Kazakhstan's Second National Communication to the Conference of the Parties of the United Nations Framework Convention on Climate Change

Astana, 2009

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WELCOME ADDRESS

Taking positive action to reduce the impact of climate change, the Republic of Kazakhstan ratified the Kyoto Protocol in March 2009 and is undertaking voluntary quantitative obligations to reduce its anthropogenic greenhouse gas (GHG) emissions.

Climate change is arguably one of the most important global issues facing the world today. Kazakhstan's Second National Communication has been prepared in line with its obligations under the UN Framework Convention on Climate Change. The National Communication reflects the current climate change situation impacting Kazakhstan and its prognosis for the future. It also reveals the influence it has on climate-dependant economic sectors and policy as well as measures proposed for adaptation and reduction of GHG emissions.

The First National Communication was prepared in 1998. The subsequent ten years brought considerable changes. To implement the obligations under the UNFCCC we established institutional expertise, implemented a national climate data and monitoring programme, conducted scientific research into the anthropogenic influence on the climate system and the economic consequences of climate change and, since 2001, we have been conducting an annual inventory of GHG emissions. The Second National Communication contains detailed analysis of the possible reduction of anthropogenic GHG emissions in different economic sectors by introducing mitigation mechanisms and using the best available technologies. The calculations were made using the MARKAL modeling tool and were based on strategic development plans for different economic sectors. The Communication assesses electricity saving potential in respect of energy efficiency and lower carbon intensity. It also reflects the possible costs related to GHG emissions reduction measures in all economic sectors.

For the first time in Kazakhstan we have analysed the influence of climate change on forests and human health, as well as the data on mudflow activity and the change in glaciers. For climate change calculations, we used the data of the hottest decade (1995-2005) combined with unified WMO methodology and climate change indices. Climate change scenaria were developed using the most recent ocean-atmosphere circulation models.

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PREFACE

The Republic of Kazakhstan actively participates in international efforts to prevent climate change and mitigate the effects of climate change. In May 1995, Kazakhstan ratified the United Nations Framework Convention on Climate Change (UNFCCC) and on 12 March 1999 signed the Kyoto Protocol to the Framework Convention (the Kyoto Protocol), joining the worldwide movement to prevent global climate change.

In order to improve Kazakhstan's inter-agency coordination and fulfill obligations under the UNFCCC, the Government created the Interdepartmental Commission in 2000. Its achievements include:

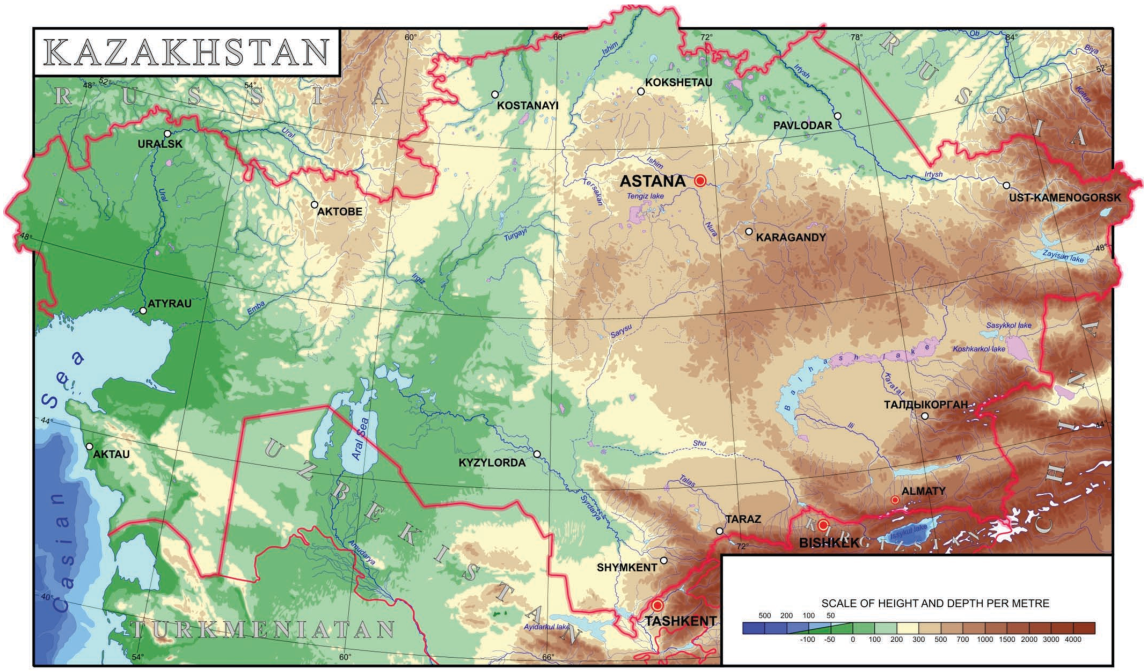
- making an initial adjustment of requirements of the Kyoto Protocol within Kazakh legislation;
- setting the base year (1992);
- encouraging Kyoto Protocol ratification by 2006;
- recommending for adoption the Regulations on procedures for selection, monitoring, verification and approval of projects to reduce greenhouse gas emission;
- tentatively approving two pilot projects to reduce greenhouse gas emissions.

Given the international and economic implications of the Kyoto Protocol, and the affect on Kazakhstan's development, an Interdepartmental Working Group on the ratification of the Kyoto Protocol to the UNFCCC was created in July 2004. The Group reviewed and analyzed the results of a preliminary study of the possible ratification of the Kyoto Protocol, the processes taking place in other states, and it examined the economic and energy aspects of ratification. The Group discussed membership of Kazakhstan as an Annex 1 country and concluded that taking the stabilization of quantitative credit commitments for the first time at the base of 1992 would be both realistic and achievable.

In 1999, the Republic of Kazakhstan expressed its intention to enter into voluntary commitments to reduce greenhouse gas emissions and the Ministry of Foreign Affairs and the Ministry of Environment Protection took active steps to adopt a decision by the UNFCCC. In 2001 at the 7th Conference of the Parties to the UNFCCC, Kazakhstan was allowed to enter the Annexe I group of countries of the Convention by fulfilling two conditions: bringing the Kyoto Protocol into force (met from 16 February 2006); and ratification of the Kyoto Protocol by Kazakhstan.

CHAPTER 1. JOINT SUMMARY

1.1. The national conditions. General data about the Republic of Kazakhstan



The Republic of Kazakhstan is situated in north-central Eurasia and is the ninth largest country in the world based on the size of its territory – 2,724.9 square kilometers. It has a population of 15,219.3 thousand (as at 1 January 2006) with a density of population of 5.6 people per 1м2 . There is a higher proportion of urban population (56–57%) than rural (43–44%).

Kazakhstan's terrain is diverse, with the country situated in four climate zones: forest-steppe; steppe; semi-desert and desert. According to assessment, nearly 75% of the country's territory is subject to high-risk ecological destabilization.

The main source of economic growth is the country's raw resources. Since 1985, Kazakhstan's production of hydrocarbons has increased 225%, while at the same time the world's output rose less than 1.3. The country's 2005 oil production (including gas condensate) amounted to 61.9 million tonnes and the production of (natural) gas was 25.2 billion cubic meters.

Between 1998-2005, Kazakhstan's gross national product increased 1.8 times, while the average annual GDP growth was 9.1%. GDP per capita increased by 2.5 times. However, the GDP growth is accompanied by significant polluting emissions into the environment. It is estimated that around 75% of the country is at increased risk of environmental destabilization.

The positive economic activity of recent years has seen considerable industry growth and around US$50 trillion of direct investments injected into Kazakhstan's economy. Kazakhstan pursues an open foreign trade policy and in 2005 the volume of foreign trade turnover amounted to US$45,201.2 million which has grown more than three times since 2001. The priority investment sectors were oil and natural gas (33.9% of the total investment in fixed assets), operations involving real estate (including, geological exploration and engineering survey) at 21.1%, transport and communications at14. 8%, and industry at 10.4%.

Covering 1.8% of the Earth's surface, Kazakhstan is home to around 0.5% of the world's balanced mineral resources of fuel constituting 30 trillion scf., of which 80% is coal, 13% crude oil and gas condensate and 7% is natural and accompanying gas.

Kazakhstan's electric power plants generate around 18 GW (thermal power plants = 87.5% and hydraulic = 12.4%). Kazakhstan has a developed infrastructure of thermofication. The installed electrical capacity of combined heat & power (CHP) is more than 6,700 MW (38% of the power plants of all countries). This generates around 40% of heat consumption and about 46% of electricity used in Kazakhstan. The energy industry is primarily orientated to carbon fuel usage. Power output generated by heat power stations is 87% and around 12% for hydraulic power stations.

Government investment has boosted the country's agricultural production in recent years, constituting 6.4% of GNP in 2005 and 32% of the country's employment. However, productivity of crops and farming is lagging behind and total investments in agriculture do not exceed 5% of GNP. Positive gains are recorded in planting, while stockbreeding remains an unstable earning power.

According to the UN, of Kazakhstan's 272.5 million hectares, 179.9 million or 66% of the total area, is prone to desertification. The damage of pasture degradation amounts to US$963 millions while loss of income due to erosion of arable land is US$779 million and secondary salinity costs US$375 millions. International experts estimate the damage due to loss of humus in Kazakhstan at US$2.5 billions. Degradation of fertile land continues, partly due to environmental reasons and the primitive technology for land cultivation. Climatic conditions result in relatively low productivity; eg., there is an average of 10 quintals per hectare a year of grain.

Kazakhstan's total area of forest (as at 1 January 2006) is 26.4 million hectares, of which land covered by forest covers an area of about 12.3 million hectares. The percentage of forest-land in Kazakhstan, taking into account saxaul forests and shrubs equates to 4.6% (11.5 million hectares). Excluding the saxaul forests and shrubs it equates to 2.3% (5.75 million hectares). Coniferous forests cover about 1.8 million hectares. The main role of Kazakhstan's forests is not economic, but protecting the soil and water. Factors threatening the forest biological diversity includes fire, unauthorized logging and livestock grazing.

1.2 National greenhouse gases inventory

This section includes Kazakhstan's greenhouse gas (GHG) emission assessments for 1990, 1992, 1994, 1998–2005, received from the Ministry of Environment Protection and revised while preparing the Second National Communication. Some figures for the 1990 and 1994 period have been revised since publication of the First National Communication.

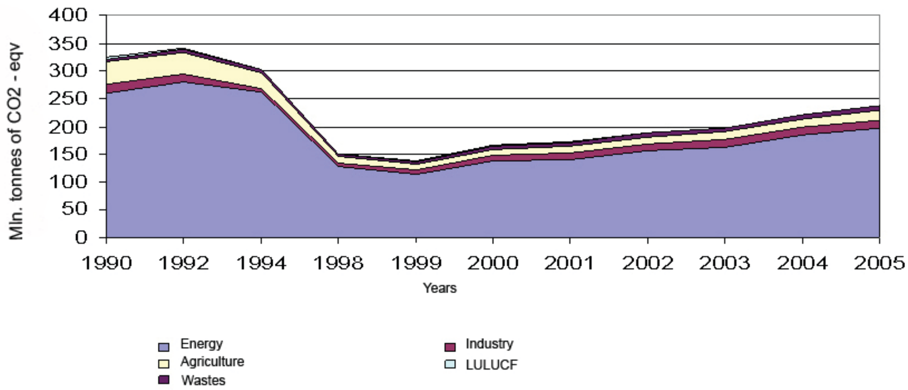
Kazakstan's total GHG emissions amount to 243.2 million tonnes of CO2 - equivalent, including 196.9 million tonnes of emissions from energy production, 15.3 million tonnes from industry processes, 22.8 million tonnes from agriculture management, and 8,2 million tonnes from waste. The CO_2 absorption in forestry and land usage amounted to 5.9 million tonnes in 2005. Thus, the net emissions taking into account the CO_2 absorption were measured for the LULUCF sector at 237.3 million tonnes CO_2 - equivalent in 2005.

The data in Table 1.1 and Picture 1.1 below illustrate Kazakhstan's GHG emissions breakdown, with the energy industry (fuel burning) constituting 78% in 2005, followed by agriculture – reduced from 15% in 1990 to 9% in 2005. The flying emissions (from fuel extraction) contributed around 9% of national emissions, industrial processes amounted to 6%, waste 3%, and absorption amounted to around 2.5% in 2005.

Table 1.1. The total GHG emissions in Kazakhstan, million tonnes of CO2 - equivalent.

Sources/GHG flow	1990	1992	1994	1998	1999	2000	2001	2002	2003	2004	2005
Energy industry	259	280	261	128	113	138	141	156	163	185	197
Fuel burning	219	246	236	113	98	119	124	138	143	164	176
Flying emissions	41	34	25	15	16	19	18	17	20	21	23
Industry	17	15	7	7	8	11	12	13	14	14	15
Agriculture	48	46	34	16	17	17	19	19	20	21	23
LULUCF	-8	-7	-5	-5	-7	-7	-7	-7	-7	-6	-6
Waste	5	5	5	5	6	6	6	7	7	7	8
Total emissions	**330**	**345**	**308**	**156**	**145**	**172**	**178**	**195**	**205**	**228**	**243**
Netto - emissions	**322**	**338**	**303**	**151**	**137**	**165**	**171**	**188**	**198**	**221**	**237**

Note: Rounding differences



Picture 1.1. Dynamics of total CO2 emissions in Kazakhstan for the period of 1990-2005.

The CO_2 emissions without the carbon absorption by forests reached 195.0 million tonnes in 2005. Methane did not exceed 16%, and the nitrous oxide input was around 5%. The main sources of methane are the flying emissions and agriculture and 95 % of nitrogen oxide emissions occur in agriculture.

Energy activity is the main source of anthropogenic GHG emissions in Kazakhstan. The GHG emissions for the 'energy activity' category accounted to 196.9 million tonnes of CO_2 - equivalent, or 81% of the country's emissions.

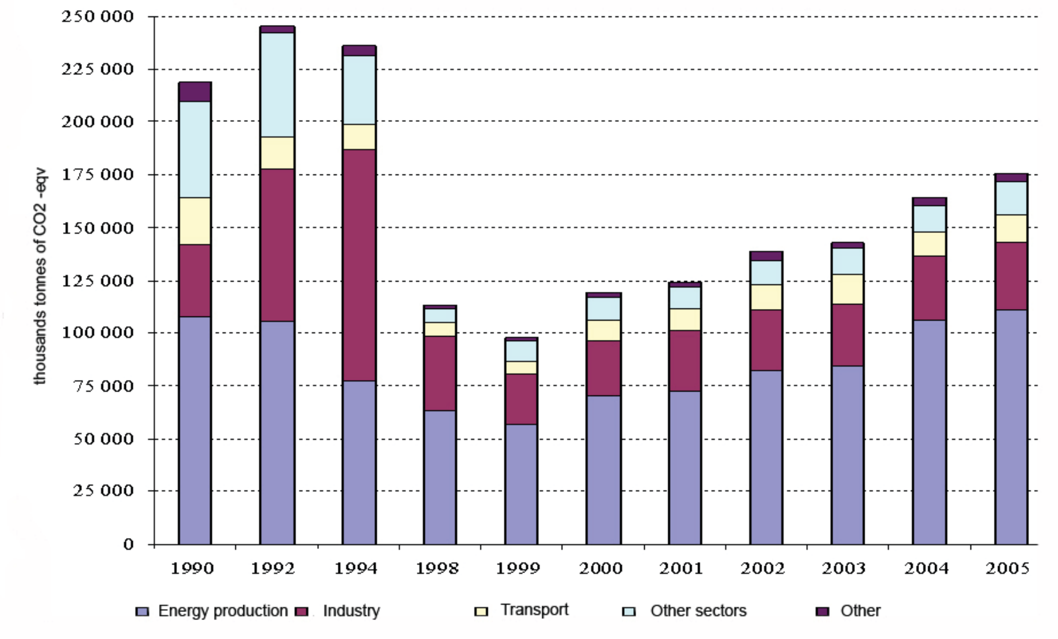


Figure 1.2. GHG emissions from 'Energy: fuel combustion' by main sources (Gg CO_2-eqv.)

The greatest contribution to the emissions from energy category (88%) was made by the fossil fuel combustion that amounted to 175.7 Tg CO_2-equivalent of emissions. In 2005 fugitive emissions were 21.6 Tg CO_2-equivalent, or 12 % of the energy emissions power. The category of fugitive emissions is the largest source of CH_4 emissions. In 2005 it comprised 44% of the total methane emissions in Kazakhstan.

In 2005 agricultural activity emitted 22,781 Gg CO_2-equivalent of methane and nitrogen oxide into the atmosphere – two times below the 1990 and 1992 emissions (Table 2). In the same year, methane emissions were 12,057Gg CO_2 equivalent and nitrogen oxide emissions amounted to 10,724 Gg CO_2 equivalent. These contributed 53% and 47% of the total GHG emissions from agriculture respectively.

The greatest proportion of methane emissions in 2005 was animal breeding (96%). Rice cultivation and burning of agricultural residue contributed 2% each to the total methane emissions from agriculture.

Since 1990 the level of GHG emissions showed a steady decline over the 90s due to the reduction of livestock animals, size of agricultural lands and amount of mineral fertilizers. This trend changed following the reorganization of the agricultural sector in 2000, with GHG emissions in 2005 exceeding the 2000 level by one third. In 2005, the amount of agricultural land cultivation and inner fermentation consisted 45% respectively. Manure activity comprises 6% of GHG emissions.

Kazakhstan's industrial processes are the third largest source of CO_2 and CH_4 emissions to the atmosphere. In 2005, the proportion of total national emissions in CO_2-equivalent was 6.3%. In 2005 the total GHG emissions from this category reached 15,292 Gg CO_2 equivalent, while the methane level was insignificant at less than 1%. Metal production made the greatest contribution to the total emissions by industry at 59% in 2005. Emissions from mineral production were 40% and the contribution of the chemical industry to the total sector emission level was less than 1%.

GHG assessments showed that forests and land conversion to forests are net carbon stocks, and emissions occur from local fires. Changes in woody biomass stocks brought a net CO_2 absorption equal to 4.46 Tg. Coniferous and soft-leaved trees give the greatest contribution to the total net sink.

Land use and land use change both result in CO_2 absorption, and emission. In 2005 the net carbon sink in this sector was 1,431 Gg or 0.6% of Kazakhstan's total GHG emissions. The LULUCF sector is the only absorption category in Kazakhstan. In 2005, GHG sinks were 5.9 Tg CO_2, or 2.5% of the total national GHG emissions. As such forests contributed 76% of the total absorption.

The fourth contributor to Kazakhstan's total national GHG emissions, the waste category comprised 3.4% in 2005, 8,225 Gg CO_2 equivalent. CH_4 emissions equated 95% of the total emissions from this sector whereas the N_2O proportion was only 5%. Emissions from waste combustion were not estimated as no such practice exists in the country.

Thirteen key sources of emissions were identified, seven of which comprise the 'energy activity' category. 45.3% of the country's total GHG emissions is produced by CO_2 emissions from fuel burning-off in the energy industry.

The fluoric gases emissions (PFC, HFC, SF6) were not calculated in Kazakhstan in 2005 as there were none produced. However, in connection with the increasing import and usage of PFC and HFC as substitutes of ozone depleting substances, and also of the planned increase in aluminum production level, these will be assessed in future inventories.

1.3 Policy and measures

1.3.1 The state and branch programs and development strategies

This section outlines the development programs for promoting the reduction of GHG emissions and reducing climate change consequences. Emphasis is given to the measures and policies directed to effective energy use and energy resources. The growing importance of energy efficiency to the country is a necessary economic and social development, as well as an important environmental concern. For the analysis of policy and measures promoting the reduction of GHG emissions the country's main macro economic development indicators were used.

In accordance with the state program for developing the Kazakh sector of the Caspian Sea, there is an output increase of crude oil and gas condensate expected at 2.7 - 3 times by the years 2010 – 2015 vs. 2004. A growth trend during recent years confirms the reality of such output growth and, consequently, the underlying stable state of the Kazakh economy as a whole.

In construction, growth was expected of 9-10 % per year, however this has been revised to 6% from 2008. The anticipated growth in other industries and the proportion of agriculture as a percentage of GNP will decrease from 6.3% to 6% by 2008 when it will stabilize.

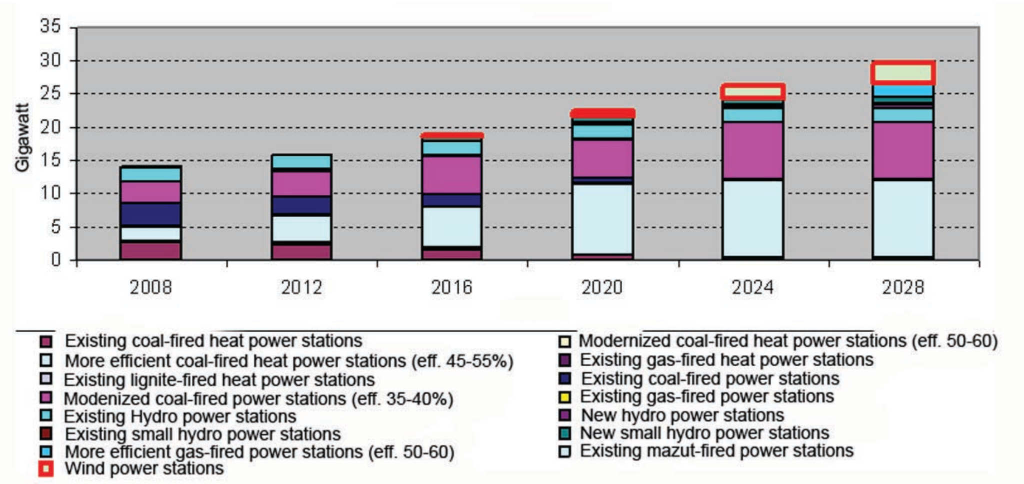
It is acknowledged that to reduce climate change in the country and reduce GHG emissions a modernized industry is required combined with the use of modern energy saving technologies.

1.3.2 The development of energy industry and energy saving

Kazakhstan's energy program to 2015 does not include gas in the fuel mix; rather the energy industry is focused on the use of local Eckibastuzsky coal, which accounts for 60% of the nation's total coal consumption. The program will assess the proportion of coal as part of the energy industry's fuel structure, aiming to reach the 1992 level of 73.6%, with targets of 74% in 2010 and 71% in 2015 (taking into account use of the Amangel'dinsky minefield's gas)

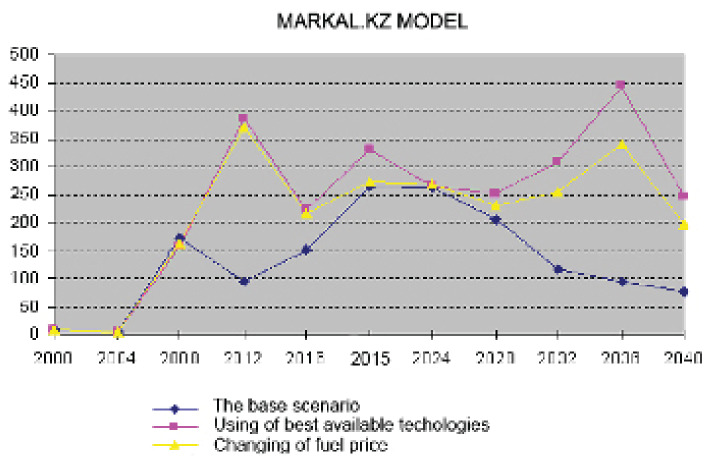
The increase in the proportion of gas turbine power stations (GTPS) is expected to grow from 3.2% of the power structure in 2002 to 6.5–7% in 2010 and 7.8–7.9% in the 2015. This increase will be determined by the development of GTPS in Western Kazakhstan, where the amount of fixed power structure will increase from 19.8% in 2002 to 41.7–39.6% in 2010 and 44.8% in 2015.

The examples of Kazakhstan's energy sector development were made using the MARKAL model.



Picture 1.3. The dynamics change of energy output by the existing and new capacities Kazakhstan (MARKAL model).

In future the major part of electricity will be produced by HPS using more effective coal technologies, and modernised coal power stations. The future development of the energy sector will require substantial investment.



Picture 1.4. The dynamics of investment into Kazakhstan's energy sector under the various development scenaria of the branch (MARKAL model KZ).

According to the base scenario, the lifetime of existing power generating capacity is 10-15 years, hence significant investment is not required before 2012. The construction of new power plants, utilizing best available technologies, will demand significant capital expenditure. This will deliver an increase in the country's energy potential, doubling energy efficiency, reducing fuel consumption and lowering GHG by more than 30% vs. the baseline scenario.

Technical renovations to Kazakhstan's power stations to raise the economic and environmental functioning efficiency will involve the combined cycle using coal and its gasification at 44.7% efficiency, the combined cycle of coal and gas burn-out with 40.5% and 44.5–56% efficiency respectively, and coal burn-out in the pre-critical and supercritical layer with 50% efficiency. These measures will essentially help reduce GHG emissions.

It is noted that the standard use of many WPS built in the 1930s-40s, will expire by 2010-2015 (about 11.000 mW). The six technologies of power and heat output are presented by the MARKAL model. The growing demand for power in the future will be restricted by the capacity of these stations and by new capabilities. The model supposes that present capacities will be reached after 2020, excluding hydroelectric stations.

As a result, demand will increase for main energy resources (coal, gas, mazout), in line with a general output reduction of power and heat because of the inability of energy generating enterprises to produce additional amounts of power and heat without putting in new capacities.

To resolve this problem and prevent an energy crisis in the coming year, complex measures to restore and strengthen HPS capacities need to occur.

Kazakhstan's main policy regulating energy saving came into effect in December 1997. More recently, the Government has been focusing its work on its energy saving program 2005–2015 (Stage 1 2005–2007).

Kazakhstan's demand on energy resources (coal, gaz, mazout) and its reduction of power and heat in coming years will require a set of measures to restore and build up the HPS.

Table 1.2 outlines the cost assessments of reducing GHG emissions in the energy sector from OA 'KazRIPIenergoprom' data. The most cost effective variants of emissions reduction is the construction of steam and gas power stations, small HPS and gas and turbine power station.

Table 1.2. The preliminary cost assessment of the reduction of greenhouse gases emissions in the energy industry's sector.

№	Sstep on Emissions Reduction	Preliminary Cost assessment (Tenge/T CO_2)
1.	Restoring the current HPC, output increase on heat consumption	2,500-4,000
2.	Executing energy saving policy (eg., changing heating system's tubes)	2,000-4,000
3.	Construction of gas & turbine and steam & gas power stations	
	- gas & turbine power stations	1,000-1,500
	- combined cycle gas turbine stations	500 - 800
4.	Development of renewable energy sources	
	- small HPS	800-1500
	- wind units	1,000-2,000

Energy saving can significantly reduce the fuel spending for securing the increase of electricity and heat energy demand in Kazakhstan. The heat cost in CHS for heating one square meter of a building is 1.5-2 times higher than in Western Europe. The priority to supply the entire Kazakh population with stable heating by 2015 is a key driver in energy savings in the SCH heat sources, heating networks and systems of heat consumption.

An important development direction for the energy industry, linked to the reduction of GHG emissions, is the potential increase in gas turbine machines. As a result, power, as part of the total energy balance, will increase from 2.3% to 7.8% - potentially doubling the power output.

In April 1999 the Government agreed to the introduction of renewable energy resources, through its Program for Energy Industry Development to 2030. Significant potential exists for developing wind energy as an industry in Kazakhstan, but the high costs involved have restricted progress.

The Hydro potential of Kazakhstan is high although water and hydro energy resources are distributed unevenly, concentrated in the Eastern, South–Eastern and Southern zones.

It is noted that previously there were around 90 small HPS (SHPS). A survey of these installations shows that 21 SHPS, with the cumulative power of around 78 mW delivering an average 357 million kWh, are in working condition. The rest are destroyed.

In perspective to the year 2020, it makes sense to introduce small HPS into the electricity mix through rehabilitation of the abandoned stations and construction of new ones. The projects currently underway include:

- setting up the Moinack HPS on the Charyn river – power of 300 mW;
- setting up the Kerbulack HPS on the Ily river – power of 50 mW;
- setting up of small HPS on mountainous rivers with total power of 100 - 120 mW.

Analysis of data shows that Kazakhstan has substantial potential for wind energy, but significant development has not taken place due to the relatively high initial investment required. Wind devices such as pumps are used for agricultural needs.

A joint project with the Indian NEPC Group building two wind–energy units, 250 kW each, is being carried out in the South – Kazakhstanskaya oblast.

Currently, WES legislation is being coordinated by relevant Ministries before going before Parliament. Its adoption will secure the support of WES usage, in particular the construction of wind electrical stations with total power to 2,000 mW and small HPS up to 1,000 mW by 2024. A result of this will see the proportion of the renewable energy industry's electrical energy output volume (excluding the big hydro electric stations) comprise around 5% by 2024.

Solar energy potential also exists within the country, with the rate of solar radiation amounting to 1,300–1,800 kW h/ м^2 per year.

Research also shows that Kazakhstan has substantial geothermal energy stores – potential rock resources comprise 317, 6 trillion tcf, and technically available (depth of 5 km industrial drilling, taking into account the extraction coefficient and fixed temperature regime of a consumer) stores of geothermal energy sources of aqueous basins are measured at 4.1 trilion tcf

1.3.3 Forecast assessments of reducing greenhouse gas emissions and general policy impact

The forecast assessments of emission dynamics and GHG reductions were based on the indicators determined in the country's strategic plans and programs for socio-economic development 2010-2030.

Potential exists to increase the role of renewable energy in the country's total power balance. General reduction of GHG emissions from the energy industry, while using the renewable energy sources, can account for 500 thousand tonnes up to 2.5 million tonnes CO_2. The CO_2 emissions scenaria were built using the MARKAL model which assesses the effects on economic policy, climate and the impact on reducing GHG emissions. The scenaria also assist in understanding changing technology and consumer demands, as demand for power services is linked to GNP growth.

The following proposals are made in Kazakhstan's transition to stable development:

- fall of GNP's energy/output ratio by two fold by 2015-2020;
- growth of production efficiency by 3–3.5 fold;
- doubling of GNP by 2015;
- annual economic growth not less than 10 % by the year 2012, 12 % by 2018, 14 % by 2024..

Table 4.11. The reduction potential of GHG emissions from the main sectors of the Kazakh economy considering the strategic branch plans of development and use of effective technologies in millions of tonnes of CO_2

Branches/Scenaria	Years						
	2000	2004	2008	2012	2016	2020	2024
Energy industry							
Base scenario	7785	9609	12283	13902	15305	1625	18311
Efficiency rise in current power stations and building new ones using effective technologies and WSE	7785	9609	11904	12652	13281	13105	13826
The transportation							
Base scenario	876	1332	1709	2229	2921	3646	4491
Introduction of the 'Euro 2 – 4', import of motor cars not older than 7 years	876	1332	1709	2073	2452	2735	3014
Oil & Gas sector							
Base scenario	803	1715	2309	2562	2935	3099	4077
Use of effective, ecologically efficient technologies	803	1716	2237	2439	267	2894	3603
Steel output							
Base scenario	659	783	863	931	1016	1098	1172
Use of more effective technologies	659	783	819	866	915	955	987
Cement output							
Base scenario	072	174	196	223	25	281	314
Rise of enterprises' productivity, gas usage	072	174	186	207	225	244	264

The output of Ferro-Alloy							
Base scenario	338	333	371	396	426	461	489
Use of new power with more effective production	338	333	353	368	384	401	411
Commercial – municipal sector							
Base scenario	191	267	32	373	409	441	491
Use of energy – saving technologies	191	267	289	314	32	326	332
Residential sector							
Base scenario	461	489	558	6	649	644	703
	461	489	532	554	575	546	537
Base scenario	218	215	271	301	383	479	555
Effective waste processing technologies and energy use	218	215	268	289	315	4	431
Total GHG emissions on the base scenario	11403	14917	1888	21517	24294	26399	30603
Total GHG emissions under the use of more effective technologies	11403	14918	18297	19762	21137	21606	23405
Total GHG emissions (potential) as a result of realization of 'Policy and steps'	0	0	583	1755	3157	4793	7198

Both optimistic and pessimistic forecasts were used and the calculations demonstrate that there is great potential to reduce Kazakhstan's GHG emissions using existing and best-available technologies in different sectors of the economy. These measures facilitate sustainable economic growth through lowering energy intensity, carbon intensity and raising energy efficiency as obliged under the UN Framework Convention on Climate Change.

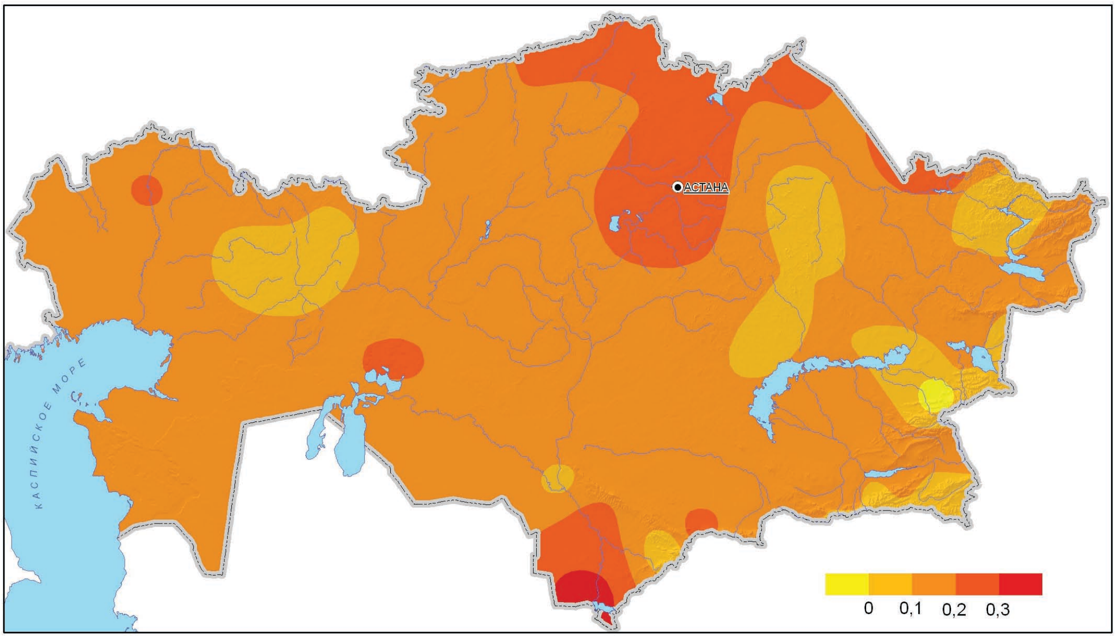
According to the MARKAL model, GHG emissions in the energy sector with existing technologies will reach 1992 levels by 2012–2014. With the introduction of more effective technologies for coal burn-out in the energy sector, considering the growing energy demand, this threshold will be reach in 2024. Through policies and measures, the total reduction of GHG emissions relative to the baseline scenario could amount to more than 31 million tonnes of CO2 by 2016 and 72 million tonnes by the year 2024.

1.4 The vulnerability assessment, climate change impact and adaptation measures

1.4.1. Climate change

During the years 1936-2005 Kazakhstan's climate has been becoming warmer. With the exception of some local regions, temperature rises were recorded in all seasons of the year.

The average annual air temperature increased by 0.31 ^{0}C for each of the 10 years. The most rapid warming was taking place in Winter – on average by 0.44^{0}C/10 years and 0.60 0.65 ^{0}C/10 years in the West, and in certain Northern and Central parts of the country. The least temperature shift occurs in Summer, on average 0.14^{0}C for 10 years, in the West – less than 0.10 ^{0}C/10 years. In transitional seasons the air temperature increased by 0.2^{0}C/10 years. The average annual air temperature rose in most parts of the country by 0.1 0.2^{0}C/10 years (according to the data of MS - by 0.26^{0}C/10 years). The Spring temperature increased the least.



Almost everywhere recorded a significantly shorter number of cold days – to 3 days in 10 years. This increased the number of hot days, when the temperature maximum was above 25 °C on average, by 1.3 days every 10 years. Most parts of the country have seen significant increases in the duration of heat waves, decreasing the duration of cold waves, greatly diminishing the daily amplitude of air temperature (on average by 0.18^{0}C/10 years).

There was no definite trend in the annual and seasonal rainfall on the territory of Kazakhstan.. In most regions, the total rainfall per year was increasing more significantly on the South mountainside of the Urals, in the valley of the river Yesil, on the windward sides of Kazakh Upland (Saryarka) and on the foothills and mountains of the South of Kazakhstan. In the sand region of Moinkum and Lake Zaisan there was a pronounced decrease in total annual rainfall.

The results show that the main shifting characteristic is the increasing climate aridity in the areas of deserts and semi-deserts of Kazakhstan, as well as in adjacent areas to them. In the Urals in the extreme northern parts of Kazakhstan and in the Saryarka zone there is an increase in total rainfall and the climate is becoming generally wetter. The same trend was seen in the mountainous parts of the South and South-East of the country, however this had less impact on rising air temperatures.

Degradation of glaciers has been recorded – with the freezing of the South-East mountains during the last half century reducing the average trend to around 0.8 % per year in area and 1% per year in ice store. On the Northern side of the Ileisky Alatau, between 1955–2004, the area of glaciers decreased by 117.26 km2, or 40.8%. Taking into account the forecast for climate change one can expect the continuation of the intensive degradation of freezing of the region in the near future. Therefore, the freezing in the Northern side of the Ileisky Alatau will practically disappear towards the end of the 21st Century, and in the Jetysuisky Alatau by 40 years from now.

Analysis of the moistening conditions has shown that, in the context of expected air temperature rises, the increase in rainfall, even by 20–25%, will not have a favorable impact on the ecosystems, agriculture and water resources. The complex influence of the surface air temperature and the amount of the falls may lead to the shift of wet zonal borders to the North.

The scenarios of climate change.

While evaluating the scenaria of probable climate change, the results of five double models of general atmosphere and ocean circulation were used. Four scenaria of concentration of GHG atmosphere changes and the averaged scenario on all the models were presented in the special report on the scenaria of the emissions (SRSE) of the Intergovernmental Panel on Climate Change (IPCC). With the aim of decreasing the uncertainty of climate scenaria there was an averaging of data of the five MGCAO. The calculations are made with the use of 4.1 ver. MAGICC/SCENGEN software taking into account the cooling effect of sulphate aerosols for the three time periods: 2016 2045, 2036 2065, 2071 2100, which characterize the possible climate change of Kazakhstan up to 2030, 2050 and 2085 in relation to the baseline period of 1961 1990.

1.4.2. Vulnerability to climate change

Grain production

From the A2_2085, B2_2050 and B2_2085 climate change scenaria there is reason to believe that expected weather conditions will be unfavorable for growing spring wheat in Kostanaiskaya, Akmolinskaya and Pavlodarskaya oblast. The reality of the A2_2085, B2_2050 и B2_2085 climate change scenaria will lead to a steep reduction in productivity. Taking into account the concentration of CO_2 growth, the productivity in Kostanaiskaya, Akmolinskaya and Pavlodarskaya oblast will be 25–60% on average for many years, in the North-Kazakhstanskaya this figure will be 70– 90%.

The young crops of spring wheat will arrive 1-3 weeks earlier than average and consequently the end of vegetation will occur 1-3 weeks earlier. The concentration of CO_2 growth will have a positive effect on the productivity of spring wheat, while at the same time a significant rise in air temperature will influence negatively on plant growth and development, eventually leading to a decrease in productivity.

Pastures

The ecological and economic indicators for possible pasture changes influenced by the expected climate change and assessment of possible adaptation can be presented by the measures of the average seasonal pastures productivity (t/ha of the dry mass), the seasonal feeding resources (t/ha) and the cattle load on the pastures (sheep heads per 100 ha.). Anthropogenic influence on the pastures is expressed by the rate of pasture digression from weak to strong.

Analysis of the joint influence of the expected temperature and falls changes showed that the moistening conditions during the whole vegetation period will worsen both under the A2, and B2 scenaria. Even the increase in the amount of rainfall in July-August during the first half of the current century on the A2 scenario will not have a noticeable effect on improving the moisture conditions due the temperature getting higher by 2 3 ^{0}C and more.. At the same time, the modeling results make it possible to suppose that, with the rise of air temperature, it becomes probable that the so-called "automatic adaptation" of plants to the changes of environmental conditions may occur through a shift in their spring vegetation to an earlier time and autumn vegetation to a later time..

Water resources

Climate change conditions will see the water resource need increase for Kazakhstan's population and industries, as well as for neighboring countries in Central Asia and China. The water dependency of Kazakhstan on these countries is almost 50%.

Kazakhstan's water–holding capacity for agricultural products (primarily cotton and rice) led to the extremely water intensive character of agricultural production. Most of the water consumed in the southern region goes to irrigated agriculture needs. In the arid climate conditions the water deficit and imperfection of the irrigation system infrastructure can lead to elimination of water resources in the south of Kazakhstan. One example of this is the Aral basin, when in recent years only 4–8 km3 of water ran into the sea, and occasionally the running water of the rivers (Syrdarya and Amudaria) did not reach the sea at all.

Research shows that as a result of freezing degradation the mountainous river flows will significantly decrease. For the Northern side of the Zailisky Alatau the flows will shorten by 163 million. m3 per year, or about 12%. For the upper part of the basin of the River Ily (PRC) the mountain river flows will shorten by 13,000-14,000 million. m3 per year and for the middle part of this basin by 400-500 million m3 per year. For the whole of the River Ily basin the flows will shorten by 1,800-2,000 million. m.3 per year. These findings have particular implications for agricultural production during the vegetation period (April-September).

Forestry

The observed and expected rising of average air temperature will cause a shift to the north, and upwards in the mountains areas, of the borders of climatic zones and, as a consequence, to the violation of sustainability of the forest ecosystems. In Kazakhstan the most basic forest forming sorts grow on the border of its natural area.

On the plains a little change in air temperature and conditions of the moistening can make up the unsustainable conditions for existence of pine, silver fir, larch and cedar and, thus, to the change of valuable forest planting to the less valuable–hardwoods and the bush. In the mountain areas of the lower border, the fir tree will rise by 100-120 meters leaving part of its zone to the leafy trees and fruiters, and the upper, correspondingly, will rise, hustle away the border of juniper stands. The silver fir can disappear from the territory of the Jetysuisky Alatau and they will remain in the small area of the East-Kazakhstansky oblast.

Mudflow activity

Glacial and rainfall mudflows present a significant danger for areas situated on the cone of output. Mudflows present no less a danger to residents of rural areas and the foothills located in the 10 km zone of Ili Valley, adjacent to the low zone Zaili Alatau They may be formed in the low zone, the zone of so-called stalls. Mudflows in the counter zones are formed after heavy rainfalls and bring tangible damage (including human loss) even in the present day climate conditions.

Population health

The predicted warming climate for the country will have pressing implications for the health of the population. The most negative impact will be in the southern regions of the country, industrial centers where the environment is polluted by industrial and automobile transportation emissions. Special consideration should be given to the Kzylordinskaya oblast, situated in the ecological disaster zone, provoked by the shallowing and shortening of the water surface of Lake Aral. The Kzylordinskaya oblast territory has the highest level of infant mortality recorded in the country.

1.4.3. Adaptation to climate change

Assessment shows that 70% of potential damage from unfavorable weather and climate conditions affects agriculture. There may be a dangerous increase in the probability of low yields due to increasing frequency of droughts and aridity in several regions of Kazakhstan

The Government has a framework of active programs to strengthen adaptation and maintenance of pasture planting, address problems of ecological resistance in warming conditions and enlarging of climate aridity (State Program of Rural Territory Development 2004–2015; Program to Fight Desertification 2007–2017; Potable Water Program 2002-2010 and other related documents). These aims are also outlined in 'The Conception of Ecological Security of the Republic of Kazakhstan for 2004–2015' - which envisage the preservation of biodiversity, prevention of desertification and degradation of pasturage.

Addressing issues on pasture adaptation within unfavorable climate and direct anthropogenic influences at the regional level is carried out within the Program Framework for Securing the Stable Development of the Balhash–Alakolsky basin for 2007–2009.

The adaptation of sheep breeding to future climate conditions involves a special set of programs: the State Program of Rural Territory Development 2004–2015; the Program to Fight Desertification 2007–2017; and applied research in the agro-industrial complex.

Forestry adaptation measures for climate change can be divided into two directions: the first – to maximize the reduction of existing forestry risks relating to the present climate conditions; and the second - to maintain at a maximum level the input of forests in ecology and economy of the country, taking into account the climate change process. The measures of adaptation to weather and climate change conditions should be directed to strengthening water protection, crop conservation, and commodity focus of the forestry.

In the final stage of anti–sills dams the necessary steps to be carried out in the first half of the 21st century should be the construction of sill dams complexes and providing safety measures for the cities and agricultural territories situated in the piedmont plains adjoining the northern sides of the Kirghiz and Talassky Alatau, Ugamsky range, and also the Kazakhstansky Altai.

1.5. Systematic monitoring and research

Climate system monitoring is carried out within the framework of active national programs of the "Kazhydromet" - a department of the Ministry of Environment Protection.

The following national programs carried out in the RSE "Kazhydromet" include:

1. A system of monitoring the environmental state, pollution, technological development for collecting, storing, dissemination and management of research data; and
2. Monitoring the climate.

The ground sub-system GSN on the territory of Kazakhstan includes 65 surface synoptic stations which supply the Global Telecommunication Network (GTN) with the reports "SYNOP" for four main periods, aerological stations which supply the reports "CLIMAT TEMP", climate stations supplying the reports "CLIMAT".

The monitoring of intensity and developing of the atmosphere processes and phenomena is carried out on a permanent basis. Out of the 251 stations carrying out the meteorological surveys, eight stations are engaged in atmospheric surveys, i.e., they are the aerological stations at the same time (GUAN). The reports "SYNOP" to GST (GSN - Global Surface Network) from the Republic of Kazakhstan provide information from 65 stations: the region RA-2–62 stations, the region RA-4–3 stations in the major four periods: 00, 06, 12 and 19 hours of the World coordinated time. Out of the 65 stations – the 43 stations provide the "CLIMAT" monthly reports.

1.6. Finance sources and technology turnover

To achieve the tasks set out in Kazakhstan's strategic documents it is necessary for the country to put into practice the scientific achievements and technologies. The energy sector is a priority sector for putting into practice new technologies. Besides CO2, coal heat power stations emit many other polluting substances, as such utilizing modern technologies will not only assist the country's reduction in GHG emissions, but will contribute to the improvement of ecological situation. The direction for putting into practice new technologies involves:

- the transition from coal technologies to gas in the southern and western regions of Kazakhstan;
- the building and rehabilitation of the small and medium size hydro–power stations in southern and eastern Kazakhstan;
- more effective technologies for coal burn–out and of the absorption system and bursts clean–out in the central and northern regions; and
- the construction of wind-power stations (WPS).

Practically all of Kazakhstan has substantial potential for wind energy use with the best possible conditions for the construction of powerful WPS in the Djungarsky gate area and Sheleksky passage.

The state of the heating network in Kazakhstan towns presents a serious concern, with research showing 80% are worn-out. New heating network insulation technologies will lead to a substantial reduction in heat energy consumption.

1.7 Education and public awareness

The following documents outline Kazakhstan's ecological education approach:

- Ecological code;
- Law on the specially protected natural territories;
- Conception of ecological security for the years 2004-2015;
- Conception of ecological education.

These documents contain the principle for all-embracing and ongoing ecological education. They highlight the role of NGOs in this process, and the necessity for introducing ecology issues in study programs at all levels, teacher education and adequate state support.

There has been greater media attention in recent years with environmental shows being broadcast, particularly emphasizing the climate change issue. In addition to international channels, regional environmental channels such as 'ORION' in Ust-Kamenogorsk specifically focus on environmental programmes. The internet is also utilized as an information channel, and the Ministry for Environment Protection provides updated online information on a regular basis.

CHAPTER 2. NATIONAL CONDITIONS – REPUBLIC OF KAZAKHSTAN

The following chapter outlines Kazakhstan's natural and socio-economic characteristics relating to climate change. There is strong attitudinal change towards the use of natural resources and the social-economic development implications of a sustainable environment. Step-by-step measures to improve the environment and ensure sustainable development are identified in the 'Conception of Ecological Safety of the Republic of Kazakhstan for 2004-2015.'

The data provided is in accordance with national statistics and official publications.

2.1.General information

2.1.1 Republic of Kazakhstan political structure

Kazakhstan is a presidential republic. The President is the Head of State and elected for a seven-year term. Kazakhstan has a bicameral Parliament comprising the lower house (Mazhilis) and upper house (Senate).

A special provision includes the Constitutional Council of the Republic of Kazakhstan – consisting of seven members for a six-year term. Ex-Presidents of the Republic are by right life members of this Council.

The Government of Kazakhstan exercises executive power, heads the system of executive bodies and provides guidance to them. A court-justice system exists through the Supreme Court and local courts.

2.1.2 Geography and topography

At 2,669,800 square kilometers, Kazakhstan is the ninth largest country in the world, exceeded by Russia, China, USA, Argentina, Brazil, Canada, India and Australia. It is the second largest amongst CIS countries. Kazakhstan borders with the Russian Federation, Republic of Uzbekistan, the People's Republic of China, Kyrgyzstan and the Republic of Turkmenistan (Figure 2.1).

