Initial National Communication of the Republic of Kazakhstan under the United Nations Framework Convention on Climate Change

Almaty, 1998

This document was prepared and published with technical and financial support of the Netherlands Climate Change Studies Assistance Programme

Table of Contents

List of Acronyms, Abbreviations, and Units

Acronyms and Abbreviations

CCC	Canadian Climate Center
ENPEP	Energy and Power Evaluation Program
FSU	Former Soviet Union
GCM	general circulation model
GDP	gross domestic product
GEF	Global Environmental Facility
GFDL	Geophysical Fluid Dynamics Laboratory
GHG	greenhouse gas
GISS	Goddard Institute for Space Studies
GWP	global warming potential
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
KazNIIMOSK	Kazakh Institute for Environment Monitoring and Climate
NAP	national action plan
NGO	nongovernmental organization
NREL	National Renewable Energy Laboratory
PPP	purchasing power parity
RK	Republic of Kazakhstan
SGP	Small Grant Program
UKMO	United Kingdom Meteorological Office
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WMO	World Meteorological Organization

Chemical Symbols

CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
N_2O	nitrous oxide
NMVOC	non-methane volatile organic compounds
NO_x	nitrogen oxides

Units of Measurement

°C	degree Celsius
bbl	barrel
Gg	gigagram
ha	hectare
km	kilometer
km^2	square kilometer
kWh	kilowatt hour
m	meter
m/s	meter per second
m^3	cubic meter
MW	megawatt
tce	tonne of coal equivalent
toe	tonne of oil equivalent
TW	terawatt
TWh	terawatt hour
W	watt

Executive Summary

Introduction

The Republic of Kazakhstan signed the United Nations Framework Convention on Climate Change (further – the UNFCCC or the Convention) in June 1992, and ratified it in May 1995. Currently Kazakhstan does not belong to any Annex of the Convention.

This national communication summarizes past studies, provides an overview of the national circumstances that influence Kazakhstan's climate change response capacity, reports the results of the GHG national inventory for the years 1990, and 1994, and outlines the main strategies and measures addressed to GHG emissions reduction and adaptation to anticipated climate change.

Climate change studies from 1994 to 1998 were carried out with support of the US Country Studies Program. The Netherlands Climate Change Studies Assistance Programme supported development of GHG inventory for 1994 as well as preparation and publishing of this document.

National circumstances

Kazakhstan is located in Central Asia within 39°49'–55°49' N and 46°28'–87°18' E, at the center of the Eurasian continent. The landlocked country has the ninth largest landmass of any country in the world, 2.72 million square kilometers. The population of Kazakhstan was 16.7 million in 1990.

Kazakhstan has four landscape zones: forest-steppe, steppe, semi-desert, and desert. The climate is continental, with wide variations throughout the territory. Precipitation varies from less than 150 mm in the central desert areas to more than 1,500 mm in mountainous regions. Average temperatures in January range from -18 °C in the north to -3 °C in the south; July averages are 19 °C in the north, and 30 °C in the south.

Most of Kazakhstan is located in the marginal zones, which are considerably vulnerable to climate change. Redistribution of precipitation and increased frequency and intensity of droughts will entail negative consequences, particularly in agriculture and water management of the country.

Climate change issues are considered important in Kazakhstan. In Kazakhstan, as in any transition country, climate change is only a priority to the extent that it is related to the main national conception of protection of the environment and sustainable development.

Overview of Kazakhstan's Economy

Kazakhstan's transition to a market economy began in 1991. In 1990, gross domestic product (GDP) in purchasing power parity (PPP) amounted to 4,089 USD per capita: in 1994, it was 2,442 USD. Thus, for the period 1990 to 1994, the GDP slid 40%, reflecting the difficulties of the transition period.

Kazakhstan is richly endowed with natural and energy resources, and it is an important producer, and net exporter, of oil. Recoverable oil reserves are estimated at 12 billion barrels. The current level of production is 470,000 bbl / day. In the GDP structure, the share of industry was 20.5% in 1990, and 30% in 1994. The share of agriculture in the GDP was 20, and 30%: the share of services 27, and 43%, respectively. Industry is dominated by mining and processing activities largely geared to exploiting the rich natural resource base. Livestock (mainly sheep-breeding) is the most important agricultural activity. The most important agricultural crop is wheat. Kazakhstan has trade communications and economic links with many FSU republics, especially Russia, China and a number of East European countries.

Kazakhstan has huge deposits of energy resources. In 1990, the total output of primary energy resources in Kazakhstan amounted to 119.4 million toe (tonnes of oil equivalent) or 170.66 million tce (tonnes of coal equivalent). There is prevalence of hard and, to a lesser degree, brown coal (lignite) in the energy resource balance. In 1990, its share was 49.3%. The share of oil, gas and nuclear fuel was 21.6, 5.2, were 23.4%, respectively. The share of renewable energy was about 0.5%.

As a result of the decline of the economy, the demand for energy Kazakhstan has dramatically decreased over the past several years. From 1990 to 1997, energy consumption fell by more than 45%. According to energy demand projections given in "The National Energy Sector Development Strategy until 2030", growth of demand for electricity is expected after 1998. It will reach the level of 1990 in 2025, or 2010, in keeping with "pessimistic" and "optimistic" energy development scenarios, respectively. It would be possible to meet the increasing electricity and heat demand by restoration of energy production up to the level of 1990 with the existing power plants, if they are modernized, and if additional turbines are installed on a number of power stations. The highest priority of the Energy Strategy is improvements in energy efficiency and energy saving. The main way to achieve the goals and implement the priorities of the Energy Strategy is to develop a power and energy market regulated by the Government.

Possible Climate Change and Its Impact on Natural Ecosystems and the Economy

A tendency towards increased, spatially averaged, seasonal and annual air temperatures was observed for the last centenary in Kazakhstan. The value of the temperature increase is about 1.3 °C for the period 1894–1997. Warming manifested itself more in spring.

