °C. In the last 75 years, the coldest year for Kazakhstan was 1969, when the average annual temperature, averaged for the territory, was minus 2.52 °C.

The average annual temperature increase rate in Kazakhstan is by 0.28 °C every 10 years, temperature in Kazakhstan grows faster in spring and autumn – by 0.30 and 0.31 °C/10 years, in winter – by 0.28 °C/10 years, while the slowest temperature growth rate is registered in summer – by 0.19 °C/10 years. The fastest average annual temperature increase was seen in West-Kazakhstan region (by 0.38 °C every 10 years), the slowest – in South-Kazakhstan region (by 0.22 °C every 10 years). In the last 30-year period years with significant positive average annual temperature anomalies dominate in all regions of the country.

The growth of winter temperatures happens in the range of 0.18 to 0.31 °C/10 years, except for Atyrau and West-Kazakhstan regions, where it was 0.38 and 0.46 °C, respectively. The warming rates in spring are 0.21 to 0.28 °C/10 years in southern and eastern regions, 0.32 to 0.34 °C/10 years in southwest and western regions (West-Kazakhstan region is an exception, there is the most significant temperature increase in Kazakhstan – 0.42 °C/10 years), and 0.35 to 0.38 °C over 10 years in central and northern regions, in fact, the biggest growth in these regions is seen in spring season. The slowest warming is seen in summer period in most regions, ranging from 0.14 to 0.28 °C every 10 years, with exception of Mangystau region, where the rate is higher – by 0.45 °C every 10 years. Temperature rise in autumn ranges from 0.26 to 0.37 °C over 10 years, and in southern and eastern regions autumn temperature grew quicker compared to other seasons.

[52] Anomalies are calculated relative to the period of 1961-1990.

Figure 2. *Annual average temperature trends for the territory of Kazakhstan in 1941-2015*[53]



Source: Annual bulletin on monitoring of climate change and climate condition of Kazakhstan, RSE Kazhydromet, 2015.

Average annual temperature trends on the territory of Kazakhstan in 1941-2015 were positive and statistically significant (Figure 2).

The same is also valid for spring, summer and autumn. Temperature trend values were mostly ranging from 0.21 to 0.40 °C over 10 years, spring temperature in the west and some parts of the north grew quicker – by 0.41-0.60 °C/10 years, during the summer season the temperature growth was slower in south-east, eastern and northern regions – below 0.21 °C/10 years. Winter temperatures grew significantly in western and south-eastern, as well as some northern regions, with the maximum of 0.41-0.60 °C/10 years. Winter months are characterized by more positive, but insignificant trends in

[53] Grading symbols are shaded where the trend is statistically significant.

air temperature. Significant warming happened in December in southern, south-eastern and western regions with trend values up to 0.46 °C/10 years, in January in the west – by 0.41-0.80 °C/10 years, and in February in south-eastern and eastern regions – by 0.41-0.80 °C/10 years. Weak negative trends appeared in January in eastern regions and in February in outmost south.

The most significant air temperature increase in spring happened in March – by 0.41-0.81°C/10 years, in some meteorological stations of Atyrau region it increased by 1.00°C/10 years. Only in some stations of Almaty, East-Kazakhstan, Zhambyl regions these trends were not significant. Positive trends continued on the whole territory of the country in April with values ranging from 0.21 to 0.60°C/10 years, they are significant almost everywhere, with exception of some districts in Mangystau, Atyrau, Kostanay, Akmola and Almaty regions. The temperature in May also increased, but the trends were not significant almost everywhere on the territory of Kazakhstan. In June, significant positive trends were observed on the whole territory of the country (up to 0.41-0.60 °C/10 years), only in some meteorological stations of East-Kazakhstan, West-Kazakhstan, Atyrau, Almaty and Pavlodar regions these trends were not significant. In July, on the contrary, mainly insignificant positive trends were observed, only in the west of the country, in southeast and east the trends were significant, with values of 0.40 °C/10 years. Weak negative trends were observed on some stations. In August the temperatures predominantly exhibited sustainable growth by 0.21-0.40 °C/10 years, weak positive trends were seen in some regions in southeast, east and north of the country.

Contrary to the air temperature, precipitation regime change on the territory of Kazakhstan over the reporting period is more diverse. Linear trends in the series of monthly, seasonal and annual amounts of precipitation were assessed using the data of 121 stations.

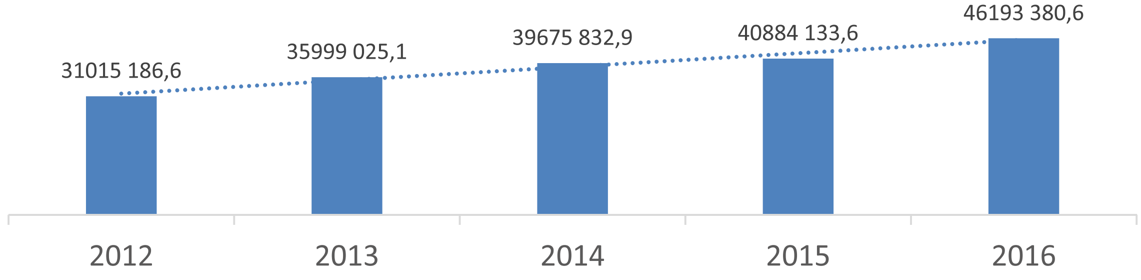
Time series of anomalies in annual or seasonal precipitation values for 1940-2015, calculated relative to the base period of 1961-1990 and spatially averaged for the territory of Kazakhstan and regions show that on average in Kazakhstan for the period of 1940 - 2015 annual precipitation amounts decreased slightly – by 0.2 mm/10 years. Looking at the changes in precipitation levels by regions, insignificant upward trends of annual precipitation amounts by 0.1-5.0 mm/10 years were seen in Aktobe, Karaganda, Pavlodar, Akmola, Almaty and North-Kazakhstan regions, on the rest of the territory precipitation decreased by 0.1-4.2 mm/10 years. No statistically significant changes in the annual precipitation rates were identified.

In relation to the territories with the highest population density (South-Kazakhstan, Almaty, Zhambyl and East-Kazakhstan regions), which are at the same time territories with the most developed agriculture, one can conclude, that there, just as on the whole territory of Kazakhstan, years with positive anomalies in annual average temperature prevail. Majority of heat spots are located in these regions. Although the maximum temperature records broken in the period of 2013–2015 were recorded outside these territories, statistically significant trend of increase in number of days with the air temperature exceeding 35 °C was seen in South-Kazakhstan, Zhambyl, and Almaty regions.

2.5. Economic situation

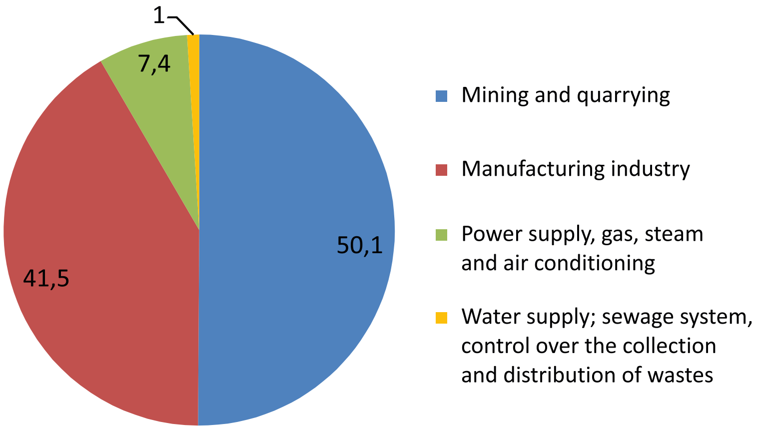
Gross domestic product (GDP) of the Republic of Kazakhstan in 2012-2016 has shown sustainable growth (Figure 3).

Figure 3. *Gross domestic product, million KZT*



Source: Main social-economic indicators of the Republic of Kazakhstan. Committee on Statistics of the RK, 2017.

Figure 4. *Structure of industrial production, 2016*



Source: Social-economic development of the Republic of Kazakhstan in January-December 2016. Committee on Statistics of the RK, 2017.

Product manufacturing comprised 36.9 percent of the GDP in 2016, services provision – 56.8 percent, industry – 26.3 percent, wholesale and retail trade together with the category 'vehicle and motorcycles repair' – 16.1 percent. The main share in the national GDP in the industry category is generated by the mining sector (13.4 percent) and manufacturing industry (10.9 percent).[54]

Amount of investment into fixed capital in January-May 2017 was 2516.6 billion KZT, which is 5.2 percent more than in January-May 2016. The main share of investment was directed to industry, in particular mining sector – 40.7 percent (755 733 million KZT), and in processing industry – 13.6 percent (253 284 million KZT).

[54] Social-economic development of the Republic of Kazakhstan in January-December 2016, Committee on Statistics of the RK, 2017.

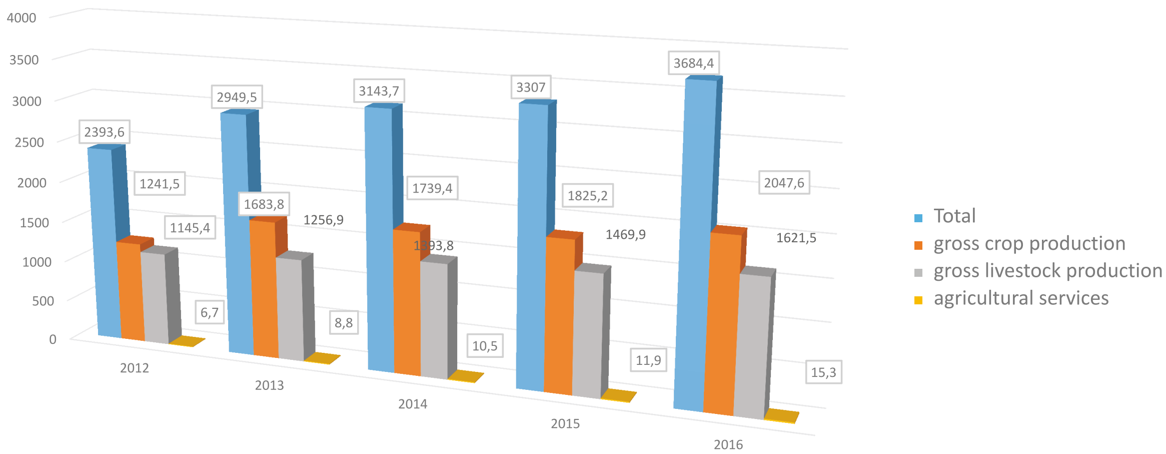
Table 3. *Structure of investment into fixed capital by types of use in 2016*

Types of use	Million KZT	%
Agriculture. fisheries and forestry	252 929	3,3
Industry	4 261 520	55,2
Construction	68 816	0,9
Wholesale and retail trade. vehicle and motorbikes repair	158 851	2,1
Transport and storage	1 159 591	15,0
Accommodation and catering services	73 046	1,0
Information and communication	63 054	0,8
Financial and insurance activities	63 362	0,8
Real-estate transactions	940 770	12,2
Professional, research and technical	53 151	0,7
Activities in the area of administrative and supportive services	225 496	2,9
Public governance and defense; mandatory social protection	36 404	0,5
Education	219 264	2,8
Healthcare and social services	62 754	0,8
Arts, recreation and entertainment	64 438	0,8
Provision of other services	15 347	0,2

Source: Main social-economic indicators of the Republic of Kazakhstan. Committee on Statistics of the RK, 2017.

Compared to similar period of 2016, amount of industrial production in current prices grew by 7.8 percent in January-May 2017. In particular, growth was seen in mining industry (by 9.2 percent), in processing industry (by 6.8 percent), in energy, gas, steam supply and air conditioning (by 5 percent). While in water supply, sewage and control over waste collection and distribution sector the production decreased by 0.4 percent.

Figure 5. *Gross product (services) output in agriculture* in current prices in the given years, billion KZT*



* - data are generated in accordance with the "Methodology for calculating the gross output of products (services) of agriculture, forestry and fisheries", approved by the order of the Chairman of the Committee on Statistics of the Ministry of National Ec

Source: Gross agricultural products output. Graphic material. Committee on Statistics of the RK, 2017.

Gross product (services) output in agriculture also exhibits growth. In January-May 2017, the growth was 655.9 billion KZT, which is 2.7 percent more than in January-May 2016. GDP growth in agriculture was delivered exclusively by livestock breeding.

Limitation factors for country's economic development include high dependence of economy and state budget on revenues driven by oil export, low development level of financial markets, which are characterized by low liquidity and cannot satisfy the need in investment capital. Furthermore, domestic companies and foreign investors note deficit of human resources with sufficient qualifications, as a key barrier for development of manufacturing in the country. Industry of the Republic of Kazakhstan falls behind other countries in terms of innovative and high-tech production. According to the report of Eurasian competitiveness institute, innovation system of Kazakhstan takes 45th place (out of 50 countries, which participate in ranking) in terms of competitiveness level of developed and developing countries.[55] Level of innovative activities in Kazakhstan's economy is still rather low. Thus, out of 4367 enterprises of Kazakhstan in 2016 only 460 (or 10.5 percent) had innovations.[56]

According to the assessment of the National bank of Kazakhstan, the periods of relative strengthening of Tenge have created additional pressure on competitiveness of Kazakhstan's enterprises. External factors, affecting the drop in prices of Kazakhstan's export goods have continued to have adverse effect on the balance of payment indicators in 2016. Reduction of income and expenses of residents almost in all components of the current accounts characterize the last three years. However, already in the second half of 2016 amount of goods export and import, as well as revenues of foreign direct investors began to grow against the backdrop of improving price situation.[57]

Table 4. *Economy openness (in percent of the GDP)*

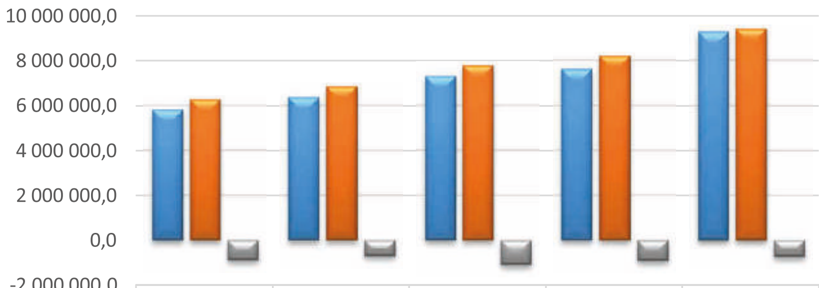
	2012	2013	2014	2015	2016
Export	41,6	35,8	35,9	24,9	27,5
Import	22,3	20,6	18,7	16,6	18,8
Goods turnover	63,8	56,4	54,5	41,5	46,4

Source: Balance of payments and foreign debt of the Republic of Kazakhstan. National bank of Kazakhstan, 2017.

Foreign assets of the country as of the end of 2016 were 169.4 billion USD, showing an increase by 12.3 billion USD over the year. Foreign liabilities of the country as of the end of 2016 were 218.2 billion USD, they increased in 2016 by 19.5 billion USD. Foreign debt of the Republic of Kazakhstan as of 31 December 2016 was 163.8 billion USD.[58] In 2012–2016, there was a deficit.

[55] Resolution of the Government of the RK of 31 December 2013, No 1497 ;On approval of the Concept for industrial and innovative development of the Republic of Kazakhstan for 2015 – 2019'.
[56] Indicators of innovative activities of the enterprises of processing industry related to product and process innovations in 2016, Committee on Statistics of the RK, 2017 г.
[57] Balance of payments and foreign debt of the Republic of Kazakhstan, National bank of Kazakhstan, 2017.
[58] Ibid

Figure 6. *Dynamics of the structure of state budget of the Republic of Kazakhstan*



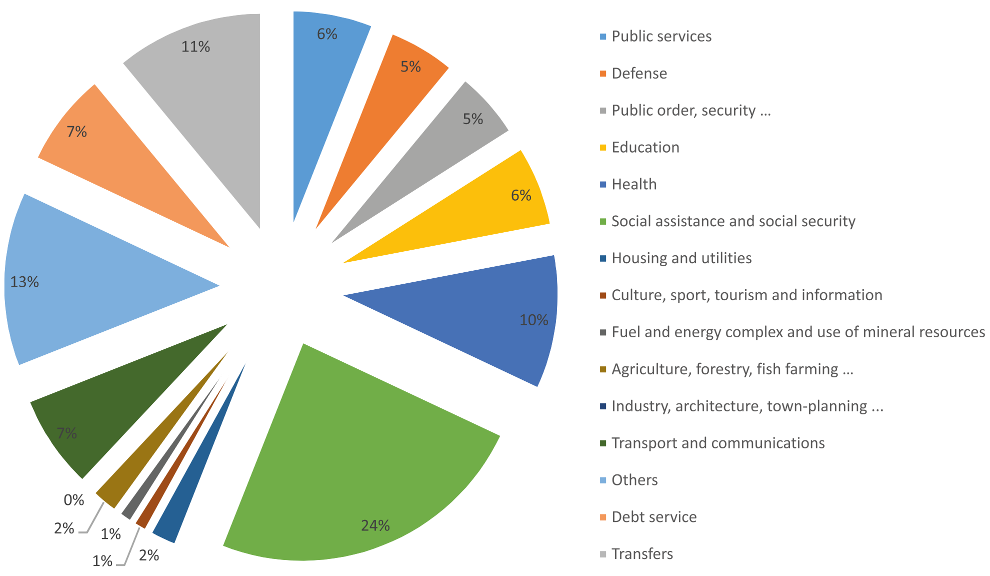
	2012	2013	2014	2015	2016
Incomes, million tenge	5 813 003,4	6 382 352,9	7 321 276,7	7 634 804,9	9 308 485,2
budget expenditures, m. Tenge	6 268 972,0	6 852 711,3	7 791 867,5	8 227 097,2	9 433 744,9
Budget deficit (surplus), million tenge	-890 308,7	-700 927,8	-1 086 670,4	-915 704,8	-737 717,6

Incomes, million tenge   budget expenditures, m. Tenge   Budget deficit (surplus), million tenge

Source: Main social-economic indicators of the Republic of Kazakhstan. Committee on Statistics of the RK, 2017

Up to 2016 main part of revenues was comprised of tax revenues: in 2013 – 3.5 trillion KZT, or 67.8 percent of all revenues of the republican budget, in 2014 – 3.66 trillion KZT, or 62 percent, in 2015 – 3.32 trillion KZT or 54.3 percent. In 2016 share of tax revenues decreased to 43.9 percent. This is related both to the fact that tax revenues decreased in terms of absolute numbers (amount of approved tax revenues in 2016 – 3.19 trillion KZT), and increase of transfers, the share of which was as follows: in 2013 – 30.1 percent of all revenues of the republican budget, in 2014 – 35.6 percent, in 2015 – 42.9 percent, in 2016 – 53.7 percent.[59]

Figure 7. *Expenditures of the republican budget, 2016.*



Source: Republican budget, National budget network of Kazakhstan, 2017.

In December 2016, about 8.5 million people were employed in the economy. Over half of all employed people were working in four sectors: agriculture, forestry and fishery (16 percent of all employed in the economy), wholesale and retail trade; repair of vehicles and motorcycles (15 percent), industry

[59] Republican budget, National budget network of Kazakhstan, 2017; Annual reports of the Ministry of finance of the RK

(12.7 percent) and education (12 percent). Unemployment level is 5 percent.[60] The share of self-employed persons is 25 percent, or 2.2 million people.[61]

The Country attaches special importance to the Manufacturing industry. The highest growth is expected in petrochemical, automotive, agrochemical, electric engineering and railroad rolling stock manufacturing.[62] According to the State program of industrial and innovative development for 2015-2019, by the end of 2019 the value of manufacturing industry's export is expected to grow by 19 percent (compared to the level of 2015). At the same time, the amount of investment in capital assets of the manufacturing industry should be increased by 4.5 trillion KZT, and energy intensity in manufacturing industry should be reduced by at least 7 percent (to the level of 2014). Therefore, manufacturing industry will probably see an increase in cumulative GHG emissions with reduction of emissions per unit of output

Given the goals, stipulated in the Concept for transition of the Republic of Kazakhstan to green economy, aimed at increasing the efficiency of water resources use and energy efficiency in various sectors, as well as modernization of the existing infrastructure and construction of the new one, one can expect reduction of GHG emissions.

2.6. Energy situation

2.6.1. Changes in energy policy

The goal of Kazakhstan›s energy policy is to ensure the growth of the economy with an adequate level and volume of generating capacities. First of all, this is achieved through the modernization of existing power plants. The investment attractiveness of the electric power industry is also increasing, including the investment into renewable energy development.

State program of accelerated industrial-innovative development was in force in Kazakhstan from 2010 to 2014[63], it has replaced a range of earlier programs, including the Program for electric energy sector development to 2030[64], the Concept for gas sector development in the RK to 2015[65] and the Program of gas sector development in the RK for 2004-2010[66]. In 2014, State program for industrial-innovative development of the Republic of Kazakhstan for 2015-2019 was adopted[67]. The focus of the current program document is put on competitiveness in processing industry, aimed at increasing labor productivity and volumes of export of processed good.

The Concept for transition of the Republic of Kazakhstan to green economy[68] has been adopted in 2013 along with an Action plan for its implementation for 2013-2020[69].

In relation to the electric energy sector development, the following technical activates are included in the Concept:

1) energy audit and modernization of all current coal power plants, which will stay in operation after 2020, with installation of gas treatment station to capture, primarily, emissions of dust, serum dioxide and nitrogen oxide, in order to comply with modern standards on emission of harmful substances;

[60] Employed population by main types of economic activities (quarterly data) in 2010-2017, Committee on Statistics of the RK.
[61] Resolution of the Government of the RK of 29 December 2016, № 919 'On approval of the Program for productive employment development and mass entrepreneurship for 2017 – 2021 ...'.
[62] Indicators of the State program for industrial-innovative development of the Republic of Kazakhstan for 2015 - 2019, Committee on Statistics of the RK.
[63] Approved by the Decree of the President of the RK of 19 March 2010. № 958.
[64] Approved by the Resolution of the Government of the RK of 9 May 1999, № 384.
[65] Approved by the Resolution of the Government of the RK of 11 January 2002, № 25.
[66] Approved by the Resolution of the Government of the RK of 18 June 2004, № 669.
[67] Approved by the Decree of the President of the RK of 1 August 2014, № 874.
[68] Approved by the Decree of the President of the RK of 30 May 2013, №577.
[69] Plan, approve by the Resolution of the Government of the RK of 30 July 2013, №750.

2) construction of new heat plants in line with best international technologies in terms of fuel burning efficiency and environmental parameters;

3) gradual replacement of the current coal capacities with the modern coal power plants, with exception of large cities, where energy generation will be converted to gas;

4) start of the renewables development by constructing wind power plants (WPP) and Solar power plants (SPP) to achieve the share of WPP and SPP on the level of 3 percent in the total energy generation by 2020, 10 percent by 2030, 50 percent of the alternative and renewable energy sources, including, solar, wind, hydro and nuclear power plants by 2050;

5) diversification of energy sector through investments in nuclear energy with parallel implementation of safety initiatives;

6) conversion of coal CHPs in all large cities to gas through investments in creation of gas infrastructure in northern, eastern and southern regions of the country;

7) conversion of the existing coal CHPs to gas, first, in large cities (Almaty, Astana, Karaganda), and construction of new gas power plants by 2020 to improve environmental situation in these cities.

As of July 2017[70], there were 50 operational renewable energy facilities in the country with the total capacity of 288.3 MW, including hydro power plants (HPP) with the total capacity of 139.8 MW, wind power plants (WPP) – 90.8, solar power plants (SPP) – 57.3 and biogas installations – 0.35. By 2020 another 53 renewable energy facilities should be built with the total installed capacity of 1966.24 MW, including 23 WPP with total capacity of 958.95 MW, 17 SPP – 724.8 MW, 13 HPP – 282.49 MW. The share of energy generation by gas power plants is currently 18.7 percent.

Activities, aimed at improving efficiency in energy sector, were included in the Program 'Plan of the Nation – 100 concrete steps'[71]. Among them, eliminating current differences in energy prices between the regions (item 50), enlarging regional electric grid companies to increase reliability of energy supply, reducing the costs for energy transmission in the regions, and therefore, reducing the energy prices for the consumers (item 51), implementing new tariff policy, aimed at providing incentives for investment in electric energy sector (item 52).

Currently there is a system of feed-in tariffs for energy generating organizations. Starting with 2019[72], a power capacities market will function along with the electric energy market. With introduction of the capacity market, the current energy tariff will be divided into two parts:

1) electric energy tariff – the variable part, which will ensure recoupment of costs of energy generation;

2) capacity tariff – fixed part, which will ensure return on investment into construction, modernization, upgrade, reconstruction, and expansion of the current capacities.

It is expected that these changes will increase investment attractiveness of the energy sector.

The Law on Support for the Development of Renewable Energy Sources (RES) was adopted in the Republic of Kazakhstan in 2009[73]. In 2014-2015, by-laws were adopted that allow implementing the necessary measures to support renewable energy, namely, feed-in tariffs[74] and rules for the centralized purchase and sale of electricity produced using renewable energy. The rules define the buyer for the electricity produced as the Billing Center (BC), guarantee the purchase of renewable energy at a fixed tariff for 15 years (fixed tariffs are subject to annual indexation for inflation), stipulate that financial regulation of RES electricity imbalances is to be managed by BC. Furthermore, renewable energy producers are exempt from paying for the services of energy transmission organizations

[70] Information on the Concept for transition of the Republic of Kazakhstan to green economy, 31 July 2017, Ministry of Energy of the Republic of Kazakhstan.
[71] Program of the President of RK of 20 May 2015.
[72] Order of the Minister of energy of RK of 3 July 2015, №465 'On approval of the feed-in tariffs on electric energy and tariffs on the services on maintenance of electric capacity readiness'.
[73] Law of the Republic of Kazakhstan №165-IV of 4 July 2009 'On support of the use of renewable energy sources'.
[74] Resolution of the Government of the RK of 12 June 2014, №645 'On approval of feed-in tariffs'.

for the transmission of electrical energy, and RES generating organizations are given a priority in transmission and dispatching of electricity. Also, legal entities that carry out the design, construction and operation of renewable energy facilities are provided with investment preferences in accordance with the legislation of the Republic of Kazakhstan on investments[75].

2.6.2. Consumption of primary energy sources by sectors and types of fuel

Industry uses 93.8 percent of all energy, consumed by Kazakhstan's economy (Table 5). In fact, it is worth noting that energy use in industry has been increasing significantly: between 2011 and 2015 the growth was 24.4 percent or 1574.4 thousand tons of oil equivalent (TOE). Changes in energy consumption in services sector exhibit even higher growth rate. Although the share of energy used by services sector is not comparable with the share taken by the industry, its amount grew almost ten times over five years.

High energy intensity characterizes economy of Kazakhstan.[76] In 2012, energy intensity of the GDP went down by 13.6 percent compared to 2008. Reduction in energy intensity of processing industry (at least by 15 percent to 2019) is defined as one of the main objectives to ensure competitiveness of Kazakhstan's economy.[77]

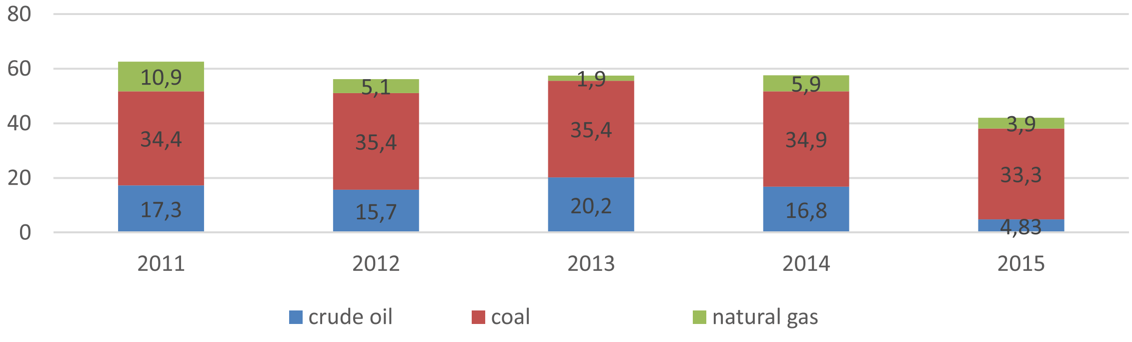
Table 5. *Total end consumption of energy by sectors, thousand tons of oil equivalent*

	2011	2012	2013	2014	2015
Agriculture and fisheries	38,3	35,0	31,3	65,2	45,2
Industry	6 443,3	6 286,9	8 199,1	8 313,0	8 017,7
Transport and storage	82,1	47,2	69,2	233,2	76,9
Service sector	41,3	41,2	146,4	364,4	406,5

Source: Fuel and energy mix of the Republic of Kazakhstan in 2011– 2015, Committee on Statistics of the RK, 2016.

The structure of primary fuel consumption (Figure 8) shows significant increase in the role of coal. While amount of its consumption is constant, its share grew from 55 percent in 2011 to 72 percent in 2015. This is related to the fact that amounts of oil and gas consumption have significantly decreased in 2015.

Figure 8. *Primary consumption of fuel and energy by fuel types, million tons of oil equivalent*



Source: Fuel and energy mix of the Republic of Kazakhstan in 2011– 2015, Committee on statistics of the RK, 2016

[75] Law of the RK of 12 June 2014, № 209-V3PK 'On introducing amendments and changes to some legal acts of the Republic of Kazakhstan on the matters of improving the investment climate'; Resolution of the Government of the RK of 20 January 2017, № 10 'On approval of the list of priority activity directions for the special economic zones and facilities, whose construction is intended to ensure performance of the priority actions in special economic zones, and the Rules for including the priority activities into the list of priority activity types for the special economic zones and facilities, whose construction is intended to ensure performance of the priority actions in special economic zones'.

[76] State program for accelerated industrial-innovative development of the RK for 2010-2014, approved by the Decree of the President of the RK of 19 March 2010, № 958.

[77] State program for industrial-innovative development of the RK for 2015-2019, approved by the Resolution of the Government of the RK of 9 June 2014, № 627.

In 2015, 67.5 million tons of coal were delivered to the domestic market of Kazakhstan. Of the total volume of coal delivered to Kazakhstani consumers, 74 percent, or 51 million tons, was shipped to energy generating enterprises, which is 1.6 million tons less than in 2014[78].

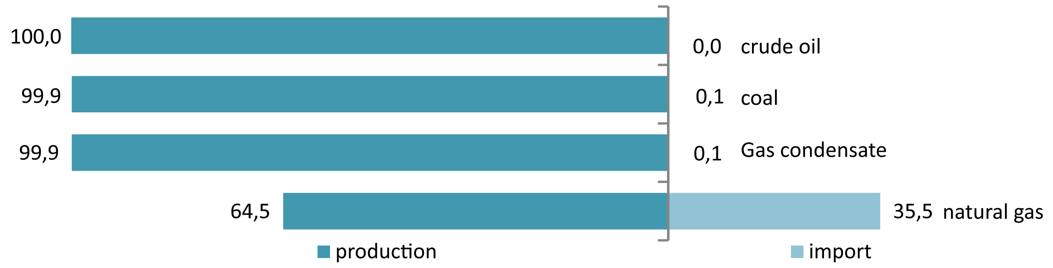
Coal exports in 2015 amounted to 29.2 million tons, or 96.1 percent compared to 2014.[79] The decrease in coal production in 2015 is due to the fact that the power plants of the Russian Federation, the main importer of Kazakh coal, since 2014, have started the transition from the use of Kazakh (Ekibastuz) coals to Russian (Kuznetsk) coals.

Resources of crude oil in 2015 amounted to 80.6 million tons, including 66.5 million tons produced in the country and 0.1 million tons of imports. Out of total resources on the domestic market, consumption was 15.7 million tons and 62.4 million tons were exported.

Oil market in the country continues to have export and raw material focus. Oil supplies are mostly directed to Italy (28.4 percent of all oil exports), the Netherlands (13.6 percent), France (8.9 percent).

In January-April 2017, the total resources of the main natural fuels (oil, including gas condensate, natural gas and coal) involved in the economic turnover of the republic amounted to 66.5 million tons of fuel equivalent.[80]

Figure 9. *Ratio of the share of domestic production and imports in energy resources pool by types, in percentage for each type of resource*

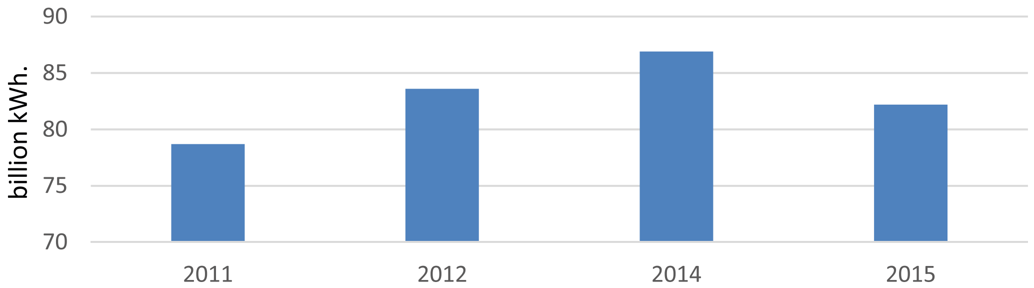


Source: Main social-economic indicators of the Republic of Kazakhstan. Committee on Statistics of the RK, 2017

2.6.3. Energy generation by sources

Energy generation in Kazakhstan in 2011-2015 demonstrated positive dynamics. In 2015 energy generation decreased compared to 2014 by 3.3 percent. This is due to reduction in energy consumption by the industrial consumers, and reduction of household consumption due to higher background temperatures.

Figure 10. *Total amount of energy generation*

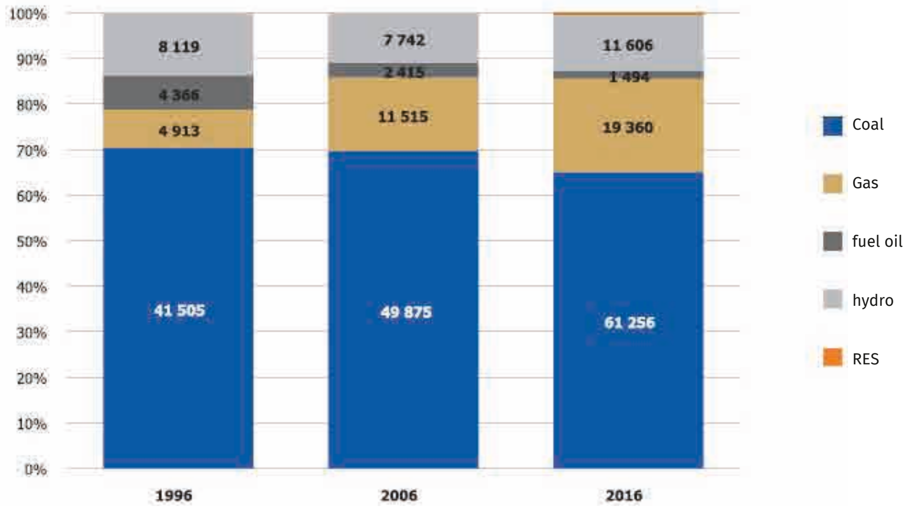


Source: Fuel and energy mix of the Republic of Kazakhstan in 2011– 2015. Statistical compendium, Committee on Statistics of the RK, 2016

[78] Ibid
[79] Ibid
[80] Ibid

In 2015, 76 power plants with various forms of ownership generated electric energy. Total installed capacity of the power plants in Kazakhstan is 21307.2 MW, available capacity – 17 500.1 MW.[81]

Figure 11. *Structure of energy generation by sources*



Source: Ministry of Energy of the Republic of Kazakhstan, 2015.[82]

In 2015, 90 976.6 million kWh of energy was generated in Kazakhstan. The share of renewable energy sources in energy generation has increased from 0.5 percent in 2012 to 0.9 percent in 2016.[83]

2.6.4. Electric energy import and export

The Program for development of the common energy market for the Eurasian economic union is now under development.

In 2015, electricity exports amounted to 1.6 billion kWh of electricity (to Russia). The electricity deficit in Western Kazakhstan is covered through supplies from Russia, in southern Kazakhstan – from Kyrgyzstan. So, in 2015, 1.6 billion kWh of electricity were imported, of which 2.7 percent from Kyrgyzstan, 97.3 percent from Russia.[84]

Kazakhstan is considering the possibility of joining the CASA-1000 project (the Central Asia-South Asia Electricity Transmission and Trade Project) and exporting electricity to Afghanistan and Pakistan, as well as to China.[85]

2.6.5. Energy prices

In general, there is a constant increase in prices for electricity, gas, steam supply and air conditioning in Kazakhstan. So, in May 2017 the prices were 112.9 compared to December 2015 and 104.4 compared to December 2016.[86]

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81 "Electric energy" (note), Ministry of Energy of RK, 5 April 2017
82 "Electric energy" (note), Ministry of Energy of RK, 29 October 2015
83 'Share of energy generated by renewable energy sources (RES) in the total amount of energy generation. Indicators of green economy'. Committee on Statistics of the RK, 2017 г.; 'In 10 years the cost of energy produced by alternative sources will decrease – Kanat Bozumbayev', IA «Kazinform», 27 October 2016.
84 'Fuel and energy mix of the Republic of Kazakhstan in 2011– 2015'. Statistical compendium, Committee on statistics of the RK, 2016
85 'Kazakhstan considers a possibility of exporting electricity to Afghanistan, Pakistan and China – B. Kazhiyev', 20 May 2016, official website of the Prime Minister of RK
86 Main socio-economic indicators of the Republic of Kazakhstan. Committee on Statistics of the RK, 2017.

In May 2017, producer prices for natural gas grew by 2.8 percent, for liquefied propane and butane by 1.3 percent, diesel fuel by 1.1 percent, coal by 0.8 percent, oil - by 0.6 percent, fuel oil by 0.9 percent, and gasoline by 0.7 percent[87]. Due to elimination of state regulation of wholesale prices for liquefied gas, starting from 2018, a more significant increase in prices for liquefied gas is possible.[88]

Table 6. *Price index of the manufacturers by types of energy resources in percent*

	January-May 2017 compared to January-May 2016
Energy resources, total	133,8
Raw material resources	137,6
Oil products	127,8
Electric energy	104,6

Source: Main social-economic indicators of the Republic of Kazakhstan. Committee on Statistics of the RK, 2017

Electricity prices in December 2016 amounted to 7490 tenge per thousand kilowatt hours[89], an increase of 12.5 percent compared to December 2014 (6655 tenge per thousand kilowatt hours[90]). At the same time, annual inflation in 2015 was 13.6 percent[91], in 2016 – 8.5 percent[92].

For the supply of electricity produced by renewable energy objects, feed-in tariffs have been approved[93] in Kazakhstan. In particular, a feed-in tariff of 70 KZT/kWh is approved[94] for solar power plant projects using photovoltaic modules based on Kazakhstani silicon (Kaz PV), with a total capacity of 37 MW.

First GHG emissions trading opened in March 2014; there were 35 transactions done with the total value of 182 million KZT, average price per ton of quota was 301 KZT. In 2015, there were 15 transactions with the value over 354 million KZT, price per ton of emissions varied from 50 to 1400 KZT[95]. In April 2016, emission trading was suspended until 1 January 2018 in line with the changes in the Environmental code of the RK[96]. 3Over this time, methodology for allocation of allowances was revised, so that the system for GHG emission quotas would reflect the needs of economic development of the country, and in particular, growing demand for electricity. Thus, the following will enter into force on 1 January 2018: updated Rules for state register of carbon units[97], National plan for GHG emissions allowances allocation[98] and revised Rules for trading of GHG emissions allowances and carbon units[99].

Trade in emission units and internal emission reduction units will be organized on commodity exchanges. In the case of primary sales of allowances, trade is carried out in the standard auction mode, in the case of secondary trade of emission units - in the dual counter auction mode. Sale and purchase of emission units and units of internal reduction will be carried out by individuals and legal entities. In the event that the quotation of prices for a unit of emissions in the secondary trade on the commodity exchange is absent on the day of trading, the price per unit of emissions is determined taking into account the exchange quotation of prices for quota units of an international independent information provider.[100]

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87 Ibid.
88 Prices for liquefied gas in Kazakhstan will grow at least three-fold, Atameken, 10 April 2017.
89 Producer prices for main types of industrial products in the Republic of Kazakhstan, December 2016.
90 Ibid, December 2014.
91 Inflation overview (4th quarter of 2015), National bank of the RK
92 Idib (4th quarter of 2016), National bank of the RK
93 Resolution of the Government of the RK № 645 of 12 June 2014.
94 Resolution of the Government of the RK № 644 of 12 June 2014.
95 'The market drives emissions trading', Kazakhstanskaya Pravda, 15 May 2015.
96 The Law of the RK of 8 April 2016, № 491-V3PK 'On introduction of amendments and changes to some legal acts of the Republic of Kazakhstan on environmental issues'.
97 Approved by the order of the Ministry of Environment Protection of the RK of 10 May 2012, № 147-ө, stipulated in the edition of the order of the acting Minister of Energy of the RK of 17 November 2016, № 496.
98 Approved by the Resolution of the Government of the RK of 15 July 2017, № 370.
99 Approved by the order of the Minister of Environment Protection of the RK of 10 May 2012, № 147-ө. stipulated in the edition of the order of the acting Minister of Energy of the RK of 17 November 2016, № 496.
100 Rules for trading of GHG emissions allowances and carbon units in edition of the order of the Minister of Energy of the RK of 12 July 2016, №316.

2.6.6. Effects of changes in energy generation and consumption on greenhouse gas emissions

The production and consumption of energy resources in Kazakhstan is mainly due to the burning of mineral fuels, in particular coal. Plans to expand coal and oil production indicate that dependence on conventional energy sources will continue. Meanwhile, work is under way to modernize coal-fired power plants, which will help reduce greenhouse gas and air pollutants emissions. In the future, it is planned to expand the capacity of two wind farms (in Akmola and Almaty regions) to 300 MW each. By 2020, with wind and solar energy, it is planned to achieve 3 percent of the total electricity generation in the country.[101]

Kazakhstan considers nuclear energy as an alternative energy source as well. Currently a feasibility study is being prepared for construction of a Nuclear power plant (NPP). It is expected that by 2050, half of electric energy in the country will be generated by renewable or alternative energy sources.

It is expected that the market for carbon trading, which will be launched as early as January 2018, will stimulate such producers of greenhouse gases, as the largest power plants, to modernize their generation and invest in RES.

The reduction of the energy intensity of the industry is still viewed by the Republic of Kazakhstan as one of the most important factors for increasing the energy efficiency and competitiveness of the economy, which can also lead to a reduction in greenhouse gas emissions.

2.7. Information by sectors of economy

2.7.1. Transport

Kazakhstan is located in the center of Eurasian continent, which drives the importance of transport sector for the country. Ground transportation is dominated by roads and railways. The length of hard-surface roads for general use is 87 thousand kilometers, and the length of railroads is 16 thousand kilometers, open waterways – about 4.2 thousand kilometers, and plane routes – 61 thousand kilometers. [102]

2.7.1.1. Transport services (passenger and freight transport)

In the reporting period (2013-2016) there was a moderate growth both in passenger transportation (measured in million passengers per one kilometer; Table 7), and freight transportation (measured in billion tons per one kilometer; Table 8). In four years, freight transportation has increased by 4.5 percent, and passenger transportation – by 11.6 percent.[103] At the same time there was reduction of passenger turnover in railway transportation (by 2 percent), increase of passenger turnover in motor vehicles (by 1.9 percent) and air transport (by 0.1 percent).

Table 7. *Passenger transportation, million passengers per one kilometer*

Year	Railway	%	Motor	%	Sea	%	Air	%	Total
2013	20624,9	8,7	205191,3	87,0	0,90	0,0004	9687,8	4,1	**235738,4**
2014	18998,6	7,7	217144,7	87,9	1,18	0,0005	10586,3	4,3	**246958,5**
2015	17011,6	6,8	222819,8	88,7	0,43	0,0002	11153,3	4,4	**251250,8**
2016	17913,9	6,7	237287,2	88,9	1,17	0,0004	11313,0	4,2	**266784,2**

Source: Main indicators of transport performance from 2013 to 2016, Committee on Statistics of the RK

[101] Information on the Concept for transition of the Republic of Kazakhstan to green economy, 31 July 2017, Ministry of Energy of the Republic of Kazakhstan.
[102] Length of transportation routes in Kazakhstan in 2016, Committee on Statistics of the RK.
[103] Main indicators of transport development in Kazakhstan, Committee on Statistics of the RK.

Freight transportation turnover has also increased (by almost 5 percent). Meanwhile, there was a significant decrease in air transport (by 32 percent) and increase of freight transport by road (by 12 percent). This trend is caused, most likely, by increase of prices for freight traffic by air due to increase of jet fuel import by more than six times in 2013-2016.

Table 8. *Freight transport, billion tons per kilometer*

Year	Railway	%	Motor	%	River and sea	%	Air (mln t /km)	%	Pipelines	%	Total
2013	231,30	46,7	145,30	29,3	2,73	0,6	63,10	0.01	116.00	23.4	**495.40**
2014	280,6	50,6	155,7	28,1	2,5	0,4	49,30	0,01	116,0	20,9	**554,9**
2015	267,4	48,9	161,9	29,6	1,6	0,3	42,7	0,01	115,4	21,1	**546,3**
2016	238,9	46,1	163,3	31,5	1,8	0,3	42,9	0,01	114,5	22,1	**518,6**

Source: Main indicators of transport performance from 2013 to 2016, Committee on Statistics of the RK.

2.7.1.2. Motor vehicle fleet

The number of registered vehicles in 2016 was 4383 thousand vehicles, which is 4.5 percent more compared to 2013.[104] Significant growth in the total number of vehicles happened in 2014 – the motor vehicles fleet increased at the time by 7 percent, or 304 thousand vehicles (Table 9). Significant (and temporary) strengthening of Kazakhstani Tenge in relation to Russian Ruble lead to increase in the number of vehicles imported from the Russian Federation.

Table 9. *Motor vehicles fleet, thousand vehicles*

Year	Passenger cars	%	Buses	%	Trucks	%	Total
2013	3678,3	87,0	100,9	2,4	450,2	10,6	**4229,5**
2014	4000,1	88,2	98,9	2,2	434,7	9,6	**4533,7**
2015	3856,5	87,7	97,7	2,2	443,2	10,0	**4397,4**
2016	3845,3	87,7	98,7	2,3	439,2	10,0	**4383,1**

Source: Main indicators of transport development in Kazakhstan in 2013-2016, Committee on Statistics of the RK.

Table 10. *Ownership of cars among the population*

Year	Cars per 100 people
2013	20,9
2014	22,0
2015	20,8
2016	20,4

Source: Main indicators of transport development in Kazakhstan in 2013-2016, Committee on Statistics of the RK.

2.7.1.3. Fuel consumption

In 2016, Kazakhstan›s fuel producers covered 72.5 percent of domestic demand for gasoline (including jet fuel), 92.6 percent for gas oil (diesel fuel) and just 1 percent for kerosene. For comparison, in 2013 the share of local production was almost 93 percent for gasoline, 68.5 percent for diesel fuel and 97 percent for kerosene[105]. In order to reduce the deficit on the domestic oil products market, refining capacities are expanding in Kazakhstan – in particular, the modernization of three oil refineries (in Atyrau, Pavlodar and Shymkent). It is expected that this will allow the transition to fuel standards Euro-4 and Euro-5, within the framework of Kazakhstan›s commitments to the Customs Union.

[104] Buses, passenger cars and trucks, Committee on Statistics of the RK.
[105] Resources and use of some types of products (goods) and raw materials in the Republic of Kazakhstan from 2013 to 2016, Committee on Statistics of the RK.

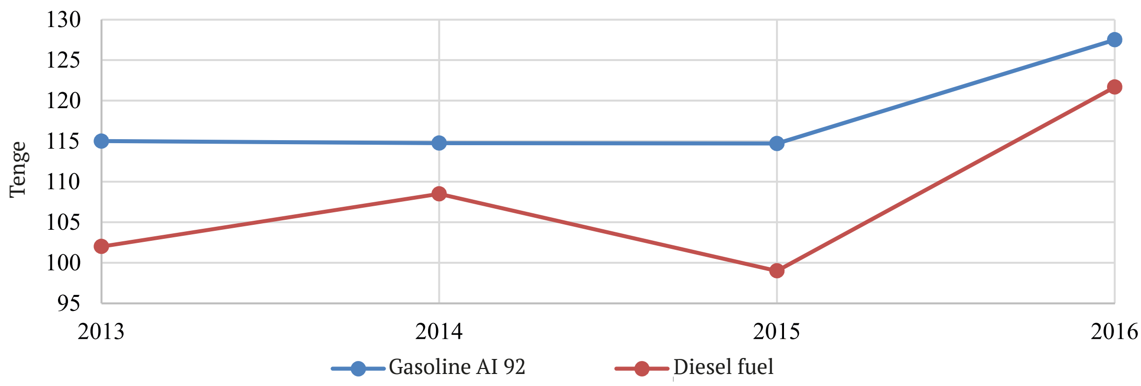
Table 11. . *Production and distribution of products in natural terms, thousand tons*

Motor fuel (gasoline. including jet fuel)				
Year	**2013**	**2014**	**2015**	**2016**
Production	2745,0	3023,6	2876,0	2950,1
Import	1279,1	1220,7	1412,0	1120,1
Use	4024,1	4244,3	4288,0	4070,2
Export	15,3	23,1	0,3	0,0
Sold on the domestic market	4008,9	4221,2	4287,7	4070,2
Kerosene				
Year	**2013**	**2014**	**2015**	**2016**
Production	136,2	113,8	33,0	0,9
Import	16,8	16,4	32,5	106,7
Use	153,0	130,2	65,5	107,6
Export	12,6	13,1	14,2	15,3
Sold on the domestic market	140,5	117,1	51,3	92,3
Gas oil (diesel fuel)				
Year	**2013**	**2014**	**2015**	**2016**
Production	5140,5	5039,0	4557,4	4691,6
Import	597,6	469,6	163,4	424,4
Use	5739,2	5508,7	4720,8	5116,0
Export	208,4	192,4	167,9	47,8
Sold on the domestic market	5530,8	5316,3	4552,8	5068,3

Source: Resources and use of some types of products (goods) and raw materials in the Republic of Kazakhstan from 2013 to 2016, Committee on Statistics of the RK.

Compared to 2013, in 2016 the production volumes of both diesel fuel and kerosene decreased; production of gasoline remained approximately at the same level (Table 11). Prices for more popular fuel brands increased: on gasoline – by 10 percent, on diesel fuel – by 16 percent (Figure 12). These changes are connected, first of all, with the gradual deregulation of the fuel prices by the Government, as well as the annual inflation of the national currency.

Figure 12. *Dynamics of price changes for the most popular types of fuel*



Source: using the data on 'Dynamics of retail prices' (infographics), Ministry of Energy of the RK.

The state does not currently regulate the price of motor fuel, except for RON-80 gasoline. After adoption of the technical regulation of the Customs Union 'On requirements set for motor and aviation gasoline, diesel and marine fuels, jet fuel and fuel oil'[106] production of RON-80 gasoline decreases in Kazakhstan with increase of high-octane petrol and diesel fuel production. This type of gasoline will not be allowed for sale from 1 January 2018.

In 2014, amendments were introduced to the legislation, which increase the levy on cars with bigger engine volume[107]; the purpose of these changes was to promote use of more energy-efficient cars and to reduce GHG emissions. Permissible emission limits for harmful substances (pollutants) of vehicles by country of origin, manufacturing year and environmental categories, were adopted in May 2015.[108]

2.7.1.4. Effects on changes in transport sector on greenhouse gas emissions

Motor vehicles produce significant amount of CO_2 emissions in transport sector (Table 12).[109] 3). In the reporting period, the contribution of motor vehicles was in the range of 83-86 percent. Contribution of domestic aviation and railway transport continued on a relatively low level – in 2015, it was 2.5 percent and 9 percent, respectively.

Table 12. *Greenhouse gas emissions in transport sector, in thousand tons of CO_2*

Year	Motor	%	Domestic aviation	%	Railway	%	Domestic navigation	%	Other	%	Total
2013	18780,9	83,8	860,5	3,8	1627,9	7,3	39,2	0,2	1091,4	4,9	22400,1
2014	16137,1	85,8	542,1	2,9	954,3	5,1	96,2	0,5	1075,2	5,7	18804,8
2015	18134,7	82,5	541,8	2,5	1981,8	9,0	289,5	1,3	1040,4	4,7	21988,2

Source: Inventory of greenhouse gas emissions in Kazakhstan, 2017.

The level of greenhouse gas emissions by motor vehicles in the period from 2013 to 2015 decreased (by 14 percent) in 2014, however the level bounced back already in 2015. There was a significant increase in emissions of railway transport (by 21.7 percent). This may be caused by depreciation of switch locomotive fleet and expansion of the routes (namely, commissioning of the China-Russia route).

Greenhouse gas emissions for domestic aviation have significantly decreased in 2015 – by 37 percent compared to 2013, which may be due to reduction of freight transportation by air (see. Item 2.7.1.1).

2.7.2. Construction sector, housing stock and heating system

2.7.2.1. Energy-efficiency standards in construction

The Law on energy conservation and improvement of energy-efficiency, which was adopted in 2012,[110] has specified the requirements to ensure energy-efficiency of the buildings, structures and facilities. These requirements, which have to be implemented by the developer, include:

- Indicators, related to the rate of energy resources consumption in the buildings, structures and facilities;
- Requirements to architectural, space-planning, constructive and engineering solutions;
- Requirements to engineering systems and technological equipment used;

[106] Decision of the Commission of the Customs Union of 18 October 2011, № 826.
[107] Law of the RK 'On introduction of amendments and changes to some legal acts of the Republic of Kazakhstan on taxation' of 7 March 2014, № 177-V (with amendments and changes as of 30 November 2016.)
[108] Order of the acting Minister for Investment and Development of the RK of 26 March 2015, № 342 'On approval of the permissible parameters of vehicles, driving on the motor roads of the RK'.
[109] Status report of the annual inventory of Kazakhstan, UNFCCC Secretariat, 14 April 2017 (hereinafter the source is specified as 'GHG emissions inventory in Kazakhstan, 2017'; available at: http://unfccc.int/resource/docs/2017/asr/kaz.pdf
[110] Law of the RK of 13 January 2012, № 541-IV. 'On energy conservation and improvement of energy-efficiency'

– Requirements to the technologies and materials, which are included in the design documents and used during construction (reconstruction, renovation), which help eliminate unsound (unreasonable) waste of energy resources.

Projects for the construction of facilities that consume energy and water resources should include the use of energy-saving materials, the installation of meters, automated systems for regulating heat consumption. In the projects of high-rise apartment buildings, mandatory use of energy-saving materials, installation of common house heat and water metering devices, individual apartment electricity, cold and hot water meters, as well as regulating devices in heating systems, automated heat control systems are also envisaged. The law does not allow the commissioning of new facilities that consume energy and water resources, but are not equipped with metering devices and automated systems for regulating heat consumption.

In 2015, the requirements for energy saving and efficiency improvement, which are applied to design (design and estimate) documentation of buildings, structures, and facilities were approved.[111] According to these requirements, a section on energy saving and energy efficiency should be included in the design (design and estimate) documentation for the construction, overhaul or reconstruction of buildings, structures, and facilities, which consume energy in the amount equivalent to 500 and more tons of standard fuel in one calendar year. This section should include: the general energy characteristic of the planned building, structure, facility; energy passport; class of energy efficiency; information on design solutions aimed at energy saving and energy efficiency; information on the compliance of design solutions with the requirements of building codes and their technical and economic indicators in terms of energy consumption

When defining or reviewing the energy efficiency class for the building, structure or facility, certain energy efficiency class is assigned: for new or reconstructed buildings it can vary from A++ (very high) to C- (normal), for current ones – D (reduced) and E (low).[112]

2.7.2.2. Modernization of construction sector in relation to energy-efficiency improvement/support

"Energy conservation-2020" program was adopted in 2013[113]. The aim of the program was to create conditions to increase energy efficiency in the industry of the country. Namely, there was an annual 10% reduction of energy intensity of the GDP foreseen in 2013–2015, with a total reduction by 40 to 2020 relative to the level of 2008.

This was done by reducing the losses in energy and heating networks, implementation of mechanisms, which promote energy saving and energy-efficiency (including the activities of energy service organizations), reduction of fuel consumption in transport sector and reduction of unit costs for generation of electricity, heat and heat consumption in housing sector.

"Energy conservation-2020" program was repealed in July 2016, but its main principles were preserved in the current State program for industrial and innovative development for 2015-2019.

2.7.2.3. Housing stock

The total square area of housing stock in the Republic of Kazakhstan is 343.4 million square meters (Table 13). Of them 217 million square meters (or 63 percent) are located in urban areas and 126.4 million square meters (or about 37 percent) – in rural areas. Meanwhile, in the reporting period (2013-2016) the total square areas of the housing stock in cities has increased by 7 million square meters, in rural area – only by 0.3 million square meters.[114]

[111] Order of the Minister for Investment and Development of the RK of 31 March 2015, № 405. 'On approval of the requirements for energy saving and improvement of energy efficiency, applied to design (design and estimate) documents for buildings, structures and facilities'

[112] Order of the Minister for Investment and Development of the RK of 31 March 2015, № 399 'On approval of the Rules for definition and revisions of energy efficiency classes for buildings, structures and facilities'.

[113] Resolution of the Government of the Republic of Kazakhstan of 29 August 2013, № 904 'On approval of the Program Energy conservation-2020'. Repealed on 25 July 2016, in line with the resolution of the Government № 434.

[114] Preliminary data for 2016, Statistical Compendium. Committee on Statistics of the RK.

Regions development program to 2020 was adopted in 2014[115]. The goal of the program is to create conditions to develop social and economic capacity of the regions by developing sound territorial structure of the country, incentivizing population settlement and capital flows to the centers of economic growth.

Table 13. *Housing stock, in millions square meters*

Year	2013	2014	2015	2016*
Total square area of housing stock	336,1	336,9	340,6	343,4
including:				
Private	329,1	328,9	332,4	335,1
Public	7,0	8,0	8,2	8,3
Of which:				
Total square area of housing stock (urban):	210,0	210,8	214,6	217,0
Total square area of housing stock (rural):	126,1	126,1	126,0	126,4

*preliminary data for 2016

Source: Statistical compendium for 2016, Committee on statistics of the RK.

It is worth noting positive dynamics in almost all spheres of housing stock utilities (water supply, sewerage, central heating, electricity supply), with exception of gas supply (Table 14). The coverage with sewerage is significantly lower in rural area – only 7 percent of rural households had toilets, connected to the central sewerage system in 2016, the rest were using toilets with individual sewage caisson or cesspits.[116]

Table 14. *Level of amenities in housing stock, percent*

Year	2013	2014	2015	2016*
Water supply	96,9	98,4	98,4	98,4
Sewerage	59,0	61,8	64,7	65,4
Central heating	39,8	40,4	40,5	40,5
Gas	91,2	88,8	88,7	88,5
Central hot water supply	35,9	35,9	36,2	36,2

*preliminary data for 2016.

Source: Statistical compendium for 2016, Committee on Statistics of the RK.

The main source of central heating is coal-fired combined heat and power plants (CHP). Over 4-year period, the share of central heating has slightly increased from 39.8 percent to 40.5 percent.

The conversion of the existing coal stations and CHPs in Astana, Almaty and other cities with population over 300 thousand people is included in the Action plan for implementation of the Concept for transition of the RK to green economy for 2013-2020[117]. To gasify central and northern regions, works are done on construction of main pipelines, which will link them to the western part of the country[118]. It is expected that about 3 million people will get access to gas as a results of these activities. Thus, Kazakhstan reduces air pollution in the cities, connects gas mains into single network and creates conditions for exporting gas from Kazakhstan to the market of the PRC.

[115] Resolution of the Government of the RK of 28 June 2014, №728 'On approval of the Program for development of the regions to 2020'.
[116] Information on amenities in households of the RK in 2016 (tables 8 and 9), Committee on Statistics of the RK.
[117] Resolution of the Government of RK of 31 July 2013, № 750 'On approval of the Action plan to implement the Concept for transition of the Republic of Kazakhstan to green economy for 2013 – 2020'
[118] "KazTransGas" JSC has presented report on activities in the first half of 2017, 4 August 2017, website of the national operator in the field of gas and gas supply KazTransGas.

2.7.2.4. Effect of changes in construction sector on greenhouse gas emissions

Greenhouse gas emissions in construction (housing and utilities) sector are directly related to consumption of electricity and heat (Table 15). In 2013-2015, emissions from household consumption have increased by 2.7 times (or by 11648 thousand tons of CO_2 equivalent), while emissions from public generation of electricity and heat have reduced by 11.5 percent (or reduction of 10856 thousand tons CO_2). [119]

Table 15. *Greenhouse gas emissions in housing and utilities sector, in thousand tons of CO_2 equivalent*

Year	Public generation of electricity and heat	Housing sector
2013	95678.1	6710.2
2014	99597.2	17399.5
2015	84821.9	18358.3

Source: Inventory of greenhouse gas emissions in Kazakhstan, 2017.

Energy saving measures (see. Items 2.7.2.1 and 2.7.2.2) allowed Kazakhstan to reduce GHG emissions (Table 15). This was also accompanied by transition to cleaner energy sources (see item 2.7.2.3). Warmer winters have probably also played a role in reduction of GHG emissions. On the contrary, GHG emissions (and therefore fuel consumption) have increased in housing sector, which may be related to growth of private detached housing in the cities, which burn coal and gas to cover their household needs.

2.7.3. Industry, trade and manufacturing processes

Despite some contraction, mining sector still plays a leading role in the total volume of industrial output (Table 16), taking 50 percent in 2016. The share of processing industry has increased in the structure of industrial output (Figure 13) from 32.8 percent in 2013 to 41.5percent in 2016.[120]

Mining sector maintained its position in 2013-2016 due to increase of natural gas production (2-fold) and metal ore extraction (by 1.3 times).[121] Stable annual growth (in the range of 2 to 9 percent) is seen in the following sectors: ‘Electricity, gas, steam supply and air conditioning’ and ‘Water supply, sewerage, control over waste collection and distribution’.

Table 16. *Industrial production output in Kazakhstan, million KZT*

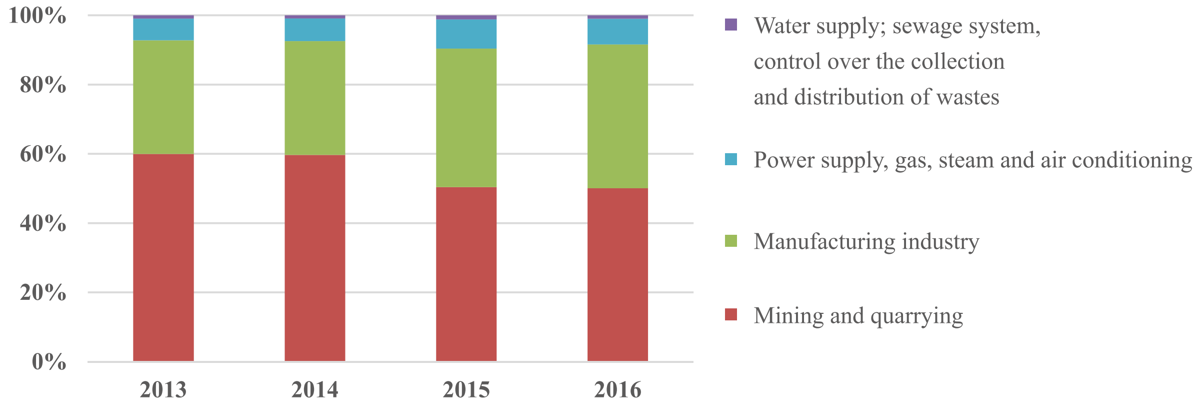
Year	2013	2014	2015	2016
Industry (total)	17 833 994	18 531 774	14 925 230	18 559 213
Mining and pit development	10 696 926	11 060 179	7 521 180	9 295 997
Processing industry	5 852 592	6 092 194	5 971 860	7 705 524
Electricity, gas, steam supply and air conditioning	1 119 063	1 210 167	1 256 429	1 371 502
Water supply, sewerage, control over waste collection and distribution	165 413	169 234	175 761	186 190

Source: Volume of industrial output by types of economic activities from 2013 to 2016, Committee on statistics of the RK.

Processing industry strengthens its position due to increase of food production (by 1.4 times in 2016 compared to 2013), consumer goods industry (by 1.2 times), timber and cork products (by 1.8 times), paper (by 1.6 times), chemical products (by 1.5 times) and metallurgy (by 1.9 times).

[119] Inventory of greenhouse gases in Kazakhstan, 2017
[120] Industrial production output by types of economic activities in the Republic of Kazakhstan, Committee on Statistics of the RK.
[121] Amount of products (goods, services) in current prices by types of economic activitiy, Committee on Statistics of the RK.

Figure 13. *Structure of industrial sector*



Source: Main industry performance indicators from 2013 to 2016, Committee on Statistics of the RK.

2.7.3.1. Effect of changes in industry, trade and manufacturing processes on greenhouse gas emissions

Reduction of energy intensity of the industry, in particular processing industry, is a priority of industrial and innovative development of Kazakhstan.

Based on the estimates on greenhouse gas emissions in industry[122] (Table 17), in the period of 2013 to 2015 there was increase of emissions (by 3.5 percent). While amount of industrial output (Table 16) has decreased over the same period by 19.5 percent.

Reduction of industrial output from 2013 to 2015 is also related to drop in oil prices in the end of 2014 and national currency devaluation in August 2015. These factors have significantly contributed to reduction of investment in energy-saving and energy-efficiency activities.

Table 17. *Greenhouse gas emissions in industrial sector in thousand tons of CO2 equivalent*

Year	2013	2014	2015
Ferrous metallurgy	9577,4	9993,9	12712,1
Non-ferrous metallurgy	8072,8	6998,0	6437,5
Chemical	694,8	603,4	692,4
Paper	34,0	6,2	43, 6
Food	645,5	672,7	1143,2
Non-metallic minerals	3862,6	4160,0	3647,2
Other	5167,6	4896,1	4396,8
Total (industry)	**28054,8**	**27330,3**	**29072,6**

Source: Inventory of greenhouse gas emissions in Kazakhstan, 2017.

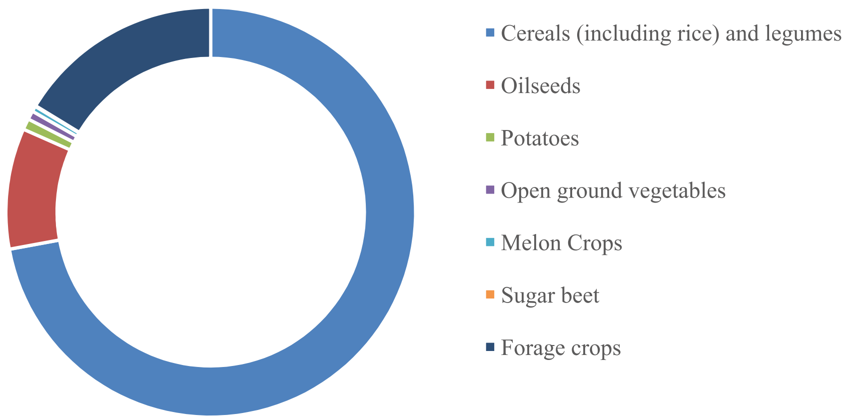
2.7.4. Agriculture

One sixth of employed population in Kazakhstan works in agriculture, forestry and fishery sectors.[123] However, agricultural production (including forestries and fisheries) takes only 4.6 percent in GDP structure[124]. Forty-three percent of the population lives in the rural areas. Total area of cultivated land (Figure 14) is – 21.5 million ha. [125] Northern regions specialize in growing grain and forage crops; southern region, where irrigation is important, have diversified cultivated crops (grain, oilseeds, fruit and berries, vegetables, cotton). [126]

[122] Inventory of greenhouse gases in Kazakhstan, 2017
[123] Employed population by types of economic activity and regions, 2010 – 2016, Committee on Statistics of the RK.
[124] Structure of GDP by production approach, Committee on Statistics of the RK.
[125] Total corrected area of agricultural plants, Committee on Statistics of the RK.
[126] Agrometeorological forecasting in Kazakhstan, Project 'Improving the Climate Resiliency of Kazakhstan Wheat and Central Asian Food Security', UNDP.

Kazakhstan is a large exporter of wheat and flour (is among top ten exporters), cotton, oils and butters, as well as barley also take a significant share of agricultural exports.

Figure 14. *Main agricultural crops in 2016*



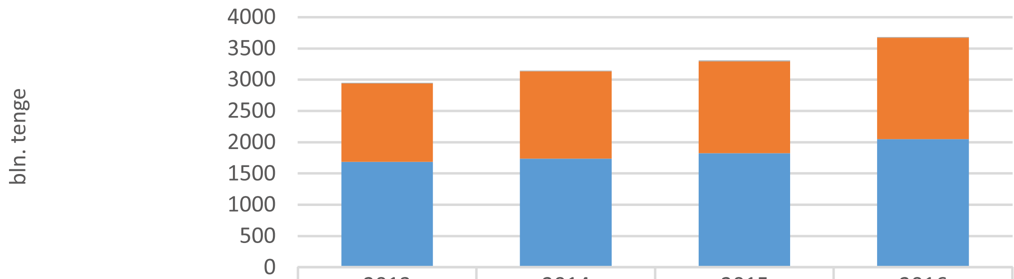
Source: Corrected area of agricultural crops in 2016, Committee on Statistics of the RK.

Since 2013,[127] the state started to move away from direct loans to agricultural entities to support their funding through commercial banks, microcredit organizations and credit partnerships. In 2016, the 'Fund for financial support of agriculture', a subsidiary of national managing holding KazAgro, has issued 11 thousand loans with the total value of 35 billion KZT.[128]

In addition to the effective use of financial measures of state support, the objectives of the current policy in the field of agricultural development[129] are as follows: engagement of small and medium-sized farms in agricultural cooperation, saturation of the domestic market with local products, development of the export potential of agricultural production, efficient use of water and land resources, provision of agricultural producers with machinery and equipment for chemicalization.

Amount of investment in fixed capital in agriculture grew by almost 78 percent, or 110 billion KZT, by 2016 compared to 2013.[130]

Figure 15. *Gross product (services) output in agriculture*



	2013	2014	2015	2016
Agricultural services	8,8	10,5	11,9	15,3
Livestock	1256,9	1393,8	1469,9	1621,5
Crop production	1683,8	1739,4	1825,2	2047,6

Source: Total yield of agricultural crops from 2013 to 2016, Committee on Statistics of the RK.

[127] With adoption of the Resolution of the Government of the RK of 18 February 2013, № 151 'On approval of the Program for agro-industrial complex development in the RK for 2013 – 2020 'Agrobusiness-2020'.

[128] Note 'On activities of the Fund in 2016', official website of KazAgro JSC

[129] According to the State program for agro-industrial complex development in the Republic of Kazakhstan for 2017-2021, approved by the Decree of the President of the RK of 14 February 2017, № 420.

[130] Investment into fixed capital from 2013 to 2016, Committee on Statistics of the RK.

The sector in general exhibits positive dynamics (Figure 15). Gross product output in crop growing has increased by 21.6 percent, livestock breeding – by 29 percent, agricultural service – by almost 74 percent.

Cattle, sheep and poultry breeding mostly represent livestock breeding. In plant growing, biggest share of cultivated lands take grain and legume crops, as well as forage crops and oil-bearing crops (Table 18).[131]

Compared to 2013, в 2016 livestock population increased for all types of livestock, including: cattle – by 8 percent, sheep – by 3 percent, horses – by 22 percent, poultry – by 6 percent. Population of pigs and goat has decreased – by 14 percent and 7 percent, respectively.

The area taken by forage crops has significantly increased in the same period – by 21.6 percent, whereas the cropped land for grain and legume crops has decreased by 3 percent.

Table 18. *Dynamics of number of livestock /poultry and area of cultivated lands*

Year	2013	2014	2015	2016
				Thousand animals
Cattle	5690,0	5851,2	6032,7	6183,8
Pigs	1031,6	922,3	884,7	887,6
Sheep	15137,2	15197,8	15535,3	15688,3
Goats	2496,1	2362,8	2379,3	2327,2
Horses	1686,2	1784,5	1937,9	2070,3
Camels	164,8	160,9	165,9	170,5
Poultry of all types	33473,9	34173,1	35020,0	35632,8
Rabbits	78,6	77,9	84,4	80,0
				Thousand hectares
Grains (including rice) and legume crops	15877,6	15291,5	14982,2	15403,5
Oil crops	1980,9	2299,5	2009,7	2035,7
Potatoes	184,8	186,8	190,6	186,7
Open field vegetables	133,1	137,7	139,5	145,9
Gourds	82,3	89,8	94,7	93,9
Sugar beets	2,7	1,2	9,2	12,6
Forage crops	2866,8	3109,9	3497,1	3485,2

Source: Main indicators of livestock breeding development from 2013 to 2016; cultivated area for harvesting of agricultural crops from 2013 to 2016, Committee on Statistics of the RK.

In 2015, Kazakhstan adopted the law "On production of organic produce"[132], in 2016 – the Rules for production and distribution of organic products[133]. The Law identifies four principles in the area of organic farming: 1) assistance in developing healthy nutrition; 2) limitation of finite natural resources use; 3) ensuring environmental safety and preservation of ecosystems; 4) preservation and recovery of soil fertility. The rules have also introduced the concepts of organic farming and organic livestock breeding.

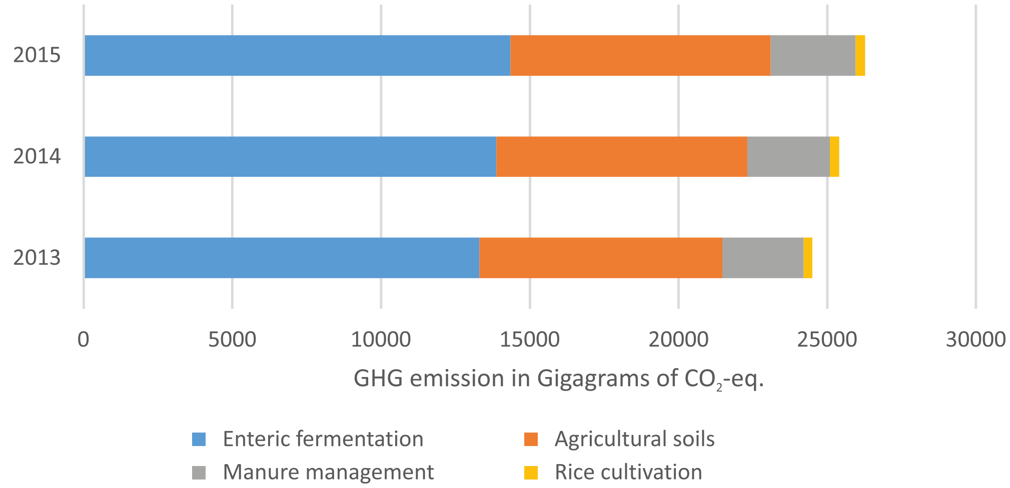
As of 2016, the share of organic farming is at least 303.4 thousand ha or 1.4 percent of the total cropped lands in Kazakhstan.[134]

[131] Statistics of agriculture, forestries, fisheries and hunting sector, Main indicators of livestock breeding development in the Republic of Kazakhstan in 2013-2016, Committee on Statistics of the RK.
[132] Law «On production of organic produce in the RK» of 27 November 2015, № 423-V ЗРК.
[133] On approval of the Rules for production and distribution of organic products of 23 May 2016, № 230.
[134] Development of organic agriculture in Kazakhstan, FAO, 2016.

2.7.4.1. Effect of changes in the sector on greenhouse gas emissions

Kazakhs agriculture is the source for methane and nitrogen oxide. [135] In particular, the source of methane emissions is enteric fermentation, nitrogen oxide is released from agricultural lands (Figure 16). These two sources combined take about 88 percent, or 23094 thousand tons of CO_2 equivalent, in the whole amount of GHG, emitted by the sector.

Figure 16. *Emissions of greenhouse gas in agriculture*



Source: Inventory of greenhouse gas emissions in Kazakhstan, 2017.

The amount of greenhouse gas emissions from the agricultural sector for the period from 2013 to 2015 increased by about 7 percent (or 1775.5 thousand tons of CO_2 equivalent), predominantly due to the increase in methane emissions. At the same time, the gross output of livestock products increased by 14.5 percent (Figure 15). Thus, with further planned increase in livestock production[136] methane emissions will increase. Measures aimed at the transition to the production of organic products, at the moment are of a local nature.

2.7.4.2. Impact of climate change on agriculture

Unfavorable changes in natural and climatic conditions and instability of weather conditions are designated as threats to the development of the agro-industrial complex of Kazakhstan.[137] Due to unfavorable climatic conditions in 2012 and 2014 large areas of crops were killed - about 1407 thousand ha (or 15% of the area of insured crops) and 369 thousand ha (or 8%), respectively. Moreover, the total area of insured crops in 2015 decreased by 40 times compared to 2012, when the total of 9320 thousand hectares were insured.[138]

The previous (III - VI) National Communication of Kazakhstan identified the reduction in the yield of cereals as one of the expected negative consequences for the agricultural sector in Kazakhstan, provided that existing inefficient cultivation technologies are preserved. In the period from 2013 to 2016 due to the introduction of resource-saving technologies for the cultivation of grain crops, including minimal and zero tillage, the transition to a more climate-resistant crop culture began.

Agrometeorological conditions in 2013-2015 in Akmola region were at the level of climate normal, however due to improvement of agrotechnologies, higher yield was gathered. This proves success in implementation of resource-saving technologies in plant growing.

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[135] Inventory of greenhouse gas emissions in Kazakhstan, 2017

[136] According to the State program for agro-industrial complex development of the RK for 2017 – 2021, the following increase in agricultural animals and birds population is expected by 2021 (thousand animals): cattle – to 6951 animals (or by 12.4 percent compared to 2016), horses – to 2957 (almost by 43), sheep and goat – to 21100 (by 17 percent), poultry – to 48516 (by 36 percent).

[137] State program for agro-industrial complex development for 2017-2020.

[138] Ibid

Strategic plan of the Ministry of agriculture of the RK for 2017-2021[139] and State program for agro-industrial complex development identify a range of measures, which will assist in climate change adaptation:

- production of organic agricultural products;
- use of phosphorus fertilizers and biostimulants to accelerate ripening of crops;
- subsidizing the purchase of herbicides by agricultural producers by reducing their cost in order to prevent the growth of weeds due to heavy rainfall in May and June;
- cultivation of at least 2-3 varieties with different maturation periods on a farm in order to reduce the likelihood of the risk of unfavorable weather and climate conditions;
- introduction of water saving technologies and stimulation of water saving through tariffs;
- state support of compulsory insurance in crop growing to insure against adverse natural phenomena;
- ensuring the guarantee of 50 percent of insurance payments to insurance companies that have fulfilled their obligations for insurance cases to producers of agricultural products;
- increasing the forest cover of catchment areas;
- performance of environmental augmentation.

2.7.5. Forestry

Kazakhstan belongs to low-forest countries. The forest fund is concentrated in the mountainous areas in the east, southeast and in the humid plain of the north of Kazakhstan, and takes about 10.7 percent of the total area, or 29 302 thousand ha.

Forest cover is 12 627 thousand ha, or 43% of the total area of the forest fund lands (Table 19). The forest cover of the country has not increased over the past four years and remains at the level of 4.6 percent.[140]

To date, 78 percent of the state forest fund is assigned to the regional executive bodies, 21 percent (mainly represented by specially protected natural areas) is managed by the Forestry and Wildlife Committee of the Ministry of Agriculture of the Republic of Kazakhstan and other ministries and departments manage about one percent.

Table 19. *Main forestry indicators in Kazakhstan*

Category	2013	2014	2015	2016
Forest fund area	28.8 mln ha	29.3 mln ha	29.3 mln ha	29.3 mln ha
% of the area of the country	10.6	10.7	10.7	10.7
Including forested	12.5 mln ha	12.6 mln ha	12.6 mln ha	12.6 mln ha
% of the area of forest fund	43.6	43.3	43.0	43.0
Forest area of the territory	4.6%.	4.6%.	4.6%.	4.6%
Forest reproduction and regeneration	68.5 thousand ha	80.5 thousand ha	60.2 thousand ha	-
Forest fires, number of cases (total area)	274 cases (1154 ha)	581 cases (3003 ha)	476 cases (9617 ha)	-
Illegal felling. Cases identified (volume)	497 cases (3352 cubic m.)	690 cases (4325.5 cubic m.)	670 cases (19504.3 cubic m.)	-

Source: Forestry and Wildlife Committee of the Ministry of Agriculture of the Republic of Kazakhstan

Amount of works done on forest reproduction and regeneration in 2015 compared to 2013 has decreased by about 12 percent (or by 8.3 thousand ha).[141]

[139] Approved by the Order of the deputy Prime minister of the RK, Minister of agriculture of the RK of 30 December 2016, № 541.
[140] Forest resources, Committee on Statistics of the RK.
[141] Forestry and Wildlife Committee of the Ministry of Agriculture of the RK

Sustainable development of forestry is one of the priorities of the Ministry of Agriculture of the Republic of Kazakhstan, which is stipulated in the strategic plan of this department for 2017-2021[142]. Among the priorities of this direction are forest management in the territory of the state forest fund, aviation works for protection of the forest fund, reproduction and regeneration of forests, artificial planting of flora objects, forestry design. In addition, the strategic document identifies the most likely risks to forestry associated with natural and climatic conditions (drought, dry winds, hurricane winds), and measures are planned to manage them.

2.7.5.1. Effects of changes in the sector on greenhouse gas emissions

Emissions and removals in Kazakhstan in forestry, calculated as a total for pastures, forests and shrubs, arable lands, wetlands and perennial vegetation increased by about 1.9 times (or by 6643 thousand tons of CO_2 equivalent, Table 20) from 2013 to 2015. This can be explained by the expansion of arable land and the increased use of mineral, mainly nitrogen, and organic fertilizers on these lands. At the same time, due to the increase in the area of the forest fund, natural pastures and perennial plantations, the potential for removals during the period in question increased by 2558 thousand tons of CO_2 equivalent.

Table 20. *Emissions/removals of greenhouse gas in forestry sector, in thousand tons of CO_2 equivalent*

Year	Forest lands	Arable lands	Pastures	Wetlands	Perennials	Total
2013	-10938.88	46405.33	-26718.13	11.88	-1409.10	7351.11
2014	-11018.75	51010.67	-27750.44	0	-1592.43	10649.05
2015	-11092.54	55618.20	-28763.84	0	-1767.88	13993.93

Source: Inventory of greenhouse gas emissions in Kazakhstan, 2017.

2.7.5.2. Effect of climate change on forestry sector

Number of forest fires has increased significantly in the period from 2013 to 2015 (Table 19) – by 1.7 times (or by 202 cases), total area of forest fires has increased by 8.3 times (or by 8.5 thousand ha). It is expected that with increase in climate aridity, the frequency of forest and steppe fires will increase.

Sustainable forest development (continuous increase of forest cover) is one of the principles of forestry legislation in the RK.[143] The increase in the forest cover of catchment areas of water bodies is planned as one of the measures to reduce the water deficit.

Currently, the legislation of the Republic of Kazakhstan establishes support for private afforestation through reimbursement of up to fifty percent of expenditures for the creation and development of private forest nurseries and the cultivation of fast-growing tree and shrub species for industrial and energy purposes[144]. Creation of targeted mechanisms aimed at attracting private investment in forestry should contribute to the increase in the country›s forest plantations.

Strategic plan of the Ministry of Agriculture of the RK and State program for agro-industrial complex development identify a range of measures, which will assist in climate change adaptation for the sector:

- increasing the frequency of ground and air patrols;
- conducting fire prevention activities;
- increasing the forest cover of catchment areas;
- performance of environmental augmentation.

[142] Approved by the Order of the Deputy Prime-Minister of the RK – Minister of agriculture of the RK of 30 December 2016, № 541 'On strategic plan of the Ministry of agriculture of the Republic of Kazakhstan for 2017-2021'.
[143] Code of the RK of 8 July 2003, № 477 'Forest code of the RK', Article 3.
[144] Code of the RK of 8 July 2003, № 477 'Forest code of the RK', Article 18-1.

2.7.6. Waste and waste water management

In 2016, 2813.6 thousand tons of municipal wastes were collected in Kazakhstan, which is 20.7 percent less compared to 2013 (Table 21). Municipal waste include municipal, industrial waste, waste from streets, parks, markets, construction sites etc.

Up to 90 percent of municipal wastes are not sorted for their processing or recycling. This amount goes for permanent landfill (storage of waste) at the waste disposal sites. The rest is sent for sorting and further recycling and/or disposal.[145]

The amount of per capita waste has decreased by 24% in the reporting period.

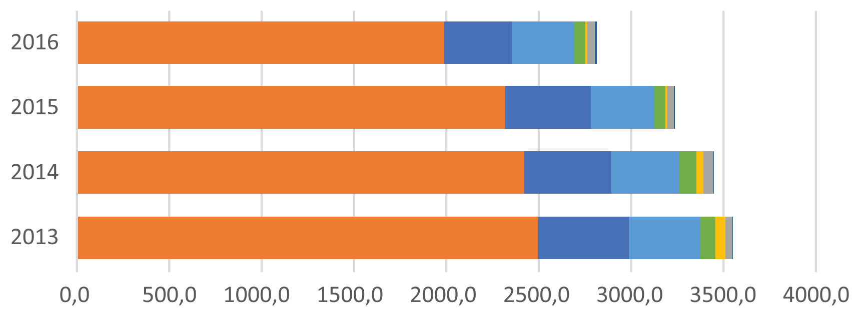
Table 21. *Intensity of waste generation and recycling rate*

	Units	2013	2014	2015	2016
Generation of municipal waste	Tsd tons/ year	3547,7	3446,3	3235,5	2813,6
Generation of hazardous waste	Tsd tons/ year	382 214,30	337 414,8	251 565,6	-
Recycling of municipal waste	Tsd tons/ year	16,0	383,0	372,5	346,2
Recycling of hazardous waste	Tsd tons/ year	3580,0	3124,3	5456,10	-
Population of the country*	Mln people	17 160 774	17 417 673	17 670 579	17 670 579
Per capita generation of municipal waste	Kg per capita	206,7	197,9	183,1	159,2
Per capita generation of hazardous waste	Kg per capita	22 272,6	19 372,0	14 236,4	-

*RK population from 2004 to 2016, Committee on Statistics of the RK.

Source: Green economy indicators of the RK, Intensity of waste generation and recycling rate, Committee on Statistics of the RK.

Figure 17. *Amount of waste collected, thousand tons*



	2013	2014	2015	2016
household waste	2495,5	2421,0	2318,3	1988,5
waste products (equated to household)	492,9	472,4	465,1	367,0
street wastes	384,5	368,8	342,0	334,2
waste from markets	82,8	92,0	60,1	63,4
waste from construction sites	53,1	36,9	6,9	8,3
park waste	38,1	54,7	40,6	42,3
others	0,7	0,4	2,5	9,8

Source: On collection, transportation, sorting and storage of municipal waste from 2013 to 2016, Committee on Statistics of the RK.

[145] On collection, transportation and storage of municipal waste from 2013 to 2016, Committee on Statistics of the RK.

Reduction in generation of municipal waste (Figure 17) in 2013-2016 is seen in the following categories: municipal waste (by 20.3 percent less) and manufacturing (by 25.5 percent less), as well as construction (by 84.4 percent less).

2.7.6.1. Legal framework and objectives on MSW and municipal waste water management

The main document regulating legal issues of waste and wastewater management in Kazakhstan is the Environmental Code[146]. This document regulates not only the full cycle of waste (general requirements, classification, certification, etc.), but also establishes requirements for storage/landfilling and landfills. Regarding the regulation of wastewater, this document regulates the requirements for discharges and their treatment.

In May 2013, the Concept for transition of Kazakhstan to green economy was approved. In this Concept, the problem of accumulation of industrial and consumer waste in Kazakhstan was identified and a step-by-step plan for its solution was established. The Action Plan for the implementation of the Concept for 2013-2020[147] envisages the adoption of a number of measures to improve the waste management system, including:

- development of a program for the modernization of the solid waste management system;
- introduction of proposals for the development of the Industrial Waste Management Program;
- development of regional maps for the location of production and consumption wastes, landfills, municipal waste dumping sites, territories subject to weathering of municipal waste;
- introduction of proposals for a thorough audit of all large industrial waste sites;
- development of an action plan for reclamation of lands under landfills with industrial waste.

Technologies recommended for disposal and processing of waste and wastewater are included in the List of Best Available Technologies[148]. In the period from 2013 to 2016, the Environmental Code has introduced a number of changes in the part of environmental requirements for the management of manufacturing and consumption waste, as well as requirements for landfills and long-term waste repositories. As of January 1, 2019, waste that is not acceptable for landfills will include plastic waste, polyethylene and polyethylene terephthalate packaging, as well as waste paper, cardboard and paper waste (Article 301).

Modernization program for municipal solid waste (MSW) management system for 2014-2050 was initiated in 2014[149], but is was repealed already in August 2016[150]. One of the targets of this program was to ensure 50 percent share of waste recycling in MSW.

2.7.6.2. MSW and municipal wastewater disposal

Modernization program for municipal solid waste (MSW) system was initiated in 2016. The main objectives of this initiative are as follows: to prevent the entry of electronic and electrical waste, including batteries, into landfills; to reduce volumes of solid waste disposal; to improve the environmental situation; to provide recycled materials to producers of goods.

The key innovation was the introduction of the principle of extended producer responsibility (EPR). Within the framework of this program, the strategy of phased regulated inclusion of waste from the list of «not acceptable for landfills» was chosen with the subsequent direction of the controlled waste types for further disposal/processing by a single operator. The first stage, which is currently being

[146] Environmental code of the RK of 9 January 2007, №212-III
[147] Resolution of the Government of RK of 31 July 2013, № 750 'On approval of the Action plan to implement the Concept for transition of the Republic of Kazakhstan to green economy for 2013 – 2020'
[148] Order of the Minister of # of the RK of 28 November 2014, № 155 'On approval of the list of best available technologies'.
[149] Resolution of the Government of the Republic of Kazakhstan of 9 June 2014, № 634 'Modernization program for solid household waste management modernization for 2014 – 2050'
[150] Resolution of the Government of the RK of 29 August 2016, № 484.

implemented, includes full processing/recycling for vehicles and their components (tires, tire casing, batteries, engine oil, etc.).[151]

In the future, a mechanism will be introduced to compensate for collection and disposal/recycling of packaging, electronics, electronic equipment (household appliances, energy saving and mercury containing lamps, as well as chemical sources of electricity). The ERP operator has allocated 1 billion 250 thousand KZT for implementation of environmental project.

Table 22. *Amount of waste delivered for sorting, disposal and storage*

Year	Number of enterprises, engaged in waste sorting. disposal and storage	Amount of total waste received. thousand tons	Of them, thousand tons			
			Sorted	Sent for recycling	Disposed	Sent for storage
2013	154,0	2772,3	14,6	13,3	16,0	2728,4
2014	167,0	3426,9	12,8	6,5	383,0	3024,5
2015	167,0	3267,9	11,3	-	372,5	2884,1
2016	162,0	2942,7	14,1	1.9	346,2	2582,4

Source: On collection, transportation, sorting and storage of municipal waste from 2013 to 2016, Committee on Statistics of the RK.

These measures have significantly contributed to waste disposal – amount of waste recycling has increased by 22 times in 2016 compared to 2013 (Table 22). With improvement of legal framework and expansion of recycling capacities, the list of waste, subject to recycling will expand.

Table 23. *Main indicators of sewerage treatment facilities performance, in thousand cubic meters*

Year	Total wastewater throughput	Wastewater treated by full-scale biological treatment	Of which		
			Tertiary treatment	Treated to standard quality	Insufficiently treated
2013	662 222,7	537 058,0	6 213,6	454 785,0	63 775,6
2014	642 644,9	525 865,8	5 867,8	442 585,8	64 549,2
2015	643 152,3	531 390,8	4 924,0	461 835,0	53 147,5
2016	639 794,0	535 597,7	5 683,1	468 378,8	50 615,5

Source: year, Committee on Statistics of the RK.

Total volume of wastewater, which was treated by treatment facilities in 2013-2016, has decreased by about 3.5 percent (Table 23). This reduction is probably due to strengthening requirements on mandatory annual reduction of water consumption per unit of output and per unit of square area of the buildings, structures and facilities.[152]

It is worth mentioning that the share of wastewater treated by means of full-scale biological treatment has increased by approximately 2.5 percent compared to the total amount of water treated. It is important to note improvement of the quality of treatment facilities performance: for instance, the share of insufficiently treated wastewater has decreased by 1.7 relative to the total volume.

[151] Official website of the EPR system operator: www.recycle.kz

[152] Code of the RK of 5 July 2014, № 234-V 3PK 'On administrative offences' (Article 292. Violation by the subjects of the State Energy Registry of the obligation to provide information entered into the State Energy Register, the requirement for mandatory annual reduction in the volume of consumption of energy resources and water per unit of output, area of buildings, structures and facilities to the values determined by the results of energy audit».

2.7.6.3. Effect of changes in MSW and municipal wastewater management on greenhouse gas emissions

For the MSW and municipal wastewater management sector the sources of GHG emissions are: MSW landfilling, system of wastewater discharge and treatment, and incineration of healthcare waste. Total amount of emissions in this sector in 2015 was 6115 thousand tons of CO_2 equivalent, which is 5 percent more than in 2013 (Table 24).

Table 24. *Greenhouse gas emissions in MSW and municipal wastewater management sector, in thousand tons of CO_2 equivalent*

Year	MSW landfilling	wastewater discharge and treatment	incineration of healthcare waste	Total in the sector
2013	3830,3	1981,0	3,4	5814,8
2014	3906,0	2070,0	7,1	5983,0
2015	3996,1	2111,6	7,5	6115,2

Source: Inventory of greenhouse gas emissions in Kazakhstan, 2017.

GHG emissions from MSW and wastewater have increased by 4-6 percent. The measures increasing share of MSW disposal (see item 2.7.6.2) cover only vehicles and spare parts so far. In the future EPR operator will expand the list of waste subject to disposal, which can cause significant reduction of emissions in this sector.

Emissions from incineration of healthcare waste have increased more than two times. This happened due to introduction of stricter regulations on hazardous healthcare waste management and prevention of their landfilling.[153]

[153] Order of the Minister of National Economy of the Republic of Kazakhstan of 28 February 2015, № 176 'On approval of the sanitary rules 'Sanitary-epidemiological requirements for collection, use, application, decontamination, transportation, storage and landfilling of manufacturing and consumption waste'.

III. INFORMATION ON NATIONAL GREENHOUSE GAS INVENTORY OF THE REPUBLIC OF KAZAKHSTAN, INCLUDING DESCRIPTION OF NATIONAL SYSTEM AND NATIONAL REGISTER

3.1. Summary tables of the national greenhouse gas inventory

According to the reporting guidelines to the UNFCCC, summary information on national greenhouse gas inventory is provided for the period, starting with the base year of 1990 to the latest inventory year, 2015. Information on national greenhouse gas inventory is provided in full compliance with the national inventory submitted. Information on the inventory is provided in summary table 1 in CTF format (Common Tabular Format).

3.2. Summary of national inventory

According to the reporting guidelines to the UNFCCC, summary information on national inventory, summary tables and figures for all GHG, specified in the summary tables, are provided. Furthermore, factors which drive the emission trends are described.

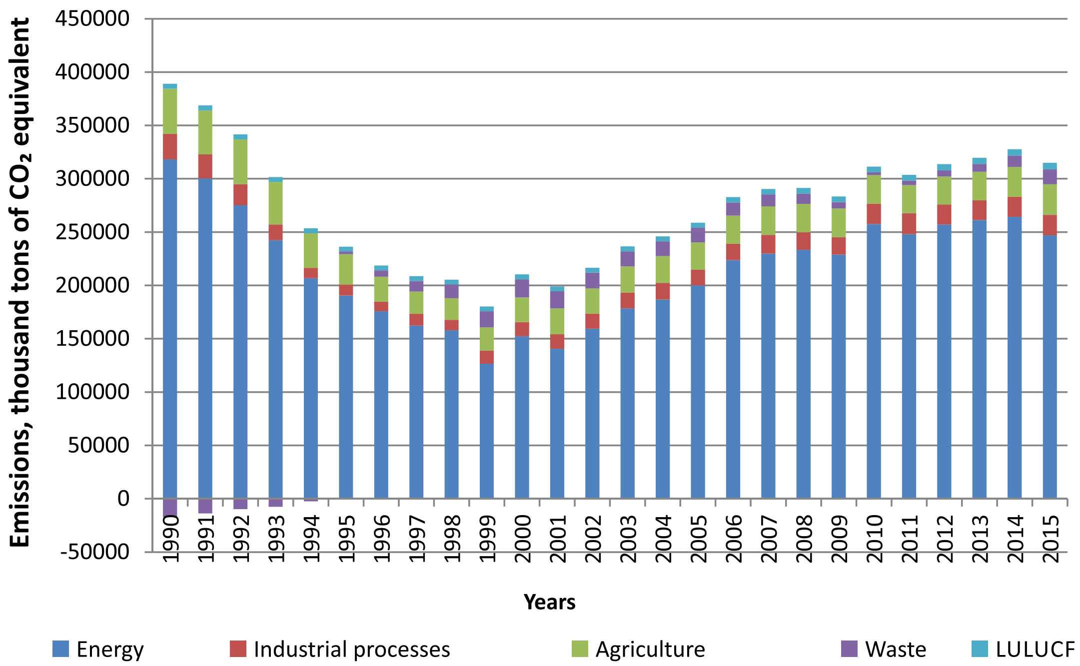
Cumulative GHG emissions in base year of 1990 in Kazakhstan without LULUCF sector were 389,104 million tons of CO_2-equivalent, and including LULUCF GHG emissions in 1990 comprised 371,831 million tons of CO_2-equivalent. (Table 25).

Table 25. *Dynamics of total national GHG emissions in 1990-2015 by sectors of the economy in the Republic of Kazakhstan, thousand tons of CO_2-equivalent*

Years	Energy activities	IPPU	Agriculture	LULUCF	Waste	Total emissions with LULUCF (net emissions)	Total emissions without LULUCF
1990	318195,02	23885,04	42249,08	-17273,21	4775,28	371831,25	389104,47
1991	300299,82	22548,28	41135,86	-13732,32	4829,70	355081,34	368813,66
1992	275111,44	19767,95	42052,82	-9795,97	4662,80	331799,03	341595,00
1993	242410,94	14718,05	39869,65	-7504,06	4521,07	294015,65	301519,71
1994	206839,48	9658,86	32410,43	-2516,46	4599,74	250869,27	253385,73
1995	190464,06	10403,75	28432,39	2574,30	4490,76	236365,25	233790,95
1996	175710,77	8998,94	23476,36	5931,78	4506,42	218624,27	212692,49
1997	162285,94	11126,27	20772,53	9988,14	4557,88	208730,75	198742,62
1998	157853,82	9843,19	20338,99	12882,08	4496,22	205414,30	192532,22
1999	126584,92	12118,79	22017,40	15052,39	4497,71	180271,21	165218,82
2000	152332,76	13305,46	23005,29	17094,15	4593,92	210331,57	193237,43
2001	140698,15	13486,50	24294,77	16040,18	4572,31	199091,91	183051,73
2002	159491,52	13979,72	23769,94	14736,75	4581,16	216559,09	201822,34
2003	178454,16	14889,00	24515,49	14043,93	4636,12	236538,70	222494,76
2004	186775,49	15539,58	25145,20	13798,45	4741,92	246000,64	232202,19
2005	200005,97	14698,04	25660,05	13606,98	4782,76	258753,80	245146,82
2006	223766,67	15293,41	26318,47	12399,53	4992,24	282770,32	270370,79
2007	229809,49	17557,77	26797,79	11118,81	5176,49	290460,35	279341,54
2008	233408,90	16373,82	26745,72	9640,18	5188,07	291356,69	281716,51

2009	228816,66	16333,41	26999,30	5937,54	5314,66	283401,83	277464,29
2010	257527,46	19072,43	26786,70	2599,92	5455,48	311442,00	308842,07
2011	247991,17	19740,37	26220,88	4121,11	5609,81	303683,33	299562,22
2012	257136,57	18806,54	26139,52	5916,81	5699,29	313698,73	307781,92
2013	261269,79	18461,93	26791,12	7351,11	5814,76	319688,70	312337,59
2014	264317,47	18974,04	27794,39	10649,05	5983,01	327717,96	317068,91
2015	246874,79	19177,99	28752,57	13993,93	6115,15	314914,43	300920,50
Difference in 2015 to 1990 in%	77,6	80,3	68,1	-81,0	128,1	84,7	77,3
Difference in 2015 to 2014 in%	93,4	101,1	103,4	131,4	102,2	96,1	94,9

Figure 18. *Cumulative greenhouse gas emissions in Kazakhstan*



As one can see from Table 25 and Figure 18, total cumulative emissions from 1990 to 1999 have reduced almost two-fold due to economic downturn in Kazakhstan: from 165,219 million tons of CO_2-equivalent, excluding LULUCF. This reduction was 42.5% of the level of 1990, excluding LULUCF.