Kazakhstan has rich flora and fauna – inhabiting 155 mammal species, 480 bird species, 150 fish species and 250 species of medicinal plants. The country's terrain comprises around a quarter steppe (26%), 167 million hectares is desert (44%) and semi-desert (14%), and 21 million hectares is forest.

The topography of the country is complex and diverse: about 10% highlands and the remaining comprising lowlands, plains, plateaus and heights. Widespread cutoff basins, deep depressions and dry hollows are typical of Kazakhstan's relief.

Figure 2.1.Map of the Republic of Kazakhstan

The terrain to the south-west, north and central areas is typically flat with low heights – around 200-300 meters above sea level. The mountains in the south-east reach 5-6 thousand meters above sea level and include the highest point of Kazakhstan - Khan-Tengri (6,995 meters, ridge Saryzhaz).

Kazakhstan has 8.5 thousand rivers – seven rivers exceed 1,000km. The country has 48,000 lakes, the largest include the Aral Sea, Balkhash, Zaysan, Alakol, Tengiz, and Seletengiz. Kazakhstan controls the majority of the northern half and east coast of the Caspian Sea.

The modern relief of Kazakhstan is the result of a long geomorphologic development process which has changed the marine and continental conditions, climate and tectonic movement. The process of mountain formation in south-eastern Kazakhstan, which began in Neogene, continues to this day.

2.1.3 Climate

The vast size of Kazakhstan and distance from the ocean creates a sharp continental climate with a lack of rainfall. The foothill areas receive 500 to 1600 mm precipitation per year, 200 to 500 mm in the steppe and 100 to 200 mm in the desert.

The average temperature for January ranges between -18єC in the North to -3єC in the South and the average temperatures in July ranges from 19єC in the North to 29єC in the South. Winter in the North of the country is long and cold – in some years the frosts reached - 52°C (Astana), but there are also thaws up to 5 °C. In the North, the highest near surface temperature in July does not exceed 41°C, and 47 °C in the South (the Kyzylkum desert). The daily temperature difference reaches 20-30є C.

The four climate zones:

- Forest - the moisture plain area is in the North of the country. The shortest season is spring at 1.5 months, summer lasts 3 months and winter extends from October to April;
- Steppe is a vast territory in the North of the country, distinguished by high wind speed. Compared with the forest zone the length of winter is shorter and the summer is longer. Spring is short and the lasts less than two months;

- Semi-desert is a zone of arid steppes occupying central Kazakhstan, with harsh winters and hot summers;
- The Desert zone occupies most of Kazakhstan's plain. Its climate consists of long hot summers, cold winters and high air aridity.

Most regions experience strong blizzard causing winds. Snow primarily falls in November and can continue until April.

The extreme weather conditions of Kazakhstan have business and economic implications for the country. The frequent heavy blizzards disrupt transport and hinder work. Severe frosts of result in the re-planting of grains and crops.

2.1.4 Institutional activity organization to meet the commitments under the UNFCCC

The Ministry of Environment Protection is the central executive body coordinating and leading the development and implementation of government policies on environment protection and management, including climate change issues. Its units – the Republican state-owned enterprises (RSE), Kazakh Research Institute of Ecology and Climate (KazNIIEK) and Kazgidromet – are responsible for preparing the annual GHG emissions inventory and climate change impact assessment and mitigation research. To prepare the Second National Communication, three expert groups comprising professionals from these and other research organisations were established.

Proactive approaches to addressing climate change issues occurs through the Climate Change Coordination Centre (CCCC) – the first NGO in Kazakhstan. The CCCC aims to coordinate and implement the provisions of the Kyoto Protocol. The CCCC has a Memorandum of Understanding (MoU) with the finance, energy and resource and environment protection ministries to work towards a greater understanding by public bodies of the effects of global warming the measures to mitigate climate change.

Substantial contributions to Kazakhstan's implementation of the UNFCCC are made by international organizations: United Nations Development Program (UNDP), Asian Development Bank (ADB), World Bank (WB), and European Union under TACIS, GEF/UNEP, and CAREC.

Table 2.1 Presents the basic data on national conditions.

Table 2.1: National circumstances

Criteria	1990	1994	2000	2005
Population, million	16.7	16.2	14.9	15.2
Urban population, %	57.5	56.4	56.4	57.1
The level of poverty, %	12	28	11.7	25.9**
Life expectancy, years old	69	65.7	65.5	64.9
The percentage of literate population	97.5-98*	96-97**	99.5	99.5
GDP at PPP, billions of USD	68.3***	41.0***	64.7	119.0
GDP at PPP per capita in the USD	4,089***	2,442***	4,342 c	7,857
The proportion of non-state sector in GDP, %	10**	15**	75 b	83 b
The share of manufacturing in GDP, %	20.5	29.1	32.6	29.8
The share of services in GDP, %	26.8	42.8	48.3	52.0

The share of agriculture in GDP, %	34.0	14.9	8.6	6.4
The amount of land used for agricultural purposes, thousand sq km	2,690.0	2,222.5	2,881	2,158
Livestock and poultry, thousands of heads				
Cattle	9,818.4	8,072.9	4,106.6	5,457.4
Sheep and goats	36,605.0	25,132.1	9,981.1	14,334.5
Pigs	2,976.1	1,982.7	1,076.0	1,281.9
Horses	1,666.4	1,636.0	976.0	1,163.5
Camels	143.0	141.2	98.2	130.5
Poultry	59.8	32.7	19.7	26,215.5
Land covered by forest, sq km	96.5	105.0	114.0	123.0

Sources: Statistical Yearbook of the Republic of Kazakhstan (2006); Human Development Report 2007/2008, UNDP (2007)

a Population Census of enumeration of 1989

b calculations of experts

c calculations based on data provided by the Agency on Statistics of Kazakhstan.

2.1.5 Demographic Situation

Kazakhstan has a population of 15,219.3 thousand people (as at 1 January 2006) with a density of population of 5.6 people per 1м2 . Population figures for 1995–2005 are provided in Table 1.2 and Figure 1.2. There is a higher proportion of urban population (56–57%) than rural (43–44%).

Table 2.2: Population of the Republic of Kazakhstan in 1995 - 2005

Year	Population (000s)			
	Entire population	Urban	Rural	Average number of employed in economy
1995	15,675.8	8,730.3	6,945.5	6,551.5
1996	15,480.6	8,635.2	6,845.4	6,518.9
1997	15,188.2	8,499.4	6,688.8	6,472.3
1998	14,955.1	8,414.5	6,540.6	6,127.6
1999	14,901.6	8,397.6	6,504.0	6,105.4
2000	14,865.6	8,413.4	6,452.2	6,201.0
2001	14,851.1	8,429.4	6,421.7	6,698.8
2002	14,866.8	8,457.1	6,409.7	6,708.9
2003	14,951.2	8,518.2	6,433.0	6,985.2
2004	15,074.8	8,614.7	6,460.1	7,181.8
2005	15,219.3	8,696.5	6,522.8	7,261.0

In 2005 the population grew by 144.5 thousand people, or 0.95% compared to 2004 – a result of fertility rates and immigration.

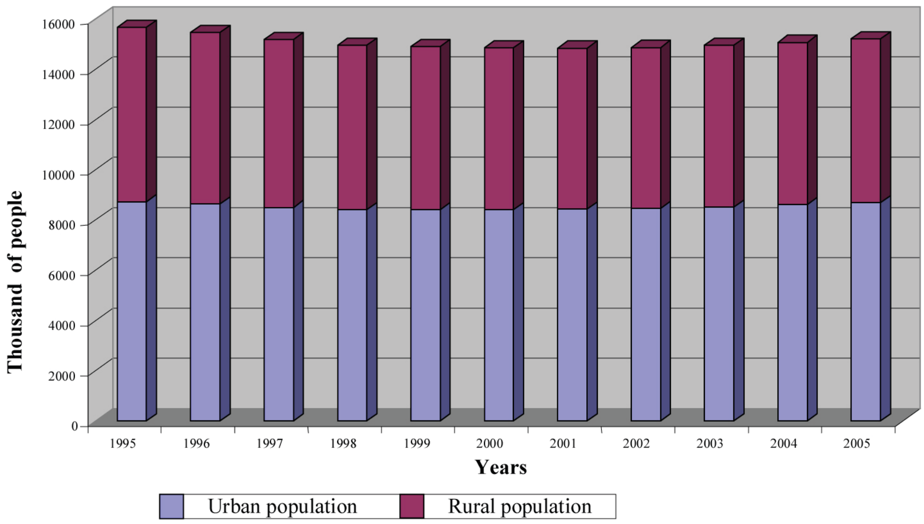


Figure 2.2 The population of the Republic of Kazakhstan

Kazakhstan is a multi-ethnic state – with more than a hundred different nationalities. According to the 1999 Census, Kazakhs comprise half of the population (7,985.0 thousand people) followed by Russians (4,479.6 thousand), Ukrainians (547.1 thousand), Uzbeks (370.7 thousand), Germans (353.4 thousand), Tatars (249.0 thousand) and Uighurs (210.3 thousand). The number of indigenous people has increased since 1999 by 640 thousand people. Natural growth accounts for 73% of the total population growth. Also since this period, the Uzbek population has recorded an increase of 0.3%, Uighur increase 0.1% and Azeris 0.1%. The proportion of Germans fell 0.9%, Ukrainians 0.7%, Russians 3.3% and Tatars 0.2%. The proportion of the population employed in 2005 was 69.4%, or 7,261 thousand people.

2.1.6 Economy

The main source of economic growth is the country's raw material resources. In comparison to the 1985 figure, Kazakhstan's production of hydrocarbons has increased 225%, while at the same time the world's output rose less than 1.3. The country's 2005 oil production (including gas condensate) amounted to 61.9 million tonnes and the production of (natural) gas was 25.2 billion cubic meters.

Between 1998-2005, Kazakhstan's gross national product increased 1.8 times, while the average annual GDP growth was 9.1%. The GDP per capita increased by 2.5 times. However, the GDP growth is accompanied by significant polluting emissions into the environment. It is estimated that around 75% of the country is at increased risk of environmental destabilization.

According to 2005 statistics, mineral products as a total export amounted to 73.8%, followed by ferrous and non-ferrous metals at 15.9%, food products and raw materials for their production at 2.4%, precious metals at 1.4%, chemical products, plastics, rubber at 3.3%, machinery, equipment, transportation, equipment at 1.3%, timber, pulp and paper products at 0.1% and other at 1,8%. International experience shows that such an export structure does not prevent the country from possible global crises.

Potential threats to the country's economic stability include its commodity focus, low uptake of individual industries to join the World Trade Organisation (WTO) and an increase in external debt.

In 2005 manufacturing production of food goods, including beverages, increased by 14.4%, textile and garment industry growth rates were 9.4%, production of petroleum products increased by 18.1%, and mechanical engineering saw an increase of 20.1% .

Inflation stabilized in 2005 at 7.6% compared with 2004. International reserves of the country as a whole, including the National Fund (US$8,014.7 million) increased in 2005 to 4.5% and reached US$15,084.4 million.

The positive economic activity of recent years has seen considerable industry growth and around US$50 trillion of direct investments injected into Kazakhstan's economy. Kazakhstan pursues an open foreign trade policy and in 2005 the volume of foreign trade turnover amounted to US$45,201.2 million which has grown more than three times compared with 2001. The priority investment sectors were oil and natural gas (33.9% of the total investment in fixed assets), operations involving real estate (including, geological exploration and engineering survey) at 21.1%, transport and communications at14, 8%, and industry at 10.4%.

2.1.7 Energy

Covering 1.8% of the earth's surface, Kazakhstan has around 0.5% of the world's mineral fuel reserves, which is 30 billion tonnes of conditional fuel - of which coal accounts for 80%, oil and gas condensate -13%, and natural gas -7%.

Kazakhstan's electric power plants generate around 18 gW (thermal power plants = 87.5% and hydraulic = 12.4%). Kazakhstan has a developed infrastructure of thermofication. The installed electrical capacity of CHP is more than 6,700 mW (38% of the power plants of all countries). This generates around 40% of heat consumption and about 46% of electric use in Kazakhstan.

The country's energy is focused primarily on the use of hydrocarbon fuels. Only 12% of electricity generated is from hydropower, with 87% from heat power plant.

Table 2.3: Primary energy production (millions of tonnes of conditional fuel)

Year	2002	2003	2004	2005
Crude oil, including gas condensate	6760	7357	8508	7796
Natural gas	692	869	1032	1112
Coal (including lignite)	4705	5393	5531	5806

'Fuel and Energy Balance for 2000 - 2004 years', Statistical Compendium, Almaty, 2005, Agencyof Statistics of the Republic of Kazakhstan.

Table 2.4: Electricity balance of the Republic of Kazakhstan (million kWh)

Year	2000	2001	2002	2003	2004	2005
Electric power produced	51,635.1	55,355.8	58,289.5	63,819.3	66,894.0	67,846.9
Imported	6,026.9	3,636.3	2,391.6	2,448.1	3,481.5	3,518.1
Exported	3,292.6	2,210.1	2,521.9	4,119.1	5,319.7	3,647.8
Including by:						
Industry and construction	33,578.7	37,098.8	37,374.1	40,257.0	42,617.3	44,020.9
Agriculture	2,649.4	2,811.7	2,849.0	2,965.4	2,237.2	2,332.7
Transport	3,065.7	2,682.5	2,885.7	3,724.3	3,429.3	3,448.4

Other industries	8,161.2	7,363.1	7,794.7	8,122.6	9,932.8	10,969.5
Networks losses	6,914.4	9,825.9	7,255.6	7,079.0	6,839.2	6,945.7

Kazakhstan's hydro potential is around 170 billion kWh per year. It is technically possible to use 62 billion kWh, economically 27 billion kWh, of which no more than 8 billion kWh per year is used today.

Kazakhstan's renewable energy sources include solar, wind, hydropower, bio-energy, ground heat, groundwater and thermal waters. The potential of renewable energy in Kazakhstan amounts to 2 trillion. kWh per year. Technically feasible potential for electricity production exceeds power use in the country and is about 337 billion kWh per year. The share of wind power accounted for 322 billion kWh per year, solar energy, 4 billion kWh per year, and small hydro power plants 11 billion kWh per year.

The strategy for industrial and innovation development by 2015 stipulates the 2 times reduction of energy intensity in the economy with an increase of GDP in 3.8 times.

2.1.8 Industry

Industrial production is an economic foundation for Kazakhstan with the mineral resource industry experiencing sustained growth since 1999. Among the CIS countries Kazakhstan is the second oil producer after Russia. The manufacturing industry also takes a significant share in the industrial production structure (Table 2.5).

Table 2.5: The structure of industrial production by economic activity for the 1998-2005 (as % of total)

Branch of industry	Share in total industrial production					
	1998	2001	2002	2003	2004	2005
All industry	100	100	100	100	100	100
Mineral resource industry	24,3	44,3	47,9	48,4	53,4	59,4
Manufacturing industry	56,2	46,9	43,3	42,9	39,7	35,2
Production and distribution of electricity, gas and water	19,5	8,8	8,8	8,7	6,9	5,3

Source: Statistical Yearbook of Kazakhstan, Almaty, 1998, 2006.

Increases in the country's mineral resource industry in 2005 was achieved primarily through the growth of natural gas production (at 25%) along with condensate gas (at 21%), lignite (at 14.5%), copper ores (11%), chrome (at 8.9%), iron unagglomerated (at 8.6%), lead-zinc (at 4.3%) and crude oil (at 1,1%). Decreases were recorded in the production of gold ore (51.5%), iron agglomerated (91.8%), copper-zinc (99.9%), iron ore pellets (79.3%), and coal (98.7%). High production rates in the industry would bring the average growth rate over the past five years to 8.4%.

The growth dynamics of industrial production is shown in Figure 2.3. The manufacturing industry rapidly increases production of coke. The growth of industrial output of the mineral resource industry and the development of western regions of the country have had a significant impact on the growth of cargo traffic.

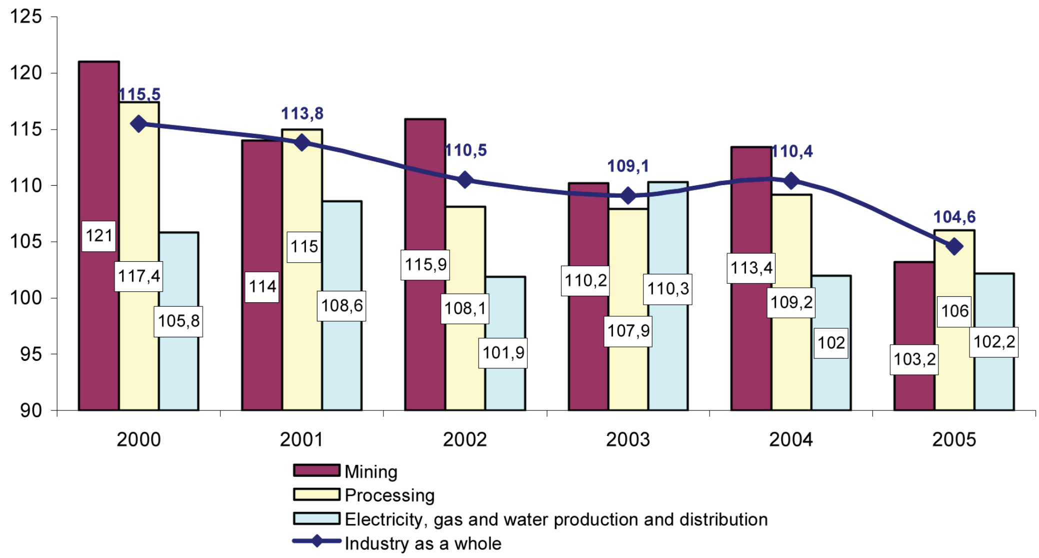


Figure 2.3. Trend of industry growth rate of the Republic of Kazakhstan in 2000 - 2005. % to previous year

2.1.9 Transport

Kazakhstan is located in the heart of the Eurasian continent and the bulk of land networks are roads and railways (around 88.4 and 14.0 thousand km respectively). The length of utilized waterways is 3.9 thousand km and airways - 61 thousand km. The density of the network at 1000 sq km of area is about 5.1 km of railway, 32.4 km of roads paved, 1.5 km of inland waterways. The breakdown of transport vehicles is presented in Table 2.6.

Table 2.6: Vehicles of the Republic of Kazakhstan (units: year-end)

Year	2001	2002	2003	2004	2005
Rail: Locomotives	1913	1896	1770	1711	1659
Steam Locomotives	54	54	53	34	36
Diesel Locomotives	1242	1227	1126	1082	1071
Electric locomotives	617	615	591	595	552
Freight cars	86119	87715	88726	60792	86921
Coaches cars	2088	2094	2559	1922	1874
Luggage vans	132	132	135	100	100
River transport: Self-propelled vessels	2	2	2	6	9
Dry cargo	2	2	2	2	5
Tankers	-	-	-	4	4
Tugs, pushers	38	44	51	49	49
Cargo and passenger vessels	8	10	13	13	8
Road transport: Trucks	204568	214191	223063	224872	281598*
Buses	50162	51367	61391	62894	65698

Cars	1057801	1062554	1148754	1204118	1405325
Special vehicles *	36960	36938	38264	40373	-
Municipal Electric Vehicles: Trams	258	260	257	264	263
Trolleybus	481	450	427	388	365

* Special vehicles assigned to trucks

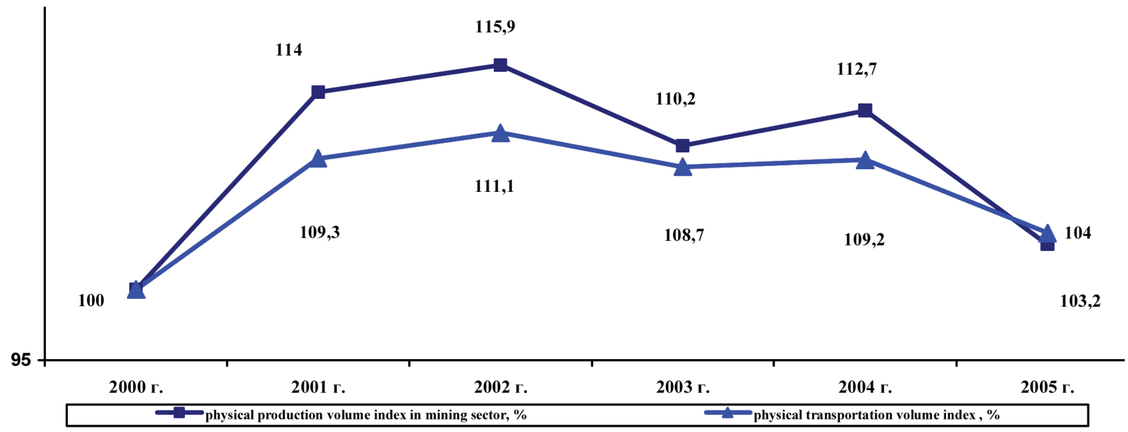


Figure 2.4. The dynamics of the physical volume of mineral resource industry and transport of goods, as % of the previous year

The growth of industrial output of the mineral resource industry and the development of western regions of the country has a significant impact on the growth of cargo traffic. Analysis of transport of goods between 2000 and 2005 show the growth rate of cargo transport from 2000 to 2002 increased, in 2003 declined, in 2004 increased, and in 2005 again declined (Figure 2.4). The main goods transported by the transport and communications sectors are coal, steel and petroleum products.

2.1.10 Housing resources

According to the register of housing resources (as at 1 January 2005) Kazakhstan's total housing area resource is 252.7 million square meters. Of these, 153.0 million square meters are in urban settlements and 99.7 million square meters in rural areas. Under existing measurements, the ownership forms consist of 97.0% private housing stock (244.9 million sq. m) and 3.0% public housing (7,8 million sq. m). Further information on housing resources is given in Table 2.7.

Table 2.7: Housing resources (total area of housing resources: million m)

Year	2002	2003	2004	2005
Housing resources - total	241,0	238,3	243,0	252,7
including:				
Private	321,0	230,2	235,3	244,9
Public	9,9	8,1	7,7	7,8

Housing construction in the republic is carried out mostly by private companies, and individuals. They built respectively 74.4% and 49.1% of the total constructing housing.

Kazakhstan adopted a national housing construction program (2005-2007) in order to provide housing for its citizens. It includes construction of housing through affordable mortgage lending schemes, as well as providing housing to low-income segments of the population. Kazakhstan's housing construction investment for 2005 amounted to 241 billion tenge.

The level of household facilities (central heating, hot and cold water, centralized sewage, gas, electricity) depends on the location of housing (urban or rural) and the level of engineering infrastructure within the area (see Table 2.8).

Table 2.8: The improvement of housing resources (as of December 1, 2005)

The proportion of area (%), equipped by					
water-supply	sewerage	Centralized heating	baths	gas	hot water
53,5	43,7	38,1	37,7	87,9	33,7

2.1.11 Waste and emission contaminants

Kazakhstan has identified solid domestic waste as a problem area, with the country accumulating each year more than 14 mln. cubic m of solid domestic waste at the rate of 1.3 to 2.2 m^3 per inhabitant. The most affordable, acceptable and safe method of long-term waste disposal involves organized dump sites.

Kazakhstan has accumulated more than 20 billion tons of production and consumption waste of which 6.7 billion tons are toxic wastes – sources of pollution from land, surface, groundwater and air quality. The volume of toxic industrial solid waste accumulated in the non-ferrous metallurgy is more than 5.2 billion tons. Wastes pf metallurgy and gold mining industry accounts for 14 billion tons and occupies 50 thousand hectares.

Table 2.9: Key indicators of the impact of economic activities on the environment

Year	2001	2002	2003	2004	2005
Production of toxic waste, thousand tones	130031	137082	141946	146117	228243

Table 2.10: Emissions and capture of harmful substances from stationary industrial sources of air pollution

Year	2001	2002	2003	2004	2005
Total, thousand tones	2582,7	2529,3	2884,3	3016,5	2968,8
including solids	672,4	673,4	729,6	752,9	713,7
gaseous and liquid substances	1910,3	1855,9	2154,7	2263,6	2255,1

On average, the structure of household waste comprises around 50% food waste, about 26% paper, around 9% plastic, and 15% glass, textiles, leather, metal, ceramics, sand. The bulk of solid waste, without material separation, is left and stored at public landfills – 97% of which does not meet environmental legislation requirements as the location and construction occur without environmental impact assessment.

Areas occupied as non-ferrous metal waste reservoirs constitutes around 15 thousand hectares, of which rock piles make up 8 thousand hectares, tails of enrichment plants - about 6 thousand hectares, and piles of metallurgical plants - more than 500 hectares.

Increasing amounts of stored waste constantly form new landscapes, negatively impacting the environment – polluting the atmosphere, soil, surface and ground water with toxic elements (mercury, arsenic, antimony, etc). The increasing height of terrace and waste rock piles is also causing more intense dust sources.

These problems are largely due to the use of obsolete technology, defective raw materials and fuel, the reluctance of businesses to invest in recycling and reclamation of waste production. A significant concern is the waste from the oil and gas industries which is now actively developing within the country.

2.1.12 Agriculture

Since 1992, the types of businesses and forms of farming in rural areas have radically changed in the agrarian sector. Currently, less than 1% account for public enterprises. The main form of farming in rural areas has been become non-state enterprises - various kinds of legal persons, peasant (farmer) households, farms and bungalow lots.

State support has seen Kazakhstan's agricultural industry develop - comprising 6.4% GDP in 2005 and 32% of the country's employment.

The total land area and agricultural land distribution by users is shown in Table 2.11.

Table 2.11: The total land area and agricultural land in the distribution by land users (thousand hectares)

	Land used by land users *	including		
		Agricultural enterprises	Peasant (farm) holdings	In the private use of citizens
The total land area				
2001	91192,5	60220,2	30576,0	396,3
2002	86500,5	54591,5	31519,5	389,5
2003	83622,1	50469,7	32766,3	386,1
2004	82505,7	47156,9	34959,9	388,9
2005	82499,4	44704,7	37424,0	370,7
All agricultural land				
2001	84562,5	54464,4	29761,0	337,1
2002	80445,7	49393,5	30722,0	330,2
2003	78601,1	46265,0	32012,6	323,5
2004	77972,4	43419,5	34227,7	325,2
2005	78383,0	41439,2	36634,9	308,9
Arable land				
2001	20476,9	12854,8	7375,7	246,4
2002	21429,1	12876,9	8311,7	240,5

2003	21351,9	12755,2	8363,6	233,1
2004	21968,1	12921,4	8815,6	231,1
2005	22152,0	13371,5	8560,2	220,3
Hayfields and pastures				
2001	61146,4	40030,3	21087,8	28,3
2002	56463,3	35253,5	21182,5	27,3
2003	54344,0	32064,4	22250,6	29,0
2004	53142,7	29133,0	23976,6	33,1
2005	53324,4	26869,4	26421,1	33,9

Productivity of Kazakhstan's farms lags 3-4 times behind many countries in the world. Total investment in the country's agriculture does not exceed 5% in recent years.

The positive dynamic of Kazakhstan's agricultural production is largely due to crop production profits, while livestock yields remains fragile.

According to the UN of Kazakhstan's 272.5 million hectares, 179.9 million hectares or 66% of the total area is prone to desertification. The damage of pasture degradation is $963 million US dollars while loss of income due to erosion of arable land is $779 million US dollars and secondary salinity costs $375 US million dollars.

International experts estimate the damage from the loss of humus in Kazakhstan at $2.5 billion dollars. Degradation of fertile land continues, partly due to environmental reasons and the primitive technology for land cultivation. Climatic conditions result in relatively low productivity – for examples with grains there is an average of 10 quintals per hectare a year.

To determine the prospects for the development of agro-industrial complex until 2010 the Government has adopted the Sustainable Development Concept in June 2005. The Concept provides for qualitative growth of technical equipment in the branch, its industrialization, infrastructure development of harvesting, processing and marketing of agricultural products, the implementation of a competitive advantage of Kazakhstan, improvement of public management of agricultural market and ensuring food security.

2.1.13 Forestry

Kazakhstan's total area of forest (as at 1 January 2006) is 26.4 million hectares, of which the land covered by forest covers an area of about 12.3 million hectares, representing 4.5% country's territory and the third largest among the countries of Central and Eastern Europe after Russia and Turkey.

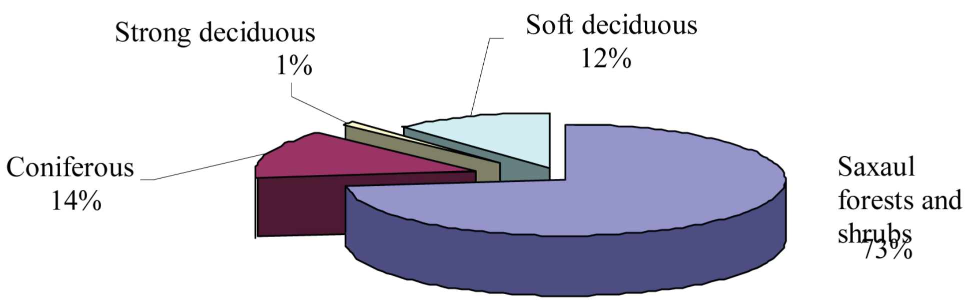


Figure 2.5. The structure of forests in Kazakhstan

Kazakhstan's forests are characterized by very uneven distribution. Approximately 80% of forest density is in the North and North-eastern part of the country, with half the resource, coniferous forests, located in East Kazakhstan region (Eastern Kazakhstan - 47%, North Kazakhstan - 18.6%, Akmolinskaya - 11%). Key indicators of Kazakhstan's forest fund are shown in table 2.12.

Table 2.12: Key indicators of forest fund on January 1

	2002	2003	2004	2005
The total area of forest fund (including forests, transferred on loan), millions of hectares	26,7	26,1	26,2	26,5
Land covered by forest, millions of hectares	11,7	11,7	12,4	12,4
The total stock of timber at its root, million cubic meters	373,6	373,6	375,6	375,8
Percentage of forest land, as a percentage	4,3	4,3	4,6	4,5

The percentage of forest-land in Kazakhstan, taking into account saxaul forests and shrubs equates to 4.6% (11.5 million hectares). Without the saxaul forests and shrubs it equates to 2.3% (5.75 million hectares). Coniferous forests cover about 1.8 million hectares.

The main role of Kazakhstan's forests is not economic, but protecting the soil and water. Factors threatening the forest biological diversity includes fires, unauthorized logging and livestock grazing. During the past 10 years, nearly 0.16 million hectares, or 20%, decreased the area of linear forests in East Kazakhstan. To address these problems the Government ruled in April 2004 the prohibition of felling and use of coniferous and saxaul stands at the state forest fund and measures for their conservation. If the annual amount of reforestation in the last decade of the previous Century was about 80 thousand hectares, in 1997 the volume of forest restoration decreased 8 times and so far remains at that level (Figure 2.6).

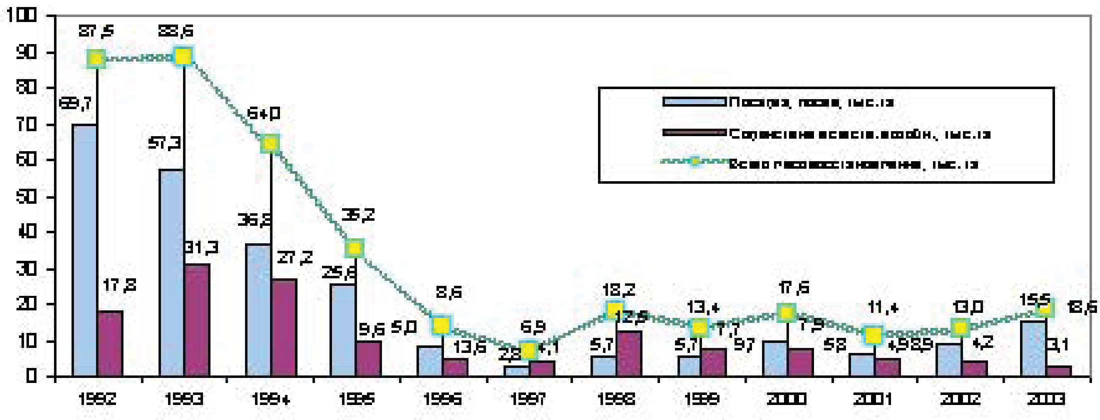


Figure 2.6: Reforestation in the Republic of Kazakhstan

In May 2004, the Government approved the forests of Kazakhstan program 2004-2006 to ensure the preservation of forests, a gradual increase in forested land, improving the protection of forests from fires, protecting them from pests and diseases ad improving the age structure, quality and health of Kazakhstan's forests.

Artificial afforestation made in past years is located on an area of 896.7 thousand hectares, protective strips along roads and railways accounts for 76.1 thousand hectares. In general, for the period from 1997 to 2005 afforestation's work was performed on the area of 25 thousand hectares, of which 8.6 thousand hectares were transferred to communal property.

CHAPTER 3. NATIONAL GREENHOUSE GAS EMISSIONS ASSESSMENT

Since 2000, as part of Kazakhstan's obligation under the UNFCCC, experts annually prepare a GHG emission assessment for the Ministry for Environment Protection.

This chapter includes Kazakhstan's anthropogenic emissions and GHG absorption estimates for 1990, 1992, 1994, and 1998-2005. The GHG emission assessment prepared for the First National Communication (1998) has since been revisited as several international projects implemented in recent years has contributed to enhanced assessment quality across several sectors, allowing the application of detailed GHG emission estimation.

The technical team of experts preparing the assessments are assigned through the Government's RSE 'KazNIIEK.' The assessments follow strict IPCC guidelines on emission estimates, and utilize a choice of Tiers, uncertainty assessment and analysis of key sources. Sources of GHG emissions are annually refined to avoid underestimation of emissions or to reflect the introduction of new technologies.

Kazakhstan's national cadastre of GHG emissions includes in five categories: energy; industrial processes; agriculture; LULUCF (land use, land use change and forestry) and waste. Detailed emission assessments for carbon dioxide (CO_2), methane (CH_4) and nitrogen oxide (N_2O) are provided for 1990, 1992, 1994, 1998-2005.

Indirect GHG emissions – so-called pollutants; nitrogen oxides (NOx), carbon monoxide (CO), non-methane volatile organic compounds (NMVOC) and sulphur dioxides (SO_2) – were estimated under the Convention on Long-range Transboundary Air Pollution (CLRTAP) and only the total figures are presented in this chapter.

Emissions from perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulfurs hexafluoride (SF_6) in Kazakhstan are considered insignificant. These gases, as well as the products containing them, are not produced in Kazakhstan and as such the emissions have not been estimated. It is supposed that these emissions will grow in the future as PFCs and HFCs are more widely applied as substitutes for ozone depleting substances (ODS).

The international methodology recommends reporting of carbon dioxide, methane and nitrogen oxide emissions, both in absolute units and CO2-equivalent by applying global warming potential (GWP). In Kazakhstan's assessment, experts used 100 year GWP equal 1 for CO2, 21 for CH4, and 310 for nitrogen oxide.

To ensure consistency, the assessment results were recalculated several times as more detailed data was obtained, national emission factors were developed or the detailed approach for emissions calculation was applied. This chapter includes the revised results.

3.1. Methodology

Kazakhstan's GHG emissions were estimated in accordance to requirements of the UNFCCC Guidelines for the Preparation of National Communications from non-Annex I Parties. As a methodical basis for estimating GHG emissions, experts used the following IPCC documents: the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories; IPCC 2000 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories; and the 2003 Good Practice Guidance for Land Use, Land-Use Change and Forestry.

The choice of the approach (Tier) for the emissions estimate was made for each category separately using the decision-tree. Mainly Tier 1 was applied for the emissions estimate. For the majority of key sources (centralised heat and power production, road transport, enteric fermentation: cows and sheep, ferrous metallurgy, LULUCF) experts used the improved Tier 2 methodology (table 1.1. Annex 1).

Uncertainty assessment was made using the Tier 1 approach according to the IPCC Good Practice Guidance. High uncertainty for the majority of sectors is explained by using Tier 1 methodology, default emission factors and aggregated national activity data.

Activity data sources include official statistics, Government Ministries and departments, scientific institutes and enterprises-sources of GHG emissions.

3.2. Total GHG emissions

Table 1.2 (Annex 1) presents Kazakhstan's total GHG emissions and sinks for 1990-2005. According to the 2005 assessment, total GHG emissions in 2005 were 243.2 Tg CO2-equivalent, including 196.9 Tg from energy, 15.3 Tg from industrial processes, 22.8 Tg from agriculture, and 8.2 Tg from waste. CO_2 absorption by forestry and land use sector in 2005 amounted to 5.9 Tg, (table 2.1). Net emissions were estimated at 237.3 Tg CO2-equivalent.

Table 3.1. Total GHG emissions in Kazakhstan, Tg CO2-equivalent.

GHG Sources/ sinks	1990	1992	1994	1998	1999	2000	2001	2002	2003	2004	2005
Energy	259	280	261	128	113	138	141	156	163	185	197
Fuel combustion	219	246	236	113	98	119	124	138	143	164	176
Fugitive emissions	41	34	25	15	16	19	18	17	20	21	23
Industrial procesess	17	15	7	7	8	11	12	13	14	14	15
Agriculture	48	46	34	16	17	17	19	19	20	21	23
LULUCF	-8	-7	-5	-5	-7	-7	-7	-7	-7	-6	-6
Waste	5	5	5	5	6	6	6	7	7	7	8
Total emissions	330	345	308	156	145	172	178	195	205	228	243
Net emissions	322	338	303	151	137	165	171	188	198	221	237

Sums may differ due to rounding

A primary source of GHG emissions is energy (fuel combustion) amounting for 72% in 2005 (Figure 2.1). The second contributor is agriculture, the proportion of which has reduced from 15% in 1990 to 9% in 2005. In 2005 fugitive emissions contributed around 9% of Kazakhstan's total emissions. Industrial processes contributed 6% and the proportion of waste was 3%. Absorption by LULUCF amounted 2.5 %.

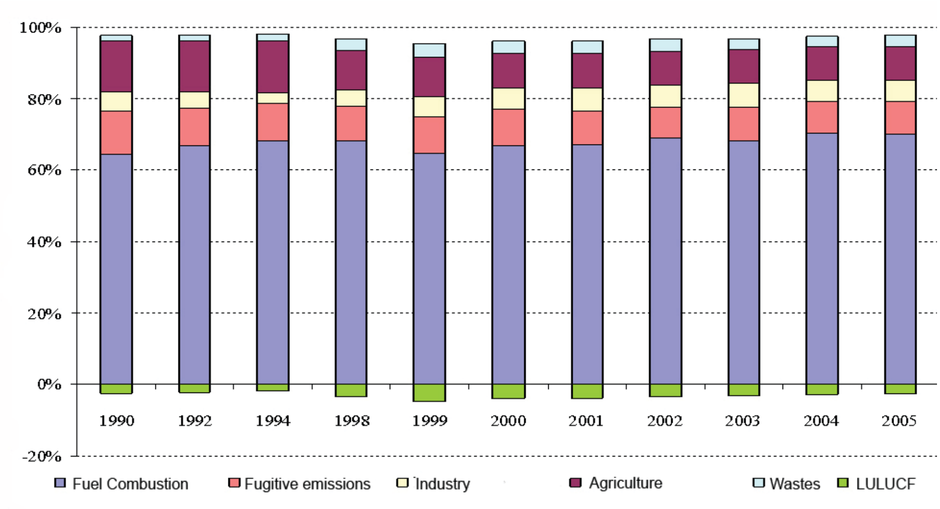


Figure 3.1. Shares of emissions sources/sinks in the total national GHG emissions

In 2005, Kazakhstan's CO_2 emissions, without carbon absorption by forests, were 195.0 Tg – this is almost 80% of the national total. The proportion of methane was around 16%, and nitrogen oxide contributed about 5% (Figure. 2.2). The main sources of methane were fugitive emissions and agriculture, and 95% of N2O emissions caused by agriculture (Annex 1, Table 1.3).

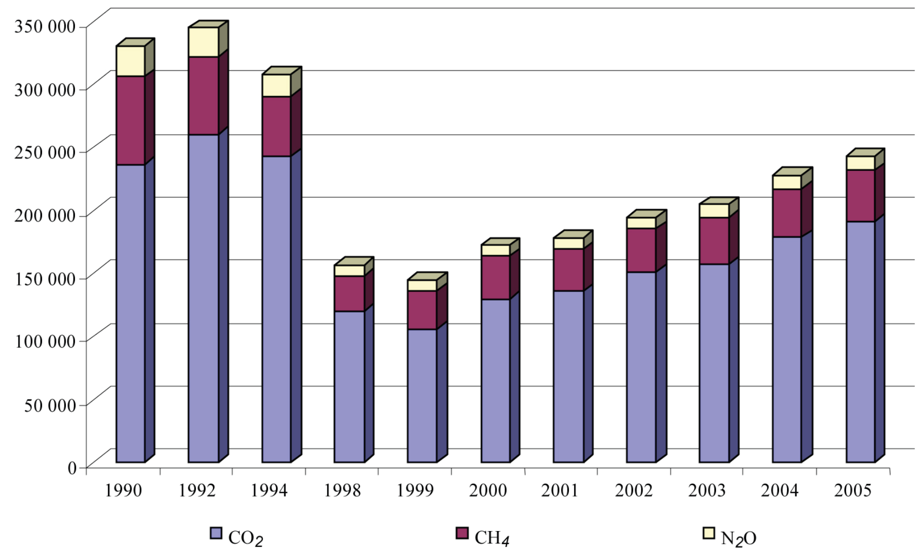


Figure 3.2. Direct GHG emissions without absorption, Gg т CO_2-экв

Kazakhstan 2005 total GHG emissions amounted to more than 16.0 t per capita, and CO_2 contributed to about 12.4 t of them. In 2005, the total national GHG emissions were 26.4 % and 29.8 % below 1990 and 1992 levels respectively.

Tables 1.4 and 1.5 in Annex 1 report Kazakhstan's GHG emissions for 1990 and 2000 according to the UNFCCC Guidelines for the Preparation of National Communications from non-Annex I Parties.

3.3. Energy

Energy activity is the main source of anthropogenic GHG emissions in Kazakhstan. In 2005, the total emissions from this category was estimated at 196.9 Tg CO2-equivalent or 81% of the total national emissions.

The greatest contribution to the emissions from energy category (88%) was made by the fossil fuel combustion that amounted to 175.7 Tg CO_2-equivalent of emissions. In 2005 fugitive emissions were 21.6 Tg CO_2-equivalent, or 12 % of the energy emissions power.

FUEL COMBUSTION

According to the IPCC Guidelines, CO_2 emissions from energy were estimated using two approaches – base and sectoral. The difference between these two was in average 5.5 %, mainly due to oil and oil product combustion.

Combustion of fossil fuel (coal, coal briquettes) gives the greatest emissions of carbon dioxide, and the proportion in CO_2 emissions from energy was 58% in 2005. CO_2 emissions caused by gas combustion were also considerable, contributing 17%. The combustion of the liquid fuels (oil, fuel oil, oven fuel, gasoline etc.) comprised 25% of energy emissions in 2005.

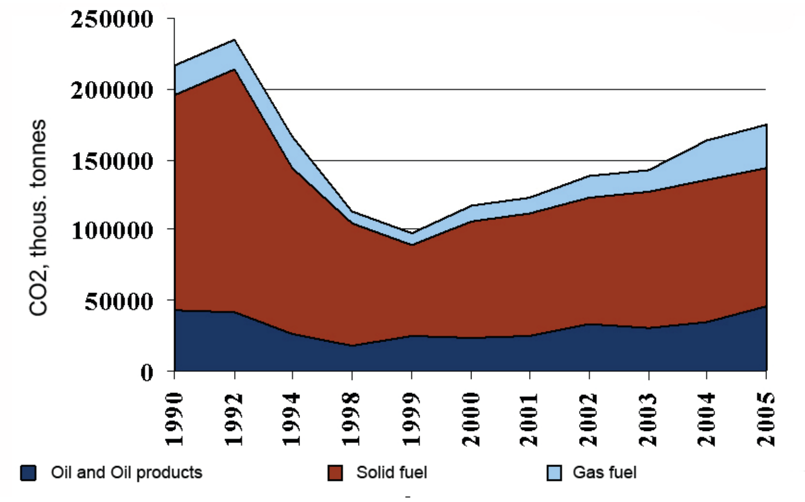


Figure 3.3 – GHG emissions from combustion of the major fuels

The total amount of GHG emissions was 175 650 Gg CO2-equivalent, of which 99.4 % were attributed to carbon dioxide,. The proportion of methane and nitrogen oxide were minor amounting to 0,3 % each.

As Figure 3.4 shows, emissions decreased in 1999 but have tended to increase since 2000. The greatest contributor to GHG emissions is the energy industry, which comprised 63% of total emissions from fuel combustion in 2005. In the same year, emissions from fuel combustion in the manufacturing industry equated 18% and transport was 7%. The categories of 'other sectors' and 'other' contributed 9% and 2% accordingly.

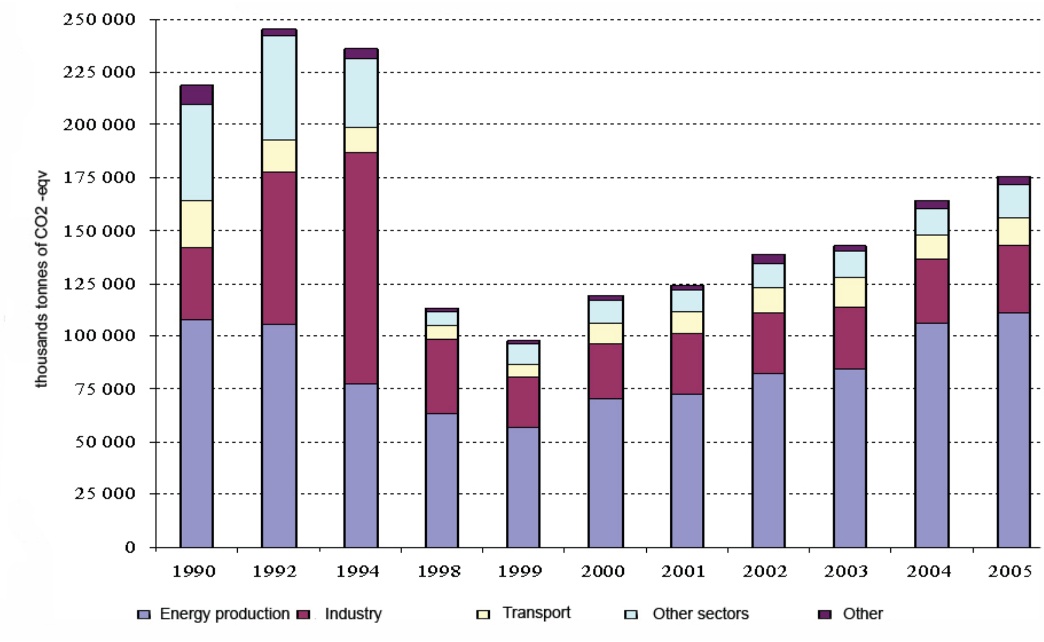


Figure 3.4. GHG emissions from «Energy: fuel combustion» by main sources, Gg CO_2-eqv.

Figure 3.4 shows that Kazakhstan's 2005 GHG emissions from fuel combustion did not exceed 1990 and 1992 levels – comprising 80.3% and 71.2% respectively.

FUGITIVE EMISSIONS

The category of fugitive emissions is the largest source of CH_4 emission. In 2005 it comprised 44% to the total methane emissions in Kazakhstan. It is also the second largest contributor to the total national GHG emissions at 8.7 % in 2005.

The total amount of fugitive GHG emissions in 2005 was more than 21 Tg. As Table 2.2 shows, 10.3 Tg came from the oil and gas sector and around 11.0 Tg are coal-related emissions.

Table 3.2 Fugitive emission of CO2 and CH4, Gg CO2-equivalent.

	1990	1992	1994	1998	1999	2000	2001	2002	2003	2004	2005
Coal	24 868	23 289	18 404	9 188	7 476	9 977	9 602	9 530	12 099	11 045	11 002
Oil and gas	15 861	10 959	6 898	5 908	8 398	9 021	7 986	7 779	7 925	9 636	10 256
Total	40 729	34 248	25 303	15 095	15 874	18 998	17 588	17 310	20 024	20 680	21 258

Sums may differ due to rounding

Since 1990, emissions decreased gradually, due to the reduction of raw material extraction. Coal mining methane emissions are mainly occurring in the underground mines, since methane content in coal-bearing layers in Kazakhstan is rather high.

The major source of GHG emissions from the oil and gas sector was transportation and distribution of gas through pipelines. Since 2000 flaring of associated gas comprises more than 50% of emissions from the oil and gas sector (64% in 2005). This is to the reduction of gas consumption in Kazakhstan and oil extraction growth. The share of oil-extraction emissions was less than 1% in fugitive oil and gas emissions. Figure 3.5 presents the shares of CO_2 and CH_4 emissions in fugitive emissions, and emissions of CO_2 occurring from associated gas flaring.