A significant increase in mean air temperatures is expected in Kazakhstan as the result of increasing

CO_2 concentrations in the global atmosphere. All general circulation models (GCMs) suggest increases in temperatures from 4 to 7 °C with the doubling CO_2 which is expected to occur between 2050 to 2075, depending on the CO_2 emissions scenario used. In Kazakhstan, maximum temperature increase is expected to be in winter and spring. In most cases, the relative changes in annual precipitation were in the range of 80–120%. Some models suggest increases in precipitation of 20%; others, a decrease of 10% from the norm.

All GCMs predict increase in climate aridity. The sub-humid zone (where the main area of grain-crops cultivation is currently located) will be reduced in area from 6 to 23%. Under the UKMO scenario, which predicts the maximum warming in the region, the sub-humid zone will disappear from Kazakhstan's territory. Instead, a hyper-arid zone will appear and occupy up to 38% of the area. A climate change of this nature will influence the economy and natural resources of the country to a considerable degree.

Vulnerability assessment of wheat yield showed that it would be especially vulnerable to the expected climate change. Spring wheat yield will decrease by 27% under possible climate change; although, between the years 2010, and 2030, wheat yield may even slightly increase.

Studies of grassland vegetation vulnerability show that any considerable temperature increase will negatively affect natural grasslands. The plants with surface root systems, which utilize mostly precipitation moisture, will be particularly vulnerable.

It is estimated that the expected climate change will also have a negative impact on sheep-breeding productivity due to both grassland yield decrease, and the direct impact of increases in duration of stable hot weather on the sheep. According to the different scenarios, the duration of these periods will increase by 27 to 57 days. The output of lambs will decrease by 5 to 25%, and wool productivity will be reduced by 10 to 20%.

Surface water resources vulnerability assessment was conducted using the North and East Kazakhstan river basins. It showed that climate change under $2\times CO_2$ levels could cause 20% to 30% reductions in the water resources of Kazakhstan. In addition, annual flow redistribution can occur: during the low water periods, the flow will increase; during high water periods it will decrease. The probability of flooding will also decrease.

In general, the studies showed that agriculture (spring and winter wheat), grasslands, livestock, and water resources are highly vulnerable to possible climate change, and negative impacts – depending both on the scenario used and on the area of Kazakhstan considered – are stronger than positive ones.

Inventory of anthropogenic greenhouse gas emissions and sinks

National inventory of anthropogenic greenhouse gas (GHG) emissions by sources and removals by sinks was compiled for the year 1990, which is recommended by the UNFCCC to be used as a reference year. In addition, a preliminary assessment of greenhouse gas emissions and sinks for 1994 was conducted.

The IPCC Guidelines of 1995 were taken as the methodological basis for estimating GHG emissions and sinks while conducting the national GHG inventory. In some cases, the IPCC methodology was complemented to reflect national circumstances and/or data availability.

In accordance with the IPCC Guidelines, Kazakhstan's inventory is divided into five main categories: Energy Activities, Industrial Processes, Agriculture, Land Use Change and Forestry, and Waste Management. The national GHG inventory represents emissions data on three gases with direct greenhouse effect: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O); and on three gases with indirect greenhouse effect – carbon monoxide (CO), oxides of nitrogen (NO_x) and non-methane volatile organic compounds (NMVOC).

According to the results of the refined inventory, total net greenhouse gas emissions in 1990 were about 266 million tonnes of CO_2-equivalent. Preliminary assessment showed that this value in 1994 was about 213 million tonnes. Thus, total GHG emissions in Kazakhstan during this period declined by more than 20%. Specific GHG emissions in Kazakhstan amounted to over 15.9 tonnes per capita: from this amount, about 13.6 tonnes are attributed to CO_2. The national GHG inventories for 1990, and 1994, are subject to adjustment in accordance with new IPCC methodology and new initial data obtained.

The relative contributions of the three direct greenhouse gases to total emissions in CO_2-equivalent for 1990 and 1994, were as follows:

- carbon dioxide – 85 and 82% of the total greenhouse gas emissions respectively, for 1990 and 1994;
- methane – about 15 and 18%; and
- nitrous oxide – 0.3 and 0.02%.

Energy activities in Kazakhstan produced 226 and 178 million tonnes of carbon dioxide emissions in 1990, and 1994, respectively. The energy production sector is the main source of CO_2 emissions in this category. Emissions from this sector amount to almost half of the total emissions from fuel combustion. In absolute terms, carbon dioxide emissions from enterprises of the Ministry of Energy equaled 93 million tonnes in 1990, and 74 million tonnes in 1994. The main feature of Kazakhstan's energy sector is a predominance of coal in the fuel balance. Therefore, in 1990 the share of emissions from coal combustion was 80.9%; from the burning of fuel oil and gas 9.7% and 9.4%, correspondingly.

In 1990, the share of carbon dioxide emissions from industrial sources was about 23%, while transport and residential sector shares were approximately equal, each of them amounting to 15% of the total CO_2 emissions. In 1994, these figures were 29.8 and 17%. Data for these categories are subject to refinement.

Uptake of carbon dioxide by forests amounted to 4,627 thousand tonnes in 1990, accounting for 2.4% of cumulative GHG emissions in Kazakhstan. In 1994, the amount of wood cut down was reduced considerably, compared to 1990. With the area covered by forests unchanged, it resulted in an increase in the CO_2 uptake to 6,627 thousand tonnes, equaling 3.7% of total CO_2 emissions in 1994.

Methane emissions amounted to about 2 million tonnes in 1990, and 1994. It should be noted that the calculated emissions for 1990 were underestimated because emissions from the oil and gas sector were not taken into account. The main sources of methane emissions in Kazakhstan are extraction and processing of coal, oil and gas (49, and 44% in 1990, and 1994, respectively), agriculture (45, and 44%), and waste (6, and 12%).