The difference between cumulative emissions including and excluding LULUCF on average is 2% of the emissions level with LULUCF and varies from – 5% to 7% with the downward trend before 1999, and further increase until 2014.

Before 1995, total emissions excluding LULUCF were higher than emissions including LULUCF by 2-5%, and after 1995, they became lower, because emissions replaced removals in LULUCF sector.

Since 2000 due to improvement of economy, GHG emissions in Kazakhstan began to grow and by 2015 have reached the level of 300,920 million tons of CO_2-equivalent excluding LULUCF and 314,914 million tons of CO_2-equivalent with LULUCF, however, they have not yet reached the level of the base year of 1990. Total national GHG emissions in Kazakhstan in 2015 including LULUCF sector were below the level of 1990 by 15.3%, and excluding LULUCF – by 22.7%.

3.3. Description of the national inventory system of greenhouse gas emissions

According to the guidelines for the submission of national systems in accordance with Article 5, paragraph 1, of the Kyoto Protocol, for Kazakhstan as a Party included in Annex I for the purposes of the Kyoto Protocol, this section presents the results of how Kazakhstan fulfills the general and specific functions of the national system item by item.

a) **the name and contact information of the national authority and its designated representative who has overall responsibility for the national inventory of the Party**

The Ministry of Energy of the Republic of Kazakhstan is responsible for national GHG inventory since August 2014. National focal point of UNFCCC is the Vice-minister of Energy Sadibekov Gani Kalybayevich. The Department for climate change of the Ministry of Energy of the Republic of Kazakhstan heads report development.

Contact information:

The Department for climate change of the Ministry of Energy of the Republic of Kazakhstan:
Astana, Mangilik El Street, 8, entrance 14. Phone: +7 (7172) 74 02 58 Fax: +7 (7172) 74 02 62,
Director of the Department for climate change: Agabekov Olzhas Pernekhanovich,
email: o.agabekov@energo.gov.kz

b) **the roles and responsibilities of national institutions and organizations in the implementation of the inventory development process, as well as the organizational, legal and procedural measures taken to prepare the inventory**

The national GHG inventory in Kazakhstan is conducted on the basis of the relevant provisions of Articles 4 and 12 of the UNFCCC and decisions of the COP. Institutional, legal and procedural mechanisms for preparing greenhouse gas inventories are also regulated by the internal regulatory documents of the Republic of Kazakhstan. National reports on the greenhouse gas inventory are the information basis for the development of climate change policies implemented by the Government of Kazakhstan.

After the ratification of the Kyoto Protocol in 2009, Kazakhstan began to submit annual reports on the national inventory of greenhouse gas emissions to the UNFCCC Secretariat in the form of national inventory reports (NIR) and the electronic table (Common reporting format – CRF). All submitted NIRs and CRF spreadsheets can be found on the website of the UNFCCC Secretariat.

Preparation of annual national GHG emissions inventory in Kazakhstan has been in place since 2009 within the framework of agreement with MEP in 2009-2013, with MEPWR in 2014, and since 2015 – with the Ministry of Energy of the RK, which currently serves as authorized body on coordination of Kyoto Protocol implementation in the RK. The same specialized organization "Zhassyl Damu" JSC works on national inventory, which ensures continuity in its preparation.

State bodies provide the information necessary to prepare the inventory at the request of the Authorized body in the field of environmental protection (Ministry of Energy of the Republic of Kazakhstan), and also check and approve the draft National inventory report.

The national system for assessment of greenhouse gas emissions and removals by sinks was developed in accordance with paragraph 4 of Article 158-1 of the Environmental Code of the Republic of Kazakhstan dated January 9, 2007. It includes institutional, legal and procedural mechanisms for estimating anthropogenic emissions by sources and removals of all greenhouse gases not controlled by the Montreal Protocol. To this end, Kazakhstan adopted the Regulation on the State System of Data Collection Inventory approved by Order No. 193-p of the Minister of Environmental Protection of July 23, 2010, and then Resolution No. 943 of the Government of the Republic of Kazakhstan dated July 17, 2012 «On Approval of the Rules of organization and the content of the state inventory of sources of greenhouse gas emissions and removals». After the reform of the government in August 2014 and the abolition of the Ministry of Environment protection and Water resources, the functions of the authorized body for coordinating the implementation of the Kyoto Protocol were transferred to the newly created Ministry of Energy of the Republic of Kazakhstan. Resolution No. 943 was repealed. Instead, the Order of the Minister of Energy of the Republic of Kazakhstan No. 214 of March 18, 2015, «Rules for monitoring the completeness, transparency and reliability of the state inventory of greenhouse gas emissions and removals» was adopted, which determines the mechanism for preparing the annual national greenhouse gas inventory.

Public authorities, in accordance with the list specified in the Annex to this Regulation, provide information and data on the volumes of production and activities resulting in anthropogenic emissions by sources and removals by sinks of greenhouse gases during the inventory preparation process.

In the Rules included in Order No. 214, the following concepts are used:

1) transparency – openness of the process of state inventory of emissions and removals of greenhouse gases, revealing the methodology used in calculating greenhouse gas emissions and removals;
2) base year is the year established to fulfill the obligations of the Republic of Kazakhstan under Article 3, paragraph 5, of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (hereinafter referred to as the Convention);
3) the key source category is the sector or subsector of the economy, which is classified in accordance with the requirements of the Convention as one of the largest contributors to greenhouse gas emissions or removals;
4) quality control – a system of standard technical measures for measuring and monitoring the quality of the state inventory of sources of emissions and removals of greenhouse gases as it is developed;
5) completeness – coverage by the state inventory of emissions and removals of greenhouse gases from all sources, sinks, greenhouse gases within the territory of the Republic of Kazakhstan.

The order specifies the functions of the Authorized body in the field of environmental protection (hereinafter referred to as the authorized body), according to which the organization and coordination of the functioning of the state system of inventory of greenhouse gas emissions and removals is carried out, and the timing of inventory preparation is determined. The authorized body organizes the preparation of state inventory of greenhouse gas emissions and removals through the collection, analysis and processing of data received from government agencies and enterprises whose activities are the source of greenhouse gas emissions and removals. State authorities submit the requested data and information within one month from the date of receipt of the relevant requests.

This order determines the measures for the preparation of the annual National inventory report, its content and the procedure for controlling the completeness, transparency and reliability of the state inventory of emissions and removals of greenhouse gases. Based on the results of the state inventory, an annual National Report on the inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol (NIR) is developed. The order defines the main sections of the National Report on the GHG inventory: data on the sources and amount of GHG emissions and removals by sectors and in the whole country; emission trends; key source categories; sectoral overview; quality assessment/quality review; recalculations and planned improvements.

Matters of quality assurance and quality control of the national inventory are also regulated by Order No. 214, all stages of monitoring for completeness, transparency and reliability of the state inventory of emissions and removals of greenhouse gases are established. By June 1 of each year, a schedule is developed for conducting the control procedure at each stage of the state inventory of greenhouse gas emissions and removals, including the stages of planning the calculation procedure and identifying information needs, analyzing the data and information obtained, assessing the intermediate and final results.

c) **description of the process for collecting activity data, emission factors and methods**

To prepare the National Inventory, the Ministry of Energy organizes data collection by sending inquiries to relevant ministries, subordinate organizations, state enterprises and private companies whose activities result in greenhouse gas emissions or they have expert information and knowledge about the factors and methods for estimating greenhouse gas emissions. The state bodies provide the information necessary for the preparation of the inventory at the request of the Authorized body in the field of environmental protection (Ministry of Energy of the Republic of Kazakhstan), and also check and approve the draft National Inventory Report.

Organization, which develops the inventory (Zhassyl Damu) gets main part of national data from the Committee on Statistics of the Ministry of National Economy of the RK. It is published in annual statistical publications, fuel and energy balance, bulletins and reference books by sectors of industry.

For calculations and estimations of greenhouse gas emissions, the data of enterprises that are direct emitters of greenhouse gases are used: CHPs, refineries, metallurgical enterprises, cement plants, mines, oil and gas producing companies, aviation and many other enterprises.

The methodology for inventorying and calculating GHG emissions is set out in the Guidelines for National GHG Inventories of the Intergovernmental Panel on Climate Change (IPCC, 2006). Revised 1996 IPCC Guidelines, as well as the IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories (2000) from 2015, are no longer used in accordance with the decision of the Conference of the Parties to the UNFCCC 24 / CP.19, «Revision of the UNFCCC Guidance for reporting information on annual inventories of Parties included in Annex I to the Convention». In order to calculate GHG emissions and removals in the LULUCF sector, in addition to the 2006 IPCC SP, the Good Practice Guidance for LULUCF 2003 is used. Also from 2015, CRF spreadsheets are generated and submitted in accordance with the new CRF Reporter software. For the presentation of CRF tables from 2017, the latest version of the Common Reporting Format tables is used.

To develop national emission factors in Kazakhstan, it is necessary to conduct studies on the carbon content of local fuels or use the default IPCC default factors. Emission estimation methods allow the use of emission factors for various types of fuel by default. This issue can be resolved in the very near future.

d) description for definition of key sources

An analysis of the key sources categories (KSC) is carried out at the level of detail of the categories presented in the CRF tables. The tables include categories in the total amount of 95% of the emission/removals by one of the following parameters:

– Contribution to cumulative emissions excluding the LULUCF sector for 1990 (estimate by level);

- Contribution to cumulative emissions, with the LULUCF sector for 1990 (estimate by level);

- Contribution to cumulative emissions excluding the LULUCF sector for 2015 (estimate by level);

- Contribution to cumulative emissions, with the LULUCF sector for 2015 (assessment by level);

- Contribution to the trend of cumulative emissions for the period 1990-2015, without the LULUCF sector (trend estimate);

- Contribution to the trend of cumulative emissions for the period 1990-2015, with the LULUCF sector (trend estimate).

The key source categories in the tables are ranked by the absolute value of the contribution to the amount or trend of emissions in the national greenhouse gas inventory using emissions/removals in the CO_2 equivalent calculated using the global warming potentials for each gas.

KSC analysis is based on the level of detail of the categories presented in Chapter 8 of Volume 1 of the 2006 IPCC Guidelines and is based on the results of calculations in the CRF (Reporter Inventory Software). The results of the KSC analysis are obtained from Table 7 of the CRF for 2015 and are presented in Table 26.

Table 26. *Key source categories according to the data of NIR of RK 2017*

Years	By level without LULUCF	By level with LULUCF	Trend estimate without LULUCF	Trend estimate with LULUCF
1990	24	28	-	-
2015	24	26	25	24

Analysis of the key source categories demonstrates the categories that are considered priority from the standpoint of improving methodological level of calculations.

e) Data archiving process description

Archiving covers the storage of all the initial information and results of calculations of emissions and removals of greenhouse gases, from the procedure for collecting and storing the initial data before recording and recording information of an administrative and structural nature for the preparation of greenhouse gas inventories.

The data on activities, parameters and other information materials for the preparation of the national greenhouse gas inventory is being registered and stored at JSC Zhasyl Damu. The accounting and control of the distribution of information received for the preparation of a national greenhouse gas inventory and providing it to experts is carried out. The archive is maintained both on paper and electronically on a dedicated server, which provides storage and retrieval of information in electronic form and on-line.

This information includes procedures for collecting activity and calculations, digital and text calculation materials and other in-house information needed to prepare individual sections of the national inventory by sector.

3.4. National register

Due to suspension of the domestic system of greenhouse gas emissions trading in the Republic of Kazakhstan until January 1, 2018, the country should develop a National Register of Carbon Units, which should monitor and record all movements of carbon units using a computerized system. At the end of the commitment period under the Kyoto Protocol, each Party›s compliance with its emission target will be determined by comparing the total emissions listed in Annex A of the Kyoto Protocol during the commitment period with its Kyoto Protocol units. These holdings, as well as transfers and acquisitions, should be tracked using the national registry of carbon units.

Each Party shall establish and maintain a national registry to track its units and operations with Kyoto units. Each national registry must comply with detailed rules for accounting for assigned amounts in accordance with Article 7, paragraph 4, of the Kyoto Protocol and the technical requirements developed in accordance with the decisions of the Conferences of the Parties. Each national registry must be connected to the International Translation Log (ITL) so that ITL can verify the credibility of the registry transactions involving the Kyoto units for compliance with the accounting rules for the assigned amount.

The implementation of the national registry is the criterion of eligibility for participation in the mechanisms of the Kyoto Protocol. Parties included in Annex I for the purposes of the Kyoto Protocol, including Kazakhstan, may create supplementary transaction logs (STLs) to monitor and verify the validity of transactions offered by their national registries when such transactions are subject to the rules of national or regional trading schemes that operate in in accordance with the Kyoto Protocol units. Such supplementary transaction logs do not duplicate the checks related to the Kyoto Protocol conducted by ITL. For example, the European Commission›s Independent Transaction Log (CITL) for supporting the EU ETS is an example of a supplementary transaction log, the STL.

In the annex to decision 13/CMP.1, «Modalities for the accounting of assigned amounts under Article 7, paragraph 4, of the Kyoto Protocol», paragraph 17, reads: «Each Party included in Annex I shall establish and maintain a national registry to ensure accurate accounting for issuance, storage, transfer, acquisition, cancellation and retirement of ERUs, CERs, AAUs and RMUs and for the transfer of ERUs, CERs and AAUs «(ERUs are emission reduction units, CERs are certified emission reductions; AAUs are units of assigned amount; RMU are removal units),

In accordance with the guidelines for the submission of National Communications, each Party included in Annex I provides a description of how its national registry fulfills the functions defined in the annexes to decisions 13/CMP.11 and 5/CMP.12 and meets the requirements of technical standards for data exchange. In Kazakhstan, the creation of a national registry of carbon units in accordance with the requirements of the Kyoto Protocol is at an early stage. But there are already prerequisites that this work will be completed. It is necessary to designate an organization as the registry administrator to maintain the national registry in the country. The requirements for national registries in Kazakhstan are achievable, since work is under way to improve the internal system of trading emissions quotas for GHGs. The structure and format of national registry data should be in accordance with the technical standards to be adopted by the COP/MOP to ensure accurate, transparent and efficient data exchange between national registries, the clean development mechanism (CDM) registry and the international transaction log. Such a system will allow to enter the international market of carbon units.

IV. POLICIES AND MEASURES

This chapter of the report describes policies and measures, adopted or planned by the government of Kazakhstan to reduce GHG emissions. These policies and measures contribute to improvement of energy efficiency, use of renewable energy sources and new technologies to reduce GHG emissions. The full list of policies and measures is presented in table 3 of CTF.

4.1. Decision-making process and government programs

In the Republic of Kazakhstan the most important decisions on climate policy are made by the President, the Parliament and the Government. The Ministry of Energy (ME RK) is responsible for climate policy administration in the country and climate negotiations on an international level. In its activity ME RK adheres to the adopted laws and planning documents in accordance with the state planning system. The interdepartmental coordinator for sustainable development is the Council for transition to green economy under the President of the Republic of Kazakhstan headed by the Prime Minister of the Republic of Kazakhstan.

Key government body, which defines and implements state policy, coordinates governing processes in the area of environment protection is the Ministry of Energy of the RK[154] (ME RK). Additionally, the Ministry of Energy develops and implements state policy, coordinates management processes in oil and gas, petrochemistry industry, transportation of hydrocarbons, state regulation of production of oil, gas products and gas supplies, main pipelines, energy, heat supply, coal industry, nuclear energy, use of natural resources, protection, control and oversight over sound use of natural resources, municipal solid waste management, development of renewable energy sources, control over state policy on green economy development. The competence of this government body is defined by Article 17 of the Environmental code and the Statute on the Ministry of Energy of the Republic of Kazakhstan.

Department on climate change was created in the structure of the ME RK[155] (DCC), which consists of the section for low-carbon development and section on adaptation and climatic risks. Main objectives of the DSS are as follows: to develop common state policy and organize development of climate and ozone layer protection program; implement the final goal and provisions of the UN Framework Convention on Climate Change (UNFCC) and other international agreements, protocols in the area of climate change and Earth ozone layer; implementation of state policy on international cooperation on climate change and Earth ozone layer protection; state regulation of GHG and ozone-depleting substances emissions and removals.

The Government of the Republic of Kazakhstan introduced several «strategic plans» that set priorities and quantitative goals for the development of the country until 2050. Significant measures were taken in the country to assist in development of renewable energy sources, increase energy efficiency and reduce impact on the climate. The concept for transition of the Republic of Kazakhstan to green economy», adopted by the President of the Republic of Kazakhstan in 2013, sets ambitious goals for reducing energy intensity of GDP, improving air quality, increasing the share of alternative energy sources and gasification of the country.

In 2013, the emissions permits trading scheme (ETS) was launched in Kazakhstan. The pilot phase began in 2013 and encompassed 178 companies from the energy, oil and gas, mining and chemical industries that were responsible for 55% of GHG emissions. During the pilot phase, the allocation of allowances was based on a historical approach, which was equal to 100% of unconfirmed emissions, presented by the companies in the reporting year, namely 2010. This approach was kept for the second stage of ETS (2014-2015), with allocation of allowances on the basis of averaged data on emissions for 2011-2012. Since 2016, it has been proposed to distribute allowances based on benchmarking. Use of benchmarking in Kazakhstan would contribute to development and implementation of effective,

154 http://energo.gov.kz/index.php?id=854#z4
155 http://energo.gov.kz/assets/old/uploads/files/2016/09/%D0%94%D0%98%D0%9A.pdf

efficient and transparent emission trading, which would comply with international standards and would effectively work towards the green growth strategy, announced by the country. However, historical approach was used during the third stage of ETS for 2016-2020. In the beginning of 2016, emissions trading under ETS was suspended until 2018 to adjust and improve the mechanism. ETS is described in more detail in the following chapters.

Paris agreement was adopted on 12 December 2015, during the 21st session of the Conference of the Parties of the UNFCCC, which was held in Paris on 30 November – 13 December 2015. Kazakhstan signed the Paris Agreement on August 2, 2016 and ratified it on December 6, 2016. On September 28, 2015 Kazakhstan announced its nationally determined contribution (INDC – Intended Nationally Determined Contributions), which states that Kazakhstan intends to achieve an unconditional reduction of greenhouse gas emissions at the level of minus 15% from the level of 1990 by 2030. There are many factors, which affect implementation of these commitments. GHG emissions in Kazakhstan grew with average annual rate of 2% in the last ten years, inventory data for 2015 have shown that total amount of GHG emissions has already reached 300.9 MtCO2-equivalent (excluding LULUCF), which is 77% of the level of 1990.

4.1.1. Country development strategies in relation to climate change mitigation

Under the current system of state planning (SSP)[156], which has been set since 2010, strategic directions for the activities of government bodies and organizations are defined in the framework of five-year strategic plans. They are developed by state bodies – administrators of budget programs and cover the entire scope of their activities, including the activities of their subordinate organizations. The system of state planning in the Republic of Kazakhstan was approved by the Decree of the President of the Republic of Kazakhstan of June 18, 2009 No. 827. This system is a set of interrelated elements consisting of principles, documents, processes and participants in state planning, ensuring the development of the country for a long-term (over 5 years), medium-term (from year to 5 years) and short-term (up to 1 year) periods. The documents of the SSP are divided into three levels. The documents of the first level include the documents defining the long-term vision of the country’s development with key priorities and guidelines - the Development Strategy of Kazakhstan until 2050, the Strategic Development Plan of the Republic of Kazakhstan for 10 years, the Projected Scheme of the Territorial Development of the Country, the National Security Strategy of the Republic of Kazakhstan. The documents of the second level include the documents determining the strategy for the development of the sectors of the economy, Forecast of socio-economic development for 5 years, state and government programs up to 5 years. The documents of the third level include documents determining the ways of implementing the State Planning System of the first and second levels on the basis of decomposition - strategic plans of state bodies for 5 years, programs for the development of territories for 5 years, development strategies for 10 years of national managing holdings, national holdings and national companies. The foundational documents are mentioned below.

4.1.1.1. Strategy ‘Kazakhstan-2050’

A general long-term basis for the development of all documents of the state planning system in the Republic of Kazakhstan, including the strategic plans of ministries and departments, programs, is the Development Strategy[157] of the Republic of Kazakhstan until 2050. Address of the President of Kazakhstan - Leader of the Nation to the people of Kazakhstan «Strategy» Kazakhstan-2050»: a new political course of the established state» defines in one of the strategic tasks the transition to a low-carbon «green» economy, which leads to a decrease in the impact on climate change and reduction of GHG emissions.

Disclosing in more detail the concept of the new economic policy, it was stressed that it is necessary to introduce a new system of natural resources management with the aim of using resources as

[156] http://adilet.zan.kz/rus/docs/U090000827_
[157] http://adilet.zan.kz/rus/docs/K1200002050

an important strategic advantage for the purpose of economic growth. To do this, it is necessary to maximize the output of raw materials to international markets and this advanced strategy will allow to quickly accumulate funds that will then help the country survive the crisis periods, and also prepare for a technological revolution that will change the structure of consumption of raw materials and devalue natural resources. The development of alternative energy production was announced, and by 2050 alternative and renewable energy should account for not less than half of total energy consumption in the country.

In order to achieve objectives on transition to green economy, which are set by the Strategy, the following Concept was adopted.

4.1.1.2. The Concept for transition of the Republic of Kazakhstan to green economy

The Concept for transition of the Republic of Kazakhstan to green economy[158] was approved by the Decree of the President of the Republic of Kazakhstan of 30 May 2013, № 577. The Concept for transition of the Republic of Kazakhstan to green economy sets the ground for deep systemic transformations in order to move to a new economy by improving welfare and quality of life of the people of Kazakhstan and becoming one of the Top 30 most developed countries of the world, while minimizing the environmental footprint and natural resources degradation. The main priorities for the transition to a «green economy», which the country faces are as follows: (1) increasing the efficiency of resource use (water, land, biological, etc.) and management; (2) modernization of existing and construction of new infrastructure; (3) improving the well-being of the population and the quality of the environment through cost-effective ways of mitigating environmental pressures; (4) enhancing national security, including water security. By 2050, transformations within the framework of the «green economy» will allow to increase GDP by 3%, create more than 500 thousand new jobs, form new industries and services, and provide universally high quality of life for the population. In order to monitor and evaluate the implementation of the Concept on the transition of the Republic of Kazakhstan to a «green economy», a decree of the President of the Republic of Kazakhstan created a Council[159] for the transition to «green economy» under the President of the Republic of Kazakhstan of May 26, 2014 No. 823.88

4.1.1.3. Strategic development plan to 2020

To implement the Development Strategy until 2050, the Ministry of Economic Development and Trade is developing a strategic development plan for 10 year period that specifies the goals, objectives, priority directions of the socio-economic and socio-political development of the country for the relevant period. This document also defines the expected results, indicating their qualitative and quantitative indicators, including those determined for intermediate stages. The President of the Republic of Kazakhstan approves strategic plans for the development of the country for ten-year periods. Currently, the Strategic Development Plan until 2020, approved by Presidential Decree No. 922 of February 1, 2010, is in effect. Climate change is defined as one of the key factors determining the current trends in the global economy. At the same time, there are urgent needs to implement measures, both to reduce anthropogenic emissions of greenhouse gases, and to address regional problems that are worsening due to global warming, including the problem of water availability and quality. The strategic development plan for 2020 provides for 5 key development directions, namely: (1) preparation for post-crisis development; (2) acceleration of economic diversification; (3) investment in the future; (4) services for citizens; (5) ensuring interethnic harmony, security, stability of international relations.

The Strategic Development Plan of the country until 2020 includes a priority for the development of a «green» policy for a low-carbon economy that involves the use of modern technologies with low energy consumption, the implementation of other measures aimed at energy saving. At the same time, the task of preventing the consequences of climate change and developing a low-carbon economy is considered in the context of Kazakhstan›s contribution to the global reduction of greenhouse gas emissions.

[158] http://adilet.zan.kz/rus/docs/U1300000577
[159] http://adilet.zan.kz/rus/docs/U1400000823

4.1.1.4. Plan of the nation – 100 concrete steps

On May 6, 2015, at an extended government meeting, the President of Kazakhstan Nursultan Nazarbayev outlined 100 concrete steps[160] to implement the five institutional reforms. As stated in the publication: 100 concrete steps is a response to global and internal challenges and, at the same time, the nation›s plan to enter the thirty most developed countries of the world under new historical conditions. This plan will provide such a safety margin that it will ensure confident passage through a difficult period of testing and will ensure the continuation of the course to implement the «Strategy-2050» and strengthen Kazakhstan›s statehood. The plan is based on five institutional reforms: (1) creation of a modem and professional civil service; (2) ensuring the rule of law; (3) industrialization and economic growth; (4) a unified nation for the future; (5) Transparency and accountability of the state.

Among the steps the following can be emphasized, which affect the levels of GHG emissions and are part of the third institutional reform – industrialization and economic growth.

Step 52. IMPLEMENTATION OF NEW ELECTRICITY TARIFFS TO ATTRACT INVESTMENTS TO THE INDUSTRY. Change in tariff structure. The new tariff will include two components: the financing of capital expenditure and generating costs for the power used to cover operating costs of energy production. This will change the current situation, when the tariffs are set, using the “cost” method.

Step 59. – ATTRACTING STRATEGIC INVESTORS TO THE ENERGY SAVING INDUSTRY THROUGH THE INTERNATIONALLY RECOGNIZED PERFORMANCE CONTRACTS

Step 65. INTEGRATION OF KAZAKHSTAN INTO THE INTERNATIONAL TRANSPORT AND COMMUNICATION ROUTES. Launch of the project to establish a MULTI-MODAL “EURASIAN TRANSCONTINENTAL TRANSPORT CORRIDOR”, which will allow free transit of freights from Asia to Europe. The transport corridor will include routes through Kazakhstan, Russia and further into Europe. Second direction will be through Kazakhstan from Khorgos to the Aktau port and through the Caspian Sea to Azerbaijan, and Georgia. Plan to work with the Asian Infrastructure Investment Bank, which was created in 2014.

4.1.1.5. Concept of innovative development of the RK to 2020

On June 4, 2013, the **Concept of Innovative Development of the Republic of Kazakhstan until 2020** was adopted, No. 579, in which the goal is to assist Kazakhstan in becoming one of the top 30 most competitive countries of the world through the development of new technologies and services, which will allow transition from a commodity-based to innovative economy. The following problems can be attributed to the tasks of the concept, which affect the issues of climate prevention: promoting the generation of innovations to expand the consumption of new materials and technologies, increasing the share of renewable energy sources in Kazakhstan›s energy mix; and further development of leading innovative clusters, including the use of the opportunities for holding the international exhibition «EXPO-2017».

[160] http://adilet.zan.kz/rus/docs/K1500000100

4.1.2. State programs of the Republic of Kazakhstan

State programs are developed according to a list[161] (approved on 19 March 2010, № 957). The list of programs, and those bodies responsible for their development is defined by the President of the Republic of Kazakhstan. According to the latest status, there are 8 State programs on the list. Among the programs, the following ones, which are related to climate change, can be emphasized: State program of infrastructure development «Nurly zhol» for 2015-2019 and State program of industrial and innovative development of the Republic of Kazakhstan for 2015-2019.

4.1.2.1. The state program of infrastructure development "Nurly zhol" for 2015-2019

The state program of infrastructure development "Nurly zhol" for 2015 -2019 was approved by the Decree of the President of the Republic of Kazakhstan No. 1030 dated April 6, 2015. The basis for the program development were paragraph 4 of the National plan for the implementation of the Message of the President of the Republic of Kazakhstan to the people of Kazakhstan of November 11, 2014 «Nurly Zhol – the path to the future» and the fifth dimension the plan of the nation "100 concrete steps to implement five institutional reforms". The program is aimed at creating a single economic market of Kazakhstan, through integration of macro regions of the country with Almaty, Astana, Aktobe, Shymkent and Ust-Kamenogorsk as hub cities of national and international level with modern infrastructure and through ensuring integration of transport infrastructure into the international transport system.

A number of tasks of this program are focused on the development of the transport infrastructure of all types, as well as ensuring its integration into the international transport system, strengthening the energy infrastructure within the Unified Energy System, upgrading (reconstruction and construction) of the housing and utilities infrastructure as well as heat supply, water sanitation systems. The fulfillment of these tasks to improve the transport and energy infrastructure has an ambiguous effect on GHG emissions. Thus, modernization and optimization of infrastructure leads to a decrease in GHG emissions due to a reduced transportation time within the country and improved road conditions, improved energy system, improved housing and utilities infrastructure as well as upgraded heat supply, water and sanitation systems. At the same time, the program plans to increase the volume of transport operations, what leads to an increase in GHG emissions.

4.1.2.2. The state program of industrial-innovative development of Kazakhstan for 2015-2019

The Program is a follow-up of the State program for accelerated industrial and innovative development of the Republic of Kazakhstan for 2010-2014 (hereinafter – SPAIID) and it takes into account its implementation experience. In this program, the goal of reducing the energy intensity of the manufacturing industry by at least 15% and the goal of developing petrochemical industry through realization of Kazakhstan›s available resource potential and favorable market conditions can be attributed to the climate change issue. The development of petrochemical industry would be a solution to address the issue of ensuring an effective use of hydrocarbon fuels - associated petroleum and dry gas, thereby reducing unproductive economic costs, including environmental ones.

[161] http://adilet.zan.kz/rus/docs/U100000957_

4.2. Policies, measures and their effect

This chapter describes the most important strategies and measures to reduce greenhouse gas emissions in the Republic of Kazakhstan. For some of these strategies and actions, the impact on greenhouse gas emissions has been estimated and presented in the summary tables for each sector, see below.

4.2.1. Cross-sectoral policies and measures

The main and important action to reduce the climate change impact was adoption of a legislative framework to start adopting policies and measures to reduce GHG emissions.

4.2.1.1. Environmental Code

National legislation to regulate greenhouse gas emissions began to emerge in Kazakhstan with the adoption of the Environmental Code on January 9, 2007. The Code includes a special chapter on the regulation of GHG emissions and removals. This chapter consists of twelve articles, specifying the regulatory principles and legislative framework for the implementation of measures aimed at keeping and reducing greenhouse gas emissions at the level of industrial plants. Along with it the legal framework for implementation of the activities aimed at GHG emissions accounting and reducing. It establishes the main provisions of state regulation, which include GHG allowance allocation to plant operators, establishing market mechanisms for GHG reduction and removals, as well as administration of plant operators.

The Environmental Code establishes requirements for plant operators to submit a verified greenhouse gas inventory report for the previous year to the authorized body responsible for environmental protection or to fill out the electronic form of the report in the system of State Cadaster of Sources of GHG Emission and Removals in accordance with the Rules of Maintaining State Cadaster of Sources of GHG Emission and Removals[162] (The Order of the Minister of Energy of the Republic of Kazakhstan No. 176 dated March 5, 2015). To operate without receiving GHG allowance is forbidden for natural resource users operating in the oil and gas, energy, chemical, mining and metallurgical sectors, in agriculture and transport, whose greenhouse gas emissions exceed the equivalent of twenty thousand tons of carbon dioxide per year.

The Environmental Code sets market mechanism of GHG emissions and removals and this mechanism includes emission trading, trading of adsorbing units of greenhouse gas, certified emission reductions, emission reduction, domestic emission reductions; international trade of assigned amount units between countries with restrictions and/or reduce emissions of greenhouse gases and their legal entities. The subjects of greenhouse gas emissions market are the legal entities, participating in the project-based mechanisms in the regulation of emission and adsorbing of greenhouse gases, as well as the Exchange trade in accordance with the legislation of the Republic of Kazakhstan. The sale of adsorbing units of greenhouse gases emission, certified emission reductions, emission reductions, allowances, domestic emission reductions in the secondary circulation is carried out on the organized commodity markets (stock exchanges), determined in accordance with the Laws of the Republic of Kazakhstan.

[162] http://adilet.zan.kz/rus/docs/V1500010673

4.2.1.2. List of the greenhouse gases

The Environmental Code introduces a list of greenhouse gases that are subject to state regulation. The Government Order of the Republic of Kazakhstan No. 655 of May 22, 2015 approved a list consisting of carbon dioxide and methane. On March 5, 2015, this list was updated to include nitrous oxide and perfluorocarbons by the order of the Minister of Energy of the Republic of Kazakhstan of March 5, 2015 No. 177[163]. Hence at the moment the list includes the following gases:

1. Carbon dioxide (CO_2);
2. Methane (CH_4);
3. Nitrous oxide (N_2O);
4. Perfluorocarbons (PCFs).

4.2.1.3. Market mechanisms of GHG emissions reduction and removals

The Law of the Republic of Kazakhstan No. 505-IV of December 3, 2011 "On amendments and changes to some legislative acts of the Republic of Kazakhstan on environmental issues"[164] Chapter 9-1 "State regulation in the area of greenhouse gas emissions and removals" of the Environmental Code was supplemented by articles 94-1 to 94-12 which introduced the main provisions of state regulation in the sphere of greenhouse gas emissions and removals, including: (1) GHG allowance allocation to plant operators; (2) establishing market mechanisms for GHG reduction and removals; (3) administration of plant operators. These articles established the legal framework for the emissions trading scheme. The main article defining the concept of a market mechanism for reducing greenhouse gas emissions and removals is the Article 94-7. According to it, the market mechanism for reducing greenhouse gas emissions and removals includes: (1) emission trading; (2) trading of adsorbing units of greenhouse gas, certified emission reductions, emission reduction, domestic emission reductions; (3) international trade of assigned amount units between countries with restrictions and/or reduce emissions of greenhouse gases and their legal entities. The subjects of the greenhouse gas emissions market are legal entities, participating in the project-based mechanisms in the regulation of emission and adsorbing of greenhouse gases, as well as the Exchange trade in accordance with the legislation of the Republic of Kazakhstan. A carbon unit is a merchandise. The sale of adsorbing units of greenhouse gases emission, certified emission reductions, emission reductions, allowances, domestic emission reductions in the secondary circulation is carried out on the organized commodity markets (stock exchanges), determined in accordance with the Laws of the Republic of Kazakhstan. It should be noted that this mechanism in the current version is effective from January 1, 2018 (ref. The Environmental Code, Article 94-7).

Emission trading is the key economically efficient tool to address climate change and to reduce industrial GHG emissions. It is generally developed on the basis of "Cap & Trade" principle and is used in EU and in the United States. Kazakhstan launched ETS in January 2013.

National Allocation Plan (NAP) 2013[165] was adopted on December 13, 2012 and covered 178 enterprises: in energy sector (55 enterprises with allowances of 84.0 megatons of CO_2-Eq), in coal mining and oil and gas sectors (69 enterprises with allowances of 19.7 megaton CO_2-Eq), in Manufacturing (54 enterprises with allowances of 43.4 megatons of CO_2-Eq). Reserve for 2013 was 20.6 million tons CO_2-Eq. Total allowance for the whole ETS was 147,.2 megatons of CO_2-Eq and it was estimated in consistence with the carbon dioxide emissions of enterprises as of December 21, 2010 (hereinafter –baseline), as indicated in their passports of physical inventory.

NAP 2014-2015[166] was adopted on December 31, 2013 and covered 166 enterprises: energy sector (55 enterprises with allowances of 84.0 megatons of CO_2-Eq), coal mining and oil and gas sectors

[163] http://adilet.zan.kz/rus/docs/V1500010682
[164] http://adilet.zan.kz/rus/docs/Z1100000505
[165] http://adilet.zan.kz/rus/docs/P1200001588
[166] http://adilet.zan.kz/rus/docs/P1300001536

(69 enterprises with allowances of 19.7 megatons of CO_2-Eq), Manufacturing (54 enterprises with allowances of 43,4 megatons of CO_2-Eq). Reserve for 2014 and 2015 was 18.0 and 20.5 megatons of CO_2-Eq. Total allowances for the whole ETS for 2014 amounted to 154.9 megatons of CO2-Eq and it was estimated in consistence with average carbon dioxide emissions of enterprises in 2011 and 2012 (baseline), indicated in their passports of physical inventory. In 2015 total allowance limit was set 1.5% lower than in 2014, and amounted to 152.8 megaton CO_2-Eq.

Current the third ETS (NAP 2016-2020[167]) covers three sectors: energy, oil and gas, coal mining and manufacturing. Cumulative allowance allocation for five years is estimated on the basis on the average level of industrial emissions in 2013 and 2014 (baseline).

In the current NAP, cumulative limit for 140 enterprises for 5 years accounts to 746.5 million tones and it is distributed between the sectors in the following manner:

- Energy sector (53 enterprises) includes state-owned and private power stations, CHP and part of the boiler facilities both in public and private property. Cumulative cap accounts to 472.6 megatons of CO_2-Eq (baseline – 94.5 megatons of CO_2-Eq);
- Oil and gas sector (44 enterprises) includes oil and gas production and processing. Cumulative cap accounts to 83.3 megatons of CO_2-Eq (baseline – 16.7 megatons of CO_2-Eq);
- Coal and manufacturing sector (43 enterprises) includes all types of coal mining activities and big enterprises in manufacturing. Cumulative cap accounts to 190.5 megatons of CO_2-Eq (baseline – 38.1 megatons of CO_2-Eq).

Currently EST is only partially in operation. In February 2016, Mr. Aset Magauov (vice-minister of energy of Kazakhstan at that time), said that Kazakhstan would suspend emission trading until 2018. It was said that during 2016 and 2017 the system will keep reporting and monitor greenhouse gas emissions, but trading will be suspended due to certain distortions in the system, and defects that need to be eliminated.

For some time one of the possible ETS modification was potential replacement of the historic method to the emission benchmarking method, which assumes setting GHG emission caps per unit of product. This method is based on the principle of fairness for those who have already made investments in energy efficiency and modernization of technological processes. The benchmark method accommodates the investments made, while the historical method does not. There was a number of studies for the industry of Kazakhstan to determine these benchmarks[168,169]. In addition to the complete replacement of the method, there is a possibility of using a hybrid approach including both historical and benchmarking methods only during of 2018-2020. Thus, the director of the Climate Change Department of the Ministry of Energy – Mr. Olzhas Agabekov during the round table in the Mazhilis of the Parliament of the Republic of Kazakhstan «Issues of legislative support for the development of the carbon market in Kazakhstan» stated that: "The emission trading system has been suspended. Since 2018, there will be two allowance allocation methods at the installations operator's discretion. The first is the benchmarking method, when approved it would be multiplied by the output of the enterprise and, thereby, the allowance will be determined. Regarding the historical method, the enterprise will receive allowances for 2018-2020 depending on the emissions, for example, from 2013 to 2015"[170].

On June 15, 2017, the Resolution of the Government of the Republic of Kazakhstan No. 370 approved the Rules for the GHG allowance allocation and the creation of reserves of the assigned amount and volume of allowances of the National Allocation Plan[171]. According to these rules, GHG allowance allocation by facilities is based on the application of a baseline or benchmark, taking into account the

[167] http://adilet.zan.kz/rus/docs/P1500001138

[168] http://kazccmp.org/wp-content/uploads/2015/06/%D0%91%D0%B5%D0%BD%D1%87%D0%BC%D0%B0%D1%80%D0%BA%D0%B8%D0%BD%D0%B3-%D0%B8-%D1%80%D0%B0%D1%81%D0%BF%D1%80%D0%B5%D0%B4%D0%B5%D0%BB%-D0%B5%D0%BD%D0%B8%D0%B5-.pdf

[169] http://carbonlimits.no/project/adaptation-of-benchmarks-for-allowances-allocation-for-specific-sectors-in-kazakhstan/

[170] https://www.kursiv.kz/news/industry/biznes-budet-vprave-vybirat-nuznyj-obem-vybrosov-parnikovyh-gazov/

[171] http://energo.gov.kz/assets/old/uploads/files/2017(1)/06/%D0%BF%D0%BE%D1%81%D1%82%20370%20%D0%BE%D1%82%20 15.06.17%20rus.pdf

commitment to limit and/or reduce GHG emissions. In order to allocate allowances, the installation operator applies to the authorized body with an indication of the allocation method for each of their installation subject to allowances. If the installation operator fails to submit an application, the allowance allocation is based on benchmarking method. If the benchmarks are not available in the list, the GHG allowances allocation is based on the baseline. The baseline for the relevant period is estimated taking into account the average level of the GHG emissions during 2013-2015.

Allowances for installations allocated on the basis of benchmarking method are estimated by multiplying average output for 2013-2015 by benchmark in accordance with the list, except for the case when the installation does not produce any output for a specified period. In this case, allowances are estimated by multiplying the volume of planned output during the NAP period by benchmark in accordance with the list. The volume of planned output is confirmed by the data of production plans, technical projects and other production records of the plant operator

The reserves set up in compliance with the commitments to limit and (or) reduce GHG emissions minus the total volume of GHG emission allowances allocated in accordance with these Rules. The reserve is intended for: (1) GHG allowance allocation for new installations; (2) issuance of additional allowances in cases of changes planned in the nature or operation of installations, or the introduction of new GHG emission sources during the reporting period. (3) GHG allowance allocation for installations of administered facilities exceeding the limit of 20 thousand tons during the NPD period; (4) issuance of carbon units for domestic projects to reduce GHG emissions and (or) increase GHG removals; (5) auctioning of allowances.

4.2.1.4. Action plan on implementation of "Concept for Transition of the Republic of Kazakhstan to Green Economy" for 2013-2020

In order to implement the «Concept for the transition of the Republic of Kazakhstan to Green Economy,» the Government of the Republic of Kazakhstan approved the «Action Plan of the Government of the Republic of Kazakhstan for the implementation of the Concept for the transition of the Republic of Kazakhstan to "Green Economy" for 2013-2020" [172] No. 750 dated July 31, 2013. This plan provides 141 positions on measures to ensure the process of transition to a «Green Economy» in 14 areas, which cover: regulatory and institutional support as well as staffing; sustainable use of water resources; sustainable and high-productive agriculture; energy saving and energy efficiency; electric power development; improvement of the waste management system; air pollution reduction; development, conservation and sustainable use of biological resources; development of the hydrometeorological service; foreign policy activities aimed at promoting implementation of the Concept for Transition of the Republic of Kazakhstan to a «Green Economy»; pilot projects; transferring vehicles to clean fuels, including adoption of electric vehicles and the creation of appropriate infrastructure; power plant emission control and universal electricity savings based on the state-of-the-art technology in production and household; providing state support for the development of domestic R&D in the field of replenishable natural resources.

4.2.2. Policies and measures in the fuel combustion sector

Reducing the carbon intensity of GDP is identified as one of the principles of transition to a «Green» economy in the Concept for the transition of the Republic of Kazakhstan to a «Green Economy». Since the main GHG emissions in Kazakhstan fall on the fuel combustion sector, reducing energy intensity and, correspondingly, the carbon intensity of GDP, directly depend on policies and measures in the fuel combustion sector. The main indicators that need to be achieved under the Concept for the transition of the Republic of Kazakhstan to a «Green Economy» are provided below.

[172] http://adilet.zan.kz/rus/docs/P1300000750#z0

4.2.2.1. Reducing the energy intensity of Kazakhstan›s GDP

Low-carbon development of the economy entails a significant reduction in GHG emissions to the GDP, a transition in the energy sector from hydrocarbon fuel and energy resources combustion to renewable energy sources (solar energy, wind power, small-scale hydropower), a reduction of energy consumption and thereby a reduction of GHG emissions in manufacturing and housing-and-municipal services (energy saving). Goals to reduce energy intensity of GDP are also reiterated in the Concept for development of fuel and energy complex of the Republic of Kazakhstan until 2030.

Table 27. *Reducing the energy intensity of Kazakhstan's GDP compared to 2008*

Year / Targets	The Concept for transition of the Republic of Kazakhstan to "Green Economy"	The Concept for development of fuel and energy complex of the Republic of Kazakhstan until 2030
2015	not available	-10%
2020	-25%	-25%
2030	-30%	-30%
2050	-50%	not available

4.2.2.2. Energy Saving and Energy Efficiency Improvement

The Law «On Energy Saving and Increasing Energy Efficiency» (No. 541) was adopted on January 13, 2012. The new law, along with a glossary of terms, the responsibilities of the Government, the authorized body and other state bodies, introduces a number of new requirements related to: implementing energy saving policies and increasing energy efficiency by state bodies and state organizations; ensuring compliance with the established requirements for energy efficiency of the designed and newly constructed premises, buildings and structures; mandatory use of metering devices for cold and hot water, electricity and heat consumption in the designed and newly built residential dwellings; a special regulatory regime for entities that consume energy above certain levels; mandatory labeling of electrical energy-consuming devices. The new legislation is focused on active implementation of energy management tools, expertise in energy saving and energy efficiency, energy use regulation, energy audit, and monitoring and evaluation of energy efficiency and efficiency requirements by state bodies and organizations in the country.

Requirements for mandatory accounting and annual reporting on the implementation of energy saving and energy efficiency measures, established for all entities that consume energy resources equivalent to one thousand five hundred or more tons of fuel equivalent per year, as well as for state institutions, state-owned enterprises and national companies, are particularly worth mentioning.[173] This requirement is implemented through the creation of the State Energy Register on January 1, 2011. The entities included into this Register will be required to develop and implement action plans for energy saving and energy efficiency improvement. The form and content of such action plans are defined by the Government Decree No. 1118 dated August 31, 2012. All entities of the State Energy Register, except state institutions, will have to be under energy audit at least once every five years, with obligatory audit during the first three years of the new law. In addition, entities that consume energy resources in the amount of one hundred thousand or more tons of fuel equivalent per year, will be subject to mandatory standards established to reduce the energy consumption (not less than 25% reduction within 5 years).[174]

Another important regulatory tool is the mandatory energy saving assessment on the pre-design and design documentation for the construction of new or expansion of existing buildings, structures and premises with energy consumption equivalent to 500 tons of fuel equivalent per year.[175] Although it was initially introduced in 2000, but it has become mandatory only recently. The permanent

[173] Article 9.
[174] Article 16 and 18.
[175] Para. 1 article 15.

commission for accreditation in the field of energy saving and energy efficiency accredits legal entities anticipated to carry out energy audit and energy saving assessment. At the same time, the new legislation devotes a great deal of attention to the mechanism for assessing central and local executive bodies dealing with energy saving and energy efficiency through reviewing their annual reports, as well as raising awareness, retraining and skills development in this field.

4.2.2.3. The Concept for development of fuel and energy complex of the Republic of Kazakhstan until

"The Concept for Development of the Fuel and Energy Complex of the Republic of Kazakhstan until 2030" was approved on June 28, 2014, under the number 724. The concept for development of the fuel and energy complex of the Republic of Kazakhstan until 2030 brings the development of the oil and gas, coal, nuclear and electric power industries under one umbrella, taking into account the world›s best practices and the latest trends in the development of global energy. The Concept development took the following tasks into account, with direct or indirect implication on emission reduction: intensive development of the fuel and energy sector by using technologies of the 21st century; active involvement in the energy balance of renewable and alternative energy sources; energy and resource saving, energy efficiency.

One of the important factors of the fuel and energy complex functioning is environmental security of the state, in particular, in oil and gas production and coal generation, as the main sources of environmental pollution; and with additional emphasis on the anticipated nuclear power generation. Among the strategic priorities of the fuel and energy complex development is the rehabilitation of the environment through implementation of the main tasks for the development of the fuel and energy complex until 2030, which directly or indirectly affect the emissions reduction, namely these tasks include: modernization and construction of new assets in electricity and heat generation and transmission, and oil refining; modernization of industry and transport, introduction of modern technologies to improve energy efficiency and reduce the negative impact on the environment; development of technologies and infrastructure for the use of alternative energy sources: renewables, nuclear power, associated petroleum gas processing, gas transportation, chemicals and coal products manufacturing.

4.2.2.4. Strategic Plan of the Ministry of Energy of the Republic of Kazakhstan for 2017-2021

The key short-term policies and measures in the fuel combustion sector are determined by the Ministry of Energy of the Republic of Kazakhstan and are reflected in the activities of the Strategic Plan of the Ministry of Energy of the Republic of Kazakhstan; currently this document is approved for the period of 2017-2021.

The Strategic Plan of the Ministry of Energy of the Republic of Kazakhstan for 2017-2021 was approved on December 28, 2016. This plan undertakes the mission to improve quality of the environment, to ensure transition of the Republic of Kazakhstan to low-carbon development and a «Green Economy» to meet the needs of present and future generations.

The first strategic direction «Development of the electric power, the coal industry and the area of nuclear energy use» emphasizes the full coverage of the economy›s energy needs and infrastructure development as the main priority areas of the electric power development. Work is in progress on the construction of new generating facilities (Balkhash CHP), the rehabilitation of existing power plants (third generating unit at Ekibastuz GRES power plant-2), the modernization of the national electric grid, the construction and rehabilitation of regional electric networks. In order to ensure energy security in the long term, it is planned to build nuclear power plants, which will involve significant uranium reserves in the fuel cycle and, thereby, diversify the generating capacities of the country›s energy sector, and optimize the use of available hydrocarbon resources. Order of the Prime Minister of the Republic of Kazakhstan No. 60-p «On Approval of the Plan of Priority Actions for the Construction of Nuclear Power Plants in the Republic of Kazakhstan» dated May 4, 2014 was amended on November 2,

2016. These amendments envisage the development of pre-design documentation (feasibility studies) for the construction of nuclear power plants in the districts of the city of Kurchatov in the East Kazakhstan oblast and Ulken village of Zhambyl district of Almaty oblast, with due consideration of the environmental legislation requirements and draft decision of the Government on the construction of nuclear power plants on the basis of the results of the feasibility studies.

The third strategic direction «Improving the quality of the environment» refers to the minimization of emissions through improved state environmental control and regulation, as well as through achieving the target indicators of the "Green Economy" concept on carbon dioxide, sulfur and nitrogen oxides emissions, and implementation of the commitments made under UN Framework Convention on Climate Change and other agreements. In order to reach nationally determined contributions[176], to limit and reduce greenhouse gas emissions across the entire economy of Kazakhstan declared under the Paris Agreement within the United Nations Framework Convention on Climate Change (UNFCCC), the following measures will be implemented: 1) regulation of GHG emissions and removals through a market mechanism – Emission Trading Scheme (ETS); 2) increasing the share of renewable energy sources (RES) in the country's energy balance; 3) modernization of thermal power plants and boiler houses; 4) implementation of energy efficiency and energy saving projects.

4.2.3. Policies and measures in the heat and power production sector

The Concept for the Development of Fuel and Energy Complex states a number of tasks to be solved and some of them, directly or indirectly, are able to reduce greenhouse gas emissions: development of renewable energy sources (RES) and their integration into the energy system; lowering the level of equipment deterioration, increase of the electric power reserve and capacity of the power transmission equipment; development of movable gas generation in the Western service area to ensure power delivery to the Southern and Northern service areas and cover the peak power demand of the North and South; increase of energy efficiency in the Republic of Kazakhstan.

Table 28. *Expected results in the electric power industry*

Description	2020	2030
Share of WPP and SPP in electricity generation	3%	10%
The share of gas power plants in electricity generation	20%	25%
Reducing carbon dioxide emissions in the electricity generating industry	Level of 2012	-15% (in comparison with 2012)

4.2.3.1. Target indicators for the renewable energy sector development

The «Rules for the Formation and Use of the Reserve Fund»[177] (No. 361) were approved on July 29, 2016 in accordance with the subparagraph 9-2) of the Article 6 of the Law of the Republic of Kazakhstan «On Support for the Use of Renewable Energy Sources». These rules determine the procedure for the formation and use of the reserve fund. The "Billing Center for the Support of Renewable Energy Sources" is responsible for the formation of this Fund; money of the Center is held in a special bank account and is used only to cover cash gaps and debts of the Billing Center owed to energy producing organizations that use renewable energy sources; due to default or delayed payment by "conditional consumers" for the supplied electricity, produced by renewable energy facilities.

"Target indicators for the renewable energy development" (No. 478) were approved on November 7, 2016 in accordance with the subparagraph 5-2) of the article 6 of the Law of the Republic of Kazakhstan "On Support for the Use of Renewable Energy Sources".

[176] http://www4.unfccc.int/Submissions/INDC/Published%20Documents/Kazakhstan/1/INDC%20Kz_eng.pdf
[177] http://adilet.zan.kz/rus/docs/V1600014210

Table 29. *Target indicators for the renewable energy sector development*

№	Indicator	Value
1	The share of electric energy produced by renewable energy facilities in the total electricity production until 2020	3%
2	Gross installed capacity of the renewable energy facilities until 2020, including:	1700 MW
	Wind power plants	933 MW
	Solar power plans with photovoltaic converters	467 MW
	Hydro power plant	290 MW
	Biogas plants	10 MW

4.2.3.2. The Law «On Support for the Use of Renewable Energy Sources»

On July 4, 2009, Kazakhstan adopted the Law **«On Support for the Use of Renewable Energy Sources».** This law provides support for the use of renewable energy sources as one of the tools for meeting the country's international commitments to reduce GHG emissions. It introduced the basic concepts related to renewable energy sources into the national legislation; defined approaches, forms and areas of state support; determined responsibility of the Government, authorized body and local executive bodies in this area. "Fixed tariffs for supply of electrical energy produced by renewable energy sources" were approved on June 12, 2014 in accordance with subparagraph 7-2) of Article 5 of this law.

Table 30. *Fixed tariffs for supply of electrical energy produced by renewable energy sources*

№	Renewable Electricity Generation Technologies	Tariff, KZT/ kWh (excluding VAT)
1	Wind power plants, excluding the EXPO-2017 wind farm with a capacity of 100 MW	22,68
1-1	EXPO-2017 wind power plants with a capacity of 100 MW	59,7
2	Photovoltaic solar energy converters, excluding the fixed tariff for solar power plant projects using photovoltaic modules based on Kazakhstani silicon (Kaz PV), to covert solar radiation	34,61
3	Small hydro power plant	16,71
4	Biogas plants	32,23

4.2.3.3. Targeted assistance to individual consumers

The **«Rules of Providing Targeted Assistance to Individual Consumers»**[178] No. 161 were approved on November 28, 2014 in accordance with subparagraph 10-7) of Article 6 of the Law of the Republic of Kazakhstan «On Support for the Use of Renewable Energy Sources» dated July 4, 2009. The rules determine the procedure for providing the targeted assistance to individual consumers for purchasing renewable energy facilities. The state provides targeted assistance to individual consumers through reimbursement of fifty percent of the cost of renewable energy facilities with a total capacity of not more than five kilowatts. The targeted assistance is reimbursed after the facility is commissioned.

4.2.3.4. Guidelines for renewable energy facilities' placement planning

The "Guidelines for renewable energy facilities' placement planning[179]» (No. 345) were approved on July 27, 2016 in accordance with subparagraph 5-1) of Article 6 of the Law of the Republic of Kazakhstan «On Support for the Use of Renewable Energy Sources. The plan for the placement of renewable energy sources is developed on the basis of the following data: 1) target indicators for the development of

178 http://adilet.zan.kz/rus/docs/V1400010083
179 http://adilet.zan.kz/rus/docs/V1600014155

the RES sector; 2) a list of operating renewable energy facilities, with indication of installed electric power, the UES area and the type of renewable energy facility; 3) the maximum capacity of renewable energy facility broken down by UES areas and types of facilities; 4) information on prioritization of projects in the RES placement plan divided by UES areas and types of facilities. The maximum capacity of renewable energy sources is required to identify the most favorable location to place renewable energy facility from the perspective of the national grid infrastructure.

4.2.3.5. Development of nuclear power generation

The Concept of development of the fuel and energy complex of the Republic of Kazakhstan until 2030 envisages development of the nuclear power generation. In the nuclear industry, the main development goal is to build a complete cycle of nuclear fuel development with a restrained increase in production and expansion of uranium distribution channels. One of the key tasks of the industry is the development and implementation of the project for the construction of nuclear power plant.

Table 31. *Nuclear power plant construction plan*

Description	2015	2020	2030
Nuclear generation development	Parameters and nuclear power plant (NPP) construction site are selected	Design is developed and NPP construction has begun	NPP with a capacity of up to 1000 MW is built and provided with a grid infrastructure

4.2.3.6. Development of coal bed methane power generation

The Concept of development of the fuel and energy complex of the Republic of Kazakhstan until 2030 envisages development of coal-bed methane power generation. As part of the transition to a "Green Economy", the chosen course for generation diversification includes continued coal generation as the main source of energy until 2030, however with restriction for significant increase of its share in the overall structure of electricity production. Improving the quality of coal and a moderate growth of coal generation with the parallel introduction of modern technologies will significantly improve the ecology. The main goal of the development of the coal industry in the Republic of Kazakhstan is to increase the efficiency of coal resource base use in order to meet the needs of the domestic market for fuel and energy resources and improve the environmental performance of the industry as a whole.

Table 32. *The plan for the development of coal bed methane generation*

Description	2015	2020	2030
Development of coal bed methane power generation	Generation capacity up to 6 MW	Partial coverage of extractive companies' electricity needs	10% of coal bed methane power generation

4.2.4. Policies and measures in the oil refining sector

The second strategic area - «Development of oil and gas and petrochemical industry» includes ongoing projects on reconstruction and modernization of oil refineries are planned to be completed in 2017-2018 within industrialization map to improve the quality and compliance of domestic petroleum products to the euro standards. This modernization will result in increased oil-refining capacity; increased depth of processing and output of light oil; as well as in increased quality of oil products to the Euro-4 and Euro-5 standards. The main strategic area of the gas industry development is to meet domestic demand for commodity gas to ensure economic development of the country. The plans for the development of the gas industry include expanding gas distribution across the country. The General Gasification Scheme of the Republic of Kazakhstan for 2015-2030 was approved on November

4, 2014. This Scheme sets economically sound strategic directions for providing gas supply to the consumers in the country. The legislative basis for the development of this document is the Law on Gas and Gas Supply and the relevant Rules approved by the Government of the Republic of Kazakhstan.

4.2.5. Policies and measure in the construction sector

«Energy Efficiency Requirements for Construction Materials, Products and Structures»[180] (No. 11666) were approved on March 31, 2015 in accordance with subparagraph 6-7) of the Article 5 of the Law of the Republic of Kazakhstan «On Energy Saving and increasing Energy Efficiency». Requirements apply to construction materials, products and engineering structures used in the construction, overhaul maintenance, reconstruction and operation of residential, public, social and special buildings. The requirements apply to the following group of the construction materials, products and engineering structures, which are elements of the enclosing structures of buildings: window constructions; balcony doors and lamps; thermal insulating materials and products.

The «Rules for the Determination and revision of Energy Efficiency Classes for Buildings, Structures and Premises»[181] (No. 11312) were approved on March 31, 2015 in accordance with subparagraph 6-9) of Article 5 and paragraph 5 of Article 11 of the Law of the Republic of Kazakhstan «On Energy Saving and increasing Energy Efficiency». Energy efficiency class is determined in accordance with the indicators specified in Table 33, in conformity with state standards, building codes and rules in the field of architectural, urban-planning and construction activities of the Republic of Kazakhstan, and in the field of energy saving and energy efficiency.

Table 33. *Energy Performance of Buildings*

№ п/п	Code of the class	Energy performance class	The deviation from the regulatory standard of the estimated (actual) value of the energy index for heating and ventilation of a building,%
When designing and operating new and reconstructed buildings			
1	A++ A+ A	High	less than -60 from -50 до -60 from -40 до -50
2	B+ B	Advanced	from -30 до -40 from -15 до -30
3	C+ C C-	Standard	from -5 до –15 from +5 до –5 from +15 до +5
When operating existing buildings			
4	D	Moderate	from +15,1 до +50
5	E	Low	more than +50

4.2.6. Policies and measures in transport

4.2.6.1. Energy efficiency in transport

«Energy efficiency requirements for transport» (No. 389) were approved on March 31, 2015 in accordance with subparagraph 6-7) of Article 5 of the Law of the Republic of Kazakhstan "On Energy Saving and Increasing Energy Efficiency". These requirements determine regulatory standard for energy efficiency of transport. The requirements apply to railway, road, maritime, inland waterway, air and urban electric transport, imported and produced after adoption of these requirements.

[180] http://adilet.zan.kz/rus/docs/V1500011666
[181] http://adilet.zan.kz/rus/docs/V1500011312

Table 34. *Energy efficiency indicator in transport*

№	Type of transport	EE in%
1	Automotive: natural gas engine Automotive: Diesel engine Automotive: gasoline engine Automobile: hybrid car (gasoline/electric) Automotive: electric engine	66 55 60 75,7 52,5
2	Airplane engine	40
3	Railway: Diesel-powered locomotive Railway: electric locomotive	41 82
4	Maritime transport	60
5	Inland water transport	60
6	Urban electric transport	75

4.2.6.2. Comprehensive development plan for the gas-engine fuel market of the Republic of Kazakhstan until 2020

The «Comprehensive Development Plan for the Gas-engine Fuel Market of the Republic of Kazakhstan until 2020», No. 433 was approved on June 25, 2015 in accordance with subparagraph 5) of the paragraph 2 of the section 3 of the "Concept of Development of the Gas Sector of the Republic of Kazakhstan till 2030". All items of this plan are aimed to expand the use of gas in transport: (1) development of measures of state support to stimulate the development of the gas-engine fuel market; (2) conversion of state and municipal official vehicles, special communal equipment to gas-engine fuel; (3) submitting proposals to the MID of the Republic of Kazakhstan for the development of a service network for gas-cylinder vehicles, including conversion services for the use of gas-engine fuel and technical certification of high-pressure cylinders; (4) submitting proposals to the Ministry of Education and Science of the Republic of Kazakhstan for the organization of training of technical personnel for working with gas-engine fuel equipment; (5) development of the gas fueling infrastructure for gas-engine fuel, including placement of natural gas modules at gasoline stations. Construction in the regions of Kazakhstan of a network of gas fueling stations for vehicles with gas-engine fuel; (6) submitting proposals to the MID of the Republic of Kazakhstan for the construction of automated NGV filling stations, multifuel stations, service centers, including stations along the «Western Europe - Western China» highway; (7) awareness-raising activities with enterprises and public about the benefits of using gas-engine fuel.

"KazTransGas"[182] JSC plays an important role in converting transport to gas fuel. «KazTransGas» JSC sets a task to convert Kazakhstan's vehicles, including state, municipal and personal transport to compressed natural gas (CNG) as one of the priority. The company claims that a new infrastructure has been created in the country to develop this area, which will be subsequently modernized in the future. «KazTransGas» JSC introduced a new subdivision to proceed with this work. «KazTransGaz Onimderi» LLP is a young company established with the aim of developing a fundamentally new market for Kazakhstan, raising the standards of the domestic motor transport, and ultimately it is one of the stages of the transition to a «Green Economy». The key activity of «KazTransGaz Onimderi» is conversion of transport to the CNG, which has advantageous qualities in comparison with other types of fuel.

4.2.7. Policies and measures in the pipeline industry

4.2.7.1. Concept of Development of the Gas Sector of the Republic of Kazakhstan till

The "Concept of Development of the Gas Sector of the Republic of Kazakhstan till 2030» No. 1275 was approved on December 5, 2014. The concept sets out the vision and key approaches to the stage-by-stage reform and integrated development of the gas sector of the Republic of Kazakhstan. Objectives

182 http://www.nomad.su/?a=4-201406180017

of this Concept are as follows: (1) Ensuring the energy and environmental security of the Republic of Kazakhstan (2) Creation of conditions for uninterrupted and economically effective gas supply to the widest possible range of consumers in the territory of the Republic of Kazakhstan and increasing the share of gas in the fuel and energy balance of the country; (3) Creation of conditions for increasing the efficiency of gas use as well as manufacturing of gas and chemical industry products with high value added. The main tasks to achieve the objectives of the Concept include: (1) Extended reproduction of the resource base through intensification and enhancement of the efficiency of geological exploration; (2) Modernization and expansion of gas processing facilities, complex extraction and use of all valuable components of associated and natural gas; (3) Increased production of marketable gas and gas chemical products for domestic market and export; (4) Development of a gas transportation infrastructure to increase efficiency and diversification of the supply structuring and channeling, including the use of new transportation technologies; (5) Incentivizing domestic demand for gas, including new categories of consumers; (6) Resource-saving, reduction of the specific gas consumption and losses in all manufacturing sectors; (7) Increase of investment attractiveness of projects in the gas industry.

4.2.7.2. General scheme of gasification of the Republic of Kazakhstan for 2015-2030

Government of the Republic of Kazakhstan approved the **«General Scheme of Gasification of the Republic of Kazakhstan for 2015-2030»**[183] No. 1171, dated November 4, 2014 as part of the implementation of goals to deliver gas transportation infrastructure to all regions of the country. One of the objectives of the General Scheme affecting emissions to the environment is the provision to create conditions for increasing the share of gas consumption in the fuel and energy complex.

Table 35. *Gasification plan*

Description	2015	2020	2025	2030
Natural gas production, bcm/year	44,19	62,0	61,0	59,8
Marketable gas for distribution, bcm/year	22,22	24,59	22,24	21,02

4.2.7.3. Construction of the "Sary-Arka" main gas pipeline

Completion of the 'Beineu-Bozoi-Shymkent' MGL created a technical opportunity to transport natural gas from the fields of Western Kazakhstan to Kyzylorda and southern region of the Republic of Kazakhstan, and subsequently, it became the basis for the feasibility study to supply domestic gas for gasification of Astana, as well as central and northern regions of Kazakhstan[184].

"KazTransGas" JSC - National Operator in the Gas Supply Industry is responsible for the project implementation, while feasibility is being developed by the Consortium of Kazakhstani Project Companies lead by the specialized engineering company «KATEK» LLP.

The proposed stages of the gas pipeline development include gasification of settlements in Karaganda, Akmola, North Kazakhstan oblasts and of Pavlodar and northeastern regions of Kostanay oblast in the future, with total coverage of up to 4.6 million people and a forecasted consumption volume of up to 3.6 bcm/year.

The total length of the «Kyzylorda-Karaganda-Astana-Kokshetau-Petropavlovsk» route is about 1.550 km, including 427 km in Akmola region.

Advantage of constructing «SARY-ARKA» MGL is elimination of the risk of dependence from an external supplier of imported gas that was the main obstacle to implementation of previously developed gasification options in Astana and the northern regions.

183 http://adilet.zan.kz/rus/docs/P1400001171
184 http://energo.akmo.gov.kz/page/read/KRATKAYA_SPRAVKA_po_proektu_stroitelstva_magistralnogo_gazoprovoda_SARYARKA_razrabotka_TEO_stroitelstva_MG_SARYARKA.html

In addition, this project provides a more complete transit capacity utilization of "Beineu-Shymkent" MGL, while MGL's long-term gas transit capacity is estimated at the volume up to 15.0 bcm/year, and in general terms that might reduce gas transportation tariff.

4.2.7.4. Autonomous gas supply

Pilot project of autonomous gas supply[185]. construction was completed in Akmola region in 2014. «The Ministry of Oil and Gas of the Republic of Kazakhstan initiated the pilot project for gasification of settlements with liquefied gas. Estimated cost of the project is 1878.5 million KZT. Commissioning of the facility will provide a possibility to connect more than 1100 subscribers, including schools, kindergartens, administrative buildings and industrial facilities. Following the design specifications and estimates requirements, technically sophisticated equipment was installed. Moreover, the length of the gas network of Zhibek Zholy village (over 40 kilometers) resulted in installation of non-traditional technical layout and equipment. Thus, automated gas distribution station sends delivered gas through networks directly to users for household needs of the population, organizations and enterprises.

Implementation of this project will address the issue of constant, stable and uninterrupted gas supply to the village of Zhibek Zholy, reducing household expenses for thermal energy up to 67% (more than 1.5 times) in the harshest and longest winter period of the year, reports "Akmola Media Ortalygy".

4.2.8. Political measures in utilities sector

4.2.8.1. Energy service companies

The Law of the Republic of Kazakhstan «On Energy Saving and Increasing Energy Efficiency» introduces a concept of an energy service company (ESCo), i.e. a legal entity that run energy saving and energy efficiency activities using its own and (or) attracted funds within the performance contracts, including with the involvement of contractors. ESC is an important tool for realizing the potential of energy efficiency through the use of performance contracts that help successfully overcome market barriers. Realization of the energy saving potential is reflected in National program as the 59th step - ATTRACTING STRATEGIC INVESTORS IN THE SPHERE OF ENERGY SAVING THROUGH THE INTERNATIONALLY RECOGNIZED MECHANISM OF PERFORMANCE CONTRACT.

According to information from the website of the Ministry of National Economy of the Republic of Kazakhstan, a certain progress has already been achieved on step 59. A model for the energy service companies[186] (ESCo) market has been developed and implemented in cooperation with the German energy agency DENA, identified as strategic partner by the Ministry of Investment and Development within the effort to involve strategic investors in energy saving sector. A legislative base for performance contracts has been created. Four strategic investors have been attracted: international financial organizations (IBRD, EIB, UNDP and USAID) for implementation of green projects, including energy saving projects (EIB), comprehensive modernization including energy efficiency of 6 kindergartens in Aktau and Pavlodar (IBRD), replacement adjacent lighting in the cities of Lisakovsk, Uralsk, Almaty, Astana, Aktau and Satpaev (UNDP), modernization of heating units in East Kazakhstan region (USAID). Other initiatives include creation of energy service operator on the basis of the «Institute Electricity Development and Energy Saving» JSC, and of the Energy Service Companies Register (171 companies from 12 countries). The operator received 101 applications worth over 64 billion KZT, and 6 projects out of them are currently implemented through the performance contract mechanism. In general, these measures will improve the energy efficiency of buildings and facilities and contribute to a general reduction in the energy intensity of GDP by 25% by 2020.

185 https://www.kt.kz/rus/economy/v_akmolinskoj_oblasti_zavershaetsja_pilotnij_proekt_po_stroiteljstvu_avtonomnogo_gazosnabzhenija_1153593452.html

186 http://economy.gov.kz/ru/plan-natsii/index.php?sphrase_id=17380976

4.2.9. Policies and measures in fugitive emissions

4.2.9.1. Prohibition on gas flaring, development and implementation of gas processing development programs

According to the IPCC, fugitive emissions are accidental or intentional release of greenhouse gases during extraction, processing and delivery of fossil fuels to the end-use site.

After the prohibition of flaring, annual volumes of flared gas in Kazakhstan were reduced by more than 3.5 times, while gas production volumes continued to grow steadily. These indicators were achieved due to the systematic implementation of gas utilization programs, which existed under the former Law of the Republic of Kazakhstan dated June 28, 1995 «On Oil.» During the period of introduction and approbation of this mechanism, insufficient systemic policies and coordinating role of the state in the process of selecting options for gas utilization resulted in choosing less rational options for the use of hydrocarbon raw materials at a number of fields. In this regard, with the adoption of the Subsoil Law, development programs have replaced gas utilization programs. Meanwhile, systematic extension of some old gas utilization programs for some fields is so far at place, and that assumes indicates insufficiently effective implementation of the programs by such subsoil users.

Subsoil users have an obligation to develop and implement development programs for gas processing. This mechanism, which replaced the gas utilization programs, specified the state policy in the sphere of rational use of gas by focusing subsoil users on maximizing processing and marketing volumes of gas produced by them.

4.2.10. Policies and measures in the industrial processes sector

Table 3 of the CTF format indicates actions to prevent climate change. Brief description of the measures with specific examples of industrial production and additional information on the relevant dates is provided below. Year 2015 is indicated as optional year; since the latest inventory includes data for 2015.

Table 36. *Assessment of the recent mitigation measures (summary)*

Mitigation action	Status of implementation	Brief description	Start year of implementation	Estimate of mitigation impact (not cumulative, in kt CO_2-Eq.)		
Measures undertaken				2015	2020	2030
National Allocation Plan for 2013,2014-2015, 2016-2020, Emission Trading System	Suspended	Establishes allowances (limits) for carbon dioxide emissions from industrial plants whose aggregate carbon dioxide emissions exceed 20,000 tons of carbon dioxide per year; (Suspended till 2018 due to the need to improve the legislative framework, to finalize coverage sectors)	2014 and 2018	N/A	400	450
Law of the Republic of Kazakhstan "On Energy Saving and Increasing Energy Efficiency" dated January 13, 2012, approved requirements for energy audit (2012), mandatory State Energy Registry set up and maintenance	Adopted	Obligatory energy audits. Reduction of GHG emissions with optimization of technological processes in 2013-2019, reduction of emissions to 2012 level	2013	860	1500	1680

The Concept of Innovation Development of Kazakhstan till 2020 (dated June 4, 2013, No. 579)	Adopted	Introduction of advanced technologies in chemicals and petrochemicals. Reconstruction and modernization of the “Kazfosfat” LLP and “KazAzot” LLP.	2013	15	20	25
The Concept for Transition of the Republic of Kazakhstan to a "Green Economy" (dated May 30, 2013, No.577) aligned with “Kazakhstan-2050: the new political course of the established state” Strategy	Adopted	Building new industries, implementation of energy efficiency measures and development of renewable energy sources. Financial resources are allocated and human resources are mobilized for the Concept implementation. However, it should be noted that now, initiatives to create a gas infrastructure have been suspended from this Concept.	2014	NA	NA	NA
Code on administrative offences Dated July 5, 2014: penalties for emissions above limits established in the allowances certificate, for submitting unreliable data on GHG inventory	Adopted	Excess GHG emissions penalty, and penalty for submission of inaccurate data on GHG	2014	NA	NA	NA
The state program of industrial-innovative development of Kazakhstan for 2015-2019	Adopted	Re-engineering of production, transition to new technologies consuming less thermal energy, reduction of Ferrosilicon production. Engineering education and internships for employees	2015	NA	NA	NA
Ban on exporting scrap and non-ferrous (precious) metals.	Adopted	Helps to reduce mining activity due to scrap metal melting. The demand for metal is covered by melting scrap metals. Data to assess an impact is not available.	2015	NA	600	1200
In the "Plan of the nation - 100 concrete steps" the President of the Republic of Kazakhstan sets the 59th step to attract strategic investors to the area of energy saving through the internationally recognized performance contracts mechanism	Adopted	Attracting strategic investors – is about attracting international financial institutions (IBRD, EIB, UNDP and USAID) to implement green projects, including energy efficiency projects (EIB), comprehensive modernization with energy efficiency of buildings included, urban lighting and industry	2015	NA	NA	NA
Strategic plan of the Ministry of Energy of Kazakhstan for 2017 – 2021	Adopted	Ensuring transition of Kazakhstan to low-carbon development and to «Green Economy» as well as equitable meeting the needs of current and future generations.	2016	NA	NA	NA
EXPO 2017 “Future Energy” exhibition	Planned	National pavilion, zone of the best energy practices, etc. will help to attract the best renewable energy and energy efficiency solutions.	2017	NA	NA	NA

International Financial Center "Astana" and development of the «Green» financial system	Planned	Improvement of legislation, moving towards an international level, attraction of investment for modernization of existing equipment and renewable energy development.	2017	NA	NA	NA
Modernization of "ArcelorMittal Temirtau" JSC, which ceased to produce open-hearth steel; production of Ferrosilicon is declining; Modernization of "Kazzinc" JSC.	Adopted	Emissions from the production of pig iron and steel decreased by 15%, ratio of emissions per ton of zinc = 0, ferrosilicon is not at the level of 2007	2000	1500	2000	2800
Planned additional measures						
The President›s Address to the people of Kazakhstan dated January 31, 2017 "The Third Modernization of Kazakhstan: Global Competitiveness"	Planned	Development of service sector for industrial production: engineering, telecommunications, geological exploration, Industry 4.0, as well as the development of the Agribusiness through indirect industrial policy, technology transfer and enhancing the quality of human capital. Assignment to develop industrialization with an emphasis on the development of competitive exportable products in priority sectors, increasing non-resource-based exports and attracting investment in MMC. Universal introduction of elements of the Fourth Industrial Revolution, i.e. automation, robotization, artificial intelligence, exchanging «Big data.»	2017	NA	NA	NA
Optimization of the technological process in ammonia production	Planned	Upgrading with the total cost of 56 mln. Using the low-potential heat of industrial furnaces, new energy-saving drum, decarbonators with reduced energy consumption, energy-efficient converters, convergence with European standards.	2018	-	400	450
Optimization of the technological process in calcium carbide production	Planned	Boiler systems for direct combustion of closed industrial furnaces, boiler systems for utilization of heat from effluent gas from semi-closed furnaces, and technology for using furnace gases in limekilns.	2020	-	400	450
Approving the list of benchmarks	Planned	Results of benchmarking analysis are used to include regulatory legal acts into the Reference Control Bank. It will incentivize enterprises to introduce emissions accounting and to achieve desirable indicators	2018	-		
Additional measures						

Installation of technology for CO2 capture and storage in the production of clinker and lime (with a capture efficiency of 80%)	Under discussion	Coverage of clinker and lime factories: 10% till 2017, 20% till 2020, 30% till 2030	2025	-	0	200
Modernization and optimization of iron and steel production to meet European standards (Benchmarking)	Under discussion	Average national GHG emission factor from pig iron production is k = 1.89, the European average is 1.35, modernization of the iron and steel industry to reduce the national average to 1.6 (2016-2020), and to 1.4 (> 2021)	2020	-	304	497
Transition to high productivity of steel melting in a blast furnace based on noncoking coal by COREX technology from Voest-Alpine, Austria.	Under discussion	Decrease in production of coke from 0.482 tCO2/t. Possibility of heat utilization and cogeneration.	2025	-	-	600

4.2.11. Policy and measures in agriculture and LULUCF

To analyze policies and measures applied, the agriculture and LULUCF sectors were conditionally divided into GHG sinks and emitters. Further, the main possible ways of increasing the removals were considered for sinks, and options for reducing emissions for emitters. On this basis, all relevant policies and measures adopted in the Republic of Kazakhstan have been defined. In conclusion, the possible socio-economic impact and mitigating measures were considered. The square brackets refer to the document or legislative act of the relevant measure or policy.

Forests and soils of Kazakhstan are the key GHG sinks in the agriculture and LULUCF sectors. Fermentation products in large and small cattle, as well as horses and birds, and other animals are the key emitters. For the convenience of analysis, sinks and emitters are considered separately.

Sinks

The forestry sector of Kazakhstan is a sink of greenhouse gases. The annual contribution of this sector to the GHG removals is about 8-10 million tons in CO2 equivalent. However, this indicator can be significantly lower if emissions from forest felling and fires reach significant levels. For example, the annual emission from forest felling is about 1.5 million tons in CO2 equivalent, and the emission from forest fires with a total area of 10,000 hectares is about 0.7 million tons in CO_2 equivalent.

Thus, policies and measures aimed at reducing forest fires and felling, as well as increasing the area of forests and forest regeneration, are measures that reduce the GHG emissions. These measures include:

a) Wildfire suppression:

- Adoption of fire-safety regulations.
- Aerial protection of forests from fires

These measures are aligned with the law on rules of fire safety and the law on the rules for aerial protection of forests from fires.

6) Reduction of forest felling volumes:

- Prohibition of all types of saxaul cutting until December 31, 2018
- Prohibition of all types of harvesting in the national forest reserve «Ertis Ormany»
- Temporary ban on sanitary forest reserve in coniferous forests

These bans were introduced by the orders of the Minister of Agriculture of the Republic of Kazakhstan.

в) Increasing forest area and forest regeneration

- Financing of forests regeneration and forest planting. For these measures, the Ministry of Agriculture allocated around 140 million KZT under the State program for Development of agribusiness for 2017-2021
- Non-forested lands transformed into area covered by forests.

These measures were implemented or reflected in the State programs "Zhasyl damu" for 2010-2014, Strategic plan of the Ministry of environment and water resources for 2014-2018 and State Program for Agroindustrial Complex Development of the Republic of Kazakhstan for 2017-2021.

Total effect of these measures can be assessed as reduction of GHG emissions in the whole agriculture and LULUCF sectors by 10-15%.

Emitters

Fermentation products in animal produce about 12 Mt of carbon equivalent per year. Measures to reduce this indicator, according to the IPCC methodology, can be the biogasification of fermentation products, i.e. gas production. This measure can significantly reduce emissions from the sector. Another measure would be to improve the quality of animal breeds in agriculture, as well as to improve the quality of feed, which may lead to a decrease in the level of fermentation. Following measures can be added to the abovementioned:

А) Technology transfer (biogas generation):

- Setting fixed tariffs for biogas plants at the level of 32.23 KZT per kWh
- Support for RES (renewable energy sources)
- The State Program for Industrial-Innovative Development

Б) Improvement of breeds of cattle, small ruminants and horses in agriculture

- Subsidizing pedigree livestock farming under the state program for the agro-industrial complex development of the Republic of Kazakhstan for 2017-2021

Another important source of emissions is the production of crops such as wheat, rice, potatoes, cotton and others. Key measures that can reduce emissions in the production of agricultural crops include production of biogas, reduction of irrigation measures. Such measures in Kazakhstan include

С) Reducing energy intensity

- Technology transfer
- Transition to drip irrigation
- Protection from land degradation (prevention of reduction of humus in soils)
- Improvement of irrigation and drainage systems. For these purposes, the Ministry of Agriculture allocated more than 49 billion KZT for 2017-2021.
- Reconstruction, rehabilitation and overhaul repair of the collection network on irrigated lands. The Ministry of Agriculture also allocated about 50 billion KZT for 2017-2021
- Reconstruction of emergency water utilization systems. (49 billion KZT is allocated for 2017-2021)

D) Efficient and sustainable use of water resources

- Reconstruction and rehabilitation of reservoirs, dams and hydropower installations. More than 21 billion KZT have been budgeted for 2017-2021.
- Construction of new reservoirs. The Ministry of Agriculture budgeted about 55 billion KZT under the program of the agro-industrial complex development of the Republic of Kazakhstan for 2017-2021.
- Conduct research on water resources use and regulation (more than 500 million KZT is budgeted for 2017-2021)
- International cooperation on water management issues
- Informing industrial enterprises about available water-saving technologies and water recycling systems to be followed by their adoption

E) Measures for agricultural producers

- Development of a new draft law of the Republic of Kazakhstan on insurance in crop production (second half of 2018)
- Submitting proposals for introduction of the insurance system in livestock (2018)
- Transfer of biotechnologies under the program of industrial-innovative development for 2015-2019

F) Infrastructure projects

- Investment into transport infrastructure within ‘Nurly Zhol’ for 2015-2019 program
- Development of an integrated environmental and natural resource monitoring solution

To assess and monitor the Strategic Development Plan of the Republic of Kazakhstan, the Government created «List of Key Indicators», which includes such indices as:

- Land under forest cover on the territory of the state forest fund managed by local executive bodies
- Average area of a forest fire on the territory of the state forest fund managed by local executive bodies

In general, it is difficult to assess the impact of certain policies and measures, such as the technology transfer. However, the table below summarizes policies and measures implemented in the Republic of Kazakhstan (implemented, adopted and planned) in the agriculture and LULUCF sectors, as well as assessment of effect on reducing greenhouse gas emissions in this sector.

Table 37. *Tabulated summary of Policies and Measures*

№	Mitigation action	Sectoral scope	GHG	Relevant objective and/or activity	Tool	Status	Brief description	Start year	Implementing agency (ies)	Estimate of mitigation impact (not cumulative, in kt CO_2-Eq.)		
										2015	2020	2030
1	Wildfire suppression	LULUCF	CO_2	Reducing fires	Regulatory	adopted	In the text above		Ministry of Agriculture	250	250	300
2	Reduction of forest felling volumes	LULUCF	CO_2	Reducing felling	Regulator	adopted	In the text above	1991	Ministry of Agriculture	100	100	100
3	Increasing forest area and forest regeneration	LULUCF	CO_2	Increased forest area	Regulator	adopted	50 bln. KZT from 2013 to 2017	1991	Ministry of Agriculture	250	250	300
4	Technology transfer (biogas generation)	Agriculture	CH_4	Organics Recycling from agriculture	Economic	adopted	In the text above	2010	Ministry of Energy	9	200	1000
5	Improvement of breeds of cattle, small ruminants and horses in agriculture	Agriculture	CH_4, N_2O	improving productivity	Economic	adopted	In the text above	2010	Ministry of Agriculture	0	10	30
6	Reducing energy intensity	Agriculture	CO_2	Reducing resource intensity	Regulator	adopted	100 bln. KZT for 2017-2021	2017	Ministry of Agriculture	-	-	-
7	Development of institutional change	Agriculture	CO_2, CH_4	Institutional reforms	Regulator	adopted	250 bln. KZT 2015-2017	1991	Ministry of Agriculture	-	-	-
8	Combating land degradation and desertification	LULUCF	CO_2	soil remediation	Regulator	adopted	In the text above	1991	Ministry of Agriculture	-	13000	25000

4.2.12. Policies and measures in the waste management sector

Table 3 of the CTF format provides information on the actions in the waste management sector undertaken by Kazakhstan to prevent climate change.

Government of the Republic of Kazakhstan approved the "Program on modernization of municipal solid waste management system for 2014-2050" No. 634, dated June 9, 2014 with the aim to improve quality of services provided in the sphere of solid waste management, to increase amount of collected and recycled secondary material resources, to maximize use of the energy potential of municipal solid waste, and to minimize negative impact on the environment. However, it was soon canceled (become invalid) in 2016.[187]

The program states that «Kazakhstan lacks waste transfer facilities (sorting yards), where it would be possible to conduct deep waste separation in order to extract secondary material resources, as well as a biodegradable fracture for recycling to produce «green» energy and compost. Finally, the system of separate collection of waste and (or) separation at the sources of municipal waste generation remains practically undeveloped... Centralized incineration or biological waste treatment facilities are non-existent at the moment, so the production of «green» energy from solid waste is not streamlined.»

In 2016, «Astana-Tazartu» LLP launched a pilot project in Astana where people separate plastic and other (mixed) waste. «Astana-Tazartu» LLP plans additionally to introduce a separate collection of paper.[188]

In 2007, a recycling plant was built in Almaty, it operated for three years, but now no longer in use due to under-regulated (low) tariff[189] for recycling.

Recycling plant in Astana (built in 2012) sorts only 7 percent[190] (plastic, glass, paper) of the total amount of solid waste. The rest (including organic waste) is compressed and sent to a landfill for burial. At the current level of sorting, only a slight reduction in methane emissions is achieved.

Kazakhstan Waste Management Association "KazWaste"[191] believes: "Kazakhstan has very low tariffs for solid waste collection. These tariffs do not include sorting, processing, waste reloading, equipping the collection sites, updating the fleet, containers, etc. In different cities, tariffs vary quite significantly (from 70 to 300 KZT per person per month). Currently, the Ministry of Energy has prepared a draft new methodology for calculating the tariff, which includes all of the above-listed components. International practice shows that without an increase in tariffs, it would be impossible to implement a rational system for waste collection and processing. After the introduction of the new methodology and carrying out calculations it will be clear how far the tariffs will rise. At the same time, compensation should be provided for vulnerable groups of population, similarly to the other utility tariffs.»

The first landfill gas capture system in the country is planned in Astana landfill (by 2020) with the subsequent Landfill Gas to Energy option.[192]

Shymkent city is implementing an investment project on construction of an anaerobic decomposition plant for wastewater area sludge. A complex is being built to process the sludge, with the production of biogas and electricity. The facility will reduce greenhouse gas emissions by 3.7 thousand tons of CO_2 equivalent annually.[193]

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187 http://adilet.zan.kz/rus/docs/P1400000634
188 http://www.abctv.kz/ru/news/astana-sortirovochnaya-2-v-stolice-zapustili-akciyu-po-sort
189 https://kapital.kz/business/60015/pochemu-musoropererabotka-terpit-fiasko-v-kazahstane.html
190 http://tengrinews.kz/kazakhstan_news/musoropererabatyivayuschiy-zavod-astane-obvinili-260272
191 http://informburo.kz/stati/vyvoz-musora-v-kazahstane-podorozhaet--9824.html
192 https://news.mail.ru/society/30394411/
193 http://wrm.kz/docs/%D0%9E%D1%82%D1%87%D0%B5%D1%82%D1%8B%20%D0%BF%D0%B5%D1%80%D0%B5%D0%B4%20%D0%BF%D0%BE%D1%82%D1%80%D0%B5%D0%B1%D0%B8%D1%82%D0%B5%D0%BB%D0%B5%D0%BC%202016.pdf

V. FORECASTS AND GENERAL EFFECT OF POLICIES AND MEASURES

The figure below shows the forecast of greenhouse gas emissions, excluding LULUCF.

Figure 19. *GHG emissions forecast, without LULUCF*

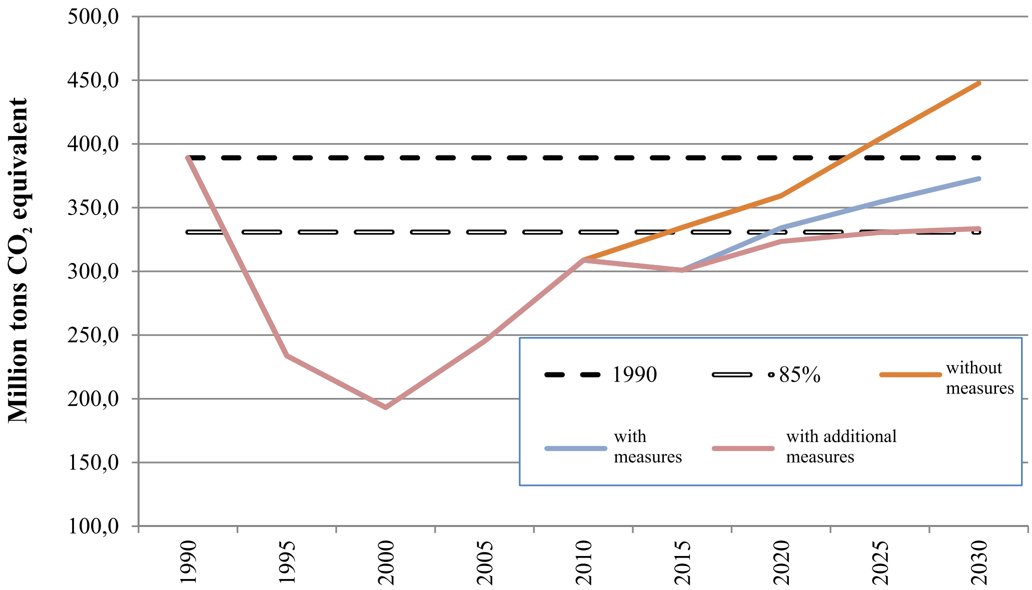


Figure 19 illustrates that scenario with measures reduces emissions by 75 million tons CO_2-eq. in 2030. Scenario with additional measures reduces emissions by additional 40 million tons CO_2-eq. in 2030.

The forecast in tables (including LULUCF and excluding LULUCF) is also presented in Table 6 of the CTF format.

The table below shows combined effect of current and additional measures.

Table 38. *Overall effect of current and additional measures*

	Emission values, million tons CO_2, equivalent		
	2020	2025	2030
Scenario without measures	359,3	404,0	447,6
Scenario with measures	334,1	354,3	372,8
Effect of current measures	25,2	49,6	74,8
Scenario with additional measures	323,5	330,6	333,4
Effect of additional measures	10,7	23,8	39,4

5.1. GHG emission scenarios (fuel combustion and fugitive emissions sector)

The model of Kazakhstan's energy system on the basis of TIMES instrument (The Integrated MARKAL-EFOM System), which uses the approach of detailed technical and economical process description of power industry (bottom-up), was used in the scenario without measures, with measures and scenario with additional measures for forecasting greenhouse gas emissions related to fuel combustion and fugitive emissions. TIMES is a tool for technical and economic model engineering of energy systems, which allows carrying out the scenario analysis of energy system development dynamics for mid and long-term periods.

Three scenarios of greenhouse gas emissions were developed to assess the impact of all policies and measures. All scenarios assume an annual GDP growth of an average of 3.5% till 2020 and 3% after 2020.

This paper looked at the following scenarios of the development of Kazakhstan›s energy system:

1) scenario without measures (WOM);

2) scenario with current measures (WCM);

3) scenario with current and additional measures (WCAM).

5.1.1. General assumptions for all scenarios

General assumptions used for all scenarios are as follows:

- all new, existing or planned power plants that lead to an increase in GHG emissions are put into operation (Balkhash TPP – 1.32 GW in 2021, Astana CHP-3 phase 1 – 110 MW in 2018 and phase 2 – 110 MW in 2021) as well as the expansion of existing ones (Astana CHP-2 – 240 MW in 2016, Karaganda CHP-3 – 110 MW in 2016, Ekibastuz GRES-1 block 2 – 500 MW in 2016 and Block 1 – 500 MW in 2017, Ekibastuz GRES-2 block 3 – 636 MW in 2018);
- Emission Trading Scheme is not taken into account (National Allocation Plan for 2013, 2014-2015, 2016-2020):
- Oil production reaches its peak (115 million tons per year) in 2035;
- Gasification of the country is progressing in line with the forecast gas balance of Kazakhstan from April 21, 2014 till 2030 (2015 – 22219 mmcm, 2020 – 24587 mmcm, 2025 – 22243 mmcm, 2030 – mmcm)

5.1.2. Scenario without measures (WOM)

This scenario reflects a possible change of greenhouse gas emissions without any measures to reduce them. Further economic growth is enabled by cheap coal as fuel for energy production. This scenario assumes that greenhouse gas emissions depend on the overall rate of GDP and population growth. This scenario is based on the following assumptions:

- all processes leading to improved energy efficiency in the process of optimization based on the achievement of reduced cost are not taken into account;
- all new existing or planned power plants that lead to a reduction in GHG emissions, i.e. gas, on renewable and alternative energy sources are not put into operation;
- gasification of heat and electricity producing facilities is limited (no more than 20% for a power plant and no more than 25% for natural gas-fired boiler plants);

5.1.3. Scenario with current measures (WCM)

This scenario includes adopted and planned measures and policies aimed directly at reducing greenhouse gas emissions or have indirect impact on reduction of GHGs:

- all new or existing processes and processes leading to energy efficiency improvement are taken into account;
- all new existing or planned power plants that lead to a reduction in GHG emissions, i.e. gas, renewable and alternative energy sources are put into operation;
- gasification of heat and power plants (CHP and TPP) is set at 20% and 25% in 2020 and 2030 respectively. For boiler plants, gasification shall be at least 25% of natural gas-fired thermal power generation;
- target indicators of renewable energy sector development are taken into account (Approved by the order of the Minister of Energy of the Republic of Kazakhstan dated November 7, 2016, No. 478[194]). According to this document, total installed capacity of renewable energy facilities in 2020 shall amount to 1,700 MW (WPP – 933 MW, SPS – 467 MW, HPP – 290 MW, Biogas plants – 10 MW);
- • in accordance with the Concept for the Development of the Fuel and Energy Complex of the Republic of Kazakhstan until 2030, a nuclear power plant with the capacity of 1 GW is put into operation in 2030 (Approved by Resolution of the Government of the Republic of Kazakhstan dated June 28, 2014 No. 724[195]).

5.1.4. Scenario with current and additional measures (WCAM)

This scenario includes possible measures and policies that are directly aimed at reducing GHG emissions:

- capacities to be installed by 2020 according to the renewable energy sector development targets are doubled by 2030 (50% in 2025 and the remaining 50%);
- an additional 1 GW nuclear power plant is commissioned in addition to the existing 1 GW NPP in 2030, according to the Concept for Development of the Fuel and Energy Complex of the Republic of Kazakhstan;
- System undertakes efforts to reduce one ton of CO2 equivalent at the cost of 10, 15 and 25 USD in 2020, 2025 and 2030, respectively.

Scenarios are summarized in the table below.

Table 39. *Description of scenarios*

Assumptions	Scenario without measures (WOM)	Scenario with current measures (WCM)	Scenario with current and additional measures (WCAM)
General assumptions for all scenarios			
All the new existing (commissioned since 2011) or planned power plants that increase GHG emissions are put into operation			
Balkhash TPP – 1.32 GW in 2021	V	V	V
Astana CHP-3 phase 1 – 110 MW in 2018	V	V	V
Astana CHP-3 phase 2 – 110 MW in 2021	V	V	V
Existing power plants that increase GHG emissions are modernized and expanded			
Astana CHP-2 – 240 MW in 2016	V	V	V
Karaganda CHP-3 – 110 MW in 2016	V	V	V

[194] http://adilet.zan.kz/rus/docs/V1600014489
[195] http://adilet.zan.kz/rus/docs/P1400000724

Assumptions	Scenario without measures (WOM)	Scenario with current measures (WCM)	Scenario with current and additional measures (WCAM)
Ekibastuz GRES-1 Block 2 – 500 MW in 2016	V	V	V
Ekibastuz GRES-1 Block 1 – 500 MW in 2017	V	V	V
Ekibastuz GRES-2 Block 3 – 636 MW in 2018	V	V	V
ETS is not taken into account			
NAP 2013	X	X	X
NAP 2014-2015	X	X	X
NAP 2016-2020	X	X	X
Crude oil production			
It reaches the peak in 2035 – 115 million tons	V	V	V
Gasification of the country is progressing in line with the forecast gas balance of Kazakhstan from April 21, 2014 till 2030			
2015 – 22219 mmcm	V	V	V
2020 – 24587 mmcm	V	V	V
2025 – 22243 mmcm	V	V	V
2030 – 21016 mmcm	V	V	V
Assumptions for scenarios			
All processes leading to improved energy efficiency are optimized to achieve reduced cost	X	V	V
All new existing or planned power plants leading to the GHG reduction (renewables and alternative energy sources)	X	V	V
Gasification of electricity producing facilities - 20% and more	X	V	V
Gasification of heat producing facilities - 25% and more	X	V	V
Target indicators of renewables sector development by 2020: Electric power generation - 3% of the total The total capacity of RES - 1700 MW WPP capacity - 933 MW SPP capacity - 467 MW Hydroelectric PP - 290 MW	X	V	V
Nuclear power plants capacity by 2030 - 1 GW	X	V	V
Capacities to be installed by 2020 according to the renewable energy sector development targets are doubled by 2030 (50% in 2025 and the remaining 50% - in 2030);	X	X	V
Nuclear power plants capacity by 2030 - 2 GW	X	X	V
Cost of efforts of the system to reduce one kt of CO_2: 2020 – 10 USD 2025 – 15 USD 2030 – 25 USD	X	X	V

5.2. GHG emission in fuel combustion sector

Scenarios without measures, with measures and with current and additional measures are based on technical and economic modeling in the processes associated with fuel combustion and fugitive emissions. All three scenarios are presented in Figure 20. The blue line in the graph represents GHG emissions level in 1990, and the red line represents 85% of the 1990 emission level, and illustrates Intended Nationally Determined Contributions (INDC) by 2030. The black line shows the level of the energy sector in 1990.