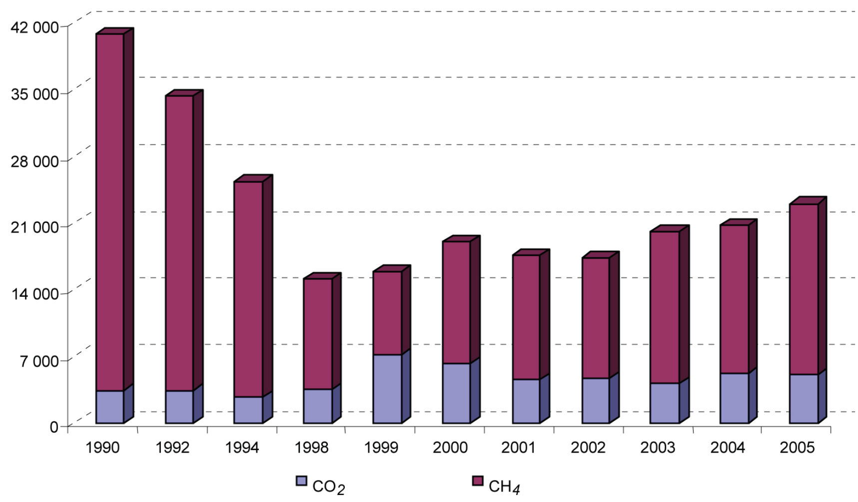


Figure 3.5. – Dynamics of fugitive CH4 and CO2 emissions, Gg of CO2-equivalent.

3.4. Industrial processes

Kazakhstan's industrial processes are the third largest source of CO_2 and CH_4 emissions to the atmosphere. In 2005, the proportion of total national emissions in CO_2–equivalent was 6.3%. In 2005 the total GHG emissions from this category reached 15 292 Gg CO_2-equiv., while the methane level was insignificant at less than 1%.

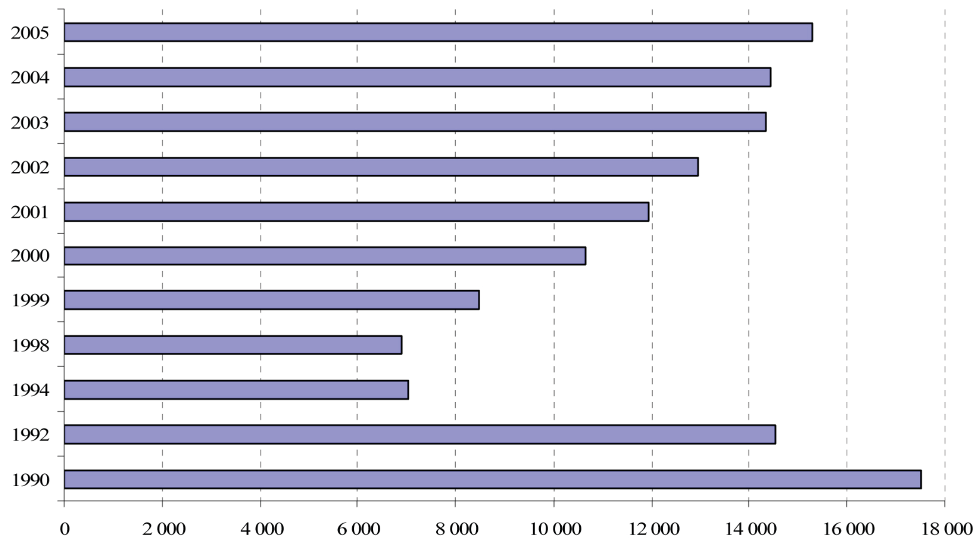


Figure 3.6. GHG Emissions from industrial processes

GHG emissions from industrial production decreased from 1990 through to 1999, but then a gradual growth is observed. Figure 3.6 shows that in 2005 emissions from this category exceeded the 1992 level by 5% and amounted to 87% of 1990 level.

Table 3.3 presents the GHG emissions from industrial processes by sub-categories of emission sources. Metal production brought the greatest contribution to the total emissions from industry – 59% in 2005. Emissions from mineral production were 40% and the contribution of the chemical industry to the total sector emission level did not exceed 1%.

Table 3.3. GHG Emissions from "Industrial processes", Gg CO_2–equivalent.

Emission sources	1990	1992	1994	1998	1999	2000	2001	2002	2003	2004	2005
Metal production	10325	8784	4905	5777	7297	7989	8083	8279	8707	9133	9034
Steel	8629	7380	3892	4789	5962	6450	6510	6586	6753	6981	6795
Ferroalloys	1696	1404	1013	988	1335	1539	1573	1693	1954	2152	2239
Mineral production	5771	4779	1871	1021	1113	2617	3755	4566	5463	5118	6115
Cement	3336	2788	781	255	344	500	808	784	1030	1155	1152
Limestone and dolomite	855	647	503	316	319	1623	2400	3218	3809	3281	4203
Lime	1580	1344	586	450	450	494	547	564	624	682	760
Chemical industry	1403	973	236	86	62	51	99	100	116	202	144
total	17499	14536	7012	6884	8472	10658	11937	12961	14334	14454	15292

Sums may differ due to rounding

3.5. Agriculture

The agriculture sector is the third largest contributor oo the total national GHG emissions. In 2005 the proportion of emissions from this category was 9.4% of total national GHG emissions.

In 2005 agricultural activity emitted 22 781 Gg CO2-equivalent of methane and nitrogen oxide into the atmosphere – two times below the 1990 and 1992 emissions. In the same year, methane emissions were 12 057Gg CO2-equivalent and nitrogen oxide emissions amounted to 10 724 Gg CO2-equivalent. These contributed 53% and 47% of the total GHG emissions from agriculture respectively.

The greatest proportion of methane emissions in 2005 is animal breeding (96%). Rice cultivation and burning of agricultural residues contributes 2% each to the total methane emissions from agriculture.

In nitrogen oxide emissions, the largest contributor comes from agricultural soils (97% of total agricultural N_2O emission). Manure management and burning of agricultural residues equals 1.9% and 0.7% accordingly.

Since 1990 the level of emissions has consistently decreased due to the reduction in agricultural animal population, agricultural land areas and the amount of mineral fertilizers applied. The situation changed in 2000 when the reorganization of Kazakhstan's agricultural sector began. In 2005, GHG emissions exceeded the 2000 level by 30%.

In 2005, agricultural soils and enteric fermentation contributed equally to the total agricultural emissions – 45% each. Manure management provided 6% of the total emissions in this category. Rice cultivation and burning of agricultural residues at fields were smaller contributors at 1.5% and 1% respectively.

Figure 3.7 - CH_4 and N_2O Emissions from agriculture in Kazakhstan, Gg CO_2-equiv.

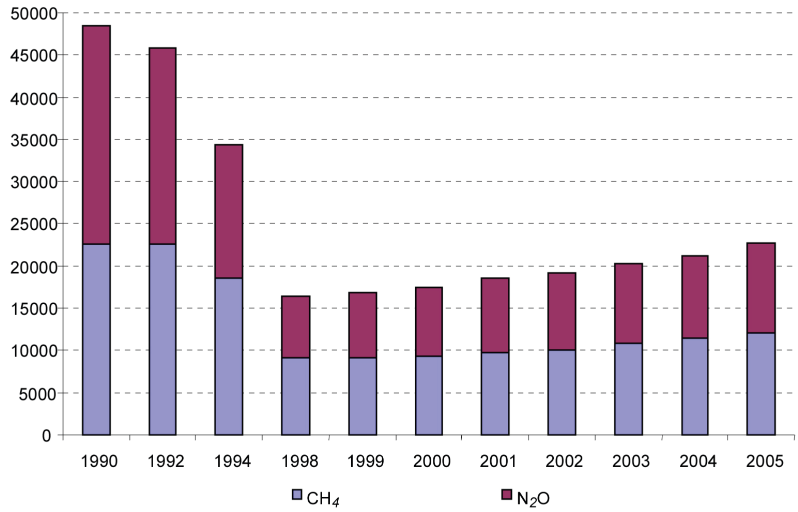


Table 3.4 – GHG Emissions from "Agriculture", Gg CO_2-equivalent.

Emission sources	1990	1992	1994	1998	1999	2000	2001	2002	2003	2004	2005
Enteric fer-mentation	19 721	19 238	15 949	7 560	7 444	7 657	8 015	8 322	8 901	9 486	10 277
Manure manage-ment	2 278	2 176	1 804	1 114	1 105	1 140	1 190	1 234	1 307	1 374	1 454
Rice culti-vation	523	483	428	322	308	303	291	276	351	339	353
Burning of agricultural residues	639	639	341	144	235	206	275	283	276	233	254
Agricul-tural soils	25 216	23 216	15 822	7 216	7 745	8 115	8 824	9 015	9 511	9 798	10 442
Total	48 377	45 752	34 345	16 355	16 838	17 420	18 595	19 130	20 346	21 229	22 781

Sums may differ due to rounding

3.6. Land use, land use change and forestry (LULUCF)

According to the IPCC guidelines, this module (LULUCF) includes GHG emissions/sinks from change in woody biomass of forests, conversion of forests and other lands and change in land use practices.

In order to estimate GHG emissions/sinks, the assumption was made that all forests and lands in Kazakhstan are managed. Data on area of forest land, remaining forest land and commercial wood stock were calculated from the national forest inventory in Kazakhstan available for every five years (1988, 1993, 1998, and 2003). Assessments allowed identification of area and stock of wood for major tree types for forest stands.

Experts also estimated GHG emissions from fires with the assumption that all fires were human-made.

Results include net GHG sink from changes in carbon stocks in soils as a result of change land use practice and land conversion.

Initial activity data has been prepared by the Land Management Agency through annual land conversions matrixes for 1990, 1995, 2000-2005, and area change balance within agricultural lands. Both CO2 emissions and sinks were estimated.

Forestry is the largest carbon sink in Kazakhstan which in 2005 absorbed 4 465 Gg of CO2 or 1.9 % of the total national GHG emissions. Table 3.5 presents the results of estimates where positive values stand for sinks, and negative values for emissions.

Table 3.5 – CO_2 Sink/emissions from forestry in Kazakhstan, Gg CO2-equivalent.

Years	1990	1992	1994	1998	1999	2000	2001	2002	2003	2004	2005
Forests	4639	4639	2614	2614	4950	4950	4950	4950	4950	4758	4444
Fires	-7	-6	-26	-84	-136	-144	-159	-162	-473	-307	-112
Conversion of land	930	980	863	373	252	180	120	84	91	112	133
Net sink	5562	5612	3451	2903	5065	4985	4910	4872	4567	4563	4465

Sums may differ due to rounding

GHG assessments showed that forests and land conversion to forests are net carbon stocks, and emissions occur from local fires. Changes in woody biomass stocks brought net CO2 absorption, equal to 4.46 Tg. Coniferous and soft-leaved trees give the greatest contribution to the total net sink.

Land use and land use change results both in CO2 absorption, and emission. In 2005 the net carbon sink in this sector was 1 431 Gg or 0.6% of Kazakhstan's total GHG emissions.

Table 3.6 presents the emissions/sinks from land use and land use change where positive values stand for sinks, and negative values – for emissions.

Table 3.6 - Emissions/sinks from LULUC in Kazakhstan, Gg CO2

Years	1990	1992	1994	1998	1999	2000	2001	2002	2003	2004	2005
Land use	3494	3377	3238	3025	2977	2929	2893	2866	2840	2833	2798
Land use change	-987	-1850	-1850	-832	-832	-832	-672	-672	-672	-922	-1367
Total	2507	1527	1387	2193	2144	2097	2221	2194	2168	1911	1431

Sums may differ due to rounding

The reduction of carbon accumulation is connected with the cutting of gardens. Abandonment of agricultural lands and their conversion to pastures gave insignificant carbon absorption.

From 1990 through to 1998 absorption from LULUCF reduced, connected with the large forest chopping. Then sinks increased because arable lands were converted into pastures. By 2005, absorption decreased a little due to the change in land use practices (Figure 3.8).

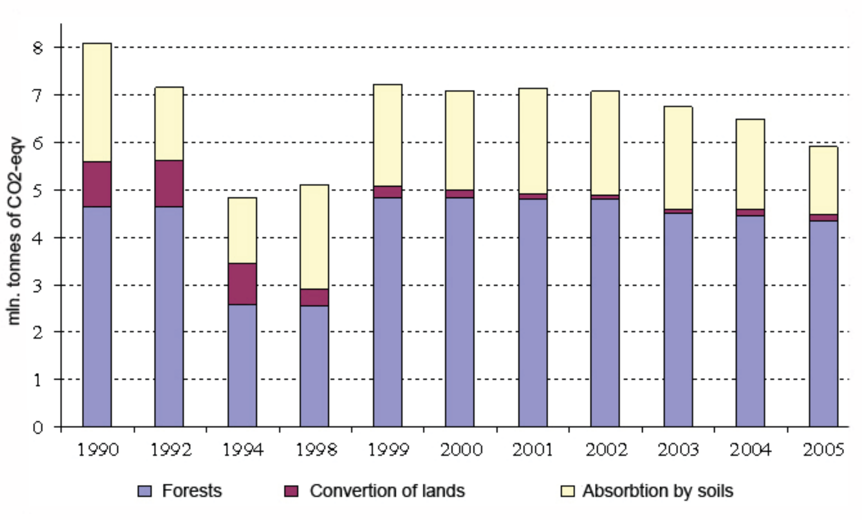


Figure 3.8. CO2 absorption by LULUCF in Kazakhstan, Tg CO2

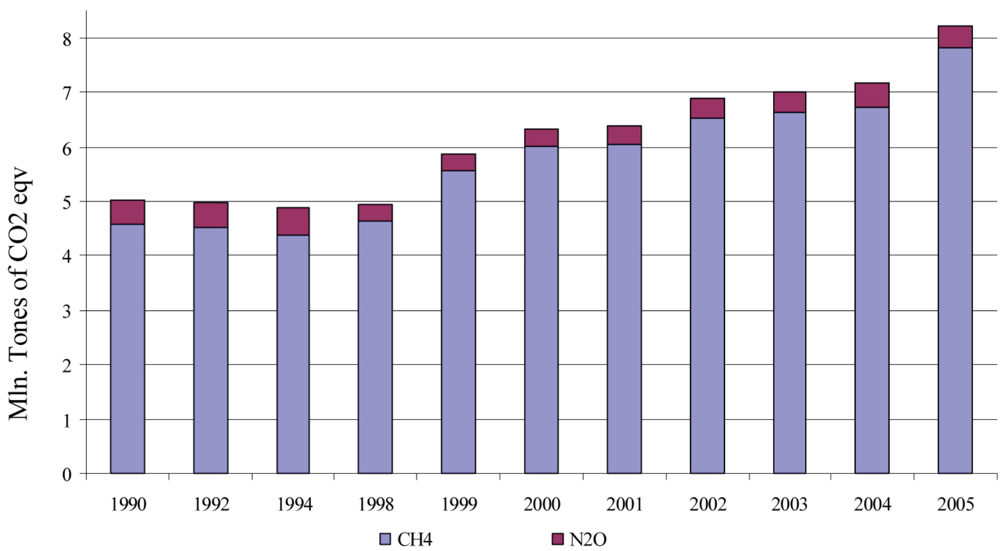
The LULUCF sector is the only absorption category in Kazakhstan. In 2005, GHG sinks were 5.9 Tg CO2, or 2.5% of the total national GHG emissions. As such forests contributed 76% of the total absorption.

3.7 Waste

The waste sector includes CH_4 emissions from anaerobic decomposition of organic waste at MSW disposal sites, CH4 emissions from anaerobic treatment of domestic and industrial wastewater, and also N_2O emissions from household sewage. Emissions from waste combustion were not estimated as no practice exists in the country.

The forth contributor to Kazakhstan's total national GHG emissions, the waste category comprised 3.4% in 2005, 8 225 Gg CO_2-equivalent. CH_4 emissions equated 95% of the total emissions from this sector whereas the N_2O proportion was only 5%.

Figure 3.9. Emissions of CH_4 and N_2O from "Waste" category, Tg CO2-equivalent.



3

National greenhouse gas emissions assessment

The decrease in emissions from 1990 to 1998 is mainly related to reduced population size and economic recession. The subsequent increase since 1999 is explained by the increase in municipal solid wastes (MSW) production, the increase in organic matter content in MSW, and industrial growth.

Table 3.7 presents the waste structure of GHG emissions. Emissions from MSW disposal sites make 94% (723 Gg). Wastewater handling contributed 6% (49 Gg) of which the largest amount come from industry (4%) and 2% from domestic.

Table 3.7 GHG Emission from "Waste" sector, Gg CO_2-equivalent.

Emission sources	1990	1992	1994	1998	1999	2000	2001	2002	2003	2004	2005
MSW	3 734	3 803	3 823	4 197	5 165	5 570	5 583	5 596	5 866	5 891	6 793
Wastewater handling	852	721	565	425	411	442	469	930	769	820	1 020
domestic	568	431	292	204	191	198	240	524	446	501	675
industrial	284	290	273	221	220	244	229	406	323	319	346
Human sewage	427	432	491	314	307	318	328	367	376	475	411
total	5 013	4 956	4 879	4 936	5 883	6 330	6 379	6 893	7 010	7 186	8 225

Sums may differ due to rounding

3.8 Key sources analysis in 2005

Identification of key sources is of great importance for fixing the priorities in preparation of the GHG emissions assessment and reducing of uncertainty. It is also important to find the source categories which contribute the most to the total uncertainty of inventory.

In Kazakhstan, assessment experts applied Tier 1 of the IPCC Good Practice Guidance for defining key sources categories. The quantitative analysis of key sources was carried out by level and by trend (cumulative contribution of 95%).

Key sources by level identified 13 emissions sources, 7 of them from energy category. The greatest contributor to total national GHG emissions at 45.3% come from CO2 emissions from fuel combustion in the energy industry.

Key sources by trend identified 13 sources, 4 of which belong to the energy category. CO2 emissions from fuel combustion in the energy industry also provided the largest contribution at 28.9%.

Table 3.8 presents the generalized results of the key sources analysis in Kazakhstan by level and by trend.

Table 3.8. Key GHG emission sources in 2005

IPCC Categories of sources	GHG	Criteria of definition of a key source
Fuel combustion: energy industry	CO2	Level, Trend
Fuel combustion: other sectors	CO2	Level, Trend
Fuel combustion: Manufacturing and construction	CO2	Level, Trend
MSW	CH4	Level, Trend
Fugitive emissions: coal	CH4	Level, Trend
Agricultural soils	N2O	Level, Trend
Metal production	CO2	Level, Trend
Enteric fermentation	CH4	Level, Trend
Fugitive emissions: oil and gas	CO2	Level, Trend
Limestone and dolomite use	CO2	Level, Trend
Fuel combustion: other	CO2	Level, Trend
Fugitive emissions: oil and gas	CH4	Level, Trend
Road transport	CO2	Level
Cement production	CO2	Trend

In 2005, 12 sources were identified as key in Kazakhstan both by level and by trend. Road transport is a key source only by level, and cement production became a key source by trend assessment. In the future experts plan to apply Tier 2 for key source analysis and to account for uncertainty of every source.

3.9 Emissions of other gases

Indirect GHG emissions

This section presents Kazakhstan's estimates of indirect GHG emissions, such as nitrogen oxides (NOx), carbon monoxide (CO), sulphur dioxide (SO_2) and non-methane volatile organic compounds (NMVOC).

Table 3.9 shows the results of NOx, CO, SO2, NMVOC emission estimates in Kazakhstan over several years. In 2005, emission of all 4 gases increased from 2000, and NOx, SO2 and NMVOC emissions increased by 13% on average, whereas CO emissions grew by 41%. Only NMVOC emissions reached the 1990 level.

Table 3.9 Emissions of NO_x, CO, NMVOC and SO_2 in Kazakhstan, Gg

Gas	1990	1992	1994	2000	2005
NOx	646	773	535	305	341
CO	2 411	2 113	1 293	372	524
NMVOC	407	383	230	359	409
SO2	2 088	1 724	1 522	982	1 108

Emissions of NOx, CO, SO2, and NMVOC in Kazakhstan are estimated under the Convention on Long-Range Transboundary Air Pollution (CLRTAP), using the CORINAIR

Methodology. The key sources of these emissions are fuel combustion and fugitive emissions (oil refining) and also industrial processes.

Emissions of PFCs, HFCs, and SF_6

According to the IPCC Guidelines the major emission sources of these gases are the following activities:

1. Replacement of ozone-depleting substances;
2. HCFC-22 production;
3. Power distribution;
4. Production of primary aluminium;
5. Production of semiconductors; and
6. Production and processing of magnesium.

Only the first and the third activities occur in Kazakhstan. PFCs and HFCs are not produced, but can be imported and consumed as substitutes for ozone depleting substances in refrigeration and conditioning equipment, fire extinguishers, as solvents and foam-blowing. They can be imported as pure substances and as products containing them. Therefore, the main source of information on HFCs and PFCs consumption is customs statistics from 1995. The registration of these gases is not yet fully registered; hence the estimation of consumption and emissions is a significant challenge.

However, it is possible to use some data collected for Kazakhstan's Montreal report in 1998. According to this 1998 data, the import of HFC-134a for refrigeration and conditioning equipment was about 240 kg, making 312 tons in CO_2-equivalent.

Emissions of SF_6 are caused by production of aluminium and magnesium which do not occur in Kazakhstan. Aluminium production is planned for the near future and will be a new source of emission. The only source of SF_6 emissions in Kazakhstan is the use of gas-isolating switches and network breakers. At present there is no data on this kind of activity in current statistical reporting, so special studies are required to estimate emissions from this source.

It is clear, that along with the implementation of the Montreal Protocol obligations and replacement of ozone-depleting substances, the consumption of HFCs and PFCs will increase. In order to estimate these emissions it is necessary to initiate special studies and extend statistical reporting to account for these substances. At present the estimation of emissions from HFCs and PFCs consumption is a significant challenge.

CHAPTER 4. POLICY AND MEASURES

The recession saw Kazakhstan's general national GHG emissions decline from 1990 to 2000. Since 2001, following economic recovery, GHG emissions have grown, however the level is still below that of 1992, which is consider the baseline year for meeting qualitative obligations of the Kyoto protocol.

In considering the Government's programs to reduce GHG emissions and reduce the impact of climate change, attention was given to the policy and process for effective energy use and energy resources. Increasing energy effectiveness is a necessary economic and social requirement as well as for Kazakhstan's general environmental improvement. For the analysis of policy and measures promoting the reduction of GHG emissions the country's main macro economic development indicators were used.

4.1. Macroeconomic policy of RK

An analysis of Kazakhstan's macroeconomic forecasts and development plans for 2015 – 2020 was developed on the basis of existing growth rate of various economic sectors, and modernization of the existing energy and industry capacities.

Key documents relating to Kazakhstan's environmental policy are:

- Kazakhstan' s development strategy to 2030;
- The Transition concept of the Republic of Kazakhstan to stable development 2007 – 2024;
- The Strategy of the industrial and innovation development to 2015;
- Kazakhstan's entering strategy into the World's 50 most competitive countries;
- The Concept of ecological security of the Republic of Kazakhstan for th 2004 – 2015;
- Corrected "Indicative plan of socio and economic development of the Republic of Kazakhstan for 2002 – 2005" with potential for 2010 – 2015;
- Budget programs for 2005 – 2007 with potential to 2010;
- The Government's program for 2006 - 2010;
- The Government's transport strategy for 2015 (April 2006);
- The RK ecological Code (adopted in January 2007);
- Kazakhstan's desertification prevention program 2005 – 2015"
- The program of "Jasyl Yel" for 2004 – 2006;
- The state program of effective use of energy and renewable resources for sustainable development to 2024.

Utilizing the above documents a short-term development plan for Kazakhstan was developed.

In accordance with the State program on developing the Kazakhstani sector of the Caspian Sea, there is an output increase of crude oil and gas condensate expected in 2,7 - 3 times by the years 2010 - 2015, comparing with 2004. A growth tempo during the last years confirms the reality of such output growth and, consequently, the stable state of Kazakhstani economy as a whole.

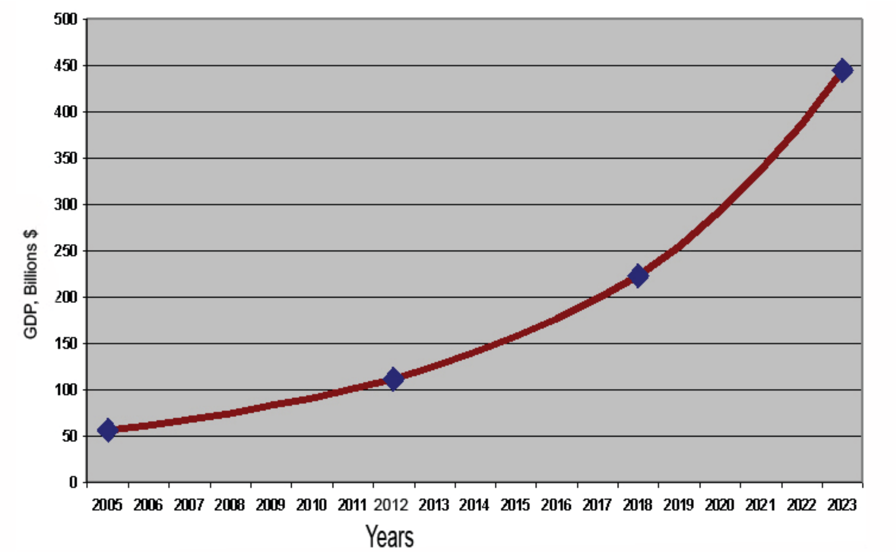
To promote a competitive economy Kazakhstan has a strategy of industrial and innovation develop to 2015 in place. This involves establishing pilot clusters in priority economic sectors and identified economic and industrial zones, with seven projects underway including: tourism, constructional material, textile industry, food industry, metallurgy, oil-gas machine building, and transportation.

The expected results of Kazakhstan's strategy for industrial and innovation development:

1. The reduction of energy/output ratio of the GNP by two times, the growth of labor capacity in 3-3,5 times and doubling the GNP by 2015;

2. The "triple" doubling of the GDP on stages, accordingly, by the years 2018 and 2024 has a decisive importance for ensuring the competitiveness of the Republic of Kazakhstan. The growth objective of the GDP must be secured by maintaining annual growth rate of production not below 10% by the year 2012, 12 % by the year 2018, 14 % by the year 2024 (pic. 4.1).

3. Efficiency of resources (economic output – input ratio) across the country for 2012 - 2018 should rise by 43% and reach 53% by 2024.



Picture 4.1. The forecast of the GNP's dynamics of the Republic of Kazakhstan in the transition process to stable growth (trl. US $).

To achieve the above objectives, three regional technoparks have been created in Almaty, Ural'sk and Karaganda, with the aim of advancing technological development.

In April 2005 the Government ...adopted a program on formation and development of National innovation system until 2015. For achieving the same objective there is a law "On investments" adopted on January 8, 2003

One of the actual issues of macroeconomic policy of the country is the problem of exclusion of "overheat" of economy, some features of which are being taking place. For the prevention of this there is a complex set of measures worked out, in particular, for the reduction of output growth (and sales) of crude oil.

A key growth factor for Kazakhstan's economy in coming years will be the maintenance of high oil prices on world markets. The positive net trade balance on the average will account for around 4 tln. US $ per year. Industry growth should amount to 8% per year.

In construction, growth is expected by 9-10 % per year, however this must be reduced down to 6% from 2008. The due growth in other industries, the proportion of agriculture as GNP will decrease from 6,3% to 6% by 2008 where it will stabilize.

It is acknowledged that to reduce climate change in the country and reduce GHG emissions a modernized industry is required and the use of modern energy saving technologies.

4.2. The constraints of economy development

The constraints of economic growth in Kazakhstan include:

- the highly worn-out fixed capital stock, the lack of own financial means for the
- the technical and technological backwardness of enterprises, a lack of working ties between science and practice and low expenditure on research and development;
- the lack or absence of local enterprises doing deep processing of raw materials using the advanced technologies. This in turn makes Kazakhstani manufacturers dependent on the world market for imported materials and the wide-rage of price fluctuations;
- the high transportation expenditures, in particular high railroad tariffs causing higher end-product costs;
- the high rates of taxation;
- the imbalance of customs - tariffs regulations: the customs duties on imported raw materials for some kinds of building materials exceed the imported customs duties for the end product;
- the low energy efficiency of some energy-intensive enterprises;
- the substantial losses in the power supply networks requiring optimization.

4.3. A comparative analysis of the results received in the First National Report and following research

After presentation of the First National Communication further research was carried out on the possibilities of the GHG reduction in Kazakhstan – in particular CCCC work in 2003 'Kazakhstan: mechanisms of GHG reduction.' This included data on GHG assessment from the KazNIIEK after 2000. Analysis of the forecasts, or scenarios of GHG emissions, shows that their uncertainty, in the first place, depends on the exactness of base data on fuel usage, taken for calculating the emissions. It was found that the amount of fossil fuel burnt and the liquid fuels is significantly higher that data received from the Statistics Agency. This is the main discrepancy between forecast and actual emissions. The systemic uncertainty of fuel data in GHG assessments after 2000 is on average 13-15%. For assessment of a certain year, it can reach 17-22%. The assessment data of the year 2000 has the most degree of uncertainty.

To therefore workout emission forecasts or scenarios for the future the rational is to average the GHG assessment data for several adjoining years. This reduces the uncertainty of emission forecasts by 30-45%.

4.4. Kazakhstan's energy industry

4.4.1. Power supply

Kazakhstan's power energy basis is comprised by heat power plants (HPP) that form more than 87% of the installed capacity of the United Power System (UPS). Coal is the primary element in producing power and heat. The output-input ratio (OIR) of the

Kazakhstani Power System (KPS) on coal does not exceed 30–32%, while at the same time world practice has reached 42–53%. The OIR of the HPP, depending on the portion thermo usage power output along with the state of facilities and exploitation level, changes from 17,7% to 37,7%.

The following Government approved documents were consulted to develop electricity consumption forecasts levels:

- the forecast balance of electro energy
- a plan of measures for developing Kazakhstan's electro energy branch for 2007–2015
- a list of electro energy facilities subject to reconstruction, modernization, expansion and construction of new power facilities for 2007–2015.

In accordance with these documents, practically all regions of the country will have reconstruction work of existing or new equipment during 2007–2015 period.

Taking into consideration the intention of Kazakhstan to enter the top 50 developed countries, a proposal was made to increase power output to up to 101 – 106, 5 tln. kWh. by 2015.

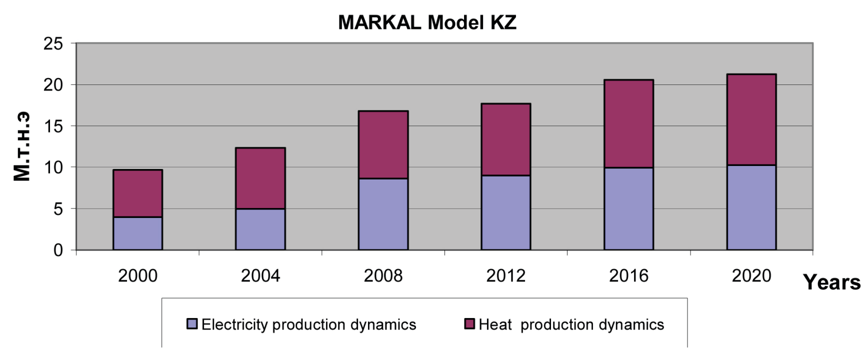
A result of the planned additional capacity, structural changes to the power set of the UES power stations will take place. The most effective use proposed is HTES and CCP power. The dynamic of heat and power output in Kazakhstan by the year 2020 is presented in Picture 4.2. This was obtained using the MARKAL model and existing documents and forecast plans on the 2006 year.

In accordance with Kazakhstan's complex energy development Program to 2015, an increase in the gas proportion of the power balance is not envisaged. The energy industry will primarily be orientated on the use of local and inexpensive Eckibastuzsky coal – comprising a total coal usage amount of 60%. According to the Program's assessment, the amount of coal fuel in the country's energy industry structure will comprise 74% by 2010, 71,5 by 2015 – almost reaching the 1992 level of 73,6% (taking into account gas usage of the Amangel'dinsky minefield in the South).

The high cost of gas, exceed the cost of coal (in equivalent of conditional fuel) in 2–2,5 times means it is not a competitive fuel for the country's energy industry.

Moreover, it is probable quite the opposite process, - the substitution change of main fuel on the power stations from gas to coal, the example is the Jambulskaya HRES, at which due to the high gas' cost, the powerful equipment for electricity generatingis not utilized.

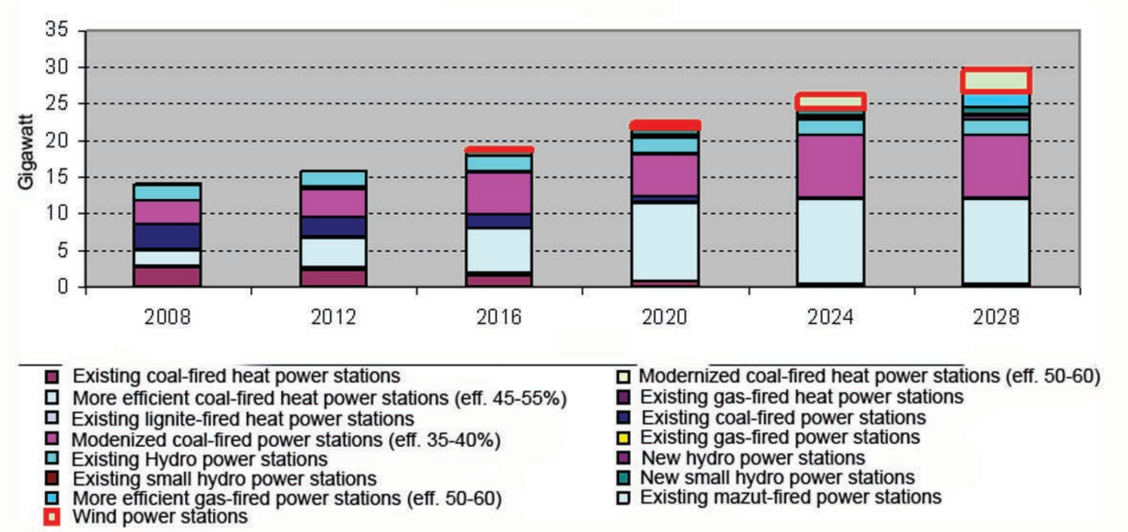
The dynamics of heat and electricity output in Kazakhstan by 2020 - assisted by the MARKAL model, existing documents and forecast plans for 2006, is presented on the picture 4.2.



Picture 4.2. The dynamics of heat's and electricity's output in RK by 2020.

The increase in the proportion of gas turbine power stations (GTPS) is expected comprise from 3,2% of the power structure in 2002 to 6,5–7% in 2010 and 7,8–7,9% in the 2015. This increase will be determined by the development of GTPS in Western Kazakhstan, where the amount of fixed power structure will increase from 19,8% in 2002 to 41,7–39,6% in 2010 and 44,8% in 2015.

The building of a new energy source (AES as an alternative source replacing the power of HES) will not be required until 2015 in Southern Kazakhstan. At the same time, with continued coal and gas price rises, there is a possibility of realization of this project, especially, taking into account that the power usage is supposed to grow by the year 2025 in 1,4 times comparing with that of the year 2015.. The deficit of power is expected in a volume of 2,0- 1,7 tln. kW h in 2020 and 4,0–3,0 tln. kW h in 2025. This requires the development of a new energy source in the South region by 2020. The future dynamics of power output by existing and new capacities was calculated using the MARKAL model (Picture. 4.3)



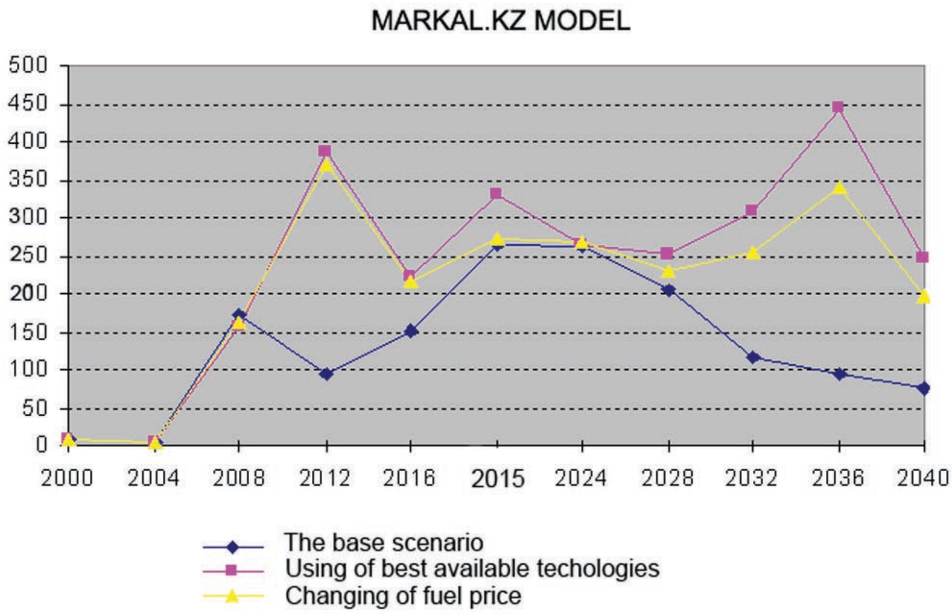
Picture 4.3. The dynamics change of energy output by the existing and new capacities Kazakhstan (MARKAL model).

According to the results presented in the Picture 4.3, the beginning of the 2008 includes investments for low-cost measures aimed at increasing efficiency of existing capacities due to the best existing fuel burning technologies.

The model reflects the modernization of existing power stations equipment, upgrading their effectiveness to 35–40%. Additionally, renewable energy sources, hydro (HES) and wind stations (WES), are actively introduced, increasing their proportion of energy output to 20–25% against 12% in 2004. The actualization of these is linked to large investment in the country's energy industry (Picture 4.4)

As seen from Picture 4.4, various areas of Kazakhstan's energy sector development will require significant investment, but with the only difference, that under the baseline scenario the state prolongs the existence time of present capacities at best for 10–15 years, and the introduction and building of new capacities using the most advanced technologies will lead to the enlargement of energy potential of the country, increase of energy efficiency in two times and reduction of fuel consumption. And, as it will be shown further, the total amount of GHG can go down more than by 30 % in relation to the baseline scenario (Picture 4.6).

It is important to note that there are some works which take into account the specifics of energy power complex and directed to the increase of stations functioning efficiency while at the same time reducing the fuel usage. If to carry out the process for bringing the burn-out of fuel to the stand level of usage on the ES SC "UEC", then fuel savings can amount to 31272 t/yr. At the same time, GHG emissions will be reduced from 100 to 150 thou. t. annually.



Picture 4.4. The investment dynamics into the energy economy sector of RK under the various development scenarios of the branch (MARKAL model KZ).

Under the rational arrangement of burning process on HPP – 2 in Almaty city coal saving will amount to the 50173 ton/year, and there will be less GHG emissions for about 150–200 thousand Tons, than under the present situation.

Technical renovations to Kazakhstan's power stations to raise the economic and environmental functioning efficiency will involve the combined cycle using coal and its gasification at 44,7% efficiency, the combined cycle of coal and gas burn-out with 40,5% and 44,5–56% efficiency respectively, and coal burn-out in the pre-critical and supercritical layer with 50% efficiency. These measures will essentially help reduce GHG emissions.

To increase the required transfer capability and reduce electric energy losses, a second transit will be built using energy saving technologies 500 kV North-South Eckybactuz–Agadyr'–SKHES–Shu - total length of 1115 km

A important place in the development of Kazakhstani inter-system network of 220–500 kV in connection with oil and gas industry's development is Western Kazakhstan. For the present and future, there is positive political and economic conditions for improving the current state and further developing the power sector, creating export potential.

As part of the program of developing the country's power energy industry by 2015, the following priority tasks are planned:

- the rehabilitation and changing of generating equipment, that outreached the normative service time at the running power stations;
- the extension of functioning power stations through introducing new generating capacities, in the first instance the lead–in of the 500 mW unit on the Eckybastuzsky HPS-2;
- introduction of the renewable energy sources (small HPS and WPS) in the South of the country;
- the building of new power stations with the use of natural and accompanying gas from the oil minefields in the Western Kazakhstan which will play a positive role in achieving energy independence for this region;
- the modernization of electrical networks of 220–500 - 1150 kV of the UPS K through re-equiping with the modern commutation facilities, relay protection devices, automatics, direction for the reliability growth of running electrical networks and granted consumers' electricity supplies.

4.4.2. Heating

The task of providing a secure and stable heat supply for consumers has critical social importance.

Three types of heating supply systems have been developed in Kazakhstan:

1. Central heating with combined output of heat and electrical energy on the TPS – the most rational way of fuel resource use for heat supply. Due to the significant economical, environmental and social advantages this system became the dominant way of supplying heat to Kazakhstan's larger cities.
2. Centralized heat supply on the base of big district boiler - houses;
3. Decentralized heat supply on the base of autonomous heating systems and the furnaces of separate buildings or rooms and small boiler – houses for compact consumer groups.

The development of central heating has increased significantly. In 1990, the heat power centers (HPC) produced 42% of all heat energy output and 45% of the power in the country - having secured a saving of about 2 mln. t. c. f. This was one of the highest indicators of central heating with combined heat and gas output in comparison with Western and Eastern Europe countries having and developing central heating.

The heat transportation network extends 11, 5 thou. km (in the double pipeline system's calculation). The average actual heat loss in city heat networks are two plus higher than standard (project) for the new heat networks.

The absence of long-term investment into Kazakhstan's energy complex saw capital funds reach a critical point. As a result, a significant gap appeared between the fixed and available capacities of energy sources, which at the beginning of 2005 amounted for 4,3 thou. mW or 23% of the fixed capacity. The losses in the heating networks twice surpass the normative ones.

It is noted that the standard use of many WPS built in the 1930s-40s, will already expire by 2010-2015 (about 11000 mW). The six technologies of power and heat output are presented by the MARKAL model. The growing demand for power in the future will be restricted by the capacity of these stations and by new capabilities.

The model supposes that present capacities will be reached after 2020, exluding hydroelectric stations. As a result, demand will increase on main energy resources (coal, gas, mazout), and also the general output reduction of power and heat because of the inability of energy generating enterprises to produce additional amounts of power and heat without putting in new capacities.

To resolve this problem and prevent an energy crisis in the coming year, complex measures on restoring and buildup of the HPS capacities need to occur.

4.4.3. The heating improvement, the combined heat and power output

The central heating system comprises a heat source (HPP or district boiler-house), the heat network and heat consumption system. The rate of physical wear–out of the HPC's generating facilities by the start of 2006 is on the average around 25–30%. The specific consumption of fuel for power output on 12 of the 38 HPC is on the level of large condensate power stations, on 16 HPPs it exceeds their level that testifies about the inefficiency of fuel usage and, consequently, of increase of the GHG emissions in the atmosphere.

The major problems with HPC's is the physical wear out of equipment and underutilization of the heat capacity set ups.

Around 60% of heat tracings have a working life of 25 years. The average age of heat networks by 2006 is to 22 years.

The main type of heat insulation is mineral cotton in the permeable defensive skin from various materials. When the moisture gets in the pipes the mineral cotton becomes damp quickly and loses its heat insulating features, hence the reason for more than normal heat losses.

Expert assessment found the quantity of losses into the main heat networks comes down by 20%, and on the distributing ones, 80%. Not less than 12–15 % of the heat networks require immediate replacement. The heat network problems include ageing, poor repair and the low quality of the insulating layer.

The running heat consumption systems in the central heating systems (CHS), as a rule, are not automatic. Neither cooperatives of the apartments' owners (CAO), nor the heat supplying enterprises are interested in the management of heat consumption by households. The main efforts to raise energy efficiency surrounds the functioning of central heating that require modernization of the HPC's capacities and heat networks and the objects with the high heat losses, such as the old residential fund, the public buildings and industrial enterprises.

In the process of improvement work on CHS it is necessary to solve the following tasks:

1. The maximum usage of existing CHS' potential, and combined heat and power on the HPCs, that is providing the work regime of the HPC on the heat schedule;
2. The radical reduction of heat losses in the heat networks, and also the power on the pipage of the heat carrier;
3. The development of complex organizational and technical measures in the heat consumption systems aimed at energy saving.

4.4.4. Introduction of energy saving technologies while producing, distributing and consuming energy

Kazakhstan's main document regulating the country's energy saving policy came into effect in December 1997. More recently, the Government is focusing its work through its energy saving program 2005–2015 (Stage 1 2005–2007). The main objectives of the Program are:

1. turning the measures on energy saving into a staged and permanent process of developing projects aimed at the scientific and technical based reduction of energy consumption in all aspects of the country;

2. the development and implementation of a short-term and prospective program adapted to real working conditions making it possible to turn energy saving into a self-regulating and forecast process.

Analysis of the country's economy and energy sector supposes the energy saving potential of Kazakhstan can reach 30% of all the volume of energy consumption.

With the aim of energy saving it is recommended the following measures are carried out:

- stimulating output and usage of fuel energy saving equipment;
- expenditure records of energy resource and expenditure control (introduction of the systems or record-keeping devices);
- State supervision over the effective usage of energy resources.

Energy saving can significantly reduce the fuel spending for securing the increase of electrical and heat energy demand in Kazakhstan. The heat cost in CHS for heating one square meter of a building is 1,5-2 times higher than that in Western Europe. The main trend in supplying the country's population with safe heating by 2015 must have measures on energy saving in all three components of SCH – energy sources, heat networks, heat consumption systems. Each of the components of the SCH energy sources, heat networks, heat consumption systems has substantial energy saving potentials.

Potential fuel economy exists in the increase of boiler unit working efficiency and secondary equipment of power stations and boiler-houses.

The energy saving potential in the heat networks is determined by the rate of more-than-normal losses through the insulation of line tubes and leakage of pipe water through worn-out stop valves and tightening packing boxes compensators.

Considerable energy saving potential and reduction of GHG emissions is linked with the use in the heat networks of pre-insulated pipes. Table 4.1 provides the scores of reducing CO_2 emissions per 1 running meter with the diameter of 700 mm. presented on the projected extension of the pre–insulated pipes.

Table 4.1 The projects of building and reconstruction of heat networks in the cities of Kazakhstan with the usage of pre–insulated pipes.

Town	The reduction of the CO2 emissions at replacing 1m pipe of the diameter 700 mm, kg/year	The extension of new and restoring main heat networks (in terms of 700 mm diameter), km	The total reduction of CO2 emissions t/year
Almaty's AIC	195	200	39 000
Almaty	105	35	3 675
Astana	285	185	52 725
Semipalatinsk	450	80	36 000

The advantages of channelless laying with the use of pre–insulation plant manufactured heat pipes in comparison with the standard laying in the crawlway channels are:

– the rising of long-term functionality (the exploitation resource of tube lines) 2–3 times;

– the reduction of heat losses – minimum 3 times;

– the going down of capital expenditures;

– the availability of operational distance - control system of insulation status;

– the high impermeability of the constructions maintains the feature stability of heat insulation when laying in the damp ground;

– the tubes, when keeping up with the standard construction technology, can serve more than 30 years, not requiring the special prophylactics.

Two international companies are used when carrying out the construction of heat networks in Kazakhstan. The ALSTOM/LOGSTOR firm has more than 30 years' experience building heat networks using pre–insulated tubes and laid out 4 km. of heat network were in Astana. Currently there are the channelless heat networks being built using pre–insulated tubes supplied by the German "ISOPLUS" firm in Astana. A Kazakhstani plan, in Astana, manufactures the pipes and molded products with foamed polyurethane insulation in the ethylene polymer covering..

Considering the possible favorable reduction of electric energy's consumption for the pipage of heat carrier, the energy saving potential in the heat networks is assessed by the amount of more than 1,5 mln. t.e.f.

4.4.5. The Program of development of the United electrical energy system to 2010, with potential to 2015

The Program work out the following two scenarios:

Scenario 1 takes into consideration the industrial innovation policy for3,69 times GDP growth in 2015 comparing with year 2000, with the annual average increase ratio of 9,1 % and energy intensity reduction by 2 times. The corresponding average annul electrical energy consumption growth in this scenario will amount to 3, 7–4,4 %, and GDP's energy intensity will not exceed 0,7 toe/ 1000 US$.

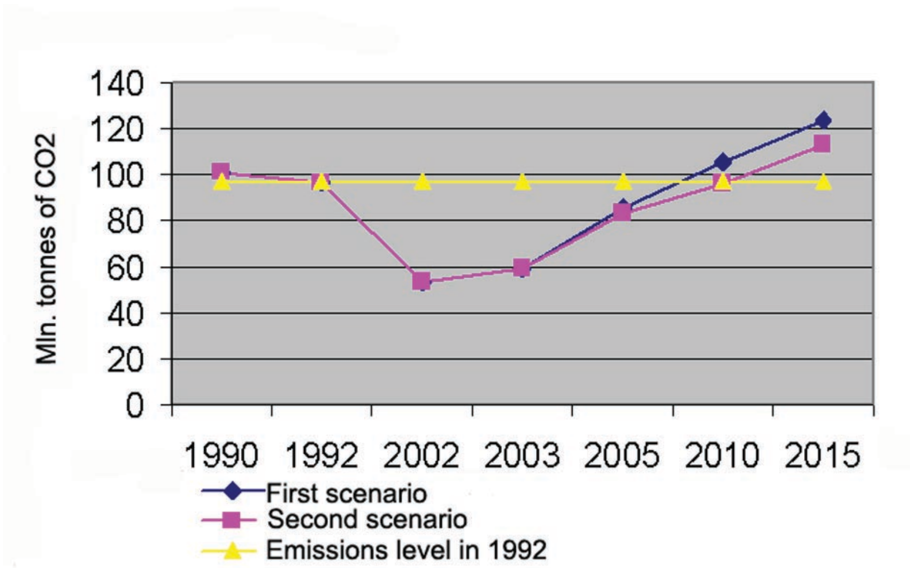
Scenario 2 is built on the basis of the development and distribution of productive forces by 2015, envisaging 3,04 times GDP growth in 2015 comparing with year 2000, with the annual average increase ratio of 7,7 %. Under the realization of this scenario the average annual electricity consumption growth ratio will comprise 3, 5–3, 8 %, GDP's energy intensity – 0, 9toe/1000 US$.