The level of uncertainty yielded by national activity (statistical) data in energy-related activities is estimated at between 5, and 20%, except in the residential sector, where errors could exceed 20%. Methane emissions from enteric fermentation in livestock were estimated to contain a 25% error. The degree of uncertainty for fugitive emissions is equal to 60%. For other categories, uncertainty varies from between 20, and 80%.

According to the preliminary estimate, CO_2 emissions reduction will reach about 45% of the 1990 level by 1998. Baseline CO_2 emissions projections show that the emissions will reach the 1990 level in 2011 and exceed this level by 37% in 2020.

Measures for Greenhouse Gas Emissions Reduction and Adaptation to Climate Change

In Kazakhstan, as in any developing and transition country, the programs on GHG emissions reduction and adaptation to climate change should be integrated with other national and sectoral development plans and programs for preservation of the environment.

Proposed Greenhouse Gas Mitigation Measures

In Kazakhstan, main efforts will be focused on GHG mitigation measures in the energy sector. The GHG mitigation measures are directly connected with the overall energy sector development strategy and the National Program on Energy Saving. In the energy production sector, the following measures were identified:

- to increase energy efficiency at fossil-fueled power plants, energy saving and district heating improvement;
- to increase the natural gas share in the energy balance;

- to include renewable sources of energy in the energy balance.

In the energy consumption sector, the following measures were defined as priority:

- to increase the energy efficiency and energy savings in industry;
- to improve energy saving in the residential and in the district heating sectors.

Measures on increasing energy efficiency and energy saving have the most significant CO_2 emissions reduction potential in Kazakhstan. Implementation of those items outlined in the National Energy Saving Program could provide reductions in fuel consumption by 25% (short and medium-term action program), and by 40% (as the result of implementation of the long-term program). The Law of the Republic of Kazakhstan on Energy Saving, adopted in December 1997, declaratively covers all the aspects of energy-saving in both energy production and energy consumption sectors, including increase of energy efficiency and development of renewable energy. The Law defines the framework for governing the energy-saving policies at the national level. However, the enabling mechanisms for implementation of the Law have not yet been fully developed. Therefore, one of the priority measures on GHG emissions reduction in energy sector as a whole is to design enabling mechanisms to implement the Law on Energy-Saving.

Taking into account the availability of natural resources in Kazakhstan, existing research and technical work, and expert studies by the Ministry of Energy, various energy technologies in energy generation were evaluated with regard to their possible contribution to the reduction of CO_2 emissions and costs of emission abatement. Among these options were rehabilitation and modernization of thermal power plants aimed at increasing their efficiency; wind, solar energy, and extended use of hydro energy; and utilization of associated gas in the oil fields. All technologies under consideration have been included in the programs on energy development.

Measures for rehabilitation and modernization of thermal power plants have the biggest GHG emissions reduction potential, followed by development of wind and hydro energy, and use of associated gas instead of coal. Solar energy also has some GHG emissions reduction potential. Implementation of these measures would result in reduction of coal and oil utilization as well as reduction of electricity import.

Rehabilitation and modernization of the thermal power plants and commencement of small hydroelectric plants appear to be the most cost-effective and feasible measures. Implementation of the first program will allow the reduction of annual CO_2 emissions by 1.6 million tonnes (2.0% of the baseline level) by the year 2005 and by approximately 2.3 million tonnes (1.6%) by the year 2020. Cumulative CO_2 emissions reduction for the whole period will amount to 40 million tonnes. To implement the whole program of improving the efficiency of fuel utilization at the power plants, presented in the Strategy for the energy sector development, will require 400 million USD by the year 2005; and 1 billion USD by the year 2020. Increasing energy efficiency at thermal power plants, along with energy-efficiency savings and district heating improvement was included as the main priority for medium and short term measures in the electricity generation sector in the Program on Energy Saving. The first step in the implementation of the last measure was taken by starting the project "Capacity Building to Reduce Key Barriers to Energy Efficiency in Heat and Hot Water Supply", with the support of UNDP / GEF.

The energy sector development strategy up to the year 2030 outlines river basins and regions most promising for constructing small hydroelectric plants. At present, it is feasible to construct about 23 small and middle-sized hydroelectric plants with 600 MW cumulative capacity and annual production of 1.3 to 1.5 TWh. With the implementation of this measure, the GHG emissions annual reduction potential is estimated at 0.2, and 3.7 million tonnes by the years 2000, and 2020, correspondingly. Small hydro power plants are the only option, which can result in reducing electricity prices and conserving financial resources. The funds required to install all the small hydroelectric plants projected by the energy sector development strategy will amount to about 17 million USD in 2005, and 578 million USD in 2020.

Kazakhstan possesses significant potential for wind energy development. According to the research work performed, nine regions were identified in Kazakhstan as most suitable for development of wind energy – these are the regions characterized by wind speeds exceeding 8 m / s. In addition to opportunities for installation of large wind facilities, there is considerable potential for small wind power facilities in the zones of decentralized electricity supply; for example, in remote areas characterized by the high costs of delivery of fuel for electricity, and heat supply. The CO_2 emission reduction potential of this measure is estimated to be from 0.7 to 3.1 million tonnes (or from 0.8 to 2.1% of the baseline level) and required funds total 223 million USD, and 1 billion USD, in the years 2000 and 2020, correspondingly.

Developing wind energy is one of the best-supported and sustainable options for long-term energy sector development program in Kazakhstan. Its development, though, requires strong governmental support. According to the energy sector development strategy, installation of large wind power plants with total capacity of 520 MW is planned. Total investment required is about 500 million USD. It is expected that the scale effect will reduce the cost of this energy, and in perspective move it closer to those of the traditional sources.