Figure 20. *Scenario of GHG emissions from fuel combustion sector*

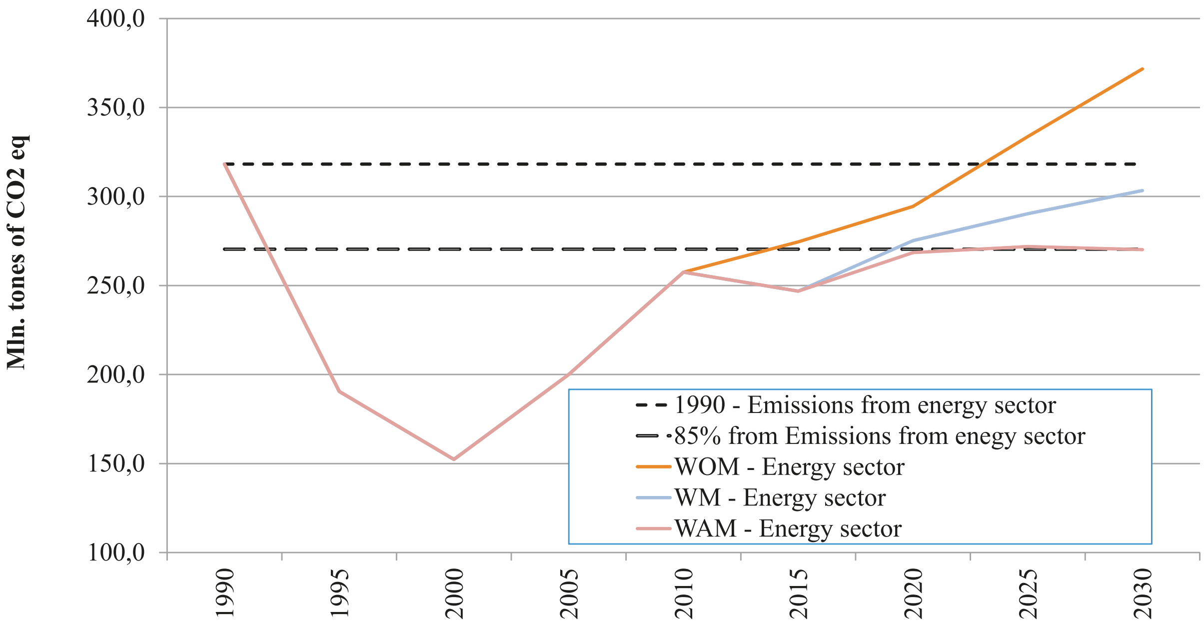


Table 40. *Scenarios of GHG emissions from fuel combustion sector*

	1990	1995	2000	2005	2010	2015	2020	2025	2030
1990 – Emissions from Energy sector	318,2	318,2	318,2	318,2	318,2	318,2	318,2	318,2	318,2
85% of emissions from Energy sector	270,5	270,5	270,5	270,5	270,5	270,5	270,5	270,5	270,5
WOM - Energy sector	318,2	190,5	152,3	200,0	257,5	274,5	294,4	333,7	371,6
WM - Energy sector	318,2	190,5	152,3	200,0	257,5	246,9	275,2	290,3	303,4
WAM - Energy sector	318,2	190,5	152,3	200,0	257,5	246,9	268,5	272,0	270,2

As shown in Figure 20, emissions in the energy sector in the scenario without measures grow throughout the forecasting period and reach the level of 1990 (power production) around 2025. The main source of emissions in the combustion sector and fugitive emissions is the «Energy industries» sector (47% out of the total combustion sector in 2015), which is dominated by electricity and heat production.

Impact of adopted or planned policies and measures to reduce GHG emissions varies from year to year. For example, until 2020, the main reduction of GHG emissions is associated with gasification of enterprises in the electricity and heat production sector. In 2025 and 2030, the biggest effect is associated in order of importance with increasing energy efficiency of existing technologies, introducing new technologies, gasification of electricity and heat production sector, and meeting the targets indicators of renewable energy sector development. The main factor enabling achievement of the NDC goal is the cost incurred by the system to reduce one ton of CO_2 equivalent across all sectors.

The influence of current or planned policies on reduction of GHG emissions varies year to year. For instance, until 2020 main reduction in GHG emissions is related to gasification of electricity and heat generating enterprises. In 2025 and 2030, the biggest effect on GHG emissions reduction will be exerted by the following factors in the order of significance: increase in energy efficiency of existing technologies, introduction of new technologies, gasification of electricity and heat generation sector and achievement of the targets in renewable energy sources sector. In scenario with additional measures the main factors, which will enable achievement of the target emission standard, are the cost, which the system bears to reduce one ton of CO_2–equivalent in all sectors.

Table 41 presents the results of the scenarios without measures, with current measures and with current and additional measures from the processes associated with fuel combustion, as well as inventory results (by types of GHGs).

Table 41. *Historical data and forecast of emissions from the combustion processes broken down by GHG types, million tons CO_2-equivalent*

Million tons CO_2-equivalent	Historical data, Inventory					Scenario without measures			
Types of gases	1990	1995	2000	2005	2010	2015	2020	2025	2030
CO_2	251,1	158,0	126,8	172,4	220,3	239,7	258,7	296,2	331,2
CH_4	53,4	26,1	22,0	22,1	30,6	34,1	34,9	36,6	39,5
N_20	1,1	0,7	0,5	0,8	1,0	0,7	0,8	0,9	1,0
HFC	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
PCFs	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total	**305,6**	**184,8**	**149,3**	**195,3**	**251,9**	**274,5**	**294,4**	**333,7**	**371,6**
Million tons CO_2-equivalent	Historical data, Inventory					Scenario with measures			
Types of gases	1990	1995	2000	2005	2010	2015	2020	2025	2030
CO_2	251,1	158,0	126,8	172,4	220,3	213,5	242,7	258,9	273,3
CH_4	53,4	26,1	22,0	22,1	30,6	28,6	31,9	30,6	29,3
N_20	1,1	0,7	0,5	0,8	1,0	1,0	0,7	0,7	0,7
HFC	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
PCFs	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total	**305,6**	**184,8**	**149,3**	**195,3**	**251,9**	**243,1**	**275,2**	**290,3**	**303,4**
Million tons CO_2-equivalent	Historical data, Inventory					Scenario with measures			
Types of gases	1990	1995	2000	2005	2010	2015	2020	2025	2030
CO_2	251,1	158,0	126,8	172,4	220,3	213,5	237,0	243,2	243,9
CH_4	53,4	26,1	22,0	22,1	30,6	28,6	30,9	28,1	25,7
N_20	1,1	0,7	0,5	0,8	1,0	1,0	0,7	0,6	0,6
HFC	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
PCFs	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total	**305,6**	**184,8**	**149,3**	**195,3**	**251,9**	**243,1**	**268,5**	**272,0**	**270,2**

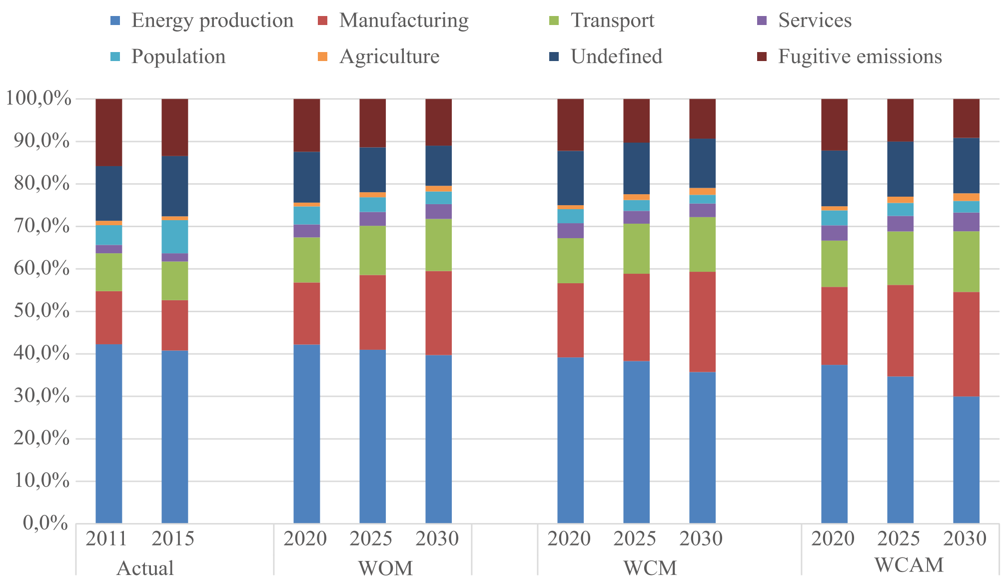
The next table presents aggregated impact of current and additional measures.

Table 42. *Aggregated impact of current and additional measures in the fuel combustion sector and fugitive emissions*

	Emission values, million tons CO_2 equivalent		
	2020	**2025**	**2030**
Scenario without measures	294,4	333,7	371,6
Scenario with measures	275,2	290,3	303,4
Impact of current measures	19,2	43,3	68,3
Scenario with additional measures	268,5	272,0	270,2
Impact of additional measures	6,7	18,4	33,2

Figure 21 shows structure of CO_2 emissions associated with fuel combustion, by sectors.

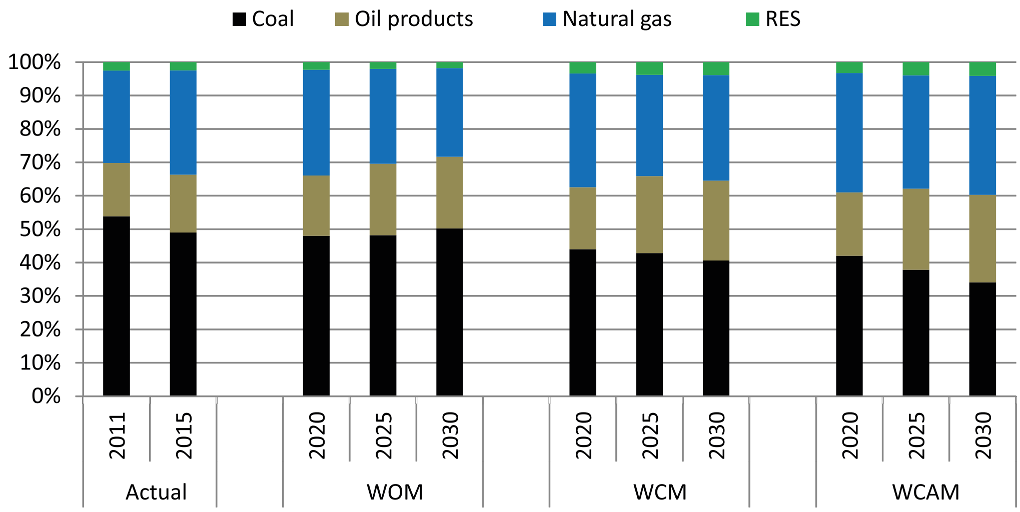
Figure 21. *Structure of CO_2 emissions associated with fuel combustion, by sectors*



	Actual		WOM			WCM			WCAM		
	2011	**2015**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**
Energy production	42.3%	40.8%	42.2%	41.0%	39.7%	39.2%	38.3%	35.7%	37.4%	34.7%	30.0%
Manufacturing	12.5%	11.9%	14.6%	17.6%	19.8%	17.5%	20.6%	23.6%	18.4%	21.6%	24.6%
Transport	8.9%	9.1%	10.6%	11.6%	12.2%	10.6%	11.8%	12.9%	10.9%	12.6%	14.3%
Services	2.0%	1.9%	3.1%	3.2%	3.5%	3.5%	3.0%	3.2%	3.6%	3.7%	4.4%
Population	4.6%	7.8%	4.3%	3.5%	3.0%	3.3%	2.6%	2.1%	3.5%	3.0%	2.7%
Agriculture	1.0%	0.9%	0.9%	1.2%	1.3%	1.0%	1.4%	1.6%	1.0%	1.5%	1.8%
Undefined	12.9%	14.2%	12.0%	10.6%	9.5%	12.8%	12.1%	11.6%	13.1%	13.0%	13.0%
Fugitive emissions	15.8%	13.4%	12.4%	11.4%	11.0%	12.2%	10.3%	9.3%	12.1%	10.0%	9.2%

Currently, the main fuel for energy production is coal. In all scenarios, coal will remain the leading fuel in the future, but in scenarios with current and additional measures, its share in total consumption is decreasing (Figure 22).

Figure 22. *Fuel structure of energy system, breakdown by scenarios*



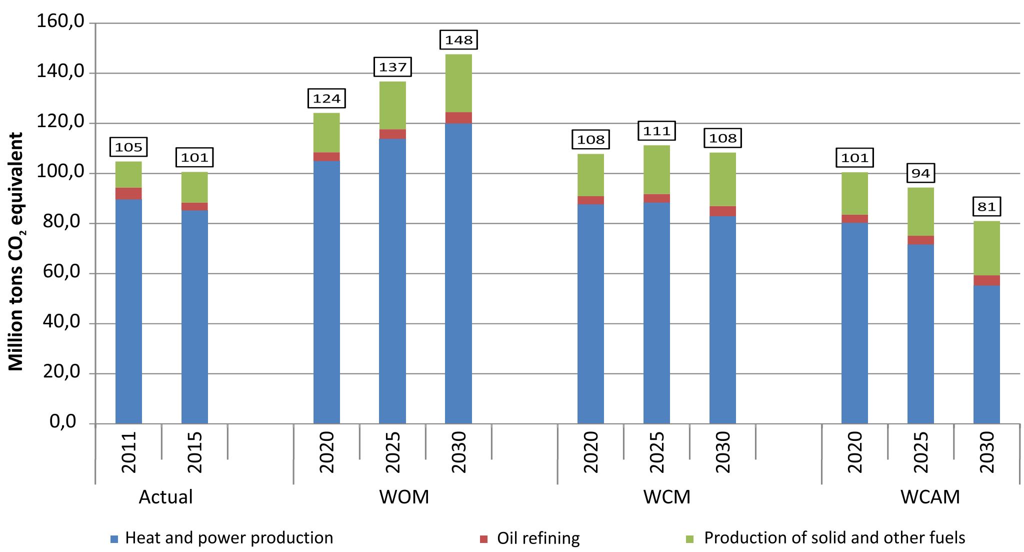
	Actual		WOM			WCM			WCAM		
	2011	2015	2020	2025	2030	2020	2025	2030	2020	2025	2030
Coal	53.9%	49.0%	48.0%	48.2%	50.2%	44.0%	42.9%	40.6%	42.1%	37.9%	34.1%
Oil products	15.9%	17.3%	18.1%	21.4%	21.5%	18.5%	23.0%	23.9%	18.9%	24.2%	26.1%
Natural gas	27.7%	31.2%	31.6%	28.4%	26.5%	34.0%	30.3%	31.6%	35.8%	33.9%	35.6%
RES	2.5%	2.4%	2.3%	2.0%	1.8%	3.4%	3.8%	3.9%	3.3%	4.0%	4.1%

5.2.1. Sector – energy industries

The energy industries include enterprises associated with production of heat, power, oil refining and with production of solid and other fuels.

Contribution to reducing emissions from the heat and power production sector is the most significant in all scenarios. Emissions from heat and power generation facilities account to 30-35% of total emissions and 46-50% of emissions associated with fuel combustion.

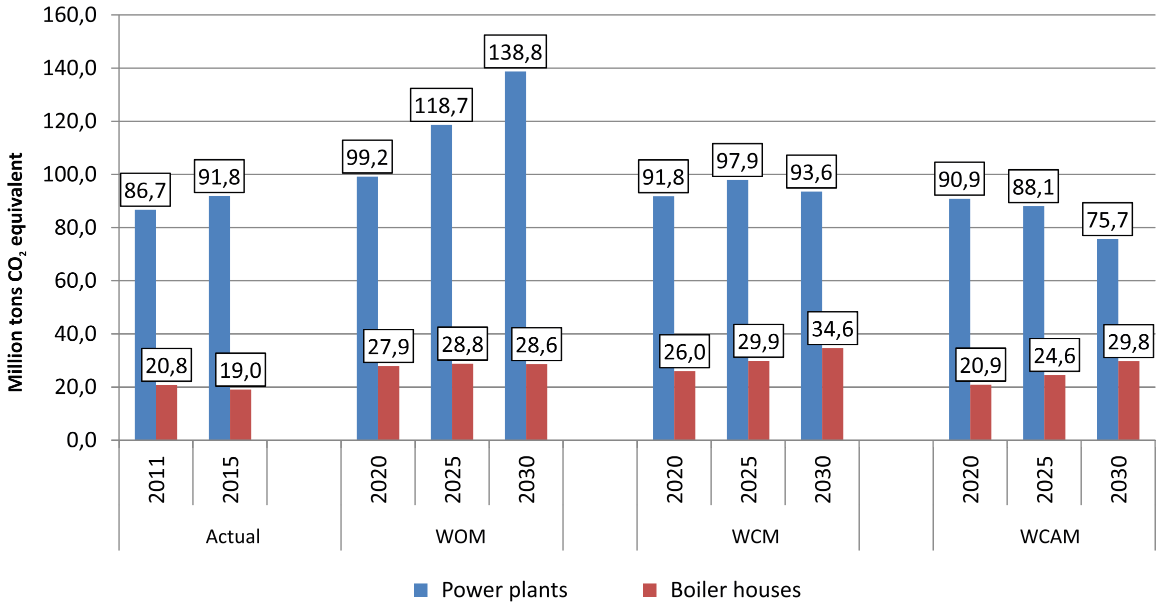
Figure 23. *Emissions from energy industries*



	Actual		WOM			WCM			WCAM		
	2011	**2015**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**
Heat and power production	89.6	85.2	105.0	113.8	120.0	87.6	88.4	82.9	80.3	71.6	55.2
Oil refining	4.7	3.1	3.5	3.9	4.5	3.3	3.5	4.1	3.3	3.5	4.1
Production of solid and other fuels	10.4	12.3	15.7	19.1	23.1	16.9	19.4	21.3	17.0	19.3	21.6
Total	**105**	**101**	**124**	**137**	**148**	**108**	**111**	**108**	**101**	**94**	**81**

GHG emissions from the energy industries are decisive in terms of impact on the reduction of total emissions. As can be seen, with the current measures and anticipated growth of economy, emissions stabilize. With additional measures, emissions are reduced.

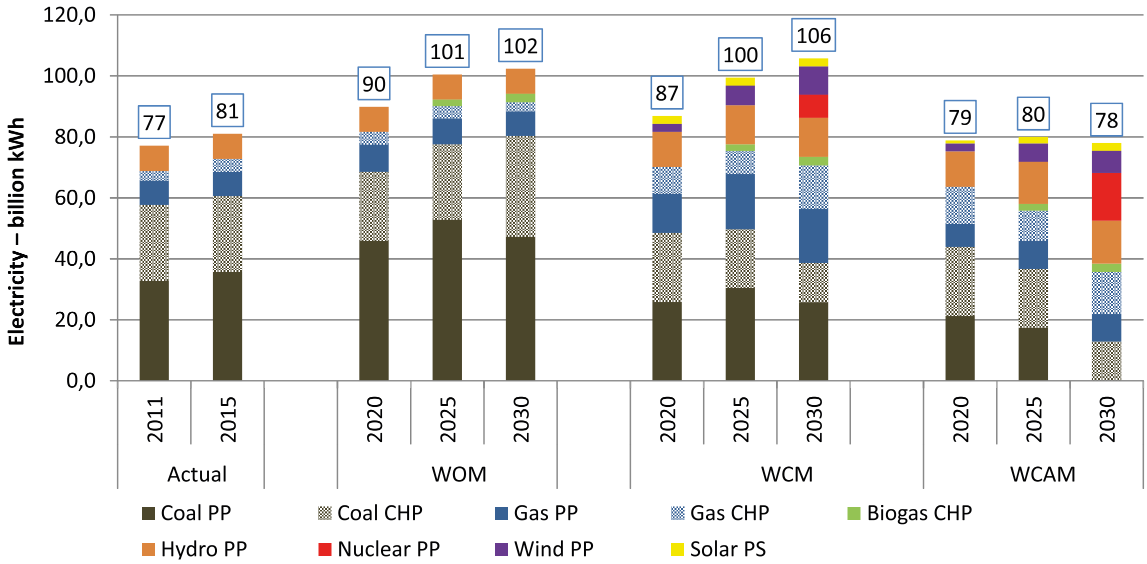
Figure 24. *Emissions from power plants and boiler houses*



	Actual		WOM			WCM			WCAM		
	2011	**2015**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**
Power plants	86.7	91.8	99.2	118.7	138.8	91.8	97.9	93.6	90.9	88.1	75.7
Boiler houses	20.8	19.0	27.9	28.8	28.6	26.0	29.9	34.6	20.9	24.6	29.8
Total	**108**	**111**	**127**	**147**	**167**	**118**	**128**	**128**	**112**	**113**	**105**

As shown in Figure 24, emissions from boiler houses in the scenario with current measures tend to increase while emissions from power plants decrease. This is due to the commissioning of new power plants that produce electricity only, stabilization of heat generation from the CHP, and the rising demand for heat is met by increasing the capacity of the boiler houses.

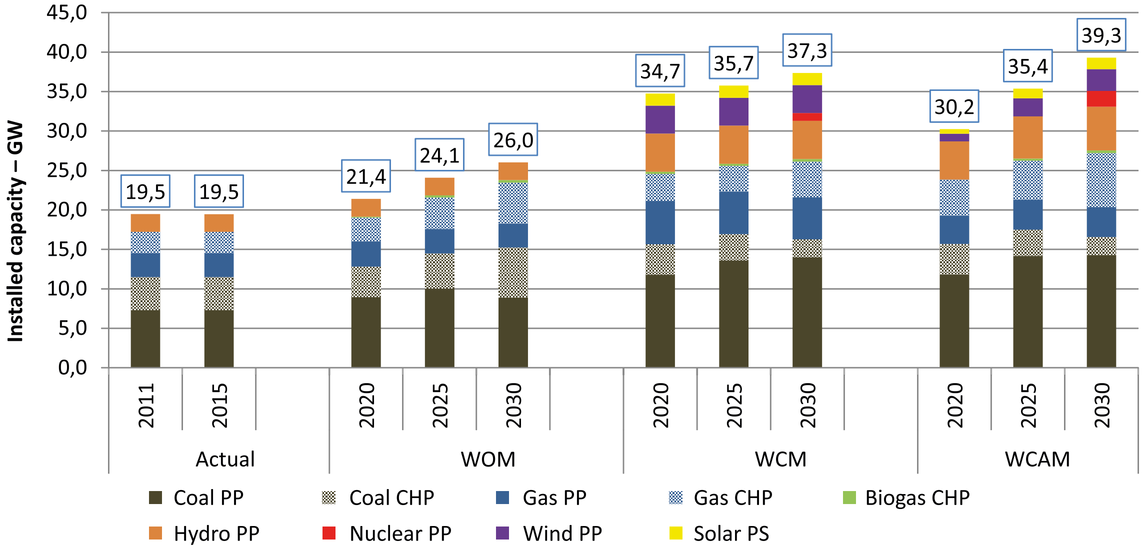
Figure 25. *Generation of electricity by types of power plants*



	Actual		WOM			WCM			WCAM		
	2011	**2015**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**
Coal PP	32.8	35.8	45.9	52.9	47.3	25.9	30.5	25.8	21.3	17.5	0.0
Coal CHP	24.9	24.8	22.7	24.7	33.0	22.7	19.2	12.9	22.7	19.2	12.9
Gas PP	8.0	7.9	8.9	8.5	8.1	12.8	18.1	17.8	7.4	9.3	9.0
Gas CHP	3.1	4.3	4.2	4.0	3.0	8.7	7.6	14.2	12.3	9.9	13.8
Biogas CHP	0.0	0.0	0.0	2.2	2.8	0.0	2.2	2.8	0.0	2.2	2.8
Hydro PP	8.4	8.3	8.2	8.2	8.2	11.6	12.8	12.8	11.6	13.8	14.1
Nuclear PP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	0.0	0.0	15.6
Wind PP	0.0	0.0	0.0	0.0	0.0	2.6	6.5	9.3	2.6	6.0	7.3
Solar PS	0.0	0.0	0.0	0.0	0.0	2.6	2.6	2.6	1.0	2.1	2.5
Total	**77**	**81**	**90**	**101**	**102**	**87**	**100**	**106**	**79**	**80**	**78**

It can be seen that in the scenario with measures, electricity consumption increases by more than 76% compared to 2011. This is due to the increasing consumption of electricity in all sectors in connection with new technologies that consume more electricity. At the same time, with the increase in electricity generation, the installed capacity practically does not increase during the twenties. Moreover, in comparison with the scenario without measures, the capacity structure has more renewable and alternative energy sources, which is characterized by less electricity generation per unit compared to traditional sources.

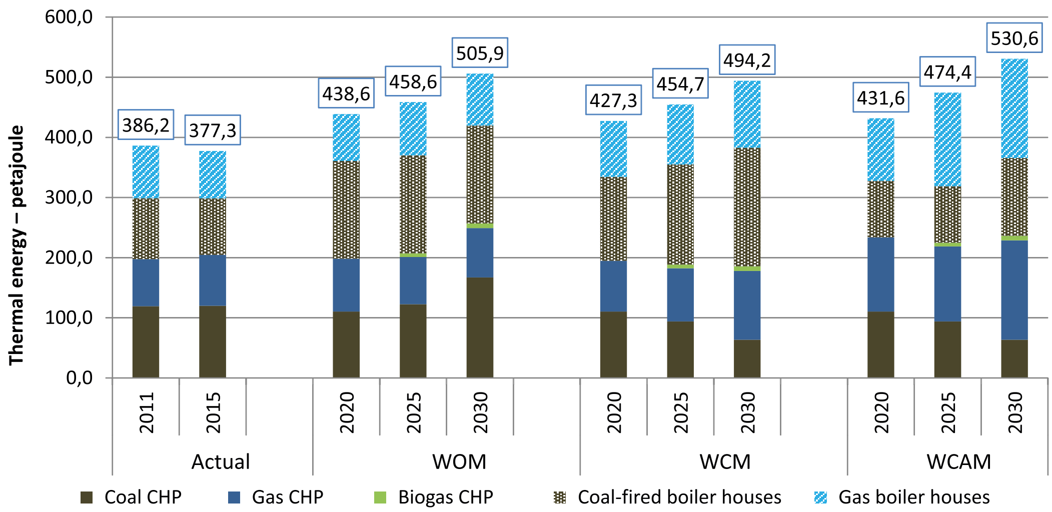
Figure 26. *Installed capacity*



	Actual		WOM			WCM			WCAM		
	2011	2015	2020	2025	2030	2020	2025	2030	2020	2025	2030
Coal PP	7.3	7.3	8.9	10.0	8.9	11.8	13.6	14.0	11.8	14.2	14.3
Coal CHP	4.2	4.2	3.9	4.4	6.3	3.9	3.3	2.3	3.9	3.3	2.3
Gas PP	3.1	3.1	3.2	3.1	3.0	5.5	5.4	5.3	3.6	3.8	3.8
Gas CHP	2.7	2.7	3.0	4.0	5.2	3.4	3.2	4.5	4.6	4.9	6.8
Biogas CHP	0.0	0.0	0.1	0.3	0.3	0.3	0.3	0.3	0.0	0.3	0.3
Hydro PP	2.3	2.3	2.2	2.2	2.2	4.8	4.8	4.8	4.8	5.3	5.5
Nuclear PP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	2.0
Wind PP	0.0	0.0	0.0	0.0	0.0	3.5	3.5	3.5	1.0	2.3	2.8
Solar PS	0.0	0.0	0.0	0.0	0.0	1.5	1.5	1.5	0.6	1.2	1.5
Total	**19.5**	**19.5**	**21.4**	**24.1**	**26.0**	**34.7**	**35.7**	**37.3**	**30.2**	**35.4**	**39.3**

Heat, as a form of energy, has a decisive importance in Kazakhstan. Thermal energy is generated at CHP plants and at boiler houses; however, only the heat generation sector from boilers will be considered here.

Figure 27. *Production of heat, by type of fuel*



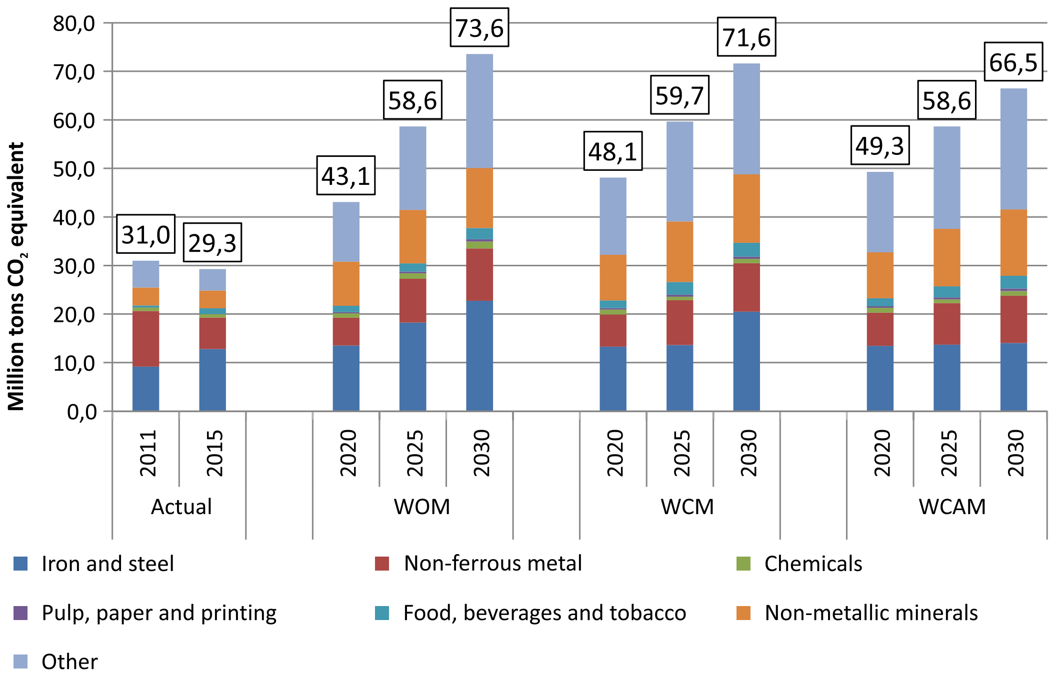
	Actual		WOM			WCM			WCAM		
	2011	2015	2020	2025	2030	2020	2025	2030	2020	2025	2030
Coal CHP	119.2	120.1	110.3	122.5	167.1	110.3	94.0	63.5	110.3	94.0	63.5
Gas CHP	78.5	84.6	87.9	78.7	82.0	84.3	88.3	114.4	123.3	124.6	165.1
Biogas CHP	0.0	0.0	0.0	6.1	7.6	0.0	6.1	7.6	0.0	6.1	7.6
Coal-fired boiler houses	101.2	94.0	162.5	162.8	162.8	139.6	166.4	197.2	94.0	94.0	129.4
Gas boiler houses	87.3	78.7	77.9	88.5	86.3	93.1	99.9	111.4	104.0	155.7	165.0
Total	**386.2**	**377.3**	**438.6**	**458.6**	**505.9**	**427.3**	**454.7**	**494.2**	**431.6**	**474.4**	**530.6**

In all scenarios, GHG emissions increase. In scenarios with measures and with additional measures, thermal energy is mostly produced using natural gas. Thermal energy is mostly produced more at boiler houses, while heat from CHP remains practically unchanged.

5.2.2. Manufacturing

Manufacturing consumes the largest share of final energy in Kazakhstan, about 47% of the total final energy consumption in 2011, with lots of electricity and heat, required for manufacturing activities. The share of GHG emissions from manufacturing is about 9.7% or 28.9 megatons of CO_2-eq. GHG emissions are reduced in manufacturing due to reduction in production volumes, due to changes in technologies and the structure of fuel consumption, where possible. The figure below shows the structure of fuels in the manufacturing sector by scenarios. The graph below illustrates the GHG emissions from the main manufacturing activities in the country.

Figure 28. *Emissions from manufacturing activities, associated with fuel combustion, by scenarios*



	Actual		WOM			WCM			WCAM		
	2011	**2015**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**
Iron and steel	9.2	12.8	13.5	18.3	22.7	13.3	13.6	20.5	13.5	13.7	14.0
Non-ferrous metal	11.5	6.5	5.7	9.0	10.8	6.7	9.2	10.0	6.8	8.6	9.7
Chemicals	0.7	0.7	0.9	1.1	1.4	1.0	0.7	0.9	1.0	0.8	1.0
Pulp, paper and printing	0.0	0.0	0.2	0.3	0.5	0.3	0.4	0.5	0.3	0.4	0.5
Food, beverages and tobacco	0.4	1.1	1.3	1.7	2.3	1.6	2.6	2.9	1.6	2.3	2.7
Non-metallic minerals	3.7	3.7	9.1	11.0	12.3	9.4	12.5	14.1	9.4	11.8	13.6
Other	5.5	4.4	12.3	17.2	23.5	15.9	20.6	22.9	16.6	21.1	25.0
Total	**31.0**	**29.3**	**43.1**	**58.6**	**73.6**	**48.1**	**59.7**	**71.6**	**49.3**	**58.6**	**66.5**

In 2011, big share of GHG emission in manufacturing comes from the ferrous and non-ferrous metals industries, and non-metallic minerals. Chemicals and other industrial sectors have only a small share in 2011. Nevertheless, over time, the structure of GHG emissions by key sectors is changing. Ferrous metallurgy is mainly represented by the production of iron and steel, and most of the emissions come from smelting processes using blast furnaces and the production of sintered iron ore. It can be seen that emissions across all manufacturing sectors are increasing in all scenarios.

According to the energy balance, the production of iron and steel in the initial phase uses heat energy (all types of heat) from industrial CHP. Under the scenario with measures in 2030, according to the technical and economic optimization, thermal power for the production of iron and steel begins to be generated by industrial boilers that use blast furnace gas and high-quality coal, and also uses heat from the COREX process. The main trends that reduce GHG emissions in all scenarios are the transition to the electric arc furnace process, which uses electricity and natural gas, as well as steel scrap processing. However, when the system incurs costs to reduce one ton of CO_2, the economic rationality of this measure is insufficient.

Non-ferrous metallurgy includes production of aluminum, copper and «Other non-ferrous metals», which take into account all other energy consumption according to the energy balance. GHG emissions from aluminum production tend to be reduced due to a wider use of inert anode technology, decreasing use of the Hall–Héroult process and expanded use of aluminium scrap.

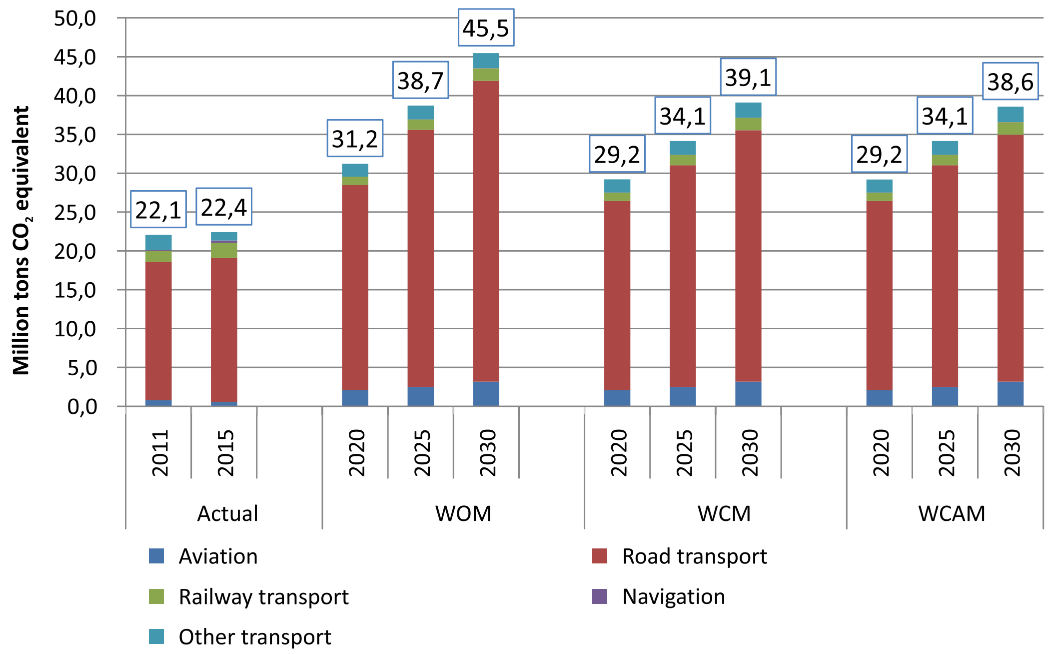
Non-metallic minerals sector includes technologies for the production of concrete, lime and «Other Non-Metallic Minerals», which represent all other types of energy consumption of this economic activity in the energy balance. GHG emissions from concrete production have increasing trends with a different set of energy forms depending on the scenario. In the scenarios GHG emissions from concrete production are mainly caused by the use of coal and in a smaller proportion of natural gas and petroleum products. Most of the GHG emissions from the «Other Non-Metallic Minerals» come from the use of natural gas and petroleum products. A common trend for this sector is the transition to global average energy and materials consumption indicators per unit of production.

GHG emissions from the other manufacturing sectors (Chemicals (ammonia and other chemicals); pulp, printing and paper; food, beverages and tobacco; textiles and leather and other manufacturing sectors) are increasing in all scenarios. GHG emissions from the chemicals using natural gas grow regardless of the scenario with a decrease in the consumption of natural gas and electricity per unit of output. Most of the GHG emissions in the base year are originating from other manufacturing sectors using oil products, and over time, emissions increase with the simultaneous transition of electricity consumption for the production of chemicals.

5.2.3. Transport

The transport sector consumed about 15.2% of the end-use energy demand in 2011. The transport sector has limited reduction potential due to high demand for transportation services. GHG emissions are increasing in all scenarios. The main sources of emissions are automobiles and freight transport.

Figure 29. *GHG emissions from transport*



	Actual		WOM			WCM			WCAM		
	2011	2015	2020	2025	2030	2020	2025	2030	2020	2025	2030
Aviation	0.8	0.5	2.1	2.5	3.2	2.1	2.5	3.2	2.1	2.5	3.2
Road transport	17.8	18.5	26.4	33.1	38.7	24.4	28.6	32.4	24.4	28.6	31.8
Railway transport	1.4	2.0	1.1	1.3	1.6	1.1	1.3	1.6	1.1	1.3	1.6
Navigation	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other transport	2.0	1.1	1.6	1.8	2.0	1.7	1.8	2.0	1.7	1.8	2.0
Total	**22.1**	**22.4**	**31.2**	**38.7**	**45.5**	**29.2**	**34.1**	**39.1**	**29.2**	**34.1**	**38.6**

Emissions in scenarios with measures and additional measures are lower than in the scenario without measures due to the use of more efficient engines that consume less oil products. Hybrid or electric vehicles are not cost effective with current prices, however, technological evolution and support policies, such as electricity subsidies for transport or lower property taxes, can increase their potential to reduce GHG emissions.

5.2.4. Population, service sector and agriculture

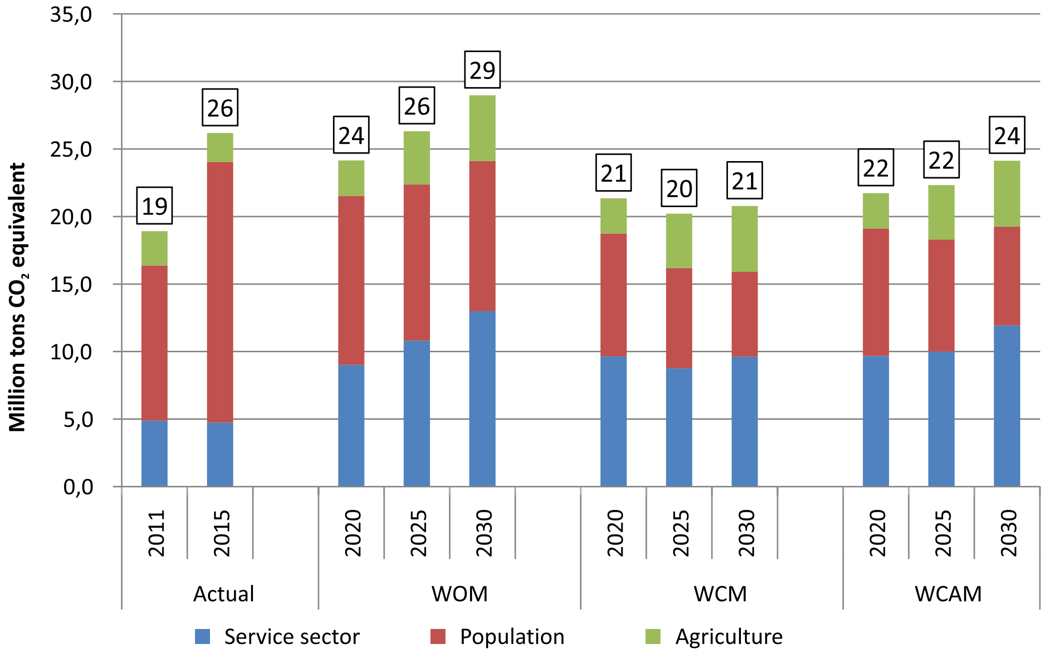
The bulk of GHG emissions in the agriculture is caused by gastric fermentation, livestock waste, rice cultivation and soil treatment, i.e., from processes not associated with fuel combustion. Agriculture consumes less than 3% of the end-use energy demand in 2011 and throughout the simulation period. CO_2 emissions from fuel combustion in the agricultural sector are negligible compared to emissions from other sectors. The average increase in emissions will be about 2% per year for the entire period from 2012 till 2030.

The residential sector consumed about 28% of the end-use energy demand in 2011. The extreme continental climate leads to a very high energy demand for space heating and water heating, while cooling accounts for a minimal proportion of total consumption. The use of coal for household needs (usually heating of premises) is still widespread in the country, with related serious health, environmental and fuel poverty problems for a significant part of the population.

GHG emissions in the residential sector are mainly originated from electric services such as cooking, heating, hot water and others. In all scenarios, GHG emissions tend to decrease.

The figure below shows emissions related to electric services, and it is evident that the main trend in all scenarios is the transition from devices supplying heat and hot water separately to devices that supply them together.

Figure 30. *Emissions from agriculture (combustion), service sector and population, by scenarios*



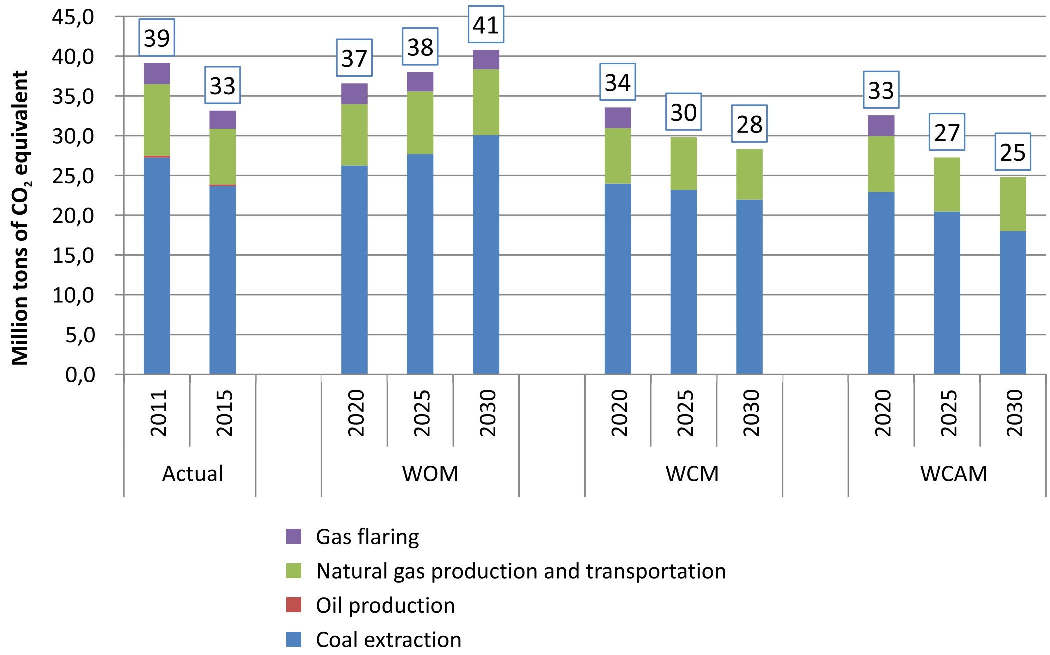
	Actual		WOM			WCM			WCAM		
	2011	**2015**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**
Service sector	4.9	4.7	9.0	10.8	13.0	9.6	8.8	9.6	9.7	10.0	11.9
Population	11.5	19.3	12.5	11.6	11.1	9.1	7.4	6.3	9.5	8.3	7.3
Agriculture	2.5	2.1	2.6	3.9	4.9	2.6	4.0	4.9	2.6	4.0	4.9
Total	**19**	**26**	**24**	**26**	**29**	**21**	**20**	**21**	**22**	**22**	**24**

The services sector consumed about 16% of the end-use energy demand in 2011. Consumption includes energy demand associated with private and public services (for example, restaurants and hotels, shopping centers, hospitals, schools, public buildings, street lighting, and other services). Emissions increase in all scenarios, with an obvious carbon leakage in the scenario with fixed cost of CO2 reduction throughout the economy, while this leakage is mainly caused by petroleum products. The main trend in all scenarios is the transition from devices that supply heat and hot water separately to those devices that supply them together. Combined energy devices that use fossil fuels, or electricity are used more intensively in all scenarios. When no restrictions are set in the field of climate change, heat and hot water supply use thermal power from CHP and/or boiler houses more intensively.

5.2.5. Fugitive emissions

IPCC defines fugitive emission as unintentional or intentional release of greenhouse gases that occurs during the extraction, processing and delivery of fossil fuels to the point of final use. In 2015 total emissions in Kazakhstan, where coal, oil and natural gas are produced, reached 11%. The figure below shows that economy-wide reduction in the use of coal leads to relative fugitive emissions reduction. Thus, fugitive emissions reduction is the effect of policies pursued and measures taken in other coal-using industries.

Figure 31. *Fugitive GHG emissions*



	Actual		WOM			WCM			WCAM		
	2011	**2015**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**
Coal extraction	27.2	23.7	26.2	27.7	30.1	24.0	23.2	22.0	22.9	20.5	18.0
Oil production	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Natural gas production	9.0	7.0	7.7	7.9	8.3	7.0	6.6	6.3	7.0	6.8	6.8
and transportation	2.6	2.3	2.6	2.4	2.4	2.6	0.0	0.0	2.6	0.0	0.0
Gas flaring	**39**	**33**	**37**	**38**	**41**	**34**	**30**	**28**	**33**	**27**	**25**
Total											

5.3. Industrial processes emission projection

Without measures (WOM) scenario

This scenario reflects possible changes in the amount of greenhouse gases when no measures are taken to reduce them, no upgrade is done, and national factors per unit of output remain at the same level. It is assumed that this scenario does not include any measures or policies that have already been implemented in the country in recent years. It is also assumed that production of open-hearth steel continues, ferrosilicon production is not reduced, Kazzinc JSC has not been upgraded, and no measures have been taken to adopt new legislation.

With current measures (WM) scenario

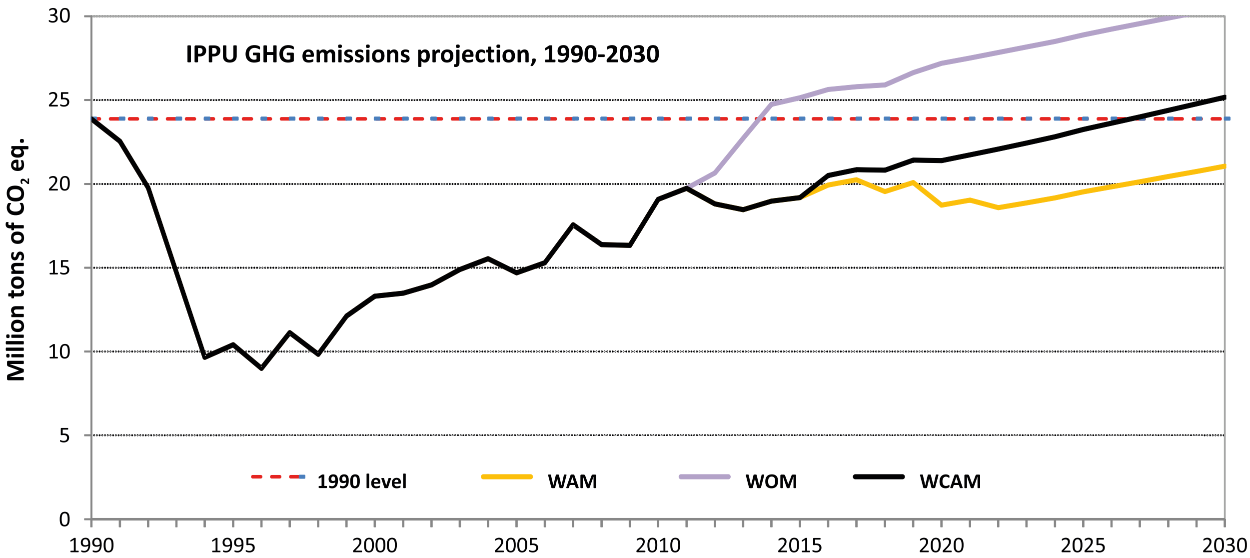
This scenario differs from the scenario without measures as it takes into account the measures and policies for greenhouse gas emission reduction that have been taken or are planned to be adopted in the near future. These measures include adoption of the Law "On energy saving and energy efficiency" (requirement to undergo energy audits) and the Law "On administrative offences" that stipulates a fine for GHG emissions in excess of the defined amount, the Concept of innovative development of the Republic Kazakhstan until 2020, Modernization of ArcelorMittal Temirtau JSC, reduction in ferrosilicon production, modernization of Kazzinc JSC, adoption of SPIID for 2015-2019, processes implemented to increase energy efficiency, and transition to a more energy-efficient and low-carbon industrial production.

With additional measures (WAM) scenario

This scenario takes into account current policies and measures and assumes potential additional measures. It is expected that additional measures will be launched in 2017. The following additional measures are considered: phased introduction of plants to capture and store CO2 in mineral materials production, process optimization in the chemical industry, modernization and optimization of cast iron production up to European standards. A hybrid ETS will be applied starting from 2018. It is envisaged that the price of efforts to reduce 1 ton of CO2 from 2020 will be formed and this price was included in scenario. Transition to more energy-efficient and low-carbon technologies is planned in metal industry.

Updated GHG projections in scenarios without measures (WOM), with current measures (WM) and with additional measures (WAM) are shown in the figure below. In WM emissions grow in the years of projection. According to the projection IPPU sector will reach GHG emission baseline (1990) in 2027. If additional measures are taken there is a chance to remain below the baseline by 11.8% in 2030.

Figure 32. *Scenario analysis: actual IPPU emissions and projection for 1990-2030*



Timely measures have significantly reduced GHG emissions in metal and chemical industries. No data on emissions of fluorinated substitutes for ozone depleting substances (ODSs) are available for 1990. Figure 32 shows that in the scenario without measures emissions would have surpassed the 1990 level back in 2013.

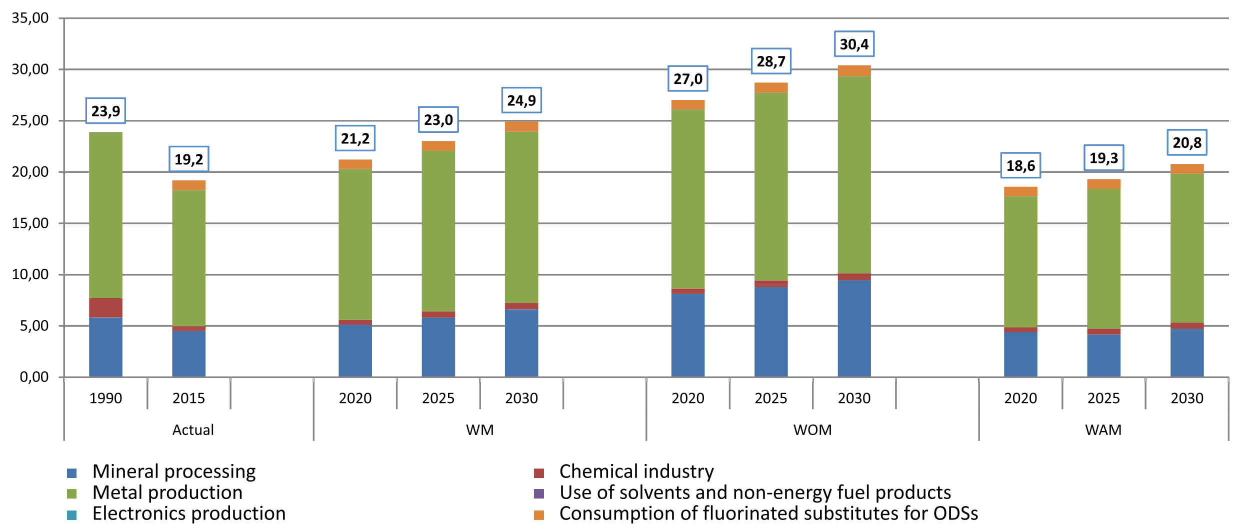
Assessments of response actions effect (Table 3 CTF format) prove that policies implemented and measures taken by the Republic of Kazakhstan have significantly reduced GHG emissions of this category. In WAM scenario GHG emissions will reach 1990 baseline neither in 2020 nor in 2030. The table below contains emission projections for industry/industrial processes sector across scenarios.

Table 43. *Industry/industrial processes sector across scenarios (short version), million tons of CO_2 eq.*

	Actual			WCM			WOM			WAM		
	1990	2010	2015	2020	2025	2030	2020	2025	2030	2020	2025	2030
Industry/industrial processes	23.89	19.07	19.18	21.21	23.03	24.91	27.02	28.73	30.40	17.63	18.35	19.82
Mineral processing	5.84	3.61	4.51	5.11	5.81	6.61	8.13	8.78	9.47	4.39	4.16	4.72
Chemical industry	1.86	0.30	0.46	0.50	0.62	0.64	0.53	0.66	0.67	0.47	0.59	0.60
Metal production	16.18	14.20	13.27	14.67	15.64	16.68	17.43	18.29	19.19	12.77	13.61	14.50
Use of solvents and non-energy fuel products	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.02
Electronics production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumption of fluorinated substitutes for ODSs	0.00	0.96	0.94	0.92	0.94	0.97	0.92	0.99	1.06	0.92	0.94	0.97

The figure below shows the results of the scenarios comparative analysis: IPPU actual emissions and emission projections for 1990-2030 in three scenarios. Without any measures emissions would amount to 30.4 million tons of CO_2 equivalent by 2030. If additional measures are taken there is a chance to remain below the baseline by 3.1 million tons of CO_2 (11.8%).

Figure 33. *Scenarios comparative analysis: IPPU actual emissions and emission projections for 1990-2030, million tons of CO_2 equivalent.*



Further industrialization of the country's economy is envisaged in the State Program for Industrial and Innovative Development of the Republic of Kazakhstan for 2015-2019 focusing on processing industry development in certain priority sectors with due regard to local peculiarities. 2016 was marked by the growth in production of refined lead[196] – by 12%, gold – by 17% (Kazzink LLP), copper ore, gold and alumina – by 3.6% (Kazakhstan Aluminum JSC), steel production – by 11% and flat rolled product – by 16% (ArcelorMittal Temirtau JSC), ferroalloys – by 270% (Taraz Metallurgic Plant JSC). Oil refinery volumes in Atyrau oblast grew by 2.6%. Unique direct current furnaces were put into operation at the Aktobe Ferroalloy Plant having increased ferrochromium production twofold. AFP plans to reach capacity production of 440,000 tons of ferrochromium per year by the end of 2018. These trends were taken into account when the GHG emissions projection model was developed.

Glass production projections were taken into account in Almaty oblast, but were decreased in Kyzylorda oblast where construction of a glass manufacturing plant was suspended due to breach of legislation in the course of construction activities.

[196] www.kidi.kz

5.4. Agriculture and LULUCF emission projection

GHG emission simulation activity for agriculture and LULUCF sectors was provisionally divided into 3 parts:

- part 1 was building the forestry GHG emission model;
- part 2 focused on pastures and farmlands;
- part 3 made projections for agriculture.

Three GHG emission scenarios were developed on the basis of policies and actions taken to reduce GHG emissions in the sector: without measures, with current measures and with additional measures, for the period from 2015 through 2030.

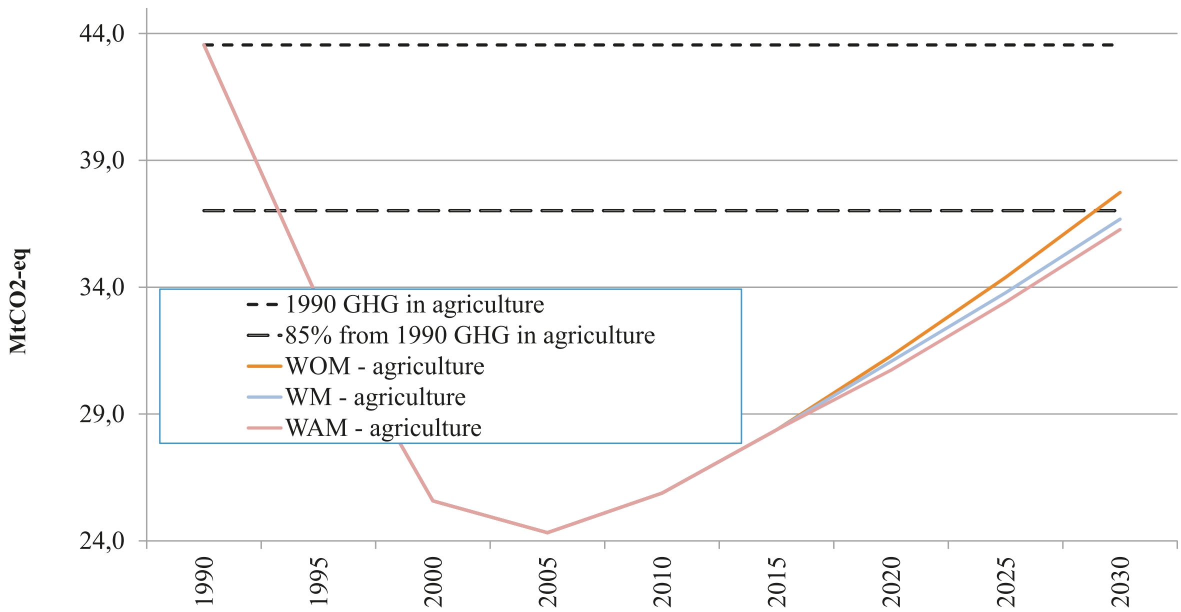
The assumption of annual GDP growth by 3% until 2030 was common for all scenarios. The assumption was based on revised expectations of the RK Government concerning GDP growth in the next 5 years.

The table below shows the forecast of GHG emissions from the agricultural sector.

Table. 43-1. *Projections of GHG emission trends from the agriculture sector, million tons of CO_2 equivalent*

	1990	1995	2000	2005	2010	2015	2020	2025	2030
1990 – Emissions from agriculture sector	43,6	43,6	43,6	43,6	43,6	43,6	43,6	43,6	43,6
85% from emissions from agriculture sector	37,0	37,0	37,0	37,0	37,0	37,0	37,0	37,0	37,0
WOM – agriculture sector	43,6	33,5	25,6	24,3	25,9	28,4	31,3	34,4	37,7
WM – agriculture sector	43,6	33,5	25,6	24,3	25,9	28,4	31,1	33,8	36,7
WAM – agriculture sector	43,6	33,5	25,6	24,3	25,9	28,4	30,7	33,4	36,3

As the table shows, the potential for reducing emissions from agriculture in 2030 – about 1.4 million tons of CO_2 equivalent.



Revised forestry projections for 2020-2030

Forestry GHG emission projections were modeled with the use of CBM-CSF3 (Carbon Budget Model of the Canadian Forest Sector) software. The model simulates the effect of various policies and measures on GHG dynamics in forestry sector in compliance with UNFCCC guidelines. It was designed to model emissions from the forestry sector of Canada but can be used for other countries too. The model is used for development of national communications in Canada, Russia and other countries.

In general the forestry sector can be both the absorber and the emitter of greenhouse gases depending on various parameters like forest age, fires, felling, young stand, afforestation, etc. This analysis is based on assumed changes in fire areas, volumes of felling and young stand within the scope of adopted and potential policies and measures aimed at GHG emission reduction in forestry. Changes of these parameters are introduced in CBM-CFS3 model as disturbances enabling projection of forestry carbon dynamics.

CBM-CFS3 input data are principal wood species, areas they occupy, growth models and the planting average age. The source of growth models of wood species and soil types is Shvidenko et al.[197] (2006). The rest of the data were provided by the Forestry and Fauna Committee of the RK Ministry of Agriculture. The CBM-CFS3 model also considers local climate. Average annual temperature data were adjusted in accordance with Salnikov et al.[198] (2015).

In 2015 Kazakhstan forest area amounted to about 19 million hectares. Shrubbery and protective plantings covered about 10 million hectares while only 3.3 million hectares were occupied by principal wood species: coniferous, soft-wooded and hard-wooded broadleaved species. As a matter of interest, the latter figure correlates with the satellite data, according to which Kazakhstan woodlands cover 1.24% of the total country area or 3.48 million hectares. The rest of the 19 million hectares is the area not covered by woods, which still refers to forestry. CBM-CFS3 does not account for carbon dynamics in shrubbery and saxaul, but their contribution to the cumulative forestry absorption is insignificant. Nine wood species analyzed in the model cover 2.969 million hectares and represent 90% of principal wood species. Other species were not included in the model because of their great number and insignificant coverage that would only complicate analysis. An adjustment factor is used to compensate for the remaining 10% of the principal wood species area.

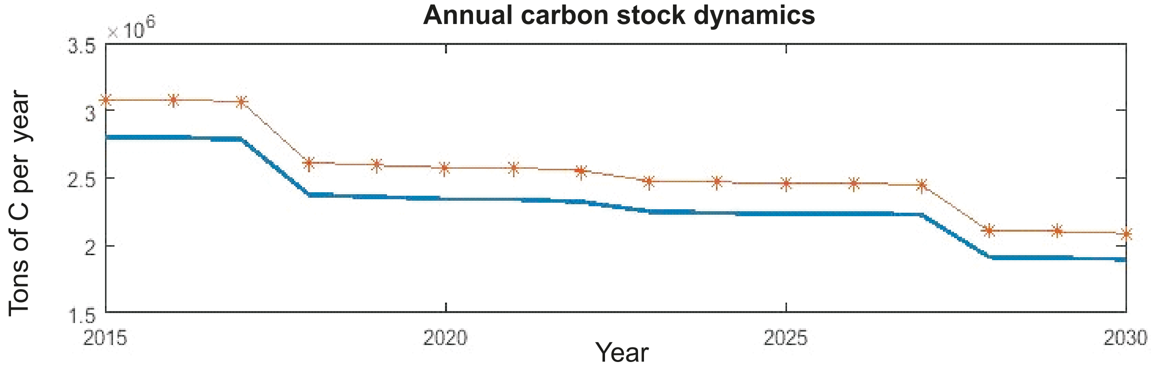
Comparison of model calculation results with the latest emission data in 2015 inventory required model simulation with given parameters without disturbances (fires, felling, young stand, etc.) for the period from 2015 through 2030.

The model showed that the total forest biomass increased by 2,803,888 tons of carbon (C) in 2015 (inventory year), while according to the inventory report forests accumulated 3,029,000 tons of carbon in the same year. The difference of around 120,000 tons appeared because the model accounted for around 90% of principal wood species area only, while the shrubbery and saxaul dynamics was omitted. If the additional 10% of forest are taken into account the inventory data and the model data are almost the same. A 1.08 adjustment factor (AF) was used to compensate for the omission of 10% of forest. With the adjustment factor 98% of principal species are taken into account and maximum conformity between calculations and the inventory is achieved. The figure below shows annual Kazakhstan forest biomass increase dynamics according to CBM-CFS3, with and without AF.

[197] A. Shvidenko, D. Schepaschenko, S. Nilsson, Y. Bouloui, 2006. Productivity and growth models and tables of the principal forest-forming species in Northern Eurasia.

[198] Salnikov, V., Turulina, G., Polyakova, S., Petrova, Y. and Skakova, A., 2015. Climate change in Kazakhstan during the past 70 years. Quaternary International, 358, pp.77-82.

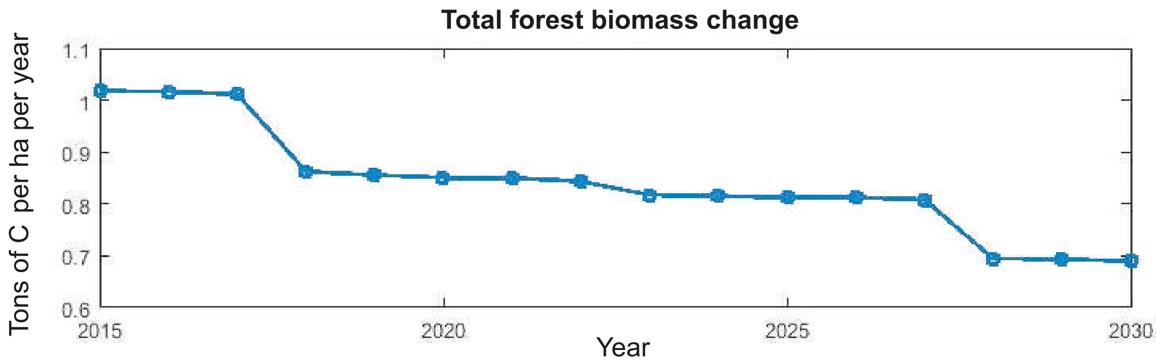
Figure 34. *Annual Kazakhstan forest biomass dynamics. Blue line – without adjustment factor; red line – with adjustment factor*



From now on all simulation results will include the adjustment factor used by default.

The figure above shows gradual decline of GHG absorption by forests even without disturbance from 3 million tons to around 2 million tons of carbon per year.

Figure 35. *Forest biomass growth in tons of C per hectare per year*



The figure above shows that in the first three years each hectare of coniferous, soft-wooded or hard-wooded trees absorbs the average of 1 ton of carbon per year that is equivalent to 3.67 tons of CO2 per year per hectare subject to lack of disturbances. However, later this parameter sharply drops to 0.7 tons of carbon per year per forest hectare. This can be explained by forest aging casing decrease in carbon dioxide absorption.

For analysis simplification the following assumptions were made for all scenarios in forestry sector:

1) Fires apply to 4 principal wood species accounting for 80% of all principal wood species. Pine and birch families account for 33% of fire area, fir and aspen – 16.5% respectively.

2) Wood fellings apply to 3 species covering around 70% of principal wood species area. Of 100% hectares of wood fellings 40% account for pine and birch each, and 20% – for fir.

3) According to official statistics wood fellings spread over some 50 thousand hectares per year. Across oblasts more fellings are registered in southern regions of Kazakhstan where saxaul is cut. That is why scenarios are based on the assumption that average principal species felling area is 10 thousand hectares per year. GHG emitted in the process of saxaul and shrubbery cutting is deemed insignificant against principal wood species felling and is disregarded in this report.

Forestry. Without measures scenario

The forestry sector is extremely sensitive to volume of financing. It is clearly explained on the example of vast fire areas in 1990s. That is why the scenario without measures assumes the fire will spread over 10 thousand hectares every year. Besides, if no measures are taken, the constant felling volume will be 10 thousand hectares (including sanitary felling), and the young stand will continuously cover 20 thousand hectares per year. The table below summarizes assumptions in the scenario without measures.

Table 44. *WOM assumptions*

	2020	2025	2030
Young stand, thous. ha	20	20	20
Fire area, thous. ha	10	10	10
Felling area, thous. ha	20	20	20

The data above were introduced in CBM-CSF3 as disturbances.

Forestry. With current measures projection

WCM is based on assumption that the government will continue implementation of the sector financing programs like the earlier adopted strategic plan of the Ministry of Environment and Water Resources of the Republic of Kazakhstan, Astana green belt plans, and Zhasyl Yel. That is why the WCM projection is made with due regard to young plantings of valuable stand in forests of state significance over the area of up to 30 thousand hectares per year until 2030.

It is also assumed that due to increased financing fire-fighting activity will be as efficient as in recent years. In particular, it is assumed that the fire area will be equal to average annual fire area in 2011-2015 (5 years) of 2.8 thousand hectares per year, while felling will be kept on the level of 10 thousand hectares until 2030.

Table 45. *WCM assumptions*

	2020	2025	2030
Young stand, thous. ha	20	25	30
Fire area, thous. ha	2,8	2,8	2,8
Felling area, thous. ha	20	15	10

Forestry. With additional measures projection

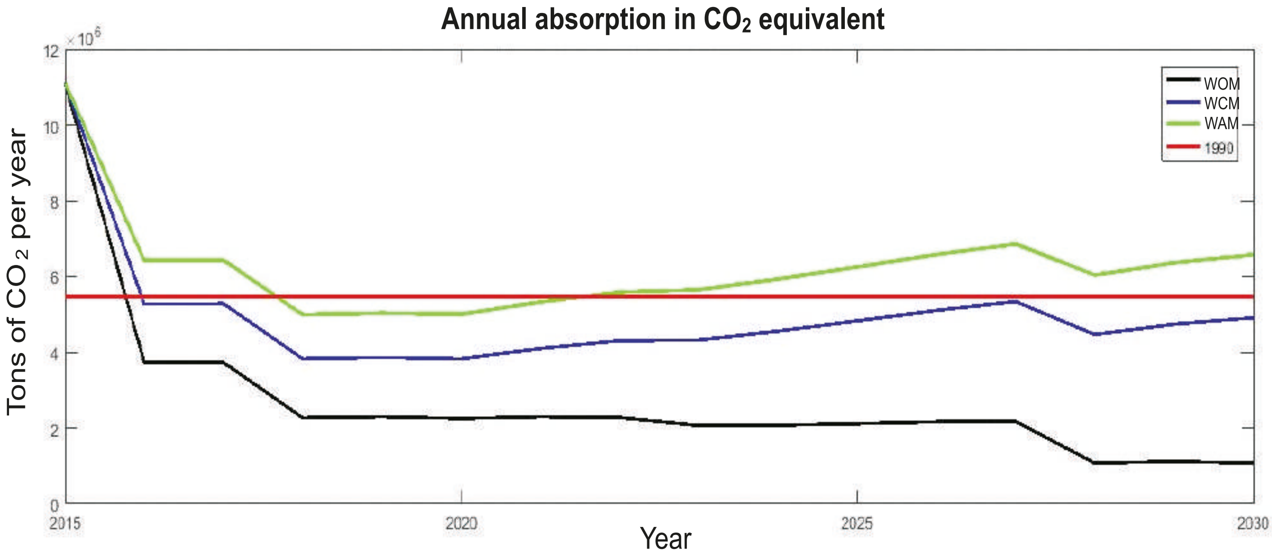
WAM projection provides for fire occurrence decrease to the level of 1990. Fellings are assumed to reduce after bans are imposed, national park areas are expanded and other measures are taken. In the long term with large stands of birch and pine forest can be expected to increase the carbon sink. WAM implies full restoration of forest after fires, fellings, and insect invasions.

Table 46. *WAM assumptions*

	2020	2025	2030
Young stand, thous. ha	20	30	35
Fire area, thous. ha	2,8	2,1	1,25
Felling area, thous. ha	15	10	5

These scenarios were introduced in CBM-CFS3 as disturbances. The simulation outcome is shown in the figure below.

Figure 36. *CO_2 absorption by forestry sector: WOM – without measures, WCM – with current measures, WAM – with additional measures, 1990 – the level of 1990*



The figure above shows that Kazakhstan forests are a sink (absorber) of greenhouse gases.

Despite the fact that Kazakhstan forests are a sink the overall trend is decrease in GHG absorption due to forest aging. As further potential measures the forestry sector may require effort aimed at forest aging prevention and maintaining fast biomass buildup. This may require felling of mature and overmature trees to be replaced with young stand. At the same time cut trees must not be used as firewood, but can serve as a raw material for wood products (furniture, wood boards, etc.).

Another potential measure is application of international financial and compensation mechanisms for afforestation of new areas. According to the model each hectare of principal wood species in Kazakhstan can accumulate around 3.67 tons of CO_2 per year. Therefore, these scenarios can be considered deep decarbonization scenarios.

Updated 2020 and 2030 projections for LULUCF without forestry

This chapter contains greenhouse gas emissions projections for LULUCF without account for forestry sector. The primary emitter in this sector is the “Farmlands” sub-sector. Other sub-sectors show insignificant changes.

The following assumptions were made for this sector.

Land use sub-sectors “Settlements”, “Pastures and haylands”, “Wetlands”, “Reservoirs”, and “Other agricultural lands” will absorb fixed average GHG amount derived from the past 5 years – 10,536 thousand tons of CO_2 equivalent.

Thus, without forestry the LULUCF sector leaves us with the “Farmlands” sub-sector.

In the scenario without measures developed for “Farmlands” it is assumed that humus loss rate and the recovery rate of lands withdrawn from cultivation (fallow) will remain unchanged throughout the projection period. In the scenario without measures cumulative emissions in LULUCF sectors without forestry (settlements, pastures and haylands, etc.) are fixed in the amount of 25,121 thousand tons of CO_2 equivalent.

Scenario with current measures makes the following assumptions for “Farmlands”. Lands withdrawn from cultivation to pasture will complete crop rotation to fallow by 2030. Thus, fallow land area doubles. At the same time it is assumed that fallow fully recovers from humus loss resulting from the land cultivation. This assumption is based on the fact that average cropland yield is 1-1.5 tons per hectare. Upon land withdrawal from cultivation the natural biomass buildup remains in soil causing reduction in soil carbon content. Biomass buildup in fallow lands will grow as fallow lands expand (from pastures) to compensate for humus loss resulting from the land cultivation.

Emissions projection for LULUCF without forestry, with current measures, follows.

The table below shows the projected greenhouse gas emissions from the LULUCF sector.

Table 46-1. *Forecast of GHG from the LULUCF sector, million tonnes of CO_2 equivalent*

	1990	1995	2000	2005	2010	2015	2020	2025	2030
WOM - LULUCF	-16,2	0,2	9,9	-13,0	-2,5	14,0	22,9	23,0	24,1
WM - LULUCF	-16,2	0,2	9,9	-13,0	-2,5	14,0	17,7	6,3	-4,2
WAM - LULUCF	-16,2	0,2	9,9	-13,0	-2,5	14,0	10,9	-3,5	-17,0

Table 47. *Emissions from "Farmlands" sub-sector, scenario with current measures*

	2015	2020	2025	2030
Fallow lands, thousand ha	4798	5672	8172	10672
Lands withdrawn from agriculture to pasture, thousand ha	5874	5000	2500	0
Emissions from fallow lands, kilotons of CO_2 eq.	-19961	-23597	-33995	-44395
Croplands, thousand ha	21399	21399	21399	21399
Emissions from croplands, kilotons of CO_2 eq.	55618	55618	55618	55618
Emissions from other LULUCF sub-sectors ex. forestry, kilotons of CO_2 eq.	-10536	-10536	-10536	-10536
Cumulative emissions from LULUCF ex. forestry, kilotons of CO_2 eq.	25121	21485	11087	687

The scenario with additional measures assumes gradual rotation of non-perennial crops over up to 20% of croplands area by 2030, i.e. croplands will be seeded with various crops to additionally reduce humus loss by 20%.

Table 48. *Emissions from "Farmlands" sub-sector, scenario with additional measures*

	2015	2020	2025	2030
Fallow lands, thousand ha	4798	5672	8172	10672
Lands withdrawn from agriculture to pasture, thousand ha	5874	5000	2500	0
Emissions from fallow lands, kilotons of CO_2 eq.	-19961	-23597	-33995	-44395
Croplands, thousand ha	21399	21399	21399	21399
Crop rotation	0%	10%	15%	20%
Emissions from croplands, kilotons of CO_2 eq.	55618	50057	47275	44494
Emissions from other LULUCF sub-sectors ex. forestry, kilotons of CO_2 eq.	-10536	-10536	-10536	-10536
Cumulative emissions from LULUCF ex. forestry, kilotons of CO_2 eq.	25121	15924	2744	-10437

When LULUCF sector projections are made, LULUCF without forestry results are to be added to forestry emission scenarios without measures, with current measures and with additional measures.

Updated 2020 and 2030 projections for agriculture

GHG projections for the sector of agriculture are based on cattle and small ruminant dynamics. Government programs like Agribusiness-2020 and the State Program for the Development of Agroindustrial Sector in the Republic of Kazakhstan for 2017-2021 contribute to increase in livestock numbers at organized farms. Therefore emissions were projected on the basis of headcount and its dynamics. Livestock and poultry population dynamics was analyzed for 10 years from 2005 to 2015. It is assumed that livestock and poultry population growth rate will be the same as in 2005-2015: cows +1.8%, non-dairy cattle +0.5%, sheep +0.3%, goats – without changes, swine -5%, camels +2%, poultry +1%, horses +4% per year.

Table 49. *Livestock and poultry projection*

Annual average livestock and poultry, thousand heads	2015	2020	2025	2030
Cattle	6183	6546	6908	7271
Dairy cattle	2999	3277	3554	3832
Non-dairy cattle	3184	3 269	3354	3439
Sheep and goats	18015	19855	21695	23535
Camels	170.5	190.5	210.5	230
Horses	2070	2523	2976	3429
Swine	887	690	493	296
Poultry	35627	40335	45043	49751

Emission projections for various agriculture sub-sectors follow. Reduction in emissions is assumed in scenarios with current measures and with additional measures due to the use of biogas facilities in agriculture.

Without measures scenario

In the scenario without measures emission projections in the following three tables are based on changes in livestock and poultry population.

Table 50. *CH_4 emissions from manure management system*

CH_4 emissions from manure management system, kilotons	2015	2020	2025	2030
Dairy cattle	13,86	15,14	16,42	17,70
Non-dairy cattle	3,71	3,80	3,90	4,01
Sheep and goats	2,12	2,33	2,55	2,76
Camels	0,22	0,24	0,27	0,29
Horses	2,26	2,75	3,24	3,74
Swine	4,44	3,45	2,47	1,48
Poultry	0,36	0,41	0,45	0,50
Total	**26,97**	**28,15**	**29,32**	**30,51**
Methane emissions, kilotons of CO_2 equivalent	674,2	703,8	733,2	762,8

Table 51. *Direct emissions of N_2O from manure management system*

	2015	2020	2025	2030
Direct emissions of N2O from manure management systems, kilotons	6,26	6.60	6.92	7.25
N_2O emissions, kilotons of CO_2 equivalent	1856	1967	2062	2160

Table 52. *CH_4 emissions as a result of enteric fermentation*

CH_4 emissions as a result of enteric fermentation, kilotons	2015	2020	2025	2030
Dairy cattle	306,05	334,42	362,69	391,06
Non-dairy cattle	196,23	201,47	206,70	211,94
Sheep and goats	134,01	147,69	161,38	175,07
Camels	7,84	8,76	9,68	10,57
Horses	37,26	45,41	53,56	61,72
Swine	1,11	0,86	0,62	0,37
Total	**682,50**	**738,61**	**794,64**	**850,74**
Methane emissions, kilotons of CO_2 equivalent	17062	18465,25	19866	21268,75

Projections of nitrogen compounds emissions from croplands and pastures

The projection of emissions from croplands and pastures is based on assumption that the amount of fertilizers added to soils will grow proportionally with GDP, i.e. by 3% per year.

Table 53. *Nitrous oxide emissions from croplands and pastures*

	2015	2020	2025	2030
Direct N_2O emissions from croplands and pastures, kilotons	28.2	32.69	37.89	43.9
N2O emissions, kilotons of CO_2 equivalent	8403	9741	11291	13082

Table 54. *Methane emissions from rice cultivation*

	2015	2020	2025	2030
Methane emissions from rice cultivation, kilotons	15.44	16.45	17.46	18.47
Methane emissions, kilotons of CO_2 equivalent	386	411.25	436.5	460.25

With current measures scenario

At present 3 major biogas facilities are operated in Kazakhstan:

1) Lugovskoye Stud Farm in Zhambyl oblast processes wastes of pig breeding complex and generates 1.93 million m^3 of biogas per year.
2) Karaman-K LLP processes cattle wastes to generate 800 thousand m^3 of biogas per year.
3) Bagration Peasant Holding generates around 146 thousand m^3 of biogas per year from cattle waste.

In 2017, in the course of SPAIID implementation it is planned to commission biogas units at Bishkul (North Kazakhstan oblast) and Kurminskoye (Karaganda oblast) poultry farms, 1MW each. Each of these biogas units is expected to generate around 4.38 million m^3 of gas per year.

The scenario with current measures suggests a growing number of biogas facilities at farms. In addition to reduction in CH4 emissions cumulative emissions are expected to go down as a result of more rational use of fuel for heat and power generation. The assumptions made in the scenario are listed below.

WCM assumptions:

1) Livestock coverage with biogas facilities will reach 1% in 2020, 3% in 2025 and 5% in 2030.
2) Amount of manure per one cow/bull is 10 tons per year, one horse – 7 tons per year, sheep and goats – 1 ton per year, poultry – 0.1 tons per year.

3) Gas production is assumed to reach 50 m^3 per ton of cow, horse, sheep and goat manure, 70 m^3 per ton of poultry manure.

4) Reduction in CO_2 emissions from heat and electricity generation without coal is 2 kg of CO_2 eq. per m^3 of biogas.

5) Reduction in CH_4 emissions is 26 kg of CO_2 eq./ton or 1.2 kg of CO_2 eq./m^3.

6) Biogas facilities do not affect the level of N_2O emissions.

Table 55. *Emission reduction due to the use of biogas facilities*

	2015	2020	2025	2030
Cattle stock, thousand heads	6183	6546	6908	7271
Horses stock, thousand heads	2070	2 523	2976	3429
Sheep and goats stock, thousand heads	18015	19855	21695	23535
Poultry stock, thousand heads	35627	40335	45043	49751
Percentage of livestock and poultry population covered by biogas facilities	-	1%	3%	5%
Total manure utilized, million tons/year	-	1.07	3.48	6.26
Biogas production, million m^3/year	0	54.31	176.87	318.04
Biogas production with existing biogas facilities, million m^3/year	2.876	11.63	11.63	11.63
CO_2 reduction as a result of optimized heat and power generation (tons of CO_2/year)	5752	131880	377000	659340
CH_4 reduction in CO_2 eq. (tons of CO_2/year)	3451	79128	226200	395604
Cumulative reduction, tons of CO_2 eq./year	9206	211008	603200	1054940

Methane burning reduces greenhouse gas emissions in CO_2 equivalent, since 1 kilogram of methane accounts for 20 kilograms of CO_2. On the other hand, the use of gas for heat and power generation instead of coal also reduces cumulative emissions. Reduction in CO_2 emissions as a result of decrease in methane emissions and optimized use of gas for heating and power supply was estimated in Jorgensen (2009).[199]

The effect of CO_2 emissions reduction due to optimization of heat and power generation is subject to deduction from the fuel combustion sector too.

In this scenario, cumulative emissions in the agricultural sector will equal emissions in the scenario without measures minus CH_4 reduction in CO_2 equivalent in the scenario with current measures (see table below).

Table 56. *Cumulative emissions in the scenario with current measures in the agricultural sector with due regard to biogas facilities*

	2015	2020	2025	2030
Cumulative emissions of CO_2, kilotons	28381	31077	33786	36679

With additional measures scenario

Scenario with additional measures assumes that farms coverage with biogas facilities will increase up to 3% by 2020, 5% by 2025 and 7% by 2030.

199 Jørgensen, Peter Jacob. Biogas-Green Energy: Process, Design, Energy Supply, Environment. Researcher for a Day, 2009

Table 57. *Emission reduction due to the use of biogas facilities*

	2015	2020	2025	2030
Cattle stock, thousand heads	6183	6546	6908	7271
Horses stock, thousand heads	2070	2 523	2976	3429
Sheep and goats stock, thousand heads	18015	19855	21695	23535
Poultry stock, thousand heads	35627	40335	45043	49751
Percentage of livestock and poultry population covered by biogas facilities	-	3%	5%	7%
Total manure utilized, million tons/year	-	3.21	5.81	8.76
Biogas production, million m^3/year	0	162.9	294.8	445.25
Biogas production with existing biogas facilities, million m^3/year	2.876	11.63	11.63	11.63
CO_2 reduction as a result of optimized heat and power generation (tons of CO_2/year)	5752	349060	612860	913760
CH_4 reduction in CO_2 eq. (tons of CO_2/year)	3451	209436	367716	548256
Cumulative reduction, tons of CO_2 eq./year	9206	558496	980576	1462016

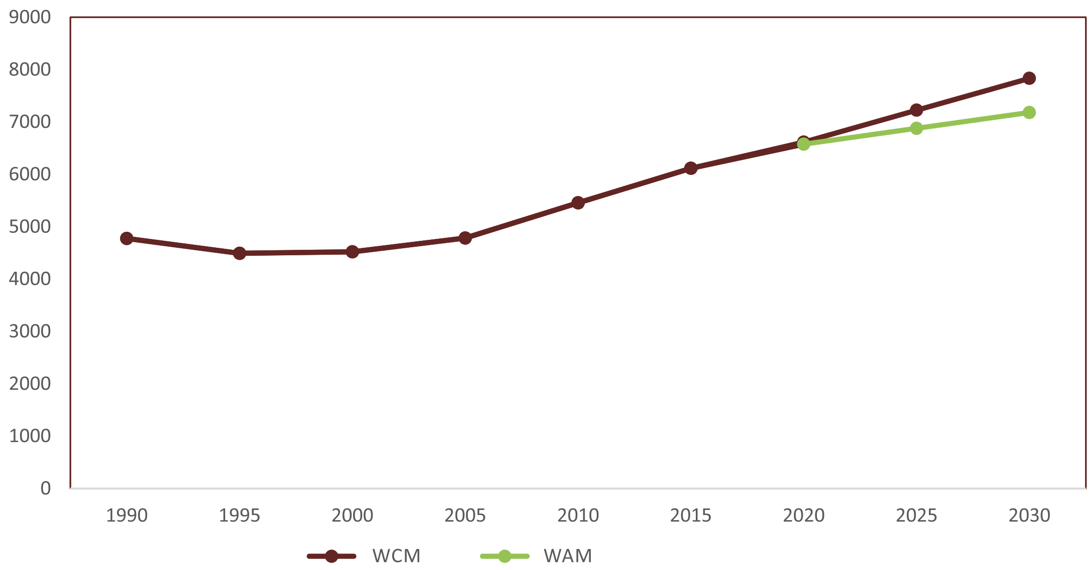
In this scenario, cumulative emissions in the agricultural sector will equal emissions in the scenario without measures minus CH_4 reduction in CO_2 equivalent in the scenario with additional measures (see table below).

Table 58. *Cumulative emissions in the scenario with additional measures in the agricultural sector with due regard to biogas facilities*

	2015	2020	2025	2030
Total emission, thousand tons	28381	30730	33408	36272

5.5. Projections in waste management sector

Figure 37. *Projection of greenhouse gas emissions in waste management sector, kilotons of CO_2 equivalent*



Projected emission in the scenario with current measures amounts to 7.8 million tons of CO_2 equivalent. If additional measures are taken – 7.2 million tons of CO_2 equivalent that is 0.6 million tons less. This effect can be ensured through implementation of waste management policies and measures listed in Table 3 CTF format.

5.6. Projection methodology

Projection methodology for fuel combustion and fugitive emissions

TIMES-KZ model used in this study estimated mid-term scenarios (up to 2030). The model is built around 1,600 products and processes. The annual amounts of electricity and heat are distributed by seasons and time of day into a total of nine time intervals. TIMES-KZ technical and economic model largely depends on a combination of industrial facilities, plants, infrastructure, demand for devices that existed in the country in the base year (2011) and on technological improvement that can possibly be achieved in the simulated time horizon. The supply and demand curves for most commodities in the model are technologically precise: instead of the usual econometric profile of quantitative pricing functions depending on certain elasticity, there are linear stepwise functions where each step corresponds to a specific technology or demand for a product.

TIMES-KZ shows demand for 33 different energy services. The demand was projected until 2030, and it varies depending on the population size, GDP and GDP per capita as well as other demand drivers.

Simulation results depend largely on the available and presupposed base year data. Total emissions associated with fuel combustion calculated for 2011 with application of national emission factors to the new edited energy balance are slightly different from the total emissions listed in the national inventory. Since TIMES-KZ is based on the edited energy balance, in some cases the model projections start with values of 2011 that differ from the national inventory. Amounts in the latest emission inventory are higher than previously estimated emissions published on the UNFCCC website.

Energy balance used in the model was arranged according to the IEA format and updated against data provided by relevant agencies and ministries. This enabled reallocation of energy resources from the "Other" category to other sectors. That is why estimations of emissions vary from sector to sector.

Projection methodology for industrial process emissions

Greenhouse gas emissions from the industrial processes sector were projected on the basis of historical data analysis of projection of the RK Ministry of Economy. Production growth rate is assumed to be the same in 2021-2030. The source of population growth projections is the report issued by the institute of economic research "Republic of Kazakhstan population projections up to 2020". Use of solvents and non-energy fuel products, fluorinated substitutes for ODSs, HFCs and PFCs was estimated with the use of average data per 1,000 people. The latest 2017 inventory was subject to thorough analysis.

Three greenhouse gas emissions scenarios were developed for evaluation of measures and policy in general.

All scenarios provide for moderate GVA growth after 2020.

The following scenarios were analyzed:

1) scenario without measures (WOM);
2) scenario with current measures (WCM);
3) scenario with current and additional measures (WCAM).

Excel-based industrial production forecast econometric model for the Republic of Kazakhstan was used to develop greenhouse gas emissions projections and estimate the total IPPU impact in scenarios without measure, with current measures, and with current and additional measures.

Forestry projections methodology

Kazakhstan forestry sector was divided into 9 principal groups according to predominant tree types (see table below). Relevant area covered by a given tree type was assigned to the type. Growth course tables and relevant soil types were taken from the "Reference book on Northern Eurasia forest growth course". The data were adapted to CBM-CFS3, and the model's climatic parameters were changed. Disturbances simulate the effect of measures and policies.

Table 59. *Tree types*

Wood species	Area covered by forest, thous. ha	Average age	Soil bonitet
Pine	783,3	67	III
Spruce	Area covered by forest, thous. ha	Average age	Soil bonitet
Fir	402	105	IV
Larch	176,8	150	IV
Cedar	44,7	172	IV
Birch	922	47	III
Aspen	324,2	41	III
Willow	47	38	IV
Poplar	82,8	42	III
Total	**2969**		

VI. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACT AND ADAPTATION MEASURES

6.1. Observation of air temperature and precipitation changes in Kazakhstan

6.1.1. Changes in air temperature

Over the last 75 years Kazakhstan has seen country-wide increase in surface temperature. Average annual temperature anomaly has gone up to 2°C. Annex 2 contains time series and linear trends of average annual temperature anomalies (°C) over the period from 1941 through 2015 averaged by administrative oblasts of Kazakhstan.

The highest average annual temperature growth rate was seen in West Kazakhstan oblast – by 0.38 °C in 10 years, the lowest – in South Kazakhstan, Almaty, East Kazakhstan, Pavlodar, Atyrau, Aktobe, Karaganda, Akmola oblasts – by 0.22...0.29°C in 10 years. Other oblasts have shown increase in average annual temperature by 0.30...0.31°C in 10 years (Annexes 2, 3).

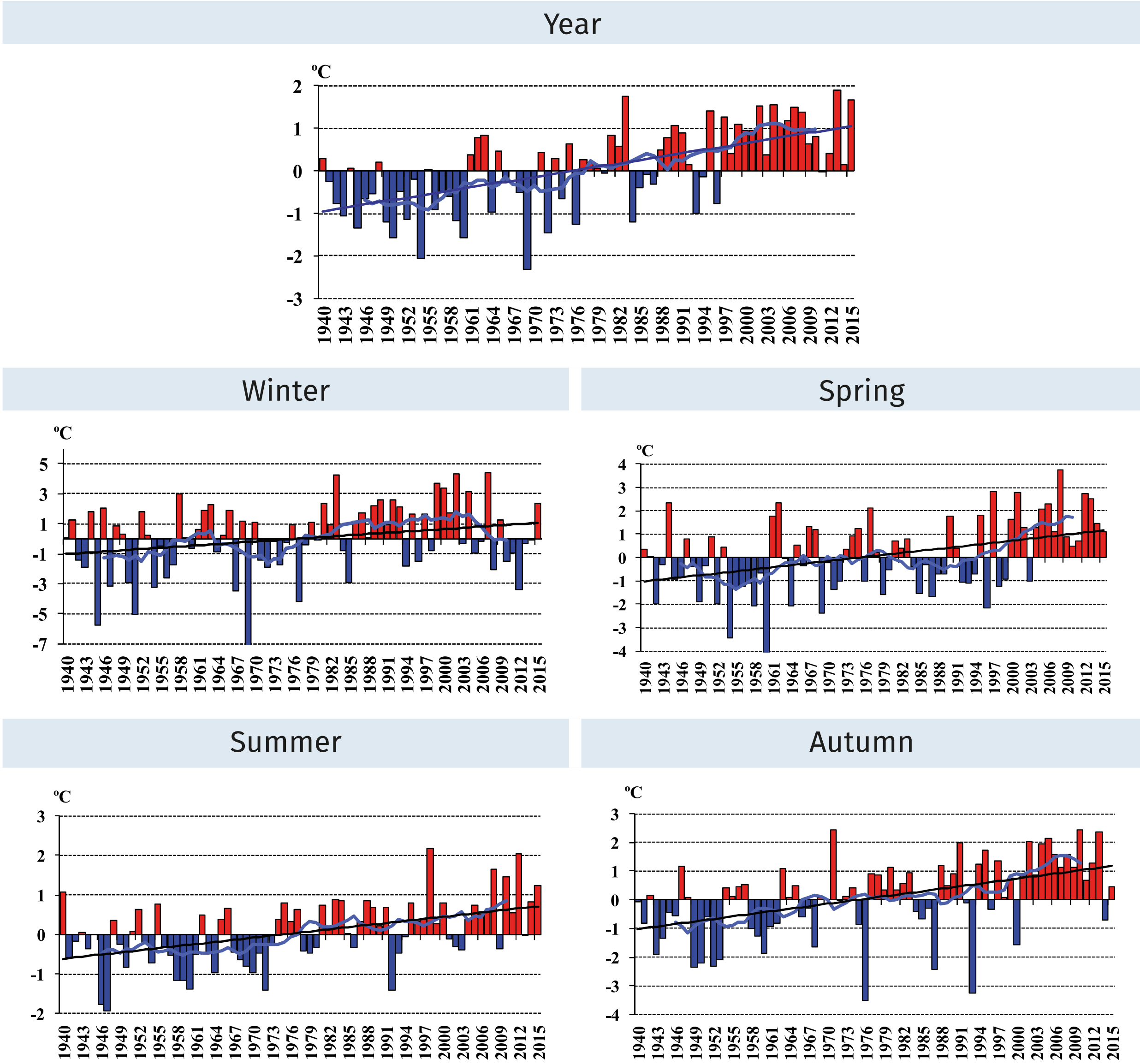
Surface temperature anomaly linear trend (Annexes 3 and 4) by seasons and years averaged by administrative oblasts and hydroeconomic basins of Kazakhstan shows temperature increase rates for Kazakhstan oblasts and hydroeconomic basins.

The average annual temperature increase rate in Kazakhstan is by 0.28°C every 10 years. Across seasons temperature in Kazakhstan grows faster in spring and autumn – by 0.30 and 0.31°C in 10 years, and a little slower in winter – by 0.28°C in 10 years, while the slowest temperature growth rate is registered in summer – by 0.19°C in 10 years (Annex 3). In the majority of cases temperature trends are statistically significant with a 95% confidence interval; trend contribution in cumulative dispersion of average annual temperatures is 40%, 7 to 27% for seasons.

The most vulnerable hydroeconomic basins are Ural-Caspian and Shu-Talas basins because of average annual temperature growth rate of 0.36°C and 0.31°C every 10 years (Annex 4). At the same time average annual temperature growth accelerates in Ural-Caspian and Yertis basins by 0.41 and 0.31°C in 10 years in winter, and in Yessil and Ural-Caspian basins by 0.37 and 0.39°C in 10 years in spring. The lowest average annual temperature growth rate was registered in summer; the highest average annual temperature growth rate in summer amounted to 0.28 and 0.32°C in 10 years in Shu-Talas and Ural-Caspian basins. In autumn, the most vulnerable are also Shu-Talas and Ural-Caspian basins.

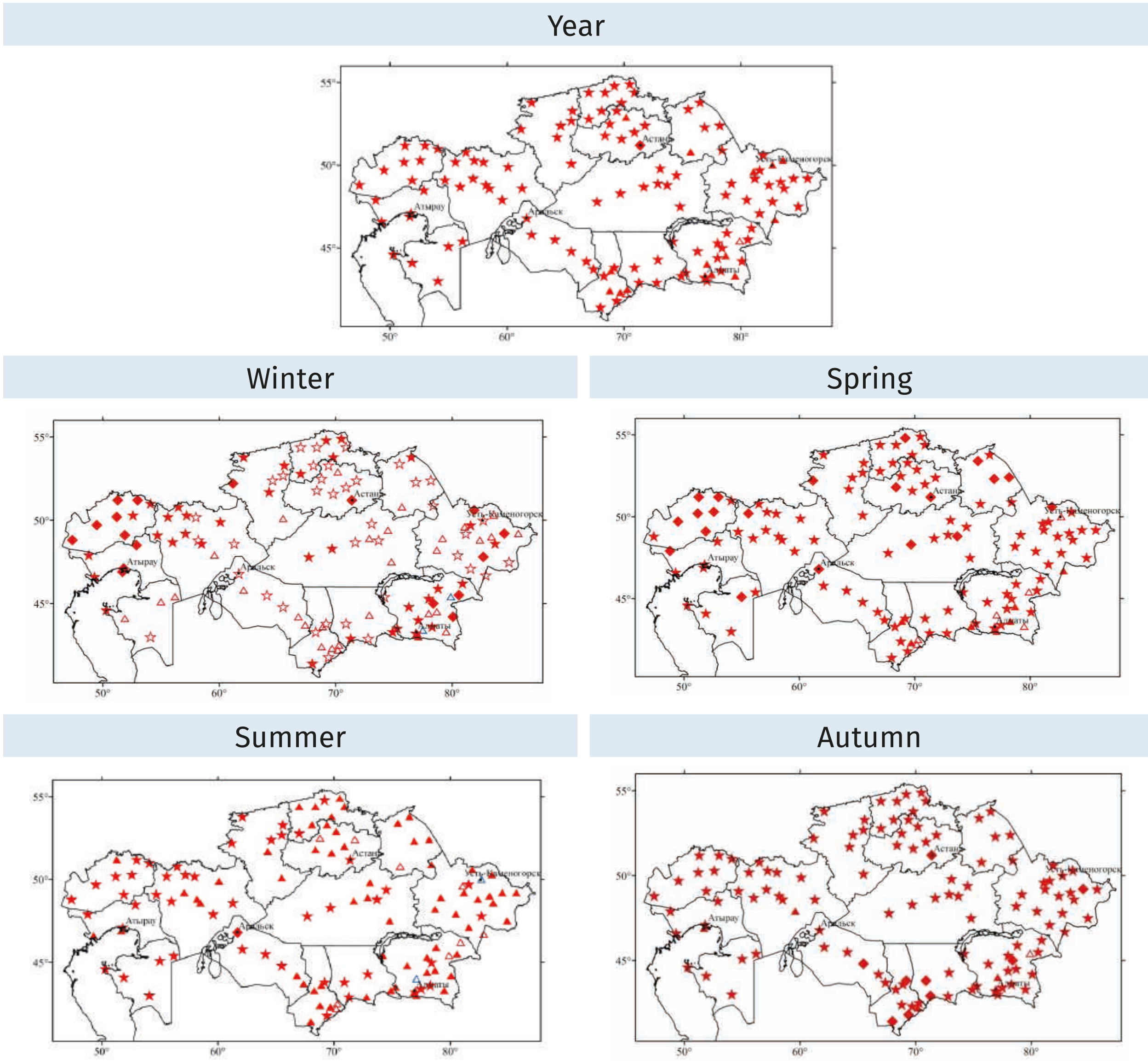
Looking at the temperature anomaly linear trend (against the base period 1961...1990) by seasons and years (Figure 38) one can see that all trends in average annual and seasonal surface temperature values are positive and statistically significant and prove stable temperature increase in Kazakhstan over the period from 1941 through 2015.

Figure 38. *Time series and linear trend of annual and seasonal temperatures over the period 1941...2015 averaged across Kazakhstan territory. Anomalies were estimated against the base period 1961...1990. Fitted curve formed with 11-year moving averaging.*



For more detailed information on average annual, seasonal and monthly temperature changes (linear trend values in °C/10 years) across Kazakhstan territory in 1941-2015 see Figure 39.