The scenarios include a forecast of GHG emissions in Kazakhstan's power industry for 2010–2015. The assessment of the GHG emissions concurs:

- the rise of electric energy output on heat usage on the HPC at 38% on the present rate to 66 % by the year 2015, that is 1,7 times;
- the potential use of energy saving, constituting 30% out of all volume of energy consumption on the present level;
- the increase of the part of the ICE in the general balance of electric energy output practically from zero to 1,0 %.

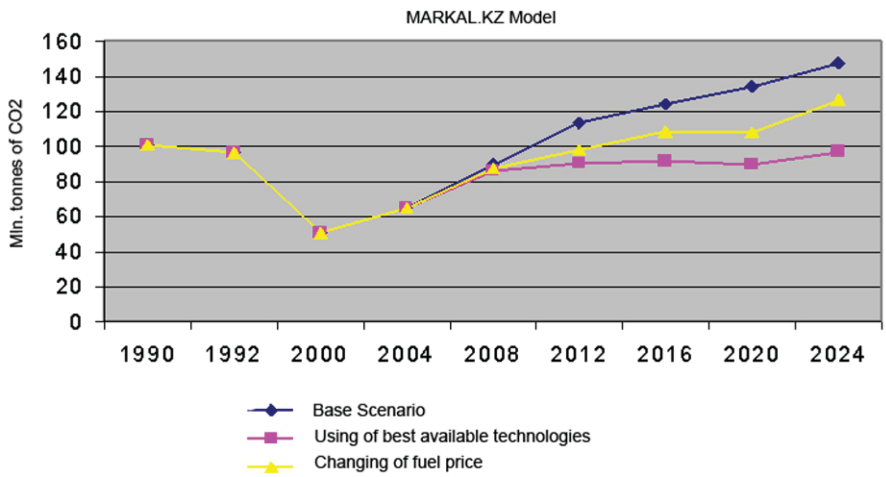
The construction of the atomic power station as part of the current program framework to 2015 in the South region hasn't been considered. The assessment results are presented in Picture 4.5.

The assessment of GHG emissions in Kazakhstan's energy industry sector for 1990 – 2003 is taken from the KazSRI's GHG assessment data. The GHG assessment results for 2005 show that CO_2 emissions from the energy complex amounted to just 64,1 mln. tons against the forecast of 85,8 mln. tons on the first scenario and 83,3 mln. tons on the second – that is by 30–35 % less than forecast in 2003.



Picture 4.5. - The CO_2 emissions' dynamics of the energy ministry of RK under the various scenarios LRP "KazNIPIENERGOPROM"

The assessment, carried out while preparing the INR using the MARKAL model, there are more than optimistic results received (Picture 4.6).



Picture 4.6. - The change dynamics of CO_2 emissions from the energy sector of RK under the various scenarios (MARKAL model).

According to the MARKAL model, GHGs emissions in the energy industry sector under the existing technologies and general state (the baseline scenario) will reach 1992 levels by 2012–2014. The introduction of more effective technologies for coal burn-out in the energy sector will be reached by the year 2024. The total reduction of GHG emissions in relation to the baseline scenario can amounts to 15 to 30 mln. tons of CO_2 by 2016 and 30 – 50 mln. tons of CO_2 by the 2024.

4.4.6. The effectiveness rise of power output in a combined cycle

This section provides information on projects which are aimed at raising the effectiveness of the production and distribution of energy.

Project 1. Extension of the HPC – 2 in Astana, end timeframe 2013–2015. The emissions' reduction can be reached on the A scenario due to the effective rise of electric energy output in a combined cycle. The base scenario (B scenario) supposes the securing of growing electrical loads on the working scheme from the Pavlodar – Eckibastuzsky energy point (Table 4.2).

Table 4.2 The emissions and CO_2 reductions on the project "The extension of the HPC – 2 in the city of Astana".

The scenario and effect	The CO2 emissions at setting up of one turbine, the CO2 thou. t / year	The CO2 emissions at setting up of two turbines, the CO2 thou. t / year
The emissions on the project, the scenario A	510	1 020
The emissions on the base scenario, B	835	1 675
The reduction of the GHG' s emissions, B - A	325	655

Project 2. The HPC – 3 construction in the city of Semipalatins, end time 2013–2015. The project will bring about the closure of around 80 boiler-houses. The CO2 emissions' reduction can be reached due to the effective rise of electric energy output in a combined cycle (the A scenario). The base scenario (B scenario) supposes securing growing electrical loads on the working scheme - from the Pavlodar – Eckibastuzsky energy point (table 4.3).

Table 4.3. The emissions and CO_2 reductions on the project "The HPC – 3 constructions in the city of Semipalatinsk".

The scenario and effect	The CO2 emissions at setting up of one turbine, the CO2 thou. t / year	The CO2 emissions at setting up of three turbines, the CO2 thou. t / year
The emissions on the project, the scenario A	255	765
The emissions on the base scenario, B	420	1 260
The GHG emissions' reduction, B – A	165	495

An important development direction for the energy industry, linked to the reduction of GHG emissions, is the potential increase of gas turbine machines. As a result, power, as pat of the total energy balance, will increase from 2.3% to 7.8% - potentially doubling the power output. (Table 4.4).

Table 4.4. - The projects on utilization of the favorable gas in the oil and gas minefields of RK.

Sites	The supposed power	Putting into exploitation
Atyrau HPC	70 mW	2007 - 2008 yrs.
Tengiz oil - gas complex	2x 120 mW (240 mW)	2007 - 2008 yrs.
Agip KCO (Kashagan minefield)	230 mW 270 mW	2010 yr. 2015 yr.
On the HHPS KPK	265 mW	2010 - 2012 yrs.
The Kumkol HHPS' extension	200 mW	2008 - 2012 yrs.

The introduction of the SGM will partly replace electrical energy production on the coal power stations in Kazakhstan and Russia. The delivery of these projects will make it possible to achieve substantial reduction in GHG emissions which can account to 1,2 to 3,2 mln. tons of the CO2 equivalent.

4.4.7. Renewable energy sources

The Government has several programs relating to renewable energy sources outlined in the following:

- (1999) Program of electric energy development to 2030;
- Program of effective energy and renewable resources aimed at sustainable development to 2024;
- UNDP/GEF project "Kazakhstan – the market development of the wind energy initiative" is being developed. The framework on WIE is being worked out as while having the economic potential in 39 tln. kWh (without big hydroelectric stations), Kazakhstan is essentially lagging behind in the volume of WIE usage.
- Project on the support of renewable energy sources use – aimed at the regulation of social issues arising from establishing production enterprises, and the delivery and completion of power energy produced with the renewable energy sources.
- Strategy for effective energy and renewable resources usage to 2024.

4.4 8. Hydroenergy

The Hyro potential of Kazakhstan is high although the water and hydro energetic resources are distributed unevenly, concentrated in the Eastern, South–eastern and Southern zones.

It is noted that previously there were around 90 small HPS (SHPS). A survey on these places shows that 21 SHPS, with the summative power of around 78 mW putting out on the average 357 mln. kWh, are in working condition. The rest are destroyed.

In perspective to the year 2020, it is rational to introduce small HPS into the electrical balance through rehabilitation of the abandoned stations and construction of the new ones.

The project currently underway include:

- setting up the Moinack HPS on the Charyn river – power of 300 mW;
- setting up the Kerbulack HPS on the Ily river – power of 50 mW;
- setting up of small HPS on mountainous rivers with total power of 100 - 120 mW.

4.4.9. Wind power

According to data analysis Kazakhstan has substantial potential for wind energy, with great potential in the Djungarsky gate area and Sheleksky passage. The annual wind speed in these passages is on average 7 to 9 m/s and from 5 to 9 m/s, respectively. These conditions surpass other existing areas in the world where wind energy is used. Significant development hasn't occurred due to the relatively high prime cost. Wind devices such a pumps are used for agricultural needs.

The construction project of the WES is being carried out with the assistance of the PDUNO/SEF in Kazakhstan and a grant component from SEP (2, 9 mln. US$). This project will generate power of 5 mW in the Dzhungarsky gate and cost of 7, 61 mln. US$. The prime cost of energy produced from this WES, will amount to 3–3, 5 cent/kWh.

A joint project with the Indian NEPC Group company building two wind–energy units, 250 kW each, is being carried out in the South – Kazakhstanskaya oblast.

Currently, WES legislation is being coordinated by relevant Ministries before going before Parliament. Its adoption will secure the support of WES usage, in particular the construction of wind electrical stations with total power to 2000 mW and small HPS up to 1000 mW by 2024. A result of this will see the proportion of the renewable energy industry's electrical energy output volume (excluding the big hydro electric stations) comprise around 5% by 2024.

4.4.10. The solar energy

Kazakhstan has a substantial potential for solar energy. The level of solar radiation is 1300–1800 kWh/м^2 per year and the number of annual solar hours reaches 2200–3000 hours. The solar units (SU) can be used for heating. Assessments show the potential for heating water through solar energy amounts to 13 mln. Gcal. per year - saving more than 1, 4 mln. s. c. f.

The SU are used primarily for the hot water supply of individual buildings. Table 4.5 presents the potential for solar energy in various regions of the country.

Table 4.5. The solar energy's potential in the regions of Kazakhstan.

№	Region	kW/м2/year	kW/m2/day		
			Mean	June	December
1	Shymkent	1780	4,88	7,95	1,65
2	Aktau	1442	3,95	6,71	0,98
3	Astana	1297	3,55	6,47	0,83
4	Semey	1441	3,95	6,74	12,05
5	Taldy - Korgan	1703	4,67	7,40	1,58

Currently, with the support the UNDP and CIDA a pilot project using simple SU is beign carried out on a one of boiler-houses in the city of Almaty. The SU is used for warming water in preparation for heating purposes. The power of SU is about 0,1 Gcal/h, the square of the solar absorbers is 260 m^2 and specific cost is around 60 US dollars for 1 m^2. The usage of these SU can be an economic advantage in the CHS where the boiler-houses are running on expensive fuel gas or mazut. The future of SU usage in CHS will be determined by proportion of fuel cost for the boiler-houses and SU equipment costs.

4.4.11. Geothermal energy

A Government study of geothermal mines, carrier resources and the prospect of heat energy usage was carried out by the Almaty Institute of Energy and Telecommunications (AIET) in 1998. The research shows that Kazakhstan has substantial geothermal energy stores. Potential rock resources comprise 317, 6 tln. s. c. f., and technically available (up to a depth of 5km industrial drilling taking into account the extraction coefficient and fixed temperature regime of a consumer) stores of geothermal energy sources of aqueous basins are assessed as 4,1 tln. s. c. f., with the temperatures: 8 – 20°C – 281 tln. s. c. f., 20 - 40°C – 332 tln. s. c. f., 40 - 60°C – 903 tln. s. c. f., 60 - 90°C – 1239 tln. s. c. f., more than 90°C – 1356 tln. s. c. f.

4.4.12. The biomass energy and the urban ore

There are substantial biomass resources in terms of vegetative waste products (straw, waste wood), animal waste and also urban ore (UO). Approximate estimations show that the vegetative waste products amount to around 18 mln. tons per year, animal waste to around 22, 1 mln. tons per year and urban ore is about 5 mln. tons annually. The use of only agricultural waste products would allow save 14 – 15 mln. of s. c. f. per year.

The issue of urban ore's mass-scale usage (primarily the city dumps) as a fuel in the cities of Kazakhstan requires a study and special program of action on collecting and sorting out of the refuse, its burial and usage.

4.4.13. The reduction of GHG emissions through utilization of renewable energy sources

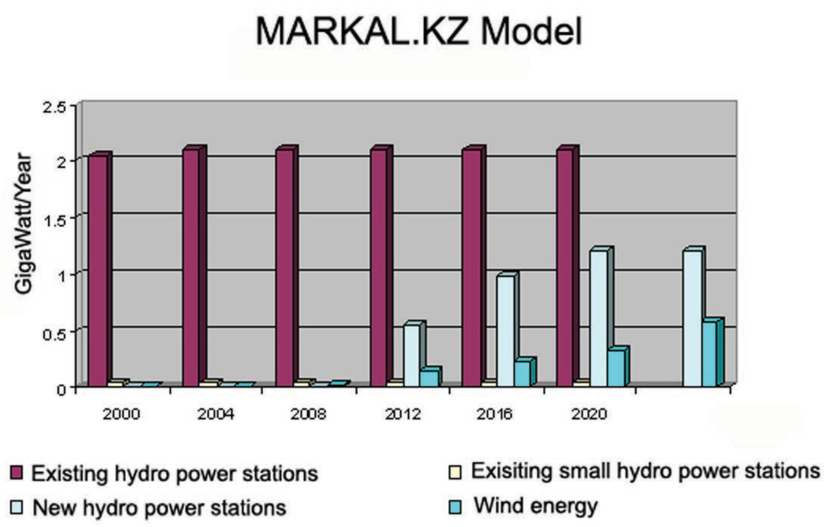
One of the ways to reduce GHG emissions with maintaining of present economy's growth ratio is utilization of the renewable energy sources (RES) and there is a huge potential for that.

Using the MARKAL model, growth scenarios of renewable energy sector outlined in Picture 4.7

As shown, potential exists to enlarge the renewable energy sector – with the general reduction of GHG emissions while using these sources amounts from 500 thou. tons to 2, 5 mln. tons of CO_2.

The usage of RES in Kazakhstan's economy assist by:

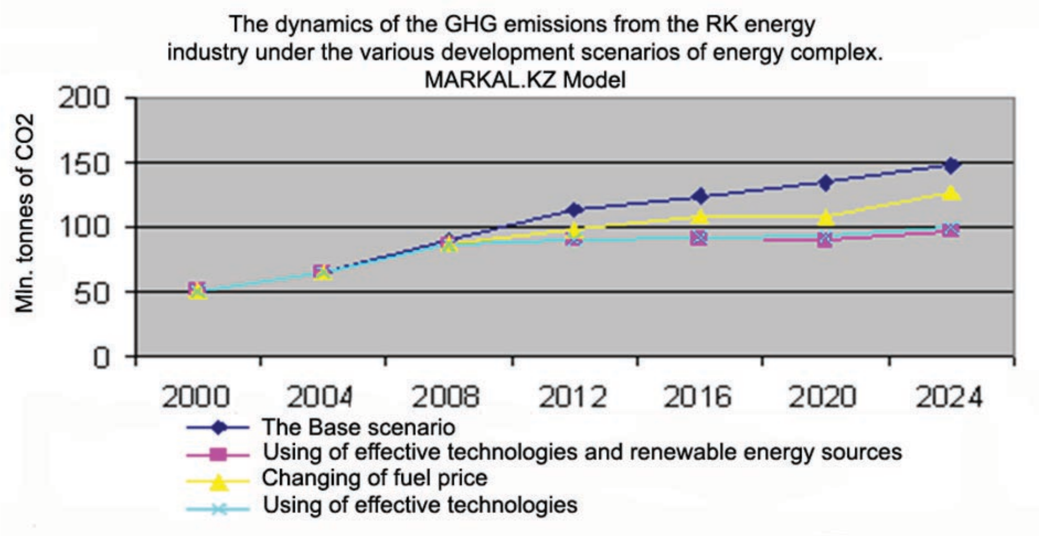
- improving the of ecological situation;
- improving social conditions of the population, especially those in rural regions and districts where there is no central power supply;
- the replacement and economy of organic fuel, mostly used in the low - potential processes.



Picture 4.7. - The change of the renewable energy sources' demand (MARKAL model, KZ).

4.5. The dynamics of GHG' s emissions from Kazakhstan's energy industry in relation to the technologies used

Picture 4.8 shows the dynamics of GHG emissions presented from Kazakhstan's power stations under the various scenarios of power production technologies.



Picture 4.8. - The dynamics of the GHG emissions from the RK energy industry under the various development scenarios of energy complex.

The best scenario uses effective technologies and renewable energy sources of WES and HPS (RES). The general reduction of GHG emissions due to in the establishment of more effective technologies into the energy complex of Kazakhstan can amount for 40–50 mln. tons of CO_2 by the 2024.

4.6. Steps for reducing GHG emissions in the energy industry

The important factor energy saving policy is equipping and building power stations with automated control (Tables 4.6-4.7).

Table 4.6. - The preliminary cost assessment of the reduction of the greenhouse gases' emissions in the energy industry sector.

№	The name of the step on emissions' reduction.	The preliminary cost assessment, tenge/t CO2
1.	The present HPC' s restoring, the output increase on heat consumption	2500 - 4000
2.	The carrying out of energy - saving policy (the change of heating system' s tubes as an example)	2000 - 4000
3.	The construction of gas turbine and steam gas power stations:	
	- gas - turbine power stations	1000 - 1500
	- combined cycle gas turbine stations	500 – 800
4.	The development of renewable energy sources	
	- the small HPS	800 - 1500
	- the wind units	1000 - 2000

The reduction of more than normal losses in the heat networks by 50% will ensure the fuel economy up to 1 mln. of t.o.e./year.

Table 4.7. - The preliminary cost assessment of reduction of the greenhouse gases' emissions in the energy industry sector from the present day's level to the year 2020.

№	The name of the step	The reduction of the GHG emissions from the present day' s level		
		2010 yr.	2015 yr.	2020 yr.
1	The present HPC' s restoring, the output increase on heat consumption	3,2 %	5 %	7 %
2.	The carrying out of energy saving policy (the change of heating system' s tubes as an example)	2 %	4 %	9 %
3.	The construction of gas turbine and steam gas power stations:			
	- gas - turbine power stations	0 %	3 %	8 %
	- combined cycle gas turbine stations	0 %	5 %	7 %
4.	The development of renewable energy sources (RES)			
	- the small HPS	5 %	7 %	12 %
	- the wind units	4,3 %	8 %	12 %
Total:		14,5 %	32 %	55 %

In the Table 4.7 there is a preliminary assessment of the reduction of GHG emissions in the energy industry sector – a variant that is possible only at the most optimistic scenario. Unfortunately, the lack of investment, the energy demand reduction in the internal market, unavailability of qualified specialists and the lack of power transmission lines in practice mean that the estimates are to be divided at least by two.

4.7. Measures for reducing GHG emissions in industrial and residential - communal sectors

Industrial enterprises

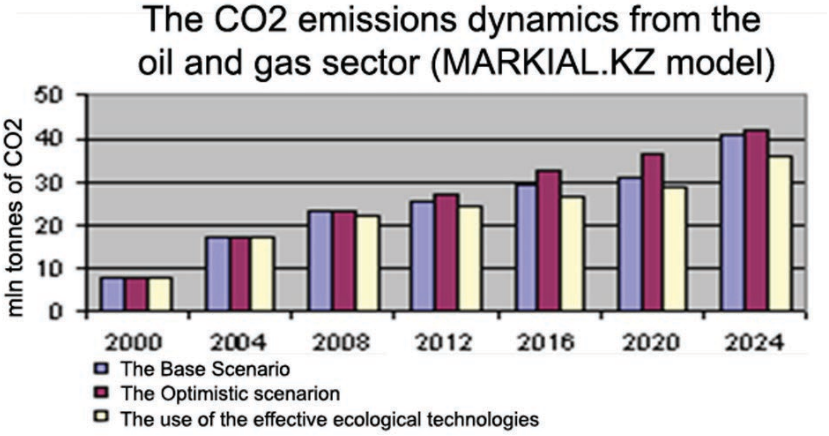
The basis of economy of Kazakhstan is formed by the mining, metallurgical and fuel energy complexes where there are the most energy intensive productions. The outdated technologies in use, physically worn and morally outdated equipment of some enterprises of the Republic predetermine the high energy intensity of the production by the Kazakhstani enterprises.

Analysis of international data on specific energy/output ratio of different parts of the economy shows availability of great potential for energy saving due to the use of outdated technologies, and also of the low technological discipline on the enterprises of the Republic, which, nonetheless, is improving from year to year.

The oil and gas industry

One of the richest zones of oil–gas deposits on the planet is the Caspian basin region. Each year the amount of extracted oil and gas in the region is growing and in coming years it will exceed 5% of the world's output.

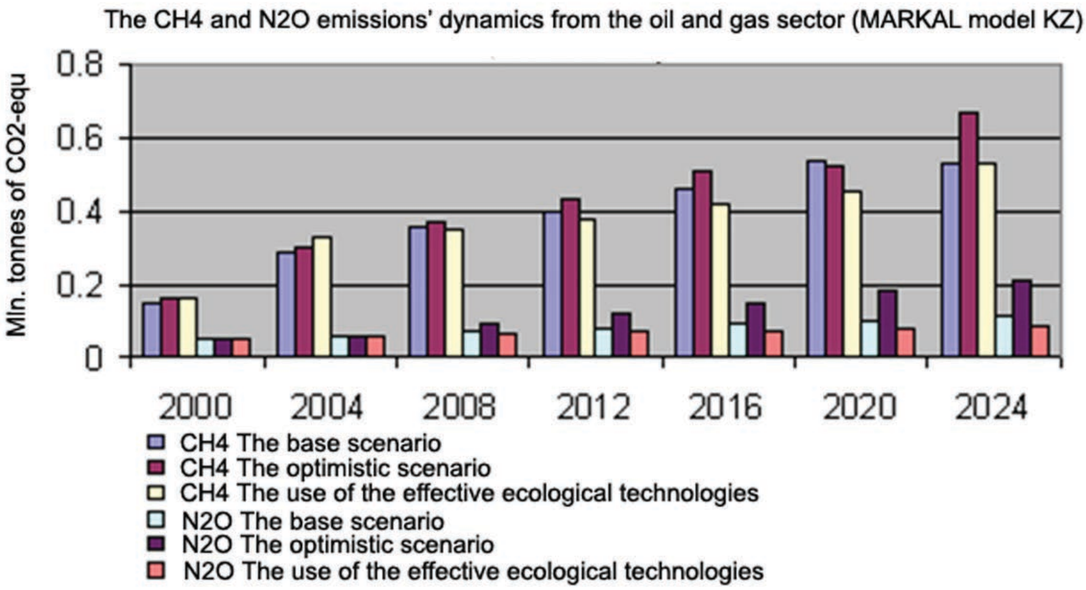
A peculiarity of the oil fields in the Caspian sea region is that almost all of them are hydrocarbon saturated. The accompanying gas is extracted in large quantities, and the main component is methane. On the large Tengiz minefield where there is about 18 mln. t. of oil, extracted annually, or 75–80 % of all the output, in the accompanying gas there is 16 – 25 % of sulphuretted hydrogen, 3–5 % of carbon dioxide and 47–52 % of methane, and also 15–22 % of ethane and propane.



Picture 4.9. - The CO_2 emissions' dynamics from the oil and gas sector of RK

In recent years serious steps have been undertaken towards reduction of the associated gas emissions. And, in the framework of the project "Expansion of the gas transportation system" the 40-inch line "the gas refinery plant – Kulsary' s minefield" was constructed, that also increases the oil export possibilities.

The perspective project "The unstripped gas flooding" is being realized by Shevron (Tengiz oilfield). At the present, preparatory work has been done and since 2007 the second stage of testing has occurred.



Picture 4.10. - The dynamics of the GHG emissions from the oil and gas sector of RK under the effective and ecologically clear technologies.

Collection and flaring of associated gas is envisaged in frames of the wastes utilization project where its refinement is not planned yet.

The realization of a big project "The modernization of gas output and export system" is being continued. The aim of this project is to modernize the equipment in order to reduce the flaring of lightweight gases and to facilitate gas refining.

In frames of "The Energy Program" it is planned that by the year 2015, 85 % of the associated gas will be supplied for production of electrical energy on the gas turbine power units. The total emissions reduction as a result of these measures is presented on the pictures 4.9 – 4.10, and also is given in the table 4.4.

But, taking into account that on the various oilfields the amounts of associated gases per unit of oil extracted is different, the permitted emission volume per extracted oil unit is not defined. As a corporate potential for emissions reduction in the sector, historical emissions were taken, about 10 mln. t., in other words the increase of oil extraction won't be accompanied by increase in methane' s emissions. These are the main tasks for the projects implemented in this sector.

The possible reduction of GHG emissions from oil and gas through achievement of the programs can account to 2 – 2,5 mln. tons - equivalent of CO_2 by the 2012 – 2016, to 4 – 5,5 mln. tons equivalent of CO_2 by 2024.

The coal industry

The coal reserves in Kazakhstan are extensive and the output is in several coal basis – the largest ones are the Eckibastuz and Karaganda. This brings half of all the methane in the category of "flying emissions" in Kazakhstan. Methane emissions in the coal output account to around 11 mln. t. annually, exceeding the oil and gas sectors (see chapter on GHG assessment). The measures for methane emission reduction are carried out in the framework of following programs:

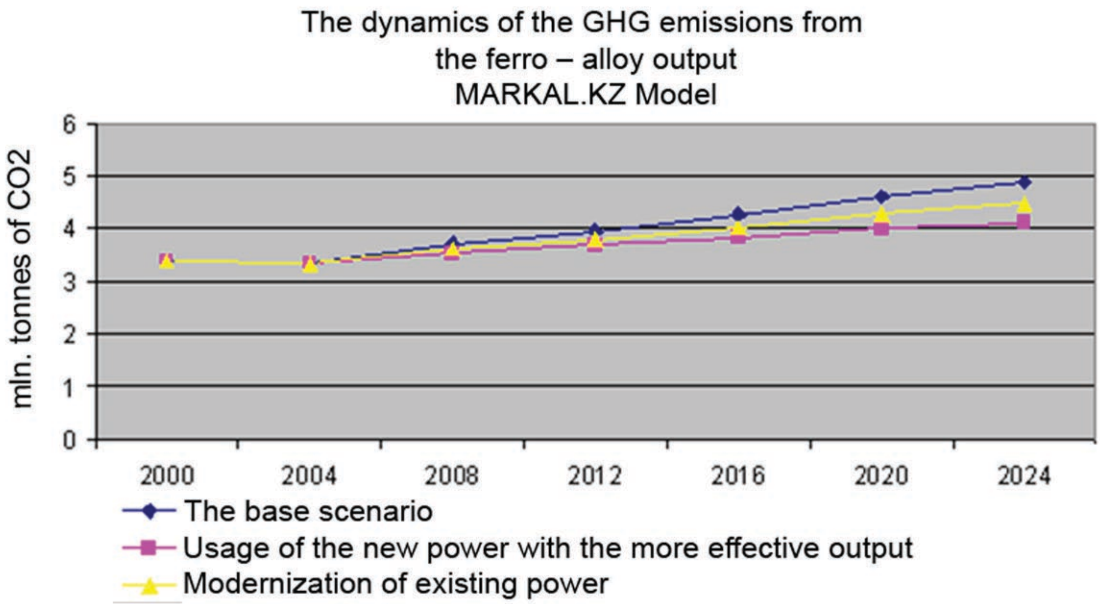
- Eckibastuz coal;
- Closing of the coal mines at Karaganda basin;
- Ensuring the coal branch transition to international standards.

The Karaganda coal basin is one of the highest gas bearing in the world. The output of each coal ton is accompanied by emitting 20 – 25 cubic meters of methane. As a result, the extracted methane volume from the coal mines and layers exceeds the 380 mln. cubic meters annually. The measures taken are directed to the full usage of methane extracted. Six boiler-houses are put into use already, with methane being the chief fuel source for them. Currently, up to 20 mln. cubic meters of methane is utilized per year, and that gives up to 35 thou. t economy of coal equivalent. There is the work on usage of methane–air mixture being done with low methane content up to the 25%. Along with Government directives, a whole set of regional rules are being developed, aimed at reducing the methane emissions in the coal branch.

At present, reducing the deep mine coal output by 1% leads to CH_4 emission reduction by around 1,4 %. The measures on methane utilization from mines ventilation systems can provide the additional emissions reduction, and the further refinement will allow to use it as an additional fuel.

Ferro–alloy output

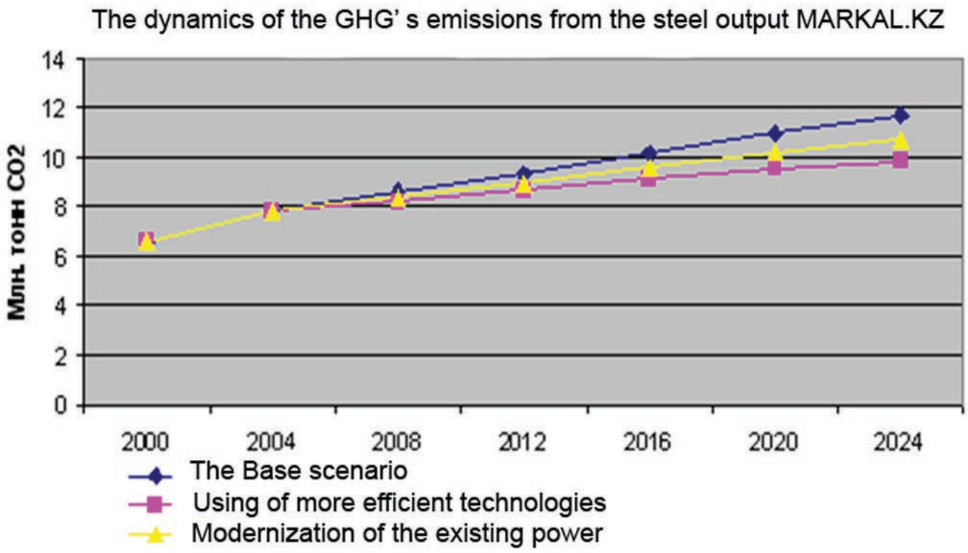
On the pessimistic (base) scenario where putting in new ferro – alloy technologies production is not envisaged, the CO_2 emissions increase expected from the present 4,5 mln. t. to 5 mln. t. by 2024, and on the optimistic scenario planning the introduction of new technologies – only to 4 mln. t. Under the conditions of modernizing the existing powers without putting in new technologies GHG emissions will increase to 4,5 mln. t. (Picture 4.11).



Picture 4.11. – The dynamics of the GHG emissions from the ferro – alloy output.

Steel output

The output of steel utilizing existing technologies (the base scenario) would see GHG emissions rise from 8 mln. t. at present to 12 mln. t. by the 2024. In the case of re–orientation to new technologies, the increase of GHG emissions will take place more slowly and by 2024 will hardly reach 10 mln. t. Through modernization of equipment the emissions for that period will increase to 11 mln. t. at the annual reduction tempo in relation to the base scenario by 1–1,2 mln. t. The use of more effective technologies under the general increase of steel output will promote further reduction in GHG emissions by 1,5–1,9 mln. tons of CO_2 per year (picture 4.12).

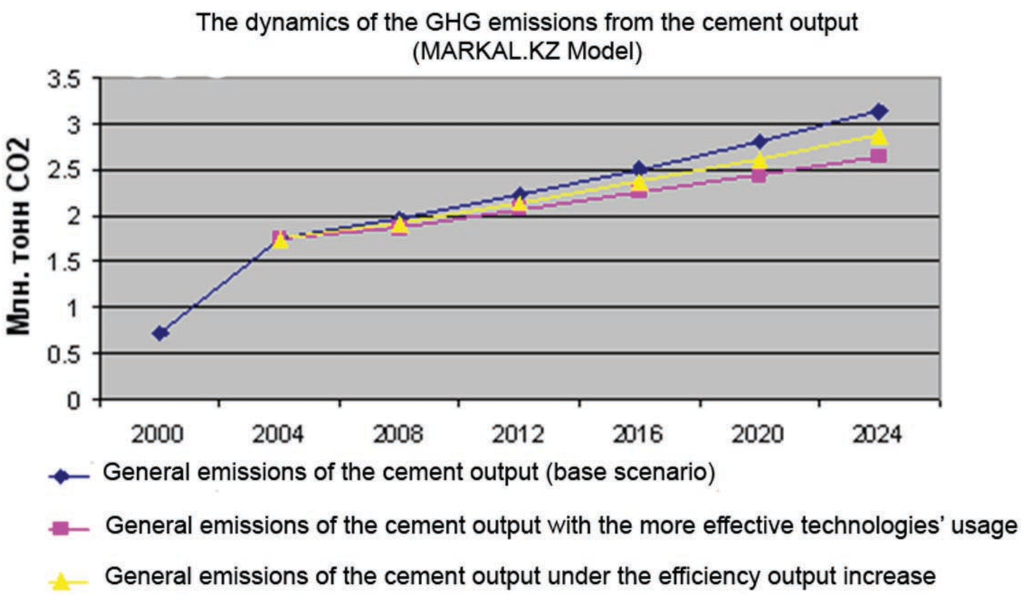


Picture 4.12. - The dynamics of the GHG' s emissions from the steel output.

Cement output

In recent years, the output of building materials has grown – concerning the output of gypsum for building purposes, cement, paints, ceramic tiles, assembly building constructions, and roofing felt. The main pre-supposition is the dynamic growth of the building sector (especially in the cities of Almaty, Astana, West–Kazakhstan and Atyrau oblast). The intensive development of the building sectors leads to growth in cement output. Three cement plants are operating in full load, as well as additional plants are being modernized and reconstructed with the aim of expanding production in the Mangistau, Aktobe and Western-Kazakhstan oblast.

Picture 4.13 shows the dynamics of GHG emissions from the cement output in relation to the technology used.



Picture 4.13. - The dynamics of the GHG emissions from the cement output.

The GHG emissions from cement output amounts for about 1,8 mln. t. at present. By the 2024 on the base scenario growth in GHG' s emissions is expected to reach 3,3 mln. t., when using the more effective technologies (the optimistic scenario) the GHG' s emissions will comprise the 2,6 mln. t., and with increase in production efficiency, without introduction of new technologies – 2,8 mln. t. (Picture 4.13).

Residential community facilities

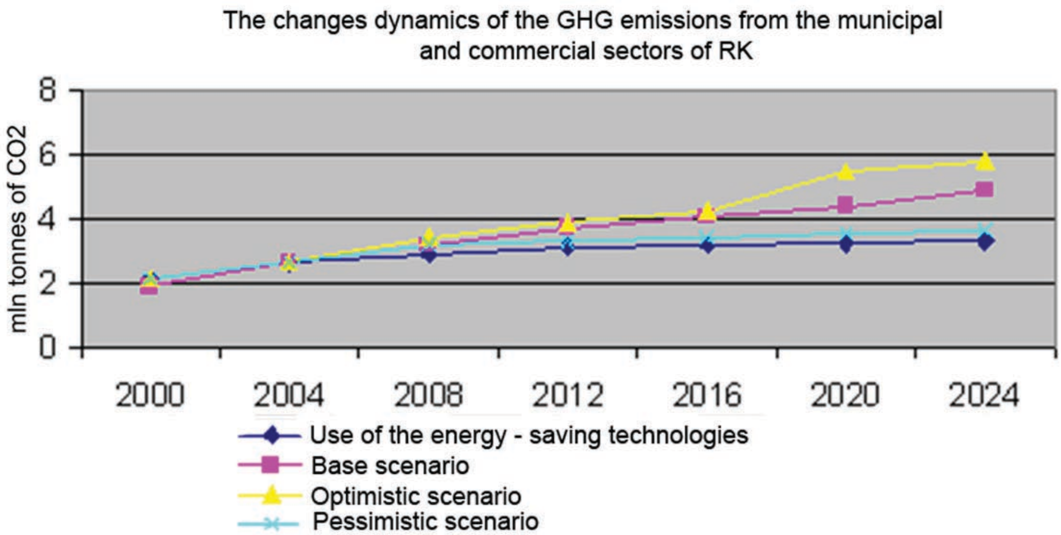
Kazakhstan requires a substantially large amount of heat for its residential community sector.

The heat consumption system of households and public buildings holds the most energy saving potential. Heat losses of buildings built in Kazakhstan, in comparison to the same buildings of Western European countries, must have the specific heat losses three times less than they have today. The energy saving potential in the residential sector is assessed by different experts in the size from 25 to 50 % of the actual heat consumption.

There is potential to consider ways of reducing the summative heat consumption (for example, the insulation of the entrance doors, windows' ledges) will allow to save around 8 mln. gCal, or 1,5 mln. s. c. f..

The real energy saving potential in the CHS can be assessed in the range of 6–7 mln. t. of the c. f., constituting around 35% out of the real fuel expenditure in CHS.

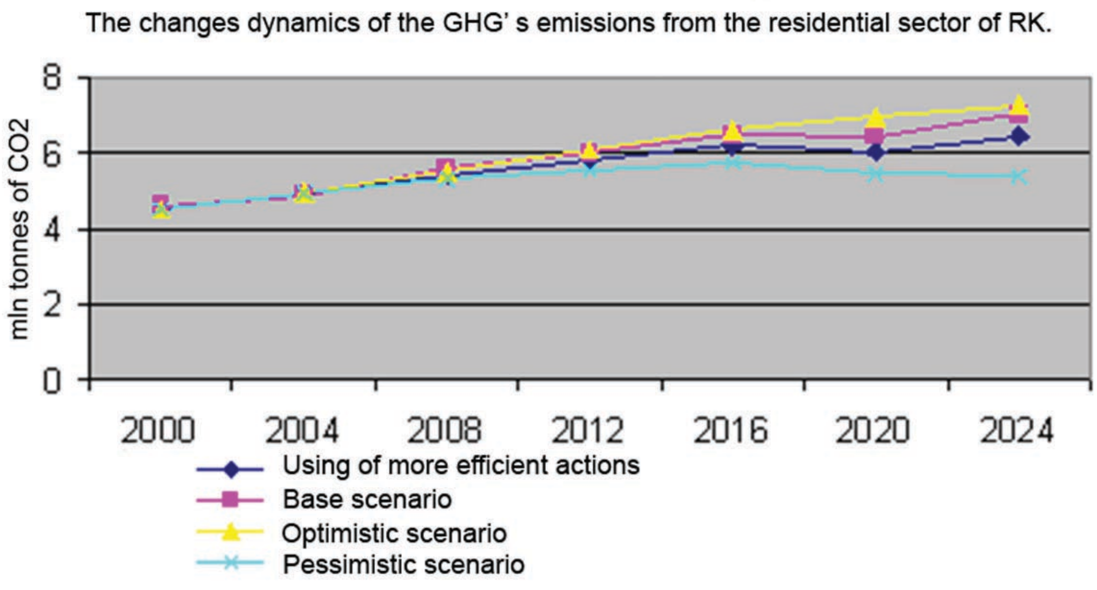
The conception of district heating accepted in Kazakhstan, made it possible to get rid of a great number of small boiler-rooms with the OIR not exceeding the 20–40 %. It will prevent the excess expenditure of millions of tons of fuel and reduce city pollution.



Picture 4.14. - The changes dynamics of the GHG emissions from the municipal and commercial sectors of RK.

Household devices (refrigerators, washing machines) are rapidly growing in the residential sector, however it is accompanied by a transition to modern energy saving appliances. Due to this, the power consuming growth by household devices is expected to be less significant.

Linked to the growth in the building sector are the increasing demands on heating. However, the mass introduction of heat and hot water meters promote substantial efficiency growth of this resource today. And the reduction of the GHG emissions from the commercial and municipal sectors has the most visible and measurable potential.. .



Picture 4.15. - The changes dynamics of the GHG' s emissions from the residential sector of RK.

Pictures 4.14 – 4.15 show the emission dynamics presented from the residential sector. The reduction of GHG emissions can amount to 1,5 mln. t. of CO_2 in 2024 from commercial and municipal sectors and from 300 – 500 thou. t. in 2012 to 1 mln. t. by 2020 from the residential sector.

Agriculture

The forecast of GHG emissions from agriculture is built on two scenarios of economic development to 2020. The first presupposes the annual increase of agricultural production by 5% (optimistic), the second by 2,5% (pessimistic).

The major steps on limiting and reducing CO_2 emissions and also increasing the absorption of GHG in agriculture are: more efficient energy consumption, lower energy intencity, energy saving, and direct limitation of the GHG emissions.

Improving the fodder output will change the intensity and character of CH_4 emissions in the internal fermentation in animal stock. Measures to fight soil erosion will be include anti–corrosion steps. A reduction of CH_4 and N_2O emissions in agriculture can be reached by improving the collection system, and keeping and usage of dung and birds' scat.

Waste

The GHG emissions forecast from waste use two scenarios of economic development to 2020. The first of these is built on the supposition that the GNP s indicator per capita will correspond to the world average level. According to the realistic scenario, the annual increase of amount of burn–out of accompanying gas on the average will account to 1 %, the square of the cropland – 5 %, the number of population – 2%.

The second scenario proposes that the development of Kazakhstan will have industrial direction. This means transitioning the national economy from raw material direction to high technology production. The triple increase of GDP per capita by the year 2020 comparing the year 2000is expected. On the optimistic scenario there is an annual reduction of accompanying gas burn–out amount by 1%, of the cropland increase by 2,5 % and the population number by 0,5%.

In accordance with the first, realistic, scenario, it is supposed that the annual SO_2, NOx, CO, NH_3 and Volatile Organic Compounds (WOC) emissions will increase, which will account to 1 %, for the NH_4 – 3 %, for the dioxin and APH – 5 %. In comparison with 2005 in 2015 it is supposed that there will be a gradual growth of the SO_2, NOx, CO, NH_3 and HMΛOC emissions' indicators by 10 %, and for each sort of pollutants, for the NH_4 by 28%, for the dioxins and APH by 63%. Correspondingly, in 2020 comparing the year 2005, there will the NH_3 emissions' growth take place by 13 %, by 15 % for the SO_2, NOx, CO, by 44 % NH_4 emissions and by 8 % for the dioxins. Thus, the main emissions' sources from the waste materials will be the activity of open agricultural waste burn-out, left.

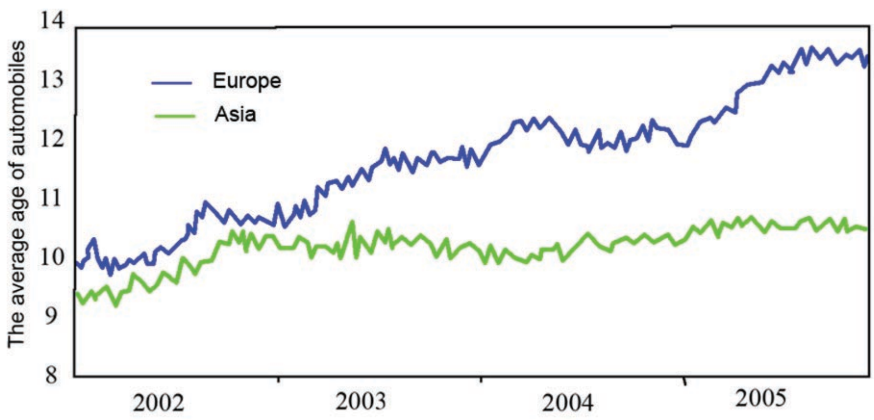
The forecast on the second scenario demonstrates the trend to annual SO_2, NOx, CO и WOC emissions reduction by 1 %, the annual emissions growth for the NH_3 by 1 %, for the dioxins, APH and NH_4 by 3 %. In 2015 in comparison with the year 2005 the SO_2, NOx, CO and WOC emissions will decrease by 10 %, the atmospheric NH_3 emissions will grow by 6 %, the APH and NH_4 emissions' amount will increase by 28 %. In 2020, compared with 2005, the reduction of SO2, NOx, CO and WOC emissions amount will strengthen to 15 %, the growth of NH_3 amount output will account to 11 %, and the APH and NH_4 emissions will grow by 45 %.

The most acceptable variant of the country's development should consider the second, optimistic, scenario due to which it can be possible for the input of advanced technologies for handling waste material. This will lessen the emissions – of the SO_2, NOx, CO and WOC and lower the growth tempo of producing other gases through waste.

Transportation

Analysis of transport sector development was built on data for the period 2000 to 2006. The petroleum transport is most widespread. It forms around 69 % of all automobiles. Automobiles running on diesel fuel are about 30 % and only one percent of all automobiles run on gas.

Most automobiles currently running in Kazakhstan are manufactured in Japan and Germany, 54 % and 32 %, respectively. The age of the country' s automobiles fleet is around 10 – 11 years (Picture 4,16).



Picture 4.16 - The average age of automobiles fleet of RK.

Data for 2006 show 50 % of motorcars are distributed between the cities of Almaty and Astana. As such, attention should be given to automobiles running in urban environments.

In recent years, in Almaty no calculations were made on freight, passenger flows. Today the situation is changing, and in major cities there are various programs aimed at reducing the impact of vehicles on the environment In Almaty program «Reducing traffic load», expansion and construction of new streets, construction of Big Almaty Ring Road (BARR), 13 bridges and 8 transport interchanges is envisaged. . .This should significantly reduce the traffic load on the city streets because in this case the transit transport will quickly go through the city not staying in it for too long. The BARR should partly take over the load of service vehicles going from one end to another (delivery of goods, couriers, etc.). In this case the total load on the interior roads will decrease by approximately 15 – 20 %, and the average speed in the city to increase from 30 km/h to 40 – 45 km/h. Besides, some hopes are also laid upon the starting-up of the first stage of the metro in the year 2008.

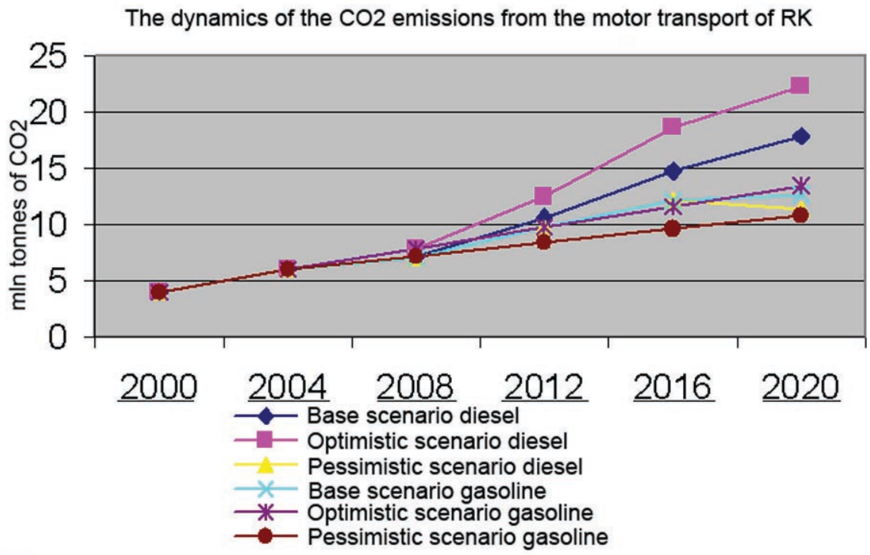
The Government established regulations regarding emissions from transport in 2007, that set up requirements for fuels and ecological characteristics of the harmful (polluting) substances emissions into the atmosphere, that is the specific standards of the motor transport emissions, on the stages:

1) Euro - 2 from 1 January, 2009;
2) Euro – 3 from 1 January 2011;
3) Euro – 4 from 1 January 2014.

Table 4.8. The steps on the reduction of the GHG emissions in the motor transportation.

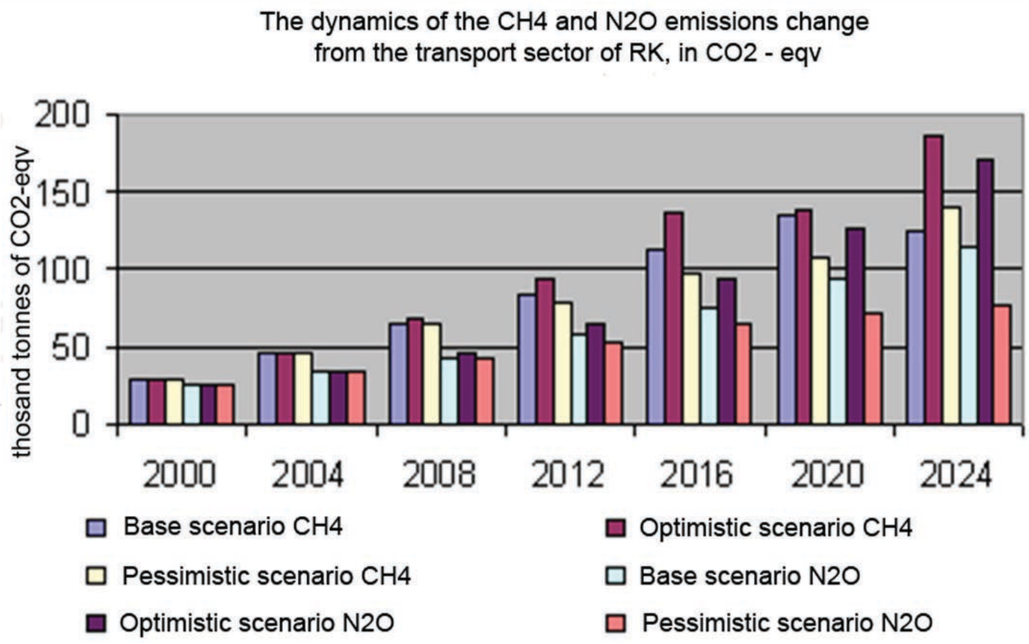
Steps on the reduction of the GHG emissions	2010	2015	2020
Putting - in into practice of new buses corresponding to the adequate standards of "Euro - 2" and so on.	2%	3%	4%
Development of public transport, lowering down of fare and so on.	0,50%	2%	3%
The metro construction.	0,50%	1%	1,50%
Development of suburban public transport.	1%	1,50%	2%
Putting - in into practice the standard "Euro - 2".	0,5 %	5 %	8%
Putting - in into practice the standard "Euro – 3".	0%	0,50%	3 %
Putting - in into practice the standard "Euro – 4".	0%	0%	0,50%
Stiffening of requirements to the auto fleet of RK.	3%	3%	3%
Building of new auto - interchanges on condition of lack of the auto fleet' s growth.	2%	4%	4%
Prohibition on import of old autos of more than 10 years old.	3%	4%	4%
Import of hybrid - autos into the country.	1%	2%	3,2 %
Change over of autos with the time of exploitation of more than 15 years onto the gas fuel.	10%	12%	15%
Import of autos, running on new kind of fuel, into the country.	0%	0,10%	1%
Total:	23,5 %	38,1 %	52,2 %

While most motor transport does not currently meet stands of 'Euro-2', this proportion will decrease as newer automotives are brought in from Europe. As seen from Table 4.8 and the pictures 4.17 – 4.18, the reduction of GHG emissions in total from the proposed measures will grow up by 15 % for each period.