The full-scale GEF project "Removing Barriers to Wind Power Production in Kazakhstan" has been in implementation since June 1997. The main objective of this project is to remove barriers to commercial scale, grid-connected, wind power production in Kazakhstan, thereby reducing the need for new fossil fuel based power plants and the associated greenhouse gas emissions. The project is expected to achieve this goal by: (i) strengthening institutional capacity for research, planning and technology transfer related to wind power production; (ii) reducing the uncertainties of cost and various technical issues related to wind power production; and (iii) demonstrating the feasibility of wind power production in Kazakhstan, as well as drawing attention to the potential future for the results of these studies to get the necessary political and financial support to move towards larger, commercial scale applications. Expected CO_2 reduction as a result of project implementation is about 0.15 million tonnes per year.

Development of solar energy at the initial stage may annually reduce the amount of the GHG emissions by 0.9% of the baseline scenario. Installation of solar plants could reduce imports of electricity to the Southern regions. At the same time, it is a rather expensive option. The sphere of utilization of these plants, therefore, is limited to remote and difficult to access areas, and to consumers requiring small capacities.

One effective way of increasing the portion of natural gas in the energy balance is utilization of associated gas in oil fields. At present, the amount of associated gas burnt in flares at oil extraction is estimated to be approximately 740 million m^3. Experts estimate the annual CO_2 reduction potential of associated gas utilization for energy generation purposes due to coal replacement to be about 2.7 million tonnes.

To develop and implement the measures on GHG mitigation recommended for inclusion in the NAP UNFCCC Kazakhstan will require technical and financial support from international and donor institutions, as well as private investments. Technology Transfer Mechanisms could serve as an effective way of attracting the funds. Development of Technology Transfer Mechanisms started in September 1997, with USAID support. The main objectives for a possible technology cooperation framework are (1) determining the most effective domestic activities and the mechanism for supporting domestic activities; and (2) developing sustainable businesses and markets to support development, adaptation, and use of energy efficiency and renewable energy technologies. This mechanism should also provide communicating climate change technology cooperation needs to international donors and securing funding for renewable energy and energy efficiency projects.

In the non-energy sector, increasing CO_2 sinks by expanding forest area and converting relatively unproductive arable land into grasslands and rangelands are the most promising measures. Measures like increasing the livestock productivity and optimization of the livestock population, biogas utilization, and optimization of areas covered with rice would provide reductions of up to 20% of the methane emissions from agriculture.

Methane emissions from the coal mining industry account for almost 50% of the total methane emissions in Kazakhstan. Utilization of coal bed methane is one promising measure for CH_4 emissions reduction.

Proposed Adaptation Measures

Results of the research showed high vulnerability of wheat production and water resources of Kazakhstan to potential climate change impacts; therefore, the adaptation measures in these sectors were assessed. In developing and assessing the adaptation measures, flexibility and cost-effectiveness were taken as the main criteria. Moreover, measures should be adopted in respect to climate change that are beneficial and necessary for other reasons, so that if the climate does not change as predicted, there will remain a net gain to the society for the effort.

In wheat production, the following adaptation measures were identified as a priority: improving the transition to a market economy by strengthening and clarifying the laws regarding the free market and agriculture; improving institutions that observe market conditions; changing land management to reduce soil erosion and improve arable lands; preventing pest infestations and disease outbreaks; and establishing (and maintaining at modern levels) centers for the preservation of the gene fund of spring and winter wheat across the regions of Kazakhstan.

Adaptation assessment of water resources was conducted for the Irtysh, Ishim, and Tobol river basins. The following adaptation measures were defined as a priority: runoff regulation, a complex of water-saving measures, runoff shift, and increasing underground water takeoff. In deciding the priorities, preference was given, first of all, to measures which provide more water, require less funding, and do not require diversion of runoff from other basins.

Full practical implementation of adaptation measures will require significant investment and a long period of time.

Education, Training, Public Awareness and NGOs

Development of educational and public awareness programs on climate change, providing public access to information on climate change issues and public participation (including NGOs) are important parts of both implementation of the general obligations of UNFCCC and development of the National action plan.

It is possible to obtain basic professional knowledge on the scientific aspects of the problem of global climate change at several universities in Kazakhstan. This curriculum is to be supplemented with the addition of the latest scientific information from climate change studies. A program for high schools on different aspects of climate change is also currently being developed. Climate change issues and study results are presented in quarterly science and technical journals, newspapers, and on radio and TV.

The first Kazakhstan Scoping Workshop on Preparation of the National Action Plan on Climate Change was held in April 1997, with the support of USAID. Representatives from all related ministries, departments, scientific organizations, and several foreign and international organizations, mass media and NGOs took part in the workshop. The main objectives of the workshop were presentation of the results of climate change studies to meet Kazakhstan's obligations under the UNFCCC; achievement of a consensus on the NAP UNFCCC objectives, sectors of interest and priority mitigation and adaptation measures; and identification of the procedures for developing an outline for the NAP FCCC and integrating it with the other sectoral plans and ecological programs of the Republic of Kazakhstan.

A network of ecological NGOs in Kazakhstan is being actively expanded. However, only some of them have climate change projects. In 1997–1998, two NGOs implemented climate change projects with the support of GEF and USAID. The role of NGOs in implementation of the UNFCCC commitments will grow with the rise of public awareness of climate change issues.

Follow-up Activities

Formulating, implementing and regularly updating national programs containing measures to mitigate climate change and facilitate adequate adaptation to climate change impacts are the general commitments of all Parties in accordance with Article 4 (1b) UNFCCC. These measures should be implemented on a constant basis in all sectors of the economy, including energy, transport, industry, agriculture, forestry, water resources and waste management.

In addition, to meet Kazakhstan's obligations under UNFCCC, scientific, socio-economic and other studies will continue to be carried out observations of the climate system, and support climate data bases which are necessary to the understanding of climate change and its causes. These are tasks for research institutes and groups of experts in climatology, energy, economy, and sociology. Climate change monitoring is a task for the National Meteorological Service and should be financed both by the government and international organizations; particularly, WMO and UNEP.