Figure 39. *Spatial distribution of surface temperature linear trend values (°C/10 years) estimated for 1941...2015. Range symbols are shaded when trend is statistically significant.*



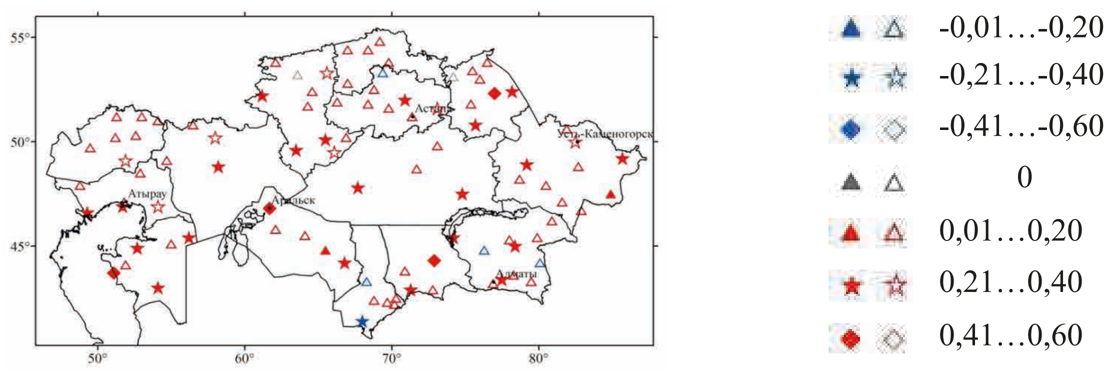
Average annual temperature trends are positive and statistically significant across the territory of Kazakhstan. It is true even for spring, summer and autumn. Average annual, spring and autumn temperature trend values are mainly 0.21...0.40°C/10 years, in spring in the west and the north – 0.41...0.60°C/10 years.

Summer temperature trends generally range from 0.20 to 0.40°C/10 years, in south-eastern, eastern and northern areas – up to 0.21°C/10 years. Winter temperatures are increasing significantly in western and south-eastern regions, as well as in certain northern regions to a maximum of 0.41...0.60°C/ 10 years.

6.1.2. Surface air temperature extreme trends

Temperature extreme trends were analyzed for the period of 1941 through 2015. Most meteorological stations in all Kazakhstan oblasts register increase in daily surface air temperature maximums.

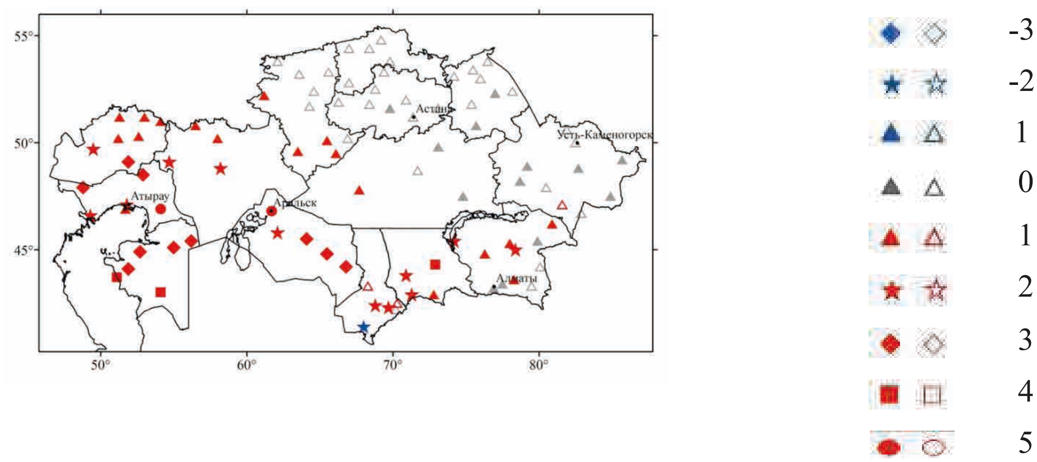
Figure 40. *Spatial distribution of daily temperature maximums linear trend coefficient (°C/10 years) for the period 1941...2015. Range symbols are shaded when trend is statistically significant.*



However, across the larger territory of Kazakhstan extreme trends are insignificant except for specific meteorological stations in various regions (Figure 40) where daily temperature maximum grows by 0.20...0.60°C every 10 years. Negative linear trend values were seen only in the south of the country, mainly up to minus 0.20°C in 10 years.

Statistically significant increase in the ***number of days with temperature above 35°C*** is seen in West Kazakhstan, Aktobe, Atyrau, Mangystau, Kyzylorda, South Kazakhstan, Zhambyl, Almaty oblasts and at some meteorological stations in Kostanay oblast – from 1 to 5 days every 10 years (Figure 41).

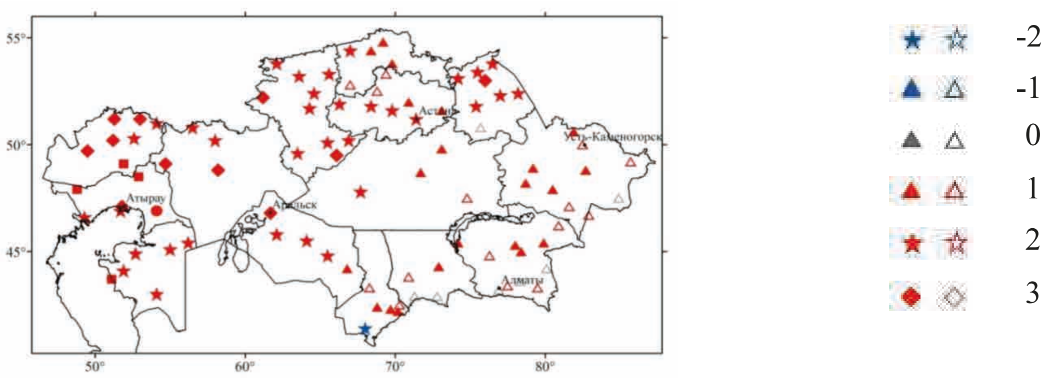
Figure 41. *Spatial distribution of linear trend of the number of days with temperature above 35 °C (days/10 years) for the period 1941...2015. Range symbols are shaded when trend is statistically significant.*



Hot days frequency has barely changed in the north, east and south-east of the country over the period from 1941 through 2015.

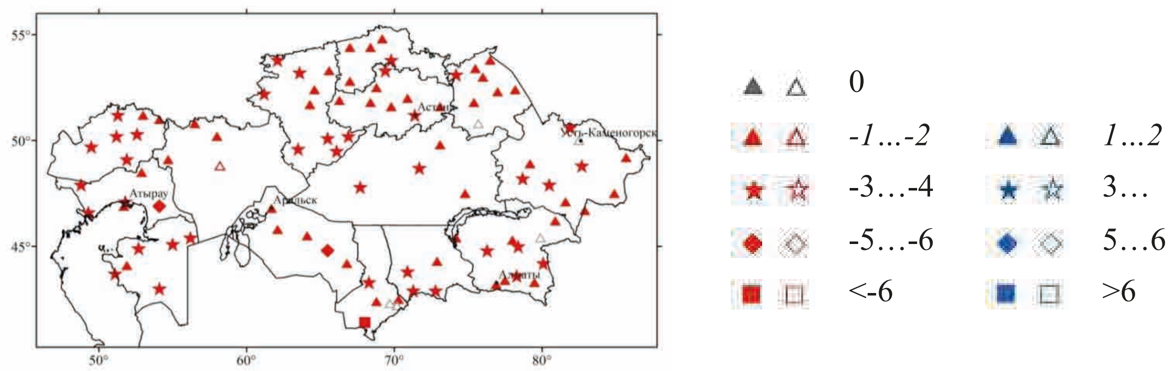
Total heatwave duration is increasing throughout the country (by 1 to 3 days in 10 years, Figure 42). Statistically significant trends are observed at over 70% of meteorological stations.

Figure 42. *Spatial distribution of total heatwave duration linear trend coefficient (days/10 years) for the period 1941...2015. Range symbols are shaded when trend is statistically significant.*



Ice days frequency trend is decreasing almost everywhere in the country. ***Ice days are days when daily minimum temperature drops below 0°C*** (Figure 43).

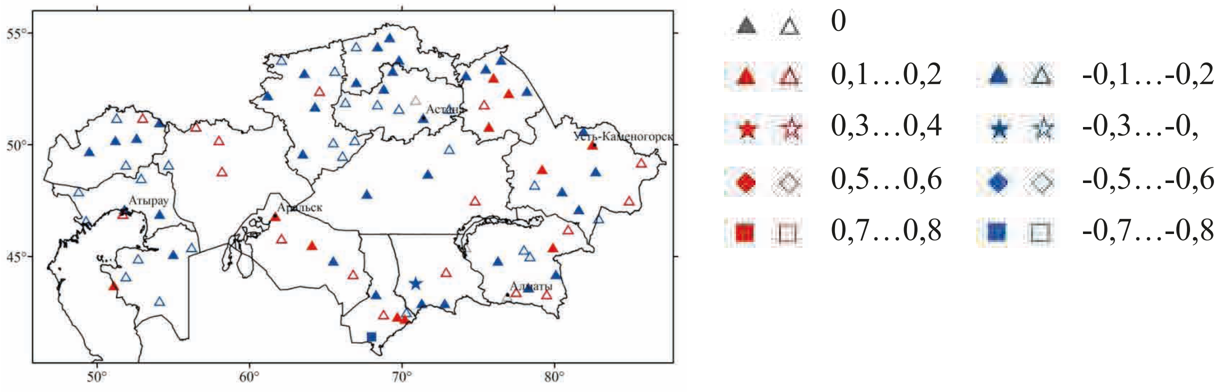
Figure 43. *Spatial distribution of linear trend of the number of days with daily minimum temperature below 0°C (days/10 years) for the period 1941...2015. Range symbols are shaded when trend is statistically significant.*



The number of ice days is going down by 5 to 6 days every 10 years in certain areas of South Kazakhstan, Kyzylorda and Atyrau oblasts. In other areas the same number is decreasing by 1 to 4 days in 10 years.

A significant decreasing trend in ***daily temperature range*** by 0.1...0.2°C (Figure 44) is observed over the larger territory of Kazakhstan.

Figure 44. *Spatial distribution of daily temperature range linear trend coefficient (°C/10 years) for the period 1941...2015. Range symbols are shaded when trend is statistically significant.*



Significant increase in daily range by 0.1...0.2°C is observed at some meteorological stations in Pavlodar, East Kazakhstan, Almaty, South Kazakhstan, Kyzylorda and Mangystau oblasts.

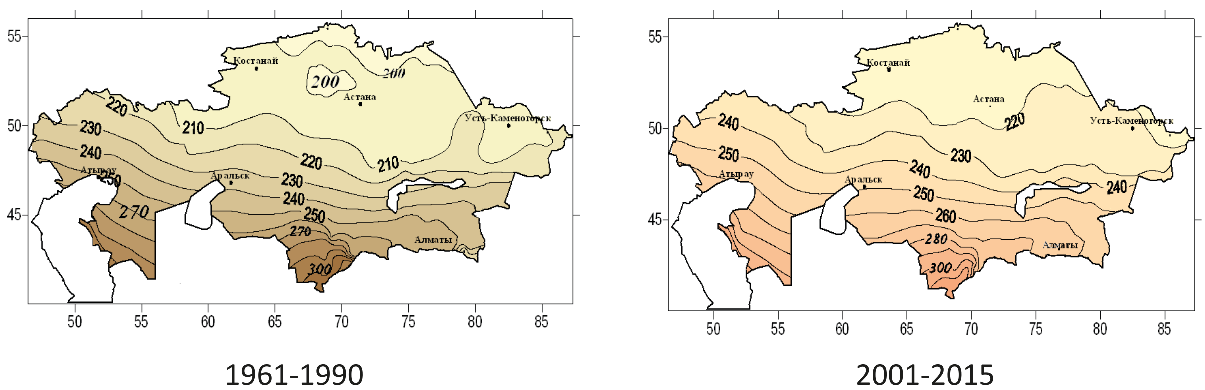
Thus, results of the analysis are: increase in daily surface air temperature maximums at the majority of meteorological stations around Kazakhstan; bigger number of hot days (air temperature above 35°C) in West Kazakhstan, Aktobe, Atyrau, Mangystau, Kyzylorda, South Kazakhstan, Zhambyl, Almaty oblasts; heatwave duration is increasing throughout the country by 1 to 3 days every 10 years (6 consecutive days with high maximum daily temperature); ice days numbers are decreasing by 5 to 6 days every 10 years in certain areas of South Kazakhstan, Kyzylorda and Atyrau oblasts; narrower daily temperature range, by 0.1...0.2°C, proving decrease in climate continentality.

6.1.3. Changes in the duration of periods with temperature above and below 0, 8 and 15°C in Kazakhstan

Climatic instability meaning frequent deviations of basic climatic variables (temperature, precipitation) from average annual or multiannual values has an impact on human health. That is why changes in the duration of periods with temperature above and below 0, 8 and 15°C are important to evaluate.

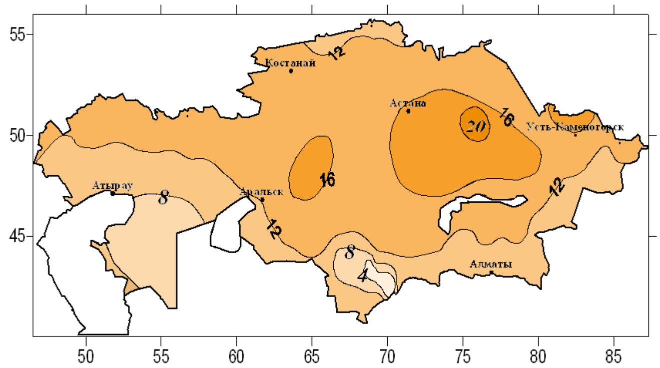
Figure 45 shows Kazakhstan maps indicating number of days with temperature above 0°C in the periods from 1961 through 1990 and 2001 through 2015.

Figure 45. *Number of days with temperature above 0°C in Kazakhstan in 1961-1990 and 2001-2015.*



It can be seen in Figure 45 that in recent years the number of days with air temperature above 0°C has changed. In Figure 46 such changes in the duration of periods with temperature above 0°C are more visible.

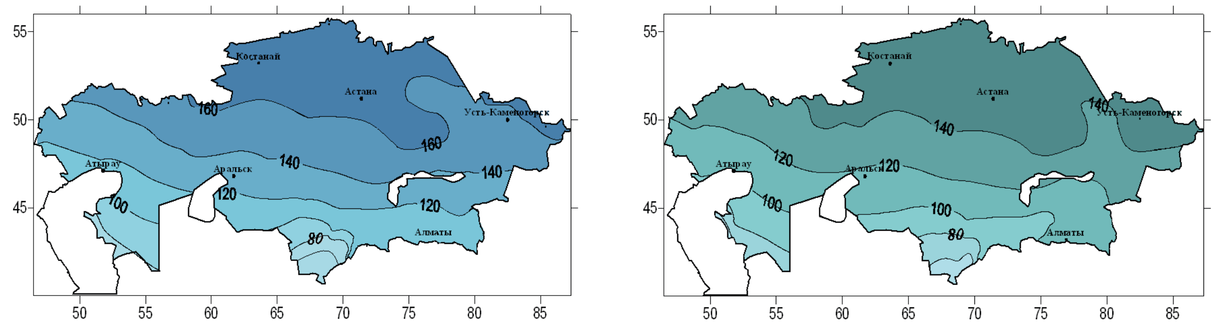
Figure 46. *Changes in the duration of period with temperature above 0°C in Kazakhstan.*



It should be noted that over the last decade Kazakhstan has seen increase in the duration of period with temperature above 0°C by 4 to 20 days a year (Figure 46). Larger increase in the duration of period with temperature above 0°C is observed in central Kazakhstan (12 to 20 days), while it reaches 4 to 12 days a year in the south, 8 to 12 days a year in the west, 12 to 16 days a year in the east, and 8 to 12 days a year in the north. More significant changes were registered in Akmola, Karaganda and Pavlodar oblasts – 12 to 20 days a year.

Figure 47 and Figure 48 show Kazakhstan maps indicating number of days and duration of temperature below 0°C in the periods from 1961 through 1990 and 2001 through 2015.

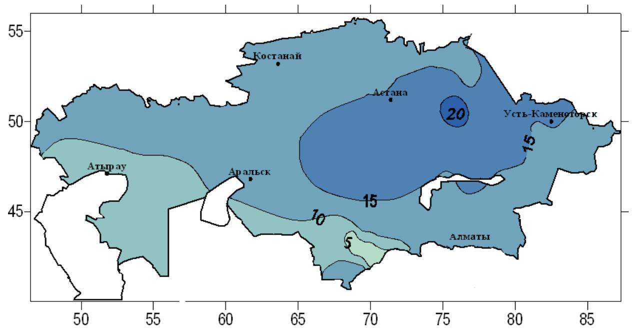
Figure 47. *Number of days with temperature below 0°C in Kazakhstan in 1961-1990 and 2001-2015.*



1961-1990

2001-2015

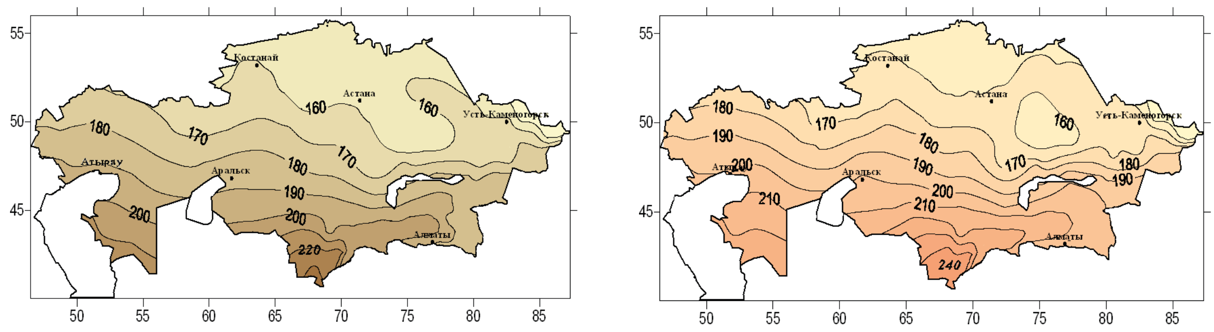
Figure 48. *Changes in the duration of period with temperature below 0°C in Kazakhstan.*



Over the last decade Kazakhstan has seen decrease in the duration of period with temperature below 0°C by 5 to 20 days a year (Figure 48). Larger decrease was registered in Akmola, Pavlodar and Karaganda oblasts.

Figure 49 shows Kazakhstan maps indicating number of days with temperature above 8°C in the periods from 1961 through 1990 and 2001 through 2015.

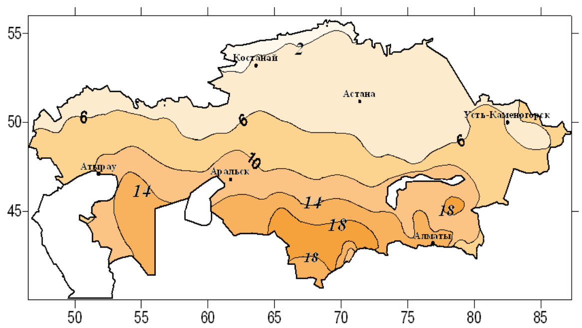
Figure 49. *Number of days with temperature above 8°C in Kazakhstan in 1961-1990 and 2001-2015.*



1961-1990 2001-2015

Over the last decades the number of days with temperature above 8°C has changed. In Kazakhstan the number of days with temperature above 8°C has grown by 2 to 18 days a year as indicated in Figure 50.

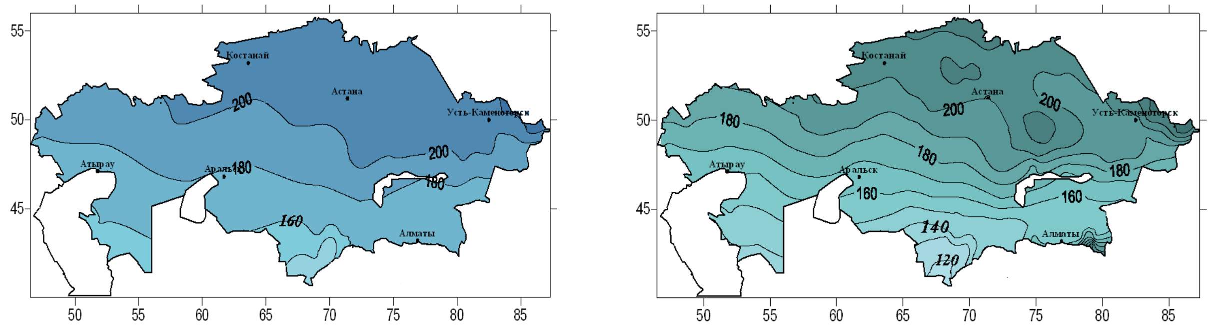
Figure 50. *Changes in the duration of period with temperature above 8°C in Kazakhstan.*



Larger increase (by 18 to 22 days) in the duration of period with temperature above 8°C is observed in southern Kazakhstan, i.e. in Kyzylorda, South Kazakhstan and Zhambyl oblasts, 14 to 18 days a year in Mangystau and Almaty oblasts.

Figure 51 shows maps indicating number of days and duration of temperature below 8°C.

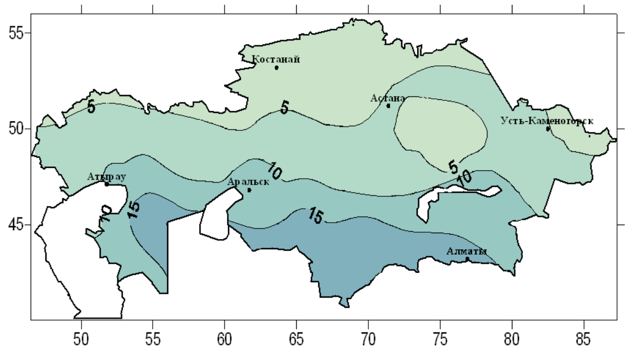
Figure 51. *Number of days with temperature below 8°C in Kazakhstan in 1961-1990 and 2001-2015.*



1961-1990 2001-2015

In recent years the number of days with temperature below 8°C has gone down by 5 to 15 days a year.

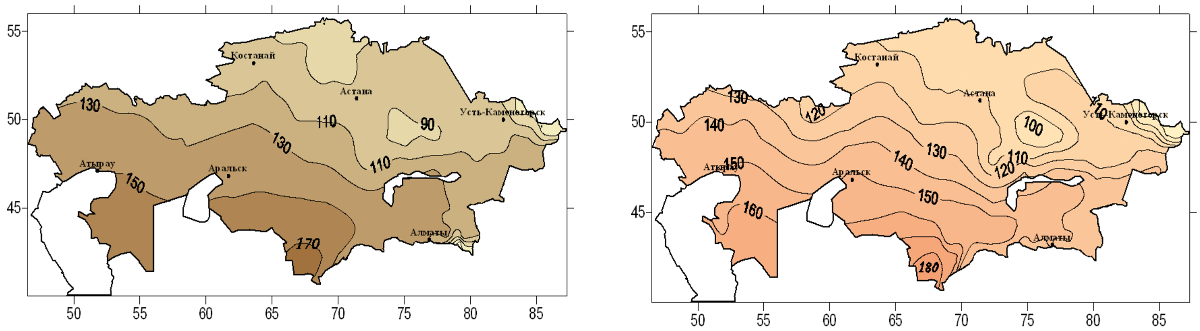
Figure 52. *Changes in the duration of period with temperature below 8°C in Kazakhstan.*



More significant changes in the duration of period with temperature below 8°C have occurred in southern regions of Kazakhstan, i.e. the number of days with temperature below 8°C has gone down by 15 to 20 days a year in the last decade. In the north and the center the same number has decreased by 5 to 10 days a year.

Figure 53 and Figure 54 show Kazakhstan maps indicating number of days and duration of temperature above 15°C in the periods from 1961 through 1990 and 2001 through 2015.

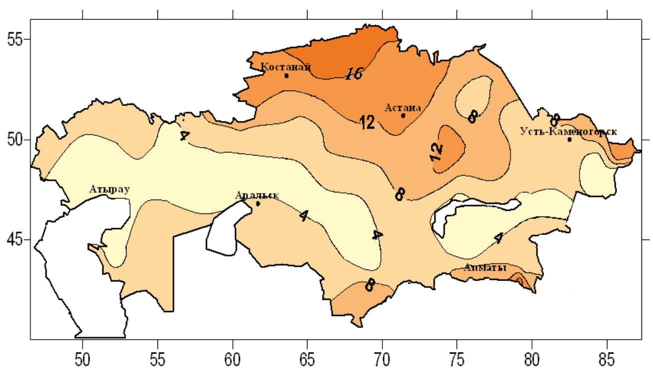
Figure 53. *Number of days with temperature above 15°C in Kazakhstan in 1961-1990 and 2001-2015.*



1961-1990 2001-2015

The number of days with air temperature above 15°C has gone up by 2 to 18 days a year.

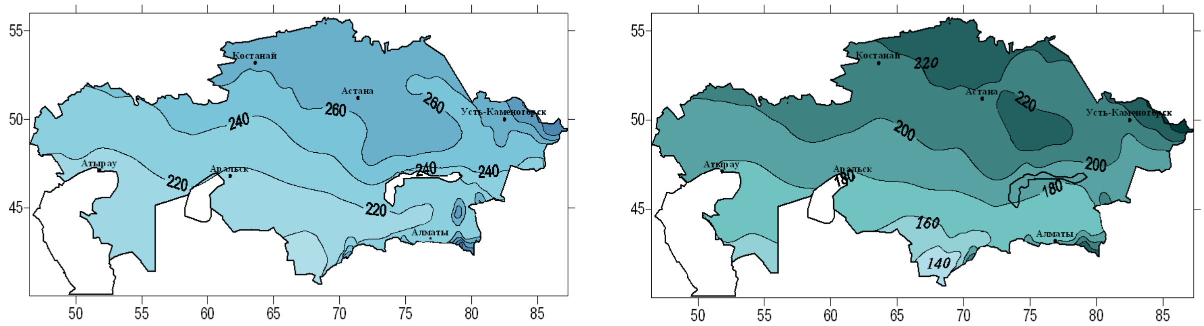
Figure 54. *Changes in the duration of period with temperature above 15°C in Kazakhstan.*



Largest increase in the duration of period with temperature above 15°C is observed in the north, while in the center the number of days with temperature above 15°C has grown by 4 to 8 days a year.

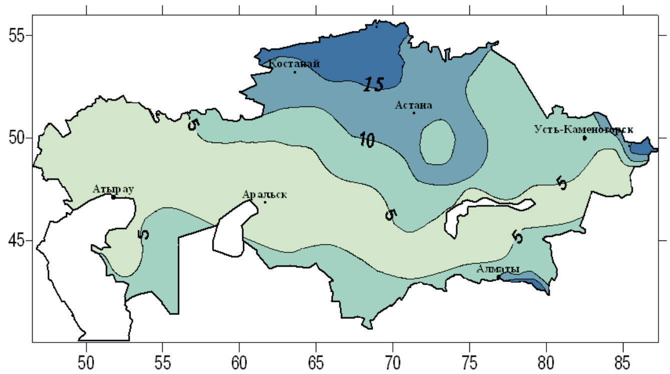
Figure 55 shows Kazakhstan maps indicating number of days and duration of temperature below 15°C in the periods from 1961 through 1990 and 2001 through 2015.

Figure 55. *Number of days with temperature below 15°C in Kazakhstan in 1961-1990 and 2001-2015.*



1961-1990 | 2001-2015

Figure 56. *Changes in the duration of period with temperature below 15°C in Kazakhstan.*



Shorter duration of period with temperature below 15°C.

6.1.4. Observed precipitation changes around Kazakhstan and in oblasts

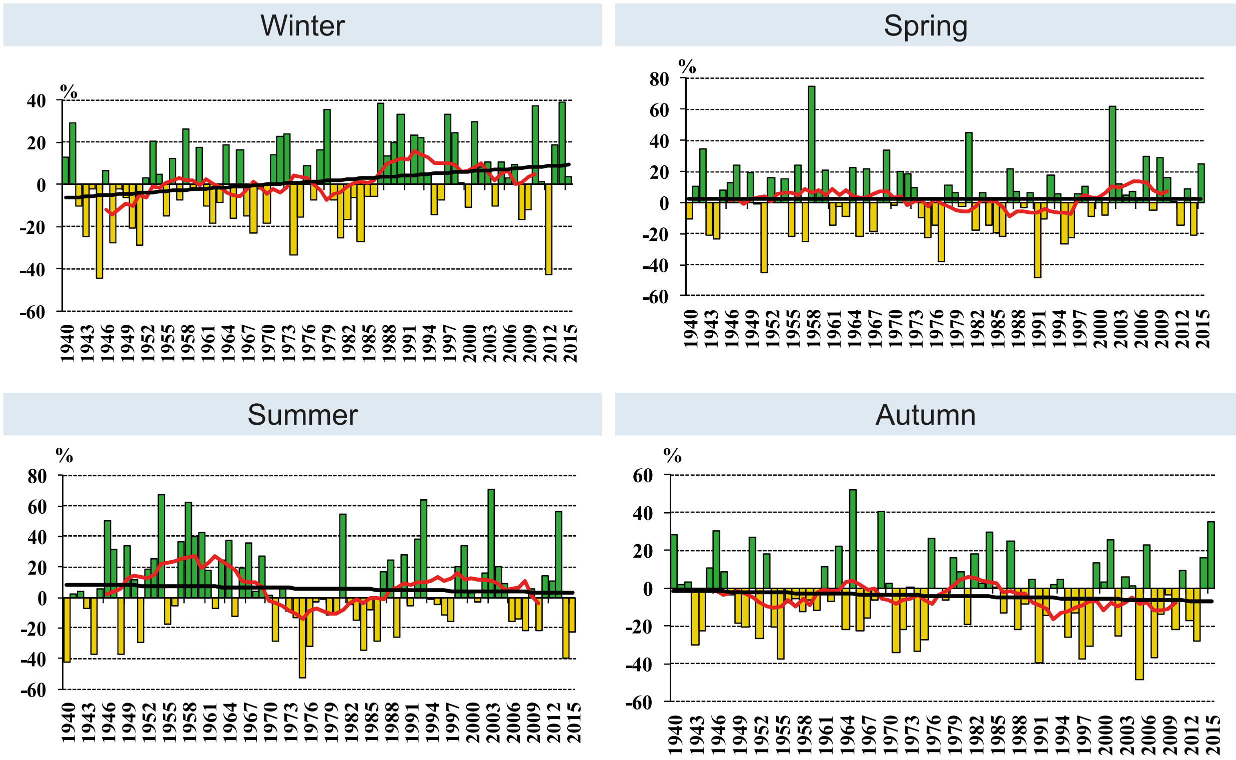
In contrast to air temperature, changes in atmospheric precipitation around Kazakhstan in the period under consideration are not so uniform.

A general impression of the nature of current changes in atmospheric precipitation in Kazakhstan (Annex 5) can be formed on the basis of time series of annual and seasonal precipitation anomalies for the period from 1940 through 2015, calculated against the base period of 1961-1990 and spatially averaged over the territory of Kazakhstan.

On average annual precipitation level was insignificantly decreasing over the period from 1940 through 2015 – by 0.2 mm in 10 years (Annexes 6 and 7). If we focus on local precipitation changes we'll see that an insignificant increase by 0.1-5.0 mm/10 years was observed in Aktobe, Karaganda, Pavlodar, Akmola, Almaty, and North Kazakhstan oblasts, while in other areas precipitation was decreasing by 0.1-4.2 mm/10 years. All the resulting annual precipitation trends are out of statistical control.

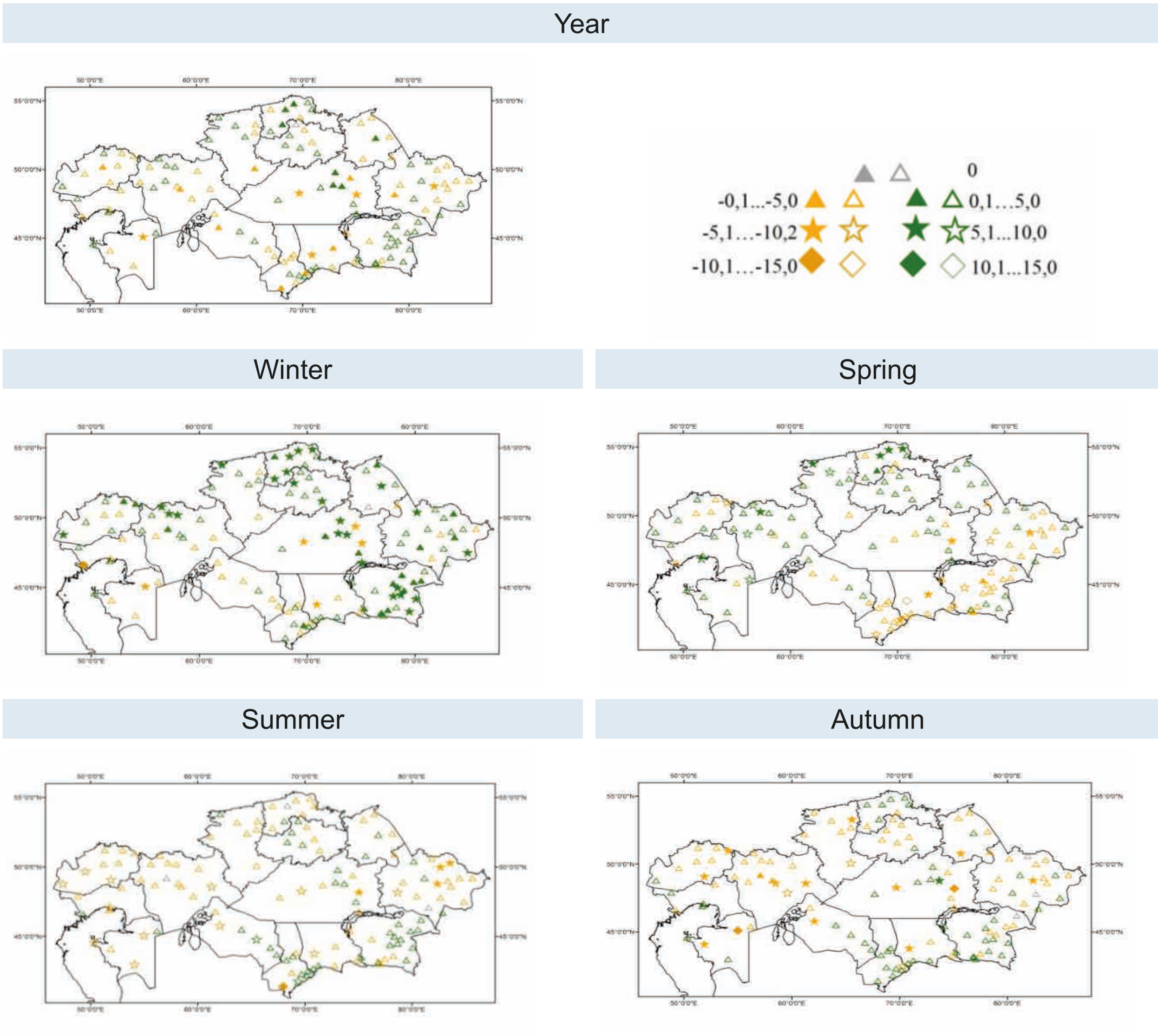
Figure 57 shows year on year variations in seasonal precipitation anomalies (%) over the period from 1941 through 2015, averaged over the territory of Kazakhstan. A weak (statistically insignificant) trend of precipitation decrease by 0.7 mm/10 years can be observed in all seasons except winter when precipitation is increasing by 1.5 mm/10 years and the trend is significant (Annex 6). Thus, over the period under consideration a significant increasing trend is observed in winter time and a decreasing one is seen in other seasons.

Figure 57. *Time series and linear trends of seasonal precipitation anomalies over the period from 1941 through 2015 spatially averaged over the territory of Kazakhstan. Anomalies calculated in% against the base period of 1961-1990. Fitted curve formed with 11-year moving averaging.*



The nature of precipitation in Kazakhstan can be seen in more details on the basis of spatial distribution of linear trend coefficient for annual, seasonal and monthly precipitation levels (%/10 years) calculated for the period from 1941 through 2015 and presented in Figure 58.

Figure 58. *Spatial distribution of linear trend coefficient for seasonal and annual precipitation levels (%/10 years) calculated for the period from 1941 through 2015. Range symbols are shaded when trend is statistically significant.*

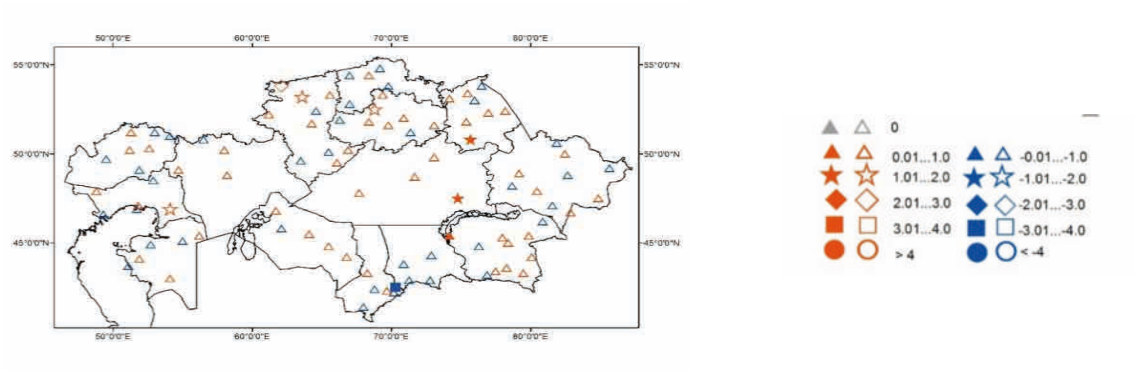


6.1.5. Atmospheric precipitation extreme trends

Atmospheric precipitation extreme trends were analyzed for the period from 1941 through 2015 on the basis of the most indicative indices promoted by WMO.

Maximum one-day precipitation values (Rx1day index) have barely changed in Kazakhstan (Figure 59). Nearly everywhere in the country weak trends of decrease or increase in maximum one-day precipitation by 0.01-1.0 mm/10 years have been observed. At the same time all the trends are out of statistical control, except for some stations. Statistically significant increase in precipitation has been observed at Kuygan (0.75 mm/10 years), Bektauata (1.3 mm/10 years) and Bayanaul (1.6 mm/10 years) stations. Statistically valid decrease in maximum one-day precipitation has been seen at Turar Ryskulov meteorological station (3.61 mm/10 years).

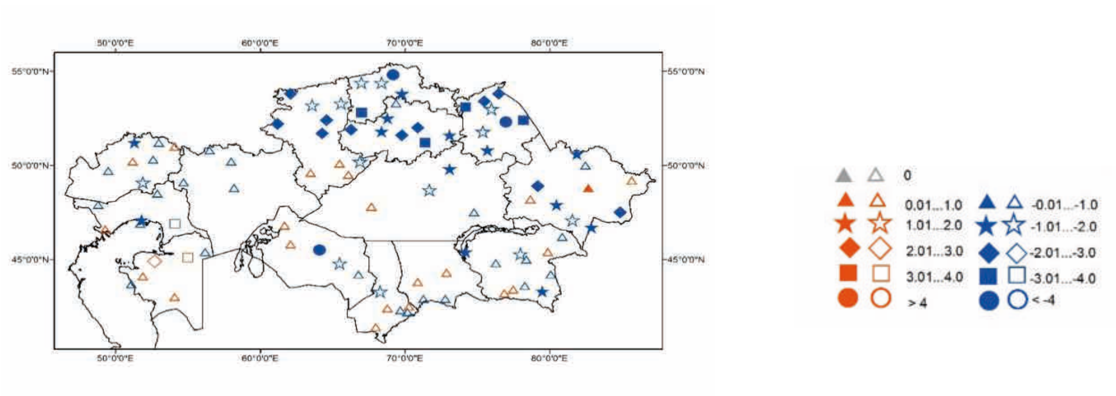
Figure 59. *Spatial distribution of linear trend coefficient of maximum one-day precipitation levels (mm/10 years) calculated for the period from 1941 through 2015. Range symbols are shaded when trend is statistically significant.*



Analysis of trend of ***extreme precipitation share in annual precipitation (R95pTOT index)*** showed that Kazakhstan in general, except at specific stations, has seen minor and statistically insignificant trends of both decrease and increase in precipitation – by 0.01-1.0%/10 years.

A general trend over most Kazakhstan areas is decrease in ***maximum dry spell length (CDD index).*** Statistically valid variations in maximum dry spell length have been detected in northern and north-eastern regions, as well as at some meteorological station in the south of Kazakhstan where dry spell decreased by 1 to 5 days. The same period increased by 2 says in 10 years at Kokpekty meteorological station. In other areas the trends are out of statistical control (Figure 60).

Figure 60. *Spatial distribution of linear trend coefficient of maximum length of dry spell (days/10 years) calculated for the period from 1941 through 2015.*
Range symbols are shaded when trend is statistically significant.



6.1.6. Observed precipitation changes in the areas of Kazakhstan hydroeconomic basins

For the purpose of hydrological design and more detailed understanding of climate change in areas with water bodies a linear trend was estimated for 8 hydroeconomic basins of Kazakhstan.

Across basins a weak trend of annual precipitation increase by 1.1-3.9 mm/10 years has been observed as we move from the south-east to the north (Balkhash-Alakol, Nura-Sarysu and Yessil basins). Around other basins precipitation amount decreases as we move from the west to the east by 1.5-3.1 mm/10 years. All trends are statistically insignificant (Annex 7, Figure 61).

In winter time precipitation amount is insignificantly increasing around all basins as we move from the south to the north by 0.2-2.8 mm/10 years. The largest amount of winter precipitation falls on the Yessil basin area (2.8 mm/10 years).

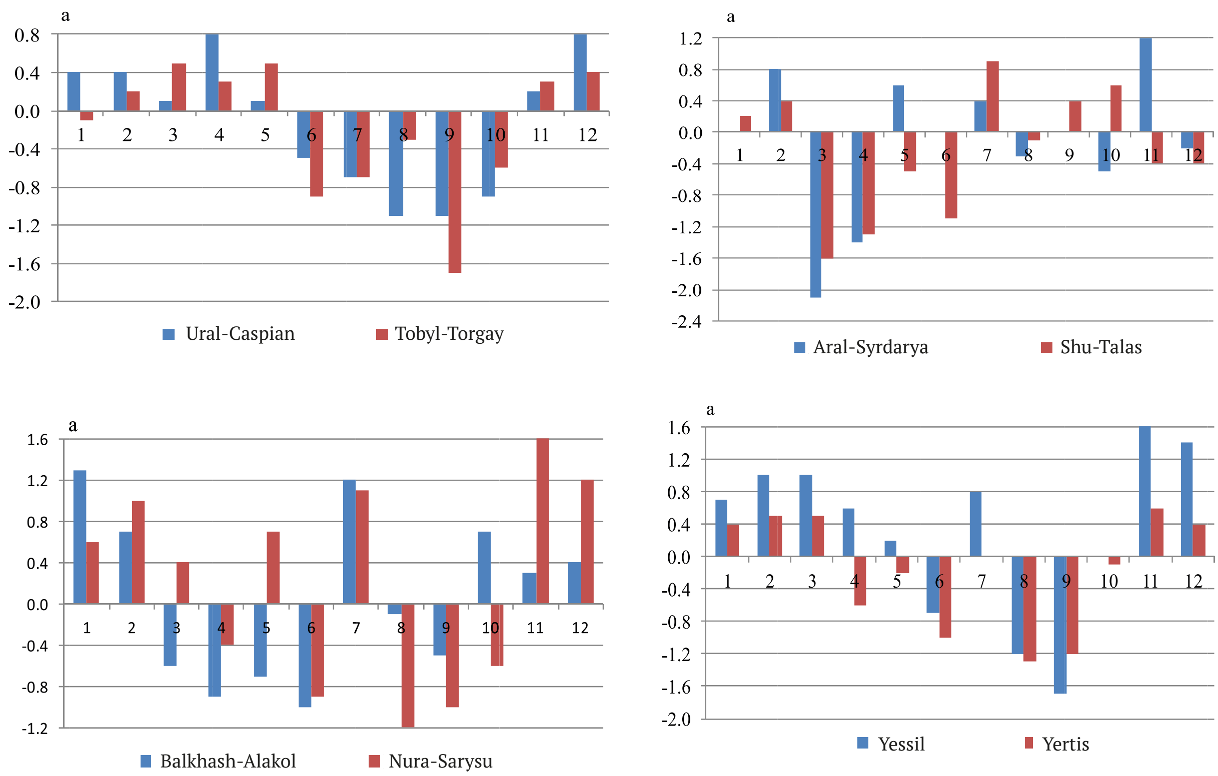
All the resulting trends of seasonal and annual precipitation anomalies are statistically insignificant, except for winter period when the trend was statistically valid for Balkhash-Alakol and Yessil basins (Annex 7, Figure 61). ***All seasonal and annual trends are statistically insignificant, except for positive winter trends in Yessil and Balkhash-Alakol areas.***

Figure 61. *Linear trend coefficient values (mm/10 years,%/10 years) of seasonal and annual precipitation amount anomalies averaged for 8 hydroeconomic basins for the period from 1941 through 2015. Anomalies were calculated against the base period 1961...1990.*

1 – Aral-Syrdarya basin	5 – Ural-Caspian basin
2 – Balkhash-Alakol basin	6 – Nura-Sarysu basin
3 – Yertis basin	7 – Tobol-Torgay basin
4 – Yessil basin	8 – Shu-Talas basin

When looking at the information on changes in precipitation amounts over Kazakhstan hydroeconomic basins in the period of observations, one can see that from November through March, precipitation over all basins increases by 0.2-3.7 mm/10 years, then in June, August and September it goes down by 0.5-3.7 mm/10 years. Statistically valid increase in precipitation amount has been observed in Balkhash-Alakol, Yessil and Nura-Sarysu basin areas (Figure 62).

Figure 62. *Linear trend coefficient values of monthly precipitation amounts averaged for 8 Kazakhstan hydroeconomic basins for the period from 1941 through 2015.*

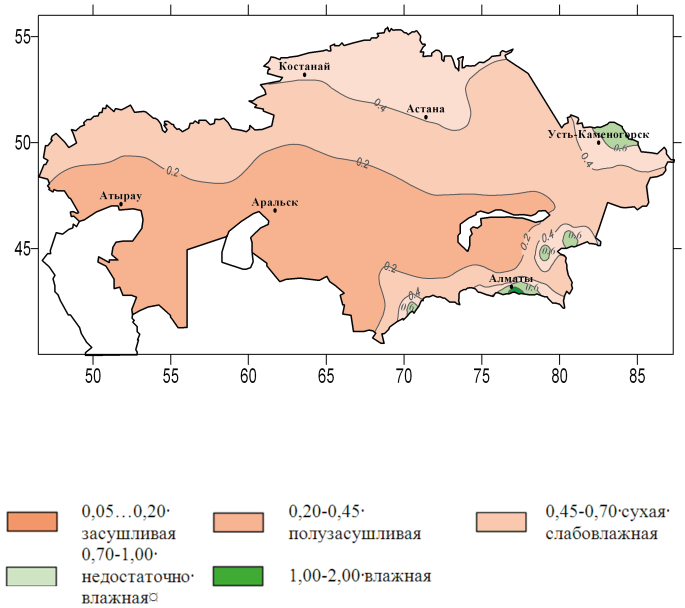


6.1.7. Moisture zones distribution around Kazakhstan

The main reason why different natural vegetation zones exist in the world is that there are different moisture conditions, i.e. the heat-moisture rate in atmosphere.

The map in Figure 63 shows distribution of different moisture zones in Kazakhstan over the base period 1961...1990.

Figure 63. *Map of N. Ivanov moisture index distribution in Kazakhstan over the base period 1961...1990.*



Kazakhstan covers nearly all the zones from arid to humid (starting from high-mountain areas). Larger part of Kazakhstan is occupied by two zones: arid and semi-arid. Arid zone stretches over southern Kazakhstan. Semi-arid zone spans over the north with a narrow strip in the south-east. A little milder conditions (dry sub-humid zone) prevail in the lowlands of Kostanay, NKO and Akmola oblasts, in the Tarbagatay Range area, in low- and medium-mountain areas of EKO, SKO, Almaty and Zhambyl oblasts. High-mountain areas 2000-2500 m high are usually sub-humid, while areas higher than 2500 m are humid. We can make a conclusion that generally around Kazakhstan moisture conditions are quite severe for both cultivation of crops and habitation. By weather conditions most regions are in the risk farming area.

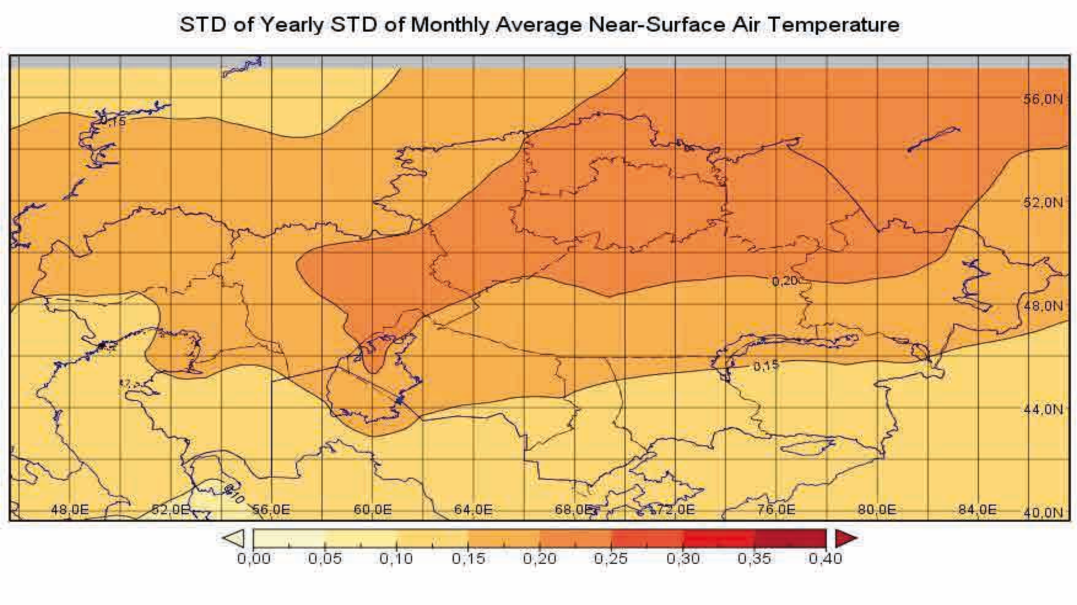
6.2. Kazakhstan climate projections

In order to increase the scale (regionalization) of AOGCM input data and adjust them to united longitude-latitude grid the research applied statistical method, the results of which are published on NASA NEX (National Aeronautics and Space Administration, NASA Earth Exchange, https://cds.nccs.nasa.gov), platform designed to support scientific cooperation of the world's research community, as well as exchange in knowledge and research. Estimated data in each global climate model were regionalized by maximum and minimum daily air temperature and by one-day precipitation amount into 0,25° x 0,25° (or 25 x 25 km) grid reference. There are around 10,000 thousand grid references around Kazakhstan. This ensures significantly better spatial detalization of climate data and their use in evaluation of climate change impacts.

An ensemble of 21 models was made for Kazakhstan (Annex 8). These models provide a satisfactory picture of the current temperature conditions in the country.

The map below shows that the standard deviation of average annual temperature values is ±0,25 °C, while it reaches its maximum in some central and northern areas of the country where temperature is most unstable (Figure 64). Maximum temperature deviation reaches ±0,4 °C, in winter and spring and ±0,3 °C in summer and autumn.

Figure 64. *Model-to-model variation (standard deviation) of average annual temperature values calculated for the historic period from 1980 through 1999 in 21 CMIP5 model ensemble.*



The resulting archive of Kazakhstan climate projections can be described as follows:

- grid size 0.25°;
- climate projections until 2055 were developed in compliance with RCP4.5 and RCP8.5 representative concentration pathways;
- average monthly temperature and monthly precipitation values were given for the historic period 1980 1999, as well as for the period 2020 2059.

All calculations and studies of the two climatic variables were carried out with four time periods and two GHG concentration pathways. Probable climate change (air temperature and precipitation amount) distribution maps for all estimated periods are given in Annex 9 below.

6.2.1 Temperature projections

According to CMIP5 ensemble calculations climate is expected to become considerably warmer in Kazakhstan in the 21st century in both RCPs (Table 60).

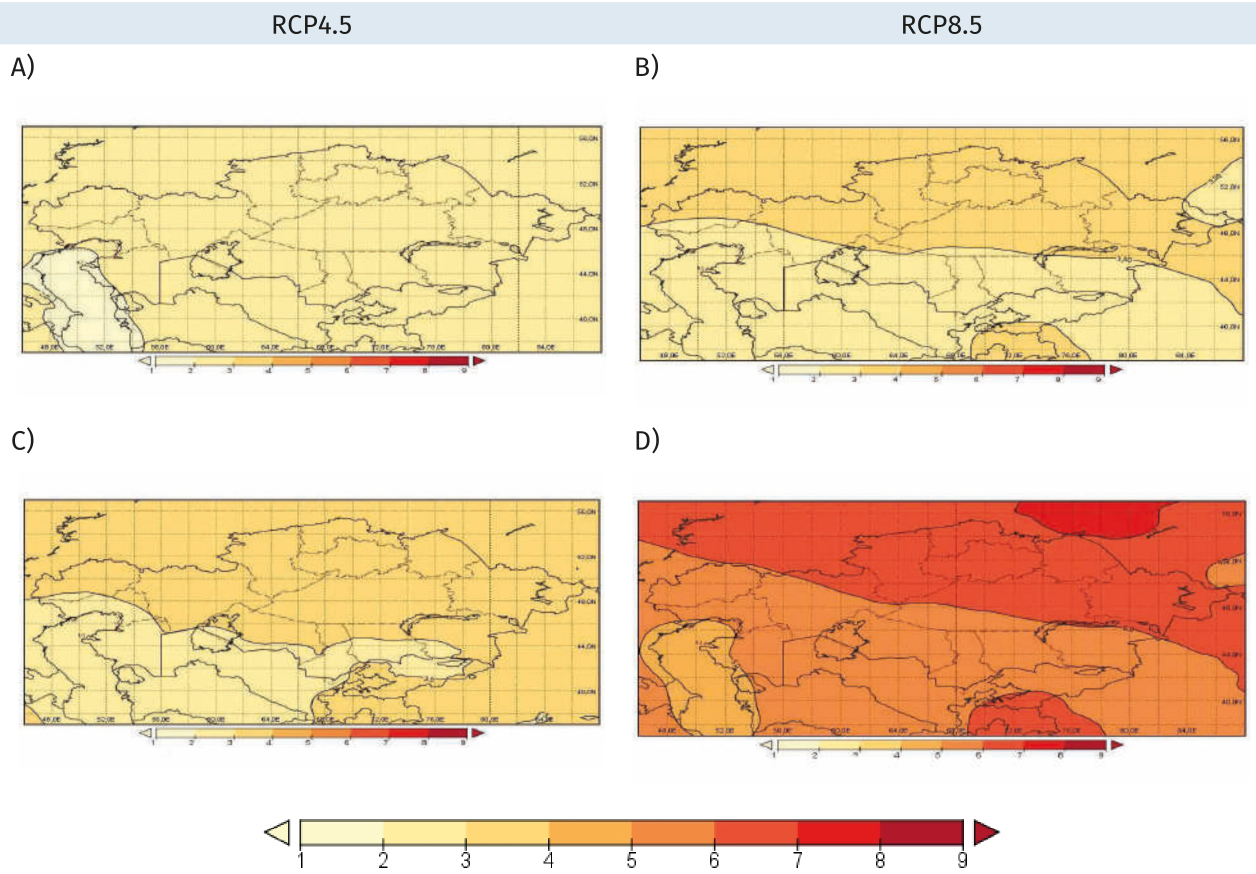
Table 60. *Probable changes in annual and seasonal temperature in Kazakhstan in the 2030-s, 2050-s, 2070-s and 2090-s against the base period 1980-1999 for two RCPs.*

RCP	Year	Winter	Spring	Summer	Autumn
2020-2039					
RCP4.5	1.7	1.7	1.6	1.8	1.6
RCP8.5	1.9	2.0	1.9	1.9	1.8
2040-2059					
RCP4.5	2.4	2.4	2.6	2.6	2.2
RCP8.5	3.1	3.0	3.1	3.2	2.9
2060-2079					
RCP4.5	3.0	3.2	3.0	3.1	2.6
RCP8.5	4.6	4.8	4.4	4.8	4.3
2080-2099					
RCP4.5	3.2	3.5	3.3	3.2	2.9
RCP8.5	6.0	6.4	5.8	6.1	5.6

Calculations are as follows:

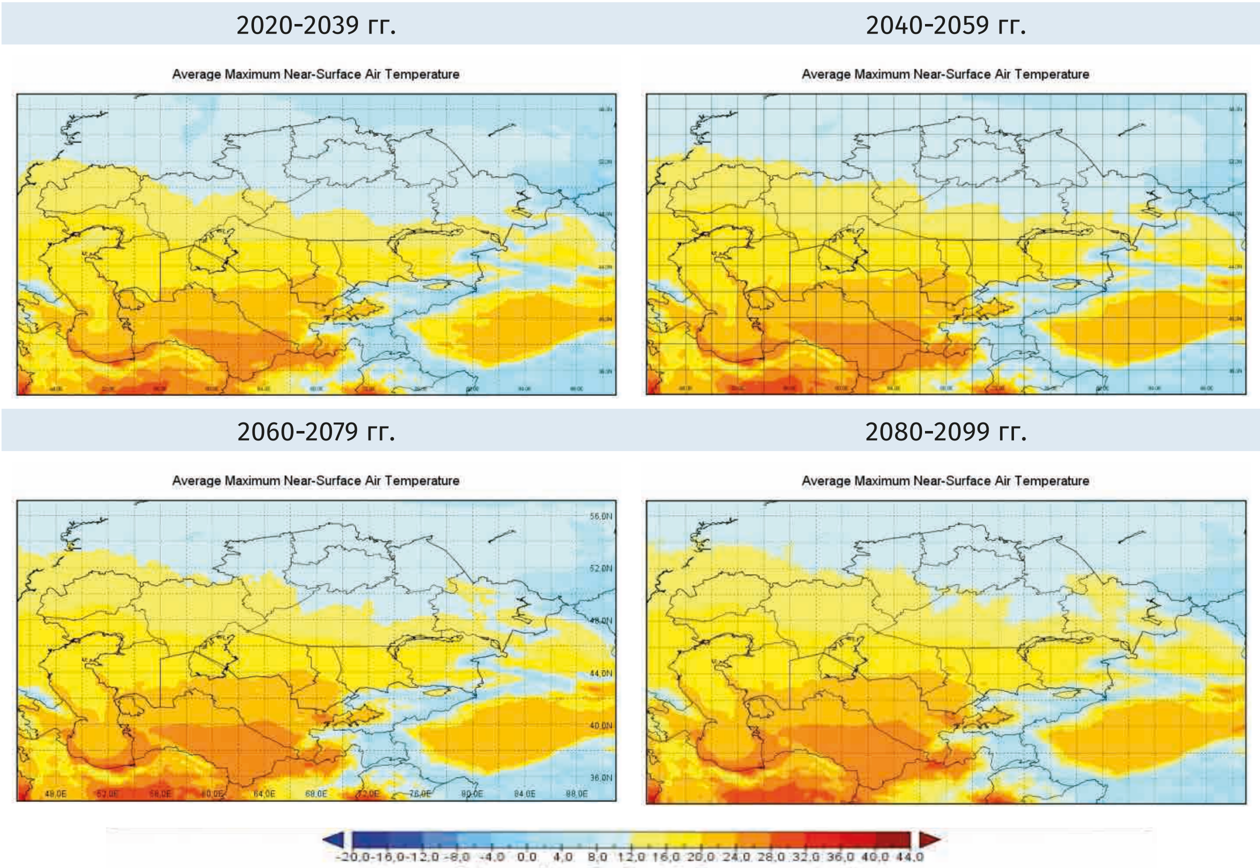
1. In case of moderate/intermediate stabilization of radiative forcing (RCP4.5) by 2030 average annual temperature projection will range from 1.5°C to 1.7°C. Warming will be gradually increasing and the average annual temperature increase may reach 2.7-4.7°C by 2085. Understandably, the highest increase will be observed along the high emissions pathway (RCP8.5). At the same time, while up to the middle of the century the average annual temperature increase will be within the tolerance margin of 2°C ranging from 1.8°C to 2.3°C, by the end of the century the margin will be exceeded two-fold when temperature goes up by 4.4°C.
2. The highest temperature rise averaged around Kazakhstan is expected in winter and summer time. In spring and autumn temperature rise is a little lower.
3. Spatial distribution of average annual temperature for three time horizons with different radiative forcing (RCP4.5 and RCP8.5) is shown in Figure 65.

Figure 65. *Changes in average annual air temperature (°C) in 2040-2059 (A and B) and 2080-2099 (C and D) with RCP4.5 (A and C) and RCP8.5 (B and D)*



4. The climate warming value exceeds standard deviation in the model-to-model variation. This proves that the models show rather similar air temperature changes.
5. One-day maximum temperature is expected to increase, more significantly in warm seasons. As a result, one-year maximum temperature (the maximum of one-day maximums) in some southern and western regions may rise by up to 24°C by the middle of the century and 34°C by its end (Figure 66).

Figure 66. *Spatial distribution of 20-year average absolute one-year maximum surface temperature (°C) in Kazakhstan in 2020-2039, 2040-2059, 2060-2079, 2080-2099 as per CMIP5 ensemble with RCP4.5.*



6.2.2 Precipitation projections

In the 21st century Kazakhstan will see insignificant increase in annual precipitation in all the considered pathways. Precipitation may be going down in summer starting from 2050-s (Table 61).

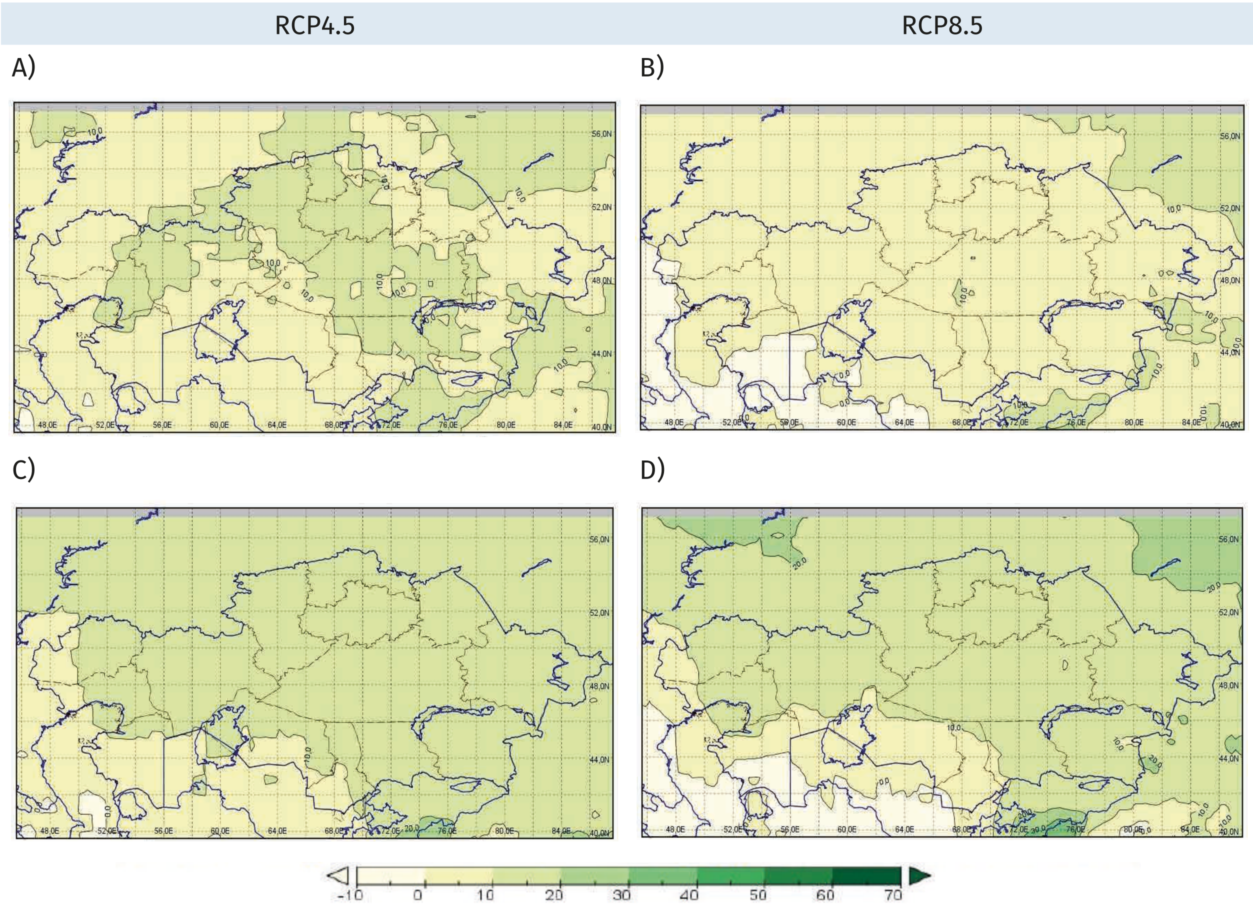
Table 61. *Probable changes in annual and seasonal precipitation (%) in Kazakhstan in 2030-s, 2050-s, 2070-s and 2090-s against the base period 1980-1999 for two pathways*

RCP	Year	Winter	Spring	Summer	Autumn
2020-2039					
rcp4.5	8.37±21.69	12.54±5.74	9.59±7.96	6.96±12.11	5.81±7.21
rcp8.5	4.94	9.47	6.04	4.40	0.76
2040-2059					
rcp4.5	9.26	15.81	10.82	5.33	7.53
rcp8.5	5.98	14.28	9.77	-0.43	2.76
2060-2079					
rcp4.5	12.70	20.91	16.58	8.51	7.71
rcp8.5	8.20	22.06	13.54	-1.88	2.75
2080-2099					
rcp4.5	13.21	21.85	17.91	7.99	7.50
rcp8.5	11.77	32.68	17.69	-2.07	4.76

Analysis results are as follows:

1. The course of precipitation changes depends on the level of radiative forcing. Particularly in situations of intermediate stabilization (RCP4.5) or high emissions (RCP8.5). Annual precipitation will be going up in Kazakhstan during the current century against the base period. On average the increase is insignificant; by the middle of the century cumulative annual precipitation is expected to reach the base period level. By the end of the century, however, it will rise higher. The highest increase in annual precipitation is expected in south-eastern, eastern and northern regions. The lowest increase in annual precipitation is projected in the south-west (Figure 67).

Figure 67. *Changes in annual precipitation amount (%) in 2040-2059 (A and B) and 2080-2099 (C and D) with RCP4.5 (A and C) and RCP8.5 (B and D)*



2. The nature of seasonal precipitation changes averaged over Kazakhstan varies considerably by seasons (Figure 68 and Figure 69). Changes in average seasonal precipitation shown in Figure 68 form a firm increasing trend all over Kazakhstan in all pathways and time periods. The highest increase is expected in winter time, more significantly in south-eastern, eastern and northern regions. By the middle of the 21st century spring precipitation will rise and remain on the same level until the end of the century with most evident gradual increase in the north and south-east of Kazakhstan.A similar change in time is applicable to autumn precipitation. Summer precipitation may go down in the second half of the century, particularly in the south-west and the west. Insignificant positive trends are expected in the north, south-east and the center in RCP4.5.

Figure 68. *Changes in average seasonal precipitation (%) in 2040-2059 (A and B), 2080-2099 (C and D) and 2081-2099 (E and F) in winter (A and C) and summer (B and D) as per CMIP5 ensemble and RCP4.5 radiative forcing pathway.*

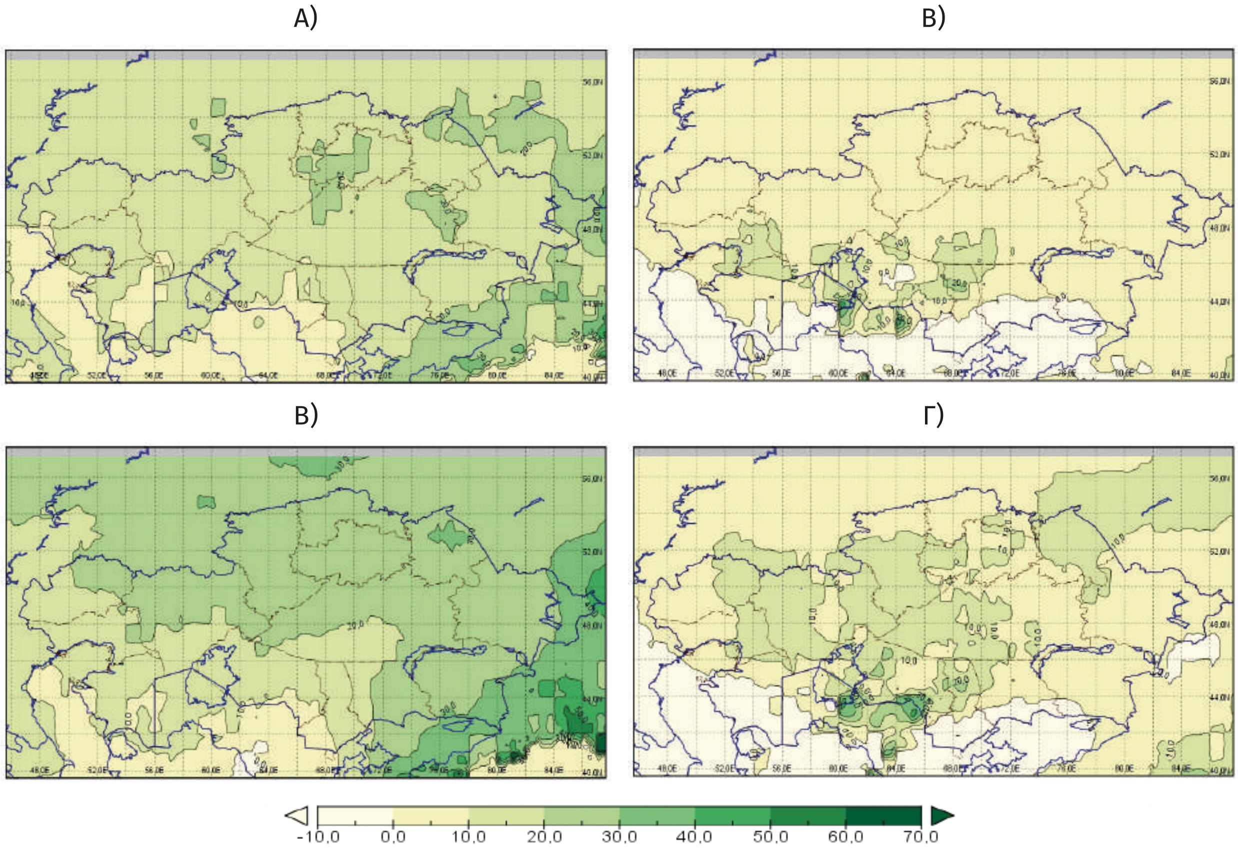
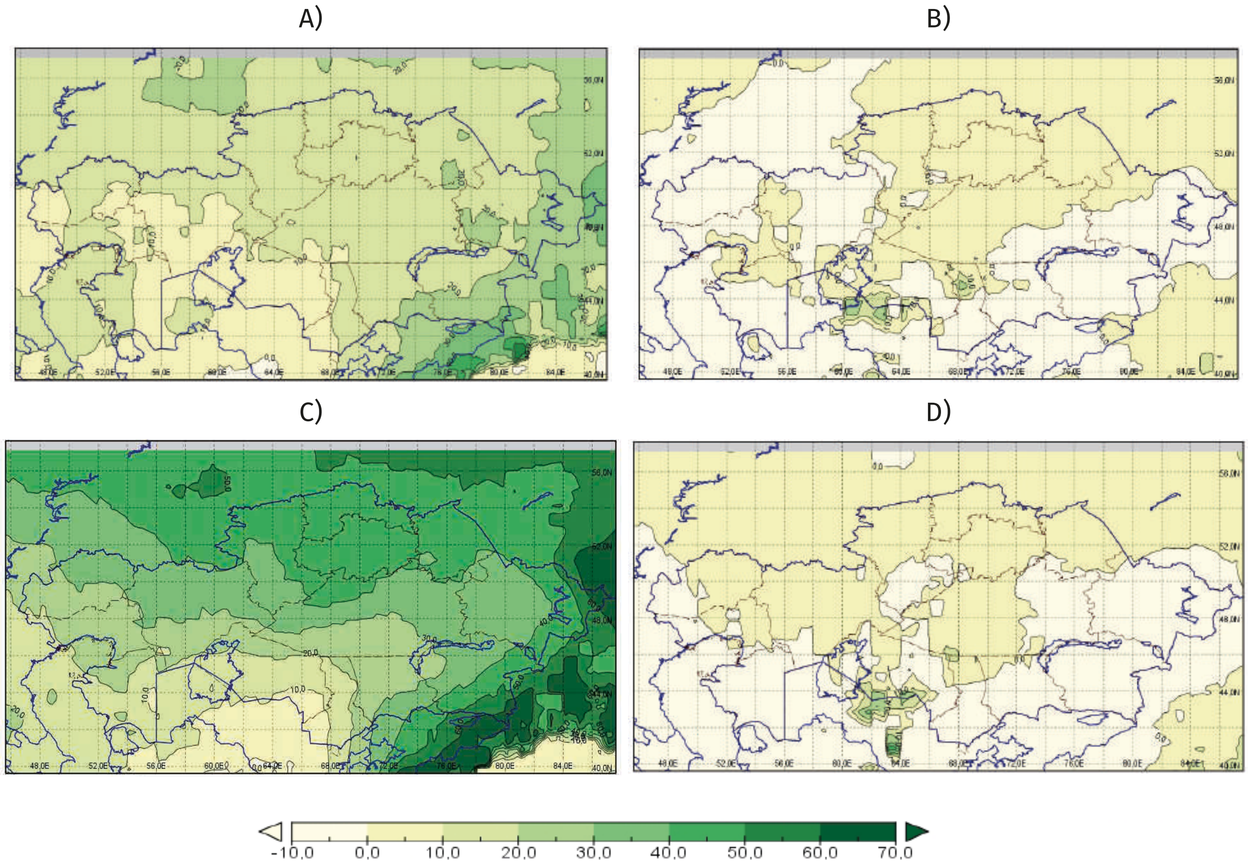


Figure 69. *Changes in average seasonal precipitation (%) in 2040-2059 (A and B), 2080-2099 (C and D) and 2081-2099 (E and F) in winter (A and C) and summer (B and D) as per CMIP5 ensemble and RCP8.5 radiative forcing pathway.*



3. At the same time, the inter-model spread of the estimates is sufficiently large and almost close to the assessment of the changes.

The model-to-model variation of estimations is rather extensive and close to change measurement. The key conclusion that can be made on the basis of these figures on temperature and precipitation is that:

- winters will be more humid and warm. This will be particularly true in northern, piedmont and mountainous areas. Many months in warm seasons will become considerably warmer and drier. Such unfavorable trend is most evident in southern, south-eastern and western regions of Kazakhstan.
- Considerable climate warming can be expected throughout Kazakhstan in the 21st century. Average annual temperature will rise by 1-2 °C by 2030 and 2-3 °C by 2050. Precipitation increase will mainly be up to 10% until 2050. Increase by a little over 10% may occur in the north, center and mountainous south-east.
- Winter and summer temperatures may rise by around 2°C by 2030 and 2-3°C or more – in the north by 2050. Winter precipitation will be going up; increase by 2030 and 2050 ranges from 10 to 20%, while in some central and mountainous regions precipitation will rise by over 20% by 2050. Summer precipitation will increase by over 10% only in specific areas, and in some southern regions it may go down. In 2050 precipitation decrease area will be more extensive.

6.3. Analysis and evaluation of extreme hydro-meteorological events in Kazakhstan that resulted in casualties and considerable material and financial losses

6.3.1. Analysis and evaluation of extreme weather events in Kazakhstan that resulted in casualties and considerable material and financial losses

Seven out of ten warmest years during 1936-2015 occurred in the beginning of the 21st century. The highest temperature was recorded in 2013 with the peak of 1.94°C, exceeding the record of 1983 with an anomaly of 1.86°C, which remained the warmest year on the territory of Kazakhstan for three decades in the history of instrumental observations. 2015 was also one of the hottest years, taking the third place in the rank. Below (Table 62) are ten abnormally warm years for Kazakhstan with the relevant anomalies

If during 1953-82 the runoff fluctuations were associated mainly with the melting of glaciers and snow patches and did not depend on precipitation (horizontal dots on the graph), then during 2001-2016 the spring-summer runoff tended to increase depending on the precipitation. This is due to the increased boundary of precipitation in the liquid form

Table 62. *Ten abnormally warm years and relevant air temperature anomalies averaged over the territory of Kazakhstan*[200]*.*

Year	Anomaly, °C	Rating
2013	1.94	
1983	1.86	
2015	1.66	
2002	1.61	
2004	1.55	
2007	1.47	

[200] Ratings calculated for the period 1936 2015. Anomalies calculated against the period 1961-1990.

1995	1.43	
2008	1.31	
1997	1.27	
2005	1.19	

In 2013 (Table 63) total amount of extreme weather events in Kazakhstan was a little higher (149 events) than in 2014 and 2015 (128 events in each year). 2013 was marked with frequent heavy rainfalls and snowfalls (71 events), strong blizzards (35 events) and strong winds (32 events). All these EWEs (138 out of 149 events) were the main triggers of emergency situations in the Republic of Kazakhstan.

Table 63. *Extreme weather events occurrence in Kazakhstan in 2013-2015*

EWE	Year		
	2013	2014	2015
Heavy rainfall	45	26	41
Strong wind	32	44	39
Strong blizzard	35	27	16
Heavy snowfall	26	18	18
Thick fog	7	8	6
Dust storm	0	0	5
Sleet formation	3	2	0
Hail	1	0	3
Ice slick	0	3	0
Total	**149**	**128**	**128**

Extreme weather events that occurred in Kazakhstan in 2013-2015 and their implications are listed and described in Annex 10.

2015 saw unprecedented occurrence of hydro-meteorological emergencies (mainly, heavy precipitation, floods, mudflows). Twice as many hydro-meteorological emergencies occurred in 2015 as in the previous 4 years (Table 64).

Table 64. *Hydro-meteorological emergencies in Kazakhstan*

Year	Amount of emergencies	Number of aggrieved persons	Number of casualties
2011	43	12	5
2012	39	20	15
2013	36	12	3
2014	43	19	9
2015	75	8	-

Source: CES MIA RK

Kazhydromet's early weather alerts and concerted efforts of the Committee for Emergency Situations and other emergency response teams enabled evacuation of over 10,000 people from danger areas in 2015 (Table 65) with no casualties.

Table 65. *Emergency response results in Kazakhstan*

Year	Number of people evacuated		Amount of vehicles rescued
	total	of which children	
2013	1759	59	491
2014	6154	232	2121
2015	9588	327	3187

Source: CES MIA RK

6.3.2. Analysis and evaluation of extreme weather events frequency and intensity changes by Kazakhstan oblasts

Extreme weather events observed on the territory of Kazakhstan during the cold period of the year include: heavy snowfalls and blizzards accompanied by storm and even hurricane winds, strong lengthy frosts, ice/frost phenomena, late spring frosts. In the warm period of the year there are heavy showers accompanied by thunderstorms, hail and squally wind. Extreme fire hazards are noted in summer. In addition to that Kazakhstan is characterized with severe drought leading to a sharp decline in crop yields.

Excessively cold weather is a significant threat for normal life activity causing failures in heat and power systems in the utility sector.

Table 66 contains data on frequency of average and severe droughts causing damage to Kazakhstan agriculture. Of all grain-growing regions severe droughts causing reduction in average oblast grain yield by 50% or more are most frequent in West Kazakhstan, Aktobe, Karaganda and Kostanay oblasts. The first three oblasts may experience severe drought once in 4 to 6 years, in Kostanay oblast – once in 8 years.

Table 66. *Drought frequency in 1966-2010 (%)*

Oblast	Drought frequency,%		Drought is probable once in ... years	
	All categories	Severe	All categories	Severe
West Kazakhstan	38	24	3	4
Aktobe	31	20	3	5
Karaganda	36	16	3	6
Pavlodar	40	9	3	11
Kostanay	27	13	4	8
Akmola	33	4	3	23
East Kazakhstan	27	7	4	15
North Kazakhstan	22	2	5	45

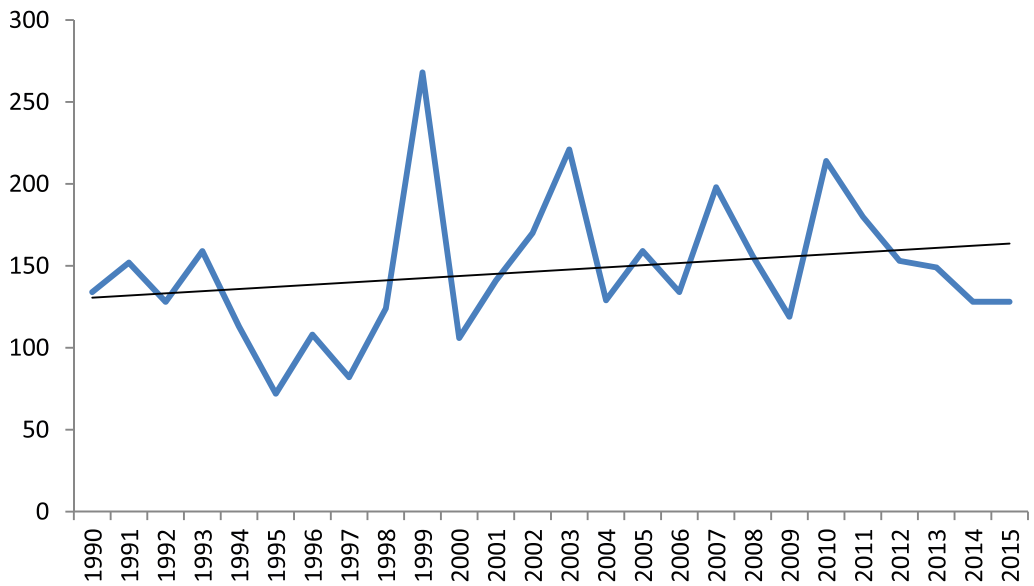
Kazhydromet annually publishes data on spontaneous hydro-meteorological events (SHME) occurring in Kazakhstan. An intensity and duration rating is assigned to each event. Table 67 contains a list of spontaneous (extreme) weather events and their rating.

1. In the period under consideration (26 years) 3,840 EWEs were registered in Kazakhstan, i.e. on average 148 events per year.

Table 67. *Extreme weather events and their characteristics*

№	Event
1	Heavy rainfall (sleet, rain with snow) with the amount of precipitation ≥30 mm in 12 hours or less in the mudflow and avalanche areas; rain and rain with snow with the amount of precipitation ≥50 mm in 12 hours or less on the rest of the territory
2	Heavy snow (snowfall) with the amount of precipitation ≥20 mm in 12 hours or less
3	Strong blizzard (ground, general) lasting 12 hours or more at a wind speed of ≥15 m/s
4	Strong wind (including squalls and tornadoes) at a maximum wind speed of 30 m/s or more
5	Hail with a diameter of hailstones ≥20 mm or intensive hail of smaller size causing significant damage
6	Strong dust (sand) storm lasting 12 hours or more with an average wind speed of ≥15 m/s.
7	Thick fog with visibility of 100 m or less for 6 hours or more
8	Severe ice slick with a diameter ≥20 mm
9	Snow deposits with a diameter ≥35 mm

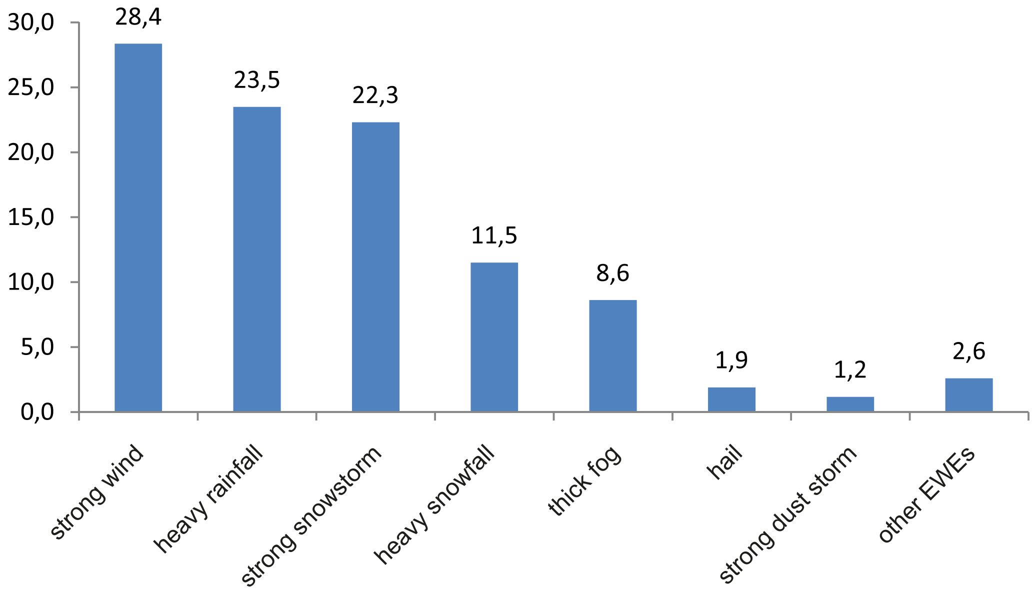
Figure 70. *Dynamics of the total number of days with EWEs in Kazakhstan over the period 1990-2015*



The largest number of EWEs (268) was observed in 1999 due to high frequency of heavy precipitation, strong snowstorms and hail (Figure 70). The smallest number of EWEs (72) was observed in 1995. In general, the trend in the total number EWEs is going up.

2. The following EWEs are most frequent in Kazakhstan: strong wind, heavy rainfall, strong snowstorm, heavy snowfall and thick fog (Figure 71). The total frequency of these events is 94.3%.

Figure 71. *Average share of EWEs in Kazakhstan (%) in the period 1990-2015.*



3. Statistical results (Table 68) were received when the period under consideration was divided into 2 parts (13 years each). In 2003-2015 versus 1990-2002 average annual occurrence of heavy rainfall (49.3) increased nearly 2.5 times, heavy snowfall (24.9) also went up 2.7 times. Strong wind and hail occurrence also increased, but not so much – by 20% and 30% respectively. Less of the following EWEs occurred in recent years: strong blizzard (1.8 times), thick fog (2.7 times), and strong dust storm (3.4 times).
4. Upon consideration of most frequent EWEs in regions (heavy rainfall, snowfall, strong wind and blizzard) we can conclude that their frequency is higher in Almaty oblast (Table 69). Nearly half of all heavy rainfall, heavy snowfall and strong wind events in Kazakhstan took place in this oblast. In addition to that, average annual occurrence of the following events increased in 2003-2015 against the earlier period of 1990-2002: heavy rainfall – 3.9 times, heavy snowfall – 3.3 times, strong wind – 1.6 times.

Table 68. *Average annual EWEs occurrence in Kazakhstan in different periods*

EWE	Number of EWEs	
	1990-2002	2003-2015
Heavy rainfall	20,1	49,3
Strong wind	38	45,8
Heavy snowfall	9,1	24,9
Strong blizzard	42,4	23,5
Hail	2,5	3,2
Thick fog	18,6	6,8
Strong dust storm	2,7	0,8

The most favorable regions in terms of EWE incidence are West Kazakhstan, Atyrau, Mangystau, Kyzylorda and Pavlodar oblasts, although in each of them from 1 to 3 EWEs on average occur every year.

Table 69. *EWE frequency (%) by oblasts of Kazakhstan**

	EWE			
Region	**Heavy rainfall**	**Strong wind**	**Strong blizzard**	**Heavy snowfall**
Kyzylorda	0,1	1,2	1,5	0,3
South Kazakhstan	14,5 (1,7)	2,7 (0,4)	1,0	28,1 (2,3)
Zhambyl	6,0 (1,5)	10,2 (1,5)	1,3	3,7 (1,3)
Almaty	59,2 (3,9)	43,6 (1,6)	0,5	43,8 (3,3)
East Kazakhstan	4,8 (3,7)	14,5 (0,7)	15,3 (0,8)	11,6 (7,6)
Karaganda	1,8	4,4 (0,8)	12,3 (0,4)	1,7
Pavlodar	1,8	1,2	4,3 (0,1)	0,9
Akmola	2,7 (0,7)	9,7 (1,6)	19,4 (0,5)	2,6 (4,0)
North Kazakhstan	2,8 (4,0)	5,0 (3,4)	6,1 (0,5)	0,0
Kostanay	2,9 (5,3)	3,6 (2,7)	18,4 (0,8)	4,3 (3,5)
Aktobe	0,8	0,8	14,8 (0,8)	1,7
Atyrau	0,7	0,4	3,1 (1,3)	0,3
West Kazakhstan	1,3	1,2	1,5	1,1
Mangystau	0,6	1,6	0,3	0,0

Note*. The multiplicity factor of the number of EWEs is given in parenthesis for the two periods (2003-2015 against 1990-2002).

If we look at all EWEs observed in Kazakhstan in recent years (Annex 10) we can see Almaty oblast stands out being on the top by the number of registered EWEs, i.e. 38.7% of all EWEs occurring in Kazakhstan. It is followed by South Kazakhstan and East Kazakhstan oblasts with their respective shares of 10.9% and 10.7%. Akmola and Zhambyl oblasts shares are 8.3% and 7% respectively. In other oblasts EWE frequency ranges from 1% (Mangystau oblast) to 6% (Kostanay oblast).

In conclusion we would like to note that the year of 2016 in Kazakhstan is likely to be one of those experiencing frequent EWEs. In Almaty alone 10 rain showers occurred in the period from April to July 2016 with gusty wind, sometimes with hail too, interfering with traffic and people movement, breaking trees, flooding houses. Thus, for example, in the evening of July 18, 2016, Almaty plunged into the darkness because of a summer storm – heavy rain broke out followed by a thunderstorm, squally wind with large hailstones in some places. Similar phenomena are not uncommon in the foothills of the Ile-Alatau, but this event was special. In the photo below (Figure 72) one can clearly see that Almaty was covered by a huge thunder cloud, a kind of a mesocyclone with a typical rotating and ascending airflow. Such mesocyclones, although small in scale (up to 50 km in a diameter), can cause rainfall with hail and stormy wind.

Figure 72. *Huge thunder cloud over Almaty city. July 18, 2016.*

Similar events had happened in Almaty area in recent years. On May 17, 2011, a shower with storm wind and hail beat down and damaged tens of thousands of trees in the Small Almaty Gorge having caused enormous damage to the valuable conservation area.

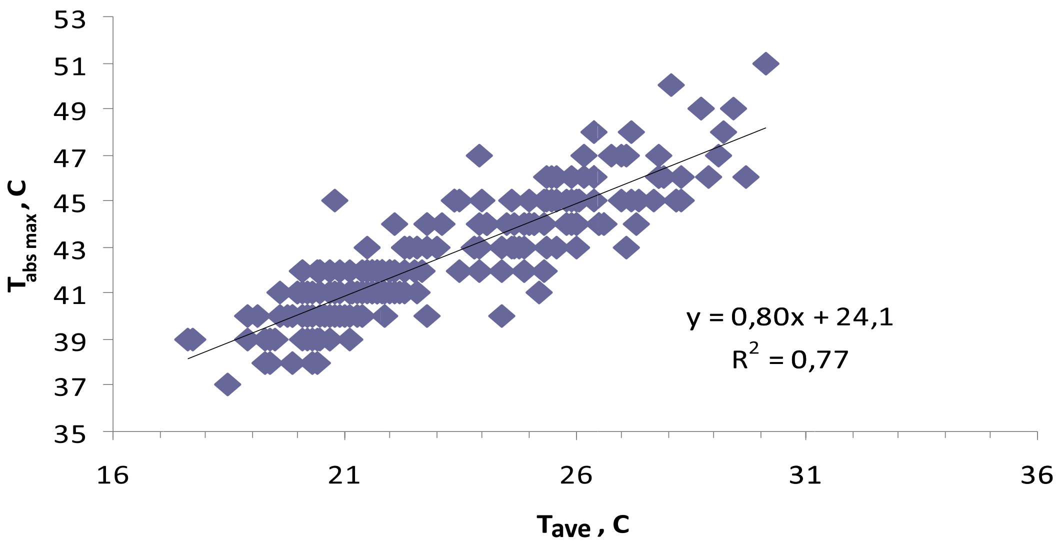
6.3.3. Short-term, mid-term and long-term evaluation of extreme weather events occurrence in climate change conditions

Extreme weather events are known to be rarely occurring, so it is hard to forecast them for the coming decades. However, having reviewed forecasts made by climate researchers, historical facts, common patterns and persistence of certain processes, in this chapter we made an attempt to evaluate future occurrence of EWEs studied above. The research group obtained climate data (temperature and precipitation variations) for the periods of 2016-2035, 2046-2065 and 2081-2099 and for two scenarios of future human impact on the global climate system: RCP4.5 and RCP8.5.

Calculation results for the two future climate scenarios in Kazakhstan are shown in schematic maps in the following chapters.

Changes in excessive heat frequency in Kazakhstan are of much interest. We reviewed absolute temperature maximums that correlate well with average temperatures in July (Figure 73).

Figure 73. *Absolute temperature maximum (°C) dependence on average temperature (°C) in July.*



Temperature distribution in July and its absolute maximums for a multiannual period over the territory of Kazakshstan are indicated in Figure 74.

Figure 74. *Temperature distribution around Kazakhstan in July.*
Absolute maximums are indicated as figures.

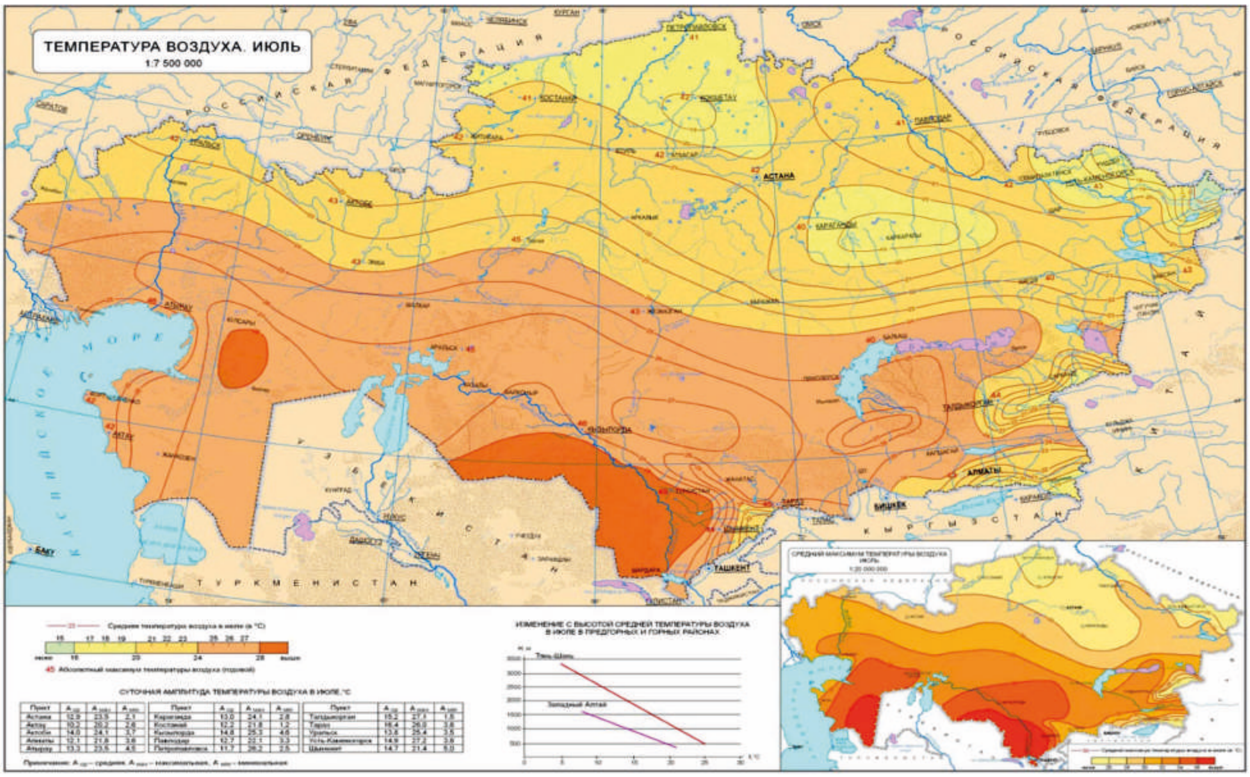


Table 70 contains the results of calculations of future absolute maximum temperature variations in northern and southern Kazakhstan.

Table 70. *Potential changes in absolute air temperature in Kazakhstan in the 21st century (°C)*

		Northern Kazakhstan		Southern Kazakhstan	
RCP	**Period**	**from**	**to**	**from**	**to**
	2016-2035	0,9	1,2	0,6	0,9
RCP4.5	2046-2065	1,9	2,2	1,5	1,9
	2081-2099	2,2	2,6	1,9	2,2
	2016-2035	1,8	2,5	1,3	1,8
RCP8.5	2046-2065	2,5	3,1	1,8	2,5
	2081-2099	4,3	5,0	3,8	4,3

The above calculation results prove higher frequency of excessive heat in the future.

As for other EWEs estimation of their future occurrence is deemed a challenging task, since they depend not only on air temperature, but also on other weather parameters not forecasted by climate researchers.

Circulation processes in Kazakhstan have also changed over the recent years. Starting back in 1970-s the south-western and latitudinal transports are increasing while north-western is decreasing. Probably, changes in circulation over Kazakhstan are another factor of extreme weather conditions frequency.

Taking EWEs frequency in global warming and circulation persistence in the nearest future into account we can suppose that the following EWEs will keep occurring in Kazakhstan: heavy precipitation (rainfall, snowfall, sleet), strong wind, strong blizzard and large hail.

Rainstorms with gusty winds, heavy snowfalls with blizzard and hail may become more frequent in mountainous and piedmont areas.

Strong blizzards are also likely to dominate in northern regions.

Strong storm winds (30 m/s or more) will also be observed over Kazakhstan lowlands. Even though such phenomena are rare, their unexpected nature represents hazard to economy and human life activity.

Due to climate change frequency of dust storms over the larger part of Kazakhstan has been going down lately. Majority of Kazakhstan meteorological stations registered decrease in average wind speed in the last 15 years (2001-2015) that have caused reduction in the number of dust storm days. Only two stations (Dzhusaly and Akkuduk) registered a minor increase in the number dust storm days (by 3-4 days) due to increase in wind speed at those locations.

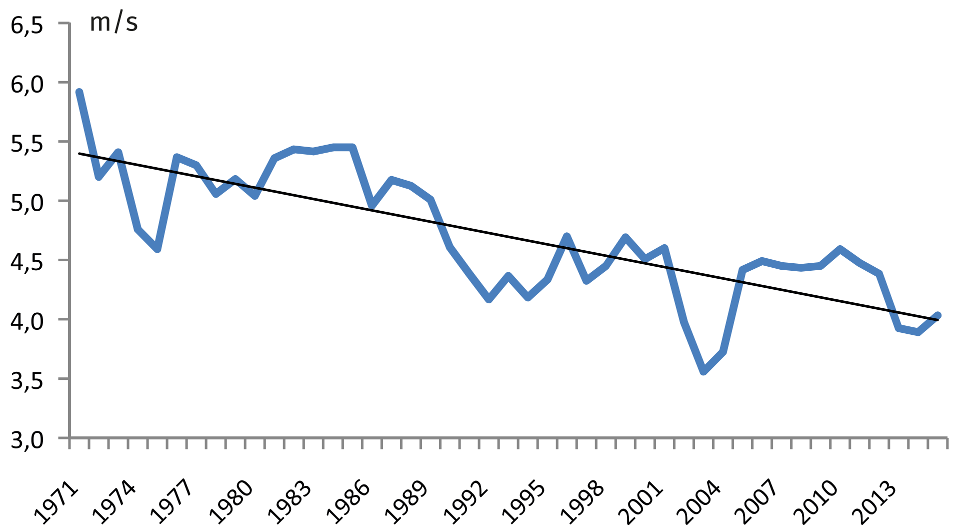
Since the Aral Sea and the Balkhash Lake have experienced the greatest human impact in recent years and dust storms are frequent in their respective areas we studied them more thoroughly and received interesting results (Table 71).