Picture 4.17. - The dynamics of the CO_2 emissions from the motor transport of RK.

Unfortunately, GHG emissions, under the all the scenarios available will increase. However, it is likely that a time will come when the number existing vehicles be optimal to the people's income and the the traffic. In this case the emissions in this sector will not change drastically. Moreover, with the coming of new technologies there is a probability of GHG level reduction in this sector.



Picture 4.18 - The dynamics of the CH_4 and N_2O emissions change from the transport sector of RK, in CO_2 - eqv.

The Government's 2006 transport strategy aims to achieve the following results by 2015:

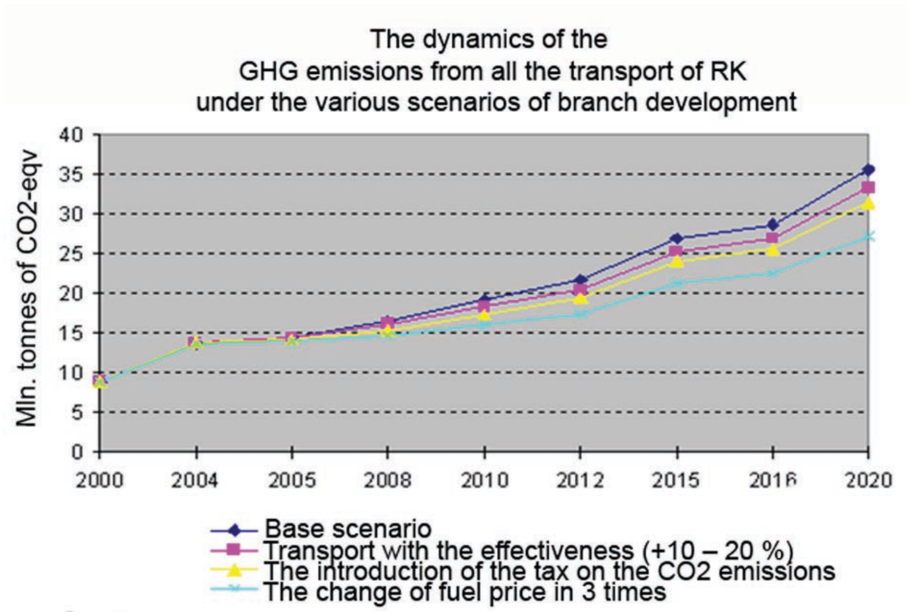
- freight turnover tp double (in 2005 to 223, 8 tln. tons - kilometers);
- passenger turnover to go up 1,5 times (in 2005 it amounted for 107,6 tln. pas-

sengers - kilometers);

- the usage of railroad and automobile transport by the population will increase in 1,5 times, the air one – in 6 times;
- the speed of freight traffic will grow by 15–20%, and on the main international transport corridors by 20–30%;
- the transport aspect in environmental pollution will come down 2,5 times (at present it amounts for 30%);
- considering the realization of the Strategy of industrial and innovation development and the prospects of territorial growth there will the freight traffic capacity of economy come down to 5 tons – kilometers/dollars of the GNP.

The expected growth in air transport services in the near future, and subsequent demand on aviation kerosene, in the optimistic scenario will increase from 0, 3 mln. t. of oil equivalent at present to 1,7 mln. t. In the pessimistic scenario, that is if the forecast of rapid air service growth is not met, then the demand by 2024 will amount for only 0, 7 mln. t. On the base scenario the demand on aviation kerosene will increase up to 1, 2 mln. t. by the end of the considered period.

Accordingly, Kazakhstan's GHG emissions from air services can on the base scenario constitute 450 thou. t. of CO_2 in 2005, to 1,2 – 1,4 mln. t. of CO_2 by 2020, and to 800 – 900 thou. t. of CO_2 on the pessimistic scenario. Based on that, the forecast for further growth in motor transport will raise GHG emissions (Picture 4.19).



Picture 4.19. - The dynamics of the GHG emissions from all the transport of RK under the various scenarios of branch development.

If the quality of motor transports remains the same then GHG emissions will rise up to 35 mln. t. (the base scenario) by 2020. The increase in engine efficiency, the use of combined engines and ethanol will raise efficiency by 10-20%, in turn reducing emissions by 2 mln. t. by 2020. The introduction of a tax could further reduce GHG emissions by 2 mln. t. by 2020 due to reducing jeeps numbers and generally more effective usage of motor transport. The most effective way for GHG emission reduction could be a triple could be a triple in the price of fuel. In this case, emissions would drop to 27 mln. t. by 2020 – that is 8 mln. t. below the base scenario.

Changing land usage and forestry

In this category, the carbon sink can be increased, mainly, due to forests restoration, forestation, trees planting in setlements and big cities, planting and expanding sanitary protection zones of big enterprises, and also rees planting on the banks of rivers and along the motor roads.

Kazakhstan has undertaken the following activities and actions as part of its implementation of the international framework conventions:

- the UNO Convention on biological diversity (CBD)
- the UNO Convention preventing desertification (CFD)
- the Government program for Kazakhstan's forests 2004-2006 – including the program of Pavlodar oblast
- the program on greening and developing the parks and squares of the city of Almaty 2005 – 2007.

The input in the carbon flow from carrying out projects on SBD and CFD is less significant because the projects in the framework are pilot projects, taking up relatively small squares, and, consequently, the biomass will not store a big amount of carbon.

The project 'Oasis' on biodiversity is an example of the Aral region. The objective is the conservation and restoration of biological diversity of the saxaul and tamarisk ecosystems and to prevent desertification in the Aral region. The project scope includes creation of 3 landscape oasises in square of 400 m^2 and buffer zones around them with total square of 1 ha. As previously outlined, the flowing in square of 1 ha., on which there grows up saxaul, accounts to 2,58 gG of CO_2 per year.

The Government program on Kazakhstan's forests was aimed at protecting, defending and restoration of forests, their rational usage and development. The Programme resulted in insuring forests' safety, the gradual enlargement of forest square coverage, improving the safeguarding of forests from fire, protection them from pests and diseases, improving the age structure and the qualitative and sanitary state of forests.

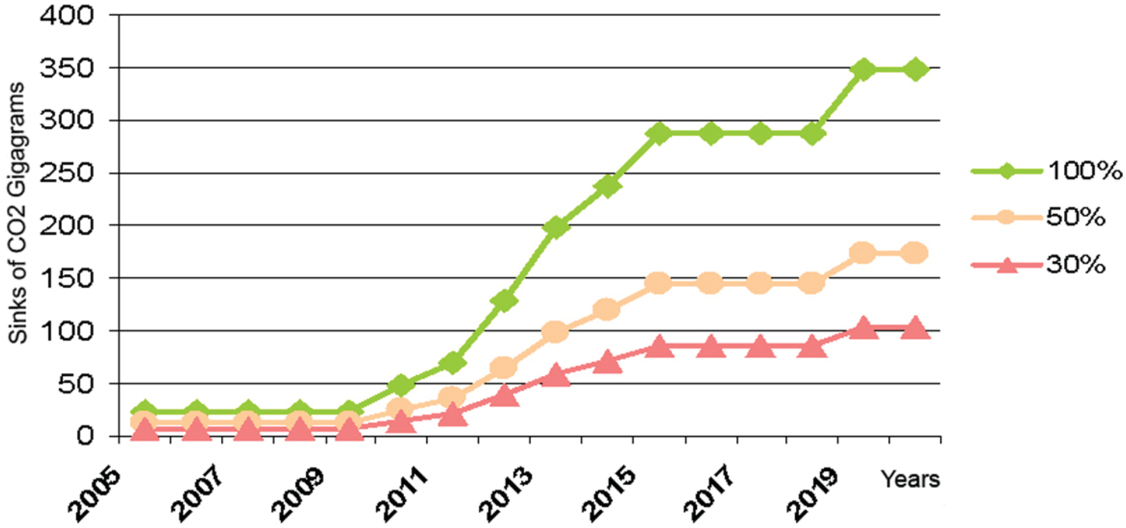
Table 4.9. The CO_2 flowing from the realization of various programs in the Republic of Kazakhstan under 100 % of acceptability (optimistic scenario), 50 % and 30 % acceptability of planting.

Name of the steps	The CO2 flowing from the steps carrying out, Gg per year		
	100% Acceptability	50% Acceptability	30% Acceptability
Program "The forests of Kazakhstan"	81,25	40,625	24,375
Program "Jasyl Yel"	107,02	53,51	32,106
Program on wooding of the city of Almaty	1,34	0,67	0,402

Green Sanitation Zones Programme	158,41	79,205	47,523
Total	**348,02**	**174,01**	**104,406**

During 2004 to 2006 the plantation of seedlings was planned for 42, 3 thou. ha (2004 - 10,9 thou. ha, 2005 - 14,5 thou. ha, in 2006 – 16,9 thou. ha). The carbon gas from fulfilling this program (Table 4.9) will comprise 81, 5 thou. tons of carbon dioxide by the 2013.

Picture 4.20 shows different scenarios and CO2 sinks growth for the period 2005 - 2020.



Picture 4.20. – The dynamics of the CO2 flowing growth under 100 % (the optimistic scenario), 50 % and 30 % (the pessimistic scenario) of acceptability of planting.

There is significant forecast uncertainty in the forestry sector as it is near impossible to foresee periodic (unplanned) forest fires.

4.8. Emission forecast assessments and the general impact of policy

The presented CO_2 emission scenarios are based on the country's agreed programs of socio-economic development for 2010 - 2030.

The CO_2 emission scenarios were built using the MARKAL model – a model of power systems working on the 'bottom - up' principle, describing both consumption and demand.

The MARKAL model provides the opportunity to assess the effect of economy policy impact on reducing climate change. At the same time, the scenarios obtained propose the optimal policy under which the technologies are changed compensating the fluctuating consumers' demands (and the advantage). All the demand for power services depends on GNP growth.

According to the country's transition to stable development, it is proposed:

- the fall of GNP's energy/output ratio by two times by 2015-2020;
- the growth of production efficiency in 3–3,5 times;
- the doubling of GNP by 2015;

- the annual economical growth of the country not below 10 % by the year 2012, 12 % by the year 2018, 14 % by the year 2024.

From an economic point of view, the power systems adds two additional factors in production activity – capital and labor. It also imitates the constant development of gross product by putting in factors of constant elasticity when replacing the functions of production, changes the rules of amortization coefficient of the MARKAL up to MAKRO model and enlarges the consumers' advantages maximally.

The general decrease of fuel usage under the best available technologies while producing the power and heat can account to, as seen from Table 4.10, from 2 to 20 mln. t. o.e. by 2025.

Table 4.10. The forecasts assessment of energy resources economy of RK (as to the year 2000).

Year	Energy resources' economy, mln. t. c. f. / year	Expected CO2 emissions' reduction mln. t. CO2 / year
2010	1 - 2 mln. t. o.e.	3 - 4 mln. t. CO2 / year
2015	5 - 7 mln. t. o.e.	7 - 10 mln. t. CO2 / year
2020	8 - 12 mln. t. o.e.	12 - 17 mln. t. CO2 / year
2025	15 - 20 mln. t. o.e.	22 - 25 mln. t. CO2 / year

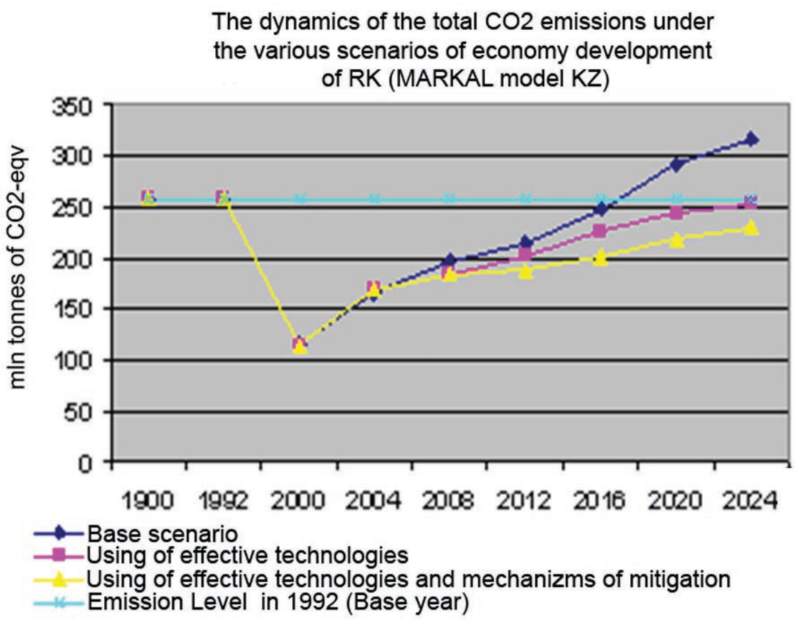
The consequence of these measures can be improvement of average efficiency of power system by 1 – 1, 5 % per year. The increase in effective production while energy intensity decreases will lead to a general reduction in GHG emissions to 50 – 70 mln. t. of CO_2 / year by 2025.

In Table 4.11 and Picture 4.21 the reduction potential of the GHG emissions from the main sectors of economy is shown.

Table 4.11. The reduction potential of the GHG emissions from the main sectors of economy of RK considering the strategic branch plans of development and usage of effective technologies, mln. tons of CO_2.

Branches/scenarios	Years						
	2000	2004	2008	2012	2016	2020	2024
Energy industry							
Base scenario	77,85	96,09	122,83	139,02	153,05	162,5	183,11
The efficiency rise of present power and building new ones with the usage of effective technologies and WSE	77,85	96,09	119,04	126,52	132,81	131,05	138,26
The transportation							
Base scenario	8,76	13,32	17,09	22,29	29,21	36,46	44,91
Introduction of the "Euro 2 - 4", import of motor cars not older than 7 years	8,76	13,32	17,09	20,73	24,52	27,35	30,14
Oil – gas sector							
Base scenario	8,03	17,15	23,09	25,62	29,35	30,99	40,77
Use of the effective, ecologically clear technologies	8,03	17,16	22,37	24,39	26,7	28,94	36,03

Steel output							
Base scenario	6,59	7,83	8,63	9,31	10,16	10,98	11,72
Use of more effective technologies	6,59	7,83	8,19	8,66	9,15	9,55	9,87
Cement output							
Base scenario	0,72	1,74	1,96	2,23	2,5	2,81	3,14
Rise of enterprises' productivity, gas usage	0,72	1,74	1,86	2,07	2,25	2,44	2,64
The output of ferro - alloy							
Base scenario	3,38	3,33	3,71	3,96	4,26	4,61	4,89
Use of new power with more effective production	3,38	3,33	3,53	3,68	3,84	4,01	4,11
Commercial – municipal sector							
Base scenario	1,91	2,67	3,2	3,73	4,09	4,41	4,91
Use of energy – saving technologies	1,91	2,67	2,89	3,14	3,2	3,26	3,32
Residential sector							
Base scenario	4,61	4,89	5,58	6	6,49	6,44	7,03
	4,61	4,89	5,32	5,54	5,75	5,46	5,37
Base scenario	2,18	2,15	2,71	3,01	3,83	4,79	5,55
Effective waste processing technologies and energy use	2,18	2,15	2,68	2,89	3,15	4	4,31
The total GHG emissions on the base scenario	114,03	149,17	188,8	215,17	242,94	263,99	306,03
The total GHG emissions under the use of more effective technologies	114,03	149,18	182,97	197,62	211,37	216,06	234,05
The total GHG emissions (potential) as a result of realization of "Policy and steps"	0	0	5,83	17,55	31,57	47,93	71,98



Picture 4. 21. - The dynamics of the total CO_2 emissions under the various scenarios of economy development of RK (MARKAL model KZ).

Picture 4.21 shows GHG emissions will reach the 1992 level by 2016 using the base scenario, and by 2024 using the reduction scenario. The improvement of energy output efficiency from the replacement of existing power to new more technologies (mainly coal co – generating technologies), along with the rise WSE usage and other measures will assist not only the substantial reduction in fuel usage, but the reduction of GHG emissions. Thus, the total potential of emissions reduction in Kazakhstan through the policies and processes outlined will account to 47, 93 mln. t. in 2020 and 71, 98 mln. t. of the CO_2 - equivalent in 2024.

It should be noted the potential available to reduce GHG emissions in the existing and best-available technologies of the economic sectors. The reduction of Kazakhstan's GHG emissions is a complicated issue – requiring cross-government and business involvement, participation and financial expenditure. It is advised that a National Commission is created to coordinate and raise Kazakhstan's energy efficiency. The Government through adopting various measures can put into action the process of energy-saving and GHG emission reduction.

CHAPTER 5. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACT AND ADAPTATION MEASURES

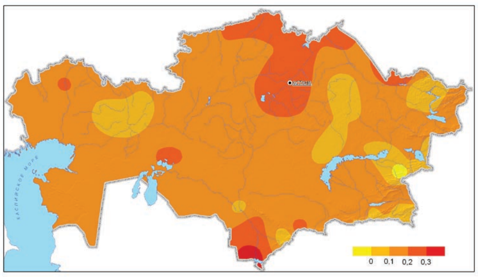
5.1. Current climate and changes

The results of the latest research into Kazakhstan's current climate and its trends are presented in this section. Linear trends are recorded for the average air surface temperature and the amount of atmospheric precipitation during the period 1936 to 2005, calculated for the data of 90 meteorological stations. The most evident changes are meteorological. Using RClimDex software, 27 basic climatic indices (as proposed by the World Meteorological Organization (WMO) Commission on Climatology) were calculated based on the data of the daily surface air temperatures and of the daily precipitation from 1936 to 2005.

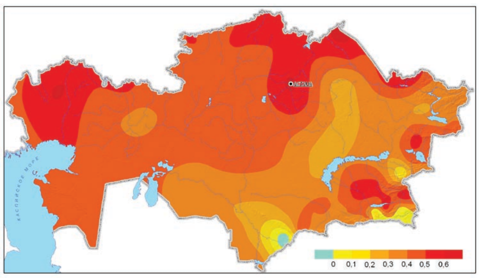
Research demonstrates that the climate of Kazakhstan is becoming much warmer – with temperature rises recorded practically everywhere, in all seasons, with the exception of some local regions (Picture 5.1.1).

The average annual air temperature increased by 0,31 °C for every 10 years. The most rapid warming is taking place in Winter– on average by 0,44 °C/10 years and 0,60-0,65 °C/10 years in the West and in certain Northern and Central parts of the country. The lowest temperature growth occurs in Summer – on average 0, 14 °C/10 years all over the area, and in the West of the country less than 0,10 °C/10 years. Transitional seasons of the year record air temperature increased of 0,2 °C/10 years. The average annual air temperature rose for most parts of the country by 0,1-0,2 °C/10 years (according to MS data by 0,26 °C/10 years). The lowest temperature growth was observed in spring as well as in all seasons in the mountainous regions of the South of Kazakhstan.

Picture 5.1.1. Spatial distribution of the linear coefficient of temperature trend of the surface air on the average annual (a), in winter (b), and in summer (c) for the period of 1936 – 2005 yrs., C/10 years.



a)



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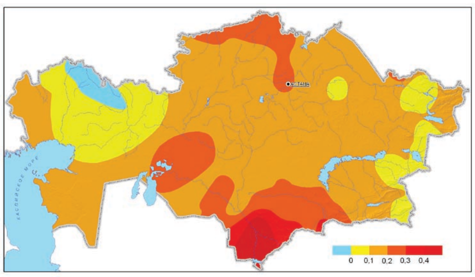
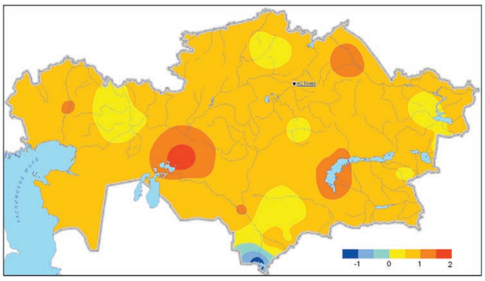


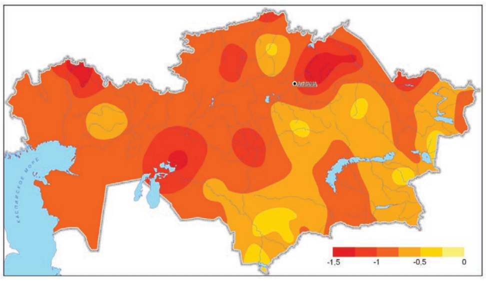
в)

Analysis of the climate change indices, calculated on percentiles for the period 1936-2005 shows:

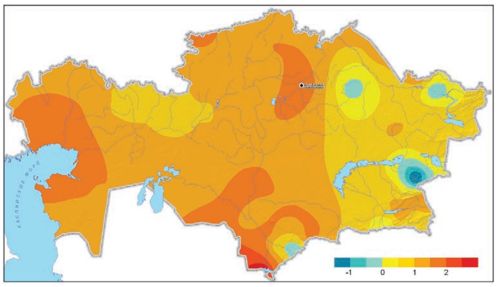
- most meteorological station data (80%) demonstrate a significant increase of the number of extremely warm days (Picture 5.1.2, a) and extremely warm nights (85 % MS, Picture 5.1.3,a);
- the number of extremely cold days (Picture 5.1.2, b) were reduced to 84% and the extremely cold nights (Picture 5.1.3, b) significantly decreased to 95% based on the MS data.

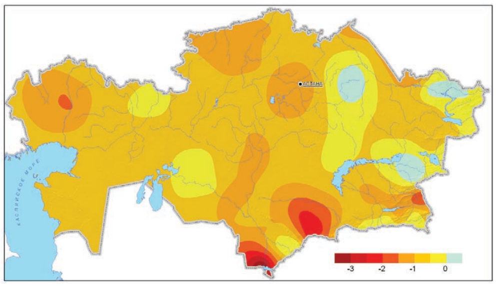
Picture 5.1.2. Spatial distribution of the linear trend (days/10 years) of the number of extremely warm (a) and extremely cold days (b) for the period of 1936 – 2005.

a) 

б) 

Picture 5.1.3. Spatial distribution of the linear trend (days/10 years) of the number of extremely warm (a) and extremely cold nights (b) for the period of 1936 – 2005.

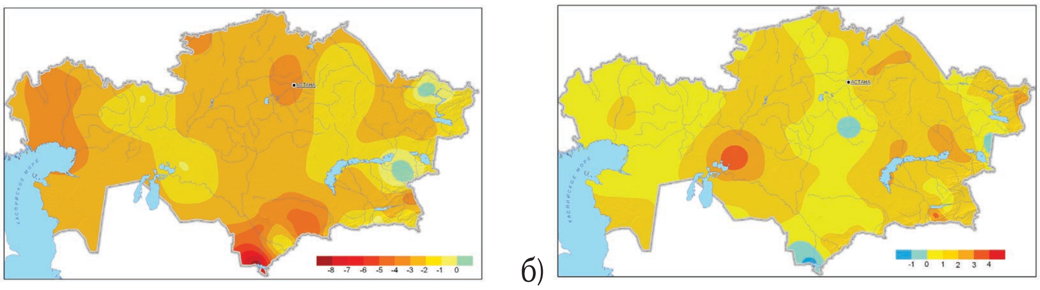
a) 

б) 

Thermal changes were characterized by the following:

- practically everywhere had significantly shorter number of cold days where the daily minimum temperature was below 0 °C, (Picture 5.1.4, a). For most of the country, the decrease accounted for 3 days within 10 years. 60% of MS recorded significantly shorter number of cold days annually where the day's maximum temperature was also below 0 C;
- simultaneously, but at less of the rate, there is an increase number of hot days where the day's maximum temperature was above 25 °C (picture 5.1.4, b) – on the average by 1,3 day every 10 years;
- for most parts of the country there are significant increases (by 2 – 3 days on end every 10 years) in the duration of heat waves when not less than 6 days in a row the air temperature was extremely high;
- simultaneously there significantly decreases (3 – 4 days every 10 years) in the duration of cold waves when not less than 6 days in a row extremely low air temperature was observed;
- considerable decrease of the temperature diurnal range (average to 0,18 °C/10 years) on the most part of the are (65% of MS).

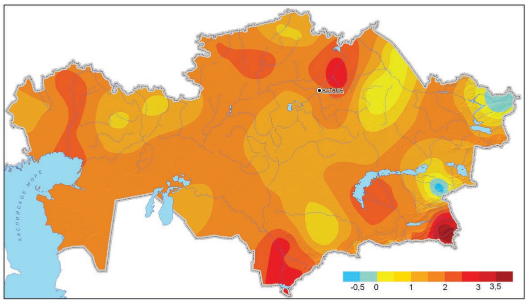
Picture 5.1.4. Spatial distribution of the coefficient of the linear trend (days/10 years) of the number of days with the daily temperature minimum below 0 °C (a) and the number of days with the daily temperature maximum above 25 °C (b) for the period of 1936 – 2005 yrs.



а) б)

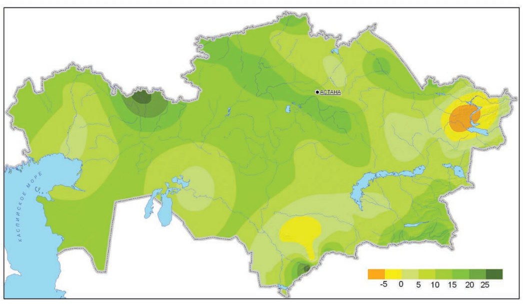
For most areas of the country there were increases (by 1 – 2 days every 10 years) in the period between the first day's temperature of a 5-day period of 5 °C and above and the last date the day's temperature of the 5-days' period was 5 °C and below (vegetation period). The spatial distribution changes of the vegetation period duration is shown in Picture 5.1.5.

Picture 5.1.5. Spatial distribution of the coefficient of the linear trend (days/10 years) of the vegetation period duration for 1936 – 2005 yrs.



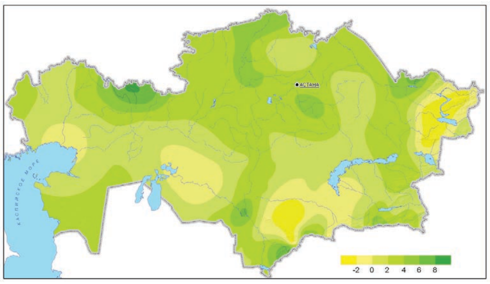
There was not well-defined trend in the regime of annual and seasonal precipitation over the area of Kazakhstan (Picture 5.1.6.). For most of Kazakhstan's regions the rainfalls per year were increasing more significantly on the south mountainside of the Urals, in the valley of the river Yesil, on the windward sides of Kazakh Upland (Saryarka) and on the foothills and mountains of south Kazakhstan. In the sand region of Moinkum and Lake Zaisan there were decreases in annual rainfalls.

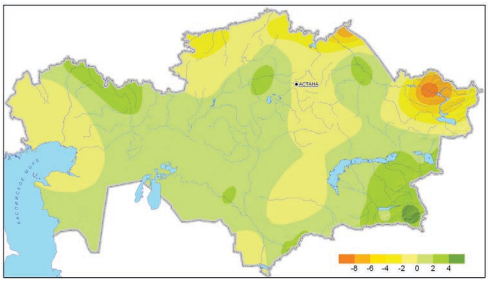
Picture 5.1.6. Spatial distribution of the coefficient of the linear trend of the annual falls' sums (mms/10 years) for the period 1936 – 2005 yrs.



The territorial trend distribution of annual rainfall results is almost totally determined by the trends of Winter fall (Picture 5.1.7, a). The changes of Summer rainfall for practically all of the country was insignificant (Picture 5.1.7 b). The Northern regions experience an increase in rainfall volume in Winter and the opposite in Summer.

Picture 5.1.7. Spatial distribution of the coefficient of the linear trend of the sums of falls in winter (a) and summer (b) periods (mms/10 years) for the periods 1936 – 2005 yrs.

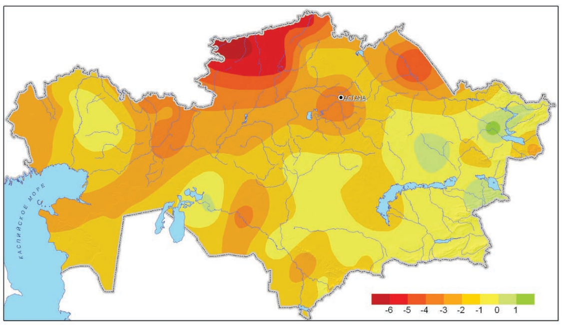
a)


б)


The change in Kazakhstan's rainfall during 1936 – 2005 is characterized by the following:

- in some parts of Kazakhstan (33% of the stations) the intensity of rainfalls increased, calculated as the proportion of the annual amount of rain to the number of days with the amount of rain > 1 mms / day;
- in Winter almost everywhere experienced an increase in the daily maximum amount of rain, the most significant of that increase was in the dewy Northern regions of Kazakhstan. The maximum daily amount of rain in Summer months remains unchanged;
- 26% of stations recorded a significant increase in the portion of annual rainfall amounts which refer to the extreme daily amounts of precipitation (when precipitation exceeded 95 percentiles within 1961-1990)..These were the areas of the Mugodjar mountains, Saryarka, in the South deserts of the Turan lowlands and in the mountainous areas of Tyan'-Shan'. The most significant portion of the extreme daily rainfall was in the areas of Caspii and Aral with its adjacent plains and deserts - increasing from 25 to 31%. But it is exactly these areas which get the minimum amount of precipitation;
- practically all of Kazakhstan experienced a decrease in the maximum duration of the rainless period, the most significant in the Northern and South-eastern parts of Kazakhstan (30% of stations, Picture 5.1.8). The maximum duration of the rainfall period was not changed.

Picture 5.1.8. Spatial distribution of the coefficient of the linear trend of the maximum duration of the rainless period (number of days/ 10 years) for the period 1936 – 2005 yrs.



The changes of humidity within the 1936-2005 period were assessed using the K humidity coefficient calculated as the relation of precipitation to the potential evaporation (Box 5.1.1). The results have shown that the main features of humidity changes have been observed in the increase of climate aridity in the deserts and semi-deserts areas and the areas adjacent to (60% of MS). The climate of Urals, extreme Northern parts of Kazakhstan and the Saryarka zone due to significant increase of precipitation , is becoming more humid. This tendency was seen in the mountainous parts of the South and Southeast but had less of a role in raising air temperatures.

Box 5.1.1. The assessment method of the conditions of moistening

The coefficient of moistening $K = \frac{\overline{R}}{\overline{E_0}}$ –, where $\overline{R}$ – the mean of many – years - sum of falls per year, mms; $\overline{E_0}$ - the vaporability per year, mms.

The vaporability is defined by the 3 main factors: the lack of air dampness, the surface thermobalance and the intensity of turbulent moisture exchange. If the meaning of K is above or lower 1 then, accordingly, there is a surplus or lack of moisture.

The classification areas of moistening used:

Coefficient of moistening K	Moistening zone
< 0,05	severe arid
0,05-0,20	arid
0,20-0,45	semi-arid
0,45-0,70	dry, damp to a lesser degree
0,70-1,00	lack of dampness
1,00-2,00	da mp
> 2,00	over – damp

The regions where the meanings of the coefficient of dampness are referred to the first gradation (K<0,05) are also called the climatic deserts.

According to IPCC conclusions, almost all climate changes observed have a multi-faceted effect when impacting the ecosystems. For example, the rise of minimum temperatures, and subsequent reduction of cold days, may lead to reducing damage to some crops and to increasing damage to other crops, to expanding and intensifying activity of some pests and carriers of diseases. In Kazakhstan, the increased inequality of precipitation can have the negative effect in terms of time when rain showers are succeeded by droughts. It may have an effect on increasing soil erosion. Other than in Summer, such falls do not bring the necessary soil moistening as the soil cannot quickly absorb the moisture, along with surface runoff and high air temperatures contributing to evaporation. Monitoring of unfavorable agrometeorological phenomena and farmlands damaged in 2005-2007 has shown that the main unfavorable phenomena in Kazakhstan were the atmospheric (60% of cases) and soil (20%) drought, rain showers and hail (14%).

The combination of global warming along with other ecological stresses and human activity can bring the rapid extinction of the existing ecosystems, especially in the arid region of the majority of Kazakhstani territory comprises.

5.2 Current glaciation mountainous system

5.2.1. Glacier monitoring system

The systematic observation of Kazakhstan's glaciers began in the 1950s and 60s under the framework program of the former USSR. In 1973 the unique program was adopted for detailed and perennial observations over specially selected glaciers. The most detailed observations were carried out on Kazakhstan's south-east mountains on the glaciers of Shumskoy (Jetysuisky Alatau) and Central Tuyuksuisky (Ileisky Alatau, the Northern Tyan'-Shan') (Kotlyakov, 2004). The Central Tuyuksuisky glacier observation spans more than 50 years. A stationary station in the glacier belt of the Malaya Almatinka river basin has recorded annual (since 1958) and perennial (since 1973) glaciohydroclimatic observations with measuring a mass balance of glacier Tuyuksu. Using aerial photography (and satellite mapping from 1990) the unified catalogues on the status of glaciers by 4-6 time slices (for Jetysuiskaya and Ileisko-Kungeiskaya glacier systems, correspondingly) include the period of 1955/56 - 2000.This made it possible to obtain objective information about the rate and intensity of glacier degradation.

The Ileisky Alatau has an annual network of stationary stations for geothermal surveys on the long-term and seasonal frozen layers embracing various landscape - facial conditions. Besides, there are mobile geothermic surveys in different landscape conditions of the low mountaineous areas and submountainous plains.

5.2.2. Freezing and cryogenesis

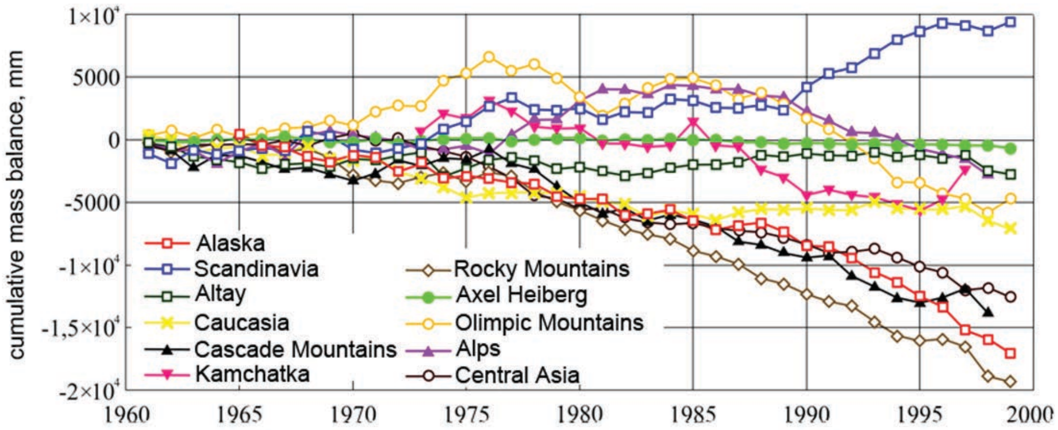
Glacier monitoring results provide obvious degradation of glaciers since the second half of the 20th century.

Against a general backdrop of decreasing ice amounts (1956 to 1975) 31% of 369 glaciers of the Ileisky Alatau and the basin of the r. Shelek increased in size. The total square increase of these glaciers for the above mentioned period amounted to 15,7 km^2. In the period from 1975 to 1990 the proportion of glaciers with prevailing positive mass balance decreased to 2,4% from the total amount of glaciers studied (Severskiy et al., 2006). The same dynamics was seen in the Central Tyan'-Shan' (Takeuchi, Uetake et al., 2007) and in the mountains of China (Yao Tandong, Vang Yuking et.al., 2007).

Over the same period of time, the degradation of different mountain systems differed significantly. In the last decades of the 20th Century the size of ice in the Northern periphery of the Tyan' Shan' differed by the maximum rate of reduction (by 0,80 - 0,83 % per year).

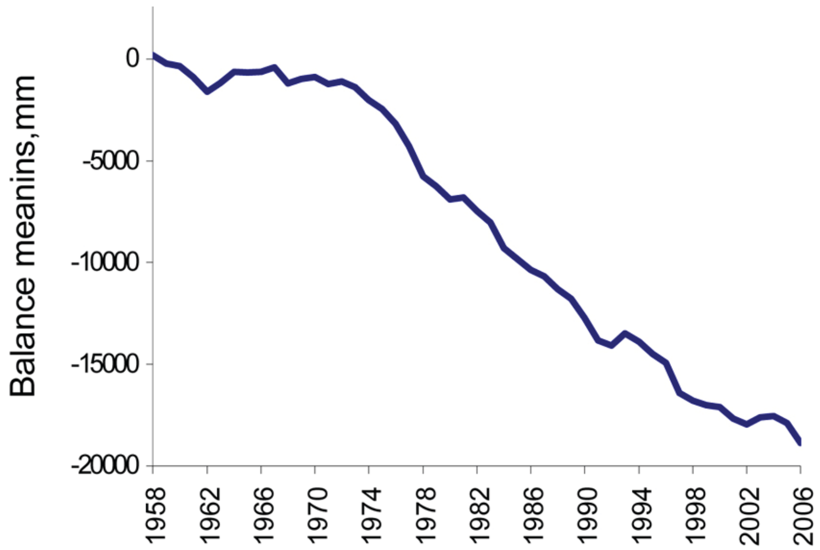
Picture 5.2.1 illustrates the difference in dynamics of glaciers near the areas with warm maritime climate (Scandinavia, Kamchatka, Alps) and the continental cold climate (Central Asia, Rocky and Cascade Mountains). The former is characterised with significantly lesser fluctuation in the annual balance glacier mass (in the range of ±1500 mm/year against ± 2000 mm/year of the glaciers of the continental type) and the relatively lower rates of reduction of galcier mass reserves (Kotlyakov, Severs-

kiy, 2007).The tempo of decreasing of the square size of the glaciers, especially in the continental dry areas (the mountains of Central Asia, Alaska, Rocky and Cascade Mountains) has grown significantly since the 1970s. This acceleration is connected with the anomalous high average air temperature at that period, corresponding with to sea ice and decreased snow falls in the Northern Hemisphere which constitutes about 0,2% per year (Dyurgerov and Meier, 2005).



Picture 5.2.1. The dynamics of the volume changes (cumulative mass balance) of the glaciers of the different regions of the world (Dyurgerov, 2005).

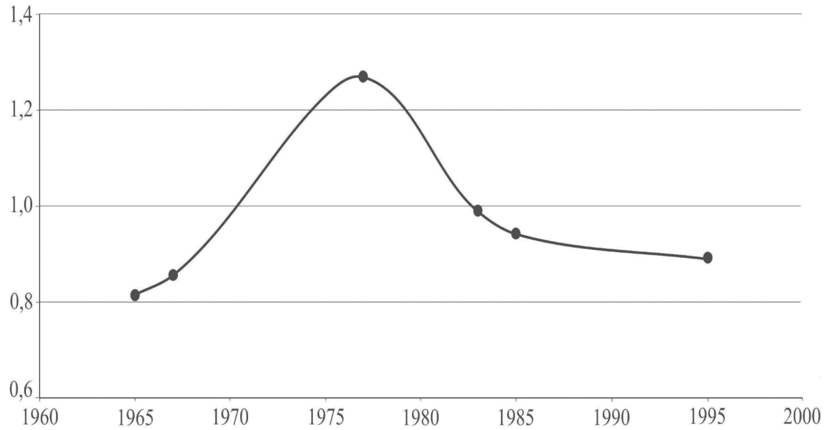
The data presented in Picture 5.2.1 shows the ice changes, averaged for the great territories – from the large mountainous glacial areas (The Alps, The Caucasus, the Altai) to the subcontinent scale (the high mountains of the Central Asia). The comparative analysis of data on the Central Tuyuksu glacier mass balance changes (Picture 5.2.2) and other glaciers of the Central Asia testifies that these changes correlate to the data on changes of large glaciers systems.



Picture 5.2.2. The cumulative glacier mass balance of the Central Tuyuksu for the period of 1957-2006 yrs.

The Central Tuyuksu glacier remained relatively stable until the 1970s when accelerated degradation. Since then the cumulative curve of the glacier mass balance has moved aside abruptly to the negative values reflecting the corresponding acceleration of reduction rates of secular glacier reserves. The analogous changes are also fixed in the glaciers of the Shumskoy in Jetysuisky Alatau and other glaciers of the Central Asia (Abramova in Gissaro-Alai, Kara-Bakak and Golubina in Tyan' Shan') (Kotlyakov (Ed.), 2006; Kotlyakov, Severskiy, 2007).

The accelerated rate of glacier degradation from the mid 1980s to the early 1990s typical in many areas of the world (The Alps, Patagonia, Alaska, Andes, Arctic) did not become apparent here. This is seen in the rate of changes of the northern side of the Ileisky Alatau (Picture 4.2.3). The maximum high degradation rate of the mid to the mid 198s had a less significant grade. The same type of changes has shown itself in the dynamics of the Ileisko – Kungeisky and Jetysuisky ice systems (Severskiy, Kokarev et al., 2006).



Picture 5.2.3. The tempo changes of the square decrease of freezing of the northern side of the Ileisky Alatau ((% per year).

The discovered changes (Pictures 5.2.2 and 5.2.3) fit with the results of corresponding assessments for the high mountains of Asia in general (Dyurgerov, Meier, 2006).

The ice coverage of Kazakhstan's south-east mountains during the last half a Century declined at an average rate of around 0,8% per year in square and 1% per year in ice store. On the northern side of the Ileisky Alatau during 1955–2004 the glacier size decreased by 117,26 km^2, or 40,8 % (Vilesov and et al, 2006). Taking into account climate changes forecasts, the continued intensive ice degradation of the region will continue in the near future. This will see ice on the northern side of the Ileisky Alatau practically disappear by end of the 21st Century and in the case Jetysuisky Alatau – in 40 years from now (Vilesov, Uvarov, 2001).

Of the 33 years geothermic monitoring in the Ileisky Alatau mountains the temperature of frozen rock got to 0,8 °C in 1974, rose by 0,6 °C in 1995 and has since stabilized around minus 0,2 °C. For 27 years the depth increase of the seasonal thaw –of frozen rock has been from 3,0 m in 1974 to 6,0 m in 2001. In 2002 the depth of the seasonal thaw decreased to 4,6 m and in the following four years stayed relatively stable with some little inter-annual fluctuation in the range of 4,6-4,9 m.

In the midlands up to the upper border of the forest (from 1400-1500 m to 2700 m) during the 1974-1998 period there was a stable decrease in the depth of seasonal freezing. On the northern and southern sides of the Ileisky Alatau the same componential and structural soils for that period decreased on the average by 25 cm and in on south side – 20cm. The average decreasing trend in the depth of freezing is for the northern side is 1,1 cm/year, and for the south - 0,9 cm/year.

The decreasing of the depth of freezing - down in the midlands is linked to the increase of snow and reduced winter hardness. The trend of snow hardness decrease accounted for 0,2 °C/year, and an increase of snow cover in the northern sides was going with the velocity of 0,48 cm/year. The average annual temperature on the 2500 m height for the period remained static, evidence that annual temperatures cannot serve as a definitive indictor of the depth of seasonal freezing. A more reliable indicator is the amount of negative air temperature. The inter-annual fluctuations of the intensity and depth of the freezing depend on two factors – the difference of the soil temperature before freezing and the proportion of the time-limit of beginning of the freezing - down and the setting of the snow (Severskiy, 2001).

In recent years the cryogenesis in the present day moraines are being investigated. The fresh moraines could intensively form the lakes of different genesis, size and configurations. In mid 1990s in the northern macro side of Ileisky Alatau there were only 10 lakes each one of more than 10 th. m^3. In 1980 this number increased up to 41 and by 1990 to 60. The origin breakdown comes from devastating glacial landslides. Through climate warming conditions there is higher probability of glacial mud-and-stone landslides. Because of this, along with the monitoring glaciers systems, there is a need to watch closely the cryogenic processes.

5.3 Climate change scenarios

The results of five double models of general atmosphere and ocean circulation (MGCAO, box 5.3.1), four scenarios of GHG concentration changes in the atmosphere from the special report on emissions scenarios (SRES) of the Intergovernmental Panel Climate Change (IPCC) and the averaged scenario of all the models (box 5.3.2) have been applied for modeling Kazkhstan's probable climate change scenarios, with the aim of decreasing the uncertainty of climate scenarios the data of the five MGCAO was averaged. The calculations are made using 4.1 ver. MAGICC/SCENGEN software taking into account the cooling effect of sulphate aerosols for three time periods: 2016-2045, 2036-2065, 2071-2100 years, which characterize the possible climate change of Kazakhstan up to 2030, 2050 and 2085 as related to the baseline period of 1961-1990 .

Box 5.3.1 The double models of the general atmosphere and ocean circulation used for the scenarios of climate change of Kazakhstan

– the model of CERF98 of the European centre CERFACS;
– the model CSI296 Australian science-industrial Organization (CSIRO);
– the model ECH498 Institute of Max Plank, Germany(MPI);
– the model CSM_98 National center of the atmospheric research, USA (NCAR);
– the model HAD300 Hadley Center in research and climate prognosis, Great Britain (Hadley Center).

Box 5.3.2 The scenarios of the emissions of the green house gasses of SRSE used while assessing the probable climate change of Kazakhstan

- A1F1 – extremely high scenario of the green house emissions;
- A2 – "middle-high" scenario of the green house emissions;
- P50 – median scenarios of SRES;
- B2 –"middle-low" scenario of the green house emissions;
- B1 – extremely low scenario of the green house emissions;

Scenarios of SRES are made up not taking into account the additional initiatives related to the climate change and not pointing out to the grade of probability of coming up of those or other events;

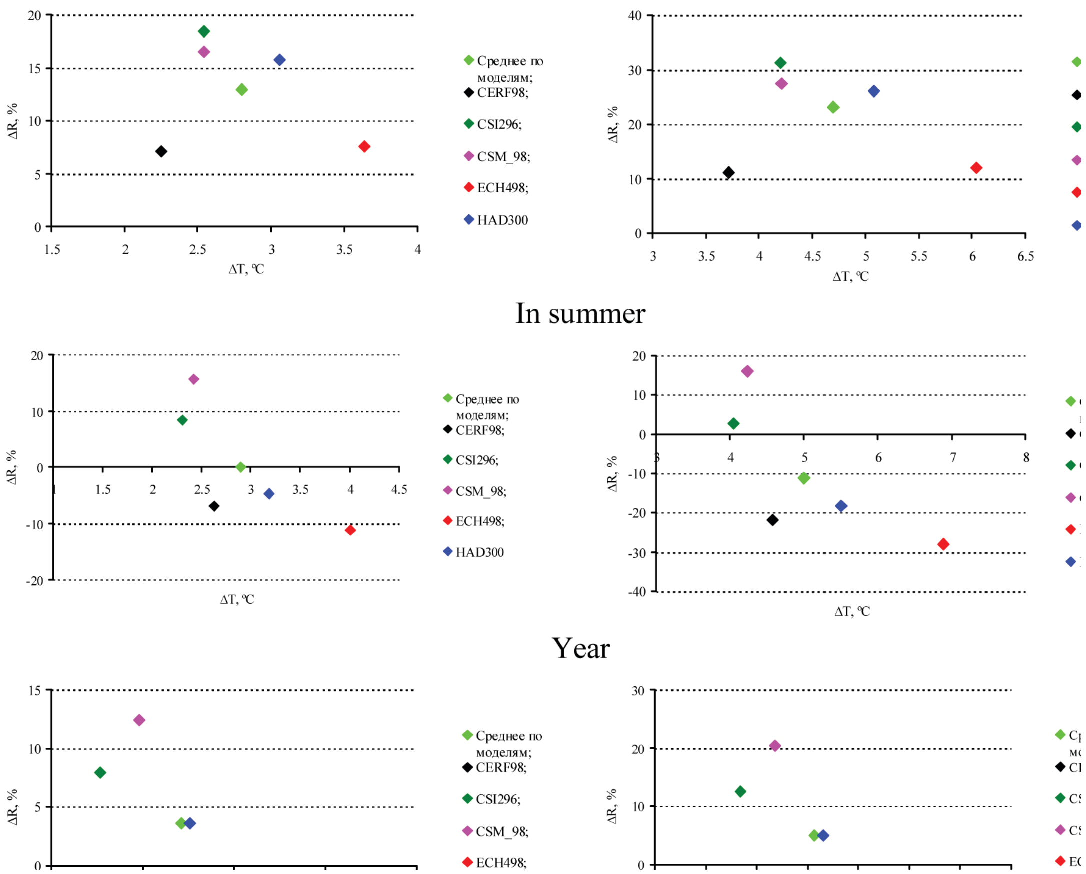
Using the average scenario of the increasing GHG concentration in the atmosphere (P-50) and the average of 5 models of air temperature and precipitation there was simulated the averaged scenario of regional climate related to the baseline period of 1961-1990 yrs. (Picture 5.3.1). In accordance with the scenario P-50, on the average the expected mean annual temperature in the territory of Kazakhstan will account to: +1,4 °C up to 2030; +2,7 °C to 2050; and +4,6 °C to 2085. The annual quantity of the rainfalls will somewhat increase: by 2% to 2030, by 4% to 2050 and by 5% to 2085.