Studies and assessments of measures on adequate adaptation to climate change will also be continued. For the moment, adaptation is recognized to be important as mitigation measures in effort to combat climate change. Adaptation assessments of the Caspian Sea coastal zone as well as mudflow and snow avalanche study for the mountains of the South and South-East of the country are being developed within the Netherlands Climate Change Studies Assistance Programme during 1998–1999.

After the government approves the NAP, a special group will conduct activity on evaluation, implementation, and monitoring of climate change projects. This group will also conduct tenders for project proposals, correct and prepare them for financing. This group has been created in the National Ecological Center for Sustainable Development in the Ministry of Ecology and National Resources.

In August 1998, the Government of Kazakhstan decided to sign the Kyoto Protocol, and therefore, a number of activities are to be done in the fulfillment of its provisions.

Introduction

The Republic of Kazakhstan signed the United Nations Framework Convention on Climate Change (further – the UNFCCC or the Convention) at the United Nations Conference on the Environment and Development in Rio de Janeiro in June 1992. Nursultan Nazarbaev, the President of the Republic of Kazakhstan, ratified the Convention on May 15, 1995. Kazakhstan lodged its instrument of ratification with the United Nations Secretary General.

The ultimate objective of the UNFCCC, as expressed in Article 2 is: "...stabilization of greenhouse gas concentrations in the atmosphere at the level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change..." According to its commitments, Kazakhstan, as a non-Annex I and non-Annex II country, should develop and provide the Conference of the Parties through the Secretariat with national inventory of GHG emissions, general description of measures on realization of the Convention and information, relating to achievement of the Convention goals.

Since 1993 Kazakhstan with support of the U.S. Agency for International Development through the US Country Studies Program has been involved in the following activities:

- Developing a national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol for 1990 base year;
- Conducting vulnerability assessments for important national economic sectors and ecosystems and developing recommendations on adaptation of these sectors to anticipated climate change;
- Conducting an evaluation of the mitigation measures that control, reduce, or prevent anthropogenic GHG emissions in relevant sectors for the period through 2020;
- Developing Nation Action Plan on UNFCCC.

This national communication summarizes past studies, provides an overview of the national circumstances that influence Kazakhstan's climate change response capacity, reports the results of the GHG national inventory for the years 1990, and 1994, and outlines the main strategies and measures addressed to GHG emissions reduction and adaptation to anticipated climate change.

The national communication and the assessment of GHG emissions for 1994 were prepared with support of the Government of the Netherlands through the Netherlands Climate Change Studies Assistance Programme.

CHAPTER 1. National Circumstances

Most of the Kazakhstan's territory is located in arid and semi-arid zones, which are considerably vulnerable to climate change. Redistribution of precipitation and increased of frequency and intensity of droughts on the background of air temperature increase will entail negative consequences, particularly in agriculture and water management of the country. Climate change can also have negative influence on human health.

On the other hand Kazakhstan is one of the largest emitters in Central Asia and has a considerable GHG reduction potential. Therefore, climate change issues are considered important in the country. In Kazakhstan, as in any transition country, climate change is a priority only to the extent that it is related to the main national objectives – protection of the environment and sustainable development. Actions in the context of climate change must meet a long-term market-based and externally oriented development strategy and fit into other development programs, and they will certainly require international assistance. Kazakhstan's long-term national priorities are to improve its physical infrastructure, increase economic growth and employment, increase self-reliance, promote rural development, and preserve the environment.

Table 1.1 presents information on the national circumstances of the Republic of Kazakhstan for 1990 and 1994. The sources of information were the official reports of national statistics. In a number of cases, when official data was missing, the expert estimations were used.

TABLE 1.1 NATIONAL CIRCUMSTANCES

Criteria	1990	1994
Area, thousand km^2	2,724.9	2,724.9
Population, million inhabitants	16.7	16.2
Urban population, %	57.5	56.4
Population in absolute poverty, %	12	28
Life expectancy, years	69	65.7
Literacy rate, %	97.5-98[a]	96-97[b]
GDP in PPP, billion USD[c]	68.3	41.0
GDP in PPP per capita, USD[c]	4,089	2,442
Share of the informal sector in the economy, %	10[b]	15[b]
Share of industry in GDP,%	20.5	29.1
Share of services in GDP,%	26.8	42.8
Share of agriculture in GDP,%	34.0	14.9
Land area used for agricultural purposes, thousand km^2	2,690.0	2,222.5
Livestock population, thousands		
Cattle	9,818.4	8,072.9
Sheep and goats	36,605.0	25,132.1
Pigs	2,976.1	1,982.7
Horses	1,666.4	1,636.0
Camels	143.0	141.2
Poultry population, millions	59.8	32.7
Forest area, thousand km^2	96.5	105.0
Grasslands, thousand km^2	1,823.0	1,823.0

Source: Statistical Yearbook of Kazakhstan (1996)
[a] Population census of 1989.
[b] Expert judgments.
[c] Calculated with the use of data provided by Statistics and Analysis Committee.

1.1 The Geography, Climate and Natural Resources

The Republic of Kazakhstan, a newly independent Euro-Asian country, was created on December 16, 1991 when the Parliament had declared its independence.

Kazakhstan is located in Central Asia within 39°49'–55°49' N and 46°28'–87°18' E (Figure 1.1) at the center of the Eurasian continent, nearly equidistant from the Atlantic and the Pacific Oceans. The landlocked country has the ninth largest landmass of any country in the world, 2,724.9 thousand square kilometers. Kazakhstan borders Russia in the north and west, Kyrgyzstan, Uzbekistan and Turkmenistan in the south and China in the east. The total length of the borders is more than 12,187 kilometers.

FIGURE 1.1 THE REPUBLIC OF KAZAKHSTAN

This land is full of contrasts: fertile valleys border on dry and barren endless steppes. Its territory is located in four natural landscape zones: forest-steppe, steppe, semi-desert, and desert. Most of its territory is lowlands and plains bordered by high mountain ranges of Altay and Tien Shan in the east and the southeast. The mountain regions occupy about 10% of the total territory. The highest point in Kazakhstan is Khan-Tengry peak (6,995 m above sea level), the lowest one is the Karagie hollow (132 m below sea level), which is contiguous with the east coast of the Caspian Sea. Kazakhstan also has a coastline of 2,320 kilometers on the Caspian Sea.