Table 71. *Average wind speed and average number of dust storm days in one year in different periods at Kazakhstan meteorological stations.*

	Wind speed (m/s)			Dust storm (number of days)		
Meteorological station	**1971-2000**	**2001-2015**	**Difference**	**1971-2000**	**2001-2015**	**Difference**
Akkum	2,1	1	-1,1	3	0,3	-2,7
Turkestan	3	2	-1	5,3	3	-2,3
Aral Sea	4,9	4,2	-0,7	64,1	42	-22,1
Bakanas	1,6	1	-0,6	42,6	31	-11,6
Matai	2	1,4	-0,6	27,9	13	-14,9
Shalkar	4,4	3,9	-0,5	18,7	1	-17,7
Zharkent	2,2	1,7	-0,5	3	4	1
Karashoky	4,9	4,4	-0,5	3,7	3	-0,7
Inderborkiy	5,4	4,9	-0,5	10	14	4
Baskuduk	4,5	4	-0,5	8,1	3	-5,1
Dzhambeity	4,2	3,7	-0,5	4,3	3	-1,3
Balkhash	4,4	4,1	-0,3	9,1	3	-6,1
Aul n4	2,7	2,5	-0,2	5,2	1	-4,2
Kyzylkum	2,5	2,3	-0,2	9,3	2	-7,3
Ushtobe	1,8	1,6	-0,2	8	2	-6
Otar	1,8	1,7	-0,1	4,2	2	-2,2
Kuigan	2,5	2,4	-0,1	39,7	30,6	-9,1
Dzhusaly	4,2	4,3	0,1	15,8	20	4,2
Shymkent	1,8	1,9	0,1	3,9	1	-2,9
Arys	2	2,1	0,1	6,2	1	-5,2
Beineu	3,3	3,4	0,1	4	4	0
Chiganak	2,1	2,2	0,1	1,8	2	0,2
Kazalinsk	2	2,1	0,1	0,7	1	0,3
Kulzhambai	3,2	3,4	0,2	4,4	3	-1,4
Sam	3,4	3,6	0,2	3,7	3,0	-0,7
Yegindykol	3,4	3,6	0,2	5	5	0
Aktogai	2,1	2,4	0,3	25,4	10	-15,4
Zhezkazgan	3,1	3,4	0,3	2,3	3	0,7
Kzylzhar	2,5	2,9	0,4	9,2	6	-3,2
Akkuduk	2,6	3,7	1,1	4,8	8	3,2

It is well known that in early 1970-s the Aral Sea started to quickly shrink due to human activity. Figure 75 shows that average annual wind speed in north-eastern part of the Aral Sea varied within the range of 5-6 m/s (Aral Sea MS). In 2000-2015 average annual wind speed at the Aral Sea MS went down to 4-4.5 m/s.

Figure 75. *Average annual wind speed dynamics at the Aral Sea MS in 1971-2015.*



However, despite the downward wind speed trend in the period from 1971 to late 1990-s the number of dust storm days went up and over 100 days in some years (Figure 76). We believe that this was caused by drain lands expansion and acceleration of desertification processes (Figure 77). Lower frequency of dust storms at the Aral Sea MS in recent years is probably linked not only to wind speed decrease, but also to reduction of load on pastures and the Aral Sea rescue measures taken in recent years (saxaul plantings, sand fixation, etc.).

Figure 76. *Dynamics of dust storm days at the Aral Sea MS in 1971-2015.*

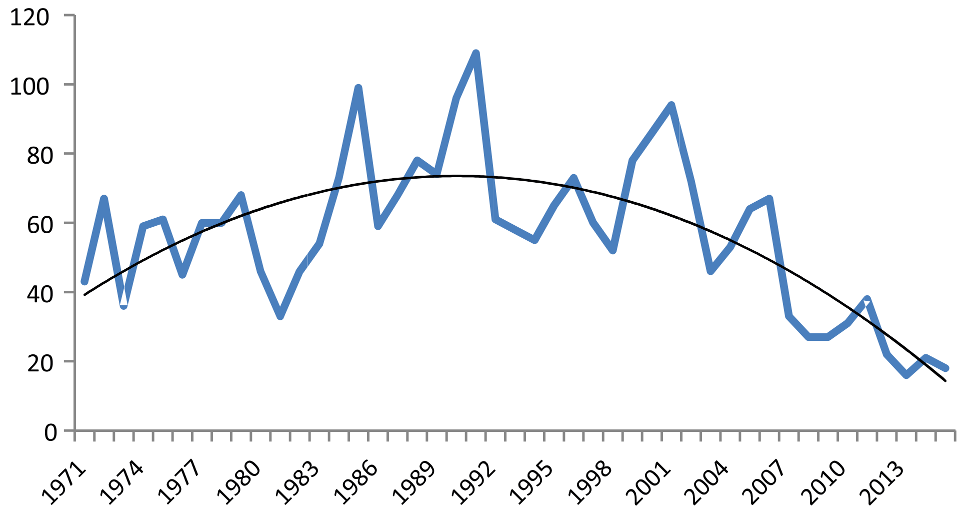
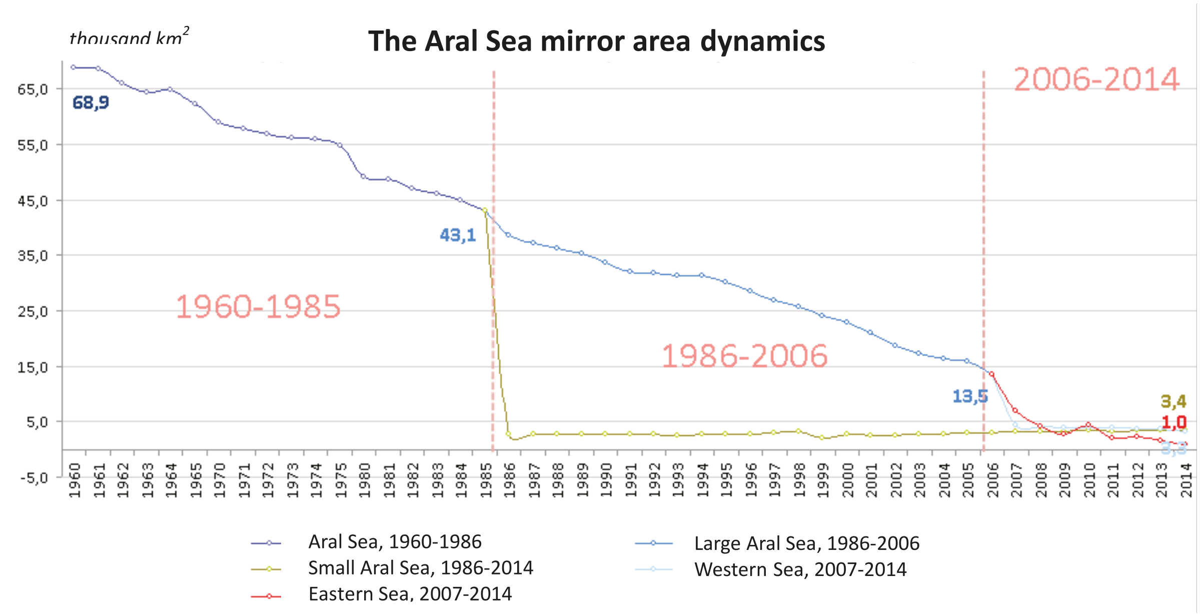
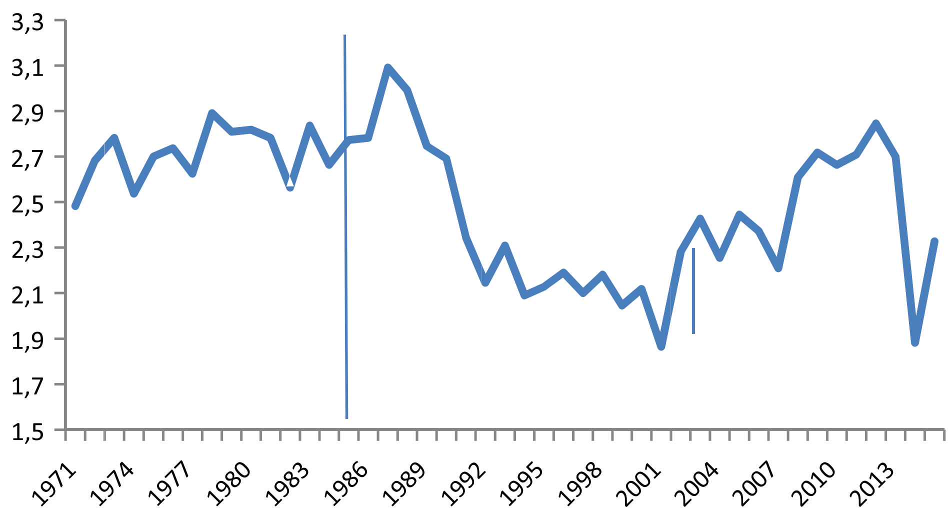


Figure 77. *The Aral Sea mirror area dynamics.*



Kuigan MS was selected for dust storm studies around the Balkhash Lake. It is located in its southern part. Evaluation of the annual average wind speed variation at Kuigan MS: 1971-1987, 1988-2001 and 2002-2015. While in the first period the average wind speed trend was going upward, in the second period wind speed was considerably decreasing year on year. In the third period the trend is in general positive.

Figure 78. *Average annual wind speed dynamics at Kuigan MS in 1971-2015, periods 1, 2, and 3*



Below are results of comparison of average wind speed dynamics (Figure 78) and the number of dust storm days by periods:

1. In the first period higher frequency of dust storms goes in line with increase in wind speed in general. However, at the end of the same period the number of dust storm days increased heavily (nearly 4 times) while average wind speed went up by only 0.3-0.4 m/s. Such sharp increase in dust storms frequency is probably linked with intensive lowering of the Balkhash Lake level that reached its minimum in 1987.

2. In the second period, despite significant wind speed reduction the number of dust storm days was going down, but was still on the high level (40 days per year on average). In this period (1988-2001) the Balkhash Lake level was below normal.
3. In the third period wind speed and the Balkhash Lake level were going up as the number of dust storm days was changing slowly year on year.

Based on the above study results we can conclude that higher dust storm frequency at the Aral Sea MS and Kuigan MS (the Balkhash Lake area) was mainly caused by lower water content in the sea and the lake.

6.3.4. Some short-term and mid-term conclusions (assumptions) on future climate

- Frequency of extreme events with heavy precipitation (rainfall, snowfall) and storm winds and hail in piedmont and mountainous areas of Kazakhstan may remain the same or increase.
- Northern and eastern oblasts of Kazakhstan may experience frequent heavy precipitation (snowfall) with gusty wind that will trigger more natural emergencies. Early snow melting due to rapid warming, and heavy precipitation may cause increased number of floods and ice jams in Kazakhstan lowlands.
- Circulation changes with mesocyclones and intensive formation of deep convective clouds may trigger frequent and rapid changes in weather accompanied by heavy storm rainfall, hail and gusty wind. Such EWEs will be most hazardous for economy and human life activity.
- Given the increased climate aridity and changing circulation processes, it can be assumed that dust storms are likely to occur more often in all regions of Kazakhstan.

In the long term:

- If the level of the Balkhash Lake goes down below the mark of 341 m BS frequency of dust storms may increase in the southern Balkhash area. Moreover, dust storms frequency will depend on lowering of the Balkhash Lake level: the more intensive the lake recession, the higher the probability of dust storms in the southern Balkhash area.
- Until the end of the 21st century Kazakhstan is likely to see increase in absolute air temperature by additional 2-4°C in the south and by 2.5-4.5°C in the north. Higher frequency of excessive heat will not only affect the economy of Kazakhstan but also have a negative impact on human health and life activity.

6.3.5. Gaps, barriers and improvements in organization of observations, database seeding, development of scientific research on extreme weather events in climate change conditions

At present Kazhydromet RSE (the National Hydro-Meteorological Service) has no sufficient capacity to render appropriate services to authorities or social and economic sectors.

It should be noted that high spatial resolution data are essential in evaluation of climate change implications and particularly of extreme weather events, while the existing observation network is too sparse. This problem can be resolved by more extensive use of hydro-meteorological data collected by Kazhydromet's observation network in combination with observations made by other agencies and organizations.

Unfortunately the climate change issue lies beyond the structure of state system functioning. For example, around 50 different development programs are implemented in Kazakhstan with no clear network of interactions among them on development and implementation stages. Environment protection authority lacks sufficient powers to ensure mandatory integration of climate change issues in state programs and strategies.

Insufficient justification of weather alerts, overlook of hazardous weather events and lack of reliable early weather forecasts in the country interfere with emergency response efficiency. This is mainly linked with insufficient network of meteorological stations and points, and a small number of aerological stations.

Practical use of space monitoring data by first responders is not properly arranged. Remote sensing of the country territory from outer space for early warning and emergency recovery efforts is in the primitive state of development.

Kazakhstan lacks a national strategy (action plan, program, etc.) on climate change. Any measures taken separately to prevent climate change and adapt to it are isolated and inconsistent.

Disaster threat mitigation goals have to be systematically incorporated in sustainable development strategies, plans and programs.

In addition to the above we detected the following gaps and barriers:

- lack of models with higher resolution for projection of extreme events and their impact on economy and human health;
- lack of data on material damage (in monetary terms) caused to economy sectors by extreme weather events;
- climate change and extreme events forecasting is still linked with numerous uncertainties;
- low levels of climate change awareness among practitioners in various sectors;
- insufficient personnel qualification, publicity and educational activities in climate-dependent economy sectors;
- interaction between various organizations and activists is often limited; another barrier is lack of climate-related risk awareness.

The following actions are suggested for improvement of extreme weather events monitoring system:

- NHMS modernization with particular focus on monitoring system improvement in areas where climate risks related to extreme weather events are highest;
- introduction of cutting-edge methods, devices and equipment (radar stations, remote sensing data) to enable full-fledged monitoring of extreme weather events;
- continuous tracking of extreme weather events occurrence, creation of databases and alerts to climate-dependent industries;
- better performance and interaction between early warning systems (NHMS) and emergency management teams;
- intensification of efforts under inter-sectoral and inter-disciplinary approach to climate risk mitigation with active involvement of stakeholders;
- research institutes operating on the national, regional and global levels need to focus on research, risk mapping, capacity-building, training and outreach activities.

Disaster risk mitigation efforts help mitigate risks and implications related to climate and extreme weather events. They are essential for adaptation to climate change.

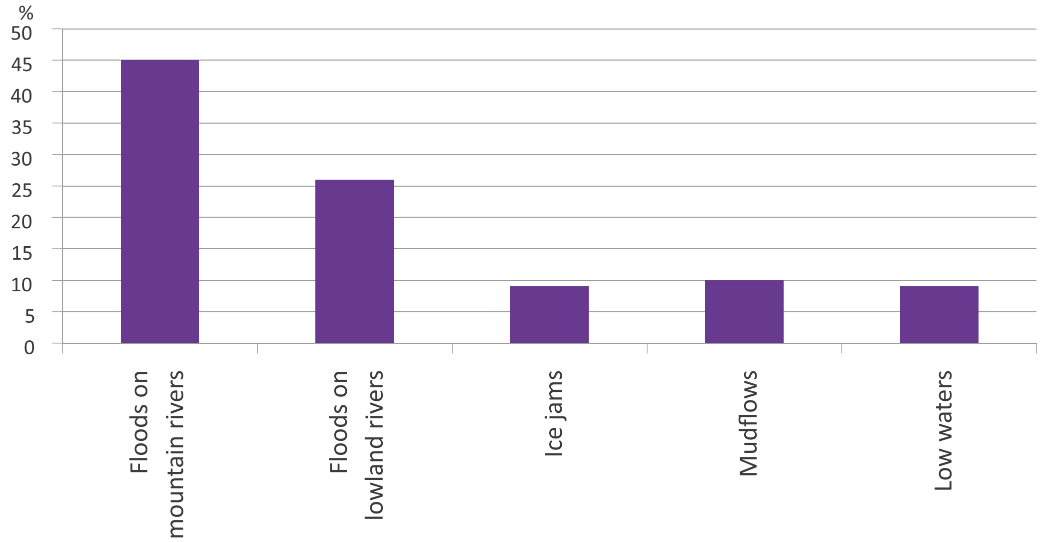
6.4. Extreme hydrological events in Kazakhstan

Of all hazardous hydrological events the most frequent in Kazakhstan are floods on mountain rivers, they take up 45% of total spontaneous hydrological events (SHEs) occurrence, floods on lowland rivers – 26%, mudflows – 10%, ice jams on rivers and extremely low waters – 9% each (Table 72, Figure 79).

Table 72. *Spontaneous hydrological events and their shares in% in the total SHEs occurrence*

SHEs	% of total SHEs occurrence in 1967-2015
Floods on mountain rivers	45
Floods on lowland rivers	26
Ice jams	9
Mudflows	10
Low waters	9

Figure 79. *Shares of different SHEs in% in the total SHEs occurrence.*

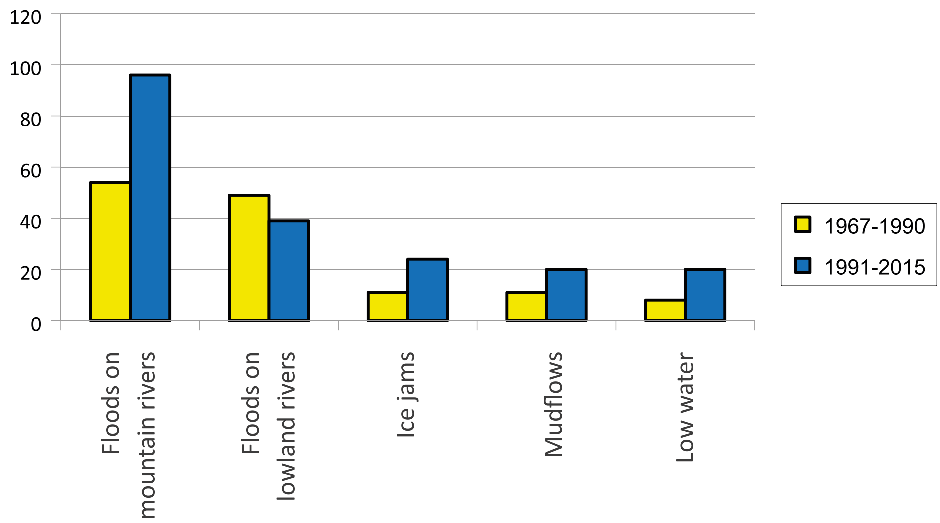


Over the period of 1991-2015 against the previous period of 1967-1990 we can see that floods on mountain rivers, ice jams, mudflows and low water phenomena have become more frequent, while the amount of floods on lowland rivers has gone down (Table 73).

Table 73. *SHEs occurrence in 1967-1990 and 1991-2015*

SHEs/periods	1967-1990	1991-2015
Floods on mountain rivers	54	96
Floods on lowland rivers	66	52
Ice jams	12	23
Mudflows	11	20
Low water	9	19
TOTAL	**54**	**96**

Figure 80. *SHEs occurrence on Kazakhstan rivers in 1967-1990 and 1991-2015.*



Below tables show data on extreme hydrological events over the period of 1967-2015 at lowland and mountain rivers of Kazakhstan (Tables 75, 56).

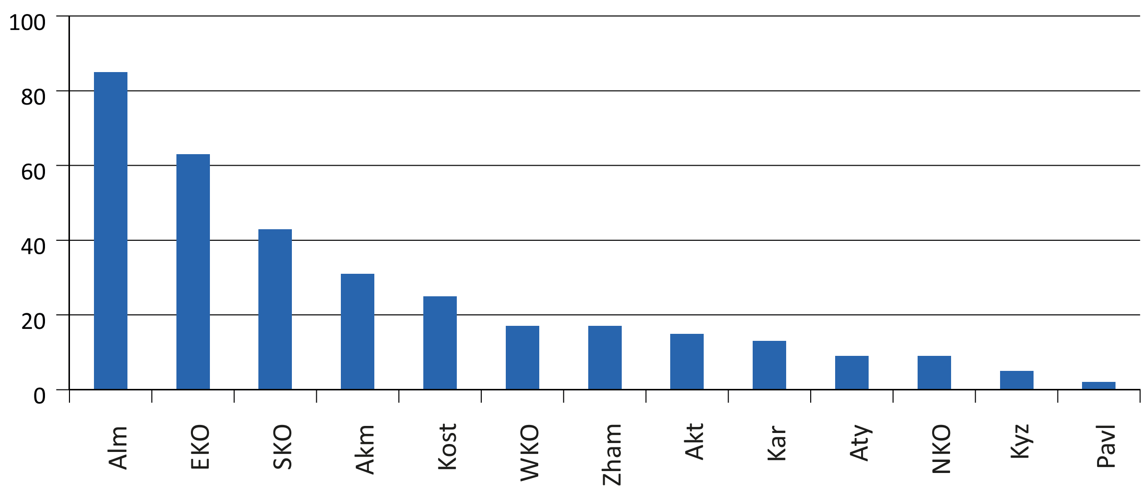
6.4.1. Analysis and evaluation of extreme hydrological events frequency and intensity changes by Kazakhstan oblasts and economy sectors in 1967-1990 and 1991-2015

Since the river network is distributed extremely unevenly around the territory of Kazakhstan the number of spontaneous hydrological events in different oblasts varies significantly (Table 74, Figure 81).

Table 74. *Total number of hazardous hydrological events broken down by oblasts*

Oblast	Number of SHEs (1967-2015)
Almaty	85
East Kazakhstan	63
South Kazakhstan	43
Akmola	31
Kostanay	25
West Kazakhstan	17
Zhambyl	17
Aktobe	15
Karaganda	13
Atyrau	9
North Kazakhstan	9
Kyzylorda	5
Pavlodar	2
TOTAL	**334**

Figure 81. *Number of SHEs in Kazakhstan in 1967-2015 by oblasts*



Over the period from 1967 through 2015 the following number of extreme hydrological events was observed across Kazakhstan (Table 75, Table 76).

Table 75. *Lowland rivers (1967-2015)*

Oblast	Number of events		
	High flood	Extreme low water	Flood caused by ice jam on river
WKO	11	6	
Aktobe	9	3	3
Atyrau	5	4	
Kostanay	20	4	1
Akmola	27	4	
NKO	8	1	
Karaganda	8	4	1
Pavlodar		2	
Kyzylorda			5
TOTAL	88	28	10

Table 76. *Mountain rivers (1967-2015)*

Oblast	Number of events			
	High flood	Mudflow	Flood caused by ice jam on river	Low water
Almaty	47	30	7	1
SKO	38	1	4	
Zhambyl	14		2	1
EKO	51		12	
TOTAL	**150**	**31**	**25**	**2**

The total number of hazardous events in Kazakhstan in the period from 1967 through 2015 equals 334. Of them high floods on lowland rivers and hazardous high floods on mountain rivers account for 71%, mudflows – 10%, floods caused by ice jams – 10%, low waters – 9%.

The highest number of SHEs is observed in mountainous regions with a developed river network – in Almaty (high floods and mudflows), East Kazakhstan (floods and ice jams) and South Kazakhstan (floods) oblasts. The lowest number of SHEs is observed in regions with limited amount of rivers and water resources – Karaganda, Kyzylorda, Aktobe, and Atyrau oblasts. In Pavlodar oblast, where the only major water body is the Yertis River, serious damage was caused by extremely low waters.

Areas where SHE-related risks are higher regardless of the oblast are river bottom-lands actively developed despite the fact that they fall into the flooding areas with 5-10% or more probability rate.

Table 77. *SHE occurrence in Kazakhstan oblasts in 1967-1990 and 1991-2015*

Oblast / SHE type, mountains	Floods		Mudflows		Ice jams		Low waters		TOTAL
	1967-1990	1991-2015	1967-1990	1991-2015	1967-1990	1991-2015	1967-1990	1991-2015	
Almaty	20	27	11	19	3	4		1	85
SKO	16	22		1	1	3			43
Zhambyl	9	5			1	1		1	17
EKO	9	42			3	9			63
Total for mountains	**54**	**96**	**11**	**20**	**8**	**17**			**208**

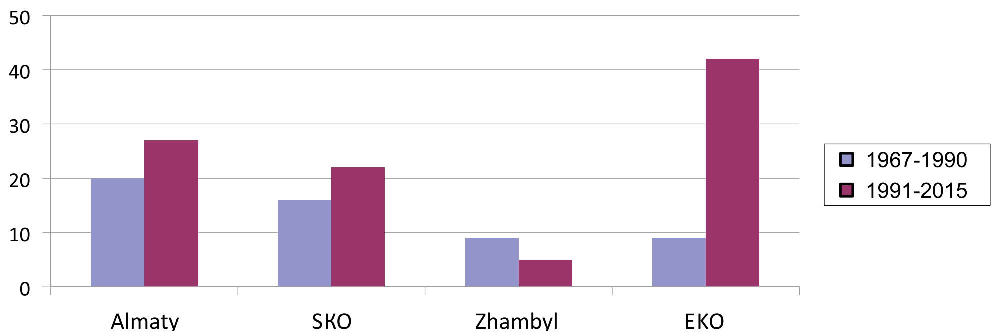
Lowlands

Oblast / SHE type	High flood		Low waters		Ice jams		TOTAL
	1967-1990	1991-2015	1967-1990	1991-2015	1967-1990	1991-2015	
WKO	6	5	4	2			17
Aktobe	6	3	1	2	3		15
Atyrau	4	1	2	2			9
Kostanay	6	14		4		1	25
Akmola	20	7		4			31
NKO	4	4		1			9
Karaganda	3	5		4		1	13
Pavlodar			1	1			2
Kyzylorda						5	5
Total for lowlands	**49**	**39**	**8**	**20**	**3**	**7**	**126**

Floods causing damage to Kazakhstan economy have become more frequent (Figure 82). This is primarily explained by increase in water content in the majority of Kazakhstan mountain rivers observed over the recent years. Floods are usually triggered by heavy precipitation, but with low water content rainfall flood wave is not that high to cause any damage. However, flood on a river with increased water content can be disastrous. Dependence between increase in water content and high flood frequency is direct.

Areas affected by high floods are mountainous and piedmont areas of South Kazakhstan, Zhambyl, Almaty and East Kazakhstan oblasts. The most significant increase in high floods is observed in East Kazakhstan oblast (4.7 times); Glubokov, Zyryanov, Katon-Karagay, Urdzhar, Abay and other EKO districts were flooded in 2015. The number of floods on rivers in Almaty oblast has gone up by 35%, in SKO – by 38%, while in Zhambyl oblast it has gone down by 40% (Figure 82).

Figure 82. *Changes in frequency of floods on Kazakhstan mountain rivers in 1991-2015 versus 1967-1990*

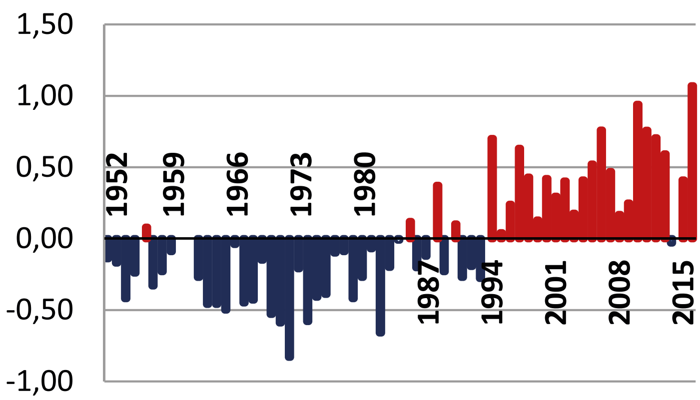


Increase in water content in the majority of mountain rivers and floods frequency results from climate change, temperature rise, degradation of mountain glaciation and increased water loss from glaciers. Besides, due to universal warming upper limit of liquid precipitation is going up to expand the area of rainfall flood formation.

Figure 83 shows the magnitude of deviations of average annual water discharge on the Ulken Almaty River (Almaty oblast, Ile-Alatau range) from normal values calculated for the period of 1952-2016. The gauging station on the Ulken Almaty River – 1.1 km above the lake – is located at the height of 2.6 thousand meters. The river on this level is mainly fed by melting snow and glaciers. Active degradation of mountain glaciation has led to a steady increase in river runoff since 1970-s.

When deviation of the Ulken Almaty River annual flow from the long-term average annual value (1.84 m³/s) was calculated it turned out that since 1990-s runoff in the highlands is above the norm, and the subject deviation is increasing (Figure 83).

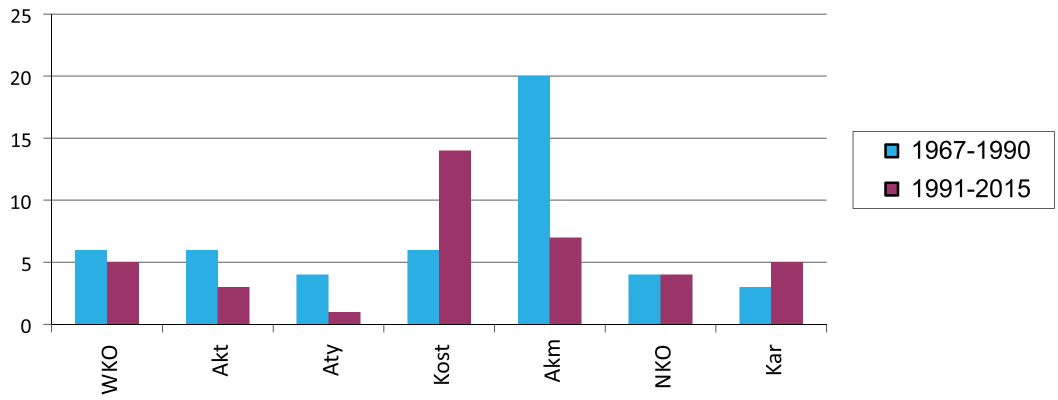
Figure 83. *Deviation of the Ulken Almaty River annual flow from the long-term average annual value of water discharge.*



Flood-related damage is not increasing only due to flood frequency. Over the last years new areas built up and developed and exposed to floods that are not necessarily infriquent floods.

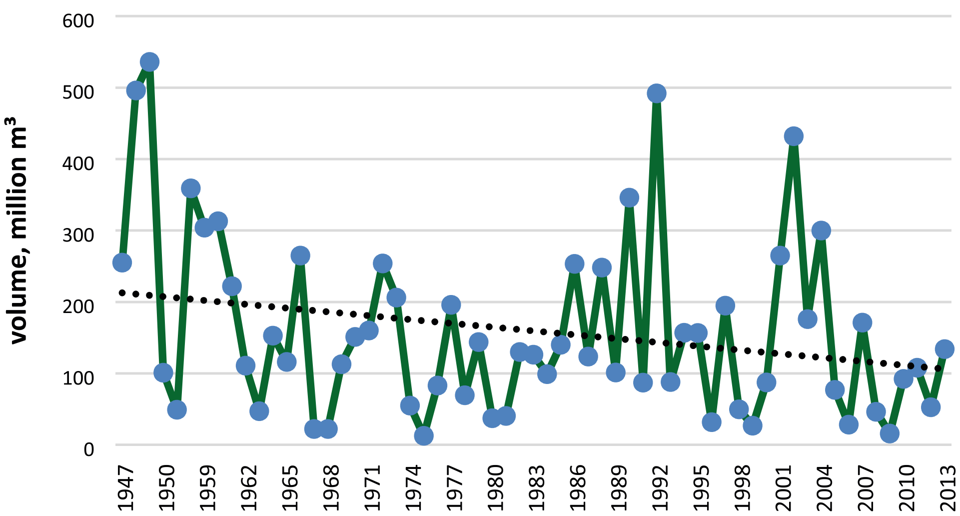
Occurrence of high spring floods on the majority of lowland rivers has gone down over the recent years (Figure 84). This is a result of decrease in water content of lowland rivers. One of the reasons of lowland river runoff reduction is climate change, first of all – temperature increase. Due to increase in March-April air temperature snow melts and Kazakhstan rivers are flooded earlier than before mid-1980s. This factor impacts the spring flood volume. Annual runoff volume largely depends on the time snow starts to melt. The later spring comes, the longer is the period of snow accumulation, the less are the runoff losses in snow melting and the more is the water content in rivers. And vice versa, earlier spring that drags on as the cold returns causes major losses of moisture content in river basins and, consequently, annual runoff reduction.

Figure 84. *High flood frequency changes on lowland rivers of Kazakhstan in 1991-2015 versus 1967-1990.*



A vivid example of decrease in the water content of lowland rivers is the Sherubainura River in Karaganda oblast (Figure 85). The trend line in the annual runoff chart for the Sherubainura River is downward. The assessment report on climate change in Kazakhstan says that every 10 years air temperature in Karaganda oblast increases by +0.27°C in winter and by +0.33°C in spring.

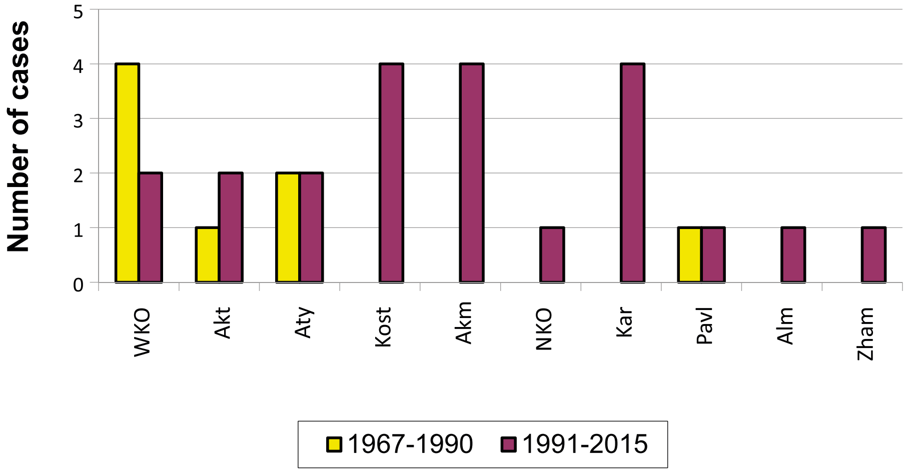
Figure 85. *Sherubainura (Kara-Murun station) annual runoff chart*



The downward trend of water content in lowland rivers doesn't rule out rare but extremely high floods, like those registered in Karaganda oblast in 2015. On average the amount of high floods in Kazakhstan lowlands in 1991-2015 has decreased by 20% against 1967-1990. In Atyrau and Aktobe oblasts high floods frequency has gone down by 75% and 50% respectively, in WKO – by 17%. In NKO high floods frequency hasn't changed, in Kostanay oblast floods occurrence increased twofold against the previous period, and in Karaganda oblast two more events were registered.

Due to decrease in water content of lowland rivers mentioned above extremely low water events have become more frequent (Figure 86).

Figure 86. *Frequency of extremely low water events on Kazakhstan rivers in 1991-2015 versus 1967-1990.*



No extremely low water events on rivers of Kostanay, Akmola, North Kazakhstan, Karaganda, Almaty, and Zhambyl oblasts were registered in 1967-1990. However, such events occurred in 1991-2015. The number of low-water years has decreased twofold in WKO, but hasn't changed in Atyrau and Pavlodar oblasts.

Ice jams on lowland rivers and depression floods they cause are mostly observed on rivers flowing from the south to the north (rivers Syrdarya, Yertis, Yessil, Tobol). Climate change and air temperature increase result in earlier ice break-up on the upper reaches while downstream is still covered with ice. Barely a single ice jam occurred on the Ural River flowing across Kazakhstan from the north to the south.

In the period from 1967 through 1990 3 ice jam events and floods they caused were registered in Aktobe oblast (all three occurred in 1981). In 1991-2015 1 event was registered in Kostanay oblast, 1 – in Karaganda oblast, 5 – in Kyzylorda oblast on the Syrdarya River.

Ice jams raise the level of water and cause waterside floods. In recent years the number of ice jams has increased by 33% in Almaty oblast, but hasn't changed in Zhambyl oblast. In 1967-1990 1 ice jam event was registered in SKO on the Arys River and three ice jam events – on the Syrdarya River in 1991-2015. Ice jams are also observed in East Kazakhstan oblast on the Yertis and other rivers, as well as on mountain rivers like the Bukhtarma, the Oba, etc. Their total number has lately gone up threefold.

Mudflows (in the form of mud-rock, mud, suspended, ice-water streams) of various origins (glacial, rain shower, mixed origin, anthropogenic) are common for mountain rivers of Kazakhstan where they cause considerable damage. The majority of mudflows are of shower origin. An example of mudflow triggered by heavy showers is the one that happened on the Sarysay River in 2013.

Mudflows that caused noticeable damage were registered only in Almaty oblast in 1967-1990. In 1991-2015 the frequency of mudflows increased by 82% and one such event was registered in South Kazakhstan oblast.

6.4.2. Short-term, mid-term and long-term evaluation of extreme hydrological events occurrence in climate change conditions

Further warming can be expected in Kazakhstan in the 21st century. Average annual temperature will rise by 1-2 °C by 2030 and by 2 3 °C by 2050. Precipitation amount will mainly increase by up to 10% before 2050, while 10% margin will probably be exceeded in northern, central and mountainous south-eastern areas.

Temperature increase means further degradation of mountain glaciation, higher maximum liquid precipitation levels, intensification of mudflows. Since precipitation increase by as much as 10% is already fraught for mountainous regions where mean annual precipitation amounts to 600-900 mm, the upward trend of mountain river runoff is expected to continue in the nearest future (Figure 87), and high slush-rainfall and suspended mudflows will occur more frequently.

Figure 87. *Average annual water discharge rate on the Bayankol River, Bayankol village. Catchment located between 2.1 – 4.5 thousand meters.*

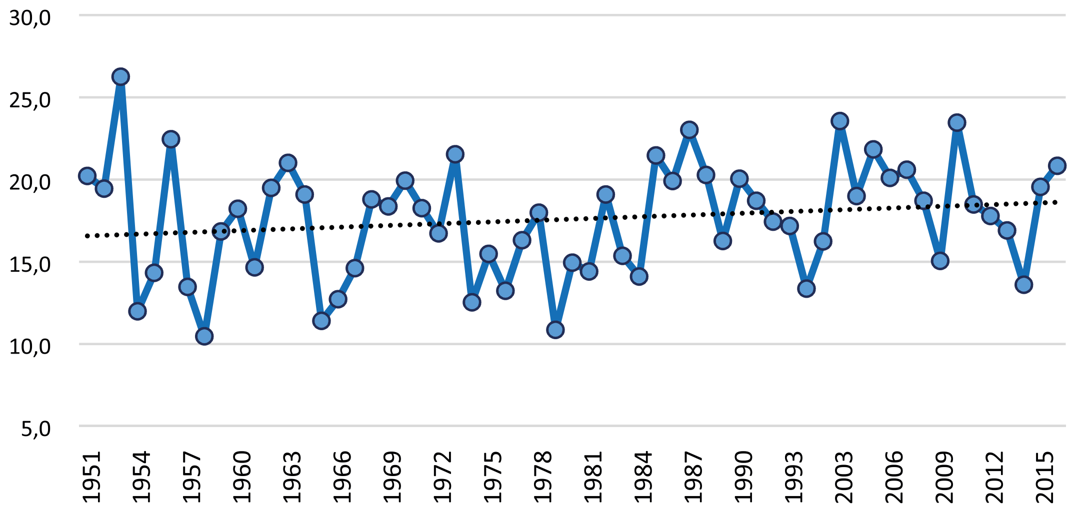
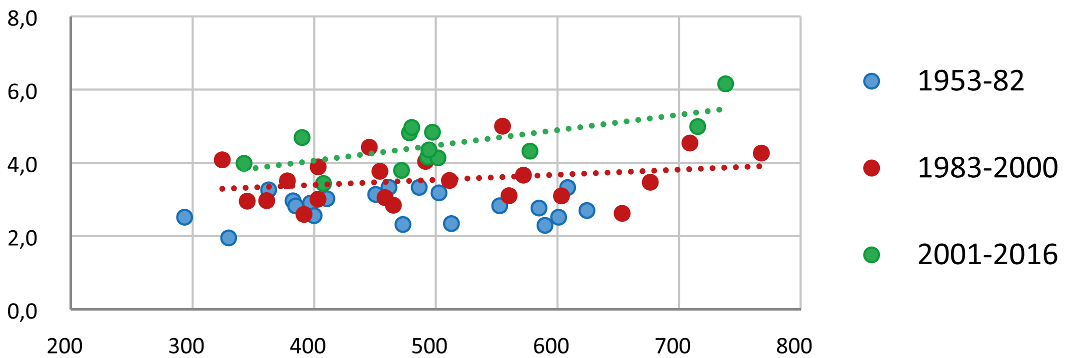


Figure 88 shows dependence of the Ulken Almaty spring-summer runoff on precipitation intensity. Given the same precipitation amount in moisture accumulation period (October-July) the river runoff is higher in 1983-2000 than in 1953-1982, and even higher in 2001-2016 than in the previous periods. Such scatter is mainly caused by degradation of mountain glaciation. In 1953-1982 runoff fluctuations were caused by glacier and snow cover melting and not by precipitation (horizontal position of points at the chart), but in 2001-2016 there is a trend of increasing spring and summer runoff that depends on rainfall. The reason is the shift of the upper borderline. Shrinkage of glaciers in the long-term will cause decrease in ablation rate and rainfall the share of glacier runoff in the total volume of mountain river runoff.

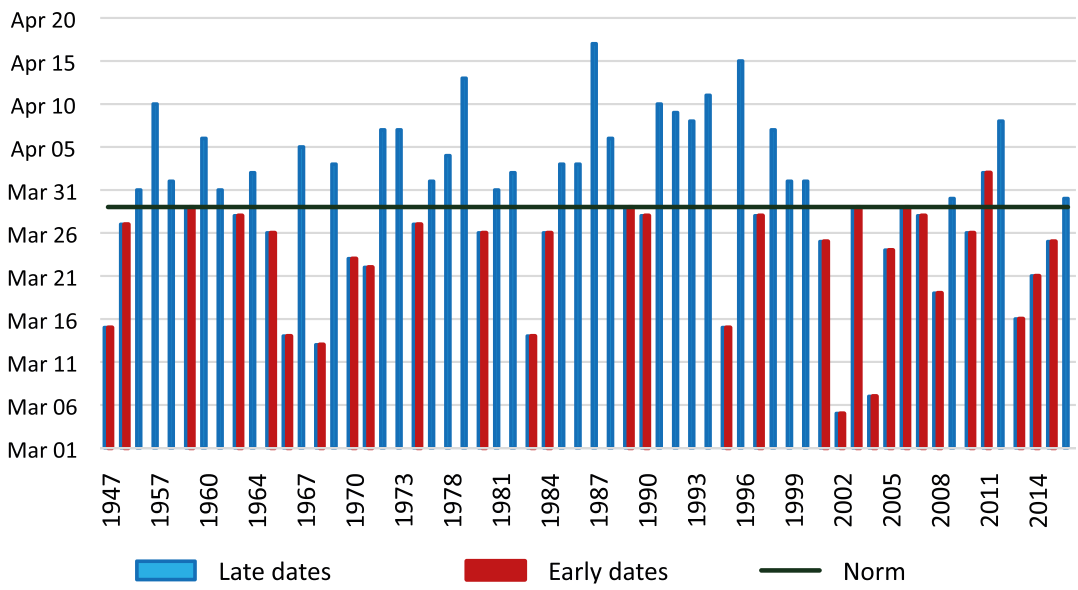
Due to increase in mountain precipitation the treat of hazardous events occurrence on rivers in these regions will continue to grow.

Figure 88. *Dependence of the Ulken Almaty spring-summer runoff on precipitation amount in October-July over different periods.*



In Kazakhstan lowland areas temperature increase will induce earlier floods on rivers (Figure 89). Earlier snowmelt will shorten the period of snow accumulation in river basins, weaken soil freezing and increase losses and will, as a consequence, decrease water content in lowland rivers. A smaller volume of spring flood will reduce natural spills and flooding.

Figure 89. *Start of floods on the Sherubainura River compared to the norm.*



Increase in air temperature in Akmola and North Kazakhstan oblasts by 2 °C by 2030 will create climatic conditions similar to those currently observed in Central Kazakhstan. In their turn they will affect the hydrological regime of Yessil and Tobol basin rivers.

However, the treat of floods in lowland areas of Kazakhstan is not promoted by high floods alone. With a general trend of decreasing water content in lowlands rivers population and infrastructure will continue to densify around water bodies. This can lead to flooding and damage caused by rising water levels in rivers during not only extreme floods, but also those close to normal, with a recurrence of every 3-5 years. At the same time, the number of ice jams on rivers as well as low water periods and droughts will increase.

Another threat is further wear and tear of hydraulic structures. Most Kazakhstan dams were constructed 40-50 years ago and their depreciation will intensify in the coming years. In addition to that, Kazakhstan has to resolve another issue – lack of a separate law governing safety of water facilities. This can be named as one of the reasons of disaster in Kyzyl-Agash settlement in 2010.

6.4.3. Analysis and evaluation of extreme hydrological events monitoring in Kazakhstan. Gaps, barriers and improvements in organization of observations, database seeding, development of scientific research on extreme hydrological events in climate change conditions.

Extreme hydrological events and potential climate change impacts will negatively affect the territory of Kazakhstan. Water is the environment where most of the climate change impacts are particularly evident: higher water temperatures; floods and mud flows, causing damage; extremely low water levels; accelerated melting of glaciers and their retreat. The increase in climate variability and vulnerability is accompanied by an increase in socio-economic vulnerability to extreme events, indicated, for example, by a decrease in wealth, educational level and health. Lack of sound local and regional adaptation plans, construction in flood-prone zones; poor hazard and risk management policies; and inadequate infrastructure and early warning systems; warning and contingency planning require the improvement of an appropriate regulatory and institutional framework, etc

Addressing vulnerability and more accurate EHE risk evaluation includes the following actions:

- reliable hydro-meteorological analysis;
- hydrologic and hydraulic simulation of surface flow, floods and mudflows;
- state-of-the-art flooding pattern simulation;
- simulation of future trends of hydrometeorological events caused by climate change
- simulation and analysis of projected changes in land use, future development (urbanization process, infrastructure development, etc.);
- simulation of future progress of hydro-meteorological events due to climate change.

Disaster risk reduction must be systematically taken into account in the course of sustainable development strategies, plans and programs elaboration. Moreover, effective disaster risk reduction requires a strong institutional framework that can be strengthened by capacity building, responsible public administration, promotion of relevant strategies and laws, facilitation to information dissemination and development of effective coordination mechanisms.

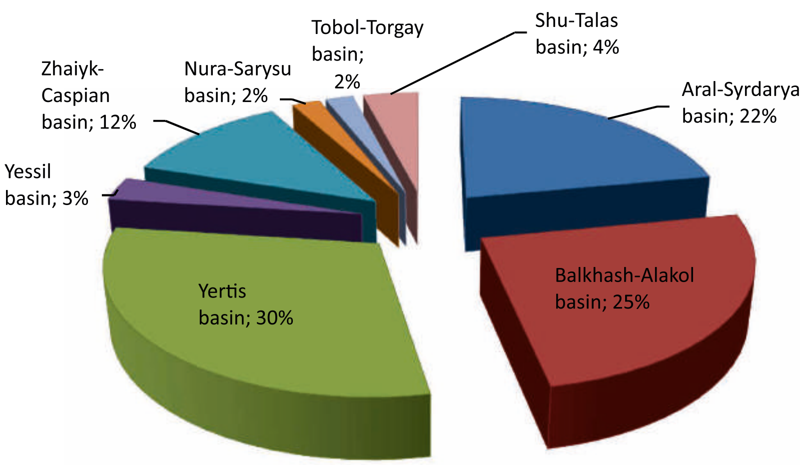
6.5. Kazakhstan water resources

6.5.1. Water availability in Kazakhstan and some other countries

Climate patterns in river areas of the country cause up to 90% of surface water runoff happening in spring. Such ***extremely uneven runoff distribution by seasons*** in most areas of Kazakhstan impacts water resources availability. Another important factor influencing the country's hydrography is ***transboundary*** nature of its major stream flows, accounting for nearly a half of all surface fresh water. ***Scantiness*** of available water resources is another limiting factor for many regions of Kazakhstan.

Cumulative multiannual runoff of rivers and temporary streams is estimated on the level of 108,5 km^3 per year, of which 47% originate in Kazakhstan. Figure 90 shows surface water resources distribution by river basins to cumulative average multiannual runoff in percentage terms.

Figure 90. *Water availability in major river basins of Kazakhstan, percentage of the total river runoff*



Source: General MWUPP, Kazgiprovodkhoz Institute, Almaty, 2016.

If we consider the country's water availability in terms of river runoff originating within its boundaries the number will be even smaller – 20.5 thousand m³/year per 1 km² or 3.3 thousand m³/year per 1 citizen. This is much less than in Russia, Tajikistan or Kyrgyzstan where water resources availability is higher, nearly the same as in Uzbekistan and more than in Turkmenistan having a small volume of its own annual river runoff (Table 78).

Table 78. *Specific water availability per 1 km² of the area and per 1 citizen depending on river runoff originating in the country*

№	Country	Area, km²	Population in 2014, million people	Volume of own runoff (average multiannual), km³	Water availability, thousand m³/year	
					per 1 km² of the area	per 1 citizen
	Kazakhstan	2 724 900	17,418	55,94*	20,5	3,3
	Russia	17 100 000	143,667	4300,00**	251,5	30,2**
	Kyrgyzstan	199 900	5,777	50,0	250,1	8,7
	Tajikistan	142 550	8,161	64,0***	449,0	7,84
	Turkmenistan	491 210	5,274	2,78***	5,66	0,53
	Uzbekistan	448 978	29,252	8,84***	19,7	0,3

Sources:

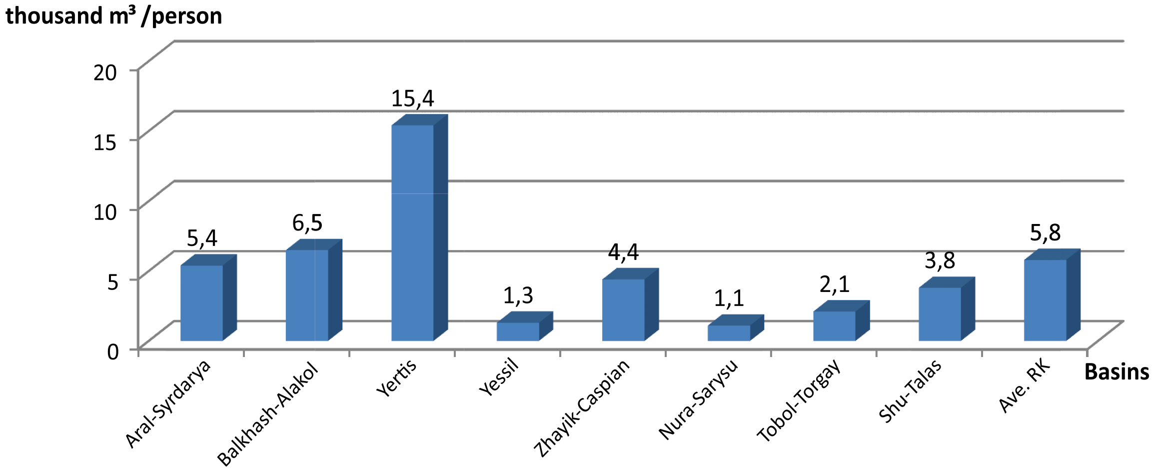
** - General MWUPP, Kazgiprovodkhoz Institute, Almaty, 2016.*

*** - RF Water Strategy until 2020. RF Government, Instruction No. 1235-p dated 27.08.2009.*

**** - Analytical summary "Water resources in Central Asia: current status, issues and use prospects". IFAS Executive Committee, Almaty, 2012.*

With Kazakhstan population of 17.418 million people about 5.8 thousand m³ of river runoff accounts for one citizen (given the cumulative multiannual river runoff equals 100.58 km³). This number differs significantly by the country's river basins. The lowest water availability is in Nura-Sarysu river basin (Karaganda and Akmola oblasts) – 1.1 thousand m³/person/year, a little higher – in Yessil basin (Astana city, Akmola, North Kazakhstan oblasts) – 1.3 thousand m³/person/year, Tobol-Torgay basin (Kostanay, Aktobe oblasts) – 2.1 thousand m³/person/year, Shu-Talas basin (Zhambyl oblast) – 3.8 thousand m³/person/year, Zhaiyk-Caspian basin (Atyrau, Aktau, West Kazakhstan and part of Aktobe oblasts) – 4.4 thousand m³/person/year. The only basin featuring unused river runoff is Yertis (East Kazakhstan, Pavlodar oblasts), which accounts for 15.4 thousand m³/person/year (Figure 91).

Figure 91. *Specific surface water availability*



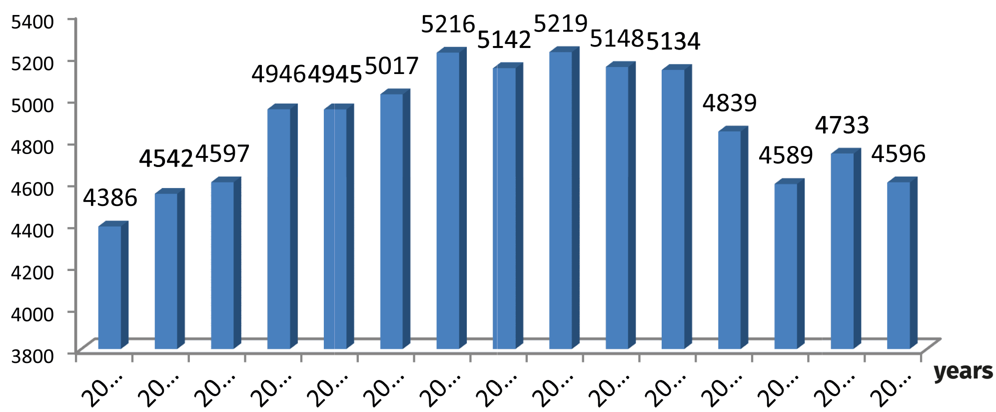
Source: General MWUPP, Kazgiprovodkhoz Institute, Almaty, 2016.

With due regard to increased river runoff withdrawal in neighboring countries, primarily in China and Uzbekistan, Kazakhstan average annual water resources may reduce to 85 km³ in the next 25 years.

6.5.2. Current state of water management in Kazakhstan and its development in 2000-2014

In the period under consideration (2000-2014) in Kazakhstan the number of water consumers grew in the first 5-6 years, then stabilized by 2010 and gradually decreased after that. This might be connected with the country's economic transformation (Figure 92).

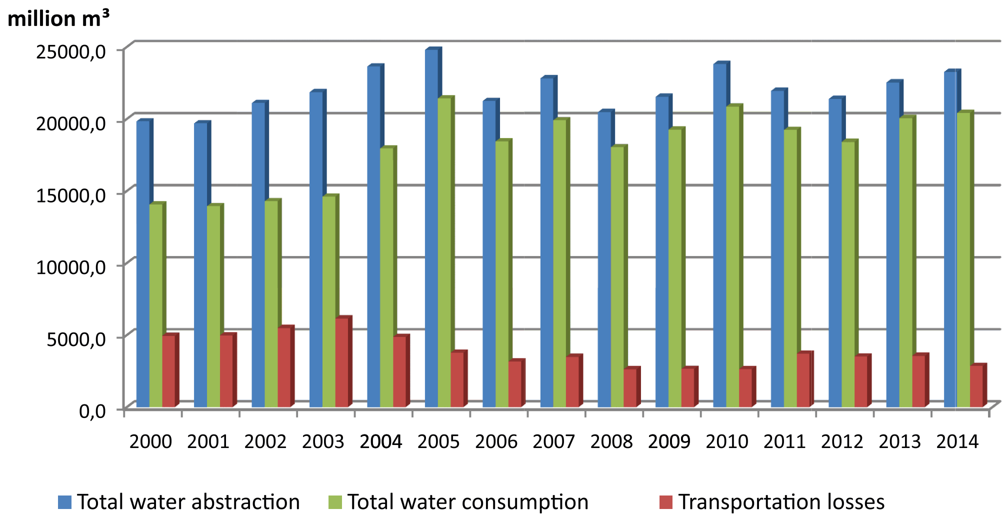
Figure 92. *Number of water consumers in the Republic of Kazakhstan*



Source: Water Resources Committee of the RK Ministry of Agriculture.

In the same period fresh water abstraction has increased from 19,830.1 million m³ in 2000 to 23,265.5 million m³ in 2014, i.e. by 17.3%. Water abstraction from surface sources has gone up by 23.1% from 18,040.7 million m3 in 2000 to 22,214.5 million m³ in 2014, while abstraction from underground sources decreased by 6.4%. Total amount of water consumed by all water consumers in the period under consideration has gone up from 14,058.8 million m3 in 2000 to 20,410.9 million m3 in 2014 by 45.2% (Figure 93, Table 79).

Figure 93. *Water abstraction, consumption and transportation losses in Kazakhstan*

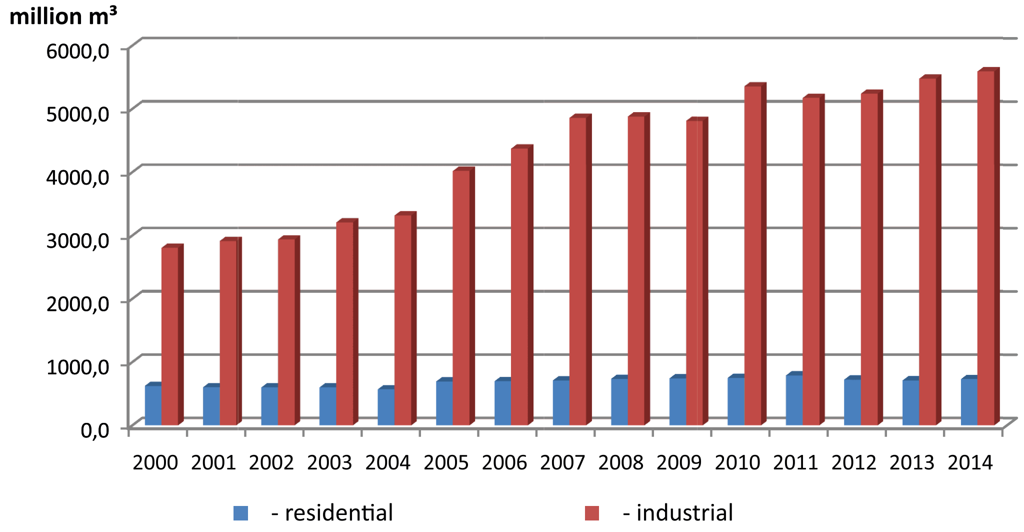


Source: Water Resources Committee of the RK Ministry of Agriculture.

Residential water consumption has increased from 623.93 million m³ to 790.0 million m³ or by 26.6%. Most significant increase in water consumption is observed in production sector with two-fold growth from 2,803.7 million m3 in 2000 to 5,591.8 million m³ in 2014 (Figure 94).

The country's consumer protection authorities continuously monitor quality of drinking water supplied to communities. 31267 water samples from all around the country were tested in laboratories in 2015, only 614 or 2.0% didn't meet microbiological standards.[201]

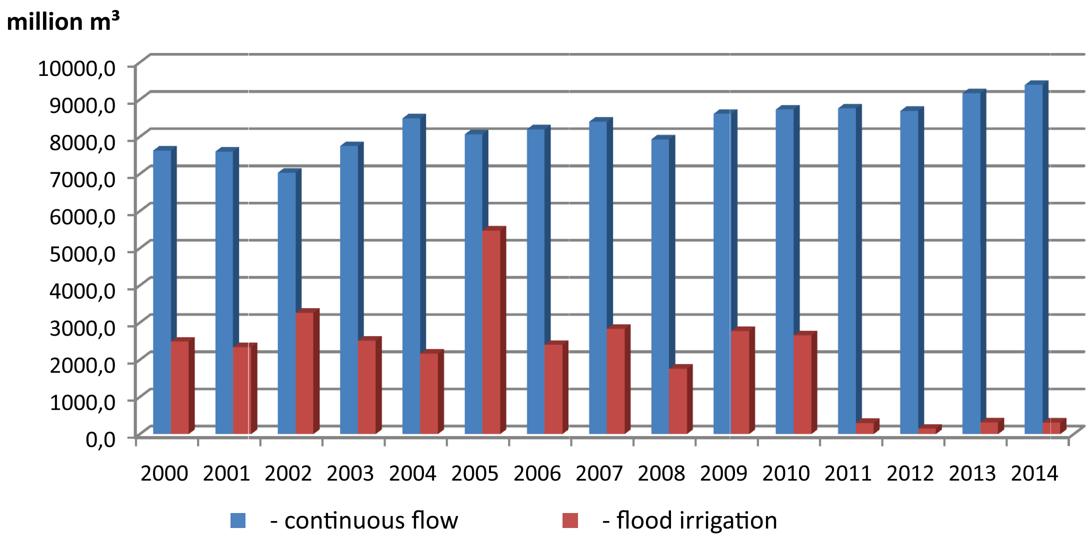
Figure 94. *Residential and industrial water consumption in Kazakhstan.*



Source: Water Resources Committee of the RK Ministry of Agriculture.

Of the country-wide fresh water consumption around 10,500 million m3 account for agriculture, including continuous flow and flood irrigation, agricultural water supply, flooding of pastures and pond fish establishment. This is almost a half of the total water consumption taking into account that unproductive water losses in agricultural production amount to 45-50% the sector consumes around 70% of the total abstracted water volume.

Figure 95. *Water consumption for continuous flow and flood irrigation in Kazakhstan*

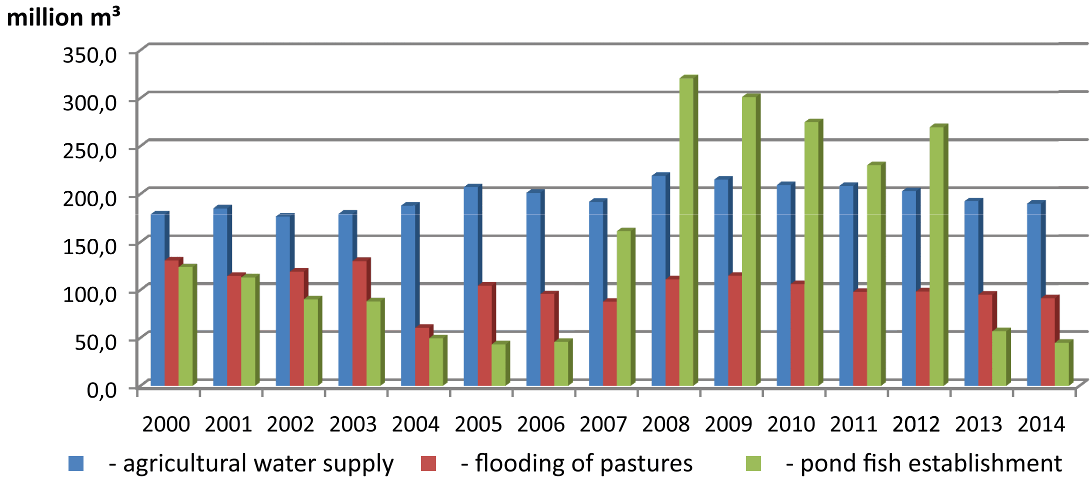


Source: Water Resources Committee of the RK Ministry of Agriculture.

201 http://npc-ses.kz/ru/2-uncategorised/468-sostoyanie-kachestva-pitevoj-vodyza-2015-god.html

As you can see from the given trend the share of flood irrigation dropped in 2011. This means such irrigation method is rarely used due to poor technical state of structures that are mostly abandoned, and lack of funds for their proper operation at organized farms. Another reason is water content increase above average in recent years, wherefore former flooded lands are being gradually converted into drylands.

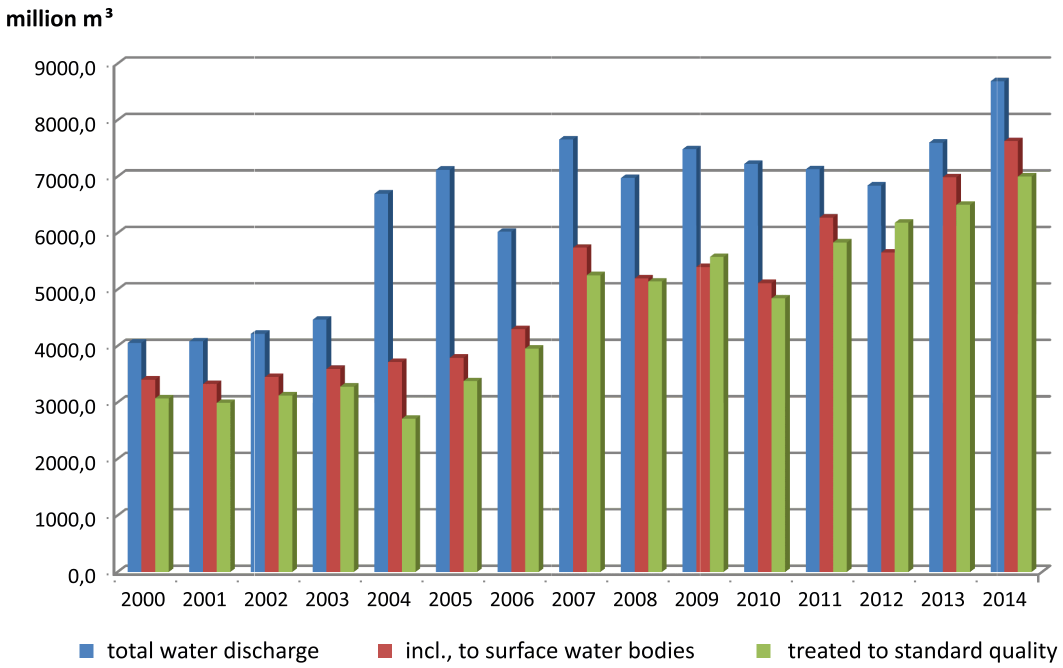
Figure 96. *Water consumption for agricultural water supply, flooding of pastures and pond fish establishment in Kazakhstan.*



Source: Water Resources Committee of the RK Ministry of Agriculture.

Water discharge has increased by 114% from 4,055.6 million m³ to 8,688.5 million m³ over the period from 2000 through 2014. This means that the total capacity of sewage systems has doubled in the last 15 years of Kazakhstan development.

Figure 97. *Water discharge in the Republic of Kazakhstan.*



Source: Water Resources Committee of the RK Ministry of Agriculture.

6.5.3. Climate change impact on current and future water management conditions in Kazakhstan. Climate change vulnerability assessment

6.5.3.1. Climate change impact on Kazakhstan water management system

In total water abstraction in Kazakhstan in 2016 was 24,62 km^3, water supply – 0,9 km^3, crops forestry and fishery- 16,3 km^3, industry 5,4 $км^3$, others – 1,97 km^3 In 2014 total water abstraction in Kazakhstan amounted to 23.3 km^3 with a limit of 25.4 km^3. Of this amount 20.4 km^3 were utilized: 0.73 km^3 – for public living needs, 5.6 km^3 – by industry, 10.0 km^3 – by agriculture, 0.1 km^3 – by fishery, 1.9 km^3 – for other needs. In 2013 groundwater abstraction amounted to 1.09 km^3.[202]

Significant human and wildlife population growth and industrial production ramp-up expectations cause more extensive water abstraction and use. Water abstraction by economy sectors until 2040 is projected in the General Multipurpose Water Use and Protection Plan[203]. These estimated data are based on specific water consumption by the country's economy sectors with due regard to installation of water recirculation systems, water-saving through elimination of losses in the network, EF improvement efforts and introduction of water-saving technologies.

Table 79. *Summary water abstraction by economy sectors (million m^3)*

Development levels (years)	Total water abstraction, million m^3	Municipal infrastructure	Industry	Agriculture	Including:						Formation pressure maintenance	Fishery	Recreation and other needs
					Continuous flow irrigation	Flood irrigation	Hayfields flooding	Flow augmentation in Yertis flood plain and Korgalzhin lakes supply	Agricultural water supply	Flooding of pastures			
1990	35573,66	1416,66	7110,70	26622,63	21539,94	1916,63	2073,26	0,00	479,60	613,20	0,00	417,74	5,92
2012	17465,45	843,58	4230,16	12255,03	11186,18	152,28	550,53	0,00	267,61	98,43	38,99	94,92	2,76
2015	20188,62	866,63	4482,23	14642,59	12124,86	408,93	778,39	837,00	364,29	129,12	40,94	118,64	37,59
2020	21004,66	932,95	4696,66	15114,81	11957,86	686,47	1047,00	857,00	428,56	137,92	44,95	168,67	46,63
2030	22140,27	1059,26	4968,30	15785,97	12082,25	1079,22	1062,00	877,00	540,16	145,35	49,28	213,10	64,36
2040	23260,19	1281,97	5230,65	16382,37	12282,62	1342,62	1062,00	875,00	667,35	152,76	54,50	242,14	68,58

Source: General MWUPP, 2013

At present the country benefits from sufficient surface and underground water resources covering nearly all economy needs. However, available water resources may prove to be insufficient in the future, so their re-regulation and intrabasin diversion will be required.

In this regard, the main issues that the country's water industry faces at the moment are:

- unsatisfactory state of utility and drinking water supply;
- irrational water use with high specific water consumption;
- unsatisfactory quality of water in water bodies;
- significant material damage related to adverse water effect;
- low efficiency of water industry government administration system;
- considerable reduction in research and development financing;
- poor technical state of fixed water industry assets;

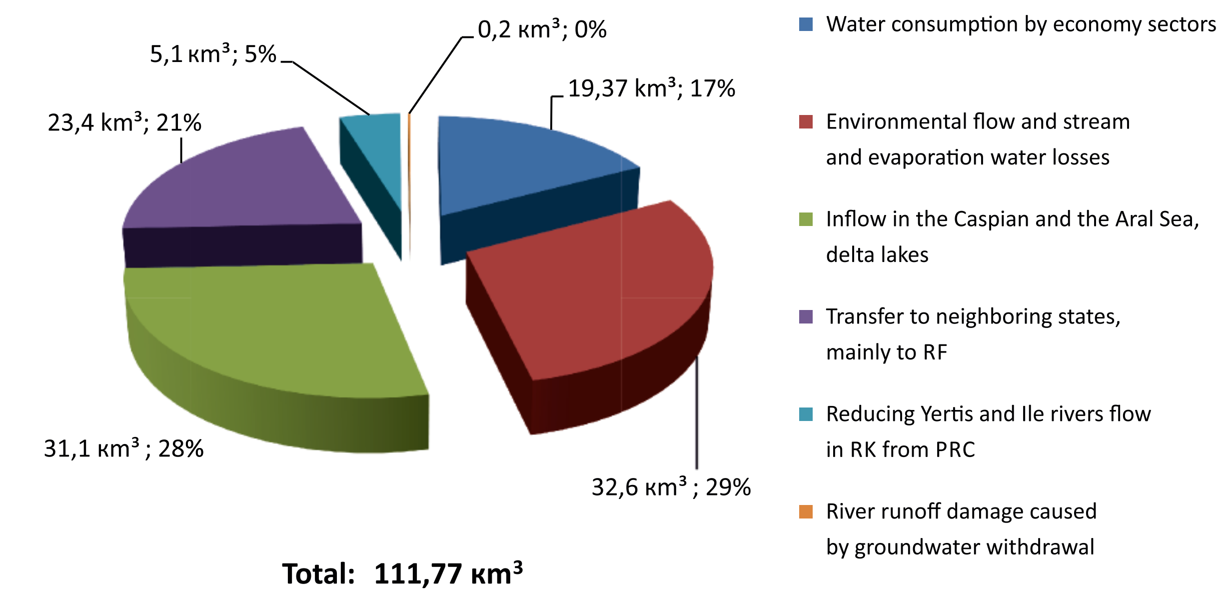
[202] Source: Water Resources Committee of the RK Ministry of Agriculture.
[203] Source: General Multipurpose Water Use and Protection Plan. Kazgiprovodkhoz Institute. Approved by the RK Government Resolution No. 200 dated 08.04.2016.

- inadequate legislative framework;
- lack of a full-fledged economic mechanism for rational water consumption.

Results of aggregated water balances by Kazakhstan's principal river basins showed that, in general, the country is going to face deficit of water resources under the influence of the following factors:

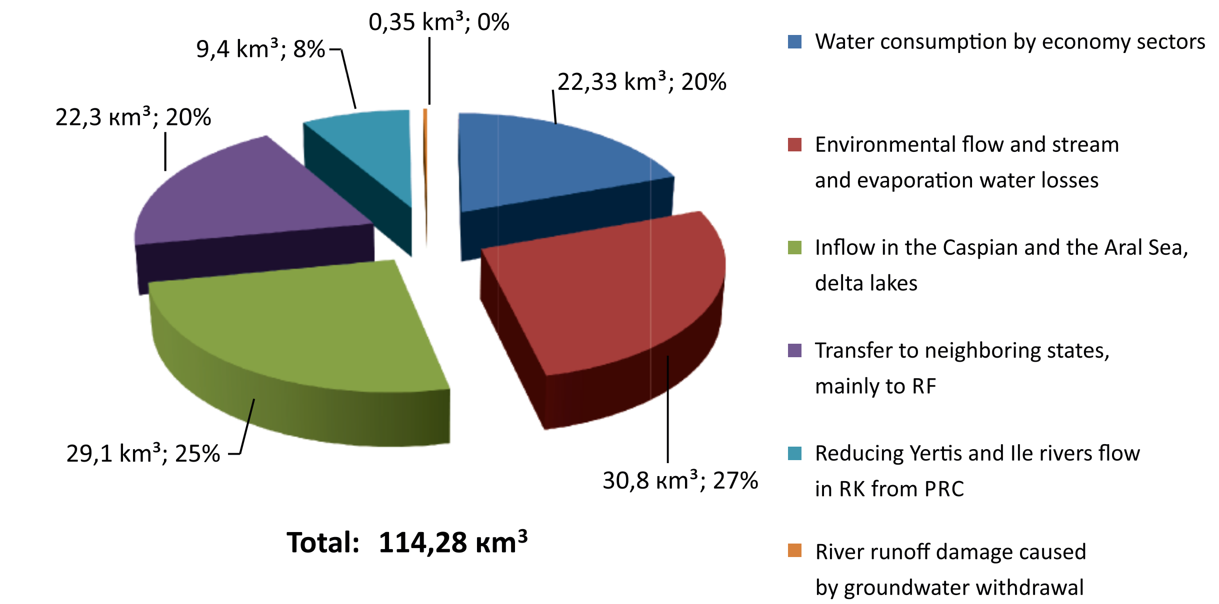
- runoff withdrawal due to economic development and irrigation farming in Kazakhstan and neighboring states – Russia, China, Uzbekistan, Tajikistan and Kyrgyzstan;
- increase in irretrievable water abstraction in Kazakhstan;
- climate change impact on river runoff.

Figure 98. *Current distribution of available water resources.*



Source: General Multipurpose Water Use and Protection Plan.

Figure 99. *Distribution of available water resources in 2040*



Source: General Multipurpose Water Use and Protection Plan.

At present water is supplied to the population and industry from internal sources (including the Caspian Sea, the Balkhash Lake and inter-basin runoff transfers around Kazakhstan) and attracted runoff (the Volga River). In agriculture, the issue of water supply to population and production is mainly resolved with groundwater utilization. Almost everywhere sufficient water amounts are available for continuous flow irrigation.

In the future certain Kazakhstan regions may face challenges related to meeting the requirements of fishery, energy, navigation and other flow augmentation types, water availability in water industry, and, particularly, keeping biological balance. This may be linked to the multiplier effect of superposition of Kazakhstan river runoff reduction due to climate change and transboundary inflow.

A disturbing factor was occurrence of disastrous spring floods in Karaganda and Akmola oblasts in April, 2015. Due to rapid increase in water discharge in the Nura River up to 3,700 m3/s (higher than the maximum estimated discharge 0.01% water availability) the Samarkand reservoir dam was under the real threat of destruction. Disaster was prevented with correct water discharge regulation. That flooding proved that reservoir regulating storage is insufficient for prevention of stronger floods that may occur in the future due to climate change.

Current state of the Shardara Hydraulic Complex on the Syrdarya River is very unsettling. Bottleneck condition on the dam emergency spillway artificially created after Uzbekistan built two reservoirs in Arnasay Depression may have disastrous consequences, especially in the face of climate change causing increase in flood discharge.

The above examples demonstrate importance of proper water engineering infrastructure management for prevention and mitigation of water-related hazardous events.

6.5.3.2. The impact of agricultural technology and weather on wheat productivity

Agriculture is a dominating sector in economic structure of the most vulnerable oblasts of Kazakhstan. Agriculture vulnerability to climatic changes determined regional sensitivity to climate change. Almaty, East Kazakhstan, and Kostanay oblasts were recognized most vulnerable to natural disaster risk. Prevalence of rural population, poor agriculture performance, insufficient water resources contribute to sensitivity of these oblasts to climate change. Climate change reduces agricultural productivity, undermines food security and deteriorates social and economic conditions and standard of living in regions.[204]

Modern agricultural practices often require significant water consumption due to incorrect crops selection (wet crops farming in dry arid regions), use of outdated irrigation technologies, etc. Such load is further aggravated by climate change impacts, like those linked with decrease in water resources availability. In addition to that, intensive agriculture adversely affects the quality of surface and ground water, impacts biodiversity and eventually undermines stability of ecosystems and their adaptive capability.

All these factors represent potential threat to the country's food security: given the number of droughty days in the vegetation period and natural precipitation decrease pastures and croplands performance will drop by 30% and that, in its turn, will affect animal performance.

In different regions of Kazakhstan, the level of crop yields varies depending on the soil and climatic conditions. Crop yields in each specific year is influenced by a complex set of factors that can be divided into two components: the level of farming standards (cultivation technology) and weather conditions. The analysis of long-term trends in average regional yields of spring wheat was carried out, the trends in the farming standards were determined, and the share of weather and agricultural technology in the crop formation was examined on the example of Akmola oblast.

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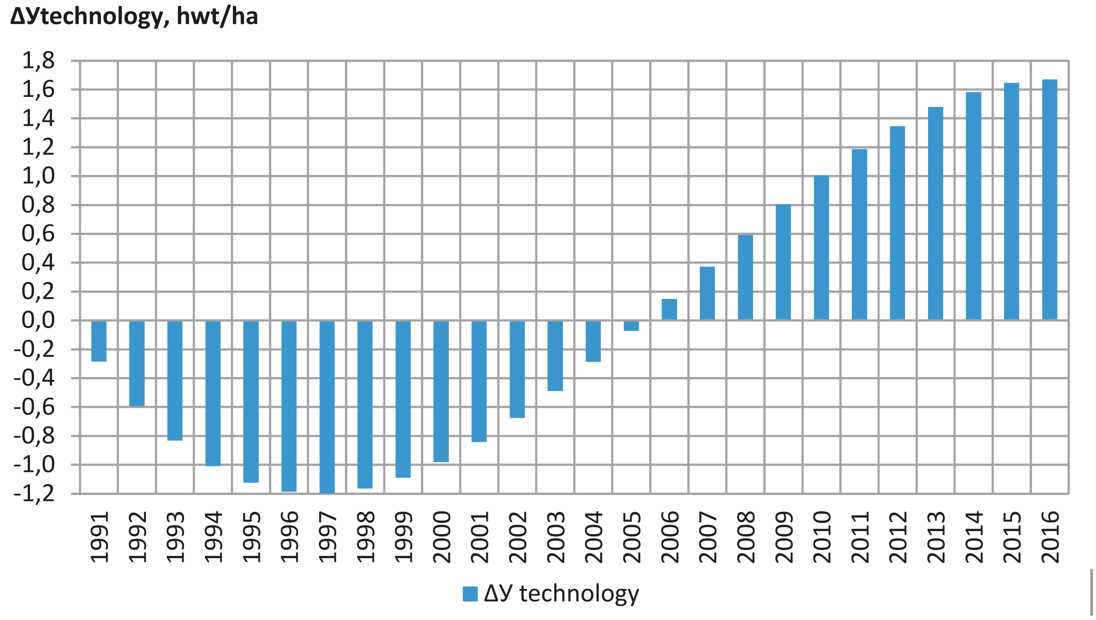
[204] III-IV National Communication of the Republic of Kazakhstan to UN Framework Convention on Climate Change. Page 163.

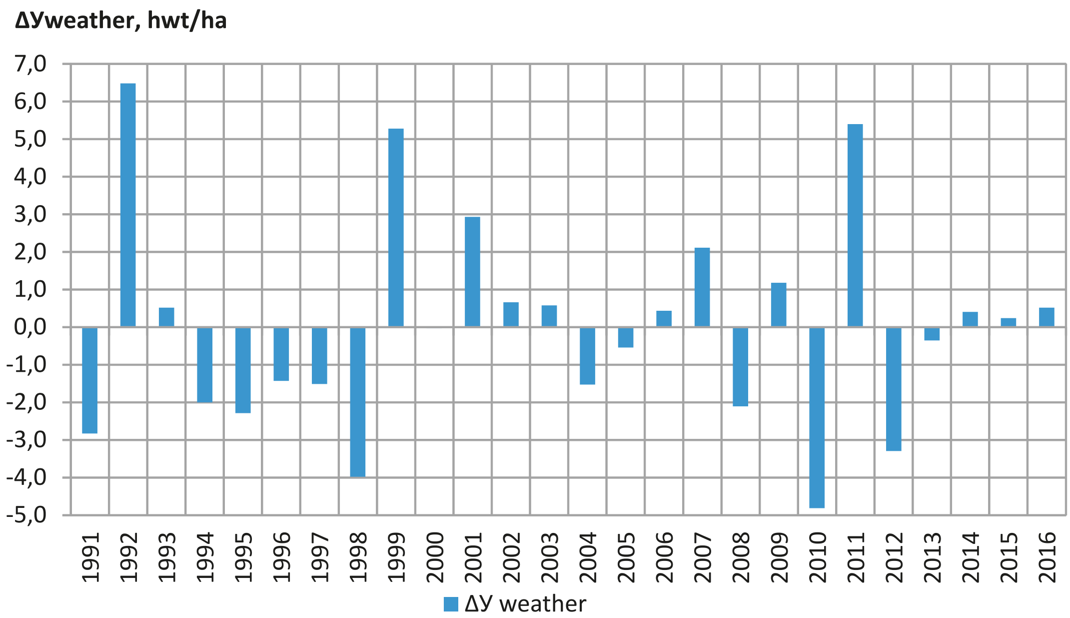
The analysis (Figure 100-b) showed that during the period from 1994 to 1998 agrometeorological conditions were not favorable. Moreover, in 1998, due to the summer drought in the north-west of the country, the yield of wheat in Akmola oblast was very low (3.8 hwt/ha). In that year, the shortfall in production due to the weather was 4.0 hwt/ha, and 1.2 hwt/ha – due to agricultural technology (Figure 100-a).

Figure 100. *Share of agricultural technology in the spring wheat yield in Akmola region*



a)

In 2013-2016 agrometeorological conditions in Akmola region were climatically normal, and the yield was above the norm (10,0-11,1 hwt/ha). During those years, yield increase due to the agricultural technology amounted to 1,5-1,7 hwt/ha (Figure 100-a)



b)

There are two following periods in the long-term course of spring wheat yield in the Akmola oblast: a period of reduction in yields from 1991 to 1996 and a period of upward trend in the yields from 1997 to 2015. Farming standards began to improve in the oblast starting from 1996, and moved into a positive balance in 2006. Consequently, 2006 is the beginning of an optimal farming standards development, as a result of effective cultivation technologies introduction.

The International Center for the Improvement of Wheat and Corn (CIMMYT), together with scientists and farmers of Kazakhstan, in 2000 began work on the introduction of a zero / minimal tillage and direct seeding system. Since 2008, the government of Kazakhstan has begun to subsidize farmers for using zero technology. According to the 2014 report on the implementation of the «Strategic Plan of the Ministry of Agriculture of the Republic of Kazakhstan for 2014-2018», resource and energy-saving technologies introduction area amounted to 12.9 million hectares.

Kazakhstan has all preconditions and strong potential for the development of competitive agricultural production, and could become a global leader in food production. The country benefits from vast farmlands (223 million ha), high labor potential (47% of population live in rural areas), favorable climatic conditions for grain and leguminous crops, potato and vegetables cultivation, high livestock breeding potential (pastures account for 85% of the total area of commercial lands). Against the backdrop of violent fluctuations in world prices on raw materials agriculture can facilitate the country's economic recovery and give a new impetus to export diversification strategy. Even today Kazakhstan is a major grain exporter and has been a world leader in flour export for two years in a row. With rich yields in recent years Kazakhstan managed to strengthen its global capacity for price stabilization on the markets of Central Asia, Russia, Middle East, Europe and Caucasus, and improve its prospects in ensuring food security in neighboring regions.[205]

According to the RK Statistics Agency in 2015 agricultural crop land area amounted to 21.02 million ha. Areas of grain cultivation are decreasing year on year; in 2015 they covered 14.98 million ha (16.3 million ha in 2012), while areas occupied by potato, beetroot, oil crops, vegetables and gourds, and forage crops are increasing. Drip irrigation areas have reached 47.8 thousand ha in 2014, that is 49.9% more than in 2013.

A major outstanding problem of Kazakhstan crop production is its excessive dependence on weather conditions and, consequently, on future climate change.

[205] Kazakhstan Institute for Strategic Studies under the President of the Republic of Kazakhstan http://kisi.kz/

6.5.3.3. Climate change impact on water availability to industrial sector of Kazakhstan and thermal power

Intensive development of minerals extraction and processing created the situation where the foundation of the country's industry is made up of metal, fuel and mining enterprises harmful for the environment. A peculiarity of Kazakhstan's subsoil use sector is progressive dynamics of oil and gas production, as well as extraction of solid minerals. The area covered with mining production waste amounts to 70 thousand km2, while rock dumps occupy huge territories and soils are buried under technogenic soils.

Climate change increases the risk of higher accident rates at industrial and infrastructure facilities, especially in wet industries and those using water from surface sources for equipment cooling and other process needs.

Figure 101. *Industrial water utilization*

Increased energy consumption. Accelerated development of water consuming industries and improvement of population welfare result in increase in energy and water consumption.

6.5.3.4. Climate change impact on water availability to Kazakhstan hydropower sector

Kazakhstan owns considerable water resources whose cumulative capacity, in theory, amounts to 170 billion kWh per year. All hydropower plants operating in Kazakhstan generate over 7.15 billion kWh per year, so only a tiny part of hydropower resources is used at the moment. Cost-effective water resources are mainly concentrated in the east and in the south of the country.

Figure 102. *Moynak HPP on the Sharyn River.*

The largest HPPs are: Bukhtarma HPP on the Yertis River – 0.7 million kW; Ust-Kamenogorsk HPP – 0.3 million kW and Shulbinsk HPP – 0.7 million kW; Kapshagay HPP built on the Ile River – 0.4 million kW, Moynak HPP on the Sharyn River – 0.3 million kW, covering 12% of the country's domestic needs. Kazakhstan is planning to enhance water resources utilization in the med-term: Bulak HPP (78 MW), Kerbulak HPP (50 MW) and a number of small hydropower plants are being designed at the moment. The total rated capacity of Kazakhstan's hydropower plants is 2,350.16 MW.

6.5.3.5. Climate change impact on water availability to Kazakhstan households

Types of water supply sources vary according to groundwater reserves availability across regions, and groundwater is usually preferred. In case of groundwater absence or scarcity, surface water resources are used for water supply. Basins with predominant surface sources utilization in water supply are Yessil – 93% and Tobol-Torgay – 84%; basins with predominant groundwater utilization are Aral-Syrdarya – 69% and Shu-Talas – 99.8%. In other basins surface and underground water sources are used in approximately equal shares to cover household needs (Table 80).

Table 80. *Water utilization from surface and underground water sources for household needs by hydro-economic basins of Kazakhstan, 2013, thousand m³*

№	Hydro-economic basin	Total utilized water	Total utilized water from surface sources	Total utilized water from underground sources
	Aral-Syrdarya	77616,8	24200,0	53416,8
	Balkhash-Alakol	206188,0	91644,0	110297,0
	Yertis	107834,4	58668,4	49166,0
	Yessil	79535,9	73650,3	5885,6
	Nura-Sarysu	78480,4	35237,9	43242,4
	Tobol-Torgay	35533,8	29703,4	5830,4
	Zhaiyk-Caspian	85637,9	40783,6	42809,5
	Shu-Talas	23649,1	47,5	23601,6

Source: Water Resources Committee of the RK Ministry of Agriculture. Key indicators of water abstraction, utilization and discharge in the Republic of Kazakhstan in 2013.

Central and Northern regions of the country which primarily use surface water sources for water supply to population are more vulnerable to climate change impact, as they don't have alternative sources in contrast to Eastern or Southern Kazakhstan.

In the long term, before 2040, development of water supply in the fastly growing Astana city and Central Kazakhstan with its potential for further development of mining industry and agricultural production, can become be limited due to the water deficit of up to 75.0 million m3/year may emerge by 2030 unless any measures are taken to increase water availability in the region. Water consumption in Astana will continue to grow fast enough until it reaches 150.0 million m3 of water in 2030 against the present level of 100.0 million m^3, i.e. increases 1.5 times. Bearing in mind poor underground sources in the region and extreme scarcity of surface water resources in Yessil and Nura river basins, we can be confident that future climate change will negatively affect water security of territories under consideration.

Figure 103. *Water abstraction for drinking water supply in Astana, Astana Reservoir*

6.5.3.6. Climate change impact on water supply to natural water ecosystems of Kazakhstan

Kazakhstan surface water peculiarity is the need to spend nearly a half of limited river runoff resources on maintaining of level and salinity of internal water bodies (the Balkhash Lake, the Aral Sea, the Caspian Sea) and flooding of natural floodplains and deltas systems.

Climate is changing so quickly that natural ecosystems do not have enough time to adapt contributing to loss of biodiversity.

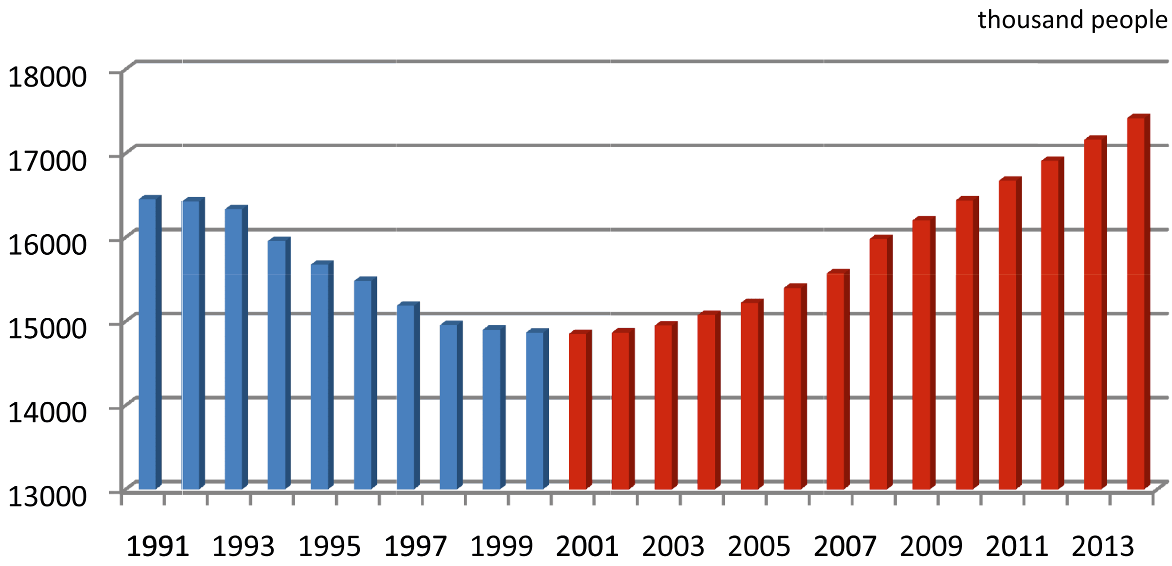
Ecosystems are capable to adapt to a certain level of change in the, so-called, autonomous adaptation process. However, the question is whether ecosystem stability will be sufficient to sustain accelerated future anthropogenic climate change in combination with other stresses, such population growth, changes in consumption models, etc. In any case, climate change will alter the manner of ecosystems functioning and their ability to render those services that society largely depends on.

The largest Kazakhstan natural ecosystems where adaptation programs have to be implemented in water and ecosystem sectors are the floodplain of the Yertis River, the delta of the Syrdarya River with lake and marsh systems in its lower reaches, and the delta of the Ile River with the Balkhash Lake.

6.5.3.7. Climate change impact on social sphere due to urbanization and population growth

Demographic changes, including population growth and migration are, undoubtedly, one of the main reasons of increase in water consumption. Kazakhstan population is steadily growing over the last one and a half decades. Back in 2001 population amounted to 14.851 million people. By 2014 it has increased up to 17.418 million people (Figure 104). People's welfare is also growing, i.e. water consumption per capita is going up, to put even greater load on natural ecosystems. Power consumption is growing not only due to population growth, but also due to increasing specific power consumption per person.

Figure 104. *Kazakhstan population dynamics*



Source: http://www.stat.gov.kz/

Urbanization, among other influencing factors, is creating urban "heat islands" (elevated temperature in big urban area due to reflecting surface change caused by urban development, and the waste thermal power generated by heating of buildings) and increasing water consumption. Expansion of waterproof surfaces increases surface drain and interferes with infiltration causing reduction of available water resources.

6.5.4. Water projection for the Republic of Kazakhstan until 2050

HBV hydrological model developed by the Swedish Meteorological and Hydrological Institute and recommended by the World Meteorological Organization was used as a methodical basis in estimation of Kazakhstan water resources exposed to anthropogenic climate change. Based on numerical study results we can make a conclusion that the HBV model can be used in estimation of water resources, especially in mountainous areas where influence of economic activity on runoff is still rather small. The following actions were taken for assessment of climate change impact on water resources of Kazakhstan:

- input hydro-meteorological data were prepared for their use in HBV hydrological model;
- HBV model parameters were determined;
- model-based numerical studies were carried out for basins under consideration;
- water resources in the given river basin were estimated under a predetermined climate change scenario.

Model parameters were determined on the basis of hydro-meteorological data for a certain period where runoff was deemed to be conditionally natural for each of the catchment basins. Model-based numerical studies were carried out for verification of accuracy of calculations results. To that end the resulting runoff hydrographs were compared with actual ones. Correlation of estimated runoff analysis results obtained in the course of model calibration was quite good around 0.89 and higher (Table 81).

Table 81. *Runoff estimation results analysis*

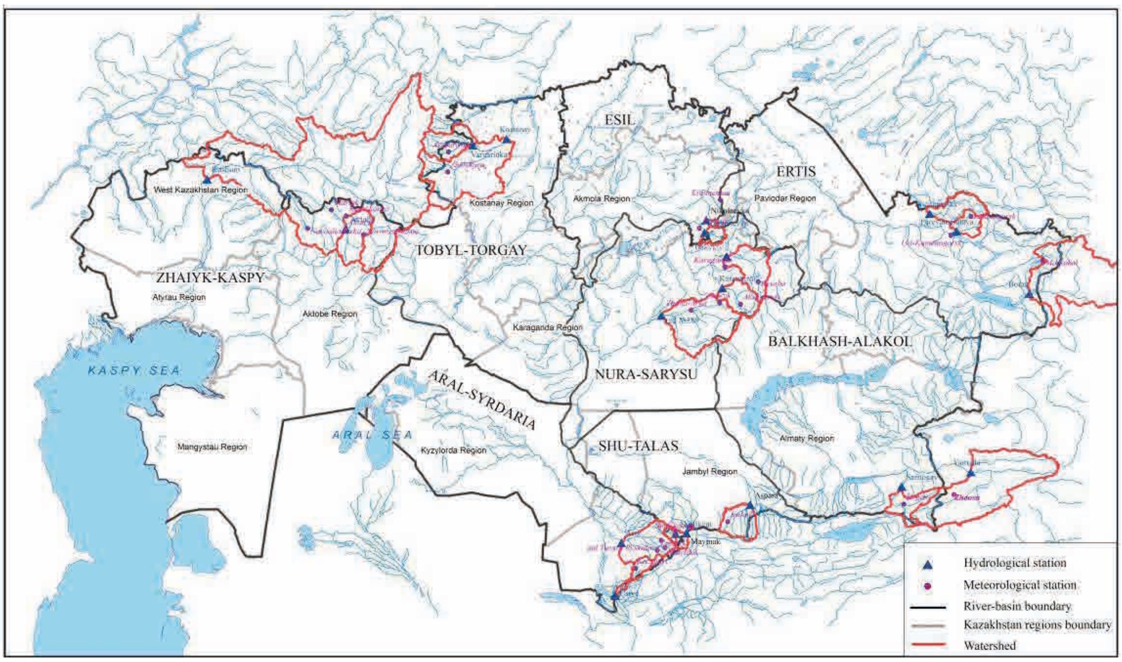
River, station	Years	Correlation	River, station	Years	Correlation
Yessil River – Turgenevka station	1983-1988	0.99	Arys River – Arys railway station	1956-1960	0.98
Moyildy River – Nikolayevka station	1983-1988	0.96	Ural River – Kyshym station	1957-1962	0.92
Tobol River – Kostanay	1954-1960	0.89	Yelek river – Aktobe city	1960-1964	0.99
Nura river - Balykty village	1963-1970	0.99	Kara Yertis River – Boran station	1984-1990	0.98
Sarysu River – pass No. 189	1967-1972	0.92	Ulba River – Perevalochnaya station	1986-1990	0,99
Assa River – Maymak railway station	1942-1946	0,91	Oba River – Shemonaikha	1986-1990	0.99
pKuragaty River – Aspara railway station	1972-1975	0,92	Ile River – Yamadu station	1980-1981	0.99
Ayat river – Varvarinka village	1983-1973	0.95	Ters river – Nurlykent village	1968-1972	0.96
Keles River – outflow	1983-1987	0.98	Sharyn River – Sarytogay stow	1987-1990	0.98
Sherubaynura river – Karamurin village	1958-1963	0.98			

In most cases calculated and actual hydrographs coincided on a satisfactory level. Kazhydromet's climate researchers updated climate projections until 2100.

Monthly atmospheric precipitation and average monthly air temperature data until 2100 were specified for a representative greenhouse gas concentration pathway – the so-called RCP4.5.

Due to limited study duration 19 indicative catchment basins were selected to represent 8 hydroeconomic basins of Kazakhstan featuring natural runoff and being representative of the whole Kazakhstan territory from the point of view of runoff formation conditions (Figure 105).

Figure 105. *Indicative basins for assessment of potential changes in average annual runoff of Kazakhstan rivers according to regional climatic models data*



Data from the table above demonstrates that if the climate change will follow scenario RCP4.5, then by 2050 water resources in mountain basins of Kazakhstan could increase on average by 6% – 17%, whereas by 2100 on the contrary there is a decrease, on average by 10% - 22.3% in the basins of Keles, Kuragaty, Assa, Ters, Ile, Oba, Ulba, Ertis, Arys, Sharyn rivers. The increase of water resources by 2050 will happen mostly due to southern basins, where glaciers take part in the formation of runoff, whereas decrease by 2100 will happen due to the depletion of these glaciers. Glaciological studies show that in the past decade there has been a downward trend in glacier runoff and by the end of the century there is a risk of the glaciers' disappearance. In the lowland rivers of western, northern and central Kazakhstan, water resources tend to decrease by 3.7% -15% by the middle of the century, and by the end of the century by 9.2% - 23.7% compared to the past runoff rate. Decrease in the runoff of the lowland rivers of Kazakhstan is connected with the latitudinal dependence of the runoff, i.e., it is arising from the prevailing influence of the increasing average annual air temperature. Water stress by basin by 2050 is shown in Figure 1.9.

The change in the average annual air temperature and the amount of annual precipitation by 2050 (2021-2050) and by 2099 (2071-2099) in the run-off formation area of the 19 river basins under study against the multiannual norm was examined, the baseline period of 1981-2010 was taken as the norm.

By 2050, the temperature is anticipated to increase by 1 to 2°C against the norm in the watersheds of the Yessil, Tobol-Torgay and Nura-Sarysu river-basin, the Ters River - Nurlykent station of the Shu-Talas river-basin, and the Ural-Caspian river-basin as well as Balkash-Alakol river-basin. On the Sarysu river - pass No. 189 of Nura-Sarysu river-basin, the temperature is anticipated to increase by 3.2°C against the norm, while the norm is 2.9°C. Temperature fall against the norm by 0.25-2.15°C is anticipated on the rivers of Aral-Syrdarya, Yertis river-basins, as well as on Assa and Kuragaty rivers of Shu-Talas river-basin.

By 2099, air temperature upside deviation from the norm is anticipated to be 0.5 – 4.6 °C on the majority of watersheds in the territory of Kazakhstan. A temperature fall against the norm is anticipated on Assa, Keles and Arys rivers by 0.1; 0.93 and 0.1 °C while the norm is 12; 11.3 and 10.9 °C, respectively.