The intra-annual distribution of rainfalls has an important practical meaning. In Winter according to the P-50 scenario it is expected that the increase of rainfalls across all the models considered: to 2030 by 8%, 2050 by 13% and 2085 by 24%. For the Summer period in accordance to the P-50 scenario to 2030 the falls will be by 5% more, but since the present mid-century, only two models predict the increase of falls (Picture 4.3.1), and on the average models up to 2050 the quantity of the falls might be on the present level. Some estimations project that by 2085 there would be the opposite tendency of an averaged decrease of precipitation by 11 %.

Pictures 5.3.1 and 5.3.2 present the existing uncertainty in the scenarios of climate change following from the uncertainty of the scenarios of GHG concentration changes and imperfection of the models. When comparing the air temperature changes the falls have much higher uncertainty.

by 2050 yr. (2036-2065 yrs.) by 2085 yr. (2071-2100 yrs.)

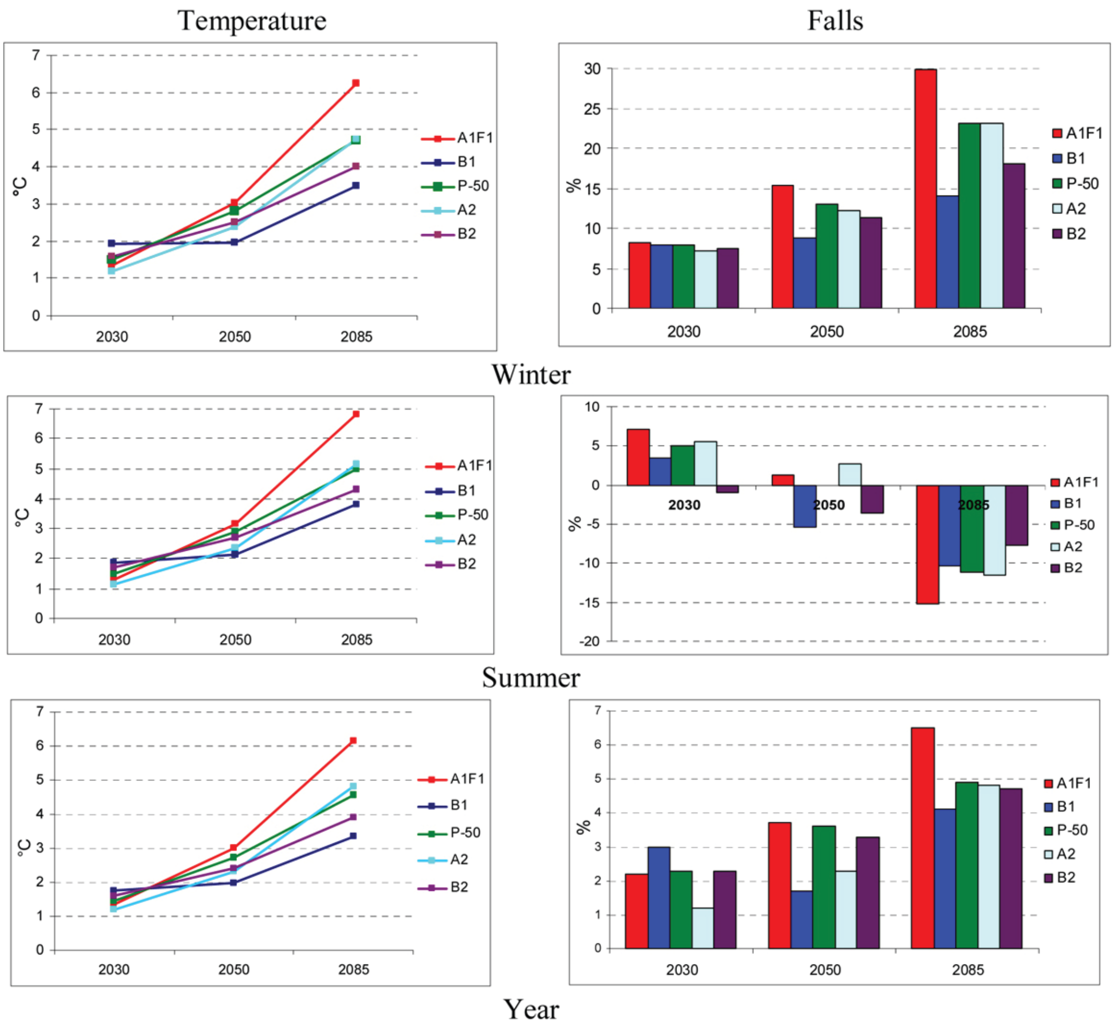
In winter



Picture 5.3.1. The changing ground air temperature (ΔT) and quantity of atmospheric falls (ΔR) as a whole across the Republic of Kazakhstan under the changing of CO_2 concentration in accordance with the P-50 scenario and different models of general circulation of the atmosphere and ocean in different periods of time.

According to the A1F1 scenario which is the most 'strict out of all considered by 2030, the changes of the mean annual ground air temperature will account for different models 1,2÷1,9 єC (1,3 єC on the average on the models), by 2050 2,5÷4,0 єC (3,0 єC model average), and by 2085 5,7 to 8,0 єC (6,2 єC model average). The changes of falls for above three periods are in the range from minus 2 up to 8 % (2,2 % model average), from minus 4 to plus 15 % (3,7 % model average) and from 8 to 28 % (6,5 % model average), accordingly.

According to the B1 scenario which is the most 'mild' by 2030 the change of the mean annual ground air temperature will account for 1,5÷2,2 єC (model average 1,7 єC), by 2050 1,6÷2,6 єC (model average 2,0 єC), by 2085 3,1÷3,4 єC (model average 3,3 єC), which is much lower than the A1F1 scenario. The change of falls is in the range of 0-8 % (model average 3,0 %), from minus 3 to plus 9 % (model average 1,7 %) and from minus 2 to plus 13 % (model average 4,1 %), respectively by 2030, 2050 and 2085.

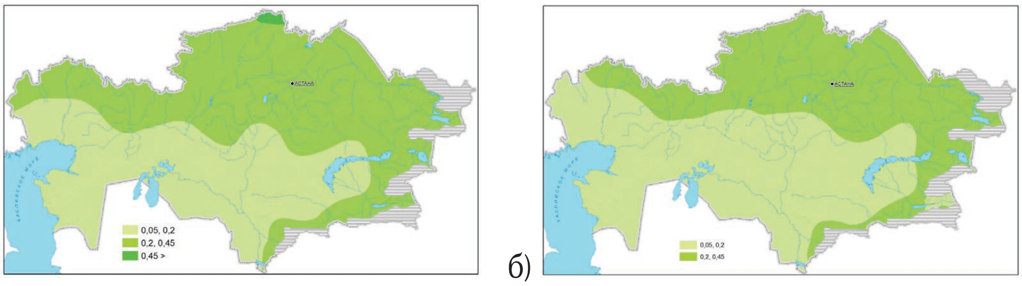


Picture 5.3.2. Average according to MGCAO (Box 5.3.1) the changing of the ground air temperature (°C) and the sum of the atmospheric falls (%) in general in the Republic of Kazakhstan under the different scenarios of the concentration of the green house gasses changes (Box 5.3.2).

An analysis of humid condition changes demonstrated that to the expected rise of air temperature, the increase of rainfalls by 20-25 % will not benefit to the ecosystems, agriculture and water resources.

Picture 5.3.3. The complex impact of the surface air temperature and precipitation intensity could lead to shifting northward the borders of humidification zones (Picture 5.3.3). The humid conditions were projected by the humid coefficient K (box 5.1.1), reflecting the ratio of the heat and moisture falling to a given part of soil.

Picture 5.3.3. The scheme of the borders of humid zones in the plain territory of Kazakhstan under the climatic conditions for 1971 2000 years (a) and for 2071 2100 years according to the scenario of the green house gasses concentration changes in the atmosphere A1F1 (b).



a) б)

The worst humid conditions are expected in the A1F1 scenario projecting the shifting of humid zone to 250-300 km northward by 2085. (Picture 5.3.3). In this case all the northern areas of Kazakhstan will be in a semi-drought zone, and the drought zone will occupy a much more expanded territory. According to the other scenarios (box 5.3.2) shifting of the humid zones to the North will be less significant.

5.4 The potential impact of the climate change

Climate changes will place greater stress on Kazakhstan's natural ecosystems. An important issue will be the deficit of water resources and the impact on the agriculture industry. The climate also has implications for the health of the nation.

5.4.1 Agriculture

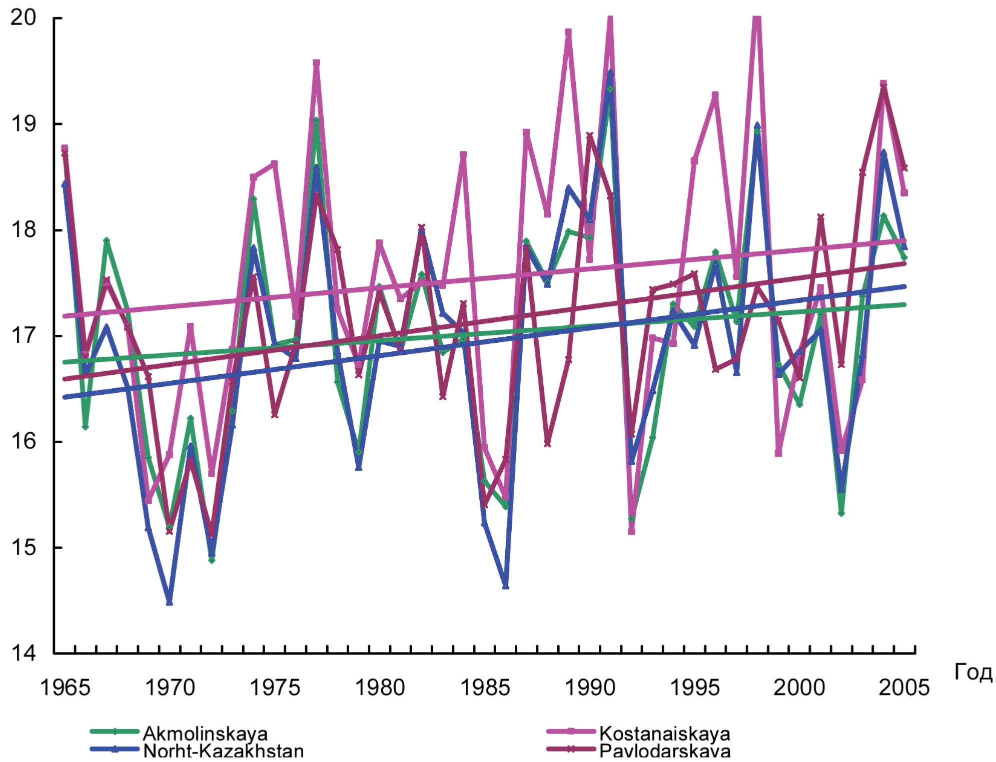
Grain production

Kazakhstan's arable farming depends largely on weather and climate conditions.

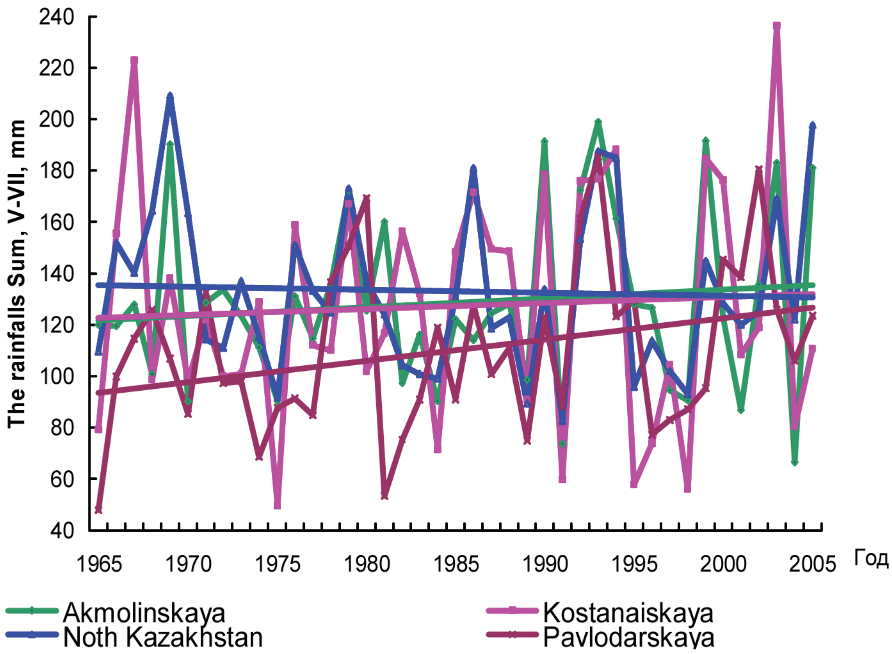
The increase in average annual temperatures in Northern Kazakhstan for the last 110 years accounted for more than 0,15 °C/10 years, with air temperature risen by 1,5 °C. For a 40 year period the average air temperature in May to July has increased in the North Kazakhstan province by 0,8 єC, in Kostanaiskaya by 0,7 єC, in Akmolynskaya by 0,5єC and in Pavlodarskaya by 1,2 єC. The trends of precipitation variability within 1965 - 2005 period showed the rainfalls in May - July in the areas of north Kazakhstan did not significantly change, except in Pavlodar province. (Pic. 5.4.1 and 5.4.2).

Progress in modeling the energy - and mass-exchange processes in the plant covering, development of the photosynthetic theory of seeds productivity stimulated establish,ment of the dynamic models of plant production process. From the practical purpose the interest was given to dynamic models for yields (O.D.Sirotenko (Russia), Gerrit Hugenboom (USA, a model DSSAT), A.N.Polevoy (Ukraine) and on their basis the methods for estimating agro - meteorological conditions for developing agricultural crops and calculation of their productivity have been elaborated.

Picture 5.4.1 The dynamics of the average air temperature changes for the May – July period 1965…2005 yrs. in the north Kazakhstan areas.



Picture 5.4.2 – The dynamics of the sum of the falls changes for the May – July period 1965…2005 yrs. in the north Kazakhstan areas.

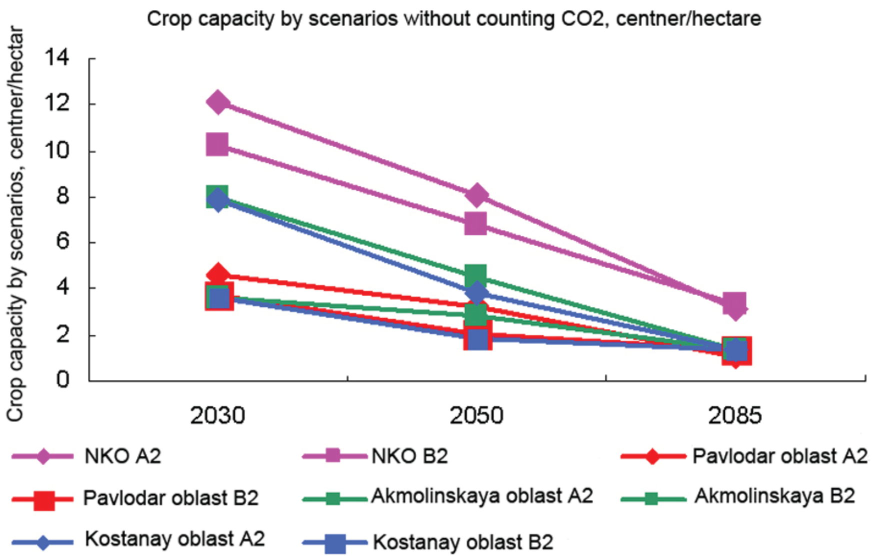


Calculations were made on the averaged regional productivity of Spring wheat for 2030, 2050 and 2085 in the four wheat-seeding provinces. Two variant models - not taking into account the changes of CO_2 and taking into account the changes of CO_2 - were used. The calculations of the averaged regional productivity of the Spring wheat according to the climate change scenarios are presented in the Pictures 4.4.3 и 4.4.4. The result is productivity will decrease in all scenarios but with different rates in relation to whether the increase of CO_2 concentration is considered an important factor in plant growth and development.

In accordance with the A2_2030 scenario while taking into account the increase of CO_2 concentration in all districts there will be the optimal agrometeorological conditions. The air temperature increase will lead to spring wheat appearing one week earlier than usual. The drought period during wheat ripening will come a week later and as a result it will benefit to yield production. The productivity according to this scenario will be in the range and even higher than in perennial value.

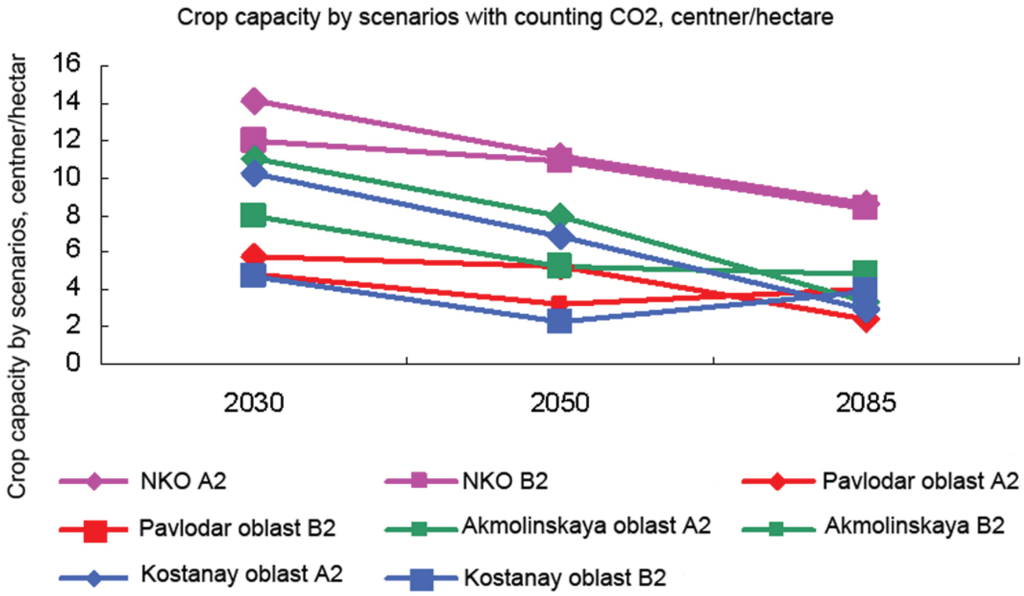
Further temperature increases in 2050 and 2085 scenarios will have a negative effect on the productivity because the wheat forming and ripening air temperature phase will exceed the optimal level by 2...4 °C. The young crops of spring wheat in the 2050 scenario will come about by two weeks (three in 2085) earlier than average.

Picture 5.4.3. Calculations of productivity of the spring wheat under the influence of the climate change in the regions of the North Kazakhstan in 2030 – 2085 yrs. not taking into account the concentration of CO_2.



An immense decrease in the productivity taking into account the increasing CO_2 concentration is observed in A2_2085, B2_2050 and B2_2085 scenarios. According to the A2_2085 scenario the yield productivity will be 74% in the North-Kazakhstanskaya oblast', 29 % in the Kostanaiskaya oblast', 39 % in the Akmolinskaya oblast', 37 % in the Pavlodarskaya oblast' versus the mean perrenial values. According to the B2_2050 scenario - 93% in the North-Kazakhstanskaya, 24 % in the Kostanaiskaya, 61% in the Akmolinskaya, 50 % in the Pavlodarskaya, According to the B2_2085 scenario - 71% in the North-Kazakhstanskaya, 41 % in the Kostanaiskaya, 56% in the Akmolinskaya, 64 % in the Pavlodarskaya. As it is seen, yield productivity will go down in the North-Kazakhstanskaya and Akmolinskaya oblasts, CO_2 concentration growth will lead to a little increase of the crop productivity by 2085 in comparison with 2050 in the Kostanaiskaya and Pavlodarskaya oblast'. On the whole, CO_2concentration growth will positively effect to the spring wheat productivity. At the same time a significant rise in the air temperature will negatively influence plant growth and development and that will eventually lead to a meaningful decrease of productivity.

Picture 5.4.4. Calculations of productivity of the spring wheat under the influence of the climate change in the regions of the North Kazakhstan in 2030 – 2085 yrs. taking into account the concentration of CO_2.



Conclusions:

1. The A2_2085, B2_2050 and B2_2085 climate change scenarios give reason to believe that the expected weather conditions will be unfavorable for growing spring wheat in the Kostanaiskaya, Akmolinskaya and Pavlodarskaya oblast'.
2. The A2_2085, B2_2050 and B2_2085 climate change scenarios will lead to a steep abrupt reduction of productivity. Taking into account the CO_2 concentration growth, yield productivity in Kostanaiskaya, Akmolinskaya and Pavlodarskaya oblast' will account for 25–60 %, in the North-Kazakhstanskaya – 70 – 90% versus the mean perennial values.
3. The young crops of the spring wheat will arrive 1-3 weeks earlier than on average and consequently the end of vegetation will occur 1-3 weeks earlier.
4. The CO_2 concentration growth will have a positive effect on the productivity of the spring wheat. At the same time a significant rise of the air temperature will negatively influence on the plant growth and development eventually leading to a meaningful decrease in productivity.

Pastures

Cattle breeding in Kazakhstan provides 44% of the gross national product in agriculture. For the past decade 30% of Kazakhstan's land was used for pasturing.

The vulnerability assessment and future risks of natural plants growth conservation (as a natural forage resources) under the climate change is carried out on the example of the South Balhash pastures. By the natural conditions the territory studied (some 1,8 mln. ha) is presented by aeolian plain desert and piedmont plain semi - desert on which parts the natural plants formations are intermittent with the ploughland occupied by the feeding grass of the crop seeds of 1993 and earlier. Due to uneven cattle load the pas-

ture digression on the sand plain is characterized by a degree from week to medium, on the piedmont plain – from medium to strong. In the last decade the natural plants on the aeolian plains have been partially restored due to the low use of pastures and lack of watering places.

The features of current climate change impact to the pastures are manifested in the deficit of moisture of the pasture vegetation which determines unstable and low crops yield. The high air temperature in summer and also the low temperature and unavailability of the pasture fodder due to a lot of snow and ice crust in the cold periods constrain the use of desert pastures in summer and winter and so predetermine the uneven cattle load by the seasons and vegetation.

The vulnerability assessment and future risks of seasonal pasture crops is made on the pasture model which is based on the production processes of the plants and takes into consideration the CO_2 concentration in the air.

The assessment of the possible changes of the natural vegetation on the pastures of the South Balhash areas is made for over three time levels (2030, 2050, 2085) and two scenarios of GHG concentration changes in the air (A2 and B2, box 5.3.2).

To assess possible climate changes in the South Balhash region, the values of climate change of Kazakhstan were used by the five averaged MGCAO (box 5.3.1). As seen in table 5.4.1, the changes of air temperature in the South Balhash region in the first half of the 20th Century are more significant according to the B2 scenario in comparison with the A2 scenario and may reach 2 °C to 2030 and over 3 °C to 2050. In the second half of this Century the maximum air temperature changes are expected on the A2 scenario and may reach in some months 5,5-5,8°C. In the atmospheric falls dynamics there is a tendency of insignificant increase of the annual values to 6 % for both climate scenarios and certain digression of precippitation from the warm to cold season of the year (table 5.4.2).

Table 5.4.1 - The dynamics of the possible air temperature changes (C) in the territory of the south Balhash (on an average on the MGCAO, box 5.3.1).

Scenario / period	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
A2 – 2030	1,4	1,5	1,6	1,5	1,5	1,1	1,1	1,4	1,4	1,3	0,5	0,8
A2 – 2050	2,7	2,8	2,8	2,6	2,7	2,4	2,3	2,7	2,6	2,3	1,4	1,6
A2 – 2085	5,8	5,5	5,4	4,6	5,1	6,0	5,4	5,4	5,2	4,2	3,8	3,8
B2 - 2030	2,1	1,7	1,5	1,3	1,6	1,9	1,8	1,8	1,8	1,5	1,5	1,4
B2 – 2050	2,6	2,7	2,3	2,0	2,5	3,1	3,1	2,7	2,8	2,2	2,3	2,1
B2 – 2085	4,9	4,2	3,8	3,3	4,0	4,9	4,5	4,3	4,4	3,5	3,6	3,3

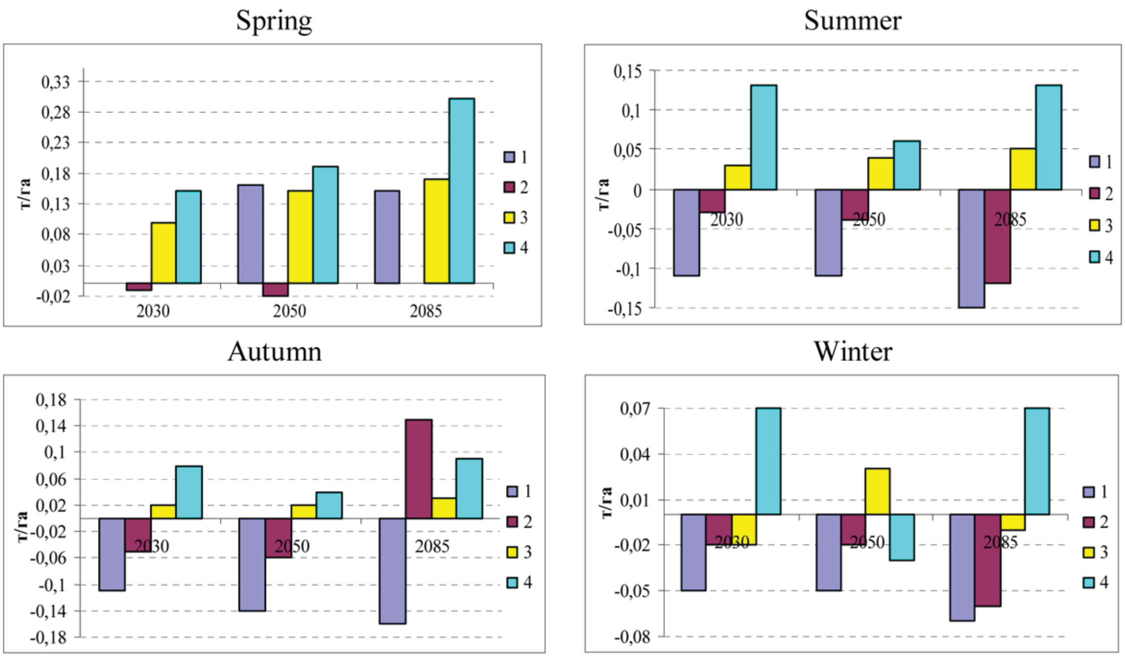
Table 5.4.2 - The dynamics of the possible quantity of the atmospheric falls (in %) changes in the territory of the south Balhash (on an average on the 5 MGCAO, box 5.3.1).

Scenario / period	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
A2 - 2030	9	15	5	5	-4	-9	30	54	6	4	12	13
A2 – 2050	15	23	10	4	-3	-13	27	52	1	4	15	17
A2 – 2085	35	39	20	7	4	-17	-15	-1	-30	0	14	19
B2 - 2030	3	10	5	3	-0,5	-2	-20	7	-14	9	4	9
B2 – 2050	16	19	8	4	0,3	-4	-10	1	-21	10	4	11
B2 – 2085	26	25	14	6	2	-7	-8	8	-31	11	6	23

Environmental and economic indicators of possible changes of natural pastures under the expected climate change and assessment of possible adaptation could be represented by values of the average seasonal pastures productivity (t/ha of the dry mass), seasonal feeding resources (t/ha) and allowable cattle load on the pastures (the conditional number of sheep per 100 ha.). Anthropogenic impact to the pastures is expressed by the pastures digression from week to strong rate.

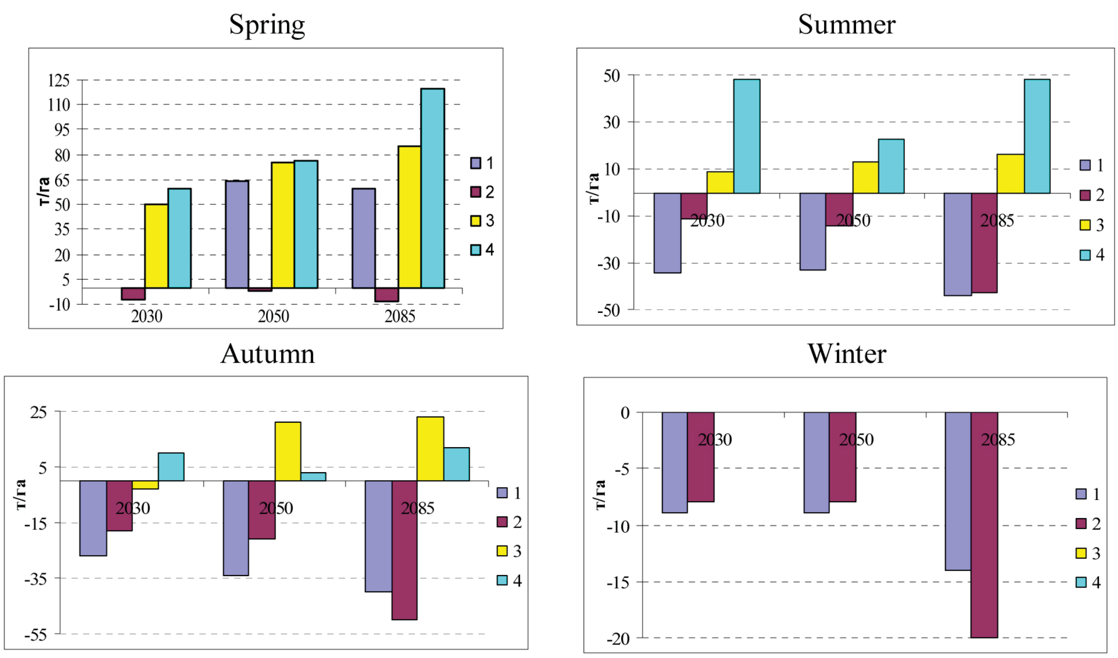
Analysis of the joint influence of expected temperature and precipitation changes showed that the humid conditions during the entire vegetation period will worsen both under the A2, and B2 scenarios. Even the increase of rainfall amount in July - August of the first half of this Century in the A2 scenario will not have a noticeably effect on enhancing the humid conditions versus the air temperature growth to 2-3 °C and higher. At the same time the modeling results makes it possible to suppose that with the rise in air temperatures it is probable that the so called 'automatic adaptation' of the plants to environmental conditions changes will occur.

Experiments with various CO_2 concentrations in the atmosphere showed that in the first half of the current Century for the A2 и B2 scenarios a slight amount of growth of the plant surface biomass (in 10 % range) will occur in the first half of the vegetation with a certain seasonal maximum shift at earlier time limits. At the same time the lowering of the biomass in the second half of the vegetation (by 10 - 25 %) will occur. The negative higher temperature shift influence on the plants is not compensated by the effect of the increase of CO_2 concentration in the air. For the second half of the current Century due to more significant increases of CO_2 concentration in the air on the A2 scenario the conditions of the biomass accumulation in the plants is estimated be more favorable in comparison with the B2 scenario. The A2 scenario anticipates increase in pasture crops by 10%, and under the B2 scenario a decrease up to 50% in relation to current level.



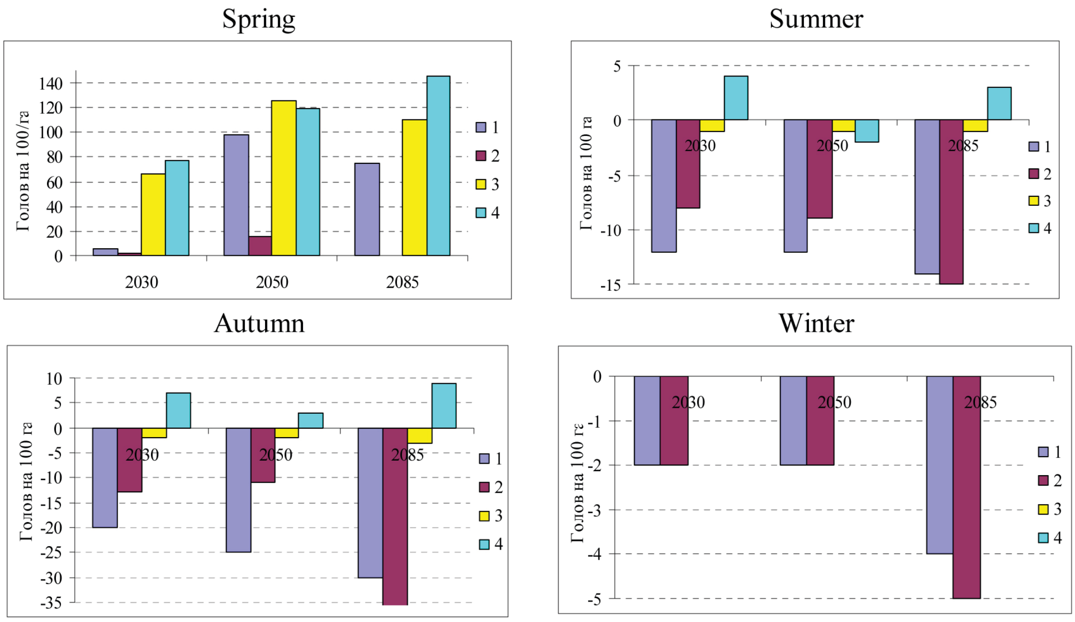
Picture 5.4.5 – The possible dynamics of the pastures crops change (t/ha) in the territory of the south Balhash regions under the climate change influence on the B2 scenario

1. - Bushy-salty-wormwood in the hillocky sands of aeolian plain of the desert of the Balhashsky region.
2. - Bushy-salty-wormwood in the hillocky sands of aeolian plain of the desert of the Jambylsky region.
3. - Wormwood-poaceous-salty in sierozem of the piedmont plain of the semi-desert Jambylsky region.
4. - Wormwood-ephemeral-salty in sierozem of the piedmont plain of the semi-desert Ileisky region.



Picture 5.4.6 – The possible dynamics of the pastures crops change (t/ha) in the territory of the south Balhash regions under the climate change influence on the B2 scenario.

1. - Bushy-salty-wormwood in the hillocky sands of aeolian plain of the desert of the Balhashsky region.
2. - Bushy-salty-wormwood in the hillocky sands of aeolian plain of the desert of the Jambylsky region.
3. - Wormwood-poaceous-salty in sierozem of the piedmont plain of the semi-desert Jambylsky region.
4. - Wormwood-ephemeral-salty in sierozem of the piedmont plain of the semi-desert Ileisky region.



Picture 5.4.7 – The possible dynamics of the allowable sheep's load (heads/100ha) change in the territory of the south Balhash regions under the climate change influence on the B2 scenario.

1. - Bushy-salty-wormwood in the hillocky sands of aeolian plain of the desert of the Balhashsky region.
2. - Bushy-salty-wormwood in the hillocky sands of aeolian plain of the desert of the Jambylsky region.
3. - Wormwood-poaceous-salty in sierozem of the piedmont plain of the semi-desert Jambylsky region.
4. - Wormwood-ephemeral-salty in sierozem of the piedmont plain of the semi-desert Ileisky region.

According to the climate change scenario, the Aeolian plain pasture productivity will increase in the spring season (Picture 5.4.5) but lessen in Summer, Autumn and Winter seasons due to pasture digression. The productivity of the piedmont plain pastures will increase in the Summer and Autumn periods Spring to a lesser degree.

Pasture maintenance risks from climate change can be assessed in the loss (gain) of the forage resources per square. For example, the Aeolian plains pastures with a degradation grade from weak to medium will incur a tendency of the crops loss in summer-autumn period and in some districts the crops loss will take place even for the spring period (Picture 5.4.6). The annual loss can amount from 40 forage points (tons) per 1 ha of square by 2030 to 80 forage points (tons) by 2085. The pastures of the aeolian plains with the minimum cattle load could have less loss of the forage resources, at least, till 2030 yr. For the piedmont plain pastures the digression grade from medium to strong from climate can expect a forage points gain from 61 to 115 tons per hectare a year, with the main gain (from 60 to 90%) falling within the Spring and early Summer.

For the semi-desert pastures of the piedmont plains there is a possibility to increase the number of sheep from 55 to 122 per 100 ha. in the spring period and by 57-118 for the whole year (Picture 5.4.7). The permissible load on the Aeolian plains in accordance with the forage resources per year can lessen by 20 and 25 sheep heads per 100 ha by 2030 and by 2085, accordingly. In the Spring time in the second half of the current Century the load could be increased.

Sheep breeding

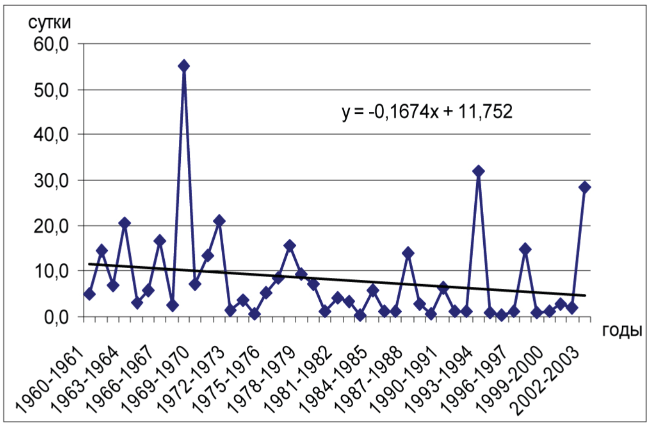
In Kazakhstan sheep breeding is the leading cattle breeding industry. The number of sheep and goats decreased from 36,7 (1987) to 9,5 mln. (1998) but in recent years has increased to 17,7 mln. heads (2007). Since 2001 the annual gain of sheep livestock comprises around 1 mln. heads. Around 87 % of the country's agricultural livestock is concentrated in small cattle farms, and the remaining 13 % in agricultural enterprises.

Climate changes have considerable influences on animals – determining the pasture vegetation and organism. Sheep must be moved long distances due to low pasture areas. The climatic conditions of the South allow sheep to pasture all year round. The climate conditions of the surrounding localities influence key activities such as lambing, migrating, insemination, shearing and sanitary actions of the sheep. However, since the 1990s sheep are contained in pastures year round, regardless of the season – resulting in a negative effect on productivity and over–pasteurization. The summer heat is also contributing to weight loss in the sheep. Currently, only large sheep-breeding enterprises are able to follow commonly recognized pasturing practices for viable sheep keeping.

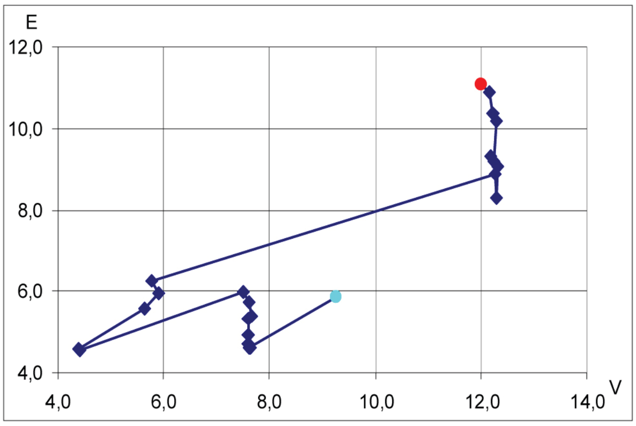
Sheep productivity assessment involves two relative (independent of livestock changes): the number of lambs per 100 sheep (OL) and the wool clip from 1 sheep (WC). OL and WC for the period studied (1963 to 2004) significantly changed over the years. The 1980s experience lower tendencies, and from the mid 90s productivity gradually increased. It demonstrates the climate change (through air temperature) did not influence the average level of sheep breeding productivity but was connected to the country's economic growth. However, in bad weather conditions, sheep breeding levels dropped, in certain years, 50% of the average level.

Sheep breeding vulnerability assessments used statistical models proposed by O.D.Sirotenko and data from 10 meteorological stations in the South of Kazakhstan for the period 1963-2004.

The main climatic indicators are the number of days impossible for grazing during the cold period (NUD), the wool clip time limits, duration of the stable heat summer period (SHP) for the sheep pasturing and the pastures productivity. The number of days impossible for grazing is shown in Picture 5.4.8 and 5.4.9 – with the mean NUD lessening from 11 to 6 days. The mean square deviation of NUD characterizing the inter-annual variability of the NUD reduced in the 90s from 12,0 to 4,4, and then increased up to 9,3. On the basis of these changes, it can be concluded that the climate changes were leading to reduced winter pasturing, although with growing inter-annual variability .



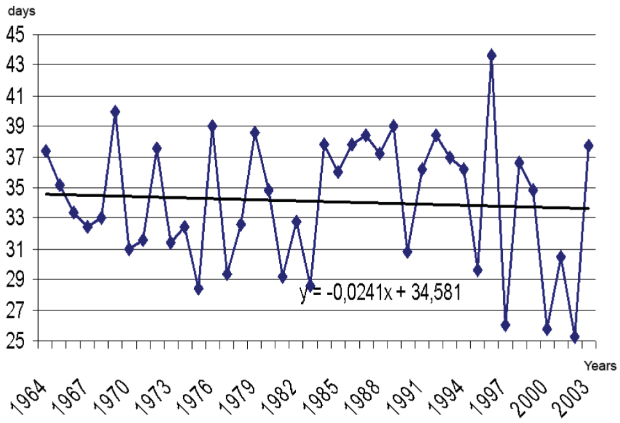
Picture 5.4.8 The dynamics of the average number of the unpastured days for the cold period in the south of Kazakhstan



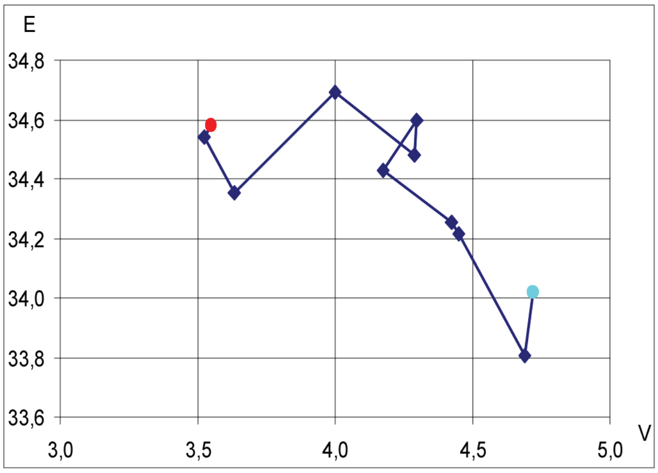
Picture 5.4.9 E – V - diagram of the twentieth sliding means of the NUD (for 1961-2003 yrs.).

E – V – the initial and final points.
E - the sliding assessment of the average of the NUD,
V - the sliding assessment of the average standard deviations of the NUD

Analysis shows the timing for wool sheering is occurring earlier in line with the onset of summer heat (Picture 5.4.10). The E – V diagram also confirms the increasing inter-annual variability (instability) of the sheering dates (Picture 5.4.11) - standard deviation grew from 3,5 up to 4,7.



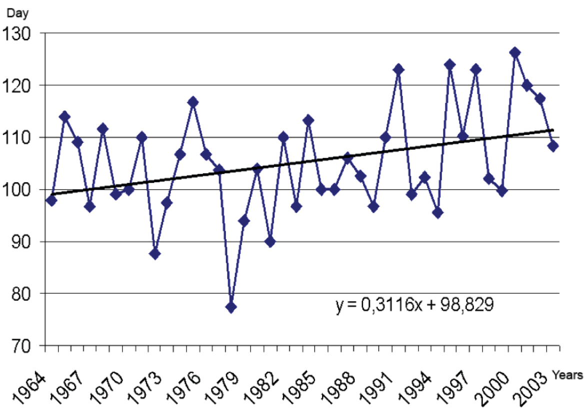
Picture 5.4.10 – The dynamics of the average time limits of the beginning of the wool clip of the sheep in the south of Kazakhstan (the deviation from April 1).



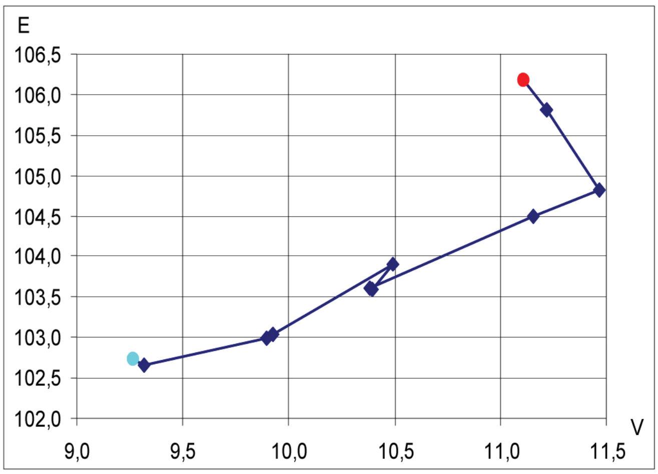
Picture 5.4.11 – E - V diagram of the thirtieth sliding means of the dates of the sheep wool clip (for 1964-2003 yrs.).

E – V – the initial and final points.
E - the sliding assessment of the average dates,
V - the sliding assessment of the average standard deviations of the dates of the NUD.

The increase in duration of the SHP has also led to weight loss. The average duration of SHP has grown (Picture 5.4.12) accounting for 12 (11%) days during the 40 year period.. An analysis of the E – V diagram showed that both the duration of the SHP and its inter-annual variability grew – the standard deviation increased from 9,3 to 11,2 (Picture 5.4.13).



Picture 5.4.12 - The dynamics of the duration of the stable hot summer period in the south of Kazakhstan (for the fine fleece sheep).



Picture 5.4.13 –E - V diagram of the thirtieth sliding means of the duration of the SHP (for 1964-2003 yrs.). E – V – the initial and final points. E - the sliding assessment of the average duration of the SHP, V - the sliding assessment of the average standard deviations of the duration of the SHP.

Research for the last 40 years shows the Winter conditions for sheep breeding has reduced.

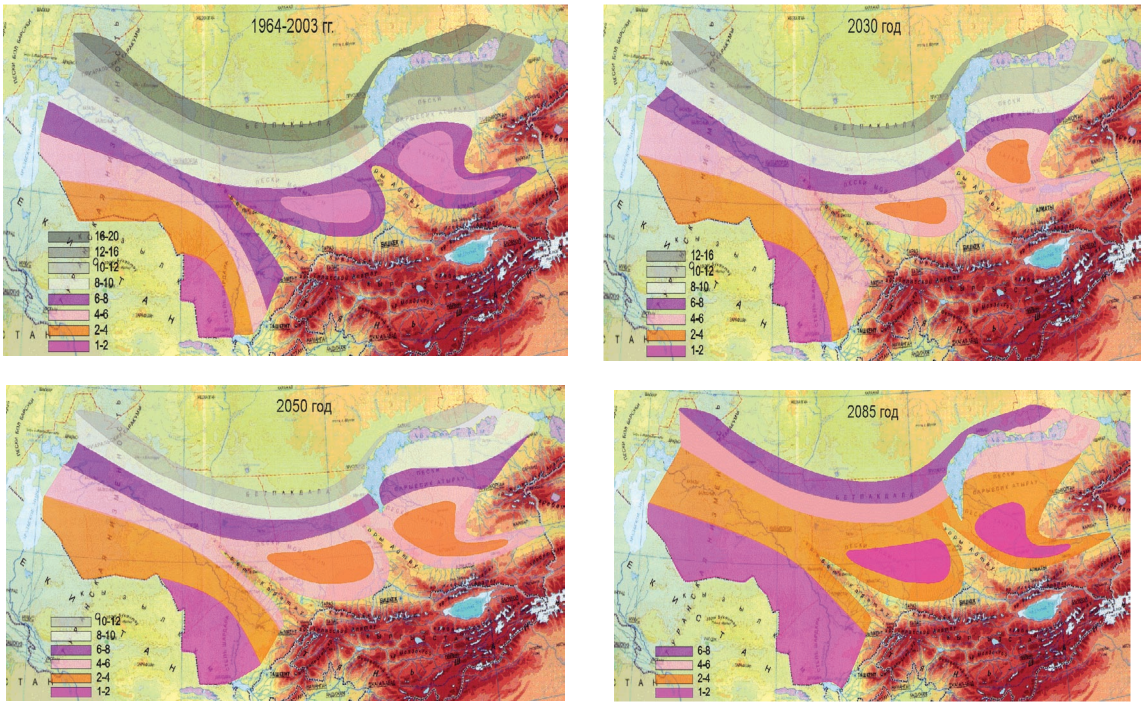
The statistical values that are dependent on agrucultural and zooclimatic indicators from the air temperature and precipitation for different seasons were identified for the vulnerability assessment of the sheep breeding to the expected climate change and the correlation of sheep productivity from the agricultural and zooclamate indicators.