The climate is continental, with wide variations throughout the territory. In the north average January temperature is -18 °C and July average is 19 °C; in the south the averages are -4 °C and 26 °C correspondingly. In the north annual precipitation reaches 400 mm, less than 150 mm in the desert areas and 1,500 mm in mountain regions. Strong winds are typical for most part of Kazakhstan.

Although a share of the land area used for agricultural purposes is about 82% of the total area of Kazakhstan, it is mainly low productive pastures. The share of arable lands is only about 15% of the territory. More than 60% of total arable land (about 23 million ha) are the land, brought under cultivation in 1950s during the “virgin lands” campaign of the 1950s. This vast area supports a dry and irrigated farming. Throughout the country, the temperature sums for the growing season are sufficient for the cultivation of all species of cereals grown in a moderate temperature belt. However, there is a shortage of precipitation, and the cultivation of cereals is only possible in the north, northeast and in a narrow foothill area in the southeast of the country. Conditions in the south are favorable for heat-loving crops.

According to the official statistical data, forests cover only about 3.7% of the territory or 9.65 million ha in 1990. In 1994 the forests' area enlarged to 4%, which amount 10.5 million ha. Coniferous forests cover 1.8 million ha. They are mainly extended at the Altay and Tien Shan Mountains and at the separate tracks of Kazakh Melkosopochnik. The rest of the forested area is made up of deciduous forests and bushes. The largest area, 4.7 million ha, is made up of saksaul (Haloxylon), a deep-rooted, practically leafless tree typical for Asian deserts. Forests in Kazakhstan have not been used for commercial purposes. They are used mainly for soil and water protection.

The river network has had only limited development. However, rivers are extremely important for irrigation and power generation. Kazakhstan also has about 57,000 lakes and more than 4,000 artificial reservoirs. The largest natural reservoirs are Caspian and Aral Seas.

Kazakhstan is richly endowed with natural and energy resources. It has the great reserves of iron, copper, lead, chrome, coal, oil, and phosphorites.

1.2 Population

In 1990, the population of Kazakhstan was 16.7 million, and in 1994, it was about 16.2 million. Kazakhstan is one of the most sparsely populated regions in the world, with an average density of about 6.2 per square kilometer. The distribution of the population is very uneven. While the population density in the southern areas is 16.8 people per square kilometer, in the central parts it is only about 1.6.

The Republic of Kazakhstan is a multinational country. Today, more than a hundred nationalities live in Kazakhstan. Kazakhs and Russians constitute the two most important ethnic groups, represented 44% and 36% of the population correspondingly. The remaining 20% are distributed over the other nationalities – Germans, Koreans, Tatars, Uzbeks, and others.

There are 14 administrative regions (oblasts) and more than 80 cities and towns in the republic. The urban population predominates; its share in 1990 was 57.5% and in 1994 – 56.4%. Average life expectancy in the country in 1994 was 69 years, which is similar to the average in upper middle income countries. Infant mortality was 26 per 1,000, lower than in Europe (30 per 1,000), but higher than in Russia and the FSU. The natural gain of the population for the last 10 years has decreased on 50.9%. According to the World Bank reports, adult literacy is comparable with that one in economies with per capita GDP above 6,000 USD.

The socio-economic decline led to the living standards reduction of the most of Kazakhstan citizens during the last few years. The transition to the market economy caused problems of poverty and unemployment and emigration. A recent emigration wave has resulted in a substantial decrease in population of about 5.3% from 1994 to 1997. However, according to the macro-economic scenarios, in 2030 population will increase by 22.8% in comparison to 1990 level.

1.3 Overview of Kazakhstan's Economy

Kazakhstan's transition to a market economy began in 1991 with tentative property privatization and institutional measures. In 1990, gross domestic product (GDP) in purchasing power parity (PPP) amounted to 4,089 USD per capita; in 1994, it was 2,442 USD. Thus, for the period 1990 to 1994, the GDP slid 40%, reflecting the difficulties of the transition period.

Recent World Bank economic reports indicate that the main macro-economic trends can be characterized by the 50% GDP in real terms decline from 1990 to 1997. The factors caused the output contraction in Kazakhstan and other FSU republics were the breakdown of supply links between enterprises within the FSU and the fall in sale of traditionally exported products (non-ferrous metals, phosphoric fertilizers). The further development of economic reform should provide a more solid foundation for the sustainable growth and employment for all sectors after overcoming the drastic downfall of the 1990–1998 period.

Kazakhstan is an important producer of gold, iron ore, and coal, copper, chrome, tungsten, and zinc. It has close to half of the total reserves of lead, wolfram, copper, and zinc and the other mineral resources found in exploitable amounts within the economy, such as oil, natural gas, nickel, titanium, tungsten, molybdenum, lead, zinc, manganese, and aluminum.

Kazakhstan is a great producer and net exporter of oil. Recoverable oil reserves are estimated at 12 billion barrels. The current level of production is 470,000 bbl / day. Production is mostly located in the western part of the republic near the Caspian Sea. The exploitation of the big oil field has begun on the south near the Aral Sea. The two largest refineries are located in the eastern part. The majority of the country's production is, therefore, exported, while crude oil for its refineries was imported from central Siberia. Last years import had been decreasing, because of the economic links breakdown. Currently the oil production increases, and much higher production levels are expected as new huge oil fields are brought on stream by international and foreign petroleum companies.

Industry, which share accounted for about 20.5% of GDP in 1990 and 30% – in 1994 (see Table 1.1), is dominated by mining and processing activities, largely geared to exploiting the rich natural resource base. The processing plants for both ferrous and nonferrous metals, heavy engineering, and metalworking plants are mainly located in the northern and eastern regions close to the mineral deposits.