Together with the air temperature, the annual precipitation was examined on the watersheds under study. By 2050, on the majority of watersheds in the Republic of Kazakhstan, precipitation is anticipated to decrease. On the Yessil river-basin, the decrease in precipitation against the norm will be 7.5% with the norm of 343 mm. On the Nura-Sarysu river-basin - from 6 to 32%. On the Kara-Yertis river, the decrease in precipitation will amount to 25% of the norm (with the norm of 557 mm). The maximum decrease in precipitation is anticipated on the Balkash-Alakol river-basin – up to 44.7% on the Ile River, and up to 16.8% on the Sharyn River.

By 2050, an increase in precipitation compared to the norm is anticipated on the Tobol-Torgay river-basin by 14.7%, with the norm of 332 mm. On the Shu-Talas river-basin, increase in precipitation on Ters and Kuragaty rivers is anticipated to be 6.8 and 20.4%, respectively. However, it appears that precipitation is anticipated to be below the norm by 21% on Assa river of the Shu-Talas river-basin. A similar trend with decreasing precipitation appears by 2099 as well. The maximum deviation by 41.5%, against the norm is anticipated on the Ile river with the norm of 473 mm. Upward trend in the amount of precipitation will occur on Kuragaty, Tobol, Ayat and Ters rivers – 26.3; 20.2; 20.2 and 10.9% above the norm, respectively.

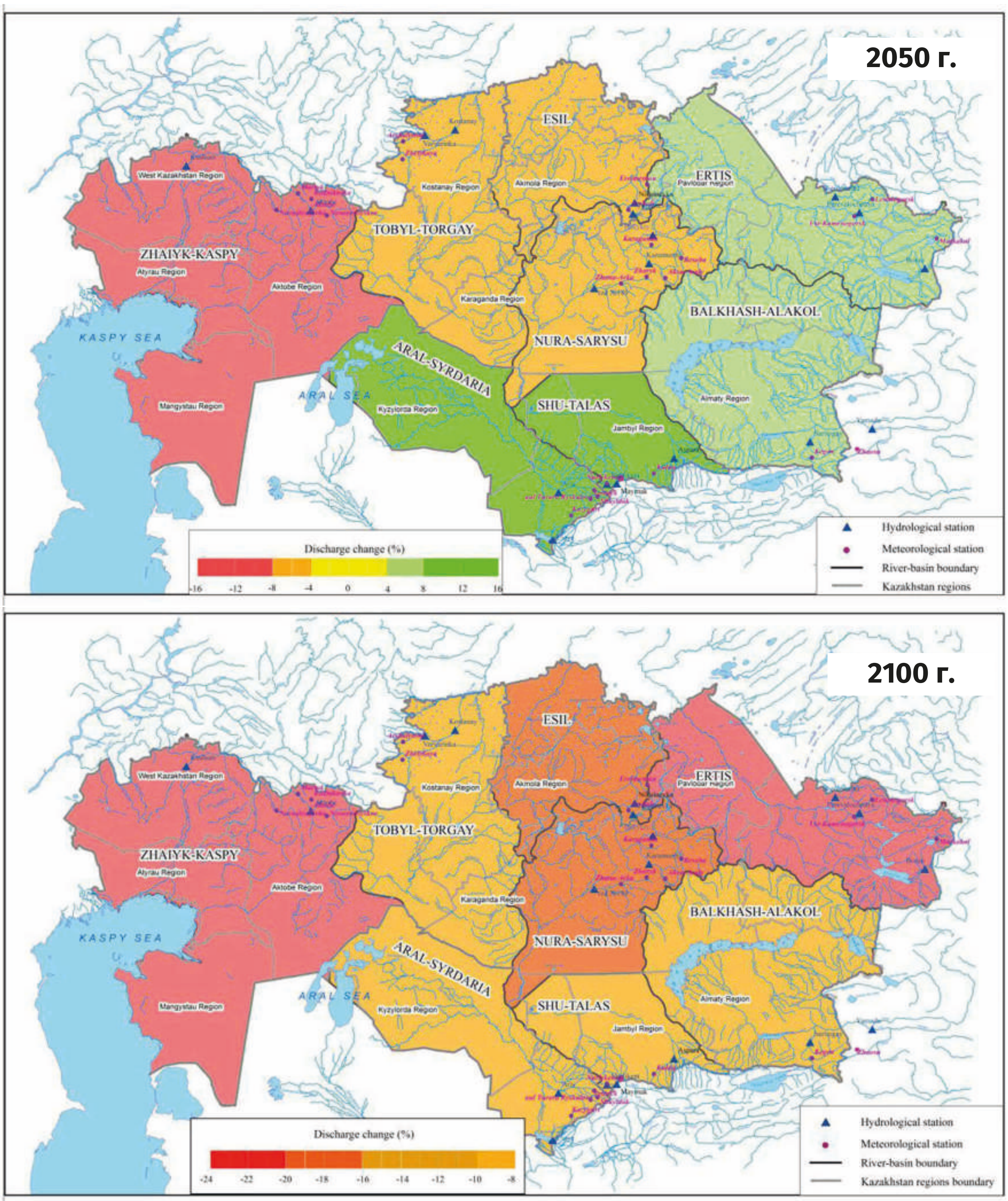
Table 82. *Simulated runoff values for different future periods and changes against multiannual runoff norm.*

	Water catchment area	Multiannual normal runoff, m³/s	Average annual runoff, m³/s		Changes in annual runoff against runoff norm,%	
				2071-2100	2050	2100
1	Yessil r.– Turgenevka village	3.8	3.5	3.1	- 8.7	- 18.0
2	Moyildy r.– village Nikolayevka	1.1	1.0	0.9	- 9.5	- 19.1
3	Tobol r. – Kostanay city	16.3	15.6	14.8	- 4.3	- 9.2
4	Ayat r. - Varvarinka village	6.0	5.8	5.4	- 3.7	- 10.0
5	Nura r. – Romanovka village	20.6	18.6	18.3	- 9.7	- 11.2
6	Sherybainura r. - Karamuryn village	5.2	4.7	4.6	- 9.4	- 12.8
7	Sarysu r.– crossing No 189	3.0	2.6	2.3	- 14.5	- 23.7
8	Assa r.– railway station Maymak	10.8	11.8	9.3	9.3	- 13.9
9	Ters river – Nurlykent village	6.0	6.7	5.4	12.0	- 10.0
10	Kuragaty r. – railway station Aspara	3.9	4.5	3.3	15.4	- 15.4
11	Keles r. - mouth	13.0	14.6	11.1	12.3	- 14.6
12	Arrys r. – railway station Arrys	11.7	13.7	10.1	17.1	- 13.7
13	Ural r. – Kyshym village	353	300	283	- 15.0	- 19.8
14	Yelek r. – Aktobe city	17.2	15.0	14.1	- 12.8	- 18.0
15	Kara Yertis – Boran village	301	326	234	8.3	- 22.3
16	Ulba r. – Perevalochnaya village	104	116	86.0	11.5	- 17.3
17	Oba r.– Shemonaikha city	165	186	141	12.7	- 14.5
18	Ile r. – Yamadu village	360	396	301	10.0	-16.4
19	Sharyn r. p – Sarytogai village	36.8	39.0	33.1	6.0	- 10.1

The table above shows that if 2050 climate changes happen according to RCP4.5 scenario water resources in Kazakhstan mountain basins may increase, on average by 1.94% – 12.54% in Keles, Kuragaty, Assa, Ile, Oba, Ulba, Yertis, Arys, Sharyn river basins. Southern basins will mainly contribute to such increase where runoff formation involves glaciers. Glaciologists' studies show that glacial runoff has reduced over the last decade and by the end of the century there is a probability of glaciers disappearance.

In lowland river basins in western, northern and central Kazakhstan water resources tend to decrease by 3,7% – 15%, and by the end of the century by 9,2%-23,7% against the past runoff norm. Decrease in lowland rivers runoff is linked to runoff's latitude dependence and dominant influence of average annual air temperature increase (Figure 106).

Figure 106. *RK water resources projection for 2050 and 2100.*



6.5.5. Measures of adaptation to climate change related to the use of water resources in economy sectors

Climate change impacts are site-specific and change over time. Therefore, any measures to counteract them should be developed on different management levels and in between them: on regional, national, local level and on the level of transboundary basins. Adaptation on one level only can promote consolidation of the given level but weaken the capacity for adaptation and actions on other levels.

The key factor of effective adaptation is capacity-building of land use and water resources management institutions.

The two main ways of water shortage elimination identified in the water sector of economy are:

1. Reduction of load on water resources implying measures taken to slow down wet production development and use of latest technologies to reduce fresh water consumption in industry, energy, agriculture and utility sectors.

Required actions:

- countrywide improvement of the technical state of utility and drinking water supply systems and their further upgrade;
- reduction of specific water consumption per irrigated hectare, per ton of plant and livestock products, per ton of all types of products, per Gcal of generated heat, kWh of generated electric power, etc.;
- keeping track on the government level of water use and protection implying establishment of additional gauging stations on rivers, including stations on lakes doing a full scope of observations, as well as gauging stations on all sewage ponds;
- countrywide protection of water sources and water bodies from pollution, obstructions and depletion;
- reduction of material damage from negative water impact by means of construction of protection dikes and other hydraulic structures, slope stabilization with the use of modern technologies and vegetative methods, etc.;
- improvement of the state water management system efficiency, including enhanced application of integrated water resources management (IWRM) principles;
- increased financing of scientific research in the water sector and design in the field of water engineering;
- improvement of the technical condition of fixed assets of the water resources utilization system;
- legal framework improvement in terms of water resources management, application of international water law and interstate cooperation with neighboring countries to address transboundary water issues;
- creation of a full-fledged economic mechanism for water conservation.

2. Enhancement of water resources available for use, including:

- further intensification of long-time and seasonal river flow regulation;
- wider use of fresh groundwater resources where necessary, in a sustainable manner and in combination with surface waters;
- desalination of low-, medium-salt and sea water using cutting-edge high-tech and innovative desalination methods;
- territorial, including transboundary, water transfer subject to in-depth scientific studies and environmental impact assessments;
- safe reuse of sewage and rainwater, recycling and re-sequential water supply, etc.

The following key activities have to be implemented in agriculture in the field of rational use of water resources:

1. Water saving and conservation:

- comprehensive reconstruction and modernization of irrigation and collector networks and systems and their hydraulic structures;
- development of optimal soil-amelioration pattern;
- technical improvement of hydro-amelioration systems with a view to bring their efficiency coefficient (EC) to 0.75 and the land use coefficient (LUC) to 0.9 to ensure saving of water resources;

- introduction of modern high-performance, water-saving and energy-saving technologies and irrigation techniques for agricultural crops: various types of sprinkling equipment, drip and mist irrigation and their combination, discrete surface irrigation, subsoil irrigation, etc.;
- introduction of modern automated and computer systems of water accounting, water distribution and irrigation;
- use of collector and drainage water for irrigation, alone or mixed with irrigation water;
- evidence-based crop rotation to increase crop yield;
- farming methods for increased soil fertility;
- replacement of relatively wet crops with drought-resistant crops;
- establishment of systems in pilot areas to test effectiveness of water use measures and introduce new water saving technologies into practice.

2. Creation of a system of real support to agricultural producers and elaboration of government measures designed to make meliorative agriculture more attractive to investors.

3. Development of appropriate legal and technological mechanisms for technical improvement of irrigation infrastructure and introduction of advanced water-saving technologies.

4. Improvement of regulatory and technical framework in the field of irrigation and drainage, which determines current criteria and indicators of efficiency, reliability and safety of land melioration systems and hydraulic structures.

Reduction of available water resources negatively affects hydroelectric power generation.

Therefore, the possible adaptation measures are:

1. Development and improvement of alternative renewable energy sources:
- study of feasibility and implementation of small hydropower;
- study of feasibility and implementation of wind energy;
- study of feasibility and implementation of solar energy.
2. Nuclear energy development.
3. Establishment of new hydroelectric power generation facilities and transmission grid construction from currently operating power plants.
4. Increase in energy carrier prices.

In the municipal and industrial sectors of economy the possible measures of adaptation to climate change are:

1. Enhancement of groundwater resources for guaranteed drinking water supply to population through additional exploration and re-confirmation of groundwater deposit reserves.
2. Reconstruction and construction of clustered water supply systems.
3. In accordance with Ak-Bulak Sectoral Program, drinking water supply to 100% of urban population and 80% of rural population.
4. Introduction of water conservation methods based on water recycling and re-supply to reduce drinking water consumption in manufacturing.

Natural aquatic ecosystems, such as wetlands, provide a wide range of services that contribute to people’s well-being, including those related to climate change prevention or adaptation to it, and they are often vital for maintenance of water and available water resources quality.

However, the same ecosystems are under threat of climate change impacts and their excessive use. Conservation and restoration of ecosystems is very important for increase in adaptive capacity and reduction of vulnerability.

6.6. Agriculture of Kazakhstan

A significant share in Kazakhstan economy is taken by agriculture based primarily on crop farming. Of the total gross agricultural production, 55% is crop production and 45% - livestock production[206].

In 1990-s the acreage for crops accounted for over 34 million hectares of Kazakhstan lands. Today over 21 million hectares are involved in the country's farming business. Of them over 1.0 million hectares are irrigated (about 5%), i.e. 95% of agricultural crops area is cultivated in natural watering conditions.

Grain production dominates in the country's crop production. Benefiting from a good level of grain production Kazakhstan is one of the world's leading producers of wheat and wheat flour.

The leading sectors of livestock breeding in the country are sheep and cattle breeding. Between 1990 and 1998, the number of cattle decreased from 9.8 million to 3.9 million head, and the number of sheep and goat – from 35.7 million to 9.5 million. By 2016, the number of sheep and goat has reached almost 18.0 million animals, and cattle – 6.2 million animals.

6.6.1. Agricultural climatic conditions and unfavorable weather events for agriculture in the Republic of Kazakhstan

6.6.1.1. Agroclimatic conditions and unfavorable weather phenomena for agriculture

In order to assess current agricultural climatic conditions and unfavorable weather events for agriculture we looked into heat and water availability in the vegetation period and occurrence of drought, dry wind and frost with a particular focus on 4 northern grain oblasts. Together they account for 73% of crops acreage: over 5.0 million ha in Kostanay oblast, over 4.6 million ha in Akmola oblast, over 4.3 million ha in North Kazakhstan oblast, and over 1 million ha in Pavlodar oblast. It should be noted that 80% of grain and leguminous crops areas are concentrated in these four oblasts.

Heat and water availability in the vegetation period was determined on the basis of data collected from meteorological stations (MS) of Kazhydromet RSE of the Ministry of Energy of the Republic of Kazakhstan, averaged over the period from 1981 through 2014.

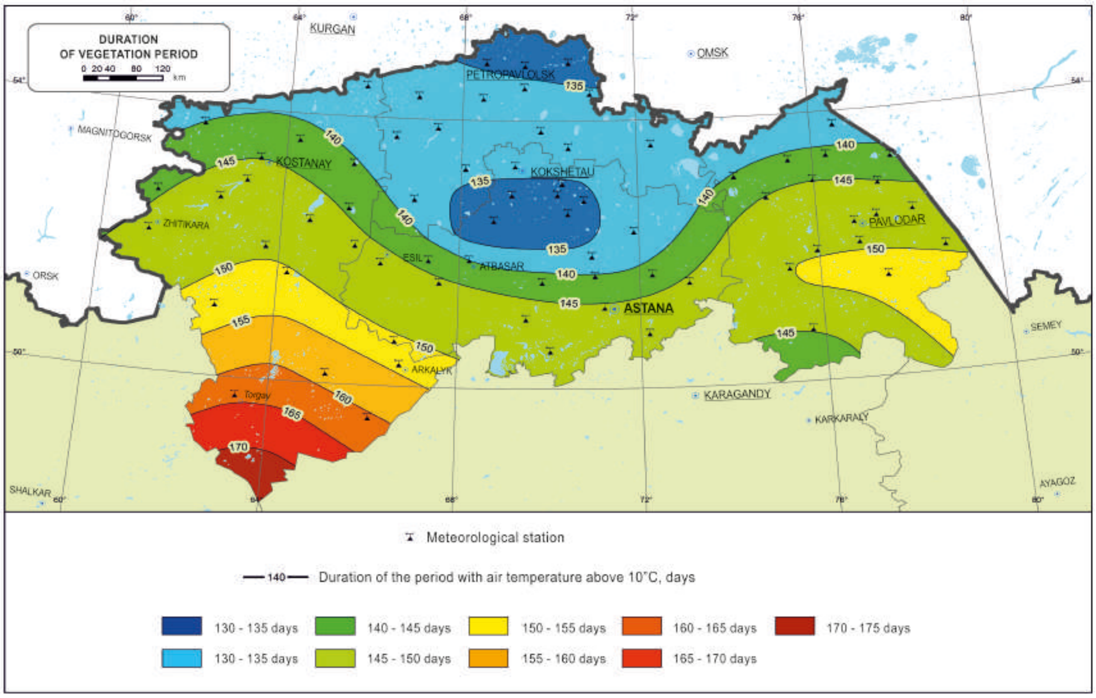
Heat and water availability indices for 6 Kazakhstan oblasts were determined in the course of "Agroclimatic Resources of Kazakhstan in the Face of Climate Change" project implementation by the branch of the Institute of Geography LLP of the Ministry of Education and Science of the Republic of Kazakhstan, under the guidance of S. Baisholanov, Associate Professor.

Heat availability in the vegetation period

A map of spatial distribution of the duration of period with average daily air temperature above 10°C (Figure 108) was made to develop a general understanding of the vegetation period duration. The figure shows that the vegetation period duration in northern Kazakhstan is increasing as we move from the north to the south from 130 to 170 days, and in the Kokshetau Upland area there is a spot where such duration is less than 135 days.

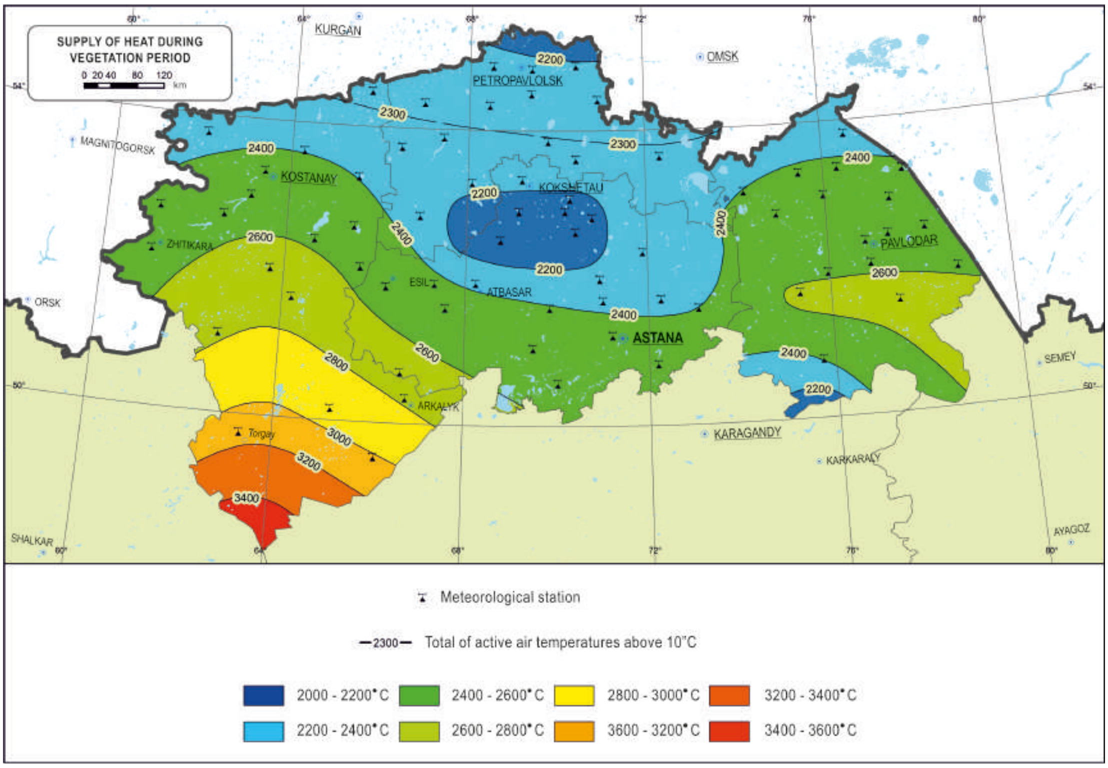
206 Official Internet resource of the Committee of Statistics of the Ministry of National Economy of the Republic of Kazakhstan [electronic resource]. – 2016. – URL:http://www.stat.gov.kz/faces/wcnav_externalId/homeNumbersAgriculture?_afrLoop=2799360813148923#%40%3F_afrLoop%3D2799360813148923%26_adf.ctrl-state%3 D57nxjwcne_50 (reference date - 20.09.2016).

Figure 107. *Spatial distribution of the (according to S. Baisholanov).*



A map of spatial distribution of accumulated effective air temperature above 10°C was made to give a general understanding of heat availability in the vegetation period in the area under consideration (Figure 109). In 4 northern oblasts of Kazakhstan accumulated effective air temperature above 10°C grows from the north to the south from 2100°C to 3400°C.

Figure 108. *Spatial distribution of accumulated effective air temperature above 10°C (according to S. Baisholanov).*



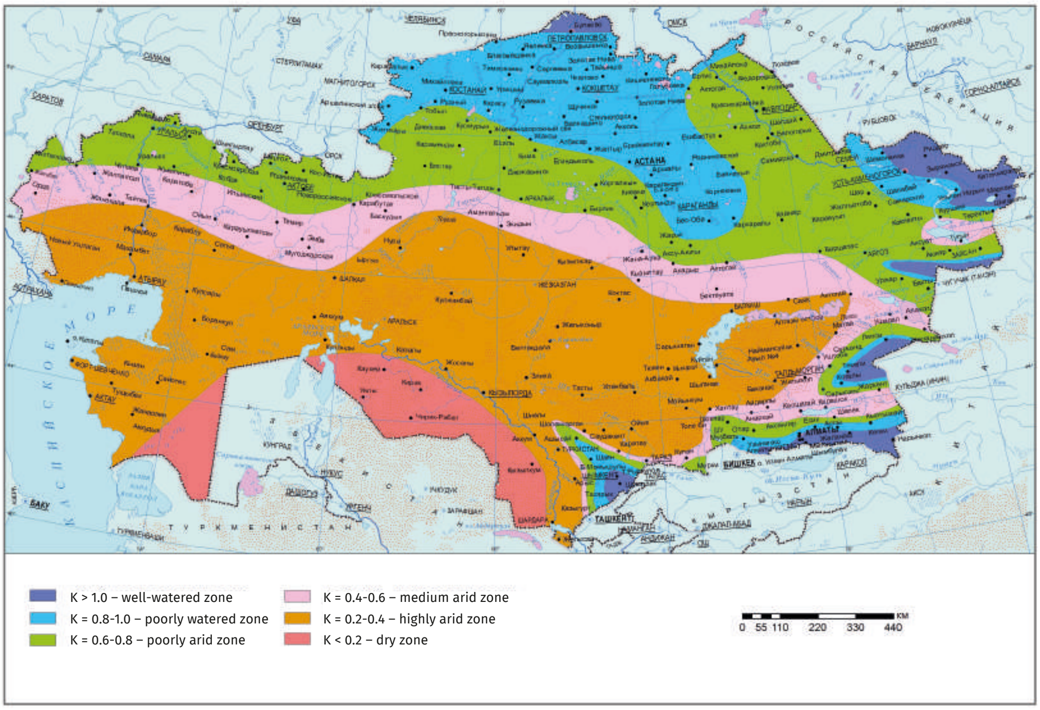
Water availability in the vegetation period

Agricultural climatology studies the following factors of moisture resources availability: precipitation, productive moisture reserves (PMR) in soil, evaporation capacity and various estimated indicators and moisture indices.

Precipitation is very important for crops during active vegetation (from sowing to ripening), i.e. in May-August. Clear weather without precipitation is favorable for ripening and harvesting process. Water availability to plants is determined by certain indicators, in the form of different moisture indices (MI).

Water availability during the vegetation period in conditions of Kazakhstan could be described by the water availability coefficient 'K'. Figure 110 shows distribution of MI values over the territory of Kazakhstan calculated on the basis of averaged data for 1970-2010. Kazakhstan is divided into 6 zones depending on the vegetation period wetting degree: from dry to well-watered.

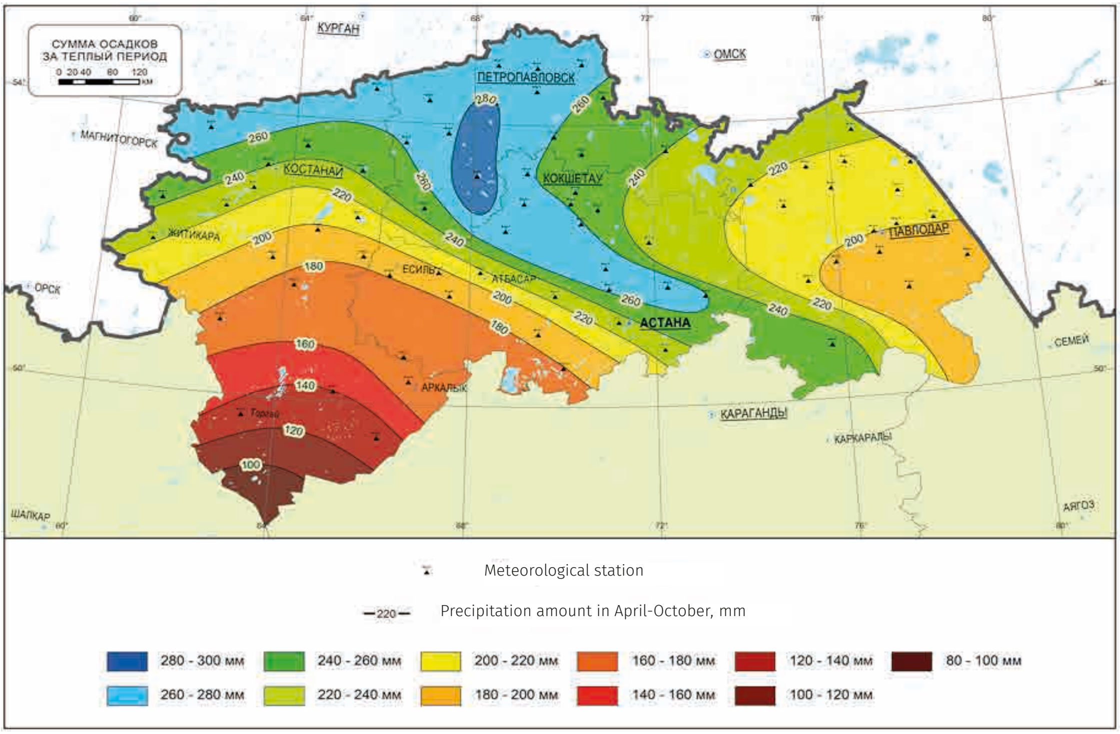
Figure 109. *Moisture index distribution in Kazakhstan (according to S. Baisholanov).*



Average multiannual precipitation in 4 northern oblasts of Kazakhstan ranges from 250 to 400 mm. Specifically, 300-420 mm in North Kazakhstan oblast, 280-400 mm in Akmola oblast, 250-350 mm in Kostanay oblast, 255-330 mm in Pavlodar oblast. In the course of one year precipitation is increasing from winter to summer with maximum precipitation observed in July and minimum – in February. In warm periods precipitation level is 2 times higher than in cold periods.

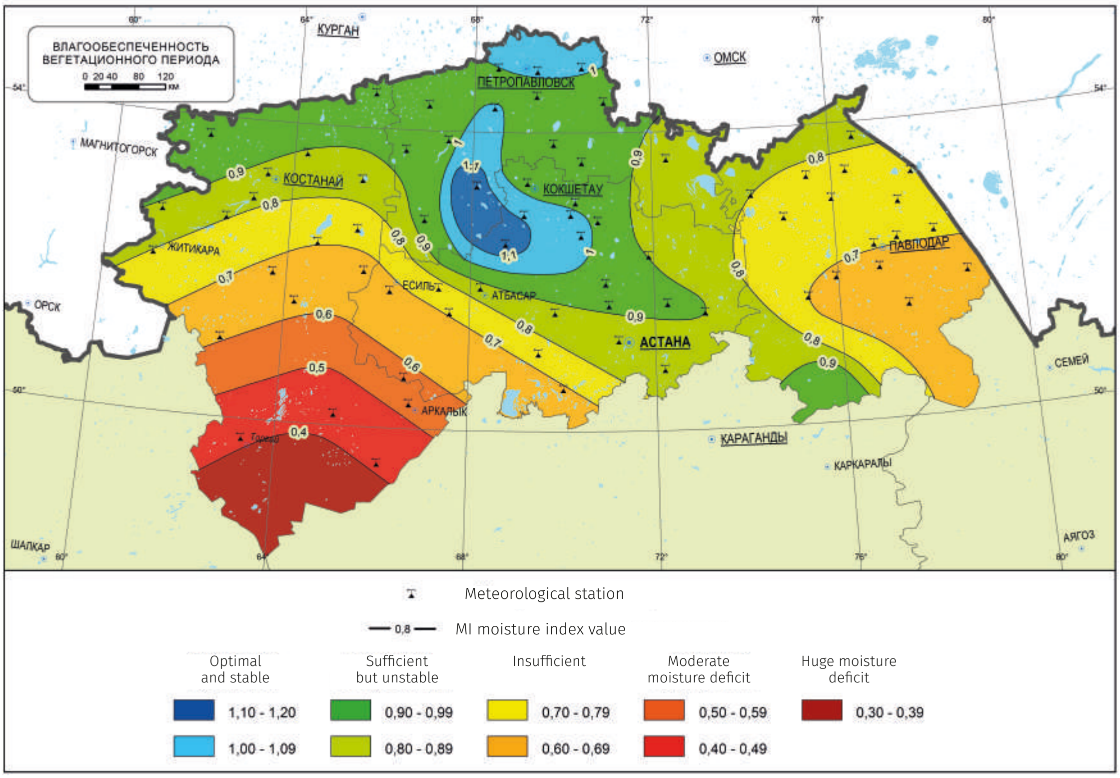
Figure 111 shows spatial distribution of precipitation amounts in the warm period (April-October) in 4 northern oblasts of Kazakhstan. Precipitation amount decreases from the north (from 280 mm) to the south-west (down to 100 mm) and to the south-east (down to 200 mm).

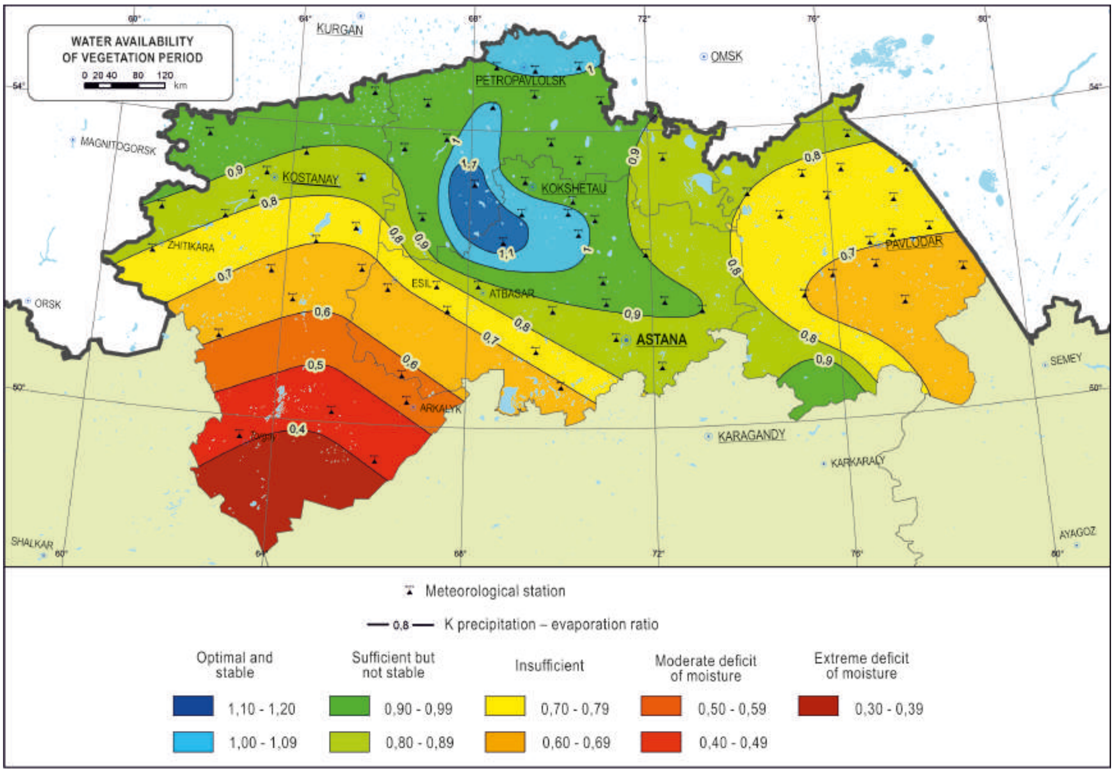
Figure 110. *Spatial distribution of precipitation amounts in the warm period of the year (according to S. Baisholanov).*



MI moisture index was also used to assess water availability to grain crops. 5 levels of water availability in the vegetation period are distinguished in 4 Kazakhstan oblasts under consideration (Figure 112).

Figure 111. *Northern Kazakhstan zoning in terms of water availability in the vegetation period (according to S. Baisholanov).*





"Optimal and stable water availability" zone (MI = 1.0-1.2) covers the far north of North Kazakhstan oblast and the Kokshetau Upland area located in the south of North Kazakhstan oblast and in the north-west of Akmola oblast.

"Sufficient but unstable water availability" zone (MI = 0.8-1.0) is located in the north of Kostanay oblast, larger part of North Kazakhstan oblast, north-east of Akmola oblast, and in the far north and south-west of Pavlodar oblast.

"Insufficient water availability" zone (MI = 0.6-0.8) is widespread in the central part of Kostanay and south-west of Akmola oblasts, as well as in the center and the south-west of Pavlodar oblast.

"Moderate water deficit" zone (MI = 0.4-0.6) occupies the southern part of Kostanay oblast and the south-western edge of Akmola oblast.

"Water deficit" zone (MI < 0.4) is located in the southernmost areas of Kostanay oblast.

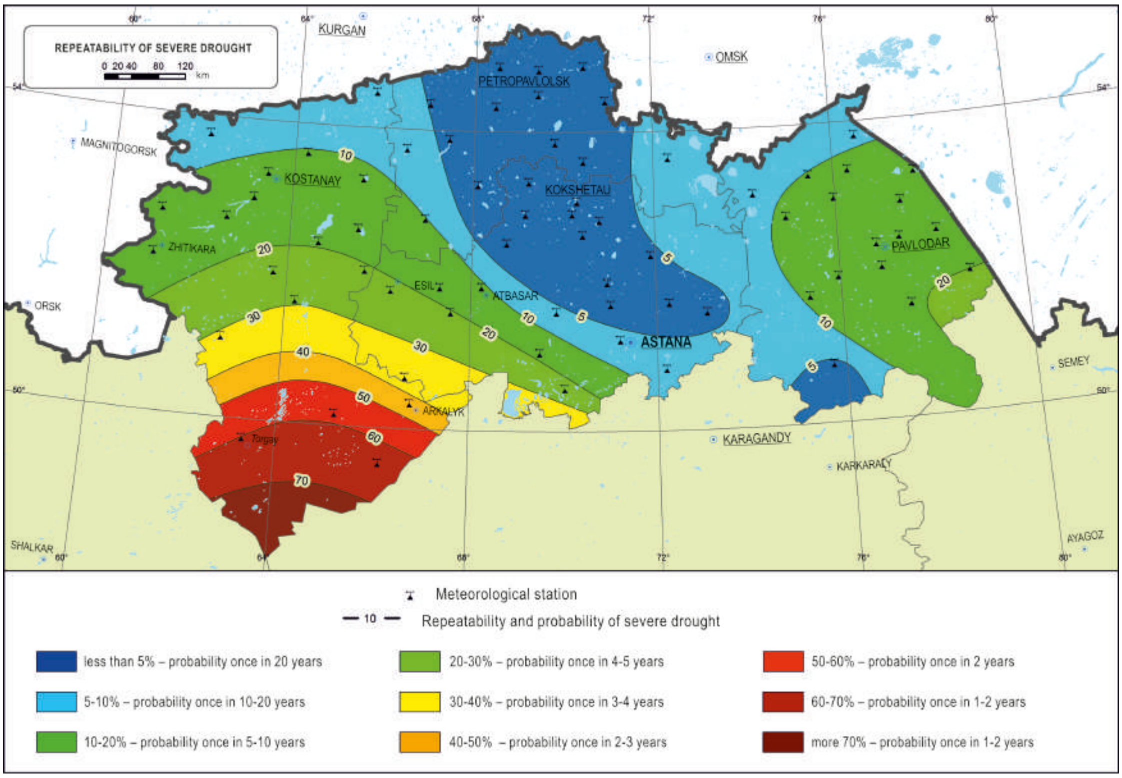
Thus, the northern part of Kostanay oblast, North Kazakhstan oblast, the north-eastern part of Akmola oblast, and the northernmost areas of Pavlodar oblast feature good moistening conditions sufficient for spring crops cultivation. In other areas of Kostanay, Akmola and Pavlodar oblasts, atmospheric moistening is insufficient for high yields of spring crops. Besides, from 1981 through 2000 the trend of water availability in Kazakhstan northern grain oblasts was upward, and was decreasing until 2016.

6.6.1.2. Weather events unfavorable for agriculture

Agrometeorological events constituting threat to vegetation cover (including crops) are: ground frosts, droughts, dry winds, heavy rainfall and hail, strong winds and dust storms. Droughts and dry winds are most common and hazardous in Kazakhstan. Analysis of unfavorable agrometeorological events that caused significant or complete destruction of agricultural crops in Kazakhstan showed that the share of atmospheric and soil drought is about 80%, rainstorm and hail – 14%, ground frosts – 2%, soil overwetting – 2%, severe frosts and strong winds – 1%.

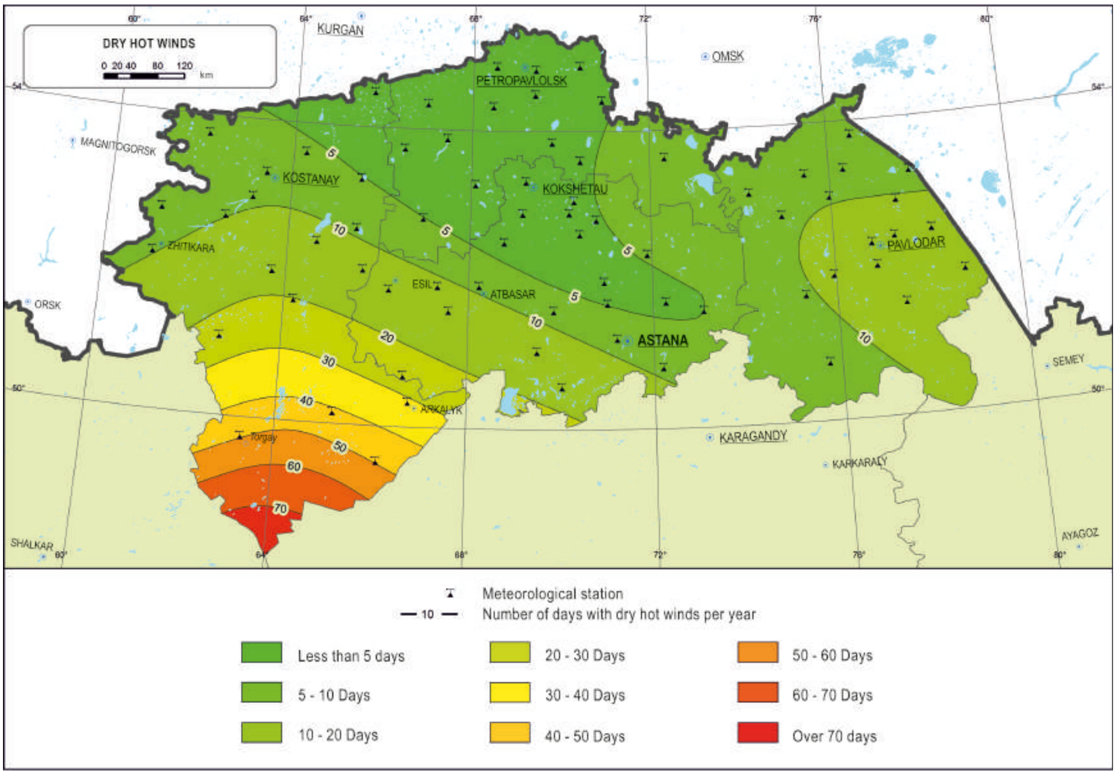
Frequency of severe droughts causing reduction in yields by 50% or more, is increasing from 5% in the north of North Kazakhstan oblast up to 70% in the south of Kostanay oblast. The lowest frequency of less than 5% (probability of 1 drought in 20 years) is specific to the large part of North-Kazakhstan oblast, to the northern and central parts of Akmola oblast, and Bayanaul mountains in Pavlodar oblast (Figure 112). In Kostanay oblast, the frequency of severe droughts from the north to the south, increases from 5-10% up to 70%, i.e. in the north a severe drought is probable once in 10-20 years, in the south – once in 2 years.

Figure 112. *Frequency and probability of severe draught (according to S. Baisholanov)*



Dry wind of moderate and strong intensity causing a negative impact on the crop growth, in North-Kazakhstan oblast, on average, occurs approximately 5 days a year. In the Kostanay oblast, the number of dry days from the north to the south, increases from 5 up to 70 days per year. In Akmola oblast, also from the north to the south, it increases from 5 up to 25 days, and in Pavlodar oblast - from 5 up to 20 days per year (Figure 113).

Figure 113. *Amount of days with moderate and strong dry winds (according to S. Baisholanov)*



6.6.2. Projection of agricultural climatic conditions and weather events unfavorable for agriculture in the face of climate change until 2050

6.6.2.1. Agroclimatic projection in climate conditions until 2050

6.6.2.1.1. Heat availability projection in the vegetation period

In order to estimate heat availability probabilistic forecasts of average monthly air temperature and monthly precipitation amounts were prepared by a group of climate experts (Kazhydromet RSE).

Two successive 20-year periods were used to describe future climate: 2020-2039, with the middle in 2030 and 2040-2059 with the middle in 2050; as well as two climate change scenarios – RCP4.5 and RCP8.5.

For estimation of changes in thermal resources projected values of average daily air temperature were calculated for May-August (ΣT_{5-8}) with due regard to future climatic conditions (2030 and 2050) according to RCP4.5 and RCP8.5, and compared with today's climate values (1981-2014).

Calculation results showed that heat availability to agricultural crops in the expected climate of 2030 will be significantly higher than today. In northern oblasts of Kazakhstan average daily air temperature in May-August (ΣT_{5-8}) in RCP4.5 will increase by 161-180°C, i.e. by 8% (Table 84), and in RCP8.5 – by 182-205°C, i.e. by 9% (Table 85).

Table 83. *Amount of daily air temperatures in today's climate (TC) and in the climate of 2030 and 2050 (RCP4.5).*

Oblast	ΣT_{5-8}, °C			ΔT, °C		ΔT,%	
	TC	2030	2050	2030	2050	2030	2050
North Kazakhstan	2102	2267	2373	165	271	108	113
Akmola	2132	2293	2397	161	265	108	112
Kostanay	2285	2465	2567	180	282	108	112
Pavlodar	2231	2401	2498	170	267	108	112

Table 84. *Amount of daily air temperatures in today's climate (TC) and in the climate of 2030 and 2050 (RCP8.5).*

Oblast	ΣT_{5-8}, °C			ΔT, °C		ΔT,%	
	TC	2030	2050	2030	2050	2030	2050
North Kazakhstan	2102	2294	2446	192	344	109	116
Akmola	2132	2314	2472	182	340	109	116
Kostanay	2285	2490	2640	205	355	109	116
Pavlodar	2231	2419	2572	188	341	108	115

Thus, further climate warming in northern Kazakhstan until 2050 is expected to induce increase in thermal resources by 12-16%, expand the variety of cultivated warm-weather crops and have a favorable effect on their growth and development.

Water availability projection in the vegetation period

For estimation of changes in moisture resources projected precipitation values were calculated for the given year (ΣR_{year}) and for the active growing period (May-August) (ΣR_{5-8}), and the moisture index (MI) was determined with due regard to future climatic conditions (2030 and 2050) according to RCP4.5 and RCP8.5. Then they were compared with today's climate values.

Calculation results showed that annual precipitation amount (ΣR_{year}) varies unevenly until 2050. Under the RCP4.5 climate change scenario, both in 2030 and in 2050 in North Kazakhstan and Akmola oblasts, annual precipitation will remain on nearly the same level as today. A slight increase is possible in Kostanay and Pavlodar oblasts (Table 86).

Under the RCP8.5 scenario, an insignificant reduction in annual precipitation is expected in North Kazakhstan and Akmola oblasts, while Kostanay and Pavlodar oblasts will see insignificant precipitation increase (Table 87).

Precipitation in the active growing period (ΣR_{5-8}) under the RCP4.5 climate change scenario will not rise significantly by 2030 and 2050. The most noticeable change (+8%) is expected in Kostanay oblast (Table 86).

Under the RCP8.5 scenario, no particular changes in precipitation amount in May-August are expected (Table 87).

Table 85. *Precipitation values for the year (ΣR_{year}) and for May-August (ΣR_{5-8}) in today's climate (TC) and in the climate of 2030 and 2050 (RCP4.5).*

Oblast	ΣR_{year}, mm			ΣR_{5-8}, mm		
	TC	2030	2050	TC	2030	2050
North Kazakhstan	357	358	359	183	190	186
Akmola	329	323	323	161	169	166
Kostanay	297	314	316	140	152	147
Pavlodar	286	295	301	149	148	152

Table 86. *Precipitation values for the year (ΣR_{year}) and for May-August (ΣR_{5-8}) in today's climate (TC) and in the climate of 2030 and 2050 (RCP8.5).*

Oblast	ΣR_{year}, mm			ΣR_{5-8}, mm		
	TC	2030	2050	TC	2030	2050
North Kazakhstan	357	344	351	183	182	182
Akmola	329	312	315	161	165	161
Kostanay	297	300	304	140	144	142
Pavlodar	286	287	295	149	147	148

Moisture index (MI) calculations for future climatic conditions have shown that until 2050 water availability in the vegetation period will be gradually deteriorating in the northern oblasts. The greatest changes are projected in climate change scenario RCP8.5. For example, by 2050 these changes will amount to minus 8-12% under the 45 scenario (Table 88), and minus 12-17% – under the 85 scenario (Table 89).

Table 87. *MI values in today's climate (TC) and in the climate of 2030 and 2050 (RCP4.5).*

Oblast	MI			MI,%	
	TC	2030	2050	2030	2050
North Kazakhstan	0,97	0,91	0,86	94	89
Akmola	0,87	0,82	0,77	94	88
Kostanay	0,72	0,71	0,68	98	94
Pavlodar	0,74	0,69	0,68	93	92

Table 88. *MI values in today's climate (TC) and in the climate of 2030 and 2050 (RCP8.5)*

Oblast	MI			MI,%	
	TC	2030 г.	2050 г.	2030 г.	2050 г.
North Kazakhstan	0,97	0,86	0,82	89	84
Akmola	0,87	0,78	0,73	89	83
Kostanay	0,72	0,67	0,64	93	88
Pavlodar	0,74	0,67	0,65	90	88

Thus, in the conditions of further climate warming until 2050, no significant changes in precipitation amount are expected in northern Kazakhstan, however, water availability in the vegetation period will be gradually deteriorating, with the decrease by 8-17%. This is linked to increased evaporating capacity due to higher air temperature.

The expected climate change will lead to a shift in thermal zones and water availability zones to the north.

Figure 113 shows spatial distribution of the moisture index in the northern part of Kazakhstan, in today's climate and climate forecasted for 2050. In comparison with current distribution of MI index, MI isolines feature certain northward shift in 2050.

The **"Optimal and stable water availability"** zone (MI = 1.0-1.2) will completely disappear in the north of North Kazakhstan oblast, while in the Kokshetau Upland area it will significantly shrink.

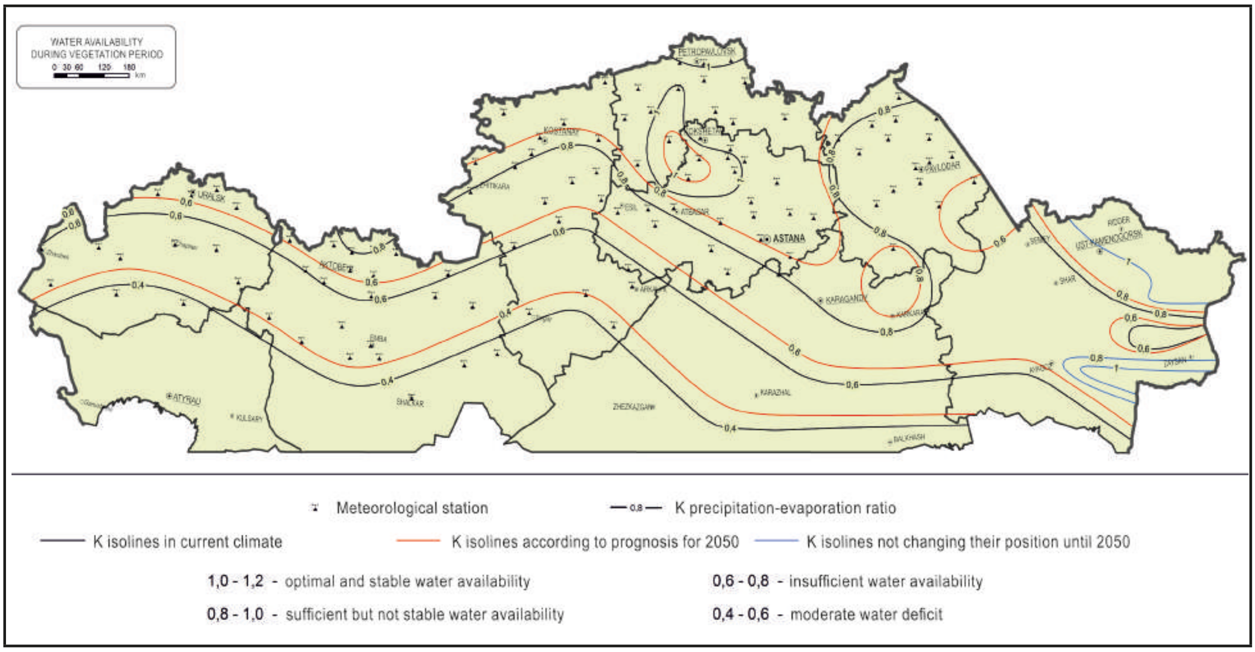
The **"Sufficient but unstable water availability"** zone (MI = 0.8-1.0) will completely disappear in Aktobe oblast, reduce in Kostanay, North Kazakhstan, Akmola, Karaganda, Pavlodar and East Kazakhstan oblasts. At the same time, this zone will almost completely disappear in the north of Pavlodar oblast, while at the border of Pavlodar and Karaganda oblasts the zone island of Korneyevka-Karkaraly-Bayanauyl will separate from the rest of the zone and remain.

The **"Insufficient water availability"** zone (MI = 0.6-0.8) will also move to the north in West Kazakhstan, Aktobe, Kostanay, Akmola, Karaganda, Pavlodar and East Kazakhstan oblasts. At the border area of Pavlodar and East Kazakhstan oblasts the **"Moderate water deficit"** zone with moisture index MI = 0.5-0.6 will appear.

The **"Moderate water deficit"** zone (MI = 0.4-0.6) will also move to the north in West Kazakhstan, Aktobe, Kostanay, Akmola, Karaganda and East Kazakhstan oblasts. This area will rather expand in the area of the Zaysan Lake in East Kazakhstan oblast.

The expected shifts in the zones of water availability in the vegetation period will adversely affect transitional areas, i.e. can lead to revision of existing production relations, like a change in kinds or varieties of cultivated crops or increase in the share of cattle breeding. Undoubtedly, climate change adaptation measures will have to be taken.

Figure 114. *Projection of water availability in the vegetation period in the northern part of Kazakhstan in the climate of 2050 (according to S. Baisholanov).*



6.6.2.2. Forecast of weather events unfavorable for agriculture

In climate warming conditions the principal weather event having adverse effect on agriculture is drought. In the long term, droughts are impossible to predict. However, we can predict climate aridity that all drought events are closely related to, including atmospheric drought and dry winds.

In order to estimate changes in climate aridity, the projected values of hydrothermal coefficient (HTC) were calculated for active growing season (May-August) (HTC5-8) in future climatic conditions (2030 and 2050) according to RCP4.5 and RCP8.5 scenarios, and compared with today's climate values (1981-2014).

If we take average oblast conditions, the climate of North Kazakhstan oblast during the vegetation period is classified as "not arid" (HTC ≥ 0.80), while Akmola, Kostanay and Pavlodar oblasts – as "slightly arid" (HTC = 0.60-079).

HTC calculations for future climatic conditions have shown that until 2050 climate aridity will be gradually increasing in northern regions. The greatest changes are projected for the climate change scenario RCP8.5. For example, by 2050 these changes will be minus 7-10% for RCP4.5 (Table 90), and minus 12-15% for RCP8.5 (Table 91).

Pursuant to the above, in the conditions of further climate warming until 2050 climate aridity will be increasing in northern Kazakhstan as HTC values are going down by 7-15%. Consequently, droughts and dry winds will become more frequent.

Table 89. *HTC values in today's climate (TC) and in 2030 and 2050 (RCP4.5).*

Oblast	HTC_{5-8}			HTC_{5-8}, %	
	TC	2030	2050	2030	2050
North Kazakhstan	0,87	0,84	0,78	96	90
Akmola	0,76	0,74	0,69	98	91
Kostanay	0,61	0,61	0,57	100	93
Pavlodar	0,67	0,62	0,61	93	91

Table 90. *3HTC values in today's climate (TC) and in 2030 and 2050 (RCP8.5)*

Oblast	HTC_{5-8}			HTC_{5-8}, %	
	TC	2030	2050	2030	2050
North Kazakhstan	0,87	0,79	0,74	91	85
Akmola	0,76	0,71	0,65	94	86
Kostanay	0,61	0,58	0,54	95	88
Pavlodar	0,67	0,61	0,57	91	85

6.6.3. Grain crops yield forecasting in climate change conditions until 2050

6.6.3.1. Spring wheat yield forecast in climate change conditions until 2050

With a view to study climate change impact on the yield of spring wheat, the yields of spring wheat were calculated for seven grain oblasts of Kazakhstan (North Kazakhstan, Kostanay, Akmola, Pavlodar, Karaganda, West Kazakhstan and Aktobe) with due regard to current and expected climate norms until 2050. Difference in yield values is an index of crops vulnerability to climate change.

A dynamic model of crop yield formation developed by Professor A. Polevoy (Ukraine) and adapted to climatic conditions of Kazakhstan oblasts mentioned above was used to forecast the yield of spring wheat.

With due regard to climate change expectations, average oblast spring wheat yield will amount to 63-91% of its current level by 2030, and 51-87% – by 2050-s (Figure 114). This implies that, subject to maintaining of present farming standards, spring wheat yield will reduce by 13-49% by 2050. The greatest changes are expected in 3 northern oblasts.

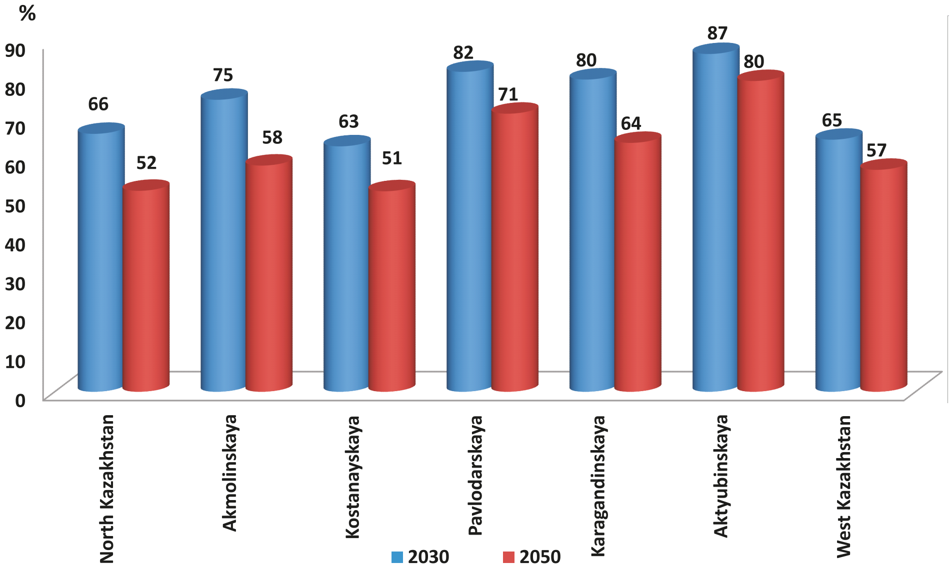
The main reasons of wheat yield reduction are:

– increase in evaporation, leading to decrease in areas moistening despite expected precipitation increase by up to 10%;

– increase in air temperature above the values optimal for spring wheat growth and development.

In the expected conditions of 2030 and 2050, higher wheat yields can be achieved with the use of higher farming standards, i.e. if adaptation measures and cultivation technologies are introduced.

Figure 115. *Spring wheat yield forecast until 2050 (Y, in percentage of the current level) under RCP4.5 climate change scenario.*



6.6.3.2. Sunflower seeds yield forecast

Sunflower is the principal oil crop in our country. Sunflower vegetation period lasts for 80-160 days depending on ripeness of sunflower varieties. Early-season, mid-early-season and mid-season varieties and hybrids are mainly cultivated in the northern part of Kazakhstan, where sunflower is sown in early May.

Sunflower is a light-demanding and heat-loving crop.

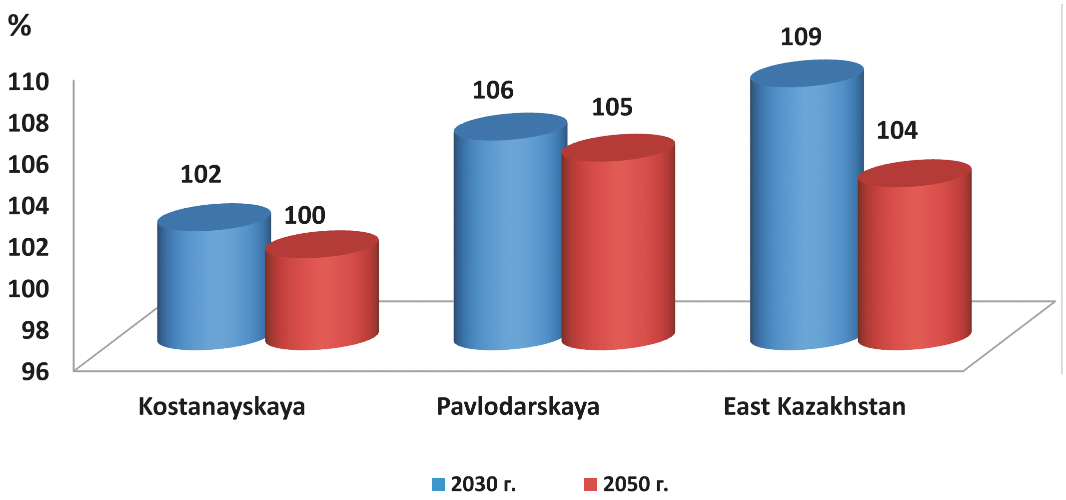
For our study of sunflower seeds yield dependence on expected climate change we selected Kostanay, Pavlodar and East Kazakhstan oblasts where sunflower is cultivated in the conditions of natural watering (without irrigation) and the dynamic model of crop yield formation developed by Professor A. Polevoy (Ukraine) was adopted as well.

Yields were calculated for the current and expected climate norms until 2050 with the Polevoy model in order to determine the degree of climate change impact on sunflower seeds yield. Difference in yield values is an index of crops vulnerability to climate change.

Predictive calculations were made for climatic conditions of 2030 and 2050 under RCP4.5 climate change scenario.

Results showed that average oblast sunflower seeds yield will amount to 102-109% of its current level in the expected climate of 2030, and 100-105% – in 2050-s (Figure 115). This implies that, subject to maintaining of present farming standards, sunflower seeds yield is not expected to decrease until 2050. On the contrary, subject to thermal regime optimization, sunflower seeds yield can be raised by 2-9% by 2030 and by up to 5% by 2050 against its current level. This highlights the need to expand heat-loving crops in northern and eastern regions of Kazakhstan. Naturally, introduction of adaptation measures and agro-technologies will ensure higher yields of sunflower seeds than today.

Figure 116. *Sunflower seeds yield forecast until 2050 (Y, in percentage of the current level), under RCP4.5 climate change scenario.*



6.6.4. Current zoo-climatic conditions for the livestock management

Livestock breeding is a key Kazakhstan economic sector, the principal source of employment and food for rural population. Principal farm animals in Kazakhstan are cattle, sheep and goats, horses, camels and pigs.

So far sheep breeding and cattle breeding have been in the forefront of livestock breeding in the Republic. Between 1990 and 1998 cattle numbers went down from 9.8 million to 3.9 million heads, sheep and goats – from 35.7 million to 9.5 million heads. By 2016 the number of sheep and goats has reached nearly 18.0 million heads, cattle – 6.2 million heads. The number of horses also decreased from 1.6 mln. to 0.97 mln. heads; today it is over 2.1 mln. heads. Similar changes are observed in camels, pigs and poultry population.

Livestock mortality is caused by adverse weather conditions. It can be induced by severe frosts, strong snowstorms, high snow cover, ice layer in the snow cover, cold weather return after shearing, heavy downpours and hailstorm, excessive heat and drought, etc. Livestock mortality can also happen due to animal diseases (infectious, parasitic and non-contagious). While there are many preventive veterinary medicine methods to counteract diseases, hazardous weather events are much harder to deal with. It is essential to have a reliable long-term weather forecast and a relevant set of economic measures (emergency feed conservation, availability of warm sheep barns, regard to weather during spring shearing and drive to pastures, etc.).

Table 92 presents data on livestock mortality in Kazakhstan. For example, in recent years, annual mortality rate for cattle is around 17000 heads, sheep and goats – up to 61000 heads, horses – up to 5000 heads, camels – up to 980 heads, and pigs – up to 42000 heads (Table 92).

Table 91. *Livestock mortality rate in Kazakhstan, heads.*

Livestock	2015	2016
Cattle	16 179	17 068
Sheep and goats	61 508	47 226
Horses	5 005	4 735
Camels	834	981
Pigs	42 051	40 248

In our country cattle is mostly confined in stalls, while sheep and goats graze in pasture to a greater extent. Therefore, sheep breeding is more dependent on climatic and weather conditions than cattle breeding.

Larger numbers of sheep and goats are concentrated in southern Kazakhstan where climate is suitable for driving-pasture approach to livestock management. Weather and climatic conditions affect animals in two ways: firstly, they determine the state of pasture vegetation, the main feed source; secondly, they have a direct effect on animal organism.

In the areas of high-intensive arable farming where natural pastures are few or non-existent, sheep breeding is industrialized. In that case, mainly stall-pasture or pasture-stall sheep management is maintained, with zero grazing in certain areas.

Stall-pasture management is the most widespread: sheep are kept inside for a certain period of time depending on climatic conditions and fodder base arrangement, and in summer – on rotation or natural pastures. This manner of sheep breeding dominates in areas of intensive farming. Its advantage is that it enables more rational use of not only stall feeds (coarse, juicy and concentrated), but also pastures available to farms.

On February 20, 2017, the President of the Republic of Kazakhstan approved the Law of the Republic of Kazakhstan on Pastures.

The legislation of the Republic of Kazakhstan on Pastures is based on the following principles:

1) rational use of pastures;
2) accessibility of pastures for individuals and legal entities;
3) publicity of activities carried out in provision and use of pastures;
4) involvement of individuals and legal entities in settlement of issues on pastures management and usage.

The Law on Pastures provides for the development of Pasture Management Plan, development and approval of pasture rotation scheme, compliance with pasture load norms. The Law also defines the rights and obligations of pasture users. Pastures are provided for maintenance of personal farmstead, peasant holding or farming, as well as for agricultural production. The Law also sets out the procedure of distant pasture provision and use.

6.6.4.1. Current zoo-climatic conditions of sheep breeding in southern Kazakhstan

The time of such important activities as sheep pasturing, lambing, drive, insemination, shearing and dipping is closely related to climatic and weather conditions in the area. It is very important in sheep breeding to evaluate favorability of weather conditions for animals in cold and warm seasons, during sheep shearing and driving to summer pastures.

Current zoo-climatic conditions in cold season

The most important for sheep breeders is winter period. Winter is the time of sharp drops in air temperature, snowfalls and ice-frost phenomena. Under thick snow cover pasture fodder becomes hardly accessible or inaccessible to small ruminants. In certain winters, unfavorable weather conditions can cause long-term pasture fodder shortage and livestock transfer to stall barn housing. In winter period dams are in a special physiological condition – pregnant. Litter's health depends on full-fledged feeding and keeping of sheep. Besides, it is very important to predict the number of non-pasturing days and prepare sufficient insurent fodder reserve.

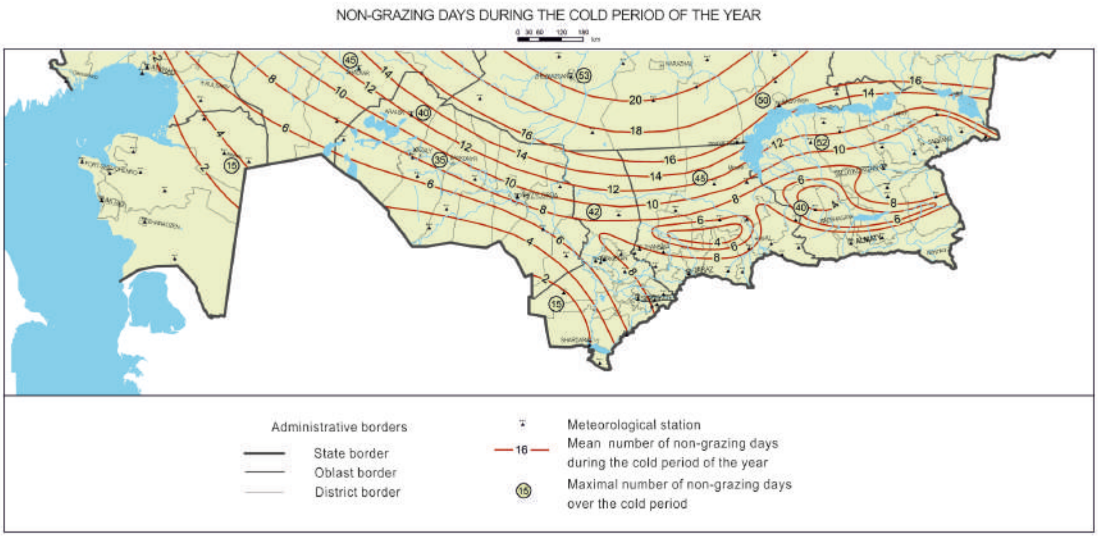
Low air temperature, wind, high or thick snow cover have an unfavorable cumulative effect on sheep pasturing. Sheep pasturing on winter pastures becomes impossible in the following cases:

- air temperature is below minus 28°C, regardless of other factors;
- snow cover is over 20 cm high, regardless of other factors;
- snow cover density is over 0.32 g/cm3, regardless of other factors;
- wind speed is over 14 m/s, regardless of other factors;
- certain combinations of air temperature, wind speed, snow cover height and density, according to the criteria developed by A. Chekeres.

A complex zoo-climatic index in cold periods is the number of non-grazing days (NGDs) over the period from November through March. NGDs were calculated for the period of 1981-2015 on the basis of data obtained from meteorological stations.

Figure 117 shows distribution of average multiannual NGD over the southern part of Kazakhstan. The average number of sheep non-grazing days varies significantly across the country. For winter pastures on the Taukum and Saryesik-Atyrau sands in Almaty oblast the average NGD value ranges from 4 to 12 days. In the north-east of the Balkhash Lake and in the vicinity of the Alakol Lake average NGD is 12-14 days.

Figure 117. *Average number of non-grazing days in cold period of the year in southern lowlands of Kazakhstan (S. Baisholanov, 2016).*



NGD changes significantly in winter too. The least favorable period for animals pasturing is January and February. Up to 70% of all non-grazing days fall on these two months.

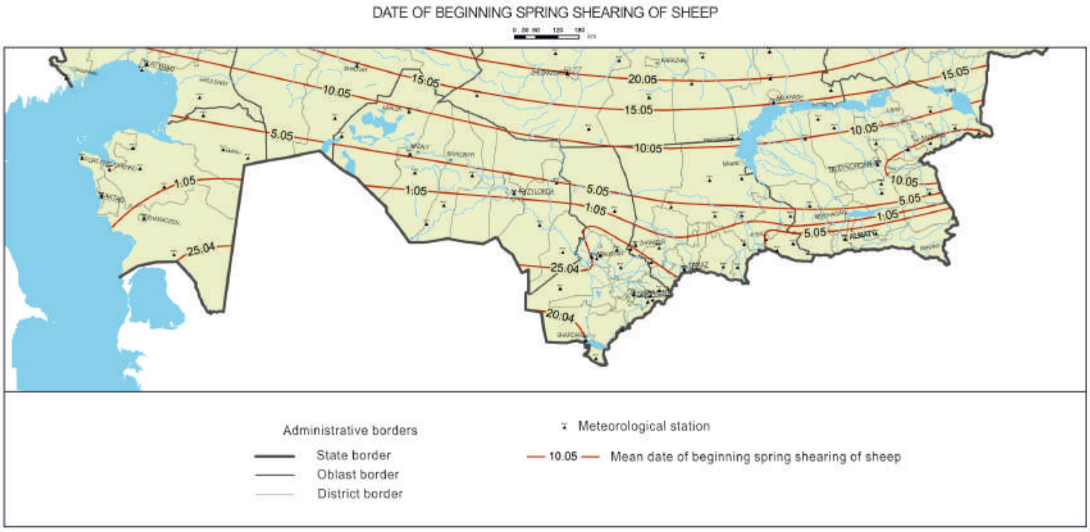
The duration of winter pasture fodder shortage is variable by years as well. Thus, in severe winters the number of non-grazing days in the south can go up to 15 days (Kyzylkum), in Moiynkum – up to 42 days, and on Betpak-Dala – up to 50 days (Figure 117).

Zoo-climatic conditions in warm season

Animals grazing is of particular importance in the warm period of the year. Before the summer heat comes, prior to driving to summer pastures, sheep are sheared. Spring shearing of sheep is carried out at the time cold weather becomes warmer. Early shearing or sharp climatic changes lead to poor quality of wool, higher probability of diseases and mortality of shorn sheep due to cold weather effects. If sheared too late sheep graze less and lose weight due to hot weather. In this regard, it is necessary and important to predetermine optimal timing of sheep shearing. It was discovered by P.Zh. Kozhakhmetov that in southern Kazakhstan shearing of sheep should begin after the date when the amount of positive daily average air temperatures sums up to 550°C. Accordingly, the date the amount of air temperatures sums up to 550°C can mark the beginning of shearing. Spring shearing timing was based on data obtained from meteorological stations (MS) for the period of 1981-2015.

Figure 118 shows spatial distribution of average start dates of spring shearing in southern lowlands of Kazakhstan. In case of early or late spring, the shearing start date deviates from the average date by 10-15 days.

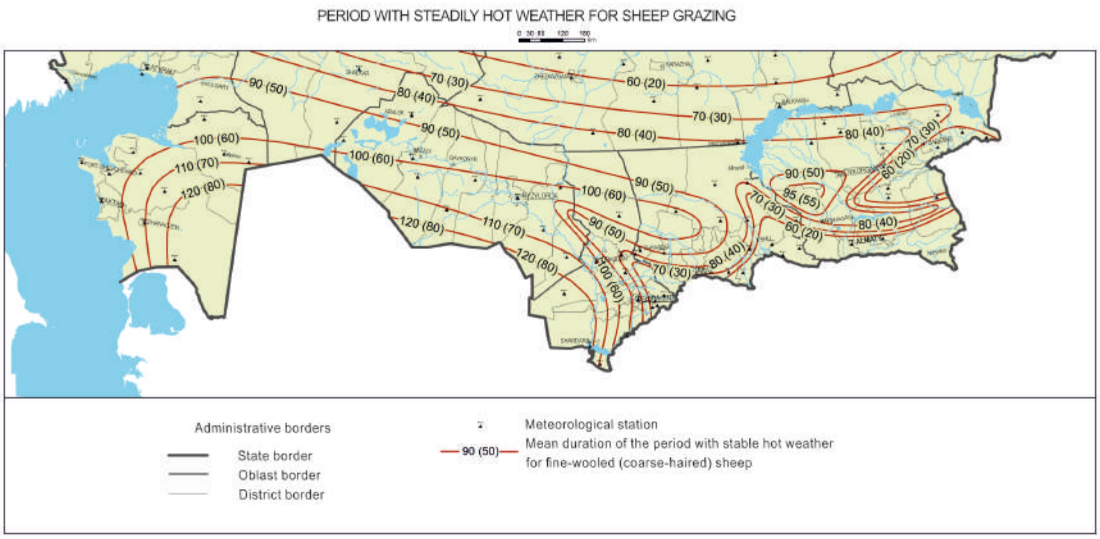
Figure 118. *Average start date of sheep spring shearing in southern lowlands of Kazakhstan (S. Baisholanov, 2016).*



The main zoo-climatic index of the warm period is the duration of a steady heat wave (SHW) for sheep. Hot weather, characteristic at this time of the year, depresses animals and leads to weight loss. Karakul and coarse-wool sheep best adapt to hot weather conditions. On a clear day without wind, the depressed state of Karakul sheep is noted at a temperature of over 27-28°C, and of fine-wool sheep – at over 24-25°C. Moderate wind reduces heat load. With increase of the wind speed, the air temperature values at which the depressed state of sheep is noted, increase.

To assess meteorological conditions of summer pasturing, the beginning, end and duration of steady heat wave were determined according to the MS data for the period of 1981-2015. On the basis of the obtained data, a map of spatial distribution of the duration of steady heat wave was built (Figure 119). Karakul and coarse-wool sheep breeds are more endurant to heat. Therefore, the duration of the steady heat wave for them is much less than for fine-wool and half-fine wool breeds of sheep.

Figure 119. *Average steady heat wave duration for fine-wool (coarse-wool) sheep in southern lowlands of Kazakhstan (S. Baisholanov, 2016).*



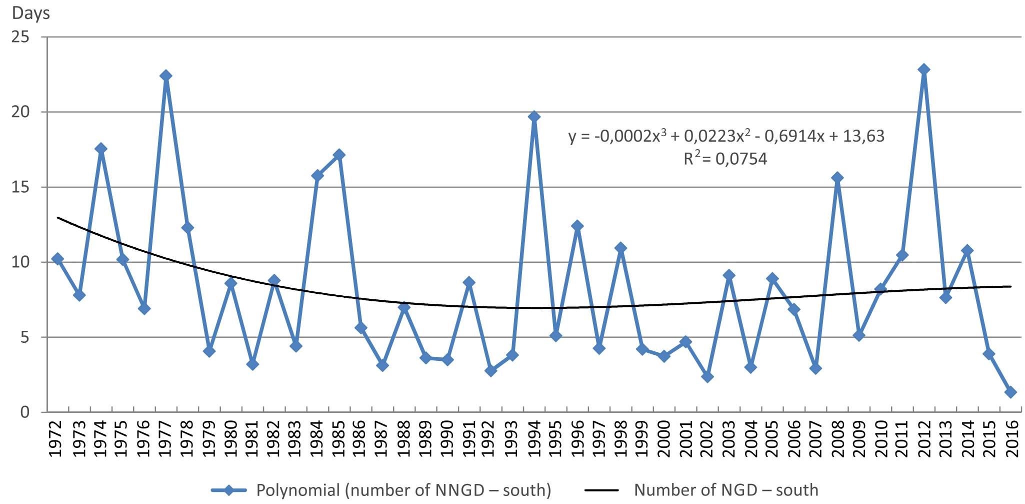
With the beginning of steady heat wave, animals must be driven to pastures more comfortable in terms of weather conditions, i.e. to more northern areas and mountain pastures. You can begin the driving on the date steady heat wave for sheep starts.

For example, driving of fine-wool (coarse-wool) sheep should be started in Kyzylkum – on May 15-20 (June 5-10), in the sands of Karakum – on May 25 (June 15), in the sands of Moiynkum – on May 25 (June 20) and Taukum – May 30 (June 25), in the sands of Saryesik-Atyrau – on June 01 (July 10). In the south of the steppe of Sary-Arka, hot weather settles for fine-wool sheep in the middle of June, and for coarse-wool sheep – in the middle of July.

6.6.4.2. Changes in zoo-climatic conditions of sheep breeding

Figure 120 shows the dynamics and trend of changes in the average (in the south of Kazakhstan) number of non-grazing days averaged over decades for the period from 1972 to 2016. Long-term dynamics of the 10-year moving averages of non-grazing days generally tends to decrease, which means milder winter conditions of sheep pasturing in the south of Kazakhstan. However colder winters have been observed in the last decades with a larger number of non-grazing days, indicating instability of meteorological regime for winter pasturing.

Figure 120. *Dynamics and trend of changes in the average (in the south of Kazakhstan) number of non-grazing days.*



Analysis of long-term dynamics of spring shearing start date showed the trend of shifting to earlier periods. This change is clearly seen since 1990 (Figure 121).

Figure 121. *Dynamics and trend of changes in the average (in the south of Kazakhstan) sheep shearing start date*

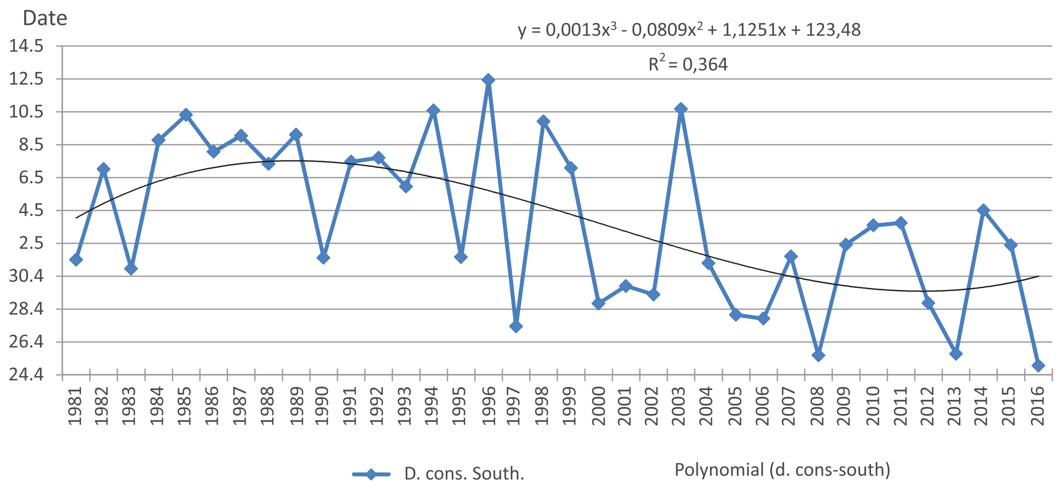
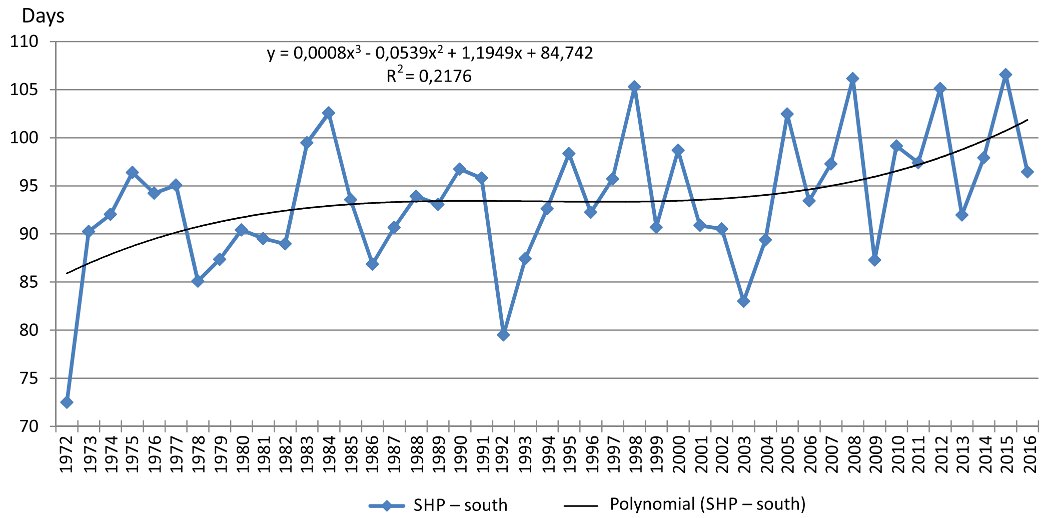


Figure 122 shows dynamics and trend of changes in the average (in the south of Kazakhstan) duration of the steady heat wave for fine-wool sheep (moving by decades). In the long run, the duration of SHW had a steady upward trend. This proves deterioration of meteorological conditions of summer sheep pasturing on lowlands in southern Kazakhstan.

Figure 122. *Dynamics and trend of changes in the average (in the south of Kazakhstan) duration of steady heat wave*



Thus, the long-term dynamics of zoo-climatic conditions showed that in the south of Kazakhstan, over the last 4 years, meteorological conditions of winter pasturing have become milder, spring sheep shearing has shifted for earlier periods and the conditions for summer sheep pasturing have become tougher.

6.6.5. Projection of zoo-climatic conditions for sheep breeding in the southern part of Kazakhstan under climate change conditions until 2050

Forecast of the conditions for winter sheep pasturing

Estimations showed that with the further climate warming, it is anticipated that in the south of Kazakhstan the conditions of winter grazing of farm animals will gradually become milder by 20-30% by 2030, and by 30-40% - by 2050 (Table 92).

Table 92. *Change of NGDs for sheep till 2050 (in days from the current conditions), according to the RCP4.5 and RCP8.5 climate change scenarios*

Oblast	Location	Current climate	2030s		2050s	
			RCP4.5	RCP8.5	RCP4.5	RCP8.5
Almaty	Saryesik-Atyrau sands	12	-2	-3	-4	-5
	Taukum Sands	7	-2	-2	-3	-4
	Ile and Zhetysu Alatau foothills	8	-2	-2	-3	-4
Zhambyl	Betpak-Dala	16	-3	-4	-5	-6
	Moiynkum Sands	6	-2	-2	-3	-4
	Northern Karatau foothills	8	-2	-2	-3	-4
	Kirghiz Range foothills	8	-2	-2	-3	-4
South Kazakhstan	Southern Karatau foothills	6	-1	-1	-2	-2
	Kyzylkum sands	2	0	-1	-1	-2
Kyzylorda	Aral Karakum	14	-2	-3	-4	-5
	Kyzylkum sands	4	-1	-1	-2	-2
Mangystau	Ustyurt Plateau	2	0	-1	-1	-2
Aktobe	Bolshiye Barsuki sands	10	-2	-2	-3	-4
Karaganda	Sary-Arka South	20	-3	-4	-5	-6

In Almaty oblast, in the winter pastures of Taukum and Saryesik-Atyrau sands, where in current conditions an average period of NGDs amounts to 7-12 days, by 2030 it is anticipated to decrease by 2-3 days, and by 2050 - by 3-5 days. In Ile and Zhetysu Alatau foothills with an average number of NGDs of 8 days, by 2050, it is supposed to be reduced by 3-4 days.

In the northern part of Zhambyl oblast in the Batpak-Dala area, where an average number of NGDs in winter amounts to 16 days, it is probable that NGDs will be reduced by 3-4 days by 2030, and by 2050 - by 5-6 days. In the area of Moiynkum sand, where an average number of NGDs is 6 days, it is anticipated to be reduced by 2 days by 2030, and by 3-4 days by 2050.

In the South Kazakhstan oblast in the southern Karatau foothills, where the number of NGDs in winter ranges around 6 days, this number is anticipated to be reduced by 1 day by 2030, and by 2 days – by 2050. In the southern part of the region in the sandy massif of Kyzylkum and in the Shardara steppe, where winters are very mild, the reduction of the NGDs is minimal, up to 1-2 days by 2050.

In the northern part of Kyzylorda oblast, in the Aral Karakum, where an average number of NGDs amounts to 14 days, it is anticipated to be reduced by 2-3 days by 2030, and by 3-4 days – by 2050. On the southern sandy pastures of the oblast the number of NGDs will decrease by 1 day by 2030, and by 2 days – by 2050.

A minimal reduction in the number of NGDs is anticipated in Mangystau oblast, on Ustyurt plateau, by 2 days by 2050.

A more significant reduction in the number of NGDs in winter is anticipated in the south of Aktobe and Karaganda oblasts. For example, in Bolshiye Barsuki sands, where the number of NGDs ranges around 10 days, the number of NGDs can be reduced by 2 days by 2030 and by 3-4 days - by 2050. In the southern part of Sary-Arka steppes in the Karaganda oblast, where number of NGDs amounts to 20 days, it is predicted to decrease by 3-4 days by 2030, and by 5-6 days- by 2050.

Forecast of the time frame for spring sheep shearing.

According to our estimations almost everywhere spring sheep shearing will be shifted for earlier periods by 2 days – by 2030, by 3-5 days – by 2050. The smallest changes are anticipated in the far south (Kyzylkum sands) and the south-west (Ustyurt Plateau) of the country, where the shift will comprise 1 day by 2030 and 2 days – by 2050.

Forecast of the conditions for summer sheep pasturing.

Our estimations showed that the anticipated climate warming will lead to an increase in the duration of steady heat waves (SHW) for sheep by 10-15% by 2030, and by 15-25% – by 2050, which will negatively impact the summer sheep pasturing. The Tabel 93 shows change in steady heat waves for fine-wool sheep.

Table 93. *Change in the duration of steady heat waves for fine-wool sheep till 2050 (in days from current conditions), according to the RCP4.5 and RCP8.5 climate change scenarios*

Oblast	Location	Current climate	2030s		2050s	
			RCP4.5	RCP8.5	RCP4.5	RCP8.5
Almaty	Saryesik-Atyrau sands	80	+10	+12	+16	+18
	Taukum Sands	90	+10	+12	+16	+18
	Ile and Zhetysu Alatau foothills	70	+8	+10	+14	+16
Zhambyl	Betpak-Dala	85	+8	+10	+14	+16
	Moiynkum Sands	100	+10	+12	+16	+18
	Northern Karatau foothills	90	+10	+12	+16	+18
	Kirghiz Range foothills	80	+8	+10	+14	+16
South Kazakhstan	Southern Karatau foothills	100	+8	+10	+15	+17
	Kyzylkum sands	120	+8	+10	+15	+17
Kyzylorda	Aral Karakum	85	+7	+9	+13	+15
	Kyzylkum sands	110	+8	+10	+15	+17
Mangystau	Ustyurt Plateau	115	+8	+10	+14	+16
Aktobe	Bolshiye Barsuki sands	85	+7	+8	+14	+16
Karaganda	Sary-Arka South	60	+8	+9	+12	+14

In Almaty oblast in the Southern Pribalkash region, in Saryesik-Atyrau and Taukum sands, where for fine-wool and half-fine wool breeds steady heat waves in summer average around 80-90 days, a forecasted increase in SHW is 10-12 days by 2030, and 16-18 days – by 2050. In Ile and Zhetysu Alatau foothills, where the duration of SHW is 70 days, an anticipated increase is 8-10 days by 2030 and 14-16 days – by 2050.

In the northern part of Zhambyl oblast in the Betpak-Dala area, where the duration of SHW for fine-wool and half-fine wool sheep ranges around 85 days, it is anticipated to increase by 8-10 days by 2030 and by 14-16 days – by 2050. In the area of the Moyinkum sands and in the northern Karatau foothills, the duration of SHW will increase by 10-12 days by 2030, and by 16-18 days – by 2050. In the Kirghiz Range foothills where the duration of SHW is about 80 days, it is anticipated to increase by 8-10 days by 2030 and by 14-16 days – by 2050. Estimations of SHW for fine-wool sheep were carried out for the rest of the south of Kazakhstan.

Table 94 shows anticipated changes in steady heat waves for hair sheep.

Table 94. *Change in the duration of steady heat waves for hair sheep till 2050 (in days from current conditions), according to the RCP4.5 and RCP8.5 climate change scenarios*

Oblast	Location	Current climate	2030s		2050s	
			RCP4.5	RCP8.5	PTK4.5	PTK8.5
Almaty	Saryesik-Atyrau sands	40	+5	+6	+8	+9
	Taukum Sands	50	+5	+6	+9	+10
	Ile and Zhetysu Alatau foothills	30	+3	+4	+6	+7
Zhambyl	Betpak-Dala	35	+3	+4	+6	+7
	Moiynkum Sands	50	+5	+6	+9	+10
	Northern Karatau foothills	60	+6	+7	+9	+10
	Kirghiz Range foothills	40	+4	+5	+7	+8
South Kazakhstan	Southern Karatau foothills	60	+5	+6	+9	+10
	Kyzylkum sands	80	+5	+6	+10	+11
Kyzylorda	Aral Karakum	45	+4	+5	+7	+8
	Kyzylkum sands	70	+5	+6	+10	+11
Mangystau	Ustyurt Plateau	75	+5	+6	+10	+11
Aktobe	Bolshiye Barsuki sands	45	+4	+5	+8	+9
Karaganda	Sary-Arka South	20	+3	+3	+4	+5

In Almaty oblast in the Southern Pribalkash region, in Saryesik-Atyrau and Taukum sands, where for medium-wool, hair and Karakul sheep steady heat waves in summer average around 40-50 days, a forecasted increase in SHW is 5-6 days by 2030, and 8-10 days – by 2050. In Ile and Zhetysu Alatau foothills, where the duration of SHW is 30 days, an anticipated increase is 3-4 days by 2030 and 6-7 days – by 2050.

In the northern part of Zhambyl oblast in the Betpak-Dala area, where the duration of SHW for hair sheep ranges around 35 days, it is anticipated to increase by 3-4 days by 2030 and by 6-7 days – by 2050. In the area of the Moyinkum sands and in the northern Karatau foothills, the duration of SHW will increase by 5-6 days by 2030, and by 9-10 days – by 2050. In the Kirghiz Range foothills where the duration of SHW is about 40 days, it is anticipated to increase by 4-5 days by 2030 and by 7-8 days – by 2050.

In South Kazakhstan oblast in the Southern Karatau foothills and in the Kyzylkum sands, where the average duration of SHW in summer for hair sheep is around 60-80 days, a forecasted increase in SHW is 5-6 days by 2030, and 9-11 days – by 2050.

In the northern part of Kyzylorda oblast, in the Aral Karakum, where an average duration of SHW is 45 days, anticipated increase by 2050 is 7-8 days. In the southern part of the oblast within the Kyzylkum sands, where the duration of SHW is around 70 days, a forecasted increase in this duration is 5-6- days by 2030, and 10-11 days – by 2050. Similar increase is anticipated in the duration of SHW on Ustyurt Plateau in Mangystau oblast.

In the area of Bolshiye Barsuki sands in Aktobe oblast, where the duration of SHW ranges around 40 days, an anticipated increase in this duration is 8-9 days by 2050. In the southern part of Sary-Arka steppes in Karaganda oblast, duration of the SHW for hair sheep might be also increased by 3 days by 2030, and by 4-5 days – by 2050.

Higher air temperature in the summer will result in earlier commencement of the period with steady heat wave. Therefore, in 2030 and 2050 sheep driving to summer pastures will start earlier than today. For example, in Almaty oblast, sheep driving to summer pastures, with more comfortable conditions (mountain pastures), in 2030 should begin 5 days earlier than the current date, and 9 days earlier – by 2050. The smallest changes are anticipated in the Kyzylkum desert, in the Ustyurt plateau, in Betpak-

Dala and in the Sary-Arka South steppe, where the starting time of SHW will be shifted for earlier periods, by 3 days by 2030 and by 7 days – by 2050. In other areas of the southern part of Kazakhstan, cattle driving to summer pastures will begin earlier by 4-5 days in 2030, and by 8-9 days – in 2050s.

6.6.6. Measures of adaptation to climate change in agriculture of the Republic of Kazakhstan

The Third (Sixth) National Communication of the Republic of Kazakhstan on climate change contained a list of potential negative and positive effects of climate change for Kazakhstan agriculture:

Positive consequences:

- increase in air temperature during the cold period of the year;
- extension of the frost-free period;
- early beginning of spring plants vegetation;
- extension of the vegetation period;
- increase in the content of CO2 in atmosphere necessary for photosynthesis;

Negative consequences:

- increase in the number of days with high air temperatures;
- increase in the proportion of rainfalls;
- increase in hail occurrence;
- increase in the frequency of abnormally cold winters and hot summers;
- increase in the interannual and interseasonal variability of weather pattern;
- early burning out of natural vegetation;
- intensification of climate aridity and increase in frequency of drought;
- shorter period with snow cover;
- development of infectious diseases, pests and weed vegetation.

During preparation of this Communication, we revealed the following expected changes by 2050, with reference to grain production in northern Kazakhstan:

- increase in heat resources during the vegetation period by 12-16%;
- increase in precipitation during the vegetation period up to 8%;
- deterioration in water availability to the vegetation period by 8-17%;
- shift of wetting zones to the north;
- increase in climate aridity by 7-15%;
- decrease in spring wheat yield by 13-49%;
- insignificant increase in sunflower seeds yield, up to 5%.

With regard to animal breeding in southern Kazakhstan, the following expected changes by 2050 were established:

- milder weather conditions for winter breeding of farm animals by 30-40%;
- shift of spring shearing 3-5 days earlier;
- increase in the duration of steady heat waves for sheep by 15-25%;
- earlier beginning of sheep driving to summer pastures, by 7-8 days.

The negative impact of climate warming on agriculture can be compensated by introduction of adaptation measures. Accordingly, in order to reduce the negative consequences of climate change, we propose the basic measures of adaptation in grain production and animal breeding of the Republic of Kazakhstan.

Certain financial investments are necessary for implementation of adaptation technologies and measures.

Analyzing the results of studies of previous National Communications of the Republic of Kazakhstan on climate change and other sources, as well as the results of our studies, the following areas of adaptation measures for agriculture to the effects of climate warming can be emphasized:

1. Improvement of technologies;
2. Tracking of weather conditions;
3. Technical support of agricultural industry;
4. Scientific and educational support of agricultural industry;
5. Information support of agricultural industry;
6. Insurance system in agricultural industry.

6.6.7.1. Measures of adaptation to climate change in crop production

With regard to crop production (grain production), the areas of adaptation to climate warming will be:

1. Technology of agricultural crops cultivation;
2. Knowledge of weather peculiarities;
3. Technical support of crop production;
4. Scientific and educational support of crop production;
5. Information support of crop production;
6. Improvement of insurance system in crop production.

The main factors in the formation of crop production are agro-technology and weather. Other factors: technical, scientific, educational and information support, contribute to improvement of the level of cultivation technology and deriving maximum benefits (or reducing damage) from weather conditions.

6.6.6.1.1. Technology of agricultural crops cultivation

The technology of agricultural crops cultivation, contributing to adaptation to the expected climate warming, can include the following measures:

- introduction of resource-saving technologies;
- structural and technological diversification of crop production;
- selection works;
- introduction of effective irrigation systems.

Resource-saving technologies

The main features of a resource-saving technology (RST) are minimum mechanical impact on soil to its complete elimination and preservation of plant residues on soil surface and crop rotation (succession cropping).

Technology of zero (No-till) and minimal (Mini-till) tillage are widely used in Kazakhstan today.

With zero tillage technology the spring wheat yield can be 50-60% higher than with traditional technology. In this case, the cost of cultivation goes down 2 or more times, and production prime cost is reduced 2 or more times respectively. Extensive introduction of zero tillage technologies in northern Kazakhstan started in the beginning of 2000-s. In 2008 the Government of the Republic of Kazakhstan began to subsidize farmers using zero tillage technologies. Important conditions for success of zero tillage technology are: weed control, crop rotation (succession cropping), fertilizers and chemicals application strategy.

In 2007 in Kazakhstan crop acreages under traditional technology amounted to 13.7 million hectares, under minimal tillage – 4.6 million hectares, and under zero tillage – 0.6 million hectares. In 2012, the areas under traditional technology were reduced down to 7.7 million hectares, under minimal tillage – were increased up to 9.5 million hectares, and under zero tillage – were increased up to 1.9 million hectares.

According to the Report on Implementation of the "Strategic Plan of the Ministry of Agriculture of the Republic of Kazakhstan for 2014-2018", in 2014 the area of introduction of resource- and energy-saving technologies amounted to 12.9 million hectares.

According to the «Stabilization of the Grain Market» Master Plan, application area of water and resource-saving technologies is planned to reach 12.8 million hectares, including absolutely new – 4.8 million hectares.

Furrow irrigation and ridge sowing of wheat are deemed effective for irrigated agriculture where water consumption is reduced, irrigation uniformity, water-air-soil regime, etc. are improved. The combination of ridge-furrow technology and zero tillage is especially effective. The obtained results proved advantages of this technology.

The technology of site specific crop management has a great potential – an integrated high-tech agricultural management system that incorporates global positioning technology (GPS), geographic information systems (GIS), Yield Monitor Technologies, Variable Rate Technology and Earth remote sensing technology (ERS).

Diversification of crop production

The purpose of diversification is to increase the variety of crops in such a way that farmers do not depend on one crop only.

Many factors need to be taken into account in the course of introduction of new types of agricultural crops with a view to diversify crop production system: availability and quality of natural resources, availability of cultivation technologies, storage and processing; investment opportunities; economic policy of the country, price and market factors; institutional and infrastructure factors, etc.

The introduction of adapted types and varieties of crops can potentially strengthen the state of farms by increasing yields, drought resistance, resistance to pests and diseases, and by capturing new market opportunities. Introduction of a wider range of types and varieties of crops increases natural biodiversity, strengthens the agroecosystem's ability to withstand external stresses and reduces the risk of crop failure from droughts.

The main barrier to diversification may be the lack of a clear state policy, predominance of small farms, poor technical equipment of farms, market prices fluctuations, etc.

In recent years Kazakhstan has seen substantial increase in cultivation of sunflower, rape, flax, soy and pea. A wide variety of crops can ensure higher profitability of crops diversification in northern Kazakhstan conditions: grains – spring barley, millet, oats and buckwheat; leguminous plants – pea, chick-pea and lentil; oilseeds – sunflower, rape, flax and mustard.

Selection works

In the course of diversification process implementation it is necessary to take advantage of selection and genetic engineering. It is necessary to create varieties and hybrids of crops that are more drought-resistant, with high productivity and good grain quality, with increased resistance to hazardous pathogens, to high and low temperatures, to increased acidity and salinity of soil. Selection of new and improved varieties of agricultural crops increases resistance of plants to various stresses resulting from climate change. These potential threats include heat stress, water salinity, lack of water and emergence of new pests. The various systems developed to counteract such threats will help to ensure that agricultural production can be improved despite the climate change impact.

At present, the quality of wheat grain is deteriorating in northern oblasts of Kazakhstan. To level this threat, it is necessary to increase specific weight of medium-ripening varieties in crops and reduce the share of mid-late-ripening varieties. It is also suggested to optimize the ratios of spring wheat varieties of domestic and foreign selection 70% to 30%. Foreign varieties are characterized by high resistance to lodging and shattering, good yield potential. Varieties of domestic selection are distinguished by high quality of grain, drought resistance, and therefore adapted to local conditions. New selection varieties are the most adapted to local weather and climatic conditions.

It should be noted that at research institutes and agricultural experimental station of the Ministry of Agriculture of the Republic of Kazakhstan, selection of agricultural crops are ongoing. For example, the A. Barayev Scientific and Production Centre of Grain Farming features a laboratory for selection of wheat, cereals, oilseeds, leguminous crops, etc.

Organic farming

Today, with due regard to active promotion of the policy of green economy, it is necessary to focus on "organic farming". It means a closed circuit of substances. All nutrients extracted from the soil by the fruits of farming and animal feed should be returned to it through green fertilizers and crop residues.