The results of the research (Table 5.4.3) show for sheep breeding, the winter will become warmer by 20 – 67%, the Summer hotter by 12 – 55%, with shearing occurring at earlier times levels of 8 – 28 % and the average vegetation crops will decline by 9-32 %. Thus, the conditions for sheep keeping in Winter will improve and significantly worsen in Summer.

Table 5.4.3 –The changes of the number of days impossible for grazing in winter (ΔNUD), the revised sheering dates (ΔD), the duration of the stable hot period (ΔSHP) and the pastures productivity (ΔP) in South Kazakhstan at the expected climate changes on the A2 and B2 scenarios.

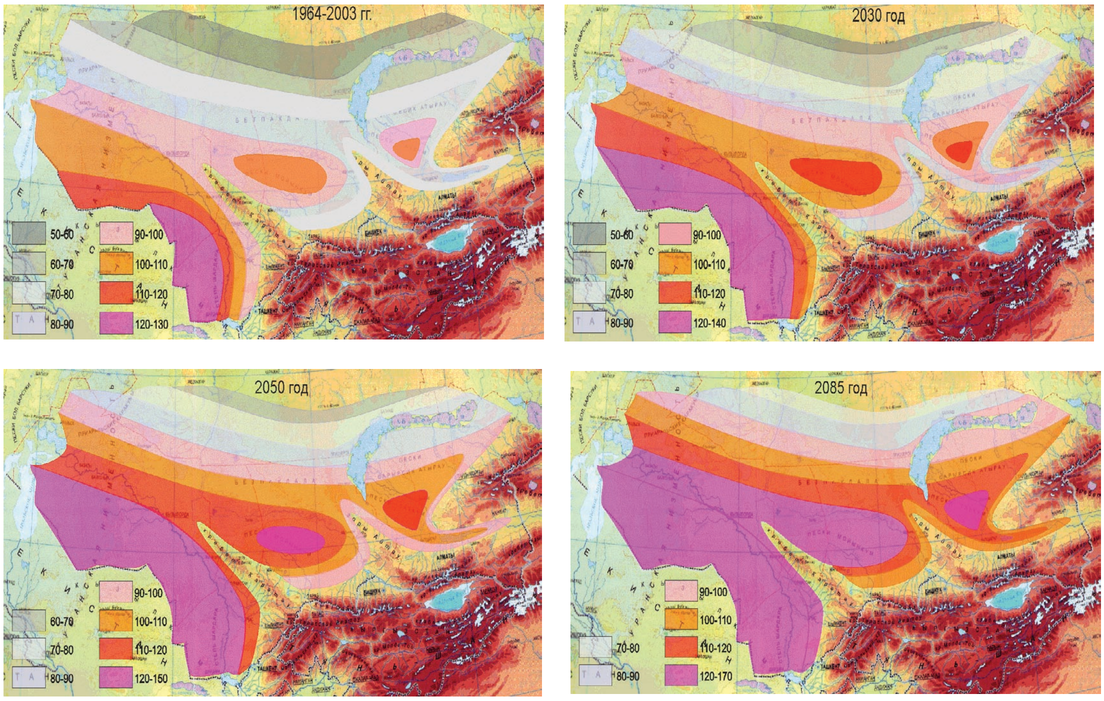
Year	ΔNUD, %		ΔD, %		ΔSHP, % (the fine fleece sheep)		ΔSHP, % (karakul sheep)		ΔP, %	
	A2	B2	A2	B2	A2	B2	A2	B2	A2	B2
2030	-20	-26	-8	-8	12	22	21	39	-9	-11
2050	-36	-38	-15	-13	24	28	43	50	-16	-16
2085	-67	-58	-28	-20	55	45	96	79	-32	-25

Picture 5.4.14 demonstrates the expected decrease of the number of the unpastured days in winter for the fine fleece sheep in the south Kazakhstan according to the A2 scenario.



Picture 5.4.14 –Spatial distribution of the number of the unpastured days for the sheep in the present day climate conditions and forecast one for the 2030, 2050 and 2085 year according to the A2 scenario.

On the Picture 5.4.15 there is the enlarging of the duration of stable hot period for the sheep shown according to the A2 scenario.



Picture 5.4.15 - Spatial distribution of the duration of stable hot period for the fine fleece sheep in the south Kazakhstan in the present day climate conditions and the forecast one for the 2030, 2050 and 2085 year according to the A2 scenario.

The results of the research on sheep productivity vulnerability demonstrate that under the appropriate management of sheep breeding in conditions of the projected global warming the significant reduction in sheep productivity is not expected (Table 5.4.4). The decrease in sheep productivity is expected mostly in the South of South–Kazakhstany oblast, in Kyzylordinskaya and Mangystauskaya oblast and also in South of Balhash region.

Table 5.4.4 – The sheep productivity change in the south of Kazakhstan under the expected climate change on the concentration of the green house gasses scenarios A2 and B2 (ΔLO – the lamb output change per 100 sheep dams in % in relation to the 1963 - 2003 yrs. period).

Scenario	A2			B2		
Years	2030	2050	2085	2030	2050	2085
ΔLO, %	-1	-2	-4	-1	-2	-3

Damaging consequences of the climate warning is an increase in unstable winter pasturage and frequency of abnormal hot years leading to significant productivity fluctuation in sheep breeding from year to year. In the future climate conditions, under the relatively cold Winter, relatively hot summer and reduced crop productivity sheep productivity will decline by 10-14 % (Table . 5.4.5). However, in more unfavorable years, the level of productivity will drop more significantly.

Table 5.4.5 –The sheep productivity change (ΔLO) in the south Kazakhstan in relatively unfavorable years (the deviation from the norm in 2030, 2050 and 2085 yrs)

Scenario	A2			B2		
Years	2030	2050	2085	2030	2050	2085
ΔLO, %	-10	-11	-14	-10	-11	-12

As such, the expected climate change warnings has both positive and negative consequences. The positive consequences include:

- reducing the conditions of winter sheep pasturage;
- earlier start of the spring vegetation;
- some productivity increase of the pasture plants in the first half of spring;
- the optimization of the temperature order of the high mountains pastures and the earlier movement to the high mountains pastures;
- the prolongation of the vegetation period of the pasture plants.

The negative consequence include:

- the increase of the inter-annual and intra-seasonal variability of the meteorological indicators;
- the increase repetition of anomalous cold winter and hot summer;
- the difficulty in Summer sheep pasturage conditions;
- the reduced pastures productivity and the earlier Summer sun burning;
- the significant reduction in animal productivity through inadequate technology for maintaining the pastures.

5.4.2 The water resources

Climate change can significantly influence Kazakhstan's water resources. Under climate change conditions the climate in the agricultural regions will become more arid. The demand for water will grow from both the population and industry, as well as neighboring countries and China. The water dependency on Kazakhstan for these countries accounts for almost 50%.

Kazakhstan's orientation for water-intensive agricultural products (cotton and rice) led to the extremely water intensity of the agricultural production.. For agriculture irrigation needs, the majority of water taken is used in the South regions. In the arid climate conditions the water deficit and imperfection of the irrigation system infrastructure could lead to the critical water scarcity in the South Kazakhstan. The example of this is the Aral basin, when in recent years only 4 – 8 km ^{3} of water ran into the sea, and occasion river water (Syrdarya and Amudaria) did reach the sea at all.

There are eight river-basin systems in Kazakhstan. (Picture 5.4.16).

Kazakhstan is referred to the regions with the scarce water supply. Especially the flat regions of the country suffer from water scarcity. The mountainous regions of Kazakhstan forming flows for large rivers, occupy only eastern and southern borders of the republic and are related to the orographic systems of Altai, Sauro-Tarbagatai, Dzungaria, Tyan–Shan'. The main water resources comprise surface water. There are some regions of relatively large underground water however the quality is not always usable

The average flowing of the rivers of Kazakhstan (the total surface water resources in the natural conditions) amounts to 115,8 km^3 per year (Table 5.4.6).

Picture 5.4.16. The lay - out scheme of the river - basin systems of the Republic of Kazakhstan. 1. – the borders of the river – basin systems; 2. – the borders of the administrative oblast'.

Table 5.4.6. - The resources of the river flowing of the Republic of Kazakhstan in the average water content year.

The river – basin system	Flowing, km3/year		
	Coming from the bordering states	Forming in the limits of the republic	Summed up resources
The Aralo – Syrdaryinsky	22,6/14,9	3,5	26,1/18,4
The Balhash – Alakolsky	12,2/8,5	16,4	28,6/24,9
The Irtyshsky	9,5/8,0	26,1	35,6/34,1
The Ishimsky		2,6	2,6
The Nura – Sarysuisky		1,3	1,3
The Tobol – Turgaisky	0,8/0,6	1,5	2,3/2,1
The Shu– Talassky	3,3/3,1	1,0	4,3/4,1
The Uralo – Kaspyisky	10,4/8,6	4,5	14,9/13,1
Total in Kazakhstan:	**58,8/43,7**	**57,0**	**115,8/100,7**

Note: in the numerator it is given the values of river flow coming from neighbouring countries in natural conditions; and in the denominator – coming into Kazakhstan in conditions of the current water consumption in frames of the foreign states.

In the last decade, the rivers flowing in Kazakhstan from bordering states reduced 15,1 km^3 per year - a decrease from 58,8 km^3 per year to 43,7 km^3 per year. Thus, the general resources of Kazakhstan's flowing rivers presently account for 100,7 km^3 in a year.

As a result of glacier degradation there will inevitably be significant changes of water flows in the mountain rivers. These changes can seriously complicate agricultural activity in irrigated cropping areas. Due to glacier degradation the river flow from the Zailyisky Alatau northern slope will shorten to about 16 % by experts estimation. The intra-annual distribution of river flows will change: its quantity in the Summer months (July - August) will decrease and in the Spring–Summer months (May - June) will increase having a negative impact on the agricultural production in irrigated land areas. These negative consequences of glacier degradation require investigative research and quantitative assessment.

Assessment of climate change impact to the annual flow of Kazakhstan's main rivers in the 20th century and at the beginning of the 21st Century

An analysis of the norms of the annual flows in 30 river basins, according to 41 hydrological points showed that there are no significant differences in the quantity of the norms. The exception are the rivers of the Balhash lake basin, where the flows increased to 8%, mostly due to additional sources of thawed water from glacier degradation.

The conceptual mathematical model for flows of mountain rivers, developed at the Kazakh research hydrometeorological institute (KazRHMI) under the leadership of V.V.Golubtsov has been apprised for research of possible vulnerability of Kazakhstan's water resources due to the anthropogenic climate change.

Daily amounts of precipitation and average daily air temperature data from the meteorological stations situated in and nearby the basin range were the input data for modeling the flow hydrograph. These results were simulated based on the models of global climate in accordance with the greenhouse gas concentration change in the A2 and B2 scenarios for the different periods of the XXI-st century: till 2030 and 2050.

According to calculations, the increase in Winter snow coverage on mountain areas leads to increases in flows during the Spring period.

A different situation in the plains basis is experienced – with higher rainfalls having less influence on the volume of flow due to water catchments losses.

By 2030, according to the A2 scenario, water resources in Kazkhstan's mountain

basis will increase on the average by 0,8 % - 4,5 % in the rivers Arys' and Shayan's basins, by 14 % - 22,5 % in the rivers Ily's, Uba's, Ul'ba's, Karatal's and Koksu's basins. However, in the river plains of the Ishim's and Tobol's basins it will decrease by 7,0 % and 10,3 %, accordingly.

According to the B2 scenario, the river flows in the mountains areas will decrease and account for 2,5 % in the basin of the r. Shayan to 12,3 % - 9,2 % in the basins of the r. Ily, Uba, Ul'ba, Karatal and Koksu. In the Arys' river basin it will decrease, but by an insignificant value - 1,9 %. It is worth noting, that the B2 scenario is more 'hard' for the mountains areas, and for the plains basins more 'soft'. In basins of the Ishym and Tobol rivers the reduced water resources will account to 6,1 % and 6,8 % respectively.

If climate change for the A2 scenario in 2050 occurs then the water resources in Kazakhstan's mountain areas will increase, on the average from 1,3 % - 12,7 % in the basins of the Arys' and Shayan rivers, to 5,7 % in the basins of the Uba, Ul'ba rivers. In the basins of the plains rivers of Ishym and Tobol it will drop by 7,8 % and 4,4 %, respectively. According to the 'hard' B2 scenario there will not be an increase of flows in the mountain areas, it will decrease in the range of 7,2 % to 19,5 % in the basins of the Arys' and Shayan rivers and only in the Uba, Ul'ba rivers will the flow increase, by 3,2 %. It is also noted that the B2 scenario in 2050 is more 'hard. So the Ishim and Tobol river basin water resource decreases will account for 7,9 % and 8,5%, respectfully.

It is believed that under the influence of the anthropogenic climate change an increase of the water resources in the mountain areas will occur and decrease in the plains area of Kazakhstan.

Table 5.4.7 – The changes of the river flowing (ΔW, %), the sums of the atmospheric falls (ΔX, %) and air temperature (ΔT oC) under the anthropogenic climate change in the rivers' basins for the prospect to 2030 and 2050 year.

River	ΔW, %		ΔX, %		ΔT oC	
	A2	B2	A2	B2	A2	B2
2030 yr.						
Uba +Ul'ba	16	9,88	1,6	4,67	1,29	1,51
Tobol	-10,3	-6,05	1,22	3,24	1,25	1,61
Ishym	-7,02	-6,76	1,35	4,57	1,24	1,52
Ily	14,2	12,3	2,01	4,01	1,19	1,59
Karatal	16,6	9,26	0,02	0,85	1,29	1,59
Koksu	22,5	9,25	0,02	0,85	1,29	1,59
Arys'	0,75	-1,95	2,86	1,85	1,31	1,72
Shayan	4,54	2,50	2,86	1,85	1,31	1,72
2050 yr.						
Uba+Ul'ba	5,72	3,17	3,95	18,8	2,47	2,38
Tobol	-4,38	-8,48	2,99	4,87	2,41	2,51
Ishym	-7,82	-7,96	3,79	6,88	2,41	2,40
Arys'	1,29	-7,25	3,14	2,11	2,48	2,64
Shayan	12,7	-19,5	3,14	2,11	2,48	2,64

The degradation of the mountains glaciation and its impact on the resources of the river flowing in the basin of the lake Balhash.

The Balhash Lake basin is one of the largest and the most densely populated area of Kazakhstan. The results of the regime and mass balance reconstruction of the Tuyuksu glacier situated in the Malaya Almatinka river basin of the Zailisky Alatau northern slope have shown that its area although slowly but constantly is decreasing since the end of the XIX-th century to the middle of the XXI-th century. From the beginning of the second half of the 20th Century the decreasing rate of the glacier area has significantly increased. Calculations show that more than 10 % of additional water flow into rivers due to the reduction of ice and water stores in the glaciers.

The research showed that the flow of mountain rivers will be significantly decreased due to glaciers degradation. For the Zailisky Alatau northern slope the flow will shorten by 163 mln m^3 per year or 12%. For the upper part of the basin of river Ily (PRC) the flows will shorten by 13000-14000 mln. $M.^3$ per year and for the middle part of this basin by 400-500 mln $m.^3$ per year. For the whole of the river Ily's basin the flow will shorten by 1800-2000 mln. $m.^3$ per year. This has significant meaning for agricultural production, in particular the irrigated lands during the vegetation period (April – September).

The intra–annual distribution of the river flows will change significantly. On average the water content flow of the third quarter of the year will increase by 20%, and also increase in the first and fourth quarter. With the decreasing water content the flow of the third quarter will decline, and increase in the fourth quarter.

River flow characteristics have important implications on future water resources in the context of climate change. It is also necessary for constructing hydraulic project structures.

The changes of regional values of the air temperature even at the general global temperature rise are characterized by cyclic fluctuations with various durations. That is why at present there is a probability of coming a number years with the higher air temperature during the so called short summer (June-August). In such conditions it might happen a partly restoration of the glacier area volume that would lead to reduction of the mountains rivers annual flow. This reduction might be two thirds of the average perennial flow values given above.

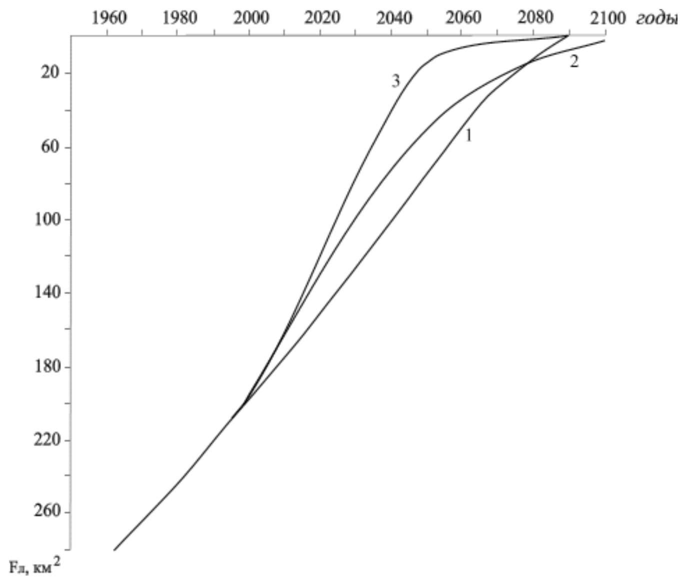
Humidification of the mountainous rivers basins is also realized by cyclic fluctuation with various durations. At the current conditions there is also a probability of some periods with reduced humidity. The annual flows of mountain rivers will decrease. It is evident that after a rather long period with higher annual and summer air temperature and a period with a rather high level of humidity might come a period with opposite values. At the current century the risks exist for the resources of the mountainous rivers' flows. The probable risks for the river flow during the glacier degradation and its consequences in conditions of water consumption increase in the Ily river basin could lead to destruction of Balhash lake ecological system.

The calculations show that the rise of global air temperature and degradation of mountain ice will lead to higher tensions when using the flow in the basin of lake Balhash. To compensate this tension, reservoir storage construction projects are required on the mountain rivers, flood protection work and landslides hydro–technical structures.

5.4.3. Mudflow activity

Glaciers melt in the North Tyan-Shan having started since 19-20 cnetures will continue to degrade due to climate change. The volumes of moraines are getting bigger due to the warter flow from glacier melting, occurring most often by underground flow channels. The research of the temperature regime and water flow turbidity of the Tuyuksu glacier showed that at the present there are underground water reserves with the volume exceeding 500 thous. m^3. The breakthrough with discharge exceeding the critical volume could cause mudflow with the volume, exceeding the capacity of the mudflow reservoir in the Medeu and, consequently, destroying the most part of Almaty city. The same danger is for the settlements that are located on the northern slopes of Zaileisky Alatau.

The mudflow activity of the glacial genesis on the North Tyan' Shan' is determined by the scale and rate of the mountains deglaciation. Picture 5.4.17 shows the diagrams on glaciers area reduction in the northern slopes of Zaileisky Alatau at different scenarios of air temperature change. By forecasting warming all the plain glaciers in the Malaya Almatinka river basin will practically melt down by 2050. Only on the shadowed parts of the highest peaks of this basin some hanging glaciers could be saved by 2100. A more positive situation is the freezing of Talgar and Issyk rivers, which will also disappear in the first decades of the 22nd Century. The active deglaciation of Tyan' Shan', will significantly increase mudflow activity in the first decades of the 21st Century.



Picture 5.4.17. The dynamics of the square shortening of the freezing of the north side of the Zaileisky Alatau.

1 – the corrected E.N.Vilesov graph; KazSRIEC scenarios:
2 – under the warming by 2 C;
3 – under the warming by 4 C.

Catastrophic mudflows in the region discussed are formed from heavy showers, covering all altitude zone of river basins. The condition for catastrophic mudflows in the Zaileisky Alatau is intensive and long rainfalls in high altitude.

Mudflows like that of 1921, will happen once in two years by 2050. It should be noted that the probability of this assessment is the most minimal. When calculating the potential mudflow activity it was not taken into account the flowing coefficient increase due to the growing proportion of rocky and ice catch basins, and also the annual layer of precipitation due to increasing air temperature and the abnormal damping of open grain rocks during cryolithozone degradation.

The glacial and rainfall mudflows present significant danger for the communities and industries situated on output cone.

The data presented in Picture 5.4.18, assesses the average amount of mudflows, on a scale measurable with the 1921 mudflow. It is evident (Table 5.4.5.1.1) the mudflow storage in the Medeu valley will be fully filled by mudflow sediment by 2030-2040.

Picture 5.4.18. The changing of the relative mudflow activity of the rainfall genesis under the various warming scenarios: 1 – 1 C; 2 – 2 C; 3 – 2,8 C.

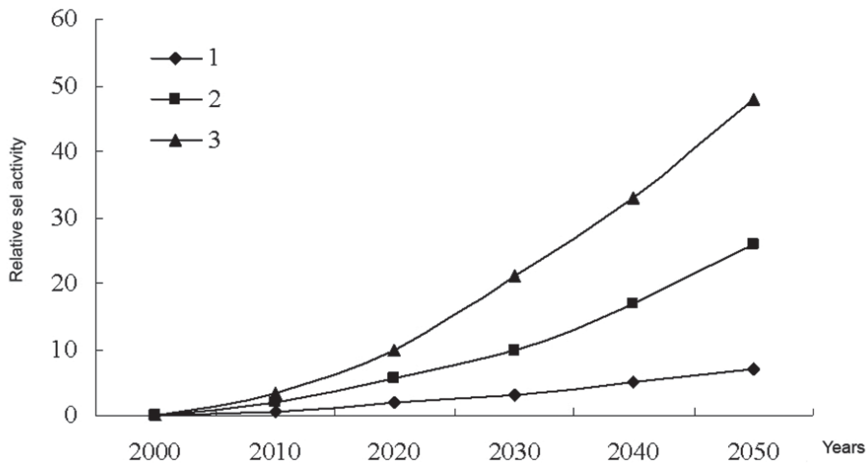


Table 5.4.8 –The number of the mudflow cases of the rainfall genesis in the interval of years under the various global warming scenario.

Years / ΔT, єC	2000-2010	2000-2020	2000-2030	2000-2040	2000-2050
1	0,05	0,25	0,55	1,0	1,7
2	0,1	0,45	1,25	2,6	4,8
2,8	0,2	0,8	2,3	4,9	9,0

Under a climate warming of 2-3 C the steppe climate of the piedmont step transforms into desert climate. The forest covering will totally disappear. Practically all rainfalls will lead to mudflow formation, sediments of which in the piedmont plains will stop the most productive lands. The sharp increase of the river flow running into the Ily river will create conditions for quick siltation of the Kapchagaiskoye water reservoir, the change of the Ily river estuary and the lake Balhash in general. There will be serious problems with watering agricultural crops.

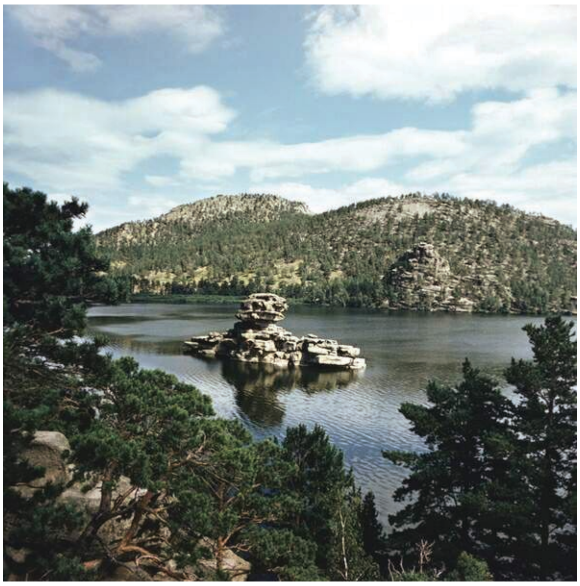
It is possible to prevent the advancing ecological catastrophe, but scientific research is required now on the adaptation of the natural economic complexities to climate change.

5.4.4. Forestry

The most part of Kazakhstan is in the arid zone presented by steppe, semi-desert and desert landscapes – unfavorable conditions for growing forest vegetation due to the lack of the rainfall.

The exceptions are the mountains in the Eastern, South-eastern and Northern regions of the country where forests are concentrated. The forest composition and conditions for productivity growth is determined by climatic conditions. According to the 2003 forest fund, the forest size comprises 12 427,8 thous. ha. and the forest lands accounts for 4,6% from the total country area. The forest lands' index of Kazakhstan is one of the lowest index in the world. However the index per capita is 0,77 ha. of forest – almost the same as the USA or Malaysia, and higher than most countries in Eastern Europe. Kazakhstan's forest comprise saxaul trees – 6 136,9 tho. ha. (49,7%), bush - 2942,7 thous. ha. (23,8%), coniferous and hardwoods and other plants comprise 3158,7 tho. ha. (24,6%) or 1,16%. The forests are characterized by low average density and uneven territorial distribution.

Kazakhstan has a history of forests planting that protect from winds, sandbanks and barchans. At present around one tenth of the country's forest resources (1 mln. ha) are artificial.



The forests of Kazakhstan implement water protecting, soil protecting, sanitary, health improving and climate regulating functions, and also serve as a source for getting the rawwood, food and medicinal products. The forest ecosystem is diverse: with 68 types of trees, 266 types of the bush, 433 sorts of small shrubs, suffrutex and semi-grass, 2598 sorts of longstanding grass, 849 kinds of annual grass and 835 sorts of vertebrata. Considering the important role of forests and the small percentage of useful forest planting territory, around 97% out of all Kazakhstan's forests are in the protected forest category and two thirds of the forest fund are totally excluded from the commercial exploitation.

In or near the forest territory live around 2,5 mln. people, many of which are directly dependent on the forest sector: these are field users, hunters, herb collectors and shepherds. Tourism is also key in the national parks and forests.

The arid steep continental climate of Kazakhstan creates environmental threats to the existing forest ecosystem from aridization/desertification, fires (the natural and anthropogenic) and pest attacks. Expected climate change in the region will raise the vulnerability of the forest sector.

Climate conditions of the last decades have led many fires. With fire burn-offs occasionally leading to full-scale fires in some Eastern and Northern regions. During 2000 – 2006 there were 6415 forest fire cases recorded, resulting in 160 tho. ha. burnt.

The higher vulnerability of forests is also linked to the coniferous species - pine, fir tree, silver fir, larch and cedar in the South that are very sensitive to temperature changes and humid conditions. The juniper, especially arboraceous, growing in the North are also susceptible to changing climate conditions.

The drying out of the Aral sea provoked the drop in ground water levels and changed conditions in the forest of Kyzylkum desert, making it unfit for the growing black saksaul, one of the main foresting species of that region.

5.4.5. The population health

Kazakhstan's complex geographic climate conditions influence the state of the population's health. Predicted climate warming will have both a direct and mediated influence on the population's health.

The direct influence is an increase in morbidity, and even death as a result of dangerous weather phenomena, for example, extreme high temperatures, floods, mudflows, landslides. The indirect impact refers to an increase in the number of the infection carriers (mosquitoes, pincers and others), the danger period of potential infectious, disruption of the water supplies, quality and lack of the drinking water.

The characteristics of population health status that are dependent on meteorological weather conditions are the indicators of population diseases and mortality from diseases on blood circulation system. The growth of which is found in practically all regions and age groups within Kazakhstan.

Climate warming will lead to higher mortality levels from blood circulation diseases and cerebral vascular diseases. The most vulnerable population groups are the people suffering from the chronic diseases, children and that the elderly (a growing proportion of the population).

Warmer air temperatures increases the risk of heat stroke, burns and water accidents, affecting children, the elderly and lower socio-economic groups the most.

The climate predictions will see increased catastrophic disasters such as mudflows, landslides and floods. According to research at the air temperature increase to 2-3 °C the mudflows' activity will increase ten times. As a result, communities situated in piedmont zone, the most economically and socially developed territory of Kazakhstan, may be prone to ecological disaster.

The rising of atmospheric air temperature will negatively impact on environmental pollution. Cities with high atmospheric air pollution level (Almaty, Ust' - Kamenogorsk, Balhash and others) will see increases in respiratory diseases and cardiovascular issues.

The indirect impact will be determined by deterioration of the social and economic level of the population lifestyle and worsening of the nutrition due to withdrawal of the agricultural lands damaged from aridity, degradation, and desertification. The risk of desertification will grow in the various regions of the Republic, especially in the south. This will impact to the population health. The growth and development of children in rural areas will be most affected

The forest and steppe fires will have serious concern and their frequency will increase due to global warming. These fires could damage considerable areas of agricultural lands and also would have an indirect impact to population health by exceeded smoke concentrations in the air.

According to research, the rise of the air temperature increases the risk of spreading infectious and parasitic diseases and stomach infections.

The future climate warming will have pressing health issues on Kazakhstan's population. Special consideration is required for the Kzylordinskaya oblast area with poor climate, environment and socio-economic conditions present. This area also has the highest recorded level of infant mortality.

An important indicator is the availability of fresh drinking water (quality and quantity). Despite several programs underway, some areas in the oblast are in need of fresh water.

5.5 Adaptation measures

5.5.1 Agriculture

Grain production

The following necessary actions are identified:

1. To develop complex measures for grain production adaptation to the climate change, namely, combat with soil erosion, introducing the soil protecting and moisture conservation technologies; minimizing the anthropogenic impact to the soil; the effective use of organic fertilizers; sowing expansion; selection of new agricultural sorts and hybrids; the use of alterative sources of energy; carrying out special educational and training programs for agricultural workers.
2. To improve the network of systematic surveys, a forecasting system, modeling and early information about the emergency hydrometeorological phenomena for the timely decision making and correction of the adaptive steps and dissemination of the results among the users.
3. To carry out research on the study of climate change, its consequences on natural resources, the economy and populations health and to work out purposeful adaptation steps.
4. To set up the Government Commission on climate change.
5. To work out the strategy for reducing emissions and increasing GHG absorbents i for 2009 – 2012 years.

The agricultural production, including grain production, must have an important role in climate change debates and decision for adapting new methods. It is necessary to consider several scenarios concerning the program of GHG relating to agricultural production (Table. 5.5.1).

Table 5.5.1 –The existing technologies and proposed steps for control and monitoring of the soil carbon in connection with the climate change.

Object	Existing technology (midterm)	Steps proposed (long term)
Agricultural production (grain)	1. Conservation farming system. 2.No-Till technology. 3. The existing sorts of grain.	1. Taking part in the Kyoto protocol. 2. Getting the carbon credit. 3. Adopting the Law and the state initiative in support of the carbon sequestration steps. 4. The change of the farming systems: – No-Till the differential use of the No-Till technology, – the replacement of the lea, – the diversification of the crop production with the applying of the wide range of the agricultural crops adapted to the stress situations, – the modeling the climate change scenarios, – the change of the structure of the use of the tillage, – the perfection of the grain sorts resistant to the drought and with the preset tapping genotypes, adapted to the stressful situations.

Future steps should surround:

- reducing the impact of global climate warming on plants through perfecting the selection of grains resistant to climate stress,

- the management of restricted water resources and adaptation of the new methods,
- the adaptation and use of agricultural biodiversity,
- the diversification of crop production, including high yielding,
- the advanced land tenure in preventing soil degradation, agricultural landscapes with the good moisture and fertility soils,
- the analysis and assessment of the effectiveness of new scientific achievements,
- the advancement of knowledge for timely adaptation to climate change, and access to the knowledge for the end users,
- the possible of renewable sources of energy including bio-energy.

For stable growth and adaptation to possible climate changes, it is necessary to:

- work out the new moisture conservation culture technologies by modeling the change (shift) of atmospheric fall distribution,
- change the tillage use structure including the cultures capable of actively absorbing carbon dioxide from the atmosphere,
- extend the adaptation of new cultures,
- use the potential of gene engineering, information and expert systems to develop more drought-resistant sorts of grain,
- work out of the agricultural management of effective irrigation water,
- develop a model of the possible character and types of drought and the preventative measures,
- educate farmers in new effective farming methods,
- integrate management of genetic resources: conservation, improvement and rational use of the agro–biodiversity in climate change conditions.

Climate change conditions and the management of agriculture in Kazakhstan requires the development of special programs for the sector to ensure stable development in new conditions. Continued research is necessary for accurate climate change condition predictions.

According to new conditions the important principles of the agricultural sector development must become the adaptation the agriculture to the climate change, taking into account the monitoring of the present and future natural peculiarities of the land resources management, the dynamics of natural and economic fertility. Based on these principles, it is necessary to realize the steps for developing the agrarian sector, its mechanization, chemicalization, and melioration supporting the innovation of scientific achievements and technical progress. In this context it is necessary to establish a regulation system (incentives, loans, taxes etc.) for prioritizing the resources allocation, investments into the agriculture, to improve the costs distribution for sustainable development of the agriculture sector in the future.

It will be important to inform key decision-makers to achieve general acceptance of the necessity to develop long-term strategies and put into practice climate change adaptation steps.

Pastures

Taking into account the experience gained in reconstructing and restoring natural pastures in arid climate conditions, the first steps in adaptation are:

- measures on establishing pastures and restoring the pasture management on the state level;

- the legal acknowledgment of pasturage users;
- to supply each individual farmer or rural community with several types of pastures for different seasonal use;
- putting into use of the remote pastures with partly restored plants;
- restoring water wells and watering-places;
- regulating the cattle pasture load through different seasonal grazing, first of all by reducing the cattle grazing load on the pastures immediate to settlements and with the strong expressed pasture digression;
- to increase production of coarse fodder by sowing perennial species of grass on on the tilled lands and productivity conservation of hayfields available.

The problem of water supply to the south Balhash pastures must be resolved, mainly based on the underground water resources by restoring wells and installing pumps with the autonomous sources of energy.

To reduce the vulnerability risk to pastures on the piedmont plains of the semi–desert the following measures are recommended by the Institute on Fodder and Pastures. They envisage establishing areas for cattle grazing with mixing natural pastures and specially planted lands by annual sorts of grass. .

Major barriers of pasture adaptation are incomplete land reforms and programs of arable cattle breeding development in Kazakhstan.

Achieving the goals on pasturage adaptation of unfavorable climate and direct anthropogenic influences at the regional level is carried out in the framework program for securing stable development of the Balhash – Alakolsky basin 2007–2009 yrs.

Sheep breeding

The following measures are advised to strengthen climate change adaptation for sheep breeding:

1. to research the identifying grade level of the adaptability of sheep and find stress-resistant sheep for each natural climate area of Kazakhstan;
2. to reconsider breeding of the sheep species due to climate change circumstances;
4. the restoration of the pasturage system for sheep farming – wider use of high mountain pastures;
5. introducing a regulated animal pasturage system;
6. surface soil improvement of vegetation on degraded pastures, planting saxaul in the desert and semi-desert pastures;
7. organizing effective veterinary and sanitary supervision, quarantine regulations and other measures to contain infectious disease outbreaks;
8. taking into consideration the recommendations provided by farmers, agricultural experts and experts from the hydrometeorological stations for identifying terms to inseminitation, lambing, shearing, sanitary supervision, migration to summer pastures as well as storage of additional volumes of fodder due to increasing weather instability.
9. improving the whole system of agricultural and meteorological service of the sheep breeding;
10. raise awareness with farmers through mass media of weather conditions and introduce a scientific approach to cattle breeding management;
11. effective regulations of state and social programs for rural and agricultural development.

The main socio-economic barriers when considering sheep breeding with climate changes are:

1. the concentration of sheep stock in small areas without potential for further development;
2. possible cuts to Government subsidies for promoting cattle breeding production.

5.5.2 Water resources

In the first instance it is necessary to:

- develop towards arid and mini-water technologies;
- increase of the proportion of ground-water usage;
- transfer some part of the river flow inside and outside the regions.

To reduce the negative consequences of the vulnerability impact to the water resources by the economy sectors the following is required to:

- reconstruct the watering systems and water supply systems to minimize water loss;
- replace water-resistant agricultural plants on irrigable lands with the less water–resistant cultures;
- introduce progressive technologies in irrigated farming lands;
- introduce mini–water technologies and recycling water systems use in existing industrial enterprises and community facilities;
- use of discharged waters;
- reconsider of the functioning regimes of hydroelectric stations;
- carrying out dredging works, renovation of wharfs and berths in navigable rivers:
- the replacement of functioning types of ships.

The steps for improving the water ecosystems and environment include the following:

- limiting the economic activity in the most water deficit regions and the economic activity transfer to the other regions;
- meeting requirements for establishing sanitary protective zones near the surface water reservoirs and underground water wells and the mandatory ecological expertise for new projects on the water resources use;
- the usage of chemical and biological cleaning of discharged water;
- the development and delivery of additional reclamation, agricultural and forestry reclamation and technical actions for providing the ecological security to the water resources;
- setting up a water heat thermal regime for existing and regeneration of fish and other live organisms.

Steps to reduce social losses include:

- allocating finances and development infrastructure to compensate people for relocating from desertification regions to new localities;
- importing food and industrial products unprofitable for their domestic production due to lack of water resources.

The steps on to promote effective decision making include:

- developing interstate regulation of water management relationships ;
- improving the advance and reliability of hydrological forecasts;

• the development of models and scientifically based recommendations making it possible to assess the situations correctly and quickly;

• preparing the necessary services for providing immediate support;

• the development of schemes for water resource usage;

• detailed assessment of the adaptation steps is necessary to set up the imitation systems.

5.5.3. Forestry

John McColgan

Forest adaptation measures can be divided into two directions – reducing the maximum existing risks for forests relating to present climate conditions and maintaining the maximum possible forestry contribution to the environment and the economy development. These measures should assist in overcoming negative changes.

Existing climate conditions are the main limiting factor for Kazakhstan's forests. Measures towards preventing forest fires and pests will have the most beneficial effect. As 80% of fires are caused by humans, attention should be given to cultivating safety responsibility and forest planting.

In the South areas there is potential for commercial forest growth and the expansion and restoration of saksauls is needed.

Under the protection of the forest belts there are the conditions for sustainable farming improving effective capacity of the crop rotation in comparison with the open fields, enhancing the biodiversity –from insects helping fertilization and to the mammals such as hares and foxes..

Forest restoration helps strengthen and protect the water function and reduce flood risks. Saxaul forests reduce wind erosion on sandy soils. The forests could become beneficial to the farmers due to the wood and not wood forests products, due to the tourism activity and recreational business.

To fight fires and increase restoration significant capital investment is needed. In November 2006 Kazakhstan and the World Bank signed a loan agreement for a project assisting the development methods of sustained forest restoration and management of adjoining pastures. The project seeks to address major problems in the country's forest industry.

Until now, the study of climate change influences on Kazakhstan's forests has been insufficient. Some applied research on climate change influences on forest planting will:

1. consider the climate change impact to the forestry sector in the national strategy and programs;
2. select species and types of wood due to the climate change impact and to assess capacity for providing raw wood to the population needs;
3. take into account climate change impact when developing effective planting technologies;
4. amend the normative legal base and reference literature;
5. elaborate the concrete steps for this sector adaptation depending on the local

conditions and requirements of the landscape planning;

6. justify budget financing for securing the forestry function in present and future climate conditions;

7. advance and update education and training courses.

5.5.4. Population health

Related Government initiative include the program for reforming and developing the public health service 2005-2010 and the a the healthy life program 2008-2016.

The necessity exists to strengthen Kazakhstan's attention on the impact of climate change and population health. Government programs do not include measures for reducing the negative climate impact on the population's health and there is limited research.

Future directions should include an improved legislation base, sustainable building solutions in response to changing climate conditions and measures to control infectious and non-infectious population diseases.

The first phase involves improving legislation and legal acts. The second phase involves the use of new technologies in building construction and the third phase surrounds education and improving socio-economic conditions.

Monitoring the population's health as part of the country's climate strategy will be necessary. Identified areas include providing potable water and healthy food, monitoring sanitation, hygiene measures and reducing disease transmission, and reducing pollution levels. A further element includes the population demographics of the country's regions.

It should be noted that actions related to the population adaptation to the climate change will be effective only in the case of their complex use considering the features of each region of the Republic of Kazakhstan. The active complex actions on the population adaptation to the climate change will promote health maintenance to the present and future generations that will become a guarantee for the sustainable country development.

5.5.5 Mudflow activity

Global warming, accompanied by regional climate characteristics will to drastic mudflow activation. A strategy safeguarding the country against mudflows is required.

For preventing transformation of lowhill zones of the mountain ranges of Kazakhstan to badlands it is necessary to carry out reclamation and agricultural works of these areas. Up to present the projection and construction of the water reservoirs, water collectors of discharged waters, tailing dumps and so on, were realized without taking into consideration the capability of the transforming floods into mudflows and as a result their capacity could be repeatedly increased.

It is necessary to develop and adopt legislative acts aimed at:

- the regulation of economic measures in the zones subject to mudflow impact;
- the protection of the environment in formation zones and mudflow deposit;

• the insurance of the mudflow risks;
• setting up a complex mudflow monitoring system.

Research is required aimed at:
• the determination of the nature of the water freezing mudflows and from this base the forecast and prevention methods;
• developing methods for super short-term forecast of the mudflows from rainfalls having the high rate of sufficiency;
• the cartography of mudflow starting zones from glaciers and rainfalls.

To develop and improve the construction norms and regulations (SNiP) requires:
• the projection, construction and operation of sill dams;
• the prevention of the appearing and developing of the surface and underground reservoirs of the morainic – glacial complexes;
• the evacuating the mudflow dangerous ponds.

To undertake the socio-economic research aimed at finding optimal technical solutions against mudflows involves:
• making projections and modernizing dams to catch overflows in the high mountain zone of the Malaya Almatynka and Kumbel' basins;
• carrying out construction work in the city of Almaty and the sports complex hosting the 2011 Winter Asiatic Olympic Games, considering the high vulnerability of its sill dam and providing strong safe structures.
• undertaking organizational measures on introducing the super short– term forecasts of mudflows from rainfalls.

With the aim of increasing efficiency of the anti–sill measures it is necessary to carry out the SRW study:

• of the methods reducing mudflow activity from rainfalls under the climate change conditions;
• of the effective methods of artificial forestation in the alpine zone;
• of the methods of super short term forecast intensity and precipitation duration; of the methods of active impact on the duration, intensity and phase composition of precipitation;
• of the measures aimed at preventing the aridity of the lowhill zones and abrupt activation of the sills on these areas.

In the following stage it is necessary to complete the projection, construction and safety measures of the cities and agricultural territories situated in the piedmont plains adjoining the northern side of the Zailesky Alatau.

In the final stage of the anti–sills dams process, there should be construction of sill dam complexes and safety measures provided for cities and agricultural territories situated in the piedmont plains adjoining the northern sides of the Kirghiz and Talassky Alatau, Ugamsky range, and also the Kazakhstansky Altai. The accomplishment will assist the sustainable society development.

CHAPTER 6. OBSERVATIONS AND RESEARCH

This section contains information on climatic system observations undertaken by the Government's Kazhydromet and draws on data from on ongoing studies and scientific analysis of climate and climate change.

6.1. Regular observations

Regular observations of Kazakhstan's climatic system are undertaken through national programs of the Kazhydromet, part of the Ministry of Environment Protection.

The Kazhydromet is undertaking the following national programs:

1. Observation systems on the environment and pollution and developing technologies for data collecting, archiving, distribution and management. Programs are aimed at developing technologies and metrological support for hydro-meteorological and helio-geophysical observations, collecting, processing and distributing observation data, and maintaining and developing the country's fund of hydro-meteorological and environment pollution data.
2. Monitoring of climate on Kazakhstan territory. The national program of climatic data and climate monitoring is aimed at maintenance and management of climatic data, preparation of climatic information for climate monitoring (inquiry-regime information) and also providing climatic information for forecasting to different sectors of the economy.

The Kazhydromet manages the observation network (Table 5.1) and provides material and technical support, finances network operations, plans and finances research on measuring methods and means, observations methods and data collection and processing.

Under the Global Climate Observing System (GCOS) there are two established networks: aerologic network (GCOS Upper Air network - GUAN) and surface meteorological network (GCOS Surface network – GSN). Operation of the Upper Air network is supervised by the European Center of Medium Weather Forecasts (ECMWF), and the surface meteorological network is supervised jointly by the Japanese Meteorological Agency (JMA) and German Weather Agency (DWD). The specified centers provide the regular results of network monitoring.

Kazakhstan's observation network systems and programs (GCOS) are based on the Global Observations System (GOS) of the World Weather Service (WWS), Guidance on the Global Observations System, technical regulations of WMO, and guidelines on the measuring devices and methods.

The GOS surface subsystem in Kazakhstan includes 65 land based surface synoptic stations, which provide the Global Telecommunication Network 'SYNOP' reports on four basic terms (Figure.1, Annex 2). The upper-air stations provide 'CLIMAT TEMP' reports, and the climatic stations provide 'CLIMAT' reports (Table 1, Annex 2.).

Table 5.1. Observation network under Kazhydromet

№	observations	number of observation sites	Global Observations System
I.	Surface meteorological network:		
1	Stations	251	65 (SYNOP), 45 (CLIMAT)
	Aerologic observations	8	7 (CLIMAT TEMP)
	Complex station of environment background monitoring	1	* (Background Monitoring Station "Borovoe")
	Actinometric observations	13	
	Ozone observations	5	
2	Posts	121	
II.	Hydrological observations:		
	• On rivers	222	
	• On lakes	31	
	• On sea	8	
III.	Environment ecological monitoring network		
1	Air pollution observation sites	43	
2	water pollution observations		
	river	53	
	Lake	8	
	channel	11	
	Water reservoirs	11	
	sea	1	
3	soil pollution observations		
	City/site	18/5	
IV.	Radiation monitoring		
	Gamma - background	69 stations	
	Beta - activity	41 station	

* The station organization is decided under the World Meteorological Organization. The information from the station goes to the Global climate and ecology institute (Russian Federation).

Additional information

Surface networks include the additional Global Terrain Network for Hydrology (GTN-H). While the GTN-H catalogue is not fixed, the Kazhydromet intends to provide daily precipitation data to the Global Precipitation Climatological Centre (GPCC), according to the GPCC request.

Extent of national observation data exchange

Kazhydromet provides data to the World Meteorological Datacentre (A) and National climatic data centre in Eshville, Northern Carolina, USA.

Kazhydromet prepares information on monthly and annual average values of atmospheric pressure at sea level, air temperatures, the maximum and minimum air temperature, and the monthly and annual precipitation statistics 1961-2000 at 30 stations.

The following publication included data and observations from 30 meteorological stations in Kazakhstan - WORLD WEATHER RECORDS 1981-90, volume 4, ASIA, Timothy W Owen, Editor, JULY 1999 .

Kazhydromet provided data from 14 stations to the Global climate observation system, including daily precipitation figures, and maximum and minimum air temperatures since the beginning of observation to 2006.

Meteorological data with VNIIGMI-MTSD (Russian Federation, Obninsk) are regularly exchanged after processing the operational regime information on four basic terms at 22 stations of the international exchange.

Institutional activity

Being a national hydrometeorological service, Kazhydromet, takes part in regional training seminars organized by the World Meteorological Organization. The main seminar and training course subjects are on metadata, analysis of climatic information quality (homogenity of historical series), climate data management and calculation of climate change indexes. Kazakhstan's attendance includes:

- Kyrgyzstan, Bishkek (2003) International seminar on climate data, data management, and data rescue;
- Russia, Moscow (2004) Sub regional training seminar PA II / PA IV on preparation of CLIMAT and CLIMAT TEMP reports;
- India, Puni (2005) Regional training seminar on climate change (Software RClimDex);
- China, Beijing (2006) Three-month training courses on the development of high-quality data management, including quality assurance and homogenization of instrumental data;
- Russia, Moscow (2006) International conference of young scientists.

Activity following Kazakhstan's publication of the Initial National Communication under the UNFCCC

Following the publication of Kazakhstan's INC under the UNFCCC, the following climate change related activities were carried out. In 1998, the CLICOM hardware and software system was installed at Kazhydromet. Since then, climatic databases have been systematically formed. In April 2004, the updated CLICOM software version was installed – a climatic data management system called CliWare, which has possibilities for forming climatic database for historical series and populate the database with meteorological systems and operative information.

The metadata base for Kazakhstan's meteorological network of has been prepared. The database on air temperature and precipitation was used to calculate climatic indexes applying the RClimDex software to analyze thermal and precipitation systems.

Principles of climate monitoring GSNK/GSNO/GSNPS

Kazakhstan's national programs for regular observation of the hydrometeorological service follows climate monitoring best-practice principles. In early 2007, 10 new stations were established since 2005 and 23 automatic stations were established. Unfortunately, due to the vast size of Kazakhstan, network upgrade budgets are limited and do no allow the introduction of all climate monitoring principles. The Kazhydromet tries to maintain a sufficient period of simultaneous works using old and new observation systems when transiting from one observation system to another.