Kazakhstan has a variety of developed agro-processing industries. Food and light industries of Kazakhstan include meat, fish and vegetables canneries, woodworking, wineries, and footwear and textile manufacture.

Agriculture, one of the main sectors in the Kazakhstan economy, was contributing 34% in GDP in 1990, and about 15% in 1994. The country is a significant producer and exporter of agricultural products. The most important agricultural crops include wheat, maize for fodder, potatoes. The food and light industries exploit the main industrial crops – cotton and sugar beets, which are cultivated in the south of Kazakhstan. The vegetables grow throughout the country, fruits and grapes – in the south and southeast.

Livestock is the most important agricultural industry, based on the extensive opportunities for grazing. Sheep-breading activity is most widely spread traditional branch of the Kazakhstan livestock husbandry.

The share of services in GDP has increased from 26.8 to 42.8% for the period from 1990 to 1994, because of increasing share of private sector and retail trade development.

The geographical characteristics of the country influenced the development of the Kazakhstan transport system. The most part of freight transport is dominated by rail sector. There are 5.4 kilometers of railways per 1,000 square kilometers. Within the FSU, Kazakhstan railways are the third largest railway system in terms of traffic volume and rolling stock. For distant areas, road transport is very important. The total length of hard surfaced road is equal 115.5 thousand kilometers or 38 kilometers of per 1,000 square kilometers.

Kazakhstan has trade communications and economy links with many FSU republics, especially Russia. China and some Eastern European countries have been the largest of these trading partners outside the FSU. From 1990 to 1994, Kazakhstan had very high rates of all basic parameters of trade development. The commodity stocks in a retail network have increased in 5.5 times for this period.

1.4 Overview of the Energy Sector

1.4.1 Resources

Kazakhstan has huge reserves of energy resources, which is sufficient to meet the domestic needs as well as to export the resources in their natural form and in the form of electricity to the other regions.

In 1990, the total output of the primary energy resources in Kazakhstan amounted to 119.4 million toe or 170.7 million tce (Table 1.2).

There was prevalence of hard and, in less degree, brown coal (lignite) in the energy resources balance in 1990. The share of the coal was 80% in the energy production sector, and 40-50% – in the residential sector. The total coal consumption was about 91 million tonnes, of which 11 million tonnes were imported from Russia and Central Asian countries. The energy and residential sectors consumed 76 million tonnes of coal and industry used 15 million tonnes.

In 1990, the crude oil and gas condensate output in the republic was equal to 26.6 million tonnes, whereas 12.66 million tonnes was imported for complete needs of refineries. The Republic of Kazakhstan is a large oil exporter, as it annually export is about 20 million tonnes of crude oil.

The current natural gas output in Kazakhstan is about 7.9 billion m^3, and only 2.9 billion m^3 is refined locally, about 0.65 billion cubic meters of associated gas is burned in the torches. The rest of the gas amount is exported for refining to Russia. The country meets its basic needs in gas (about 16 billion cubic meters) at the expense of import from the other regions, mainly, from Russia and Uzbekistan. The import approximately makes 12.8 million cubic meters. In the country fuel balance, the share of gas is less than 15%.

The renewable energy (RE) resource potential in Kazakhstan is significant but was largely neglected. RE resources development would be suitable for electricity production at the national and local level and is suitable to serve small distributed loads.

Kazakhstan's hydro potential is quite large amounting to an estimated 170 TWh / year, of which only about 23.5 TWh / year has been exploited. Within the total, small hydro potential, defined as units of less than 10 MW, is significant. Based on existing studies, there is at least 453 potential small hydroelectric power projects with 1,380 MW of total installed capacity and 6.3 TWh of mean annual production. Some of them consist of existing irrigation channels, which makes them more readily available for implementation (at lower cost and shorter time period).

TABLE 1.2 PRODUCTION AND CONSUMPTION OF PRIMARY ENERGY RESOURCES IN 1990

Primary Energy Resource	Production, million toe	Share of Total Primary Energy Resources, %	Consumption, million toe
Coal	58.90	49.30	49.30
Crude oil	25.80	21.60	19.95
Gas	6.16	5.20	11.56
Nuclear fuel	27.90	23.40	0.58
Renewable sources	0.63	0.50	0.63
Total	119.40	100.00	81.02

Kazakhstan has a great possibility of the wind power use, especially in the regions of Dzhungar Gates and Chillik wind corridor, where the annual average wind velocity is estimated in the range of 7 to 9 m/s and of 5 to 9 m/s correspondingly. Close proximity of existing high-voltage transmission lines, good correlation of the windy seasons and the high demand for the electricity provide the conditions to use these resources effectively.

In spite of the geographical location, Kazakhstan has sufficient solar energy resources potential. There are between 2,200 and 3,000 hours of sunshine per year and insolation energy is 1,300–1,800 kWh per square meter per year. This allows using of the sun water-heater and sun batteries, in particular portable photovoltaic applications in the rural area on the cattle farms.

In 1990 the total renewable-based energy production (including hydro energy) was 7.35 billion kWh, or 8.4% of total energy production. Current share of the RE amounts 0.3% of total energy production, 80% of which accounts for small hydro.

1.4.2 Energy Transformation and Distribution

Energy sector plays a significant role in the future economic development of the country. However, with the large energy resources, Kazakhstan has serious electricity deficits, which have to be covered by imports from Russia and other Central Asian countries. Furthermore, the size of the country's territory and its geography (desert land dividing north from south) together with the concentration of coal deposits in the north, require high investments in transmission systems with attendant high losses and low reliability. The power sector needs considerable rehabilitation and serious upgrading if the country is to decrease its heavy reliance on electricity imports.

Ten energy distribution systems were formed in Kazakhstan by the late eighties. They provided energy connection with Russia and the central Asian republics. The vast territory of the republic predetermined the huge total length of electricity transmission network, which was about half a million kilometers.