Kostanay Research Institute for Agriculture LLP developed the technology of crops cultivation in the organic farming system. This technology of organic farming has shown high cost efficiency of wheat cultivation. Samples of soil and obtained products showed lack of pesticides.

Positive experience of organic farming needs to be spread around Kazakhstan.

Introduction of effective irrigation systems

Today various irrigation systems are widely introduced in the south of Kazakhstan: drip irrigation, subsoil irrigation, automatic irrigation, furrow irrigation, sprinkler irrigation (sprinklers, drum and wide-coverage sprinklers, micro-sprinkling systems), etc.

Drip irrigation has many advantages and is a measure of adaptation to climate warming: water is drained evenly and rationally, along with water, fertilizers can directly flow to the roots of plants, appearance of weeds is minimized, salts are constantly washed out from the root system, and a high yield is guaranteed. Irrigation using plastic pipes and mixed use of drainage and irrigation water showed an increase in water productivity by 15-25% in Kyrgyzstan, Turkmenistan and Uzbekistan.

Further research of best practices of foreign countries in irrigation is required, and not only in the south of the Republic, but also in the west and the north.

6.6.6.1.2. Weather peculiarities

Tracking of peculiarities of weather conditions promotes adaptation of crop production to the expected climate warming. Such measures include:

- tracking of agroclimatic resources;
- taking current weather conditions into account.

Tracking of agroclimatic resources

Introduction of resource-saving technologies (RST), irrigation systems, cultivation of new types and varieties of crops should be based on tracking of agroclimatic resources and the probability of adverse weather events (drought, dry wind, ground frosts, etc.).

In the Branch of the Institute of Geography LLP of the Ministry of Education and Science scientific and practical agroclimatic directories will be prepared for 6 oblasts[207], (electronic version), which will be useful in scientific support of crop farming, in determining the strategy for diversification of crop production, in adopting administrative and agro-technological decisions for the growing season, in agro-meteorological support for agriculture in Kazakhstan and etc. Agrimeteorological maps are posted on the website of Kazhydromet RSE (https://kazhydromet.kz/ru/agrometeo/climat?obl=21&tip=15&ha=OK). This step could also be considered as a scientific approach to climate change adaptation.

Also, updates of agroclimatic directories in the other 8 oblasts of Kazakhstan are required. Their last update was done 35-40 years ago (1975-1978).

Consideration of current weather conditions

It is necessary to align agrotechnical measures implementation time with weather conditions. For instance in northern Kazakhstan, grain sowing is done in a timely manner only at 45%, and harvesting – at 38% of farms. Violation of deadlines for technological operations results in loss of up to 40% of crop yield.

Agro-meteorological support of agriculture of the Republic of Kazakhstan is ensured by Kazhydromet RSE of the Ministry of Energy of the Republic of Kazakhstan. Forecasting and analytical information is provided. On the basis of provided information, certain strategic and production decisions are made in the crop sector of the agriculture of the Republic of Kazakhstan.

Today, further development of hydro-meteorological monitoring and forecasting system, agrometeorological service system for agriculture is required. This implies modernization of the hydro-meteorological observation system, improvement and development of forecasting of weather events hazardous for agriculture and methods of their control, determination of optimal time when agro-technical measures should be taken, methods of crop condition forecasting, as well as improvement of the system of prompt circulation of information to end users (farmers). These measures altogether will promote effective use of climatic and soil resources, rational sowing, agro-technical measures and harvesting within optimal terms, which will significantly reduce the risk of exposure to adverse weather events.

It should be noted that in 2014-2016 the United Nations Development Program supported certain activities design to assist Kazhydromet RSE. Selection of analogue year was automated in the department of long-term forecasting for faster compilation of monthly weather forecasts. In the Agrometeorological Forecasting Department, QGIS was introduced to visualize spatial distribution of agrometeorological parameters, improve drought monitoring, the process of calculation of standardized precipitation index (SPI) was automated, an automated base of agrometeorological data was constructed, and the calculations based on A. Polevoy dynamic model of crop yield forecasting was automated. Polevoy model was adapted to forecast yield of wheat in 7 oblasts, to forecast sunflower seeds in 3 oblasts of Kazakhstan. In addition to that, assistance was provided for more extensive use of satellite monitoring data in the assessment of agrometeorological conditions.

The following key actions are still required:

- improvement of forecasting of the time when spring fieldworks and sowing of early spring grain crops should start;

[207] https://ingeo.kz/?page_id=3544

- development of forecasting methodology for productive moisture reserves in soil in the vegetation period;
- development of forecasting methodology for water availability in the vegetation period;
- development of forecasting methodology for heat availability in the vegetation period;
- development of forecasting methodology for droughts;
- adaptation of Polevoy model for forecasting other agricultural crops.

6.6.6.1.3. Technical support to crop production

Equipment of agricultural enterprises and farms with advanced agricultural machinery is currently at a low level. The use of modern high-performance tractors and combines, various other machines and equipment is essential for timely, high-quality and complete (without losses) implementation of agrotechnical measures, sowing and harvesting, with a view to significantly reduce the risk of exposure to adverse weather events.

6.6.6.1.4. Scientific and educational support to crop production

Today's accelerated development of science and technology makes higher education alone insufficient for high-quality training of specialists in agriculture. Other training activities (courses, seminars, conferences) have to be regularly and systematically organized for agronomists, managers and farmers. They need to collect new knowledge of modern agricultural techniques, resource-saving and adaptive technologies, of varieties and hybrids of agricultural crops, of methods and means of plants and soil protection, irrigation, soil and climatic conditions of the region, climate change and measures of adaptation to it.

A specialist of the regional and district agriculture department or agronomist, who masters new knowledge, will help farmers choose the right strategy in selection of crops and their varieties, setting the time and choosing methods of implementation of agro-technical activities to obtain eventually high yield or reduce losses from adverse weather events.

At present, such work is carried out in various centers for knowledge dissemination. At the state level, the system of knowledge dissemination in agro-industrial complex is established in the Non-Commercial Joint-Stock Company " National Agrarian Scientific and Educational Center of the Ministry of Agriculture of the Republic of Kazakhstan (NANOC)" (http://nanoc.kz). The key mission of NANOC is to promote innovative development of agro-industrial complex of the Republic of Kazakhstan. Advanced training and seminars for specialists of agro-industrial complex are systematically conducted in centers for knowledge dissemination of NANOC branch organizations and higher education institutions.

Further development of knowledge dissemination system requires the following:

- expansion of the network of knowledge dissemination centers;
- training not only senior and middle specialists, but also district level specialists and farmers on basic provisions of RST and other adaptation activities;
- introduction of RST and other adaptation activities in the curricula of college and university students.

6.6.6.1.5. Information support to crop production

Information support to agriculture means provision of a variety of information to promote agriculture development and increase productivity of crop farming, with the use of Internet technologies (websites, Internet portals).

The main types of information include:

1. Analytical and forecasting information on the state of the climate and weather;
2. Knowledge database on agricultural crops and agro-technologies;
3. Recommendations for the growing season.

The main users of information are:

1. Production departments of the Ministry of Agriculture of the Republic of Kazakhstan;
2. Regional agriculture departments of the Ministry of Agriculture of the Republic of Kazakhstan;
3. Scientific organizations of the Ministry of Agriculture of the Republic of Kazakhstan (Research Institutes and Agricultural Experimental Stations);
4. Agricultural enterprises and farms;
5. Higher educational institutions in the agricultural sector;
6. the Union of Farmers of Kazakhstan;
7. Insurance companies;
8. Farmer.kz agroportal.

Today there is an urgent need to improve the system of information delivery to end users. The system should also enable interactive communication with the user.

At present the main active Internet information sources useful for farming are:

1. The website of Kazhydromet RSE (www.kazhydromet.kz);
2. The website of the National Agrarian Scientific and Educational Center (http://nanoc.kz) and the websites of its branch organizations;
3. The geoportal of space monitoring of droughts of the National Center of Space Research and Technology (http://zasuhi.gzi.kz);
4. The Farmer.kz agroportal (http://xn--e1aaupct.kz);
5. The website of the Union of Farmers of Kazakhstan (www.sfk.kz);
6. The Atlas of Solar Resources of the Republic of Kazakhstan (http://atlassolar.kz/).

The main source of agrometeorological information is Kazhydromet RSE. It should be noted that despite vital importance of weather conditions for agriculture, there is no specialized automated information transmission system between Kazhydromet RSE of the Ministry of Energy of the Republic of Kazakhstan and the Ministry of Agriculture of the Republic of Kazakhstan.

Specialized agrometeorological information produced by Kazhydromet RSE is barely accessible to farmers. The information sent to the Ministry of Agriculture of the Republic of Kazakhstan does not reach them either. Most data, including the latest data, some survey and forecast information of Kazhydromet RSE are paid for all users, including farmers.

In order to improve the system of agrometeorological information delivery the following action are proposed:

- Improvement and filling the website of RSE «Kazhydromet» with materials developed on the basis of GIS technologies;
- creation of subsystems to transfer agrometeorological and agrotechnical information, scientific advisory to the oblast and district akimats level in the unified automated management system for the branches of the agro-industrial complex "E-Agriculture".
- Creation of a Web portal based on the GIS technology, to place agroinformation and to provide a possibility of interactive communication with the user

6.6.6.1.6. Improvement of the insurance system in crop production

One of the measures aimed at reduction of damage from adverse weather events is crop insurance. Today the Ministry of Agriculture is improving the insurance system in crop production established upon adoption of the Law "On Compulsory Insurance in Plant Production" in 2004.

World Bank experts and Kazakhstan scientists in the field of agriculture insurance proposed improvement of the insurance system in crop production by means if its transition to market system and transformation into a commercial pool. Herewith, transition to the voluntary insurance is proposed. An effective system of insurance in crop production will minimize financial losses of agricultural producers in the face of adverse weather conditions.

According to the «Stabilization of the Grain Market» Master Plan, it is planned to increase the share of cultivated area covered by insurance in crop production up to 100% by 2020.

6.6.6.2. Adaptation to climate change in livestock breeding

Similarly to crop production, the following areas of adaptation to climate change impact are suggested for livestock breeding (sheep breeding) in Kazakhstan:

1. Technology of farm animals keeping;
2. Tracking of peculiarities of weather conditions;
3. Technical support to animal breeding;
4. Scientific and educational support to animal breeding;
5. Information support to animal breeding;
6. Introduction of insurance system in animal breeding.

Livestock products formation is mainly based on such factors as technology of animals keeping, pasture conditions and weather conditions. Other factors include: technical, scientific and educational and information support, contribution in upgrade of technology for keeping animals and reduction of damage caused by adverse weather conditions.

6.6.6.2.1. Technology of farm animals keeping

The technology of farm animals keeping, contributing to adaptation to the expected climate change, can include the following measures:

- restoration of the driving-pasture system for sheep in southern Kazakhstan;
- development of the pasture-stall system for keeping animals on an industrial basis;
- selection and stock breeding work;
- veterinary safety;
- pastures improvement.

Restoration of the driving-pasture system of sheep keeping in the southern part of Kazakhstan

In 1990-s the driving-pasture system of animals keeping, established for centuries, was destroyed, and the practice of year-round sheep keeping around settlements began. Today, for the further development of animal breeding in the south of Kazakhstan, it is necessary to develop the state-of-the-art driving-pasture system of animal breeding based on the regulated pasturing of animals, taking into account the capacity of pastures and climatic conditions, to restore wells and watering points in pastures, to legally reserve pasture lands for users. It is also necessary to organize effective veterinary-sanitary supervision, security-quarantine and other measures.

The driving-pasture system of animals keeping is a measure of adaptation to climate change. It enables reduction of load on animals, effective use of pasture resources, and, as a result, increases livestock productivity. The driving-pasture system assumes reduction in the prime cost of livestock products

Development of a pasture-stalling system of animals keeping on an industrial basis

This technology is especially important for the northern part of the Republic. Here animals can be kept on pasture forage from May to October, and in the cold season - on the stalling regime. Transition to industrial keeping involves construction of mechanized farms, introduction of new technologies for full mechanization of production processes. Mechanized farms can be breeding ones, for growing of young stock, fattening ones or feature a complete production cycle. This would lessen dependence of animal productivity on external weather conditions.

One of the issues in animal breeding development is small scale of production. The main producers of animal products are private farm holdings. By sheep and goat population, the share of private farm holdings is 56%, of farms - 39%, of agricultural enterprises - 5%. Small farms do not have sufficient capacity for development due to lack of financing, professional knowledge, low profitability of production and low labor productivity. They are poorly organized; they have difficulties in selling their products. Consequently, it is necessary to enlarge animal farms in order to increase production efficiency.

Selection and stock breeding work

Selection and stock breeding work is very important for the development of animal breeding industry. In 2007, the cattle breeding base was represented by 558 economic entities. Of them 71 have the status of a breeding factory and 487 have the status of breeding farms (143 are engaged in sheep breeding). In 2007, the number of breeding stock of sheep amounted to 1.09 million heads. Today, the number of breeding stock of sheep in the country exceeds 2.1 million heads, which is 12% of the total number of heads.

In 2016, the Republican Chamber of Sheep Breeders was established in Kazakhstan to deal with selection and development of pedigree sheep breeding in the country.

The Master Plan for the “Development of Sheep Breeding in the Republic of Kazakhstan until 2020” specifies that selection will be done in several ways at breeding farms.

In climate warming conditions it is important to identify more stress-resistant and adapted breeds of sheep separately for each natural and climatic zone of Kazakhstan and their subzones.

Veterinary safety

Climate warming may induce development of infectious diseases among livestock population. With an increase in air temperature, outbreaks of infectious diseases can be expected with increase in the number of such diseases as foot and mouth disease, brucellosis, hoofed form of sheep necrobacillosis, soil infections (anthrax, blackleg, etc.) and parasitic diseases (itch, trichophytosis, Hypoderma, etc.). This can be prevented by means of:

- implementation of timely and effective veterinary and sanitary supervision;
- organization of anti-epizootic, protective and quarantine and other measures to prevent infectious and non-contagious diseases (vaccination, immunization, isolation, disinfection, etc.);
- maintenance of proper sanitary condition of pasture areas, watering points;
- organization of mobile medical and preventive stations on summer pastures.

Improvement of pastures

The decisive factor for sustainable development of cattle breeding is the provision of cattle numbers with complete feed. The main sources of cattle forage in the Republic are pastures, natural and sown hayfields. In conditions of climate warming and aridity, the reduced pastures productivity and its earlier burning out in the summer is expected. Therefore, measures should be taken to improve the condition of pastures. It is necessary to radically and superficially improve the vegetation cover on degraded pastures, to flood pastures.

Desert and semi-desert pastures require the planting of natural roofs from forest saxaul. It is also necessary to provide for the production of forage by restoring crops of permanent grasses on long-fallow lands. Such measures will not only increase the availability of animal feed, but also mitigate the heat load on animals.

6.6.6.2.2. Tracking of the peculiarities of weather conditions

Zoo-technical measures such as sheep lambing, spring shearing, driving to summer pastures, preparation of insurent fodder reserve, winter keeping of animals, etc. require strict accounting of weather conditions.

Taking into account the peculiarities of weather conditions promotes the adaptation of cattle breeding to the expected warming of the climate. Such measures include:

- tracking of zoo-climatic conditions;
- consideration of weather conditions.

Tracking of zoo-climatic conditions

The development of driving-pasture system of animals keeping should be based on tracking of zoo-climatic conditions and the probability of adverse weather events (extreme heat, strong wind, dust storm, snowstorm, drought, etc.).

Zoo-climatic conditions of sheep keeping are given in agroclimatic reference books of the southern regions of Kazakhstan, published 35-40 years ago (1975-1978). Today, taking into account the climate change trend, they have to be updated on the basis of latest data and GIS technologies.

Consideration of weather conditions

Today, there is no service in Kazakhstan for zoo-meteorological support of animal breeding. We only monitor pasture condition on 25 MS in the south of Kazakhstan. Moreover, their data are not used.

Our scientists (A. Chekeres, N. Konyukhov, A. Fedoseyev, V. Petrashin, I. Ivanov, P. Kozhakhmetov) developed a variety of zoo-meteorological and agro-meteorological forecasts in relation to driving-pasture sheep breeding: the conditions of sheep pasturing, shearing time and sheep driving time, etc. Later works describe methods of forecasting of sheep productivity and estimating summer feeding (weight gain), as well as best shearing time. However, due to climatic changes and violation of breed zoning some methods require adjustments. Currently there is an urgent need to rehabilitate hydrometeorological support for livestock in the country, that will help to mitigate risk of severe weather events' impact in animals.

6.6.6.2.3. Technical support to animal breeding

Certain mechanisms, equipment and machinery is needed for successful management of driving-pasture animal breeding. Technical means in animal husbandry include vehicles, equipment for watering of animals, mobile housing, solar panels, wind generators, tele- and radio communication facilities, etc. Furthermore, it is necessary to provide shepherds (or create conditions for acquiring) with the necessary technical means for moving and driving animals to seasonal pastures.

6.6.7.2.4. Scientific and educational support to animal breeding

Currently, such work is carried out at various knowledge centers. At the national level, knowledge dissemination system in agro-industrial complex is streamlined in the non-commercial joint-stock company «National Agrarian Scientific and Educational Center» of the Ministry of Agriculture of the Republic of Kazakhstan. Priority is given to knowledge about new breeds of farm animals, on technologies for their management, on modern technical means of water supply in pastures, on solar panels and wind installations, on tele- and radio communication facilities, on the zoo-climatic conditions of the fields, on climate change and on adaptation measures.

6.6.6.2.5. Information support to animal breeding

Information support to animal breeding means information provision for promotion of animal breeding development and its productivity with the use of Internet resources (websites, Internet portals). It is necessary to implement similar measures to those proposed for crop production.

6.6.6.2.6. Introduction of insurance system in animal breedin

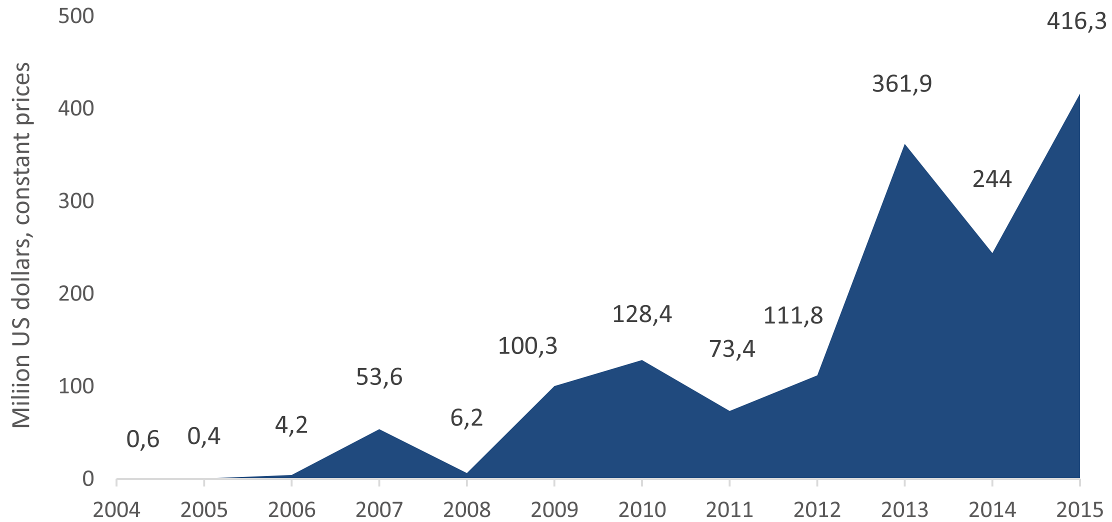
One of the measures aimed at reduction of damage caused by adverse weather events is farm animals insurance. KazAgroGarant JSC of the Ministry of Agriculture of the Republic of Kazakhstan is planning to develop and implement insurance in the animal breeding sector.

VII. FINANCIAL RESOURCES AND TECHNOLOGY TRANSFER

7.1. New and additional financial resources

According to the statistical database of the Organisation for Economic Co-operation and Development (OECD/DAC) in the reporting period (2012 – 2015) Kazakhstan attracted the total amount of 1,134 million US dollars in climate development projects. The greater part of this amount (about 95%) was allocated to GHG emissions reduction projects, and the rest – to adaptation projects.

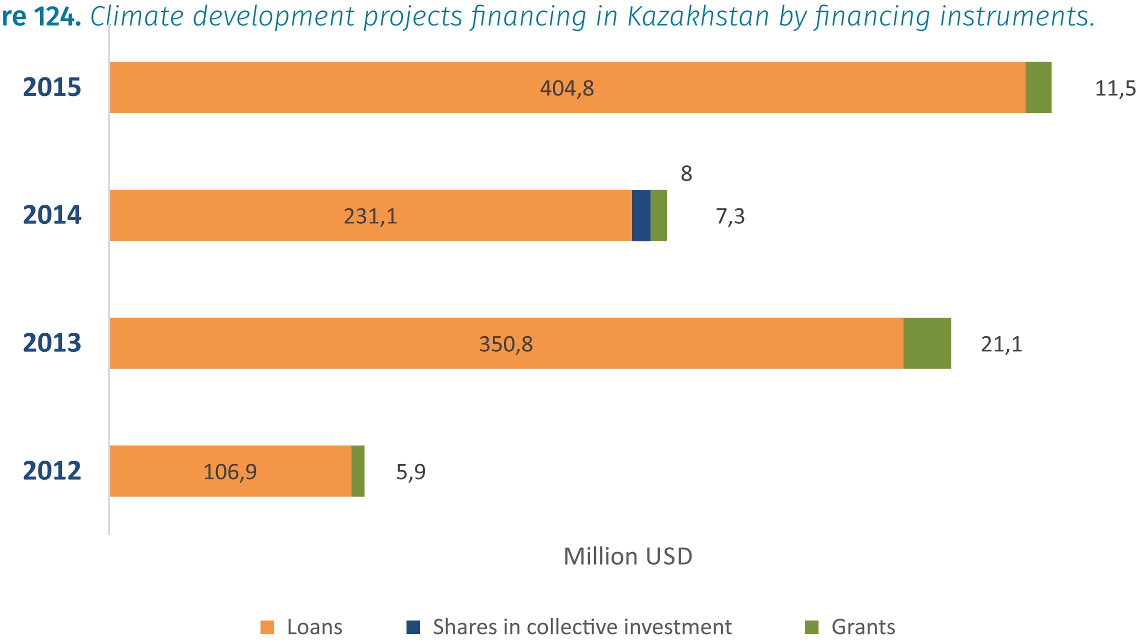
Figure 123. *Climate development (mitigation and adaptation) projects financing in Kazakhstan*



Source: OECD/DAC

In 2015 funds allocated to development and climate change projects in Kazakhstan amounted to 416.3 million US dollars. Around 97% of this amount were loans, and around 3% was grant financing. Loans were provided by the European Bank for Reconstruction and Development (EBRD) and grant – by the Global Environmental Facility (USD 9.66 million) and governments of certain states (USA – USD 1.83 million, Japan – USD 30 thousand, Korea – USD 22 thousand).

Figure 124. *Climate development projects financing in Kazakhstan by financing instruments.*



Source: OECD/DAC data

In 2012-2015 loans were mainly provided by EBRD. For example, 15 loans for about 367.5 million euros for municipal and environmental infrastructure and energy development were approved in 2012-2016.

Table 95. *EBRD loans for municipal and environmental infrastructure and energy development projects, 2012-2016.*

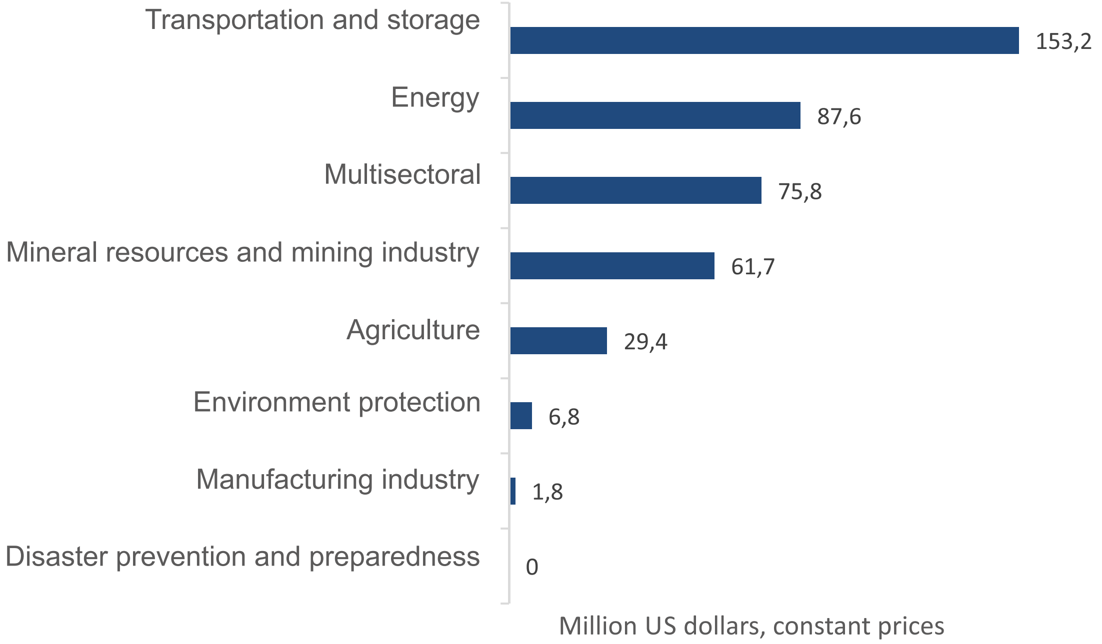
Project	Signed on	Loan amount	Co-financing amount
South Kazakhstan Water Supply Project	November 16, 2016	USD 180.0 million (EUR 167.4 million*)	
Kyzylorda Waste Management	September 7, 2016	EUR 12 million	EUR 4.4 million (Clean Technology Fund)
Ust-Kamenogorsk Water	May 24, 2016	EUR 5.9 million	
Meters Installation Programme	October 19, 2016	EUR 31.5 million (KZT 12.2 billion)	
Kostanay Water	May 9, 2016	KZT 2.4 billion (EUR 6.24 million*)	
Kostanay District Heating sub-project	May 24, 2016	KZT 3.7 billion (EUR 9.73 million*)	
Semey Water	December 18, 2015	KZT 1.16 billion (EUR 3.5 million)	
Taraz Water	(n/a)	KZT 1.05 billion (EUR 3.5 million)	
Kyzylorda Electricity Distribution	December 10, 2014	KZT 4.5 billion (around EUR 18 million)	
Pavlodar Tram Project	December 10, 2014	KZT 2.46 billion (EUR 10 million)	
Yereymentau Windfarm	November 26, 2014	KZT 14 billion (EUR 61.39 million*)	EUR 18 million (Clean Technology Fund)
Almaty Bus Sector Reform Phase 2	December 18, 2012	EUR 30.2 million	
Semey District Heating	December 16, 2015	KZT 3 billion (EUR 8.14 million*)	USD 6.4 million (EUR 5.82 million*) (Clean Technology Fund)
TOTAL:		**367,5**	**28.22**

* exchange rate as per oanda.com

Source: official EBRD website data (ebrd.com)

The main destination sectors for climate financing in 2015 were transportation and storage, energy, mineral resources and mining industry, agriculture (Figure 125). Throughout the reporting period (2012-2015) significant funds were also allocated to environmental activities in water supply and sanitation, construction and environment (Table 96).

Figure 125. *Destination sectors for climate projects financing in 2015*



Source: OECD/DAC

Table 96. *Financing got by Kazakhstan for climate development projects implementation, by sectors*

	2012	2013	2014	2015	Total in the reporting period
Sector not defined	53,87	253,70	106,20	-	413,77
Energy	34,09	4,80	78,50	87,6	204,99
Transportation and storage	-	34,20	4,30	153,20	191,70
Other sectors, multisectoral	0,42	56,10	2,3	75,80	134,62
Mineral resources and mining industry	0,90	-	6,50	61,70	69,10
Water supply and sanitation	23,32	12,40	9,90	-	45,62
Construction	-	-	32,30	-	32,30
Agriculture	-	-	-	29,40	29,40
Environment protection	-	10,60	3,80	6,80	21,20
Banking and financial services	-	-	2,60	-	2,60
Industry	-	-	-	1,80	1,80
Demographic programs and policies, reproductive health	0,17	-	-	-	0,17
Public administration and civil society	0,06	0,10	-	-	0,16
Healthcare	-	0,10	-	-	0,10
Trade policy and regulation	-	-	0,10	-	0,10
Disaster prevention and preparedness	-	-	-	-	-

Source: OECD/DAC data

Since 2010 the Global Environmental Facility has supported 9 control and adaptation-related projects for the total amount of around 276 million US dollars (Table 97).

Table 97. *Projects supported by the Global Environmental Facility with a focus on Climate Change (GEF-4 - GEF-6)*

Project (type)	Implementing agency	Responsible authority	Implementation period	Grant amount, million USD	Co-financing, million USD
Energy Efficient Design and Construction in Residential Sector (full-size project)	UNDP	RK Ministry of Industry and Trade	2010-2015	4,568	27,895
Sustainable Transport in the City of Almaty (full-size project)	UNDP	RK Ministry of Environment Protection, Almaty City Akimat	2011-2016	4,886	76,526
Promotion of Energy Efficient Lighting in Kazakhstan (full-size project)	UNDP	RK Ministry of Environment Protection, RK Ministry of Energy and Mineral Resources	2012-2017	3,400	28,622
Reducing GHG Emissions through a Resource Efficiency Transformation Programme (ResET) for Industries in Kazakhstan (full-size project)	EBRD	RK Ministry of Industry and New Technologies	2012-2018	7,090	44,996
Sustainable Low-Carbon City Development (full-size project)	UNDP	RK Agency for Construction, Housing and Utilities, RK Ministry of Environment Protection, RK Ministry of Economy and Strategic Planning, city akimats	2014- ...	5,930	65,389
Development of Kazakhstan's National communication to the UNFCCC and Biennial Report (enabling activity)	UNDP	RK Ministry of Environment Protection and Water Resources	2014- ...	0,852	0,857
Southeast Europe and Central Asia Catastrophe Risk Insurance Facility (full-size project)	World Bank	Europa Re	2016- ...	5,000	15,000
Sixth Operational Phase of the GEF Small Grants Programme in Kazakhstan (full-size project)	UNDP	United Nations Office for Project Services (UNOPS)	2017- ...	2,650	4,702
Energy Efficient Standards, Certification, and Labeling for Appliances and Equipment (full-size project)	UNDP	RK Ministry of Investment and Development	2017- ...	3,500	12,243
TOTAL:				**37,876**	**276,23**

Source: official GEF website data (thegef.org)

In 2013 the World Bank attracted 23.06 million US dollars for implementation of Kazakhstan Energy Efficiency Project[208]. 21.76 million US dollars was a grant from the Swiss Agency for Development and Cooperation of the Swiss Government, the rest – co-financing from other institutions and partners on

[208] http://projects.worldbank.org/P130013/energy-efficiency-project?lang=en&tab=overview

site. Project implementation will be completed by March 31, 2019. Implementing agency on the part of RK Government is the Ministry of Industry and New Technologies. The project is the only ongoing project of the World Bank focused on Climate Change.

In 2012, 2014 and 2015 Kazakhstan received of 107.8 million US dollars from the Clean Technology Fund for implementation of five renewable energy and energy efficiency projects. In each case assistance was channeled through projects of multilateral development banks (MDBs) that ensured co-financing in the amount of 338.3 million US dollars (Table 98).

Table 98. *Projects supported by the Clean Technology Fund starting from 2012*

Project	Implementing agency	Project approved in	Financing amount, million USD	Expected co-financing, million USD
Waste Management Project	EBRD*	December, 2012	22,4	80,6
Energy Infrastructure Program	International Finance Corporation (World Bank Group)	June, 2014	1,2	2,7
Yereymentau Windfarm	EBRD*	November, 2014	20,7	0
Renewable Energy Financing Facility	EBRD*	October, 2015	29,5	95,0
District Heating Modernization Framework	EBRD*	October, 2015	34,0	160,0
TOTAL:			**107,8**	**338,3**

* EBRD parallel loans are specified in Table 95.

At the moment two climate change projects supported by the European Commission for the total amount of 10.35 million euros are implemented in Kazakhstan (Table 99). Assistance is rendered through the Development Cooperation Instrument.

Table 99. *Climate change projects implemented in Kazakhstan with the European Commission support*

Project	Implementing agencies	Implementation period	Grant amount, million EUR
Energy-saving and Greenhouse Gas Emissions Reduction in Kazakhstan	EBRD*	December, 2013 – December, 2019	3,250
Support of Kazakhstan Transition to Green Economy	UNECE, UNDP	April, 2015 – November, 2018	7,100
TOTAL:			**12,348**

* EBRD parallel loans are specified in Table 95.

Several projects with a total cost of 42 million US dollars are implemented on regional level (Table 100).

Table 100. *Regional mitigation and adaptation projects*

Project	Donor	Implementing agency	Implementation period	Grant amount
Climate Adaptation and Mitigation Program for Aral Sea Basin (CAMP4ASB)	International Development Association (World Bank Group)	World Bank, Regional Environmental Centre for Central Asia, etc.	November, 2015 – April, 2021	USD 38 000.000 thousand
Regional coordination and support for the EU-Central Asia enhanced regional cooperation on Environment, Climate Change and Water (WECOOP Phase 2)	European Commission	Montgomery Watson Harza (MWH), Regional Environmental Centre for the Caucasus,	August, 2016 – February, 2019	EUR 1 998.000 thousand (USD 2 227.000 thousand*)
Sustainable and climate sensitive land use for economic development in Central Asia	German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety	German Corporation for International Cooperation (GIZ)	2016-2019	(n/a)
Ecosystem-based adaptation to climate change in high mountainous regions of Central Asia	German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety	German Corporation for International Cooperation (GIZ)	2015-2019	(n/a)
Capacity building and strategic framework for support of low-carbon development in Central Asia	UNEP	Regional Environmental Centre for Central Asia (REC CA)	February, 2015 – August, 2015	USD 52.400 thousand
Sustainable Energy Programme for Central Asia (CASEP)	European Commission	German Corporation for International Cooperation (GIZ), GFA, REC CA	March, 2013 – April, 2016	EUR 331.755 (USD 425.187 thousand*)
Integrated Approach to the Development of Climate-Friendly Economics in Central Asia	German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety	REC CA	December, 2011 – May, 2014	EUR 982.000 thousand (USD 1 272.360 thousand*)

* * exchange rate as per oanda.com

Source: official websites of the World Bank (vsemirnyjbank.org), European Commission (ec.europa.eu), GIZ (giz.de) and REC CA (carececo.org)

In 2013-2017 USAID (United States Agency for International Development) supported the Kazakhstan Climate Change Mitigation Program (KCCMP). USAID contributed around 8.475 million US dollars in program implementation. The project was implemented by US-based Tetra Tech Company.[209]

In 2014-2016 Kazakhstan received technical assistance in the amount of 1 million US dollars from the Partnership for Market Readiness (PMR, World Bank Group). Assistance was rendered through Zhasyl Damu JSC and focused on GHG emissions trading scheme development and introduction.[210] Over the period from 2011 through 2015 Kazakhstan benefited from assistance to emissions trading scheme development from EBRD (Preparedness for Emissions Trading in the EBRD Region[211]), USAID (Enhancing

[209] Midterm Evaluation of the Kazakhstan Climate Change Mitigation Program, March 2017, c. 2.

[210] https://www.thepmr.org/country/kazakhstan-0; https://www.thepmr.org/system/files/documents/Kazakhstan_PMR%20ISR_October%202016_0.pdf

[211] PETER project official website http://www.ebrdpeter.info/en/kazakhstan/

Capacity for Low Emission Development Strategies[212]), as well as governments of Norway, Germany and the Netherlands.

As on October, 2017 Kazakhstan has sent a request (through UNDP) to the Green Climate Fund on its readiness to launch capacity-building activities for the authority responsible for climate financing (Readiness Programme) and elaboration of relevant programme framework. Project is planned for 12 months with a USD 300,000 budget.[213]

Incoming climate financing is expected to increase further. In 2017 the Asian Development Bank (ADB) alone approved three projects directly related to climate change mitigation and adaptation for the total amount of 2.3 million US dollars (Table 101).

Table 101. *Technical assistance projects for climate change supported by ADB in 2017.*

Project	Implementing agency	Planned implementation period	Amount, thousand USD
Samruk-Energy Green Transformation	Sovereign Wealth Fund Samruk-Kazyna Joint Stock Company	September, 2017 – September, 2018	225,0
Irrigation Rehabilitation Sector Project	Kazvodkhoz RSE	July, 2017 – April, 2018	1 100,0
Promoting Renewable Energy	KEGOC JSC	March, 2017 – February, 2018	1 000,0
TOTAL:			**2 325,0**

Source: official ADB website (adb.org)

7.2. Assistance to Parties that are developing countries particularly vulnerable to adverse climate change impacts

In addition to humanitarian aid that amounted to around 1.362 million US dollars[214],in 2016 Kazakhstan renders assistance to developing country Parties.

In 2015 the initiative known as Africa–Kazakhstan Partnership for the SDGs was launched[215] to help 45 African countries implement Sustainable Development Goals (SDGs). Program budget amounts to 2 million US dollars.[216]

In 2016 Kazakhstan and the Caribbean Community (CARICOM) signed an agreement to support CARICOM member states in climate change and sustainable development efforts. Under the agreement Kazakhstan made a US$770,000 grant support package available to CARICOM to strengthen capacity of its member states to engage in regional and international discussions of climate matters.[217]

Environment and climate protection is one of the four basic principles of the RK national policy for official development assistance.[218] Since 2013[219] the country has worked on establishment of KazAID Kazakhstan Agency for Development Aid and Technical Assistance. Kazakhstan's assistance to developing countries under UNFCCC is expected to increase.

[212] EC-LEDS project official website https://www.ec-leds.org/countries/kazakhstan
[213] Progress and outlook report of the Readiness and Preparatory Support Programme, Green Climate Fund (GCF/B.15/Inf.08, 9 December 2016), c. 13
[214] According to the Financial Tracking Service of the UN Office for the Coordination of Humanitarian Affairs (https://fts.unocha.org/donors/4795/flows/2016).
[215] Kazakhstan and UNDP adopted a new program of assistance to African countries, September 29, 2015, MFA RK official website (http://www.mfa.kz/ru/content-view/kazakhstan-i-proon-prinyali-novuyu-programmu-pomoshchi-stranam-afriki)
[216] D. Sultanoglu, opening remarks at Astana Economic Forum, May 26, 2016. UNDP in Kazakhstan official website (http://www.kz.undp.org/content/kazakhstan/ru/home/presscenter/speeches/2016/05/26/-.html).
[217] "CARICOM, Kazakhstan sign support grant agreement", March 14, 2016, CARICOM website (http://today.caricom.org/2016/03/14/caricom-kazakhstan-sign-support-grant-agreement/)
[218] RK Presidential Decree No. 415 dated January 31, 2017 "On approval of principal areas of RK national policy for official development assistance for 2017-2020".
[219] RK Presidential Decree No. 538 dated April 9, 2013 "On approval of the RK Concept on official development assistance".

Kazakhstan launched the practice of holding seminars for farmers and agricultural specialists from developing countries in order to popularize and transfer knowledge on the use of resource-saving technologies. In September 2015, 32 specialists from 15 African countries passed training in Kazakhstan, in April 2017 – farmers and agricultural specialists from Central Asia. Both seminars were organized by UNDP-Kazakhstan.

7.3. Membership fees and voluntary contributions

Table 102. *Mandatory membership fees paid by Kazakhstan to UNFCCC and Kyoto Protocol, USD.*

	2013	2014	2015
UN Framework Convention on Climate Change	23 761	23 778	24 186
Kyoto Protocol	15 000	14 887	13 124

Source: Ministry for Foreign Affairs of the Republic of Kazakhstan (in response to inquiry of the RK Ministry of Energy, Ref. No. 18-05-5935/4 dated 28/05/2015).

Table 103. *Kazakhstan's voluntary contributions to UNEP and UNDP, USD*

	2013	2014	2015
United Nations Environment Programme (UNEP)	30 000	30 000	30 000
UNDP		200 000	435 000

Source: Ministry for Foreign Affairs of the Republic of Kazakhstan (in response to inquiry of the RK Ministry of Energy, Ref. No. 18-05-5935/4 dated 28/05/2015).

7.4. Technology transfer

As part of received financial assistance Kazakhstan is a recipient of technologies. In its turn Kazakhstan has launched two meaningful initiatives in the field of technology transfer and best practice exchange.

The "Green Bridge" Partnership Programme is designed to promote international cooperation in green economy by means of technology transfer, knowledge exchange and financial assistance to investment projects implementation.[220] The Programme was initiated by the Republic of Kazakhstan in 2012 at the 66th session of the UN General Assembly and approved at the UN Conference on Sustainable Development as an inter-regional initiative for sustainable development. The "Green Bridge" Partnership Programme was included in the final document of the World Summit on Sustainable Development RIO+20 "The future we want". As of year-end 2015 14 countries (Kazakhstan, Russia, Kyrgyzstan, Georgia, Germany, Mongolia, Belarus, Montenegro, Latvia, Albania, Finland, Hungary, Bulgaria, Sweden) and 12 non-governmental organizations have joined the Charter of the "Green Bridge" Partnership Program.

"Green Bridge" partners maintain the register of best green technologies[221] and render assistance to Arnasay Green Technologies Center (Arshaly village, Arshaly district, Akmola oblast). Around 35 innovative green technologies are displayed at Arnasay visitors center, including pyrolysis heating, solar panels and collectors, light-emitting diodes and phytodiodes in lighting, energy efficient pumps,

220 http://gbpp.org/
221 Available of the Green Bridge Partnership website, link: http://gbpp.org/register-of-green-technologies

solar well, air ionizer, etc. 18 companies display their technologies, and around 4,000 people have been trained at the National Academy of Green Technologies established at the Center.[222]

In June-September, 2017 Kazakhstan hosted ***Astana EXPO-2017 "Future Energy"*** international exposition. The Ministry of Energy selected 28 home-grown developments in renewable energy, waste management and energy efficiency; they were displayed in Kazakhstan pavilion during EXPO. Kazakhstan is also planning to introduce the best technologies displayed in other pavilions at Astana EXPO-2017. To that end, the Ministry of Energy has set up an expert working group uniting representatives of national companies and analytical experts. The group has made a list[223] of 105 technologies divided into 4 areas: oil and gas (27); coal and nuclear industry (5); electric energy, energy saving and renewables (44); environment protection (29). Technologies will be introduced by business entities, universities and akimats.[224]

7.5. Challenges and gaps and relevant need for finance, technologies and capacity-building

When finance and technologies are attracted little attention is paid to adaptation measures in agriculture. Climate financing still doesn't cover disaster prevention and preparedness efforts. In terms of reporting under UNFCCC the national agency still requires assistance from the Global Environmental Facility.

222 Arnasay Green Technologies Center (reference), February 3, 2017. Coalition for Green Economy and G-Global Development website (https://greenkaz.org/index.php/tsrz-narodnaya-akademiya-zelenykh-tekhnologij/item/1292-tsentr-zelenykh-tekhnologij-arnasaj).

223 Available on the website of the RK Ministry of Energy, link: http://energo.gov.kz/index.php?id=14127

224 Press release on the results of EXPO-2017, September 22, 2017, press office of the RK Ministry of Energy (http://energo.gov.kz/index.php?id=14127).

VIII. RESEARCH AND SYSTEMATIC OBSERVATIONS

8.1. Research and systematic observations policy

8.1.1. The main national plans and programs on climate research

Climatic observations are made in Kazakhstan under the budget program No. 039 of the RK Ministry of Energy "Hydro-meteorological and Environmental Monitoring Development" consisting of two sub-programs: No. 039-100 "Environmental Observations" and No. 039-102 – "Hydro-meteorological monitoring".

Program tasks are as follows:

- collect hydro-meteorological and environmental monitoring data and develop the stations network, including their re-equipment, and improve observations metrology;
- develop operating and monitoring observations data collection, processing and circulation technologies, including update and development of the Republican Hydro-meteorology and Environmental Database;
- store and manage climatic data, including preparation of classified and reference information and disclose climatic information to population and various economy sectors for the purpose of forecasting.

Table 104. *Program No. 039 "Hydro-meteorological and Environmental Monitoring Development" budget, KZT*

	2014	2015	Plan		
			2016 (revised budget)	2017	2018
039. Hydro-meteorological and Environmental Monitoring Development	7,012,634	5,479,731	5,718,125	5,718,125	5,718,125
039-100. Environmental Observations	2,230,164	1,370,119	1,642,763	1,642,763	1,642,763
039-102. Hydro-meteorological monitoring	4,782,470	4,109,612	4,075,362	4,075,362	4,075,362

8.1.2. National organizations involved in climate research

Systematic climate observations are made by Kazhydromet Republican State Enterprise (RSE) that is a structural division of the RK Ministry of Energy. RSE is made up of 15 branches located in all oblast centers of Kazakhstan and in Almaty.

The function of the RK National Hydro-Meteorological Service is to provide information on weather and climate conditions, water resources and environment, notify on occurrence of hazardous and spontaneous hydro-meteorological events and extremely high levels of environmental pollution.

The hydro-meteorological network of Kazakhstan includes 328 meteorological stations and 307 gauging stations (in 2011 they amounted to 260 and 298 respectively). 86 meteorological stations (of all available stations) transfer information on a daily basis to the Global Observing System of the World Meteorological Organization (WMO). 66 meteorological stations are united into the WMO Regional Basic Synoptic Network, 44 – into the WMO Regional Basic Climatological Network.[225] In addition to that Kazhydromet provides information on agrometeorological and ecological state of environment.

Kazhydromet RSE Modernization Program for 2017-2020 will soon be adopted to expand the methodological framework of hydro-forecasting and improve technical equipment of observation network for environmental, meteorological and hydrological monitoring. For example, it is planned to install 25 meteorological radars all around the country to ensure higher accuracy of forecasts.

[225] Surface and upper-air stations, Kazakhstan Country Profile, WMO (https://www.wmo.int/cpdb/kazakhstan).

The Institute of Geography of the RK Ministry of Education and Science (MES) is engaged in assessment and projection of RK surface water resources with due regard to climate change and economic activity. JSC National Center of Space Research and Technology monitors droughts occurrence for agriculture.

The Institute of Geography also conducts studies of natural hazards in mountainous areas and glaciological studies. Surveillance of areas exposed to mudflows and landslides is carried out by Kazhydromet and at the stations of Observation and Alert Service of "Kazselezaschita" State Enterprise of the RK Ministry of Internal Affairs.

8.1.3. International cooperation

Kazakhstan became a party to the World Meteorological Organization Convention in December, 1992[226] By geographic principle the Republic of Kazakhstan is a part of Regional Association II (Asia).

The Republic of Kazakhstan is a member of Interstate Council for Hydrometeorology of the Commonwealth of Independent States (CIS). In May, 2012 the CIS Council of Heads of Government approved the Strategy of Development of Hydrometeorological Activities of the State Parties of the CIS[227]. Priority tasks of this strategic document are:

1. Observation network development.
2. Development of basic technologies of data processing and dissemination, environmental state and pollution forecasting.
3. Development of government databases on environment state and pollution.
4. Handling of applied problems:
    4.1. climate research development, including assessment of future climate change and implications of such changes, vulnerability of economy sectors, certain regions, their capacity to adapt to climate change, and ways to mitigate anthropogenic impact on climate;
    4.2. update of agrometeorological support system;
    4.3. advanced meteorological support to air navigation and air traffic safety in terms of meteorology;
5. Development and introduction of models and methods of assessment of economic effect of hydro-meteorological support to social and economic development of the State Parties of the CIS.
6. Enhancement of relationships among participants of hydro-meteorological and related activities.

Kazhydromet RSE is a member of the Coordinating Committee on Hydrometeorology of the Caspian Sea (CASPCOM)[228]. Kazhydromet is charged with provision of hydro-meteorological information to the population, business and nature protection in the Caspian Sea area. This is done in compliance with the budgetary program of the RK Ministry of Economy "039. Hydro-meteorological and Environmental Monitoring Development".

With the help of the World Meteorological Organization and the US Agency for International Development (USAID) Kazakhstan is working on establishment of the Regional Center for Flood Prevention in Central Asia.

The Central Asia Regional Glaciological Center (category 2) is going to be established on the basis of Institute of Geography under the auspices of UNESCO[229]. ЦThe Center will fulfill the following functions:

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[226] RK Supreme Court Ruling dated December 18, 1992.

[227] Decision of the CIS Council of Heads of Government "On the Strategy of Development of Hydrometeorological Activities of the State Parties of the CIS" dated May 30, 2012. (http://cis.minsk.by/reestr/ru/index.html#reestr/view/text?doc=3450)

[228] CASPCOM official website - www.caspcom.com

[229] RK Law No. 50-VI 3PK "On ratification of Agreement between RK Government and the United Nations Educational, Scientific and Cultural Organization (UNESCO) for establishment of the Central Asia Regional Glaciological Center (category 2) under the auspices of UNESCO" dated March 1, 2017

1. improve coordination of research activity and information exchange between various organizations involved in monitoring of glaciers, snow and permafrost in the area of surface runoff formation in Central Asia;
2. do research for better scientific understanding of climate change implications for glaciers, snow and water resources; elaboration of further needs for research in the region;
3. encourage development of regional research programs linked with regional and global initiatives, including with a focus on glaciology, hydrology and climatology issues in mountainous areas under UNESCO International Hydrological Programme (IHP).
4. exercise and coordinate efforts in education and human and institutional capacity-building in terms of assessment of climate change implications for snow and glaciers with application of latest methods and technologies, including use of satellite pictures and GIS technologies;
5. set up a program for raising awareness on mountain glaciers melting projections and risks among decision-makers on the national and regional levels;
6. circulate research results to wider academic circles and IHP networks in the form of theoretical seminars and practical workshops, training courses, conferences and periodicals.

8.2. Systematic observations and data management

8.2.1. Atmosphere and land observations

The land meteorological network of Kazakhstan includes 328 stations making regular monitoring observations at eight synchronized times (00, 03, 06, 09, 12, 15, 18 and 21 o'clock of the World Coordinated Time (WCT)). At 09 and 15 o'clock WCT precipitation amount is measured. This ensures required accuracy to diurnal ranges of the main meteorological characteristics: temperature and air humidity, wind speed and direction, atmospheric pressure, soil temperature, visibility, clouds quantity and form, cloud base height.

Since 2010 Kazhydromet has published annual bulletins to provide reliable scientific information on regional climate, its variability and change. The bulletin analyzes changes, anomalies and trends. Data are obtained from the Republican Hydro-meteorological Database of Kazhydromet RSE:

1) average monthly air temperatures and monthly precipitation amounts (since 1941), at the same time data delivered by over 190 meteorological stations are used to determine climatic norms for 1961-1990 and over 110 meteorological stations are used in trends assessment;
2) daily maximal and minimum air temperatures and daily precipitation amounts (since 1941) delivered by over 90 meteorological stations.

The analysis of meteorological observations is published on Kazhydromet website in the form of meteorological daily and monthly summaries.

8.2.2. Agrometeorological observations

Kazhydromet's agrometeorological network makes observations at 203 observation stations, including 115 meteorological stations, 72 agrometeorological stations and 16 automated stations. During the vegetation period observations of crops and pasture herbage growth and development, soil humidity are made; in winter period – snow cover height, soil freezing, temperature on the depth of winter crops tillering node are observed.

Specialists of Kazhydromet's Agrometeorological Forecasting Department produce forecasts of spring and winter wheat yield, productive moisture reserves in soil before spring field works and various references on current agrometeorological conditions. Department experts are involved in inspection of damage caused by adverse weather events (drought, frosts, heavy rainfall, hail, etc.) to farm fields at organized farms covered by mandatory crops insurance scheme.

JSC National Center of Space Research and Technology, with UNDP and USAID support, has developed a pilot version[230] of Geographic Information System of Satellite Drought Monitoring. The system enables topographic application of indices like Normalized Difference Vegetation index (NDVI), Vegetation Condition index (VCI) and Temperature Condition index (TCI). The geoportal (applied method, algorithms and GIS-technologies) is expected to improve accuracy of drought severity and distribution area assessment.

8.2.3. Hydrological systems monitoring

307 hydrological stations monitor surface water to determine such hydrological parameters as water level and discharge, average flow rate, etc. Hydrological bulletin is published on the website of Kazhydromet on a daily basis; it also contains forecast of the main hydrological phenomena. Mudflow bulletin is published in summertime.

Hydrological monitoring is carried out in the Caspian Sea. Observations are made at six maritime stations and posts of Kazhydromet. In winter periods ice situation in the Caspian Sea is monitored; monitoring data are published in weekly summaries. When ice period ends annual summary tables of main ice parameters in the Caspian Sea are made on the basis of urgent observation materials from each maritime hydro-meteorological station (Table 105). After that they are published in the document "Annual Caspian Sea water administration data. Kazakhstan coast".

Table 105. *Data on principal elements of the Caspian Sea ice pattern.*

Ice formation							
Below 00C air temperature stabilization date in autumn	Below 00C water temperature stabilization date in autumn	First ice formation date	Ice stabilization date	First shore ice formation date	Shore ice stabilization date	Brought ice emergence date	Shore ice stable width value

Complete freezing						
Station	Maximum shore ice width, km	First date of complete freezing	Final date of complete freezing	Maximum measured ice thickness, cm	Date of maximum ice thickness observation	
Thawing and melting						
Station	Above 0°C air temperature stabilization date in spring	Above 0°C water temperature stabilization date in spring	Meltwater pool emergence date	Thaw holes emergence date	Young shore ice formation date	Cracking start date or first shore ice movement date
Individual ice blocks cleaning						
Station	Shore ice final breaking date	First cleaning date	Final cleaning date	Number of days with ice	Number of days in ice period without ice	Notes

8.2.4. Forecasting

Kazhydromet RSE forecasts hazardous events for the next 24 hours, makes 3-day weather forecasts, monthly and seasonal advisory weather forecasts. Average accuracy of weather forecasts and weather alerts on hazardous events, spontaneous hydro-meteorological events (SHMEs), sudden weather breaks over the period from 2010 to the first half of 2017 is:

[230] Available by link: http://zasuhi.gzi.kz

- first day in a city – 89 percent;
- first day in an oblast – 95 percent;
- 2-3 days in an oblast – 90-91 percent;
- hazardous events, SHMEs, sudden weather breaks – 90-95 percent.

Average accuracy of monthly forecasts (dover the period from 2011 to 2017) is 73 percent for temperature, 65 percent for precipitation; accuracy of 10-day forecasts (on average from 2014 to 2017) – 86 percent.

8.2.5. Simulation

In recent years Kazhydromet has worked more actively on simulation of hydro-meteorological processes. Computational models like WRF and COSMO are used in weather forecasting.

In addition to that, mathematic simulation is successfully applied to diagnostics and forecasting of hydrological condition of the Caspian Sea. In particular, application of computational hydrodynamic simulation on the basis of SWAN (Simulating Waves Nearshore) wave spectral model for forecasting of surges on the Caspian Sea allows:

- to choose optimum paths of sea vessels crossing;
- to rationally plan time and location of any maritime operations;
- to ensure safety of works at sea;
- to increase cost-effectiveness of works at sea;
- to prevent technogenic and environmental disasters.

River runoff simulation and forecasting is based on hydrological models with daily time interval: conceptual water-balance HBV model (developed by the Swedish Meteorological and Hydrological Institute) and SRM snowmelt runoff model (developed within the framework of Swiss Aral Sea Mission).

The HBV model simulates daily runoff on the basis of daily precipitation, temperature and evaporation input data; digital terrain model data classified by height with GIS are also used as input data. This model provides accurate flood and average water discharge data.

The SRM model uses daily precipitation, temperature and snow cover area. All data are introduced for the basin high-rise zones, in 500 m. Digital terrain model is used as well. The model can’t be adjusted, all parameters and coefficients formula-based. Useful for prompt weather alerts.

8.3. Research on climate change and adaptation

Climate change impact on water resources and glaciers is studied by the Institute of Geography of the RK Ministry of Education and Science. The research project “Agroclimatic Resources of Kazakhstan in the Face of Climate Change” was implemented in 2015-2017 at the expense of grant financing. Research on “Evolution of Glaciers and Glacial Systems in Transboundary Basins of Kazakhstan and Neighboring Central Asian States as the Basis of Assessment of Current and Expected Changes in Regional Water Resources” was conducted within the framework of program target financing.

Research center of Kazhydromet RSE was involved in preparation of UNEP overview of adaptation in mountainous areas of Central Asia[231]. This research revealed gaps and suggested measures (of scientific, institutional and political and financial nature) on adaptation of various sectors (water resources, agriculture, a biodiversity and the woods, health care, a power engineering and transport) to climate change. Kazhydromet is always involved in preparation of all National Communications at an expert level.

231 “Adaptation to climate change in mountainous areas in Central Asia”, UNEP, 2017.

IX. EDUCATION, PERSONNEL TRAINING AND AWARENESS-RAISING CAMPAIGNS

9.1. Education and personnel training

Education and development of environmental consciousness in business and communities is one of six basic principles of transition to green economy as described in the Concept of the Republic of Kazakhstan transition to green economy[232], adopted in May 2013. In order to achieve the goals set in the Concept it is necessary to improve existing and develop new educational programs on rational use of resources and environment protection for education and personnel training system.

At the same time, the issues of environmental education have not yet been reflected in the Law "On Education"[233] or the State Program for Development of Education and Science for 2016-2019[234].

The system of education in the Republic of Kazakhstan is based on the principle of continuity and succession of general training and educational programs that incorporates the idea of "environmental education". Climate change matters are studied to a different extent and in a different scope on the following levels:

- preschool upbringing and education;
- elementary education;
- basic secondary education;
- secondary education (general secondary education, technical and vocational education);
- postsecondary education;
- higher education;
- postgraduate education.

9.1.1. Preschool upbringing and education

According to 2015 data, 758.8 thousand people were covered by preschool upbringing and education, which is 4.4 percent of the total Kazakhstan population. In accordance with the State Compulsory Standard of Preschool Upbringing and Education[235], three basic obligatory programs are being implemented:

– "Algashky Kadam" (1-3 years old);
– "Zerek Bala" (3-5 years old);
– "Biz Mektepke Baramyz" (5-6 years old).

Preschool organizations offer a variety of educational programs. Along with the state programs, they work on four additional programs ("Balbobek", "Kainar", "Ulan", "Men Zheke Tulga"). These programs contain teaching packages, including over 90 printed, audio and video materials for teachers and learners.

Variable components of the Standard Curriculum for preschool upbringing and education[236] ensure arrangement of the pedagogical process with due regard to learners' age in such fields as "Health",

232 The Decree of the President of the Republic of Kazakhstan "On the Concept on Transition of the Republic of Kazakhstan to the Green Economy" of May 30, 2013 No. 577.
233 The Law of the Republic of Kazakhstan "On Education" of July 27, 2007 No. 319-III.
234 The Decree of the President of the Republic of Kazakhstan "On Approval of the State Program for Development of Education and Science for 2016-2019" of 01 March, 2016 No. 205.
235 The Order of the Government of the Republic of Kazakhstan "On Approval of the State Compulsory Educational Standards for the Corresponding Levels of Education" of August 23, 2012 No. 1080.
236 In accordance with the Order of the Minister of Education and Science of the Republic of Kazakhstan of December 20, 2012 No. 557 "On Approval of Standard Plans for Preschool Upbringing and Education of the Republic of Kazakhstan".

"Communication", "Creativity", "Cognition" and "Society" established by the State Compulsory Educational Standard (SCES). The work with preschool children in this direction includes, among other things, enhancement of their knowledge about objects and phenomena of animate and inanimate nature, seasonal phenomena, the planet Earth as a common home of people, its nature peculiarities.

The sequence of education, aimed at creating careful and responsible attitude to environment, is shown on an example of the program for preschool children "Green Planet"[237].

Table 106. *Tentative plan of "Green Planet" program for preschool organizations.*

Year of study	Subject	Age
First year	"How wonderful this world is"	3-4 years old (second junior group)
Second year	"Miracle of life"	4-5 years old (middle group)
Third year	"Magic of creation"	5-6 years old (senior group)
Fourth year	"I am responsible for everything on the planet"	6-7 years old (pre-school group)

To develop the foundations of environmental consciousness of preschool children, "Good World of Childhood" educational and development complex was developed. The complex was issued in 1000 copies by Zhandau Alemi Foundation for children aged 5 to 10. The entire content-related component was presented in Kazakh, Russian and English languages.

The developed programs and teaching development packages are introduced in the network of preschool organizations. The number of children's institutions (both public and private) and children in them is shown in Table 107.

Table 107. *Network and population of preschool organizations.*

Years	Total number of preschool organizations	Public		Private		Population of preschool organizations, thousand people
		city	village	city	village	
2011	7 591	1 906	5 236	308	141	538, 5
2012	8 392	2 022	5 702	396	272	631,5
2013	8 143	1 921	5 167	643	412	630,8
2014	8 467	1 789	5 218	858	602	727,5
2015	8 834	1 845	5 214	999	776	758,8

Source: The National Report "On the State and Development of the Educational System of the Republic of Kazakhstan as of Year-end 2015", the Ministry of Education and Science of the Republic of Kazakhstan.

As it was noted in the National Report "On the State and Development of the Educational System of the Republic of Kazakhstan as of Year-end 2015", publishing houses Almaty Kitap, Arman PV, and Education Fund – A New Solution, are developing teaching packages for a new preschool education program. Authors of teaching packages offer 8 cross-cutting topical units, i.e. both for preschool and primary education.

Pursuant to the above, cross-cutting education features smooth transitions from one stage to another, within which the foundations for understanding of the processes happening in environment are laid.

[237] The variative complex sequential system of education and upbringing - "Green Planet". The Regulation on the variative part of the Standard Curriculum for preschool organizations. The Republican Center of Preschool Childhood, the Ministry of Education and Science of RK, Astana, 2013.

9.1.2. General secondary education

According to the Ministry of Education and Science of the Republic of Kazakhstan in 2015 there were 7,511 schools in Kazakhstan with 2,799,589 children accounting for 16% of the total population.

Nevertheless, it should be noted that in-depth study of climate change issues in general education schools is mainly initiated by teachers who teach additional classes as extracurricular elective courses or school clubs.

The state compulsory standard, as amended by the Law of the Republic of Kazakhstan No. 398-V dated November 13, 2015, does not provide for a separate course to study climate change issues.

In primary school, ecological and environment-oriented topics are studied within the framework of school subjects like "Understanding the World" and "Self-knowledge". In "Understanding the World" class junior schoolchildren study interrelations of a human-being and the world around one, learn elementary concepts of biology, ecology, geography and physics. One of the main tasks of "Self-knowledge" subject is "development of understanding of interrelations between the inner and outer world of a human-being, one's unity with nature, and interdependence of physical and spiritual health".

In secondary and high school schoolchildren look into climate change issues indirectly, within the framework of basic sciences (natural science, geography, biology, physics and chemistry). Geography curricula consider climate-forming factors in grades 6-7 and climate change issues in Kazakhstan – in grade 8. In grade 11 the influence of anthropogenic and abiotic factors on climate change is studied in the course of biology, "Ecology" chapter.

The more in-depth study of environment and climate issues is conducted at Nazarbayev Intellectual Schools (NIS), with a focus on schoolchildren training in chemistry and biology. This work is carried out by nine of the 20 regional branches of NIS Autonomous Organization of Education (AOE).

Zhandau Alemi Foundation developed educational materials on environmental education for pupils of secondary and high school. In particular, the course of "Environmental consciousness" was tested in 2014 in four cities of Kazakhstan (Aktau, Pavlodar, Almaty and Karaganda). In support of the system of continuous environmental education, the Foundation developed an experimental textbook for senior classes of "Ecology and Sustainable Development"[238].

The portfolio of projects on adaptation to climate change and natural disaster risks reduction of the United Nations Development Program in the Republic of Kazakhstan, includes the adapted elective course for Kazakhstan on climate change – "Climate box", developed in 2017 and taught at Nazarbayev Intellectual Schools Autonomous Educational Organizations and city schools of Astana.

This course contains educational and methodological aid with scientific and educational materials and various questions, tasks and intellectual games aimed at academic preparation of pupils and their independence on the topic of "Climate Change", as well as methodological recommendations for teachers on how the resource should be used during classes in different grades.

Using the aid for schoolchildren on climate change of "Climate Box", developed and adapted for Kazakhstan, more than 15.000 children study complex issues related to climate change in an interesting and entertaining form.

Specially for Kazakhstan version of the Climate Box, three intellectual ecological games have been developed, which are intended to help consolidate and verify knowledge after studying each section, because the game approach is an excellent tool for increasing pupils' motivation, it provides the context that promotes better mastering of the material, and also allows the teacher conducting a fascinating, and memorable lesson.

Kazakhstan version of the Climate Box has received an appreciation of I. Altynsarin National Academy of Education of the Ministry of Education and Science of the Republic of Kazakhstan and was recommended as an additional aid in studying subjects of the natural science scope in schools of the Republic of Kazakhstan.

[238] "Ecology and Sustainable Development" is an experimental textbook for senior classes. Authors: Nazarbayeva A.N., Syzdykova G.S., Shaykheslyamova K.O., Abdugalina S.Ye.

9.1.3. Technical and vocational education

The system of technical and vocational education of Kazakhstan is represented by a network of educational organizations that train skilled workforce, specialists of middle-level and applied bachelor's degree programs.

In 2015, the Law of the Republic of Kazakhstan "On Education" was amended according to which a "tertiary college" is defined as "an educational institution that implements integrated modular educational programs of technical and professional, post-school education".

In 2015, 807 colleges conducted training in 183 majors and 463 qualifications.

The issues of climate change are included in college training programs "Agriculture, Veterinary and Ecology", where 33578 people studied in 2015. Of them in "1504000 Farming" - 12776 people, "1502000 Agronomics" - 1491 people, and in majors directly related to environmental issues ("1509000 Ecology and Nature Protection Activities (by types)", "1514000 Ecology and Rational Use of Natural Resources (by industries)" and in "1515000 Hydrology and Meteorology") – a total number of 11.831 people[239].

9.1.4. Higher education

In 2013, 90 hours of "Ecology and Sustainable Development" were an obligatory component in the Standard Curriculum of all majors. The following topics were included in the standard curriculum of this discipline:

- "Economic Aspects of Sustainable Development. Green Economy and Sustainable Development. Management of Water Resources";
- "Ecoenergetics. Strategy of Global Energy-Ecological Sustainable Development in the 21st century. Renewable Energy Sources".

In 2016, amendments were made to the State Compulsory Standard of Higher Education[240] in the article of "Requirements for the Level of Training of Learners", paragraph 16. As a result of these changes, the subject "Ecology and Sustainable Development" was removed from the scope of compulsory disciplines and proposed as an elective component. In this regard, not all higher educational institutions, and not in all majors, include this discipline in the Standard Curriculum.

In higher school until 2016-2017 academic year, there were two ways to study the climate change issues: 1) basic education - for students of all majors and 2) specialized education - for students majoring in biology, chemistry, geography, environment and other technical matters.

The students of not majoring in the issues of climate change studied the discipline of "Ecology and Sustainable Development".

Since September 01, 2013, the State Compulsory Educational Standard of the relevant levels of education has entered into force[241]. In accordance with the data of the State Compulsory Educational Standard, new Standard Curricula were developed[242]. In the process, standard educational curricula and programs on "Electric Power Engineering", "Heat Power Engineering", "Agriculture Energy Supply" were revised. Thus, the following disciplines were introduced to the component for the selection of working curricula of the specified majors:

- "Energy Saving in Heat Power Engineering and Heat Technologies";
- "Non-traditional and Renewable Energy Sources";
- "Renewable Energy Sources";
- "Power Engineering and Sustainable Development";
- "Resource-Saving Technologies in Heat Power Engineering";

[239] Secondary Education in Kazakhstan: Status and Prospects. Analytical collection, Astana, 2015.
[240] The changes were introduced by the Order of the Government of the Republic of Kazakhstan of May 13, 2016 No. 292.
[241] Approved by the Order of the Government of the Republic of Kazakhstan dated August 23, 2012 No. 1080.
[242] Approved by the Order of the Minister of Education and Science of the Republic of Kazakhstan dated August 16, 2013 No. 343.

- "Energy Audit in Power Engineering and Heat Technologies";
- "Heat Power Systems and Energy Use";
- "Basics of Safety in Electrical Installations".

As part of the study of the above disciplines, students develop knowledge on the use of renewable sources, energy saving and environment protection, as well as on climate change issues.

In some higher educational institutions, educational and scientific laboratories of "Energy saving, non-traditional and renewable energy sources" are established. Projects are also being implemented to introduce energy-saving technologies and explanatory works are being carried out among students and teachers.

Many higher educational institutions of Kazakhstan are training specialists in the field of profession-oriented majors that provide for in-depth study of the climate change issues:

- "Ecology";
- "Safety of Life and Environment Protection";
- "Geography";
- "Water resources and water consumption";
- "Hydrology";
- "Geodesy and cartography".

Students majoring in these subjects study the issues of impact of anthropogenic factors on climate, climate change and biodiversity conservation, climate impact on natural resources. These subjects are studied within the disciplines of "Biological Ecology", "Geo-Ecology", "Environmental Monitoring", "Teaching about the Environment", "Ecological Aspects of Natural Science", "Origin and Evolution of the Biosphere". The specialized subject on studying climate change issues is introduced with the support of international projects.

Kazakhstan has experience of cooperation between international and Kazakhstan public organizations in the development and implementation of educational program on climate change at higher educational institutions.

In 2016-2017 academic year a new academic course of "Climate Risks and their Management" appeared in Korkyt-Ata Kyzylorda State University in the structure of five majors ("Water Resources and Water Consumption", "Melioration, Recultivation and Protection of Lands", "Land Organization", "Ecology" and "Agronomy"). The course was developed by the Cooperation for Sustainable Development Center in collaboration with the UNESCO Cluster Office in Almaty, the Water Partnership of Kazakhstan and Kazakh Scientific and Research Institute of Rice named after I. Zhakhayev

During the same academic year, the new course of "Climate Change and Green Economy" appeared in two higher educational institutions of Kazakhstan - Taraz State University named after Kh. Dulati and Almaty University of Power Engineering and Telecommunications. The course was introduced into the programs of the mentioned institutions on a pilot basis as an elective discipline. During the first half of the year, 88 bachelor students of various profile areas were trained. The course was developed by the Public Foundation of Cooperation for Sustainable Development Center with the support of Kazakhstan Program on Climate Change Control, implemented with the support of the United States Agency for International Development (USAID). It is expected that in the academic year of 2017-2018 this course will be included in the programs of seven more Kazakhstan higher educational institutions.

9.1.5. Postgraduate education

At Kazakhstan universities, including the International Nazarbayev University, the students work on PhD theses on topics related to climate change.

Through the international Bolashak system students, master's students and PhD students have an opportunity to receive educational grants to study at higher educational institutions of the far and near abroad majoring in environment protection, including climate change. The List of Priority Knowledge Areas, which is annually developed by the Ministry of Education and Science of the Republic of Kazakhstan on the basis of applications submitted by central and local executive bodies, includes the following for 2017: Environment and Climate Change; Climate System and Climate Change; Climate Change: Impact and Mitigation; Climate Change: Management of the Marine Environment; Climate Change: Environment, Science and Policy; Ecosystem and Environment Changes.

9.1.6. Advanced training and personnel development

ПPersonnel advanced training and upgrading of their qualification on issues related to climate change is carried out both by government departments, including the key one: the Ministry of Energy of the Republic of Kazakhstan, as well as non-budgetary and public organizations, such as the Regional Environmental Center for Central Asia (CAREC), Green Academy Research and Education Center, Information and Analytical Center of Environment Protection (IACEP).

The Department of Climate Change of the Ministry of Energy of the Republic of Kazakhstan organizes and conducts educational seminars and trainings on the basis of IACEP and Green Academy Research and Education Center. In particular, Green Academy conducts educational seminars for managers and employees of the department, as well as for representatives of business structures. For example, in 2014, 290 people were trained, including 120 representatives of the Ministry (that time it was the Ministry of Environment and Water Resources) and 170 participants representing business companies. In 2015, Green Academy held six panel discussions and seminars on topics related to the consequences of climate change for Kazakhstan, commitments, measures on adaptation and mitigation and participation of the country in the 21st Conference of the Parties to the UNFCCC (United Nations Framework Convention on Climate Change). Representatives of state bodies, business companies and associations, and international organizations took part in these events.

To increase the potential of representatives of business and public organizations, IACEP conducts annual seminars on the topics of "Greenhouse Gas Inventory" and "Mechanisms for Implementation of the Kyoto Protocol in the Framework of the Environmental Code". Participation of non-governmental organizations representatives in these seminars is free of charge.

Educational trainings and seminars on thematic issues of climate change and sustainable power engineering are held for specialists from Central Asian countries, including Kazakhstan, CAREC. For 2013-2015 in the framework of the program of the "Climate Change and Sustainable Energy", annually, CAREC organizes the Central Asian School of Environmental Leadership for Sustainable Development, in which young professionals from Kazakhstan also take part[243].

Within the framework of the Kazakhstan program on mitigation of climate change, which has been implemented in Kazakhstan since 2013 with the support of USAID, personnel training programs in the field of energy saving have been developed and seminars have been held.

An important direction of the personnel training is the professional development of teachers. However, the program of advanced training courses for teachers of preschool and secondary education, approved by the Minister of Education of the Republic of Kazakhstan[244] has not yet reflected the issues of climate change.

The leading role in teachers' professional development on the issues of climate change belongs to CAREC, which together with public organizations (united in the network of "Education for Sustainable Development") conducts seminars on the issues of climate change and energy efficiency in the regions of Kazakhstan.

[243] Climate Change and Sustainable Energy, CAREC website.

[244] On the approval of educational programs for advanced training courses for teachers of preschool, secondary, additional, and special education. The Order of the Minister of Education and Science of the Republic of Kazakhstan of January 28, 2016 No. 92.

9.2. Awareness-raising

9.2.1. General policy for public awareness

During the reporting period (2012-2016), the legislation of the Republic of Kazakhstan has undergone changes in the provision of ecological information, including the information on climate change. Additions and changes were made to the Environmental Code of the Republic of Kazakhstan regarding the access to environmental information. In particular, the creation of the State Register of Pollutants Release and Transfer (Article 160) is provided for, the composition of the information of the State Environmental Information Foundation is expanded (Article 160), an annual preparation and publication of the National Report on the State of the Environment and on the Use of Natural Resources is provided for. The standard of the state service of the "Provision of Ecological Information"[245] and the regulation of the state service of the "Provision of Ecological Information"[246] were introduced.

The National Report on the state of the environment and on the use of natural resources is compiled on an annual basis. The purpose of this document, which is available on the website of www.ecodoklad.kz, is to inform the public about the environmental situation in the country and the measures taken to improve it. The National Report is prepared by the Information and Analytical Center of Environmental Protection of the Ministry of Energy of the Republic of Kazakhstan (IACEP). The structure and procedure for providing the information for filling out the Report is determined by the Interdepartmental Working Group[247]. The National Report provides the information on the following sections: atmospheric air, climate, water resources, biodiversity, land resources, agriculture, power engineering, transport, wastes, as well as data on the state of the environment by regions. The annual expert assessment of the quality of the Report provides for the participation of non-governmental organizations representatives.

According to the standard of rendering the state service of "Provision of Ecological Information", ecological information is provided by the Information and Analytical Center of Environmental Protection of the Ministry of Energy of the Republic of Kazakhstan at the request of individuals and legal entities. In the absence of grounds for refusal, the requested information is provided free of charge within 15 calendar days. In determining the grounds for refusal, the Standard refers to the Law of the Republic of Kazakhstan No. 92-II, dated October 23, 2000 "On Ratification of the Convention on Access to Information, Public Participation in Decision-Making Process and Access to Justice in Environmental Issues". The service is provided for only in paper form, which reduces its efficiency and limits opportunities for the public.

In November 2015, a new law "On Access to Information" was adopted, which stipulates that access to the information on the state of the environment is not subject to restriction.

It should be noted that, along with the state authorities, the holders of information are the legal entities that possess:

- ecological information;
- information on emergency situations, natural and man-made disasters, their predictions and consequences;
- information on the state of fire safety, sanitary-epidemiological and radiation situation;
- information on food safety and other factors that have a negative impact on health and safety ensuring of citizens, settlements and production facilities (Article 8 of the Law "On Access to Information").

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245 Approved by the Order of the Minister of Energy of April 23, 2015 No. 301.
246 Approved by the Order of the Minister of Energy of May 22, 2015 No. 369.
247 According to the Order of the Minister of Energy of the Republic of Kazakhstan of January 27, 2015 No. 43.

Correspondingly, this imposes the obligations on such legal entities, that prescribed for the holders of information, namely:

- provision of information on request;
- the placement of information in the premises occupied by information holders and in other places designated for this purpose;
- providing access to meetings of the boards of state bodies in accordance with the legislation of the Republic of Kazakhstan and online broadcasting of open meetings of the Chambers of the Parliament of the Republic of Kazakhstan, including joint, local representative bodies of the region, the city of republican significance, the capital and the boards of state bodies held at the end of the year, on Internet resources;
- hearing and discussion of reports of the heads of central executive bodies (with the exception of the Ministry of Defense of the Republic of Kazakhstan), akims and heads of national higher educational institutions; placing the information in the media;
- placing the information on the Internet resource of the information holder;
- placing the information on the relevant components of the "e-government" web portal and in other ways not prohibited by the legislation of the Republic of Kazakhstan (Article 9 of the Law "On Access to Information").

9.2.2. Public information campaigns

The largest information campaign was the exhibition of Astana EXPO-2017, which was held from June to September 2017 in Astana under the motto "Energy of the Future". The participating countries presented their experience and best technologies in the field of alternative power engineering and energy efficiency increase. About four million guests, including more than 77 thousand of Kazakhstan schoolchildren, visited the exhibition.

In general, public organizations are the initiators of public information campaigns in Kazakhstan. Target groups of such campaigns are pupils of preschool institutions, pupils of schools, students of colleges and higher educational institutions, the general public, which is also covered through cooperatives of homeowners (Cooperatives of Apartment Owners (CAO). Campaigns are held in the form of promotional events, contests, competitions and distribution of information materials. Due to the fact that the production of printed materials and holding of meetings (trainings, seminars, conferences, summer camps) are expensive and, accordingly, have limited application, electronic information and training tools have been increasingly used lately: websites and webinars. In this regard, it should be noted limited access to the Internet among a large part of the potential audience, especially in rural areas[248]. In addition, much less information is produced in Kazakh (compared to Russian-language sources of information), which also reduces the audience.

One of the successful examples of the work on the public awareness in regard of climate change issues is the activity of the public association of EcoObraz (Karaganda), which since 2000 coordinates the International School Project on the Use of Resources and Energy SPARE[249]. in Kazakhstan. In Kazakhstan, the Project was originally aimed at schoolchildren aged 10 to 12 years, but now it involves school teachers, kindergarten teachers, young people with disabilities and specialists involved in their rehabilitation. The audience continues to expand: if in early 2012, 52 schools were registered on the national website of the Project, at the moment there are already 62 schools[250].

[248] According to the data of TNS Web Index, 71% of the population of large cities in Kazakhstan use the Internet, in rural settlements this percentage is much lower. Source: Advertising on the Internet, as an Anti-Crisis Solution. September 15, 2015, Webzine – "Vlast".
[249] School Project for Application of Resources and Energy is the largest educational project of its kind in the world, which was initiated in 1996 by the Norwegian Society for Nature Conservation of "Friends of the Earth".
[250] The website of the public organization of "EcoObraz": http://www.spare.ecoobraz.kz

In the framework of SPARE-Kazakhstan project, the information and educational program of "School, Friendly to Children and the Environment" was launched in 2014, which is operational at the moment. The focus of the program is the joint work of all representatives of the school community. The emphasis, herewith, is on conduction of low-cost activities, which not only reduce the consumption of resources and electric energy, but also improve the learning environment. Six schools of Kazakhstan took part in the pilot phase of the Program (2014-2015): School No. 15 (Shakhtinsk), Gymnasium School No. 1 (Sarkand), School No. 16 (Temirtau), Gymnasium School No. 4 (Stepnogorsk), the school in Turgen village (Akmola region) and the school in Novoukrainka village (North-Kazakhstan region). It should be noted that all these schools are located either in small cities or in rural areas. During the project, the schoolchildren formed energy teams that estimated how much resources and electrical energy their school consumed, identified sources of energy losses and developed action plans to improve the electrical energy efficiency of the building. The exchange of information between the Project participants takes place through groups in social networks.

The range of public organizations that are engaged in informing the public about climate change is expanding. Thus, in 2012-2014, five cities of Kazakhstan (Aktau, Astana, Karaganda, Ridder and Shymkent) conducted an information and educational campaign on energy efficiency. This three-year initiative was implemented by a group of public organizations (EcoObraz, Human Health Institute, EcoMangistau, Youth Information Service of Kazakhstan, Ak-Kem-Ridder and ROST) with the support of the SPARE project. Within the framework of the campaign, the work was carried out with educational organizations and students, cooperatives of apartment owners and residents, as well as with business companies. In particular, schools and universities conducted: "Energy Workshop" (the scope of practical classes) for schoolchildren and trainings for students, master classes for energy teams, Art Competition of "Energy Saving through the Eyes of Children".

The same group of public organizations in the above-mentioned cities conducted information and educational work with the population in the place of residence. In the period from 2012 to 2014, an annual promotional event was held in these cities, where residents and representatives of Cooperatives of Apartment Owners (CAO) were taught how to conduct household and communal services in accordance with the principles of energy efficiency. In 2012, a contest was held among CAO to determine the most energy-efficient residential yard. 50 CAO and more than 1500 people took part in these events. Information and educational work was conducted among enterprises in five cities: in 2012, a contest was held to determine the most "greenest" office, in 2013, a series of trainings on energy saving opportunities in the offices were conducted.

An information resource for public organizations working with apartment owners, including Cooperatives of Apartment Owners, is the portal of "Energy Efficiency+"[251]. This web resource is a database of four UNDP (United Nations Development Program) projects implemented with the support of the GEF (Global Environmental Facility): "Energy Efficient Design and Construction of Residential Buildings" (2011-2013), "Energy Efficiency in Heat Supply" (2007-2013) and its continuation of "Integrated Solutions of Housing and Utility Infrastructure Sector to Promote Energy Efficiency in Small Cities" (2013-2014), "Energy Efficiency in Lighting" (2012-2016), "Sustainable Cities for Low-Carbon Development" (2015-2020). The website provides the information on energy-efficient technologies that can be used in the design and construction of buildings, heating and lighting.

In the structure of the Ecological Forum of Kazakhstan, which is a network of public organizations and experts, there is a working group on the climate change issues. Within the framework of this direction the information work is carried out, but it is limited due to the lack of constant financial support. In 2013-2014, the Ecological Forum of Kazakhstan and the Social and Environmental Foundation with the support of the Climate Action Network (CAN) and the Norwegian Society for Nature Conservation, realized the project of "Cooperation of Non-Governmental Organizations on Energy and Climate Change Issues in the Republic of Kazakhstan". In the summer of 2014, a youth ecological camp was realized in the Aral Sea region by public organizations – participants of the Climate Coalition of Civil Society Organizations of Kazakhstan, namely by the Social and Environmental Foundation (Almaty), ECOM (Pavlodar) and Zhayik-Caspian Aarhus Center (Atyrau). Participants in the educational program were 27 young activists from the regions of Kazakhstan.

The expert community discusses the results of climate meetings, with the involvement of the public. In 2016-2017, the Ecological Forum and the organizations included in the network organized three public discussions in three cities of Kazakhstan:

[251] www.eep.kz

- "Paris Agreement: Real Actions on the Climate for Sustainable Development of Kazakhstan", April 2016, venue – Almaty and Astana;
- "Paris Agreement: Implementation of National Commitments and Climate Negotiations in Marrakech", November 2016, venue – Almaty and Astana;
- "Planning of Sustainable Development in the Cities of Kazakhstan", February 2017, with the support of AUA Group and the Internews Project of "Media for the Effective Coverage of Environment and Natural Resources in Central Asia", venue – Almaty, Astana and Karaganda.

Those, wishing to take part in the discussion from other cities, were connected remotely, in a webinar format.

9.2.3. Resource and information centers

In Kazakhstan there are several resource and information centers aimed at informing on the climate change issues.

The educational portal on energy efficiency in the countries of Central Asia was created within the framework of the Kazakhstan Climate Change Mitigation Program (KCCMP)[252], which is a four-year project of the United States Agency for International Development (USAID). The program is aimed at supporting Kazakhstan in the long-term and sustainable reduction of specific greenhouse gas emissions.

Information and training center for natural resources users is Zhasyl Damu JSC. One of the fundamental goals of this organization's activity is to reduce greenhouse gas emissions through the establishment and clear functioning of the system of regulation and trading of greenhouse gas emission quotas in the Republic of Kazakhstan. The functional tasks of the joint-stock company include representation of the Republic of Kazakhstan in the negotiation processes within the framework of the UN FCCC, providing expert support for this activity[253].

Information and educational work is carried out under the Green Bridge Partnership Program[254]. The Partnership maintains a register of the best "green" technologies[255] and supports the Center of Green Technologies of Arnasay (Arnasay village, Arshaly district, Akmola region). Arnasay demonstration center presents about 35 innovative "green" technologies. 18 companies demonstrate their technologies, about 4 thousand of people have been trained in the People's Academy of Green Technologies, opened at the Center[256].

In 2018, Kazakhstan plans to create the International Center for Green Technologies. This Center will demonstrate the best technologies in the field of alternative energy and energy efficiency presented at Astana EXPO-2017[257].

9.2.4. Involvement of the public and non-governmental organizations

Currently, the Republic of Kazakhstan provides the state support for the activities of non-governmental organizations through the mechanism of state social order. With regard to the activities of public organizations on the issues of climate change, this support is of limited nature. One of the examples is, in 2012-2014 the Youth Public Association of the Human Health Institute (since 2016 – the Public Association of the Human Health Institute) implemented the project aimed at promoting energy efficiency within the framework of the social order of the Ministry of Environment Protection of the

[252] http://kazccmp.org/

[253] http://zhasyldamu.kz/o-kompanii/missiya-tseli-i-zadachi-kompanii.html

[254] http://gbpp.org/

[255] Available on the website of the Green Bridge Partnership by reference: http://gbpp.org/register-of-green-technologies.

[256] Center of Green Technologies of Arnasay (reference), February 03, 2017, the website of the Coalition for the Green Economy and the development of G-Global (https://greenkaz.org/index.php/tsrz-narodnaya-akademiya-zelenykh-tekhnologij/item/1292-tsentr-zelenykh-tekhnologij-arnasaj).

[257] The International Center for Green Technologies will start operation in 2018 ..., July 13, 2017, Press Service of the Ministry of Energy of the Republic of Kazakhstan: (http://energo.gov.kz/index.php?id=11655).

Republic of Kazakhstan[258]. The aim of the project was to strengthen the dialogue between the concerned parties (state authorities, public organizations and experts, business and international organizations) on the issues of promoting energy-efficient, energy-saving and environmentally friendly technologies. For this purpose, a number of meetings were held in Astana: republican public hearings, a seminar, a panel discussion, a republican conference and two exhibitions. Recommendations, announced by experts at these meetings, were sent to the relevant state authorities. Within the framework of the project, booklets with Kazakh proverbs and proverbs about the careful attitude to the environment in the state and Russian languages were also issued in the number of 200 copies.

The Joint Project of the European Union, the Development Programs of the United Nations and the United Nations Economic Commission for Europe of "Support to Kazakhstan for the Transition to a Model of the Green Economy" help to involve public organizations in the activities on climate change adaptation. "Zhenskiy Luch" Public Organization (Stepnogorsk) and the Alliance of Volunteers of Kazakhstan (Astana) with the support of this initiative, held the republican competition for young people to introduce water-saving technologies in rural areas "Water in Aul". As a result of the competition, four business projects and 18 demonstration projects in various regions of Kazakhstan were supported. In the future, consultations with specialists on business development were conducted with the selected projects and the best ones were realized on the demonstration area on the basis of S. Seyfullin Kazakh Agrotechnical University.

Representatives of the public are informed and actively involved in the processes through international projects. Thus, in June 2013 and May 2014, the World Bank held the First and the Second Central Asian Knowledge Forums on climate change in Almaty. The event was attended by NGO representatives who had the opportunity to exchange views, information and experience with officials, practitioners, international experts and other concerned parties on a wide range of issues related to climate change. In particular, the Second Forum was devoted to technical discussions on climate change, integrated water resources management and disaster risk management from the perspective of regional and international experience, as well as to discussions of the regional program of measures to increase climate resilience.

9.2.5. Participation in international activities

The Regional Environmental Center for Central Asia (CAREC) is coordinating regional initiatives on climate change[259]. This interstate organization of Central Asian countries initiates or takes part in the coordination of a significant number of projects aimed at addressing issues related to climate change. Among such projects are "Covenant of Mayors - the East", "Integrated Approach to the Development of Climate-Friendly Economies of Central Asian Countries", "Program for Climate Adaptation to Climate Change and Mitigation of its Consequences for the Aral Sea Basin (CAMP4ASB)".

Kazakhstan participates in the initiative of the European Commission of "Covenant of Mayors", which is aimed at the formation and implementation of sustainable energy development programs in the cities since 2011. With the support of the Regional Environmental Center for Central Asia (under the "Covenant of Mayors– the East" funded by the European Commission) nine cities of Kazakhstan (Astana, Aksu, Lisakovsk, Karaganda, Petropavlovsk, Satpayev, Taraz, Temirtau, Zhezkazgan) joined this initiative, three of them developed action plans for sustainable energy. CAREC provides information and consultations to representatives of the local administration, organizes an exchange of experience between the signatories of the Agreement at the level of the Central Asian region (totally in five countries of the region the agreement was signed by 15 cities) and conducts activities to increase managers' potential in energy efficiency, sustainable energy and environmentally sound development.

In August 2016, the project of "Program for Climate Adaptation to Climate Change and Mitigation of its Consequences for the Aral Sea Basin (CAMP4ASB)" was launched, which will last until 2021. The partners of the project are the Executive Committee of the International Fund for Saving the Aral Sea

258 http://www.hhikz.com/
259 http://carececo.org/

(EC IFAS), CAREC and the World Bank. The program will strengthen the knowledge base and the capacity on adaptation and mitigation at the regional and national levels, including Kazakhstan. In particular, a regional information and analytical platform will be established, climate observing systems, tools for facilitating decision-making on adaptation and mitigation will be updated, information products will be developed and outreach and awareness-raising work will be carried out, and the mechanism of climate investment assessment will be implemented. National coordination groups have been created to implement the program in the countries.

International cooperation between non-governmental organizations is also being developed among civil society organizations from different countries. There is the Climate Coalition of Civil Society Organizations of Central Asia, which unites the national climate coalitions of Kyrgyzstan, Kazakhstan, Tajikistan and Uzbekistan.

LIST OF ABBREVIATIONS

AAU	Assigned Amount Units
ADB	Asian Development Bank
AEO	Autonomous Educational Organization
AES	Agricultural Experiment Station
AF	Adjustment Factor
AFP	Aktobe Ferroalloy Plant
AGFCS	Automobile Gas-Filling Compressor Station
AIS	Agroindustrial Sector
AOGCM	Atmosphere-Ocean General Circulation Model
ARI	Agricultural Research Institute
ARRIAM	All-Russia Research Institute for Agricultural Microbiology
AWC	Abrupt Weather Changes
BSH	Baltic System of Height
CA	Central Asia
CAC DRMI	Central Asia and Caucasus Disaster Risk Management Initiative
CAREC	Regional Environmental Centre for Central Asia
CASPCOM	Coordinating Committee on Hydrometeorology of the Caspian Sea
CC	Climate Change
CDIA	City Department of Internal Affairs
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CES	Committee for Emergency Situations
CHPP	Combined Heating and Power Plant
CIMMYT	International Maize and Wheat Improvement Center
CIS	Commonwealth of Independent States
CNG	Compressed Natural Gas
COP	Conference of the Parties (Conference of the Parties serving as the Meeting of the Parties)
DCC	Department of Climate Change
DRR	Disaster Risk Reduction
DSD	Direct seed drill
EAEU	Eurasian Economic Union
EBRD	European Bank for Reconstruction and Development
ECE	Economic Commission for Europe
EE	Energy Efficiency
EEC	European Economic Community
EF	Efficiency Factor
EHE	Extreme Hydrological Event
EIB	European Investment Bank
EKO	East Kazakhstan Oblast
EME	Extreme Meteorological Event
EP	Environment Protection
EPR	Enhanced Producers’ Responsibility
ERU	Emission Reduction Units
ESCO	Energy Service Company
ETS	Emissions Trading System
EU	European Union

EXPO	International Specialized Exposition
FAO	Food and Agriculture Organization of the United Nations
FES	Fuel and Energy Sector
FSBI	Federal State Budgetary Institution
FSC	Financial Settlement Center
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse Gases
GIS	Geographic Information System
GVA	Gross Value Added
HFC	Hydrofluorocarbons
HP	Hazardous Phenomena
HPP	Hydro Power Plant
HQ	Headquarters
HTC	Hydrothermal Coefficient
IACEP	Information and Analytical Center of Environment Protection
IEA	International Energy Agency
IFAS	International Fund for Saving the Aral Sea
IHL	Institution of Higher Education
IHP	International Hydrological Programme
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
IRDB	International Reconstruction and Development Bank
ISC	Interdepartmental State Commission
IWRM	Integrated Water Resources Management
JSC	Joint Stock Company
KFU	Kazakhstan Farmers Union Republican Public Association
KP	Kyoto Protocol
KSC	Key Source Category
LLP	Limited Liability Partnership
LUC	Land Use Coefficient
LULUCF	Land Use, Land Use Change and Forestry
MA	Ministry of Agriculture
MDB	Multilateral Development Bank
MDG	Millennium Development Goal
ME	Ministry of Energy
MES	Ministry of Education and Science
MEP	Ministry of Environment Protection
MEWR	Ministry of Environment and Water Resources
MGPL	Main Gas Pipeline
MIA	Ministry of Internal Affairs
MID	Ministry of Industry and Development
MJ	Ministry of Justice
MS	Meteorological Station
MSW	Municipal Solid Wastes
MWUPP	Multipurpose Water Use and Protection Plan
NAP	National Allocation Plan
NAREC	National Agricultural Research and Education Centre
NAS	National Academy of Sciences

NC	National Company
NCSRT	National Center of Space Research and Technology
NGD	Non-Grazing Day
NGO	Non-Governmental Organization
NHMP	Natural Hydrometeorological Phenomena
NHS	National Hydrometeorological Service
NIR	National GHG Inventory Report
NIS	Nazarbayev Intellectual School
NKO	North Kazakhstan Oblast
NPP	Nuclear Power Plant
NPS	National Planning System
ODS	Ozone Depleting Substances
PA	Public Association
PC	Production Cooperative
PF	Public Foundation
PFC	Perfluorocarbons
PJSC	Public Joint Stock Company
PMR	Productive Moisture Reserves (in soil)
POL	Petrol, Oils and Lubricants
PP	Power Plant
PRC	People's Republic of China
PUS	Public Utility Sector
RCP	Representative Concentration Pathway
REC	Research and Education Centre
RES	Renewable Energy Sources
RF	Russian Federation
RFG	Government of the Russian Federation
RI	Research Institute
RK	Republic of Kazakhstan
RMU	Removal Units
RPA	Republican Public Association
RPCGF	Research and Production Center of Grain Farming
RSE	Republican State Enterprise
RST	Resource-Saving Technology
SCES	State Compulsory Education Standard
SDG	Sustainable Development Goal
SDPP	State District Power Plant
SEF	Specific Emission Factor
SHW	Steady Heat Wave
SKO	South Kazakhstan Oblast
SPAIID	State Program for Accelerated Industrial and Innovative Development
SPIID	State Program for Industrial and Innovative Development
SPP	Solar Power Plant
SR	Small Ruminant
TEO	Technical and Economic Feasibility Study
TL	Transmission Line
TMP	Temirtau Metallurgical Plant
UN	United Nations
UN FCCC	UN Framework Convention on Climate Change

UNDP	UN Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNISDR	United Nations International Strategy for Disaster Reduction
USA	United States of America
USAID	United States Agency for International Development
USSR	Union of Soviet Socialist Republics
UTC	Coordinated Universal Time
VAT	Value Added Tax
WAM	With Additional Measures Scenario
WB	World Bank
WCAM	With Current and Additional Measures Scenario
WCM	With Current Measures Scenario
WKO	West Kazakhstan Oblast
WMO	World Meteorological Organization
WOM	Without Measures Scenario
WPP	Wind Power Plant
WRC	Water Resources Committee

Annex 1.

The Second Biennial Report of the Republic of Kazakhstan on Climate Change

1. Introduction

This Biennial Report of the Republic of Kazakhstan on Climate Change was prepared as an annex to the 7th National Communication of the Republic of Kazakhstan. The document contains new information for the years 2016-2017.

For the purpose of consistency, this Biennial Report contains a summary of the relevant information described in the 7th National Communication. References to the 7th National Communication CTF Tables contents are sometimes given for prevention of duplication. When the relevant information is missing in the above documents additional information is provided in accordance with reporting guidelines for biennial reports.

2. Greenhouse gas emissions data and trends

Summary of the national greenhouse gas (GHG) inventory data and emissions trends in the period from 1990 through 2015.

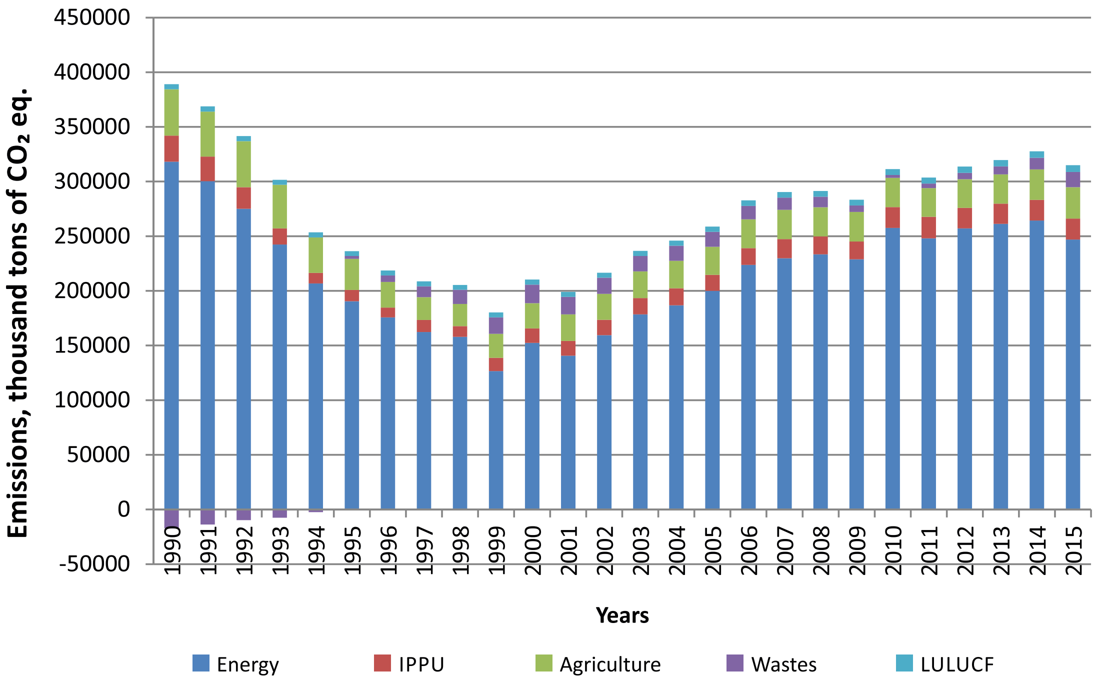
Inventory summary, summary tables and charts for all GHGs specified in summary tables were made in accordance with UNFCCC Guidelines. There is also description of factors emissions trends are based on.

In the base year of 1990 cumulative GHG emissions in Kazakhstan without LULUCF amounted to 389.104 million tons of CO_2 equivalent, with LULUCF – 371.831 million tons of CO_2 equivalent (Table 108).