The climate data management system is an important element of the monitoring system. However, software and technological data management complex CliWare is not in operation, causing difficulties in forming long-term observation data series and updating databases with operative information.

6.2. Meteorological, atmospheric, oceanographic and terrestrial observations

Meteorological and atmospheric observations

The surface meteorological network of Kazakhstan currently has an area of 2756 thousand km^2 and includes 251 stations. This network carries out regular regime observations (eg. observations in the volume corresponding to climatic stations) since 1966 for eight synchronous terms: 00,03,06,09,12,15,18 and 21 hour of the World co-coordinated time. It provides the necessary accuracy to describe a daily course of basic meteorological characteristics (air temperature and humidity, wind speed and direction, atmospheric pressure, soil temperature, visibility, cloud quantity and forms, height of their lower end). In the terms nearest to the 7 and 19 hour Winter time zone, precipitation quantity is measured. Observations of the intensity and development of atmospheric processes and phenomena are conducted continuously.

Eight (8) stations out of the 251, provide atmospheric observations, eg. they are also aerologic stations (GUAN). 65 stations provide SYNOP reports to GST (GSN - Global Surface Network): Region RA-2 - 62 stations, region RA-4 - 3 stations for the four core terms: 00, 06, 12 and 19 hour of the World coordinated time. 43 out of 65 stations submit monthly CLIMAT reports and 8 aerologic stations submit CLIMAT TEMP reports (Table 5.2).

Table 5.2. Participation in systems of global atmospheric observation

Stations	GSN	GUAN	GAV (global atmosphere service of WMO)	other
How many stations does the party have?	65	8		
How many of them do currently operate?	65	8		
How many stations will possibly operate?				
How many stations provide data to the international datacentres?				VNIIGMI-MTSD 22 stations*

* regularly

The control and archiving of Kazakhstan's surface station networks is carried out using the PERSON–MIS software (an automated system for meteorological information processing, developed by VNIIGMI-MTSD, Obninsk, Russian Federation). The control of the representativeness of the station site is assured by the software 'Interstation control' developed in Voejkov GGO, St.-Petersburg, Russian Federation. After climatic processing, the historical series are checked for consistency using various methods of revealing and eliminating climatological inhomogeneity.

6.3. Climate change studies

Climate change studies are included in the Government's Environment Protection budget program 2005-2007 and in international projects. The MEP prepare GHG assessments, climate change adaptation studies and develop climate change scenarios. Since 2004 the following studies were carried out:

- Quantitative estimation of GHG emissions, development of GHG emission scenarios, development of the national strategy for GHG emissions mitigation, preparation the conditions for creating the national GHG licensing system, establishment of the GHG emissions monitoring and reporting system (KazNIIEK);
- Assessment of current regional climate change, vulnerability and possibilities of climate change adaptation of ecological systems and climate-depending economic sectors, development of the regional climate change scenarios under increasing carbon dioxide concentration in atmosphere (KazNIIEK);
- Estimation of the physical and chemical processes impact on the ozone layer, and ozone layer change, particularly the impact of changes in ultra-violet and sunlight radiation on human health and other living organisms, climate, and natural and artificial materials (KazNIIEK);
- Studies on Kazakhstan ozone layer dynamics and measures to prevent negative consequences (Kazhydromet).

The most important results of these studies are included in the Second National Communication of Kazakhstan under the UN FCCC.

CHAPTER 7. FINANCIAL SOURCES AND TECHNOLOGY TRANSFER

Technology plays an important role in mitigating climate change, helping to eliminate its causes and simultaneously adapt to its consequences. As such, a wide distribution of the required technologies is essential. Most technologies necessary for activating climate change mitigation are already available. Methods such as increasing energy efficiency and energy saving through changing behavioral patterns, using renewable energy sources, applying water saving technologies, using drought-proof seeds and restoring soil fertility have already proved their efficiency in reducing global emissions and contributed to the acceptance of adaptation measures in the short-term.

Most of these technologies belong to develop countries, which according to Article 4.5 of the UN FCCC "undertake all practical steps for encouragement, simplification and financing in cases of transfer of environmentally safe technologies and know-how or access to them for other Parties, especially developing countries to help them in fulfillment of the Convention obligations."

In regards to technology transfer, it is also necessary to have a donor country. The key factor for successful transfer and introduction of technologies, especially in developing countries, is favorable conditions. The social and economic advantages of technology transfer can be achieved only if local factors are considered and the institutional and organizational conditions exist. Kazakhstan, through its strategy of industrial and innovative development 2003-2015, is aiming to achieve sustainable development in the country by diversifying the economy, promoting a shift from raw-materials and preparing conditions for a long-term transition to a service and technological economy.

For Kazakhstan to shift from a raw-material orientated economy to service and technology orientation will require using international experience in innovative development to foster a high-technological and scientifically sound industrial sector.

Kazakhstan's economy is characterized by high power consumption, which considerably exceeds similar indices in developed countries. If power consumption per 1 dollar of gross national product is considered, as well as labor productivity, Kazakhstan is behind some developed countries by more than 7-10 times. The technological backlog has several causes:

- the basic process equipment for the most power-intensive industries was delivered from the COMECON countries which had lower energy efficiency in comparison with world analogues;
- lower technological level and automation means for regulation and control over technological processes;
- Insufficient and poor quality control systems in all energy sources;
- Low level use of secondary and by-product resources

The greatest potential for GHG emission reduction in Kazakhstan is the energy sector. Corresponding mitigating actions include reduction losses and increasing efficiency of fuel and energy resources, introducing state-of-art energy saving production technologies in the power and industrial sectors and further development of renewable energy sources. Also, significant reduction can be expected from switching, where possible (Southern and Western Kazakhstan), from coal to gas, or by introducing more effective coal technologies.

The major power generating capacities of the country work on mineral fuel – around 84% of the energy balance comprises thermal coal power plants. The hydropower contribution is less than 12%, and the remained 4% is gas power. Wind and solar energy is practically non existent for generating power.

A positive aspect in Kazakhstan's energy sector development of recent years, is that indices of power consumption for gross national product tends to have decreased. Its level compared to developed countries remains high and amounts, according to the International Energy Agency, to 1.75 ton oil-equiv. per 2000$.

Kazakhstan's energy sector is responsible for almost 80% of GHG emissions, and it faces two problems: the first is to refine the structure of primary energy resources; and the second is to modernize the power stations.

As such, the energy sectors faces the task of increasing fuel and energy production competitiveness to meet domestic demand for energy resources and oil and gas exports taking into account the Kyoto Protocol requirements to reduce GHG emissions.

The potential energy saving is very high, however levels of CO_2 emissions per unit of primary energy sources remains rather high – 70.5 tons CO_2/TJ in comparison with OECD countries where it is 55.,6 tons CO_2/TJ (International Energy Agency statistical report 2007].

One of the main barriers to energy saving implementation and GHG emission reduction is the insufficient amount of scientific, technical and technological studies.

It is possible to identify the following major problems, which negatively impact the development of domestic innovative technology potential and implementation of new technologies:

- Incomplete scientific studies on technologies and products for market supply;
- Absence of modern tools for introducing technological innovations and their market supply;
- Absence of developed infrastructure to promote innovative projects, such as technological parks and specialized business incubators, a network of financing funds (venture funds), financial mechanisms to support fast growing enterprises and certificated appraisers of intellectual property;
- Absence of credible demand for high technologies and industrial innovations on the domestic market.

In examining these problems, the economic mechanisms of the Kyoto Protocol supporting the transfer of modern technologies should play an important role. One example of positive technological transfer in Kazakhstan is a Japanese organization's pilot project for new energy development and industrial technologies (NEDO) being implemented in Uralsk in Western Kazakhstan. Based on existing infrastructure and heat and power generation systems, experts installed a gas turbine with the capacity of 26.9 MW as well as boiler-utilizator with heat capacity of 30 Gkal/h and 76% efficiency on the Ural thermal power plant platform. The energy saving amounts to 241 000 Gkal/year and annual GHG emission reduction of 62 thousand tons CO_2. It is the only pilot project in Kazakhstan with technology transfer that could receive the status of CDM/JI project under the Kyoto Protocol if Kazakhstan ratified it.

Another example is the GEF/UNDP project started in 2004, on wind energy development in Kazakhstan which is:

(a) assisting to the Government in developing the National Wind Energy Development Program;

(b) providing information support and local capacity building for wind energy projects in Kazakhstan and their financing (including preparation of wind potential maps and extension of the wind speed measurements program);

(c) assisting in constructing the first pilot wind power plant with capacity of 5 MW to establish the basis and reduce risks to future wind power investments ; and

(d) monitoring, analyzing and distributing the experience and the results of the project.

To fulfill the tasks of Kazakhstan's industrial and innovative development strategy and other documents, it is necessary to introduce new scientific achievements and technologies. The priority sector for introducing new technologies is the energy sector. Besides CO_2, coal thermal power plants emit a number of pollutants, so countries introducing modern technologies in Kazakhstan will help to reduce GHG emission and contribute to improved ecological conditions.

The most promising directions for introducing of new technologies are:

- switching from coal to gas in the Southern and Western regions of Kazakhstan;
- building and rehabilitation small and average hydropower plants in Southern and Eastern Kazakhstan;
- More effective coal combusting technologies and recovery system in the Central and Northern regions;
- Building large wind power plants. Almost all areas of Kazakhstan has high potential wind energy use, with optimal conditions for wind power plants in the Dzhungarsky gates and the Sheleksky corridor.
- New isolation technologies in heat distribution will allow considerable reduction of thermal energy losses. The heat distribution network in the cities is a serious concern with studies showing 80% depreciation.

CHAPTER 8.
EDUCATION AND PUBLIC AWARENESS

The following documents outline Kazakhstan's ecological education approach:

- the Ecological code;
- the Law on the specially protected natural territories;
- the conception of ecological security for the years 2004-2015;
- the conception of ecological education.

These documents contain the principle for all embracing and ongoing ecological education. They highlight the role of NGO in this process, and the necessity for introducing ecology issues in study programs at all levels, teacher education and adequate State support.

Education and awareness can be divided into 4 subsections as outlined in the INC. The education system in colleges, institutes and universities should be separately distinguished:

1. Obtaining initial basic knowledge. This level of preparation is mainly provided at the general school level through general educational programs;
2. Education through special programs in colleges and higher education institutions, holding seminars and courses of advanced training for high school teachers;
3. Increasing awareness through the mass media using popular programmes for various ages and levels;
4. Conducting seminars and distributing literature to representatives of informal associations, NGOs and local communities;
5. Conducting national workshops for officials from ministries and departments, politicians and decision-makers from different economy sectors with impacts related to climate change.

8.1. Education

Climate change education is considered part of the wider issue of environment protection and is an integral part of education curriculums for secondary schools, institutions and universities.

When the INC was published, curriculum programs for secondary schools on environment protection and climate change had just been prepared or approved. As such the level of education was not reflected in the INC although it did comprise some geography, biology and other courses. At the same time, public organizations and groups began forming.

In higher education, the program to develop experts has developed and education programs include a wide range of climate change issues. A list of Institutes and Universities teaching ecological experts is provided in Table 1 Annex 3. Currently there are three directions of ecological education:

1. Ecology and nature management;

2. Applied ecology;
3. Agro ecology.

The number of the Government grants for these specialties in 2006 was 140 – 3.5 more than was allocated five-seven years ago. The 'safe living activity' specialty, of which ecology is the main component, received 250 grants (Ministry of Education and Science official data).

Many students receive environmental education on a commercial basis. As a result, the total number of expert environmentalist graduating annually exceeds 500. It is more than required in the country, however it maintains a high level of ecological education.

The deep systematised professional knowledge in climate is obtained at the meteorology department of Kazakh National University where engineer-meteorologists are trained.

In order to improve ecological education and public awareness the corresponding ministries and departments developed the an integrated plan presented in Table 8.1.

Table 8.1. Integration of ecological education into existing education system

Tasks	Measures (action)	Responsible organisation
1. Expansion of possibilities of ecological education and awareness, including information on the international ecological conventions, arrangement of ecological education	Memorandum on joint actions of MES, MEP, MA, etc.	MES, MEP
	Development of joint action plan for all responsible organisations	MES
	creation of the Public Centers of Ecological Education and Sustainable development, Jointly with MES and MEP	MEP
	Preparation, publication and constant update in the Internet (MEP) the joint plan of ecological educational campaigns (MEP, MES, etc.)	MEP
	Regular informing of the public on possibilities of participation in educational campaigns (sources and conditions of financing, access to the information, etc.)	MES
2. Training of teachers, instructors and active NGO representatives on environment issues, including international conventions	Development and introduction of advanced training courses for teachers in the field of environment protection	MES
	Advanced Training for teachers	MES
	Include environment protection issues when evaluating qualification of teachers	MES
	Development and publishing of teaching materials on international environment protection conventions	MES
3. Development of structure and regulation to search, access and exchange ecological educational information on the international environment protection conventions between educational institutions, training centers.	Studying information situation in the field of ecological education in existing educational institutions, programs, courses, NGOs, etc.	MES
	Development of structure, regulation and management for the system of search, collection, storage of educational information, including the wide access through the Internet and information portals at the ministries responsible for the international conventions	MES
	Maintenance of the created information system of the educational ecological information on the international environment protection conventions	MES

Corresponding indicators for estimating the effectiveness of the plan are being developed and include:

- Quantity of the developed and approved ecological education manuals on climate

change issues and its consequences;
- Quantity of teachers trained at advanced courses;
- Amount of annual finance provided to public ecological education and sustainable development centres.

This plan is being successfully implement with 16 leading higher institutions having signed the Memorandum of mutual trust and cooperation with the MEP.

Table 8.2. The list of the High Institutions signed the Memorandum with MEP about interaction and cooperation in the field of ecological education

№	name
1	L.Gumilev's Euroasian national university of, Astana
2	Kazakh national agrarian university, of Almaty
3	Abay's Kazakh national pedagogical university, Almaty
4	H.Dosmuhamedov's Atyrau state university, Atyrau
5	M.Dulati's Taraz state university, Taraz
6	Shakarim's Semipalatinsk state university, Semipalatinsk
7	D.Serkibaev's Eastern Kazakhstan state technical university, Ust Kamenogorsk
8	K.Satpaev's Kazakh national technical university, Almaty
9	M.Tynyshpaev's Kazakh academy of transport and communications, Almaty
10	Almaty institute of energy and communication, Almaty
11	M.Utemisova's Western Kazakhstan state university, Uralsk
12	Zhangirkhan's Western Kazakhstan agrarian-technical university, Uralsk
13	Kazakh state technical university, Karaganda
14	T.Ryskulov's Kazakh economic university, Almaty
15	S.Sejfullin's Kazakh state agrotechnical university, Astana
16	M.Auezov's Southern Kazakhstan state university

* data of MES as of 01.06. 2006

Base levels of ecological education are now included in the specialist programs of almost all Kazakhstan's higher education institutions.

Current ecological education (school, college, university) challenges include:
- a lack of methodical courses and state and public support in primary and secondary schools;
- Program on ecological education does not operate;
- a lack of advanced training for qualified people;
- limited access to modern forms and methods of ecological education;
- a lack of manuals and methodical guidance in the high schools and universities – there is no teaching techniques for ecological education;
- the absence of interrelations between theory and practice for students;
- no educational practice between institutes and schools in the field of ecology. For instance, 6760 hours out of 9100 (75%) are devoted to natural-science, general, special subjects and specialization courses;
- the number of Government grants allocated for ecological specialty in higher

institutions reduced during the last three years. The number of grants for 'ecology and nature management' has decreased from 100 in 2000 to 40 in 2004. However, it increased to 140 in 2006.

Improving Kazakhstan's environmental education is linked with the following:

- increasing the efficiency of higher ecological education;
- ecological training of experts to work in public production management;
- organizing training for engineering staff in technical, technological, and other industrial spheres focused on creation and wide use of resource saving and nature protection technologies;
- professional training of staff in ecological education;
- training experts in nature management, public health services, economic activities connected with human impact on the environment, responses to human health due to environment deterioration, and impact on the economy due to exhaustion of natural resources, climate changes;
- training experts who are not connected to nature management and direct impact on environment (experts in arts, humanities etc.).

The above-mentioned issues are not critical. They reflect growing increase in attention to ecological education and quite easily solved. At the same time, progress in this field is significant in comparison to the Initial National Communication.

8.2. Mass media

Raising public awareness through the mass media has significantly development during recent years. Education and awareness is necessary for the active and informed participation of the population.

Kazakhstan has a number of environmental journals and publications, including The Ecological Courier, published twice weekly since 1991 and since 2003 a new environmental newspaper Atameken KZ.

A number of round-tables, lectures, seminars and phone conferences involving media participation has been introduced at state and regional levels.

The internet is also utilized as an information channel, and the Ministry for Protection of the Environment provides updated online information on a regular basis.

There has been an increase in environmental shows broadcast, particularly emphasizing the climate change issue in recent years. In additional to international channels, regional environmental channels such as 'ORION' in Ust-Kamenogorsk specifically focus on environmental programmes.

8.3. Non-governmental organizations

A comprehensive list of organizations reflecting education activity and communication is presented in Table 1 of Annex 4.

The independent body on climate change issues is the Climate Change Coordination Centre (CCCC) established in 2002 – the first NGO in Kazakhstan. The CCCC aims to coordinate and implement the provisions of Kyoto Protocol. It prepares reports for Government, organizations and companies. Its experts have initiated working groups for implementing the first GHG reduction projects. The centre functions as the independent sustainable organization

Studies include:

- Improving economic and financial mechanisms for environment management and protection;
- Estimations of the economic impact of the Kyoto Protocol on the UN FCCC Annex 1 countries and prospect of Kazakhstan participating in a carbon market;
- Assessment of the fuel and energy development impact on the environment to 2020;
- Situational scenarios of CO2 emissions and regulations
- Reports (for international organizations) on Kazakhstan's readiness to implement GHG emission reduction projects and programs.

The international partners of CCCC are PROFING (Slovakia), RAMBOL (Denmark), TOHOKU (Japan), NEDO (Japan), SOFRECO (EU), TACIS, UNDP, UNEP, the Canadian agency of international development (CIDA), the Asian development bank (ADB), the World Bank and the Regional ecological centre of the Central Asia.

National partners of CCCC are KazNIIEK, Ecomuseum and the Kazakhstan Business Council for sustainable development (KBCSD), Association of NGOs in Kazakhstan and the Department of Scientific Environment Management Methods under the Almaty Institute of Energy.

CCCC works as projects operator. Together with USAID experts, the iniative to decrease GHG emissions project was implemented. Another project – strengthening the national system for GHG emission reduction – was financed but the Government of Great Britain. Together with CIDA, the CCCC implemented projects on obtaining advantages from CDM and JI to struggle against global climate change and the Caspian program developing GHG reduction experts. The last projects resulted in the reconstruction of small hydropower stations at Gorvodokanal enterprise in Almaty, Fabrichny village and creation of a small hydro on the Bartogay water basin in Almaty area.

At the international level CCCC actively cooperates with the European Union. Together with Danish company RAMBOL, the project developing CDM projects in Kazakhstan was implemented. CCCC participated in the EC/TASIS project 'Technical assistance to Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan to fulfill their obligations on mitigating global climate change'. CCCC also took part in the project with Japanese company NEDO mentioned earlier. Currently, CCCC assists in implementation of the UNDP/GEF project 'Assistance to the Republic of Kazakhstan in preparation of the Second National Communication under the UN FCCC.'

Another NGO organization, the Karaganda Regional Ecological Museum, collects and distributes ecological information in Central Kazakhstan in order increase the public's role in decisions on environmental problems. Since 2000, the Museum has implemented the 'Biogas' project (in Karaganda region) financed by the Small Grants Program GEF/UNDP and HI VOS fund from Netherlands. The project is aimed at reducing river pollution from manure in Central Kazakhstan, reducing GHG emissions (methane) and increasing the economic stability of the economy. The project intends to also to raise public awareness. The Museum organized the first Central Asian Conference on the Renewable Energy in 2006.

8.4. Conducting workshops

The increased involvement in the environmental field is accompanied by an increase in the amount of various workshops. Training workshops for high schools teachers is the norm in the leading regional universities of Astana and Almaty. In the Kazakh National University, training workshops are also held, however climate change issues and possible consequences are not covered completely. The majority of this field of work is done by the NGOs.

Measures are undertaken to ensure that seminars are regularly held for Government officials and decision-makers. Progress has been made in organizing seminars for MEP representatives and the regional authorities.

Conferences are bringing together a wide range of representatives and from the 2000 Aarhus Convention, the Parliament ratified three requirements on public access to environmental information, as a means of fulfilling Article 6 of the UN FCCC:

1. Access to ecological information;
2. Access to ecologically significant decision making;
3. Access to administrative and legal measures to protect the rights for ecological environment favorable for living.

In relation to this, the MEP held a number of meetings and public hearings in 2000-2005 on the content and implementation of the UN FCCC requirements. These public meetings were organized in Ust-Kamenogorsk, Semipalatinsk, Karaganda, Almaty, Sepnogorsk, Astana, Aktau, etc. At the same time on this issue, training seminars have been conducted and all activities were advertised in press media

ANNEX 1

Table 1.1. Approaches for the GHG emissions estimation

SOURCES OF GHG EMISSIONS / SINKS	Method	Tier	EF	Uncer-tainty	Key source
Total national emissions and sinks					
1 Energy					
A fuel combustion (sectoral approach)					
1 Energy	GPG	P2, P3	CS, PS	3 %	Yes
2 Manufacting and construction	GPG	P1	D, CS, PS	5 %	Yes
3 Transport	GPG	P1, P2	D, CS	11 %	No
4 Other sectors	IPCC 96	P1	D	5 %	Yes
5 Other	IPCC 96	P1	D	5 %	No
B Fugitive emissions					
1 Solid fuel	GPG	P2, P3	CS, M	20 %	Yes
2 Oil and gas	GPG	P1, P2	D, CS, M	35 %	Yes
2 Industrial processes					
A Mineral production	GPG	P1, P2	D, CS, PS	7 %	Yes
B Chemical industry	IPCC 96	P1	D	10 %	No
C Metal production	GPG	P2	CS, PS	7 %	Yes
4 Agriculture					
A Entheric fermentation	GPG	P1, P2		80 %	Yes
B Manure management	IPCC 96	P1		80 %	No
C Rice cultivation	IPCC 96	P1		45 %	No
D Agricultural soils	IPCC 96	P1		55 %	Yes
F Residual combustion at fields	IPCC 96	P1		60 %	No
5 LULUCF					
A Change in forest and other woody biomass	GPG LULUCF	P2	D, CS	90 %	
B Conversion of forest	GPG LULUCF	P1, P2	D, CS	90 %	
D CO2 Emissions and absorption from soils	GPG LULUCF	P1, P2	D, CS	80 %	
6 Waste					
A Solid Municipal Waste	GPG	P1, P2	D, CS	35 %	Yes
B Wastewater handling	IPCC 96	P1	D	40 %	No
C Human sewage	IPCC 96	P1	D	40 %	No

GPG - Guidelines on effective practice and the account of factors of uncertainty in national cadastres of hotbed gases, 2000
IPCC 1996 - the Reconsidered Supervising principles of national inventories of hotbed gases, 1996
GPG LULUCF - Guidelines on effective practice for sector ЗИЗЛХ, 2003
D - emission factor by default; CS - factor of emission for Kazakhstan; PS - factor of emission for the separate enterprise; M - the measured emissions

Table 1.2. Total direct GHG emissions in Kazakhstan, Gg CO2-equiv

CATEGORIES OF GHG EMISSIONS/ SINKS SOURCES	1990	1992	1994	1998	1999	2000	2001	2002	2003	2004	2005
Total national emissions and sinks	**322 316**	**337 853**	**302 702**	**151 328**	**137 453**	**165 378**	**171 251**	**187 636**	**197 953**	**221 399**	**237 310**
1 Energy	259 497	279 749	261 304	128 249	113 470	138 053	141 471	155 718	162 998	185 004	196 908
A fuel combustion (sectoral approach)	218 768	245 500	236 001	113 154	97 596	119 054	123 883	138 409	142 975	164 324	175 650
1 Energy	108 169	105 217	77 047	62 831	56 754	69 954	72 676	82 063	84 757	106 183	110 965
2 Manufacturing and construction	34 162	72 358	109 825	35 333	23 491	26 766	28 473	28 629	29 415	30 282	31 720
3 Transport	21 941	15 762	12 203	7 028	6 017	9 374	10 389	12 438	13 758	11 364	13 041
4 Other sectors	45 768	48 946	32 591	6 490	10 053	10 759	10 043	11 242	12 234	12 259	16 029
5 Other	8 728	3 218	4 334	1 472	1 281	2 202	2 303	4 037	2 810	4 235	3 895
B Fugitive emissions	40 729	34 248	25 303	15 095	15 874	18 998	17 588	17 310	20 024	20 680	21 258
1 Solid fuel	24 868	23 289	18 404	9 188	7 476	9 977	9 602	9 530	12 099	11 045	11 002
2 Oil and gas	15 861	10 959	6 898	5 908	8 398	9 021	7 986	7 779	7 925	9 636	10 256
2 Industrial processes	17 499	14 536	7 012	6 884	8 472	10 658	11 937	12 961	14 334	14 454	15 292
A Mineral production	5 771	4 779	1 871	1 021	1 113	2 617	3 755	4 566	5 463	5 118	6 115
B Chemical industry	1 403	973	236	86	62	51	99	116	164	202	144
C Metal production	10 325	8 784	4 905	5 777	7 297	7 989	8 083	8 279	8 707	9 133	9 034

4 Agriculture	48 377	45 752	34 345	16 355	16 838	17 420	18 595	19 130	20 346	21 229	22 781
A Entheric fermentation	19 721	19 238	15 949	7 560	7 444	7 657	8 015	8 322	8 901	9 486	10 277
B Manure management	2 278	2 176	1 804	1 114	1 105	1 140	1 190	1 234	1 307	1 374	1 454
C Rice cultivation	523	483	428	322	308	303	291	276	351	339	353
D Agricultural soils	25 216	23 216	15 822	7 216	7 745	8 115	8 824	9 015	9 511	9 798	10 442
F Residual combustion at fields	639	639	341	144	235	206	275	283	276	233	254
5 LULUCF	-8 069	-7 139	-4 838	-5 096	-7 210	-7 082	-7 131	-7 067	-6 735	-6 474	-5 896
A Change in forest and other woody biomass	-4 632	-4 633	-2 588	-2 530	-4 813	-4 806	-4 791	-4 788	-4 476	-4 451	-4 332
B Conversion of forest	-930	-980	-863	-373	-252	-180	-120	-84	-91	-112	-133
D CO2 Emissions and absorption from soils	-2 507	-1 527	-1 387	-2 193	-2 144	-2 097	-2 221	-2 194	-2 168	-1 911	-1 431
6 Waste	5 013	4 956	4 879	4 936	5 883	6 330	6 379	6 893	7 010	7 186	8 225
A Solid Municipal Waste	3 734	3 803	3 823	4 197	5 165	5 570	5 583	5 596	5 866	5 891	6 793
B Wastewater handling	852	721	565	425	411	442	469	930	769	820	1 020
C Human sewage	427	432	491	314	307	318	328	367	376	475	411

Sums may differ due to rounding

Table 1.3. Comparison GHG emissions for 1990 and 2005, Gg.

CATEGORIES OF GHG EMISSIONS/ SINKS SOURCES	CO2		CH4		N2O	
	1990	2005	1990	2005	1990	2005
Total national emissions and sinks	**229 292**	**189 083**	**3 149**	**1 746**	**87**	**38**
1 Energy	**219 910**	**179 715**	**1 852**	**798**	**3**	**2**
A fuel combustion (sectoral approach)	216 502	174 646	75	27	3	2
1 Energy	107 646	110 515	2	2	2	1
2 Manufacturing and construction	34 162	31 720	2	3	0	0
3 Transport	21 790	12 946	6	4	0	0
4 Other sectors	44 535	15 665	50	15	1	0
5 Other	8 370	3 800	16	4	0	0
B Fugitive emissions	3 408	5 070	1 777	771	0	0
1 Solid fuel			1 184	524		
2 Oil and gas	3 408	5 070	593	247		
2 Industrial processes	**17 451**	**15 263**	**2**	**1**	**0**	**0**
A Mineral production	5 771	6 115				
B Chemical industry	1 356	115	2	1		
C Metal production	10 325	9 034				
4 Agriculture	**0**	**0**	**1 076**	**574**	**83**	**35**
A Entheric fermentation			939	489		
B Manure management			91	59	1	1
C Rice cultivation			25	17		
D Agricultural soils					81	34
F Residual combustion at fields			21	9	1	0
5 LULUCF	**-8 069**	**-5 896**	**0**	**0**	**0**	**0**
A Change in forest and other woody bio-mass	-4 632	-4 332				
B Conversion of forest	-930	-133				
D CO2 Emissions and absorption from soils	-2 507	-1 431				
6 Waste	**0**	**0**	**218**	**372**	**1**	**1**
A Solid Municipal Waste			178	323		
B Wastewater handling			41	49		
C Human sewage					1	1

Sums may differ due to rounding

Table 1.4. Anthropogenic emissions and sinks of GHG not regulated by the Montreal report, 1990

CATEGORIES OF GHG EMISSIONS/ SINKS SOURCES	CO2 Emissions	CO2 Sinks	CH4	N2O	CO	NOx	HMY	SO2
	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg
Total national emissions and sinks	**237 361**	**-8 069**	**3 149**	**87**	**2 411**	**646**	**407**	**2 088**
1 Energy	**219 910**		**1 852**	**3**				
A fuel combustion (sectoral approach)	216 332		76	2				
1 Energy	107 648		2	2				
2 Manufacturing and construction	33992		3	0				
3 Transport	21 790		6	0				
4 Other sectors	44 533		50	1				
5 Other	8 370		16	0				
B Fugitive emissions	3 408		1 777					
1 Solid fuel			1 184					
2 Oil and gas	3 408		593					
2 Industrial processes	**17 451**		**2**					
A Mineral production	5 771							
B Chemical industry	1 356		2					
C Metal production	10 325							
D Other production								
E Production of hydrocarbons and SF6								
F Use of hydrocarbons and SF6								
G Other								
3 Solvents and Other product Use								
4 Agriculture			**1 076**	**83**				
A Entheric fermentation			939					
B Manure management			91	1				
C Rice cultivation			25					
D Agricultural soils				81				
E Prescribed combustion out of savannas								
F Residual combustion at fields			21	1				
G Other								
5 LULUCF		**-8 069**						
A Change in forest and other woody biomass		-4 632						

B Conversion of forest		-930						
C Abandoned lands								
D CO2 Emissions and absorption from soils		-2 507						
E Other								
6 Waste			218	1				
A Solid Municipal Waste			178					
B Wastewater handling			41					
C Human sewage				1				
D Other								
7 Other								
International bunker								
Aviation								
Navigation								
CO2 emissions from biomass combustion	973							

Table 1.5. Anthropogenic emissions and sinks of GHG not regulated by the Montreal report, 2000

CATEGORIES OF GHG EMISSIONS/ SINKS SOURCES	CO2 Emissions	CO2 Sinks	CH4	N2O	CO	NOx	HMY	SO2
	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg
Total national emissions and sinks	**315 145**	**-7 082**	**1 338**	**29**	**372**	**305**	**359**	**982**
1 Energy	**124 515**		**623**	**1**				
A fuel combustion (sectoral approach)	118 219		18	1				
1 Energy	6 9626		1	1				
2 Manufacturing and construction	26 617		2	0				
3 Transport	9321		2	0				
4 Other sectors	10 517		10	0				
5 Other	2 138		3	0				
B Fugitive emissions	6 296		605					
1 Solid fuel			475					
2 Oil and gas	6 296		130					
2 Industrial processes	**10 630**		**1**					
A Mineral production	2 617							
B Chemical industry	23		1					
C Metal production	7 989							
D Other production								
E Production of hydrocarbons and SF6								

F Use of hydrocarbons and SF6								
G Other								
3 Solvents and Other product Use								
4 Agriculture			**428**	**27**				
A Enteric fermentation			365					
B Manure management			40	1				
C Rice cultivation			14					
D Agricultural soils				26				
E Prescribed combustion out of savannas								
F Residual combustion at fields			9	0				
G Other								
5 LULUCF		**-7 082**						
A Change in forest and other woody biomass		-4 806						
B Conversion of forest		-180						
C Abandoned lands								
D CO2 Emissions and absorption from soils		-2 097						
E Other								
6 Waste			**286**	**1**				
A Solid Municipal Waste			265					
B Wastewater handling			21					
C Human sewage				1				
D Other								
7 Other								
International bunker								
Aviation								
Navigation								
CO2 emissions from biomass combustion	208							

ANNEX 2

Table 1: List of stations connected to the Global Climate Observing System

№	Country Area	Station Name	Index Nbr	ObsRems	Lati-tude	Longi-tude	Hp
1	KAZAKHSTAN	PETROPAVLOVSK	28679	CLIMAT(C)	54.5	69.09	142
2	KAZAKHSTAN	BLAGOVESCHENKA	28766	CLIMAT(C)	54.22	66.58	151
3	KAZAKHSTAN	URITSKY	28867	-	53.19	65.33	216
4	KAZAKHSTAN	KOKSHETAU	28879	CLIMAT(C)	53.17	69.23	229
5	KAZAKHSTAN	KUSTANAI	28952	CLIMAT(CT)	53.13	63.37	170
6	KAZAKHSTAN	RUZAEVKA	28966	CLIMAT(C)	52.49	66.58	227
7	KAZAKHSTAN	BALKASINO	28978	CLIMAT(C)	52.32	68.45	398
8	KAZAKHSTAN	SHCHUCINSK	28984	-	52.57	70.13	395
9	KAZAKHSTAN	MIKHAILOVKA	29802	-	53.49	76.32	114
10	KAZAKHSTAN	IRTYSHSK	29807	CLIMAT(C)	53.21	75.27	94
11	KAZAKHSTAN	ZHALPAKTAL	34398	CLIMAT(C)	49.4	49.29	10
12	KAZAKHSTAN	NOVYJ USHTOGAN	34691	CLIMAT(C)	47.54	48.48	-10
13	KAZAKHSTAN	GANJUSHKINO	34798	-	46.36	49.16	-23
14	KAZAKHSTAN	ESIL	35067	CLIMAT(C)	51.53	66.2	221
15	KAZAKHSTAN	ATBASAR	35078	CLIMAT(C)	51.49	68.22	304
16	KAZAKHSTAN	AKKOL	35085	-	52	70.57	384
17	KAZAKHSTAN	URALSK	35108	CLIMAT(C)	51.15	51.17	37
18	KAZAKHSTAN	ZHALTYR	35173	-	51.37	69.48	305
19	KAZAKHSTAN	ASTANA	35188	CLIMAT(C)	51.08	71.22	350
20	KAZAKHSTAN	DZHAMBEJTY	35217	CLIMAT(C)	50.15	52.34	32
21	KAZAKHSTAN	AKTOBE	35229	CLIMAT(CT)	50.17	57.09	219
22	KAZAKHSTAN	CHAPAEVO	35302	-	50.12	51.1	17
23	KAZAKHSTAN	TORGAI	35358	-	49.38	63.3	-
24	KAZAKHSTAN	BERLIK	35376	CLIMAT(C)	49.53	69.31	349
25	KAZAKHSTAN	KARAGANDA	35394	CLIMAT(CT)	49.48	73.09	553
26	KAZAKHSTAN	TAIPAK	35406	CLIMAT(C)	49.03	51.52	2
27	KAZAKHSTAN	UIL	35416	CLIMAT(C)	49.04	54.41	128
28	KAZAKHSTAN	TEMIR	35426	CLIMAT(C)	49.09	57.07	234
29	KAZAKHSTAN	ZHARYK	35497	-	48.51	72.52	656
30	KAZAKHSTAN	MUGODZARSKAYA	35532	CLIMAT(C)	48.38	58.3	398
31	KAZAKHSTAN	KZYLZAR	35576	CLIMAT(C)	48.18	69.39	-
32	KAZAKHSTAN	ZHEZKAZGAN	35671	CLIMAT(CT)	47.48	67.43	346
33	KAZAKHSTAN	BEKTAU-ATA	35699	-	47.27	74.49	620
34	KAZAKHSTAN	ATYRAU	35700	CLIMAT(CT)	47.07	51.55	-22
35	KAZAKHSTAN	ARALSKOE MORE	35746	CLIMAT(C)	46.47	61.39	62
36	KAZAKHSTAN	BALKHASH	35796	CLIMAT(C)	46.48	75.05	350
37	KAZAKHSTAN	KAZALINSK	35849	CLIMAT(C)	45.46	62.07	68
38	KAZAKHSTAN	SAM	35925	CLIMAT(C)	45.24	56.07	88

№	Country Area	Station Name	Index Nbr	ObsRems	Lati-tude	Longi-tude	Hp
39	KAZAKHSTAN	DZHUSALY	35953	CLIMAT(C)	45.3	64.05	103
40	KAZAKHSTAN	ZLIKHA	35969	-	45.15	67.04	138
41	KAZAKHSTAN	PAVLODAR	36003	CLIMAT(CT)	52.18	76.56	122
42	KAZAKHSTAN	SEMIYARKA	36152	-	50.52	78.21	149
43	KAZAKHSTAN	SEMIPALATINSK	36177	CLIMAT(C)	50.25	80.18	196
44	KAZAKHSTAN	LENINOGORSK	36208	CLIMAT(C)	50.2	83.33	811
45	KAZAKHSTAN	ZHANGIZTOBE	36397	-	49.13	81.13	455
46	KAZAKHSTAN	BOLSHE NARYMSKOE	36428	CLIMAT(C)	49.12	84.31	401
47	KAZAKHSTAN	KOKPEKTY	36535	CLIMAT(C)	48.45	82.22	512
48	KAZAKHSTAN	URDZHAR	36639	-	47.07	81.37	491
49	KAZAKHSTAN	ALGAZY OSTROV	36686	-	46.33	76.52	349
50	KAZAKHSTAN	BAKANAS	36821	-	44.5	76.16	396
51	KAZAKHSTAN	ZHARKENT	36859	CLIMAT(C)	44.1	80.04	645
52	KAZAKHSTAN	OTAR	36864	-	43.32	75.15	743
53	KAZAKHSTAN	ALMATY	36870	CLIMAT(CT)	43.14	76.56	851
54	KAZAKHSTAN	FORT SHEVCHENKO	38001	CLIMAT(C)	44.33	50.15	-25
55	KAZAKHSTAN	KYZYLORDA	38062	CLIMAT(C)	44.51	65.3	130
56	KAZAKHSTAN	CHIILI	38069	CLIMAT(C)	44.1	66.45	153
57	KAZAKHSTAN	ACHISAY	38196	-	43.33	68.54	822
58	KAZAKHSTAN	TURKESTAN	38198	CLIMAT(C)	43.16	68.13	207
59	KAZAKHSTAN	TOLE BI	38222	-	43.42	73.47	456
60	KAZAKHSTAN	AKKUDUK	38232	CLIMAT(C)	42.58	54.07	78
61	KAZAKHSTAN	SHYMKENT	38328	CLIMAT(C)	42.19	69.42	604
62	KAZAKHSTAN	AUL TURARA RYSKULOVA	38334	CLIMAT(C)	42.29	70.18	808
63	KAZAKHSTAN	ZHAMBYL	38341	CLIMAT(CT)	42.51	71.23	655
64	KAZAKHSTAN	KULAN	38343	CLIMAT(C)	42.57	72.45	683
65	KAZAKHSTAN	CHARDARA	38439	CLIMAT(C)	41.22	68	275

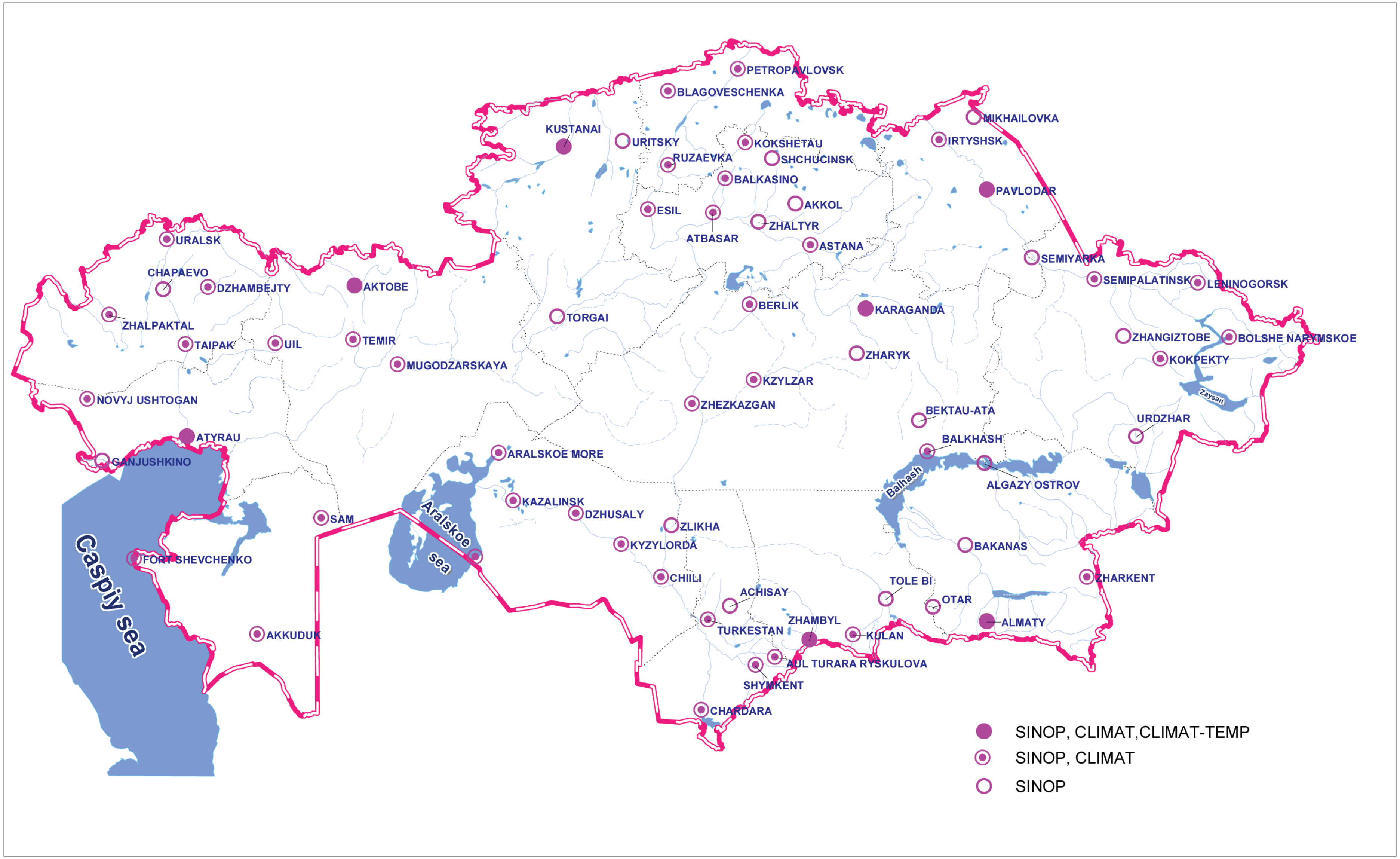


fig.1. Global Climate Observing System – Republic of Kazakhstan

ANNEX 3

Table 1: List of Public Institutes with ecological faculties

№	Name
Ecology and Nature Use (specialty 010900)	
1.	Kazakh National University named after Al-Farabi, Almaty
2.	Eurasia National University named after L.N. Gumilev, Astana
3.	Kazakh National Technical University named after K. Satpaev, Almaty
4.	Aktyubinsk State University named after K. Zhubanov, Akyube
5.	Atyrau State University named after Kh. Dosmukhanedov, Atyurau
6.	East-Kazakhstan State University, Ust-Kamenogorsk
7.	Zhetysu State University named after I. Zhansugurov, Taldykorgan
8.	West-Kazakhstan State University, Uralsk
9.	Kazakh Economic University named after T. Raskulov, Almaty
10.	Kazakh Femail Pedagogical State Institute, Almaty
11.	Almaty University named after Abai, Almaty
12.	Karaganda State University named after E.A. Buketov, Karaganda
13.	Kyzylorda State University named after Korkyt-Ata, Kyzylorda
14.	Kostanay State University named after A. Baitursynov, Kostonay
15.	Pavlodar State University named after S. Toraygyrov, Pavlodar
16.	Northern-Kazakhstan State University, Petropavlovsk
17.	Taraz State University named after M.Kh. Dulati
18.	Kokshetau State University named after Sh. Ualikhanov
19.	Semipalatinsk State University named after Shakarim, Semey
20.	International Kazakh-Turkish University named after Kh.F. Yasavi, Turkestan
Applied ecology (specialty 170300)	
21.	Kazakh National University named after Al-Farabi, Almaty
22.	Kazakh National Technical University named after K. Satpaev, Almaty
23.	Aktau University named after Sh. Essenov, Aktau
24.	Atyrau Oil and Gas Institute, Atyrau
25.	Zhezkazgan University named after O.A. Baikonurova, Zheskazgan
26.	Kazakh Academy for Transport and Telecommunications named after Tynyshpaeva, Almaty
27.	Karaganda State University named after E.A. Buketov, Karaganda
28.	Karaganda State Technical University, Karaganda
29.	Taraz State University named after M.Kh. Dulati
30.	South-Kazakhstan State University named after M. Auezova, Shymkent
31.	Almaty Institute of Power and Telecommunications, Almaty
32.	Kazakh-Britain Technical University, Almaty
33.	International Kazakh-Turkish University named after Kh.F. Yasavi, Turkestan
34.	Eurasia National University named after L.N. Gumilev, Astana
35.	Kazakh National Technical University named after K. Satpaev, Almaty
36.	East-Kazakhstan State Technical University named after D. Serikbayev, Ust-Kamenogorsk

37.	Kazakh Architecture and Construction Academy, Almaty
38.	Kyzylorda State University named after Korkyt-Ata, Kyzylorda
39.	Pavlodar State University named after S. Toraygyrov, Pavlodar
Agroecology (specialty 450400)	
40.	Kazakh National Agricultural University, Almaty
41.	Pavlodar State University named after S. Toraygyrov, Pavlodar
42.	Kokshetau State University named after Sh. Ualikhanov, Kokshetau
43.	Kazakh Agricultural University named after S. Seifulin, Astana
44.	Western-Kazakhstan Agro-Technical University, Uralsk
45.	International Kazakh-Turkish University named after Kh.F. Yasavi, Turkestan

*data provided by MES RK as of 01.05.06.

List of abbreviations

ADB	Asian Development Bank
GDP	Gross domestic product
RE	Renewable energy sources
WMO	World meteorological organization
GNP	Gross national product
GRP	Gross regional product
SNC	Second national communication
GOST	State standards
HPP	Hydro Power Plant
GEF	Global Environmental Facility
EEA	European Environment Agency
CC	Climate change
GDAHDI	Gender-disparity-adjusted HDI
HDI	Human development index
KBCSD	Kazakhstan Business Council for Sustainable Development
PRC	People's Republic of China
KP	Kyoto Protocol
CCCC	Climate Change Coordination Centre
MARKAL	Macroeconomic modeling tool
IC	Interdepartmental Commission
IPCC	Intergovernmental Panel on Climate Change
MFA	Ministry of Foreign Affairs
ICSD	Interstate Commission for Sustainable Development
MES	Ministry of Education and Science
MEP	Ministry of Environment Protection
MA	Ministry of Agriculture
ASSF	Aral Sea Salvation Fund
CDM	Clean development mechanism (the Kyoto Protocol Mechanism)
SRR	Scientific research report
VAT	Value added tax
NHDR	National Human Development Report
NEAP	National Environmental Action Plan
NGO	Non-governmental Organization
NECSD	National Environmental Center for Sustainable Development
EPR	Environmental Performance Review
UN	United Nations
SPNT	Specially protected natural territories

EP	Environment protection
LE	Life expectancy
OECD	Organization for Economic Cooperation and Development
GHG	Greenhouse gases
PPP	Purchasing Power Parity
WEI	Women's empowerment indicator
UNDP	United Nations Development Programme
RK	Republic of Kazakhstan
UNFCCC	United Nations Framework Convention of Climate Change
CIS	Commonwealth of Independent States
JI	Joint Implementation (the Kyoto Protocol Mechanism)
Strategy - 2030	Kazakhstan's development strategy till 2030
SP	Solar panel
SDC	Sustainable Development Council
USA	United States of America
LTD	Limited Trust Company
HPP	Heat Power Plant
SD	Sustainable Development
WBCF	World Bank Carbon Fund
CA	Central Asia
MDG	Millennium Development Goals
UNEP	United Nations Environment Programme

CHEMICAL FORMULAS AND SUBSTANCES	
CH4	Methane (GHG)
CO2	Carbon dioxide (GHG)
O3	Ozone
N2O	Nitrogen dioxide (GHG)
UNITS	
OC	Centigrade degree
ha	hectare
Gcal	Giga calorie
Kwh	Kilowatt-hour
Km3	Cubic kilometer
MW	Megawatt
Bln	Billion
cm	Centimeter
t/ha	Tons per hectare (yield unit)
Ths. years	Thousand years
ppm	pro mil

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