Table 108. *Cumulative national greenhouse gas emissions dynamics in 1990-2015 by economy sectors in the Republic of Kazakhstan, thousand tons of CO_2 equivalent.*

Year	Energy	IPPU	Agri-culture	LULUCF	Wastes	Cumulative emissions with LULUCF (net emissions)	Cumulative emissions without LULUCF
1990	318195,02	23885,04	42249,08	-17273,21	4775,28	371831,25	389104,47
1991	300299,82	22548,28	41135,86	-13732,32	4829,70	355081,34	368813,66
1992	275111,44	19767,95	42052,82	-9795,97	4662,80	331799,03	341595,00
1993	242410,94	14718,05	39869,65	-7504,06	4521,07	294015,65	301519,71
1994	206839,48	9658,86	32410,43	-2516,46	4599,74	250869,27	253385,73
1995	190464,06	10403,75	28432,39	2574,30	4490,76	236365,25	233790,95
1996	175710,77	8998,94	23476,36	5931,78	4506,42	218624,27	212692,49
1997	162285,94	11126,27	20772,53	9988,14	4557,88	208730,75	198742,62
1998	157853,82	9843,19	20338,99	12882,08	4496,22	205414,30	192532,22
1999	126584,92	12118,79	22017,40	15052,39	4497,71	180271,21	165218,82
2000	152332,76	13305,46	23005,29	17094,15	4593,92	210331,57	193237,43
2001	140698,15	13486,50	24294,77	16040,18	4572,31	199091,91	183051,73
2002	159491,52	13979,72	23769,94	14736,75	4581,16	216559,09	201822,34
2003	178454,16	14889,00	24515,49	14043,93	4636,12	236538,70	222494,76
2004	186775,49	15539,58	25145,20	13798,45	4741,92	246000,64	232202,19
2005	200005,97	14698,04	25660,05	13606,98	4782,76	258753,80	245146,82
2006	223766,67	15293,41	26318,47	12399,53	4992,24	282770,32	270370,79
2007	229809,49	17557,77	26797,79	11118,81	5176,49	290460,35	279341,54
2008	233408,90	16373,82	26745,72	9640,18	5188,07	291356,69	281716,51
2009	228816,66	16333,41	26999,30	5937,54	5314,66	283401,83	277464,29
2010	257527,46	19072,43	26786,70	2599,92	5455,48	311442,00	308842,07
2011	247991,17	19740,37	26220,88	4121,11	5609,81	303683,33	299562,22
2012	257136,57	18806,54	26139,52	5916,81	5699,29	313698,73	307781,92
2013	261269,79	18461,93	26791,12	7351,11	5814,76	319688,70	312337,59
2014	264317,47	18974,04	27794,39	10649,05	5983,01	327717,96	317068,91
2015	246874,79	19177,99	28752,57	13993,93	6115,15	314914,43	300920,50
Difference in 2015 against 1990,%	**77,6**	**80,3**	**68,1**	**-81,0**	**128,1**	**84,7**	**77,3**
Difference in 2015 against 2014,%	**93,4**	**101,1**	**103,4**	**131,4**	**102,2**	**96,1**	**94,9**

Figure 126. *Cumulative GHG emissions in Kazakhstan*



As you can see in Table 108 and Figure 126, total cumulative emissions in Kazakhstan decreased almost twofold over the period from 1990 through 1999 due to economic recession: down to 165.219 million tons of CO_2 eq. without LULUCF. This decrease amounted to 42.5% of the 1990 level without LULUCF.

Average difference between cumulative emissions with and without LULUCF is 2% of the emissions level with LULUCF and ranges from -5% to 7% with a downward general trend before 1990 and growth up to 2014.

Before 1995 total emissions without LULUCF were higher than emissions with LULUCF by 2-5%. After 1995 they became lower, because absorption changed into emission in LULUCF sector.

Starting from 2000 as economy was recovering GHG emissions started to go up and in 2015 reached the level of 300.920 million tons of CO2 eq. without LULUCF and 314.914 million tons of CO_2 eq. with LULUCF. However, the base year level hasn't been reached yet. In 2015 cumulative nation-wide GHG emissions in Kazakhstan with LULUCF sector remained below the level of 1990 by 15.3%, without LULUCF – by 22.7%.

Complete inventory information is specified in the summary table 1 CTF (Common Tabular Format).

The procedure of national inventory compilation is described in chapter III of the 7th National Communication.

3. Certain quantified economy-wide emissions reduction targets

Table 2 CTF format and Table 109 below specify quantified emissions reduction targets for the whole economy.

Table 109. *Emissions reduction target in the full scale of Kazakhstan economy.*

№	Section	Information
1	Base year	1990
2	Quantified emission reduction target	15%
3	Period of target achievement	1990-2020
4	Gases and sectors covered	All gases and sectors except LULUCF
5	The global warming potential, as it has been established in the relevant decisions adopted by the COP	Fourth Assessment Repot 24/CP.19
6	Approach to accounting emissions and removals from LULUCF, taking into account any relevant decisions adopted by the COP	Not taken into account
7	The use of international market mechanisms to achieve the emission reduction target, taking into account any relevant decisions adopted by the COP, including a description of each source of international units and/or allowances through market mechanisms and possible extent of contribution of each of them	Not used
8	Any other information, including the relevant accounting rules, duly taking into account any relevant decisions of the COP	Not available

4. Progress in achievement of particular quantified economy-wide emissions reduction targets and relevant information

In the Republic of Kazakhstan the most important decisions on climate policy are made by the President, the Parliament and the Government. The Ministry of Energy (ME RK) is responsible for climate policy administration in the country and climate negotiations on an international level. In its activity ME RK adheres to the adopted laws and planning documents in accordance with the state planning system. The interdepartmental coordinator for sustainable development is the Council for transition to green economy under the President of the Republic of Kazakhstan headed by the Prime Minister of the Republic of Kazakhstan.

The central executive body in the structure of the RK Government that develops and implements state policy, coordinates the management process in environment protection is the RK Ministry of Energy[260] (ME RK). ME RK also develops and implements state policy, coordinates the management process in such areas as oil and gas, petrochemical industry, transportation of crude hydrocarbons, government control over oil production, gas and gas supply, trunk pipelines, power industry, coal industry, nuclear energy, environmental management, protection, monitoring and supervision of rational use of natural resources, solid waste management, development of renewables, control over state policy of green economy development. The scope of competencies of this government body is also defined in article 17 of the Environmental Code and the Regulation on the Ministry of Energy of the Republic of Kazakhstan.

The structure of ME RK includes the Department of Climate Change[261] (DCC) that consists of low-carbon development division and adaptation and climate risks division. DCC key functions are: develop and implement uniform state policy, arrange elaboration of a climate and ozone layer protection program, implement the ultimate goal and provisions of the UN Framework Convention on Climate Change (UNFCCC) and other international treaties and protocols on climate change and ozone layer of the Earth, pursue state policy in international cooperation for climate change and protection of the ozone layer; state regulation of emission and absorption of greenhouse gases and ozone-depleting substances.

260 http://energo.gov.kz/index.php?id=854#z4
261 http://energo.gov.kz/assets/old/uploads/files/2016/09/%D0%94%D0%98%D0%9A.pdf

The RK Government has introduced several "strategic plans" to set priorities and quantitative goals for the country's development until 2050. Considerable measures were taken in the country to promote development of renewables, increase energy efficiency and reduce impact on climate. The Concept for the Republic of Kazakhstan transition to green economy approved by the President of the Republic of Kazakhstan in 2013 sets ambitious goals to reduce GDP energy intensity, improve the quality of air, increase the share of alternative energy sources and complete country gasification.

Emissions trading scheme (ETS) was launched in Kazakhstan in 2013. The pilot phase covered one year, 2013, and 178 companies representing energy, oil and gas, mining and chemical industries. All together they emitted 55% of GHGs. During the pilot phase allowances were allocated on the basis of historical approach equal to 100% of unverified emissions reported by companies in the reporting year, namely 2010. The same approach was applied to the second ETS phase (2014-2015) where quotas were allocated on the basis of average emissions data for 2011-2012. Starting from 2016, it was suggested that quota allocation should be based on benchmarks. Use of benchmarks in Kazakhstan would promote development and introduction of a viable, efficient and transparent emissions trading scheme compliant with international standards and facilitating the country's green strategy of growth. However, historical approach was again used at the third ETS phase (2016-2020). At the beginning of 2016, emissions trading was suspended until 2018 for the mechanism adjustment and improvement. ETS is described in more details in the following chapters.

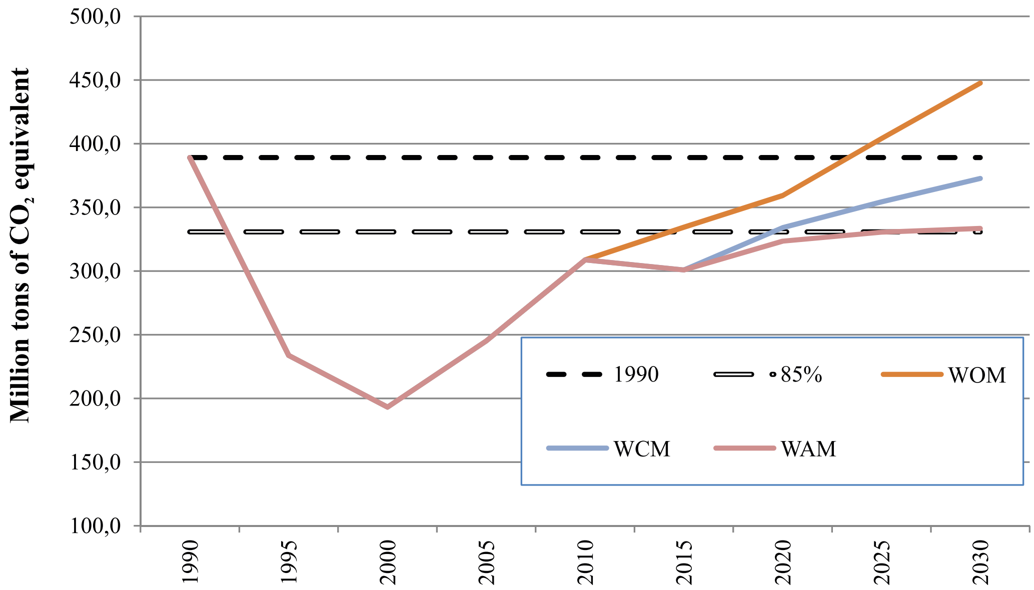
On December 12, 2015, at the 21st session of the Conference of the Parties of UNFCCC that took place in Paris on November 30 – December 13, 2015 the Paris Agreement was made. Kazakhstan signed the Agreement on August 2, 2016 and ratified it on December 6, 2016. On September 28, 2015 Kazakhstan announced its Intended Nationally Determined Contribution: achievement of absolute greenhouse gas emissions reduction minus 15% of the level of 1990 by 2030. Many factors affect implementation of this commitment. GHG emissions have grown by the average annual of 2% in the last 10 years; 2015 inventory data showed that the total GHG emissions amount has already reached 300.9 Mt of CO_2 eq. (without LULUCF) that is 77% of the level of 1990.

Detailed information on mitigation actions is provided in chapter IV of the Seventh National Communication and Table 3 CTF format.

5. Projections

The Figure below shows GHG emissions projection without LULUCF.

Figure 127. *GHG emissions projection, without LULUCF.*



You can clearly see in Figure 127 that in the scenario with measures emissions decrease by 75 million tons of CO_2 equivalent in 2030. Scenario with additional measures brings emissions down by additional 40 million tons of CO_2 equivalent in 2030.

Detailed projections by sectors are given in chapter V of the Seventh National Communication.

Detailed projections in a table format (with and without LULUCF) are described in table 6 CTF.

The table below specifies cumulative effect of current and additional measures.

Table 110. *Cumulative effect of current and additional measures*

	Emissions, million tons of CO_2 equivalent		
	2020	**2025**	**2030**
Scenario without measures	359,3	404,0	447,6
Scenario with measures	334,1	354,3	372,8
Current measures effect	25,2	49,6	74,8
Scenario with additional measures	323,5	330,6	333,4
Additional measures effect	10,7	23,8	39,4

Projection methodology by sectors is described in chapter V of the 7th National Communication.

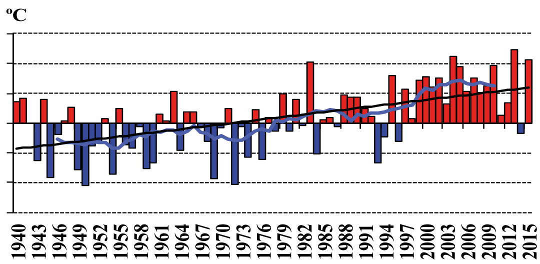
6. Financial and technical assistance, capacity-building support to developing country Parties

Detailed information on financial and technical assistance to developing countries is given in chapter VII of the Seventh National Communication.

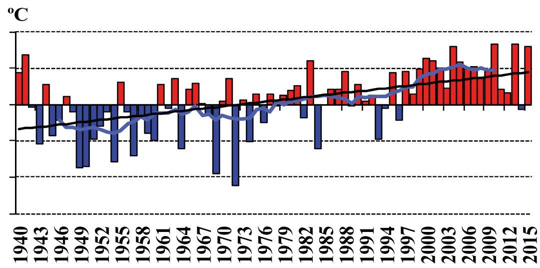
Annex 2.

Time series and linear trends of average annual temperature anomalies (°C) over the period from 1941 through 2015 averaged by administrative oblasts of Kazakhstan. Anomalies were calculated against the base period 1961...1990.

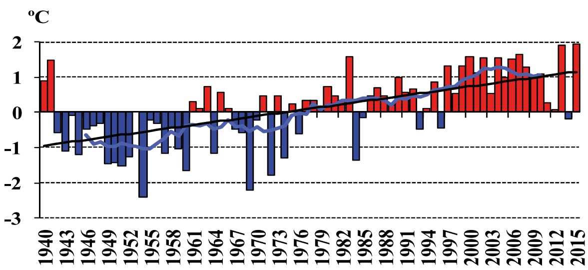
Kyzylorda oblast



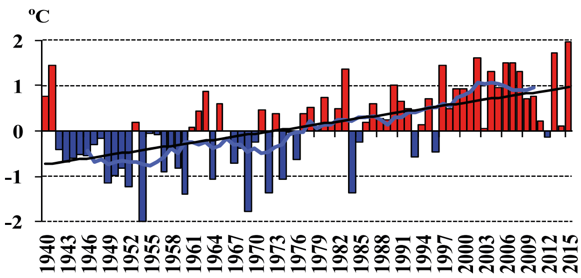
South Kazakhstan oblast



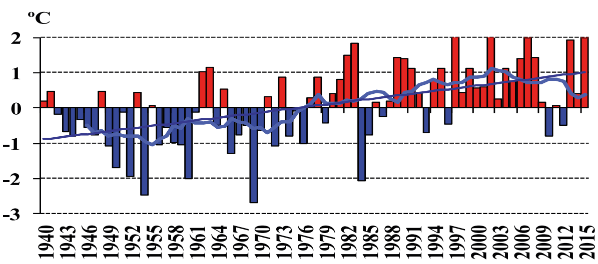
Zhambyl oblast



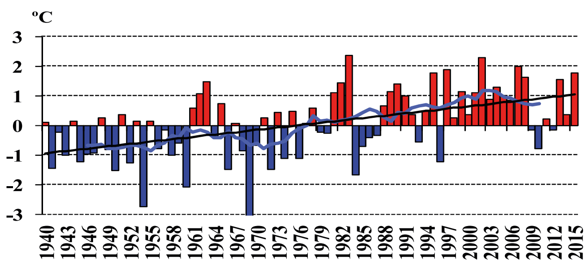
Almaty oblast



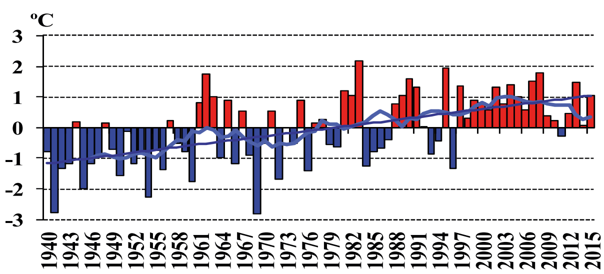
East Kazakhstan oblast



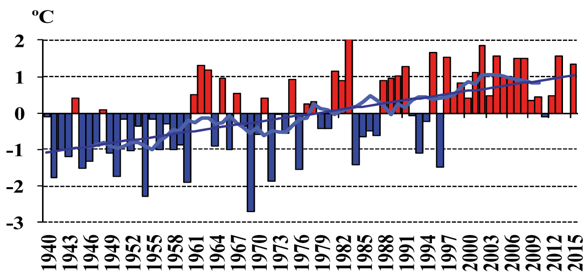
Pavlodar oblast



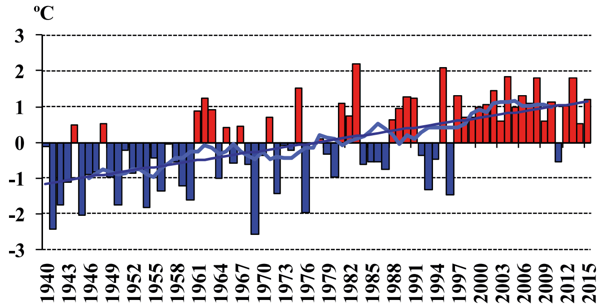
North Kazakhstan oblast



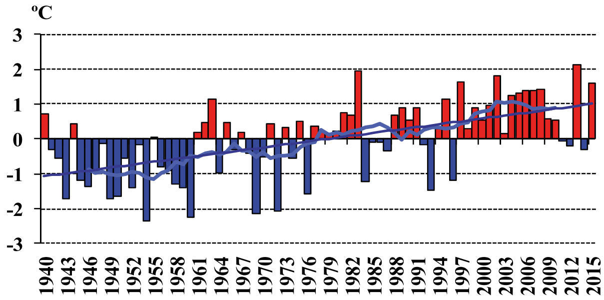
Akmola oblast



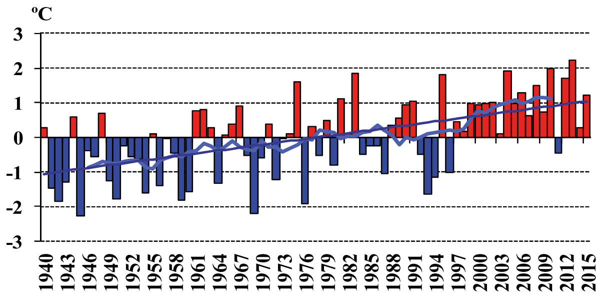
Kostanay oblast



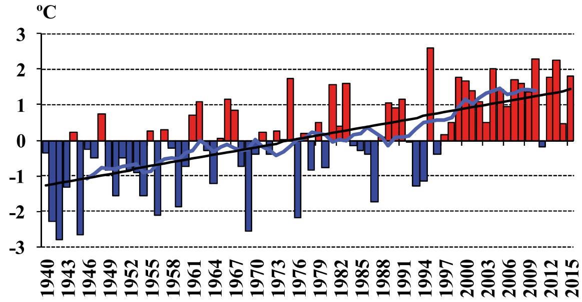
Karaganda oblast



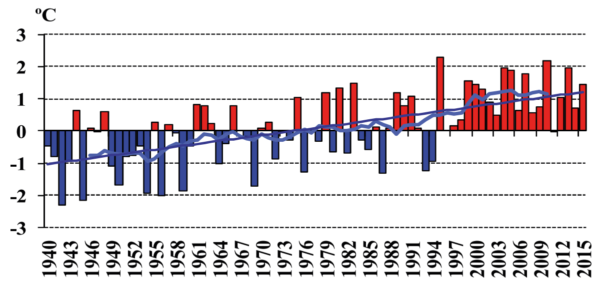
Aktobe oblast



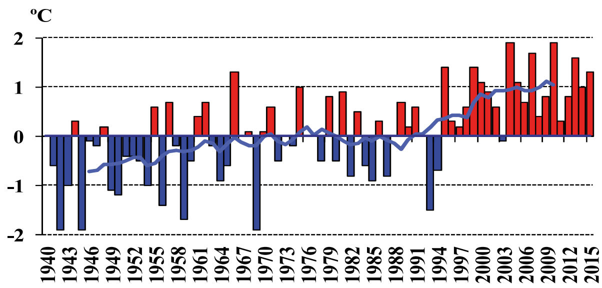
West Kazakhstan oblast



Atyrau oblast



Mangystau oblast



Annex 3.

Surface temperature anomaly linear trend characteristics in Kazakhstan and oblasts in the period from 1941 through 2015 by seasons and years

Region/oblast	Year		Winter		Spring		Summer		Autumn	
	*a	**R^2	a	R^2	a	R^2	a	R^2	a	R^2
Kazakhstan	0,28	40	0,28	7	0,31	18	0,19	27	0,30	24
Kyzylorda	0,30	34	0,23	3	0,33	17	0,28	36	0,29	22
South Kazakhstan	0,22	29	0,18	2	0,21	12	0,18	20	0,31	26
Zhambyl	0,30	41	0,28	5	0,25	14	0,27	39	0,37	34
Almaty	0,24	34	0,28	8	0,23	13	0,14	15	0,28	25
East Kazakhstan	0,26	27	0,28	6	0,28	12	0,15	12	0,30	18
Pavlodar	0,27	26	0,29	4	0,38	18	0,14	9	0,26	12
North Kazakhstan	0,30	31	0,31	6	0,37	17	0,19	11	0,30	14
Akmola	0,29	32	0,27	5	0,38	16	0,17	11	0,31	15
Kostanay	0,31	34	0,31	6	0,36	14	0,23	15	0,31	16
Karaganda	0,28	32	0,25	5	0,35	17	0,20	19	0,31	19
Aktobe	0,29	32	0,30	6	0,32	11	0,22	15	0,29	16
West Kazakhstan	0,38	41	0,46	11	0,42	20	0,27	18	0,34	22
Atyrau	0,29	35	0,38	9	0,31	16	0,21	21	0,27	17
Mangystau	0,31	30	0,20	2	0,34	14	0,45	38	0,26	10

* a – linear trend coefficient, °C/10 years

** R^2 – coefficient of determination,%

calculations for Mangystau oblast were made for the period of 1961-2015

Annex 4.

Surface temperature anomaly linear trend characteristics averaged by hydroeconomic basins of Kazakhstan in the period from 1941 through 2015 by seasons and years

Region/basin	Year		Winter		Spring		Summer		Autumn	
	*a	**R^2	a	R^2	a	R^2	a	R^2	a	R^2
Aral-Syrdarya	0,25	32	0,2	3	0,25	14	0,2	26	0,29	25
Balkhash-Alakol	0,24	33	0,27	7	0,24	14	0,16	18	0,29	24
Yertis	0,28	28	0,31	6	0,31	15	0,15	13	0,3	17
Yessil	0,29	32	0,29	5	0,37	17	0,18	12	0,3	15
Ural-Caspian	0,36	43	0,41	10	0,39	19	0,28	24	0,34	23
Nura-Sarysu	0,27	28	0,3	6	0,33	17	0,16	12	0,32	20
Tobol-Torgay	0,29	32	0,29	5	0,33	12	0,2	14	0,29	15
Shu-Talas	0,31	41	0,23	3	0,26	15	0,32	48	0,38	34

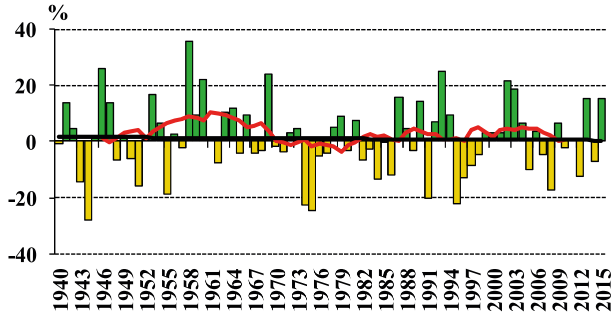
* a – linear trend coefficient, °C/10 years

** R^2 – coefficient of determination,%

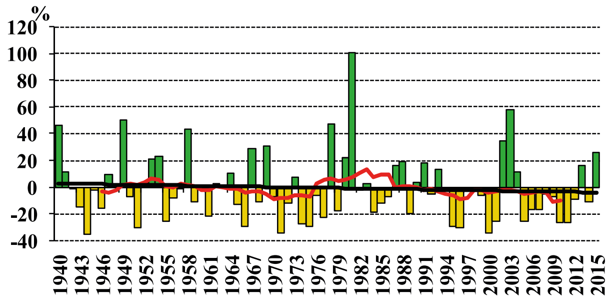
Annex 5.

Time series and linear trends of annual precipitation anomalies (%) for the period from 1940 through 2015, calculated against the base period of 1961-1990 and spatially averaged over the territory of Kazakhstan and oblasts

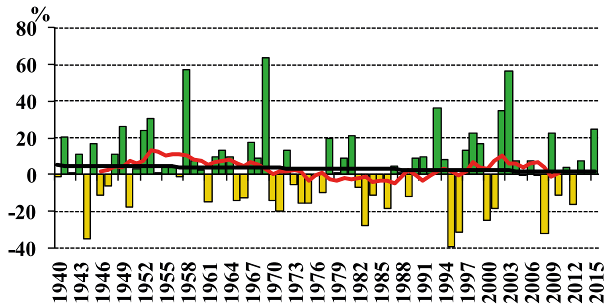
Kazakhstan



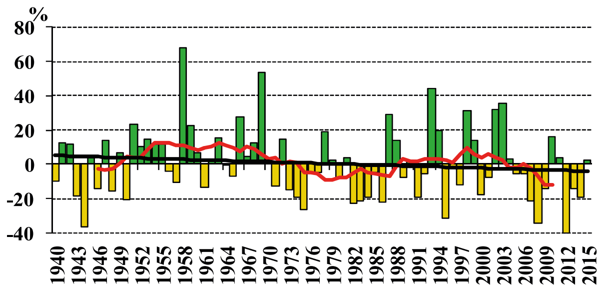
Kyzylorda oblast



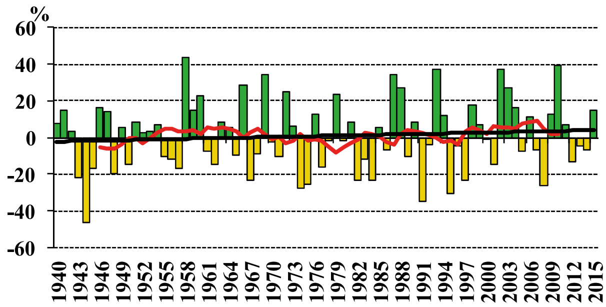
South Kazakhstan oblast



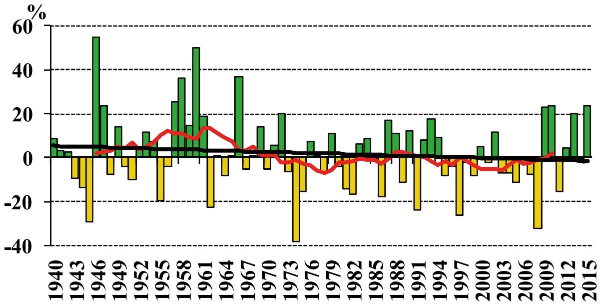
Zhambyl oblast



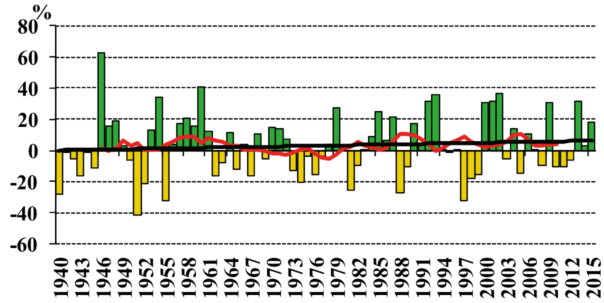
Almaty oblast



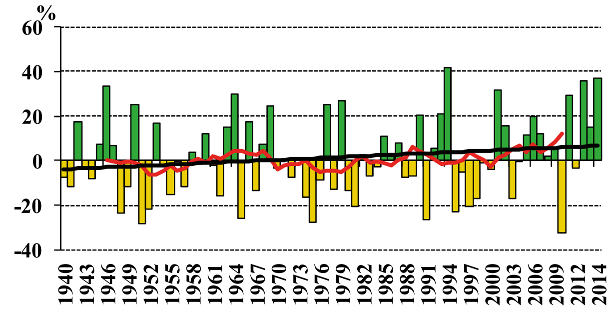
East Kazakhstan oblast



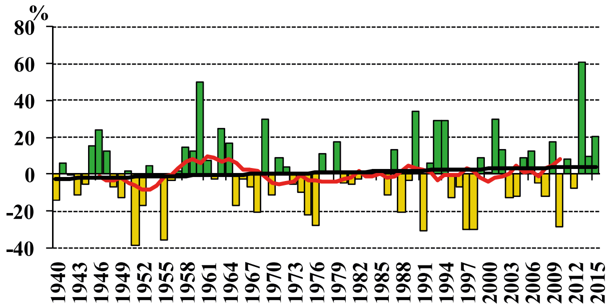
Pavlodar oblast



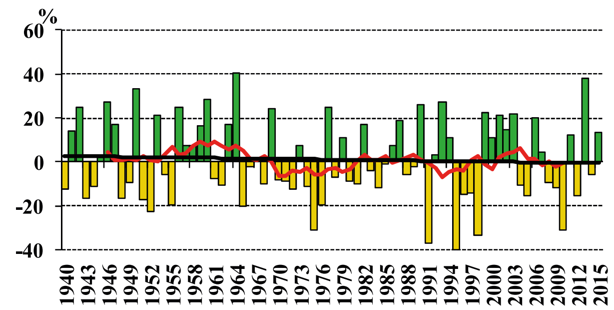
North Kazakhstan oblast



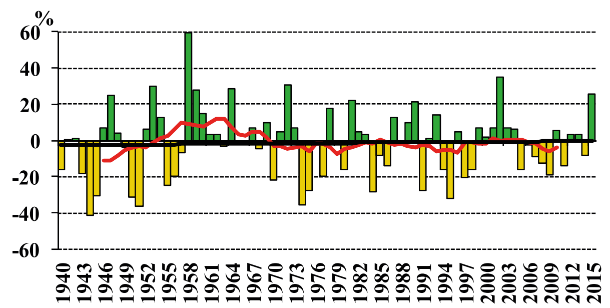
Akmola oblast



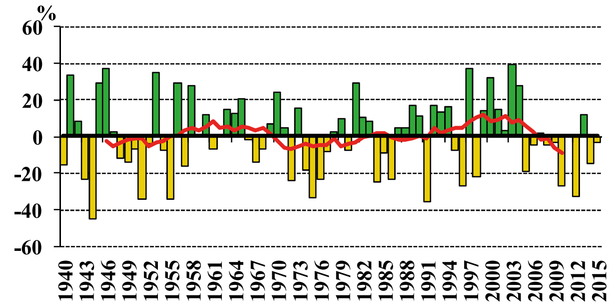
Kostanay oblast



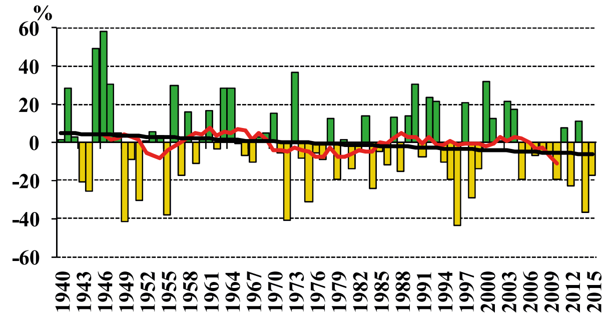
Karaganda oblast



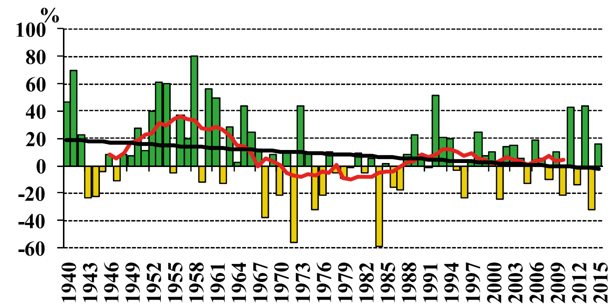
Aktobe oblast



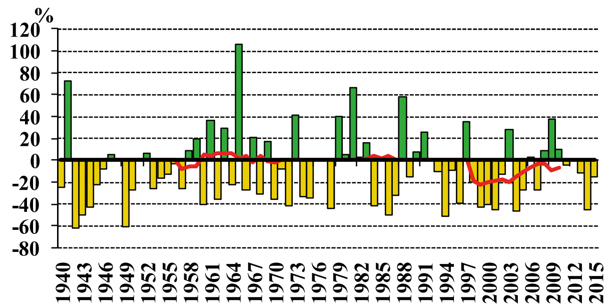
West Kazakhstan oblast



Atyrau oblast



Mangystau oblast



Annex 6.

Linear trend characteristics (mm/10 years,%/10 years) of seasonal and annual precipitation anomalies over the period from 1941 through 2015 spatially averaged over the territory of Kazakhstan. Anomalies calculated in% against the base period of 1961-1990.

Region/oblast	Unit	Year		Winter		Spring		Summer		Autumn	
		*a	**R^2	a	R^2	a	R^2	A	R^2	a	R^2
Kazakhstan	mm	-0,2	0	1,5	7	-0,6	0	-1,1	1	-0,3	0
	%	-0,2		2,3		-0,1		-1,3		0,3	
Kyzylorda	mm	-0,6	0	-0,7	1	-0,1	0	-0,1	0	0,1	0
	%	-0,4		-1,4		-0,1		0		0,6	
South Kazakhstan	mm	-2,2	0	0,8	0	-4,6	3	0,2	0	1,1	1
	%	-0,5		0,3		-2,7		-0,6		2,2	
Zhambyl	mm	-2,9	2	0,8	0	-3,9	5	-0,1	0	0,3	0
	%	-1,4		0,5		-3,5		-0,5		0	
Almaty	mm	3,3	1	3,3	10	-2,4	1	0,9	0	1,3	1
	%	0,9		4,6		-1,8		0,9		1,7	
East Kazakhstan	mm	-2,9	1	0,8	1	-1,1	1	-2,8	3	-0,3	0
	%	-0,9		1,3		-1,7		-2,3		-0,3	
Pavlodar	mm	1,3	0	1,3	6	1,2	2	0,1	0	-1,7	3
	%	0,5		2,9		2,1		0,2		-2,3	
North Kazakhstan	mm	5,0	3	3,4	19	2,2	5	-1,9	1	1,2	1
	%	1,4		7,0		3,3		-1,3		1,3	
Akmola	mm	2,5	1	2,2	9	1,5	2	0	0	-1,6	2
	%	0,7		4,5		2,0		0		-2,0	
Kostanay	mm	-1,5	0	0,6	1	1,5	2	-1,8	1	-2,3	4
	%	-0,6		1,3		2,2		-1,7		-2,9	
Karaganda	mm	1,2	0	2,0	7	0,3	0	-1,4	1	0	0
	%	0,1		2,4		0,3		-2,1		-0,3	
Aktobe	mm	0,1	1	2,0	5	2,0	3	-2,1	3	-2,1	4
	%	-0,2		2,9		3,0		-3,0		-3,1	
West Kazakhstan	mm	-4,2	2	1,1	1	-0,6	0	-2,7	4	-2,1	3
	%	-1,5		1,9		-1,0		-3,7		-2,8	
Atyrau	mm	-4,0	4	-2,2	10	0,1	0	-1,6	2	-0,4	0
	%	-2,5		-7,0		0,2		-3,6		-1,0	
Mangystau	mm	-0,9	0	0,6	1	-0,1	0	-0,9	1	-0,5	0
	%	-0,2		1,9		0,1		-2,5		-1,1	

* a – linear trend coefficient,%/10 years, mm/10 years

** R^2 – coefficient of determination,%

*** Figures in bold are statistically significant trends

Annex 7.

Linear trend characteristics (mm/10 years,%/10 years) of seasonal and annual precipitation anomalies over the period from 1941 through 2015 averaged over 8 hydroeconomic basins of Kazakhstan. Anomalies calculated against the base period of 1961-1990

Basin	Unit	Year		Winter		Spring		Summer		Autumn	
		*a	**R^2	a	R^2	a	R^2	a	R^2	a	R^2
Ural-Caspian	mm	-1,5	0	1,4	3	1,0	1	-2,3	4	-1,8	3
	%	-0,6		1,9		1,7		-3,4		-2,4	
Tobol-Torgay	mm	-2,1	1	0,4	0	1,3	2	-1,9	2	-2,1	5
	%	-1,0		0,8		2,0		-2,5		-3,1	
Aral-Syrdarya	mm	-1,5	0	0,2	0	-2,9	1	0,1	0	0,6	1
	%	-0,4		-0,4		-1,6		-0,3		1,3	
Shu-Talas	mm	-3,1	2	0,3	0	-3,5	5	-0,3	0	0,4	0
	%	-1,4		-0,2		-3,3		-1,0		09	
Balkhash-Alakol	mm	1,1	0	2,3	6	-2,3	2	0,1	0	0,6	0
	%	0,1		3,2		-2,1		-1,3		0,7	
Yertis	mm	-1,8	0	1,0	3	-0,3	0	-2,2	1	-0,7	1
	%	-0,5		1,9		-0,5		-1,7		-0,8	
Nura-Sarysu	mm	2,7	0	2,3	5	0,9	0	-0,9	1	0,1	0
	%	0,6		2,4		1,0		-1,6		-0,3	
Yessil	mm	3,9	2	2,8	14	1,8	4	-1,0	0	-0,1	0
	%	1,1		5,8		2,7		-0,7		-0,2	

* a – linear trend coefficient,%/10 years, mm/10 years;

** R^2 – coefficient of determination,%

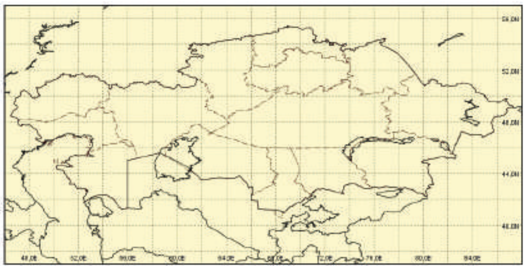
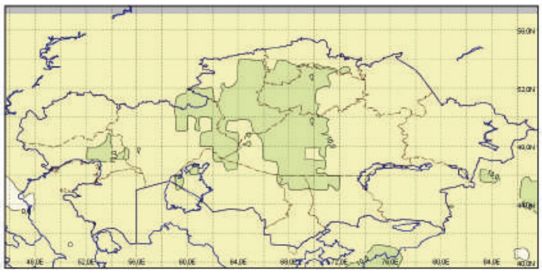
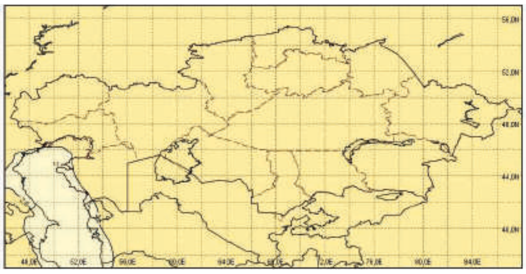
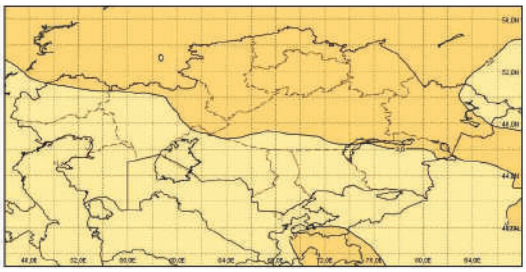
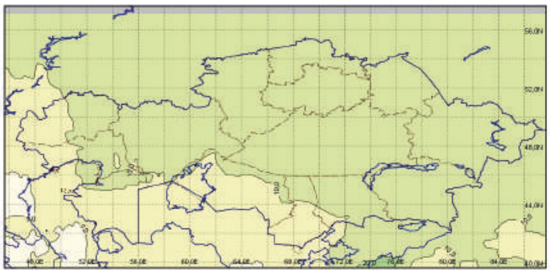
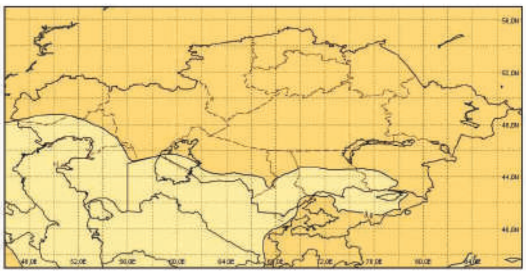
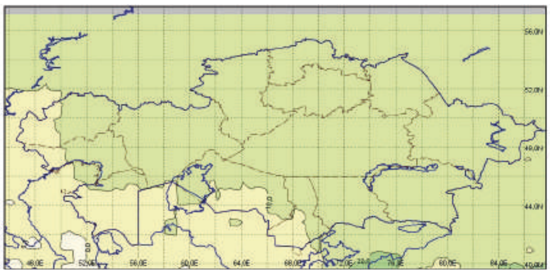
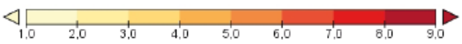
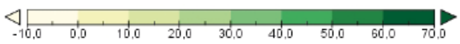
Annex 8.

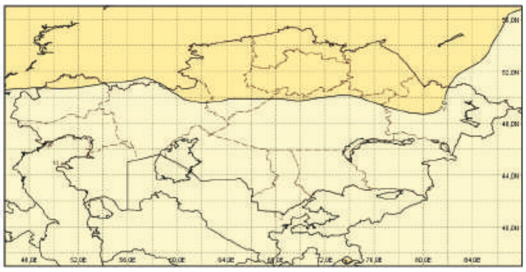
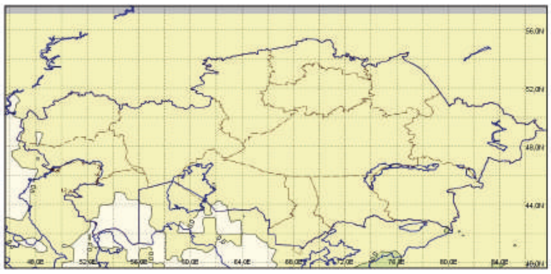
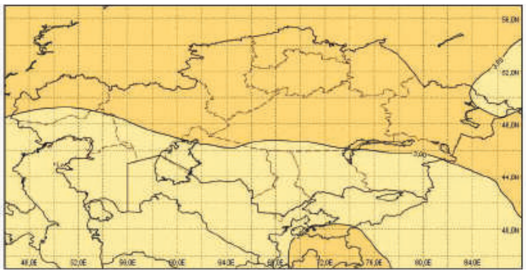
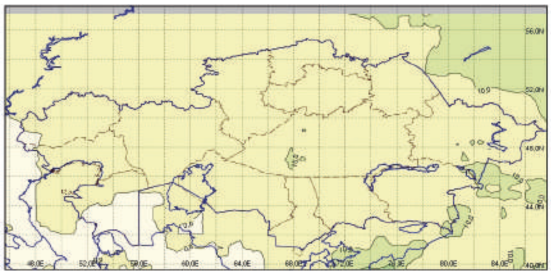
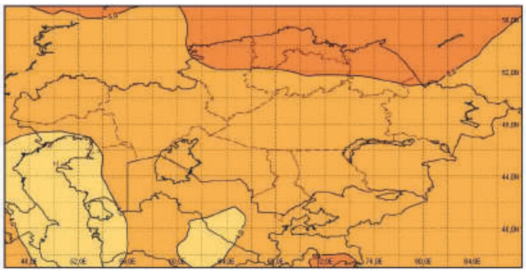
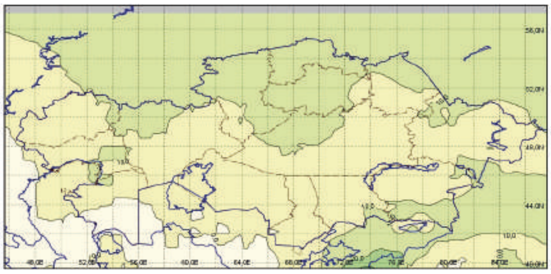
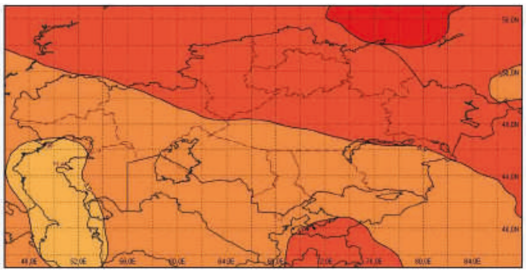
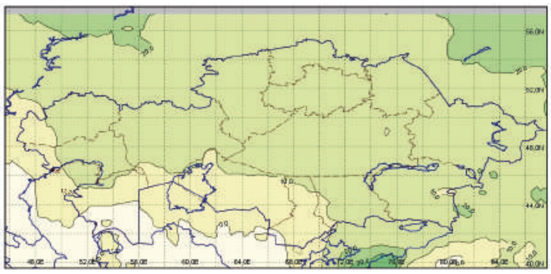
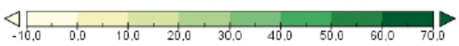
Ocean-atmosphere general circulation models used in CMIP5 project and selected for this study

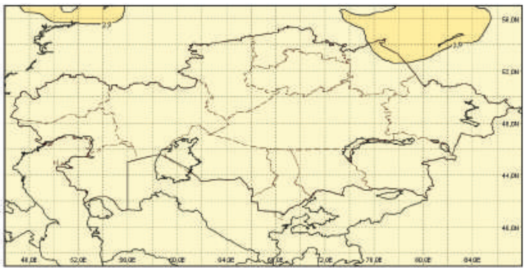
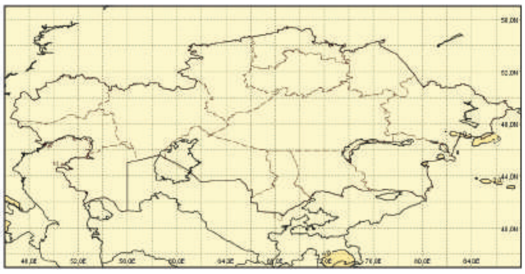
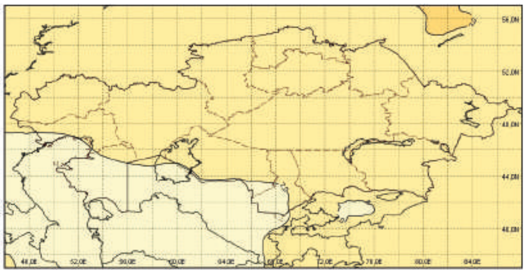
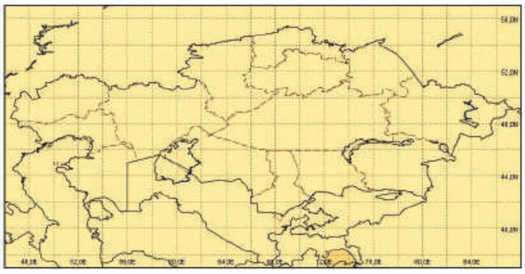
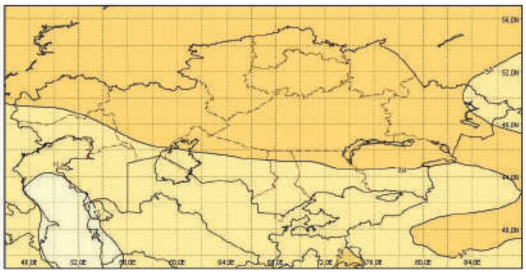
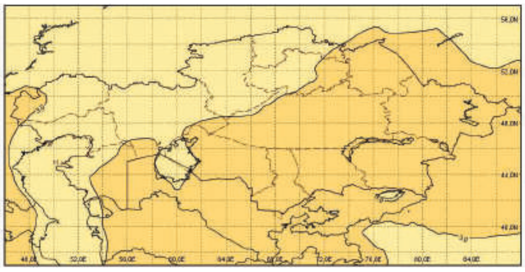
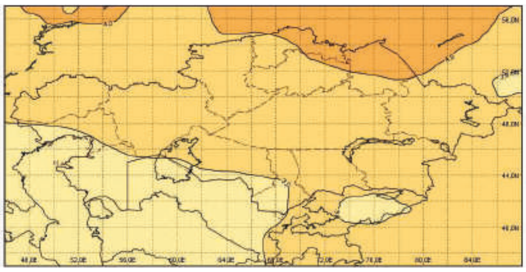
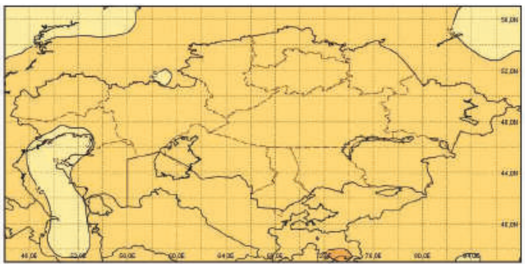
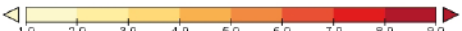
№ пп	Model index	Research organizations, countries	Atmospheric resolution (latitude x longitude)
	ACCESS1-0	CSIRO&BOM, Австралия	1,875° x 1,25°
	CSIRO&BOM, Australia	BCC, Китай	2,8° x 2,8°
	BNU-ESM	BCC, China	2,8° x 2,8°
	BNU, China	CCCMA, Канада	2,8° x 2,8°
	CCSM4	CCCMA, Canada	1,25° x 0,94°
	NCAR, USA	NSF-DOE-NCAR, США	1,25° x 0,9°
	CNRM-CM5	CNRM, Франция	1,4° x 1,4°
	CNRM, France	CSIRO, Австралия	1,8° x 1,8°
	GFDL-CM3	GFDL, США	0,25x0,25
	GFDL, USA	GFDL, США	2,5° x 2,0°
	GFDL-ESM2M	GFDL, США	2,5° x 2,0°
	INM CM4	Computer Simulation Institute, Russia	2,0° x 1,5°
	IPSL-CM5A-LR	IPSL, France	3,75° x 1,8°
	IPSL, France	IPSL, Франция	2,5° x 1,25°
	MIROC5	A&ORI/NIES/JAMES&T, Japan	1,4° x 1,4°
	IPSL, France	JAMES&T/A&ORI/NIES, Japan	2,8° x 2,8°
	MIROC-ESM-CHEM	JAMES&T/A&ORI/NIES, Japan	2,8° x 2,8°
	MPI-ESM-LR	MPI, Germany	1,90° x 1,90°
	MPI-ESM-MR	MPI, Germany	MPI, Germany
	MRI-CGCM3	MRI, Japan	1,1° x 1,1°
	NorESM1-M	NCC, Norway	2,5° x 1,9°

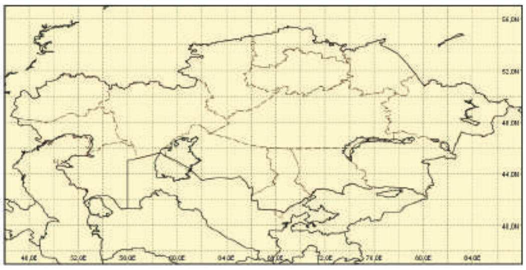
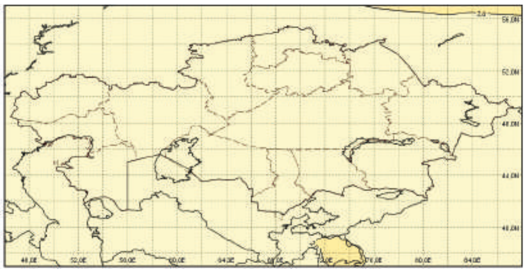
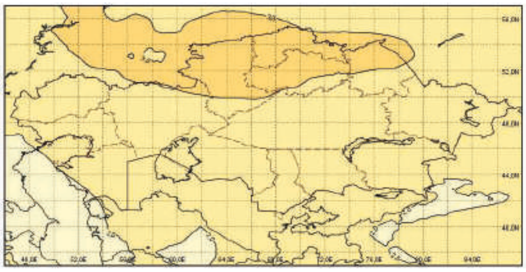
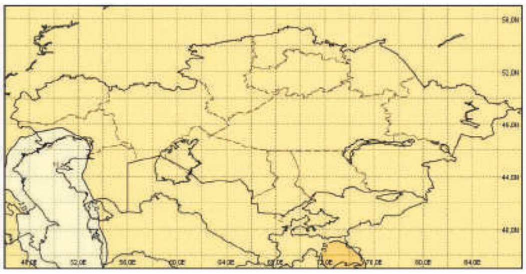
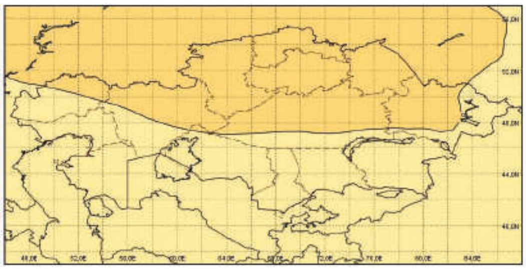
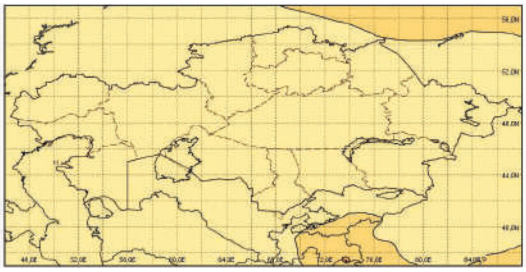
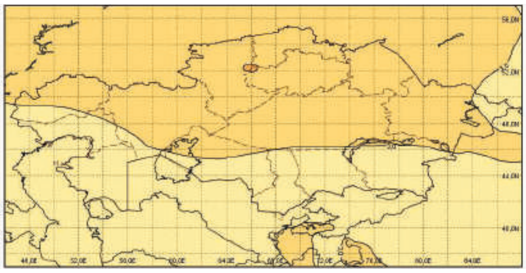
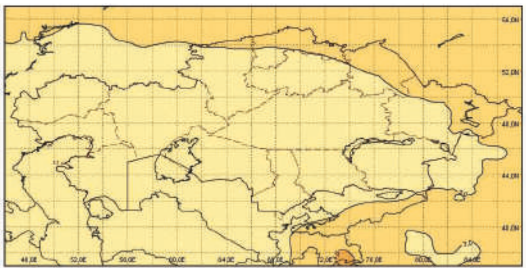
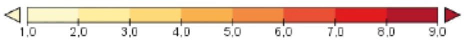
Annex 9.

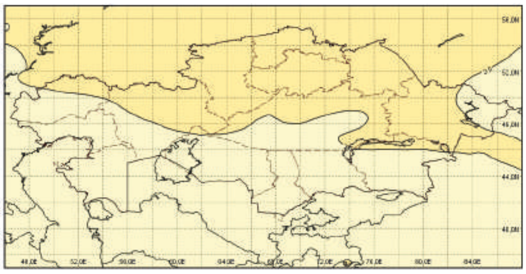
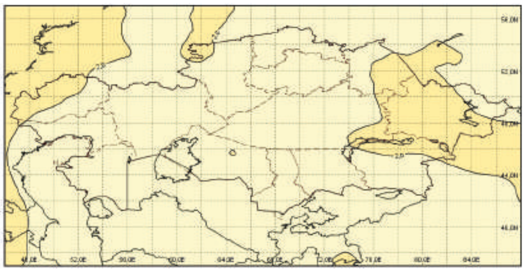
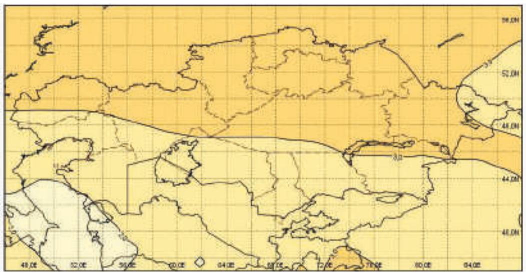
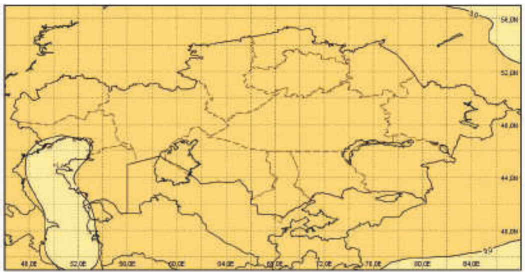
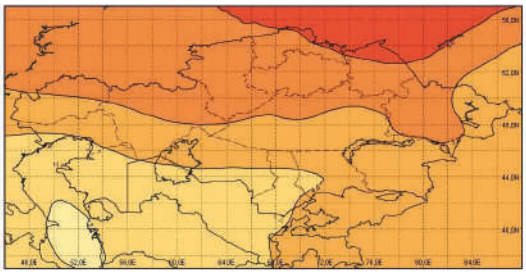
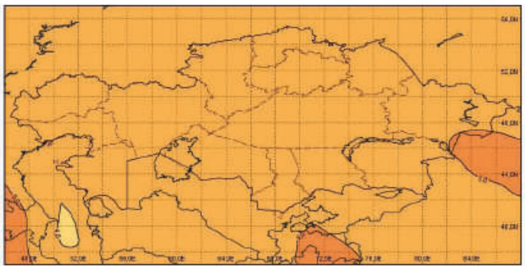
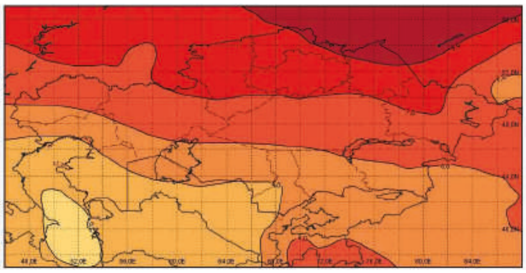
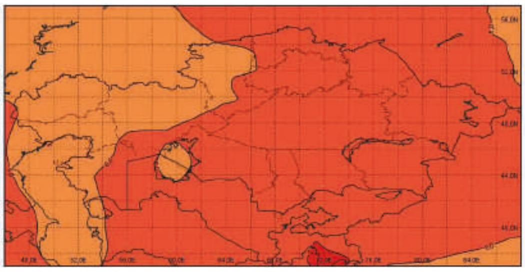
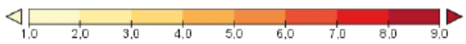
Probable air temperature and precipitation amount changes distribution maps for RCP4.5 and RCP8.5 representative concentration pathways. Changes calculated against the base period of 1981-2000

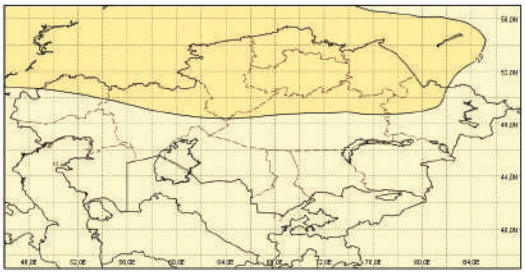
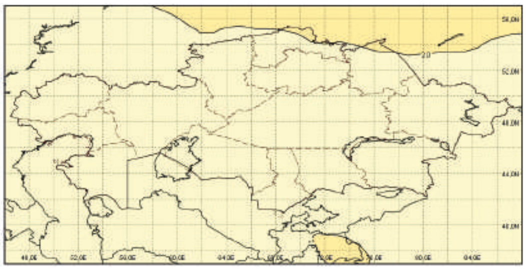
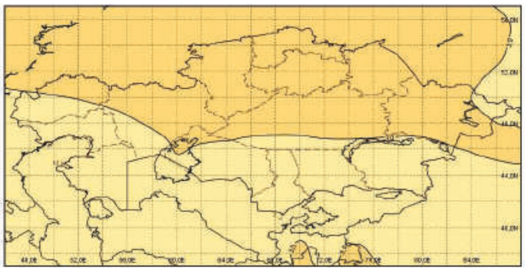
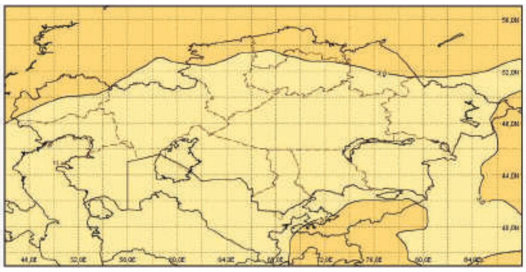
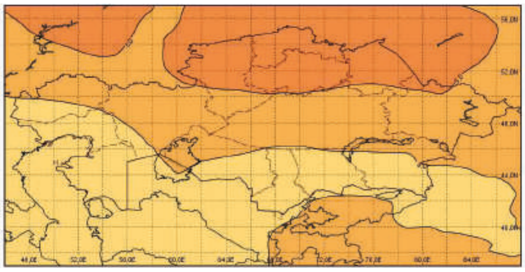
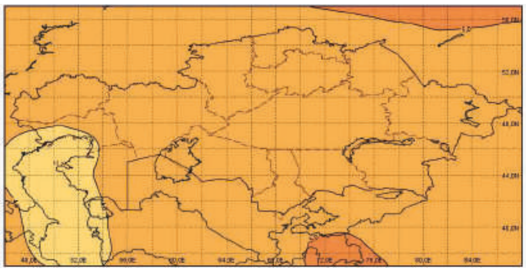
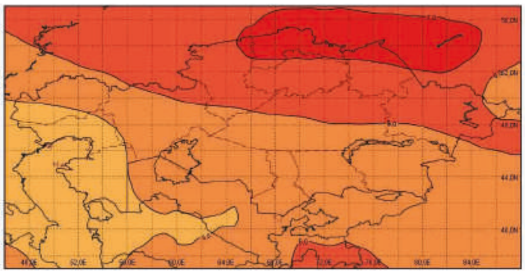
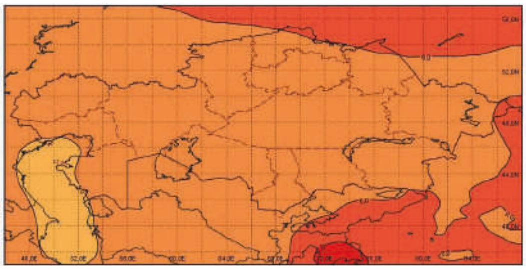
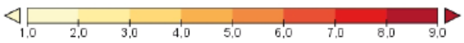
Changes in average annual air temperature (°C) and annual precipitation amount (%) for GHG concentration scenario RCP4.5		
Period	**Temperature**	**Precipitation**
2020-2039		
2040-2059		
2060-2079		
2080-2099		
		

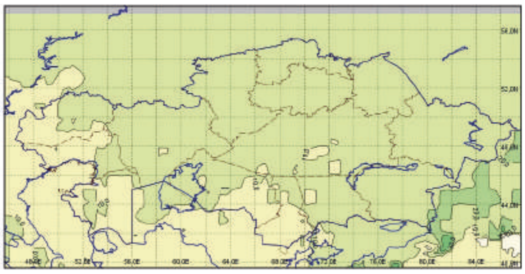
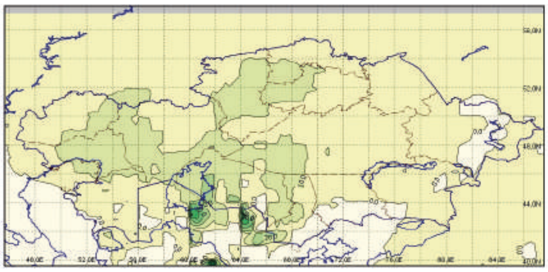
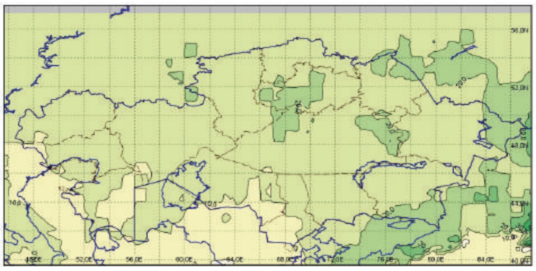
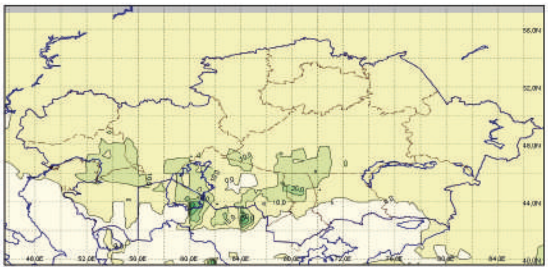
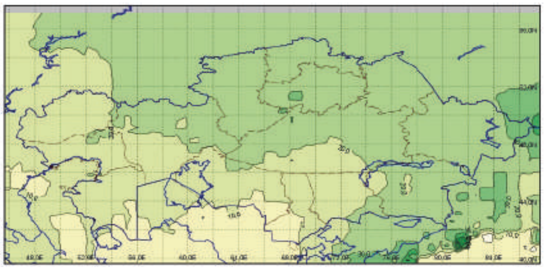
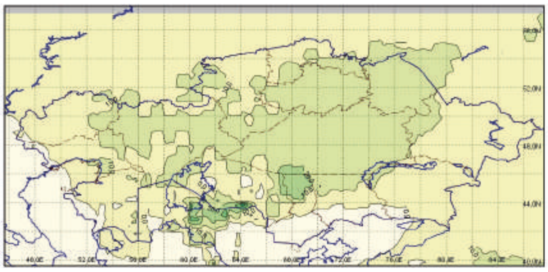
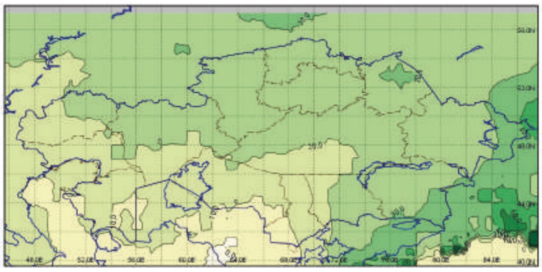
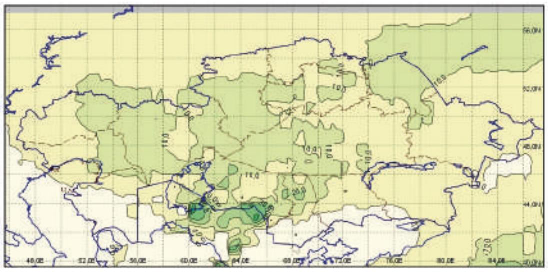
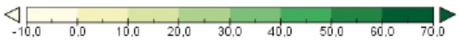
Changes in average annual air temperature (°C) and annual precipitation amount (%) for GHG concentration scenario RCP8.5		
Period	**Temperature**	**Precipitation**
2020-2039		
2040-2059		
2060-2079		
2080-2099		
	 1,0 2,0 3,0 4,0 5,0 6,0 7,0 8,0 9,0	 -10,0 0,0 10,0 20,0 30,0 40,0 50,0 60,0 70,0

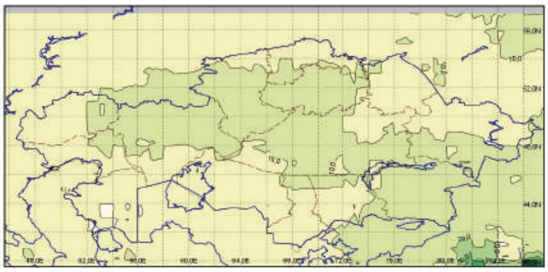
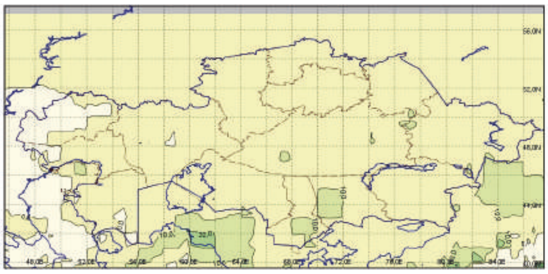
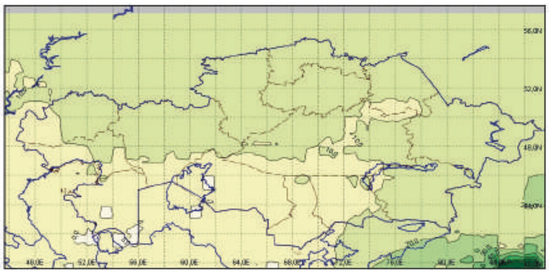
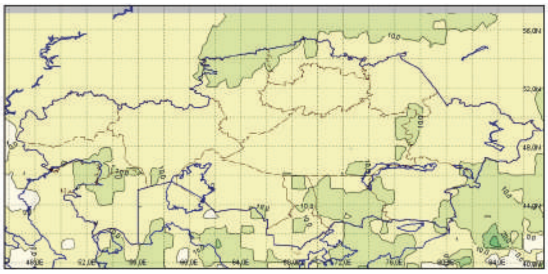
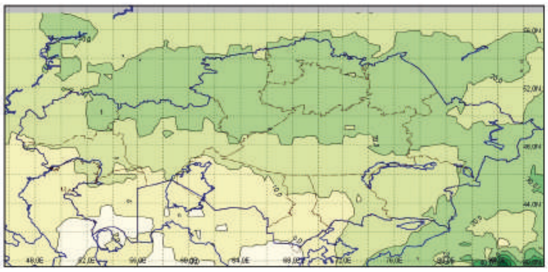
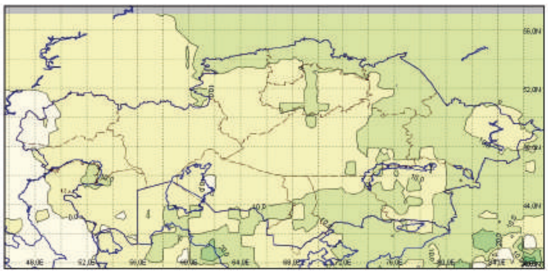
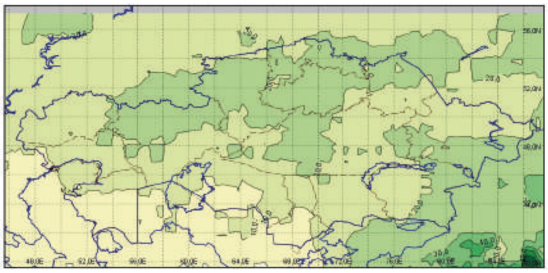
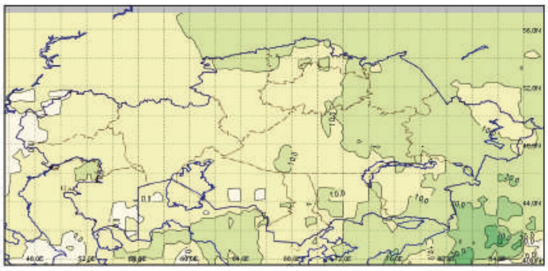
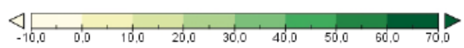
Changes in seasonal air temperature (°C) for GHG concentration scenario RCP4.5		
	Winter	**Summer**
2020-2039		
2040-2059		
2060-2079		
2080-2099		
		

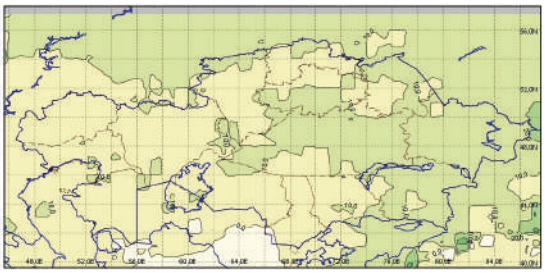
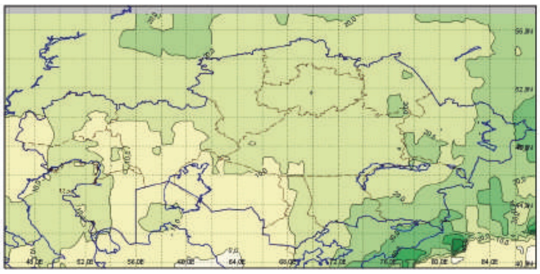
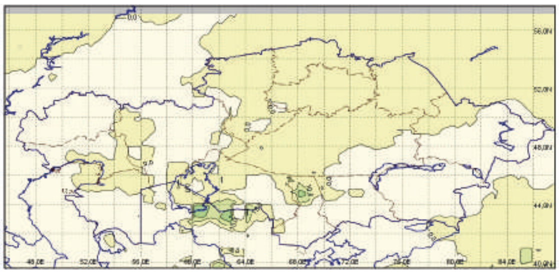
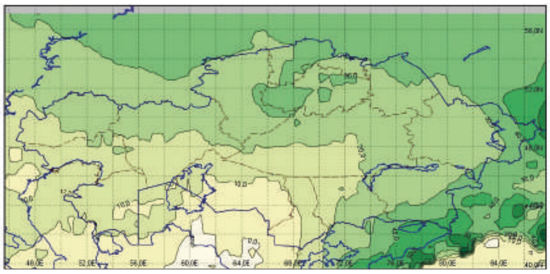
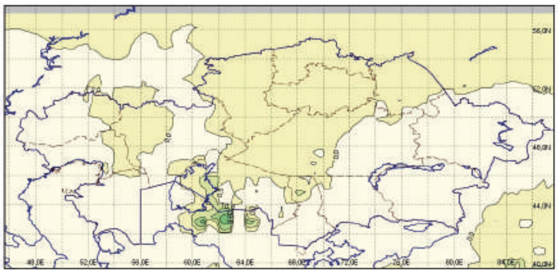
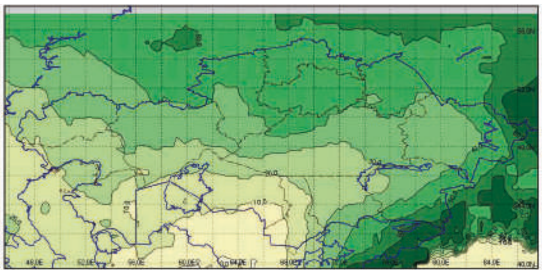
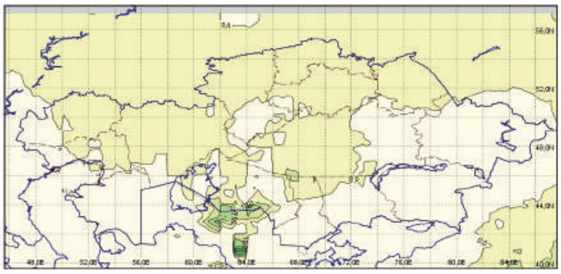
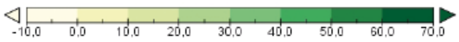
Changes in seasonal air temperature (°C) for GHG concentration scenario RCP4.5		
	Spring	**Autumn**
2020-2039		
2040-2059		
2060-2079		
2080-2099		
		

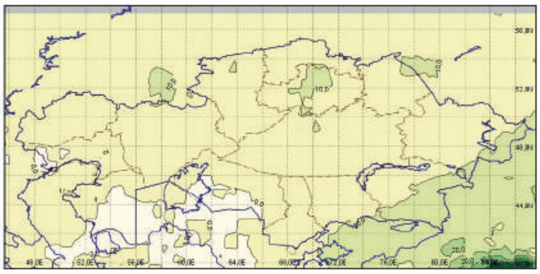
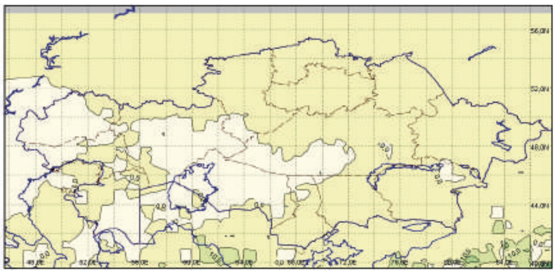
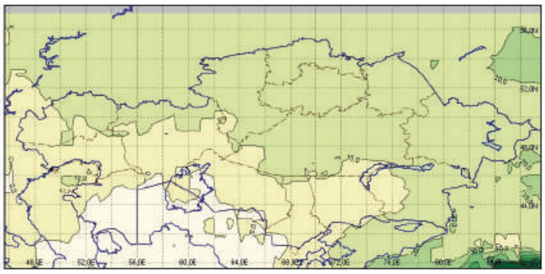
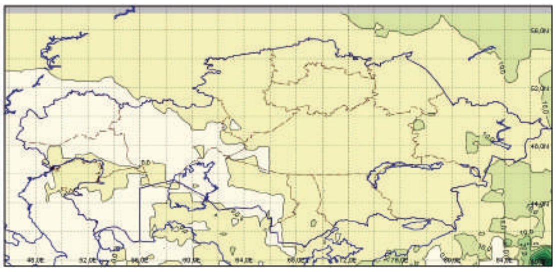
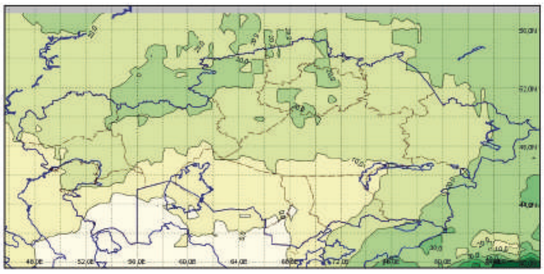
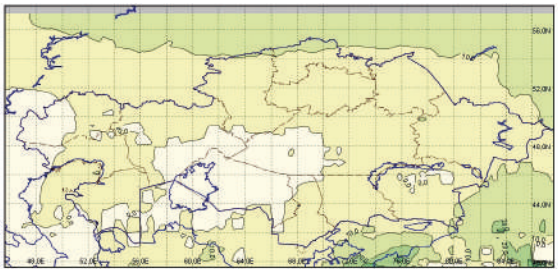
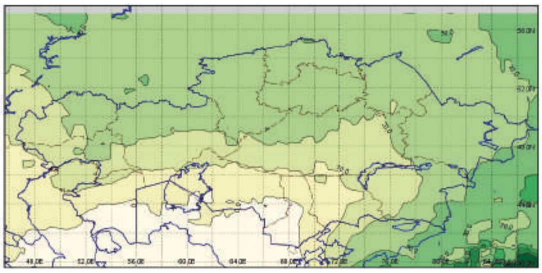
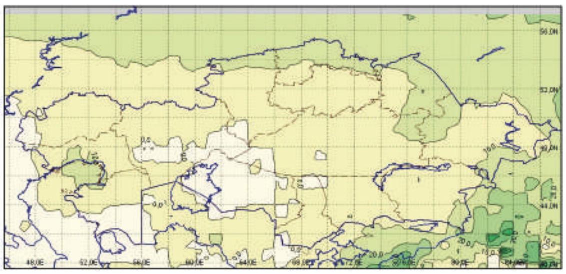
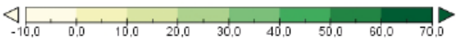
Changes in seasonal air temperature (°C) for GHG concentration scenario RCP8.5		
	Winter	**Summer**
2020-2039		
2040-2059		
2060-2079		
2080-2099		
		

Changes in seasonal air temperature (°C) for GHG concentration scenario RCP8.5		
	Spring	**Autumn**
2020-2039		
2040-2059		
2060-2079		
2080-2099		
		

Changes in seasonal precipitation amount (%) for GHG concentration scenario RCP4.5		
	Winter	**Summer**
2020-2039		
2040-2059		
2060-2079		
2080-2099		
		

Changes in seasonal precipitation amount (%) for GHG concentration scenario RCP4.5		
	Spring	Autumn
2020-2039		
2040-2059		
2060-2079		
2080-2099		
		

Changes in seasonal precipitation amount (%) for GHG concentration scenario RCP8.5		
	Winter	**Summer**
2020-2039		
2040-2059		
2060-2079		
2080-2099		
		

Changes in seasonal precipitation amount (%) for GHG concentration scenario RCP8.5		
	Spring	Autumn
2020-2039		
2040-2059		
2060-2079		
2080-2099		
		

Changes in annual and seasonal precipitation (%) by Kazakhstan oblasts and inter-model standard deviations calculated for CMIP5 ensemble of 21 models against the base period of 1980-1999 for RCP4.5 pathway.

Oblast	Period															
	2020-2039				2040-2059				2060-2079				2080-2099			
	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn
Almaty	14.31	11.60	1.13	6.02	18.57	12.67	1.97	8.68	22.84	17.26	4.29	10.13	27.21	20.48	2.64	10.73
Akmola	15.23	12.50	9.33	7.14	19.73	14.41	6.96	7.34	27.76	23.20	11.36	9.39	26.70	21.61	9.81	9.31
Aktobe	12.77	11.56	10.52	3.15	14.38	12.82	6.82	6.22	20.11	17.48	10.61	4.71	20.60	20.09	11.55	3.81
Atyrau	9.36	7.08	12.84	3.04	12.93	8.34	8.47	8.20	17.73	12.37	7.00	4.18	17.89	15.94	9.64	5.36
East Kazakhstan	14.42	9.33	0.83	7.78	18.76	12.36	2.51	7.40	25.06	21.00	5.89	10.89	27.17	19.82	4.65	11.46
Zhambyl	11.49	9.53	1.22	8.93	15.79	8.59	1.40	10.85	17.39	10.97	4.75	11.16	21.19	16.26	3.99	9.34
West Kazakhstan	9.62	8.56	7.53	-0.50	12.81	11.17	4.12	4.33	16.51	17.48	6.37	1.10	18.93	16.70	8.08	1.31
Karaganda	12.85	11.03	7.54	7.31	16.86	10.78	7.95	7.42	22.75	19.18	13.22	8.44	22.66	19.60	10.04	9.21
Kostanay	14.07	12.20	10.13	6.26	17.62	15.27	5.69	8.75	24.75	23.09	9.95	8.63	24.14	21.09	10.47	7.68
Kyzylorda	10.59	7.00	12.11	5.14	11.44	4.26	7.19	5.15	13.95	6.75	8.36	4.29	13.61	12.18	12.56	3.75
Mangystau	8.47	2.32	4.71	3.35	9.76	3.01	4.11	8.13	13.51	3.68	3.97	5.23	12.49	7.21	-0.84	2.41
Pavlodar	13.85	8.13	5.03	7.85	19.22	12.71	6.89	7.90	25.23	22.08	11.88	11.14	28.11	19.73	10.94	11.73
North Kazakhstan	15.70	9.38	9.58	6.73	18.68	15.78	5.60	9.42	26.54	21.15	9.90	10.40	26.90	20.65	8.99	9.82
South Kazakhstan	9.21	7.71	5.11	8.49	10.87	5.53	0.52	8.80	11.19	5.36	3.31	8.28	12.28	11.10	3.77	7.30
Kazakhstan	**12,54**	**9,59**	**6,96**	**5,81**	**15.81**	**10.82**	**5.33**	**7.53**	**20.91**	**16.58**	**8.51**	**7.71**	**21.85**	**17.91**	**7.99**	**7.50**

Changes in annual and seasonal air temperature (°C) by Kazakhstan oblasts and inter-model standard deviations calculated for CMIP5 ensemble of 21 models against the base period of 1980-1999 for RCP4.5 pathway.

Oblast	Period															
	2020-2039				2040-2059				2060-2079				2080-2099			
	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn
Almaty	1.6	1.4	1.9	1.6	2.3	2.2	2.6	2.3	3.1	2.7	3.2	2.7	3.4	2.9	3.3	2.9
Akmola	1.9	1.8	1.7	1.7	2.7	3.1	2.6	2.3	3.6	3.5	3.0	2.6	3.9	3.8	3.2	2.9
Aktobe	1.7	1.7	1.8	1.6	2.5	2.7	2.5	2.2	3.3	3.1	2.9	2.5	3.6	3.4	3.2	2.8
Atyrau	1.6	1.4	1.7	1.5	2.2	2.2	2.4	2.1	2.8	2.6	2.9	2.5	3.1	2.8	3.1	2.7
East Kazakhstan	1.6	1.6	1.9	1.7	2.4	2.5	2.7	2.3	3.2	3.0	3.2	2.8	3.6	3.3	3.4	3.0
Zhambyl	1.6	1.3	1.8	1.5	2.2	2.1	2.5	2.2	2.9	2.6	3.1	2.6	3.3	2.8	3.2	2.7
West Kazakhstan	1.7	1.6	1.8	1.6	2.4	2.5	2.6	2.2	3.1	2.9	3.0	2.6	3.4	3.2	3.2	2.9
Karaganda	1.7	1.7	1.8	1.6	2.5	2.7	2.6	2.2	3.3	3.1	3.1	2.6	3.6	3.4	3.3	2.9
Kostanay	1.9	1.8	1.7	1.7	2.7	3.1	2.5	2.2	3.6	3.5	2.9	2.6	3.9	3.9	3.2	2.9
Kyzylorda	1.5	1.8	1.6	1.6	2.2	2.3	2.6	2.2	2.9	2.8	3.1	2.6	3.2	3.0	3.3	2.8
Mangystau	1.3	1.3	1.8	1.4	1.8	2.1	2.5	2.1	2.3	2.5	3.0	2.5	2.6	2.7	3.2	2.7
Pavlodar	1.9	1.9	1.8	1.7	2.8	3.0	2.6	2.4	3.7	3.5	3.1	2.8	4.0	3.8	3.3	3.0
North Kazakhstan	1.9	1.8	1.7	1.7	2.7	3.1	2.5	2.3	3.7	3.5	3.0	2.7	4.0	3.9	3.1	3.0
South Kazakhstan	1.5	1.3	1.8	1.5	2.1	2.2	2.6	2.2	2.7	2.6	3.2	2.6	3.1	2.8	3.3	2.8
Kazakhstan	**1.7**	**1.6**	**1.8**	**1.6**	**2.4**	**2.6**	**2.6**	**2.2**	**3.2**	**3.0**	**3.1**	**2.6**	**3.5**	**3.3**	**3.2**	**2.9**

Annex 10.

Extreme weather events in Kazakhstan in 2013-2015 and their consequences

Oblast, region	Event	Description and consequences, evaluation of damage	Affected sectors	Source
West Kazakhstan oblast	Ice slick (January 4-5, 2013)	Due to increase in air humidity and precipitation (ice slick, drizzle) in West Kazakhstan oblast blackouts occurred in a number of settlements; 10 remote settlements in Akzhaiyk, Zelenov, Terekty and Kaztal districts had no power supply. Emergency management required involvement of 39 emergency response and restoration teams of ZapKazREK JSC, 200 people and 24 units of equipment, DES task force.	Energy Population	Press Office of the Committee for State Energy Supervision and Control of the Ministry of Industry and New Technologies of the Republic of Kazakhstan. http://www.zakon.kz/kazakhstan/4533847-v-zko-bez-jelektrosnabzhenija-ostalis.html
Oblasts in northern, central and eastern regions	Snow drifts (January 14-15, 2013)	The region was hit by blizzards and frost. Rescue teams rescued over 100 people from snow drifts. 65 people rescued on Urdzhar district highway in East Kazakhstan oblast alone. These numbers include children. Highways closed in East Kazakhstan and Karaganda oblasts due to adverse weather conditions.	Transport Population	http://www.zakon.kz/4535806-na-trasse-astana-burabajj-stolknulis-20.html http://www.zakon.kz/4535200-spasateli-vyzvolili-iz-snezhnogo-plena.html
Zhambyl, Kyzylorda, South Kazakhstan oblasts	Strong wind and blizzard (January 12-14, 2013)	As a result of strengthening of southwest wind rushes over 30 meters per second visibility worsened on some highways (to zero). Blackouts over the larger part of Sarysu district of Zhambyl oblast, motor road traffic stopped due to snowstorm. Due to adverse weather conditions the central boiler of Karatau was stopped on January 12, at 07.15; at 08:15 a concrete chimney pipe 60 meters long collapsed on the boiler building causing destructions. Heat supply stopped to all Karatau boiler clients. Besides, central water supply stopped due to blackout. Over 30 aggrieved from a hurricane, 31 people sustained various injuries addressed to the central district hospital, 23 people received medical care without confinement to hospital, including 3 underage persons. 8 people admitted to hospital with various injuries, of them 3 minors. Preliminary figures indicate damage in the amount of KZT 2.5 billion.	Energy Transport Population	http://www.zakon.kz/4535474-svyshe-30-chelovek-postradali-ot.html
East Kazakhstan oblast	Ice slick (January 15, 2013)	12 people admitted to trauma unit in Ust-Kamenogorsk with fractures of shoulder and knee joints. People got injured as they got off transport, severe ice slick at bus stops.	Population	http://www.zakon.kz/4535427-za-poslednie-pjat-dnejj-v-bsmp-ust.html
Zhambyl oblast	Strong wind (January 19, 2013)	Strong wind hit Zhambyl oblast. Power line supports fell in ten settlements of Zhualyn district, no time to recover from the first hurricane that hit the area on January 12-13, 2013.	Energy	http://www.zakon.kz/kazakhstan/4536439-v-zhambylskojj-oblasti-snova-silnyjj.html
Karaganda oblast	Strong blizzard (January 24, 2013)	Severe snowstorm in Karaganda caused tens of major car accidents. 10 cars collided on one of the city bridges.	Transport Population	http://www.zakon.kz/auto_news/4537314-iz-za-burana-v-karagande-proizoshli.html
Almaty oblast	Thick fog, ice slick (January 29, 2013)	Thick fog and ice slick caused collision of several tens of cars on Almaty East Ring Road. According to different data, the number of damaged cars ranges from 25 to 38.	Transport Population	http://www.zakon.kz/kazakhstan/4538106-v-dtp-na-vostochnojj-obezdnojj-doroge-v.html

Akmola, Pavlodar Aktobe, Kostanay, North Kazakhstan, Karaganda oblasts	Strong blizzard (March 7-10, 2013)	Due to bad weather: severe snowstorm and limited visibility on highways traffic stopped for all types of transport in many oblasts. In Akmola oblast traffic stopped along Astana-Korgalzhyn, Astana-Kokshetau, Astana-Yessil, Astana-Yereymentau-Shiderty, Astana-Karaganda stopped, 32 rescue operartions carried out. 197 cars and 576 people rescued from snow drift. 267 units of equipment, 371 persons carried out rescue operations. 353 persons placed at heating stations. In Pavlodar oblast 300 people were evacuated and 124 cars were pulled out from drifts on March 9-10.	Transport Population	Press Office of Akmola Oblast Department for Emergency Situations http://www.zakon.kz/4545646-bolee-500-chelovek-spaseny-iz-snezhnykh.html http://www.zakon.kz/4546012-pogoda-ne-daet-rasslabitsja-zhiteljam.html
North Kazakhstan oblast	Heavy showers, hurricane (May 21, 2013)	Heavy rainfall raised water level in lakes and caused flooding near Bekseit village. Gusty wind and heavy rainfall brought water to villagers' houses. 20 houses were in the flooded area. In Belogradovka village hurricane wind broke the roof off the school building and broke glass in several classrooms. Roofs of 16 houses partially destroyed.	Housing and utilities Population	http://www.zakon.kz/incidents/4557586-shkvalnyjj-veter-i-pavodki-zastali.html
Almaty oblast	Strong wind (July 22, 2013)	On July 22 in Akkol village, Balkhash district, strong wind broke the roof off the high school building (152 sq.m.). 15 windows were broken by the element; metal protection 12 meters long was tumbled down.	Transport Population	http://www.zakon.kz/kazakhstan/4567873-v-almatinskojj-oblasti-silnyjj-veter.html
Almaty oblast	Heavy precipitation (July 21, 2013)	Heavy rainfall over the foothills of Ile-Alatau induced a mudflow in the Small Almaty gorge. The mudflow originated in the Shymbulak River, washed away tens of logs, then the stream of stones and dirt fell on protective structures having caused serious destruction.	Transport Population	Kazselezaschita SE http://www.zakon.kz/incidents
Karaganda oblast	Strong wind (August 7, 2013)	At 17:30 on August 7 Balkhash was hit by strong gusty wind (15-20 m/s) that partially broke roofs of the buildings of the railway station (550 sq.m.) and boarding school No. 2 (938 sq.m.).	Transport Population	http://www.zakon.kz/incidents/4570437-v-balkhashe-silnyjj-veter-sorval-kryshi.html
Akmola, Pavlodar, Karaganda, Almaty oblasts	Strong blizzard (December 5, 2013)	Many regions of Kazakhstan were hit. In Karaganda the wind broke roofs off the buildings of military and technical school, high school number 25 and hospital of the Department of Internal Affairs. In Terenkol village, Pavlodar oblast, the roof of the prosecutor's office building was torn off. In Usharal, Almaty oblast, the wind with rushes up to 20 meters per second damaged roofs of numerous buildings including the headquarters of military unit number 9807, the central district hospital and Nokerbek hotel. Blizzard interfered with traffic, traffic was limited on motor roads.	Transport Housing and utilities Population	http://comments.ua/world/440407-silnaya-metel-obrushilas-kazahstan.html
Almaty oblast	Fog, ice slick (February 24, 2014)	In Almaty oblast thick fog and ice slick caused traffic accident with numerous cars. Visibility on the road was almost zero due to thick fog.	Transport Population	http://www.zakon.kz/auto_news/4605086-bolee-desjatka-mashin-popali-v-dtp-v.html
Aktobe oblast	Strong blizzard (March 18-21, 2014)	In Aktobe oblast bad weather stormed for several days. Rescue operations for people and cars on highways were conducted around the clock. 130 people were evacuated. According to the press office of "Kazakhavtodor" RSE, in Khromtau District snowstorm, gale and sleet interfered with work.	Transport Population	Press Office of Kazakhavtodor RSE http://www.zakon.kz/4611055-aktjubinskie-sotrudniki-chs-spasli-ot.html

Aktobe, Pavlodar, North Kazakhstan, Kostanay, Akmola, Zhambyl oblasts	Drought (summer 2014)	Because of a drought in Aktobe oblast only 149 thousand tons of grain were harvested. Low productivity indices were registered in Hobdin and Agin districts. In Hobdinsky district nearly all harvest – 95.6 percent was written off. In Pavlodar oblast only 28% of crops grain was in good condition, 54% - satisfactory, 18% - poor. In a number of Zhambyl oblast districts productivity was lower than four hundred kilos from hectare.	Agriculture	http://www.caravan.kz/news/v-aktyubinskojj-oblasti-spisano-30-urozhaya-336992/ http://www.caravan.kz/news/pogodnye-usloviya-skazyvayutsya-na-kolichestve-urozhaya-v-pavlodarskojj-oblasti-335493/ http://www.caravan.kz/gazeta/zhambylskaya-oblast-nyneshnyuyu-bitvu-za-urozhajj-proigrala-79052/
North Kazakhstan oblast	Snow drifts (January 15-17, 2015)	In North Kazakhstan oblast 93 persons and 45 pieces of equipment were evacuated from snow drifts. 93 persons were evacuated from G. Musrepov, Taiynshy, Yessil, Shal Akyn, Aiyrtau, Jambyl and Kyzylzhar district highways - drivers and passengers – as well as 45 pieces of equipment (mainly passenger vehicles).	Transport Population	http://www.caravan.kz/news/v-sko-iz-snezhnykh-zanosov-v-minuvshie-vykhodnye-ehvakuirovali-93-cheloveka-362704/
Atyrau oblast	Significant weather change, ice slick (February 5-15, 2015)	After a short thaw hard frosts came to Atyrau and caused black ice on roads and sidewalks. About 400 people came to emergency stations.	Transport Population	http://www.zakon.kz/4690588-gololed-s-nachala-mesjaca-v-travmpunkty.html?_utl_t=mr
Atyrau, Mangystau oblasts	Strong wind, dust storm (March 30, 2015)	Because of wind (20 m/s) several buildings were left without roofs and facings. In the morning many inhabitants could not leave their houses because of a dust storm. Wind caused trouble to inhabitants of the neighboring Mangystau oblast. The day before an unprecedented sandstorm forced closing of roads.	Transport Population	http://www.caravan.kz/news/v-atyrau-bushuet-uragannyjj-veter-345525/
Atyrau oblast	Heavy rainfall (May 11-12, 2015)	As a result of heavy rainfall in Atyrau on May 11-12, there was a flooding of 42 private houses and 252 domestic territories on Baitursynov St., Aliyev St., Shalkarskaya St., Chekhova St.. 532 inhabitants were evacuated. According to Atyrau meteorological station 25 mm precipitation fell in the afternoon on May 11, and 55 mm – at night on May 12.	Housing and utilities Population	http://caspionews.kz/?p=16713 Kazhydromet RSE
Aktobe, North Kazakhstan, Kostanay oblasts	Significant weather change (mid-May, 2015)	In mid-May, 2015 there was a mass death of saigas. The pestilence of saiga startd on May 12 in Kostanay oblast, then proceeded in Aktobe and Akmola areas. According to scientists unusual weather - excessively cold winter followed by a very wet spring - can lead to development of a bacterium of pasteurellosis (Pasteurella) of toxins which can cause fatal internal bleeding in animal bodies. A third of Betpakdala population - more than 150 thousand saigas - died. The total amount of individual species in Kazakhstan before mass death ranged from 280 to 300 thousand heads.	Animals	http://www.zakon.kz/4795976-uchenye-vydvinuli-novuju-versiju-o.html
East Kazakhstan oblast	Strong wind, lightning, heavy rainfall (June 14, 2015)	On June 14 the city of Semey was hit by strong wind with rushes up to 30-35 meters per second. Simultaneous thunderstorm, heavy rainfall with visibility of 100 m, 24 mm of rain. In Semey local natural emergency was announced. 10 aggrieved persons addressed to emergency medical units. No loss of life registered.	Housing and utilities Population	East Kazakhstan Oblast Department for Emergency Situations http://www.vkogps.kz/ru/news.htm?id=002542
Pavlodar oblast	Significant weather change (July 4-5, 2015)	On July 4-5, 2015 cold weather caused cattle mortality in Pavlodar oblast, over 2000 animals died. In Ekibastuz area - 1322 heads. Also, over 700 heads of small ruminants died in Lebyazhinsky district.	Agriculture	https://regnum.ru/news/accidents/1940578.html

Almaty oblast	Excessive heat, glacier meltdown, mudflow (July 24, 2015)	At night on July 23 at 3:00 a mudflow descended from Almaty mountains. It partially flooded the settlements of Tausamaly and Karagaily of Nauryzbaysky district, inhabitants of settlements were evacuated. The raised water line in the Kargalinka River caused flooding. The mudflow occurred due to abnormal heat and rapid melting of glaciers in Almaty mountains: air temperature on glaciers rose up to 11 degrees above zero while the norm is 0 degrees.	Housing and utilities Transport Population	http://www.caravan.kz/news/temperatura-v-gorakh-almaty-podnyalas-do-11c-351640/
Almaty, Karaganda, Aktobe, Mangystau, Atyrau, West Kazakhstan East Kazakhstan oblasts	Excessive heat (July, August, 2015)	Excessive heat up to 45°C in Aktobe, Mangystau oblasts and excessive heat in Almaty, Atyrau, West Kazakhstan, Karaganda oblasts. On July 31 – August 4 Aktau faced excessive heat. Temperature in the city of Aktau on August 3 reached 45 degrees Celsius. In East Kazakhstan oblast the steppe fire (near Ayagoz) registered over the area of 49 hectares.	Population Forests	http://www.caravan.kz/news/v-kazakhstane-obyavili-shtormovoe-preduprezhdenie-izza-zhary-352012/ http://www.caravan.kz/news/shtormovoe-preduprezhdenie-izza-zhary-obyavleno-v-shesti-oblastyakh-kazakhstana-351971/ http://www.caravan.kz/news/aktau-stradaet-ot-anomalnojj-zhary-352145/
Akmola oblast	Ice slick (November 25, 2015)	Ice in Astana became the reason of increase in the number of injured persons and road accidents. On November 25, 103 persons asked for a medical assistance. 68 persons got injured outside: bruises, fractures and dislocations.	Transport Population	http://www.zakon.kz/4759106-iz-za-gololeda-v-astane-uvelichilos.html
Zhambyl oblast	Snow drifts (December 19-20, 2015)	Due to deterioration in weather conditions, blizzard, poor visibility and heavy snowfall traffic on highways was limited in a number of oblasts. 152 people, of them 16 children, were evacuated from two passenger buses, four trucks and 42 cars stuck in a snow drift on 556-593 km of the highway «Almaty-Tashkent».	Transport Population	http://www.caravan.kz/news/svyshe-500-chelovek-popali-v-snezhnyjj-plen-na-vykhodnykh-361209/
East Kazakhstan oblast	Heavy snowfall, blizzards (December 24-27, 2015)	In just two days a monthly amount of snow fell on Zyryanovsk. Many citizens were blocked in their houses, and car drivers had to dig out their cars for hours. The blizzard paralyzed traffic. In the next days the situation was aggravated. Snow-removing equipment did not cope with such amount of snow. Because of snowstorm highways to Zyryanovsk were closed for a long time, and avalanches descended from ridges in the neighborhood. Snowfall stopped only on December 27.	Transport Housing and utilities Population	http://www.zakon.kz/4765852-v-zyrjanovske-obilnyjj-snegopad-stal.html?_utl_t=fb

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