The management structure and forms of property of the distribution system have been radically changed recently. In transition from the planned economy to the market one indivisible power engineering system, all the generators and the transit and energy distribution networks being its indispensable parts, were reorganized. To develop the competitive conditions, all the generators got independence as joint-stock companies, some of them have been sold to the foreign investors, and the rest are in the process of selling. The regional energy distribution networks have also been reorganized into joint-stock companies and are nominated for the auctions. The national energy system company "Kazakhstanenergo" has been reorganized into Kazakh Electricity Grid Operation Company (“KEGOC”) which is joint-stock venture, but it is preserved as the state property. Thus, the power sector of Kazakhstan is going out of the governmental subordination. The government preserves the regulatory functions in accordance with the Law on the Power Engineering.

1.4.3 Consumption

As a result of the process of profound economic reforms, crises of the transition period and disintegration of the industry and economy complex of the former USSR, the demand for energy in Kazakhstan has been decreased over past several years. Since 1990 to 1997, the energy consumption has fallen by 47.6 billion kWh or on about 45% of the level of 1990. It should be noted that the share of hydropower energy increased because its total electricity production remained practically the same.

Electricity demand projections by 2030 under the “maximum” and “minimum” scenarios, according to the "Energy sector development strategy until 2030" project are presented in Table 1.3. It can be seen from the table that electricity demand level of 1990 will be reached in 2015 and 2010 according to "maximum" and "minimum" energy demand scenarios respectively. It would be possible to meet the increasing electricity and heat demand by restoration of the energy production up to the level of 1990 on the existing modernized power plants, as well as by installation of new turbines on a number of power stations. It is expected besides, that the total energy production on the renewable energy resources will reach 10.7 TWh (including wind energy) in 2030. The total share of these resources (mainly hydro and wind resources) in the overall energy production will amount to 7% in 2030.

1.4.4 Energy Strategy

The Energy Strategy in Kazakhstan is elaborated in accordance with the President’s Strategy of the Development of Kazakhstan up to the year of 2030, and is based on the analysis of the world power engineering market development and the domestic potential of the country.

The main goal of the Energy Strategy of Kazakhstan is definition of the ways and development of the means for the most efficient use of the energy resources and power production

TABLE 1.3 ELECTRICITY DEMAND PROJECTIONS ACCORDING TO DIFFERENT ENERGY DEVELOPMENT SCENARIOS UNTIL 2030 (TWH)

Scenario	1990	1995	1996	1997	1998	1999	2000	2005	2010	2015	2020	2030
Maximum	104.7	74.4	66.2	57.1	60.0	65.0	80.0	95.0	110.0	120.0	130.0	145.0
Intermediate	104.7	74.4	66.2	57.1	56.0	57.0	60.0	80.0	95.0	105.0	115.0	130.0
Minimum	104.7	74.4	66.2	57.1	54.6	55.5	57.0	67.5	78.0	88.0	98.0	115.0

Source: Energy Development Strategy until 2030 (June 1998).

complex, in order to rise the living standards of the population and the socio-economic development of the country.

The most important objectives of the Energy Strategy are as follows:

- to reduce significantly the impact of the fuel and energy production complex on the environment;
- to preserve and strengthen energy independence and security of the country.

The highest priority of the Energy Strategy is increase of energy efficiency and energy-saving improvement. In accordance with the developed strategy, rational energy consumption will prevent an increase of the energy demand, which is ruinous for the country and beyond the possibilities of the fuel and energy complex. It will also give an economic effect of fivefold return on energy-saving expenditures.

Energy saving will make it possible to reduce the detrimental emissions into the atmosphere by 15-20%. Saved energy resources should be the main source to provide the necessary fuel and energy export.

The strategy in the area of development of structure of the energy sector for the nearest 15-30 years is addressed to the following action:

- to increase the share of oil in the national energy balance and export, and increase efficiency of its use;
- to increase the share of natural and associated gas in the energy balance and efficiency of its use;
- to have a profound refinery and combined use of the raw hydrocarbons as a high priority;
- to improve coals quality through their profound enrichment and electrochemical refinery, the confinement of the high-ash beds exploitation, stabilization and then the increase of the coal mining volume (mainly, using the strip mining method) in the course of development of ecologically fit technologies;
- to intensify the local power resources development (hydro energy, small deposits of hydrocarbons, etc.);
- to increase use of nontraditional renewable energy sources (wind, solar, geothermal waters, coalbed methane, biogas, etc.).

The highest priority of the Energy Strategy is improvement in energy efficiency and energy saving. The main way to achieve the goals and implement the priorities of the Energy Strategy is to develop a power and energy market regulated by the Government.

1.5 National Organizations for Coordinating Climate Change Studies and UNFCCC Activities in Kazakhstan

At present, a national lead agency for coordinating activities both on the UNFCCC and the other ratified environmental conventions in Kazakhstan is the Ministry of Ecology and Natural Resources.

Since October 1993, the works on climate change issues in the framework of the UNFCCC have been carried out by the Main Administration on Hydrometeorology (Kazhydromet) and the Kazakh Scientific and Research Institute of Environmental Monitoring and Climate (Russian abbreviation is KazNIIMOSK). The Climate Change Study Laboratory was organized in KazNIIMOSK. Experts from different sectors, ministries, and institutions were involved into the climate change study team. The Initial National Communication of the Republic of Kazakhstan is based on the results obtained by this team, including GHG emission inventory, vulnerability and adaptation assessment, and mitigation analysis.

After the Third Conference of the UNFCCC Parties in Kyoto, the works on climate change have been made more active in Kazakhstan. In February 1998, the Interagency Coordinating Committee was established for implementation of the UNFCCC provisions and decision-making procedures for climate change matters. It includes representatives from interested national ministries and other national entities and is leaded by the Ministry of Ecology and Natural Resources. In April 1998 the National Ecological Center for Sustainable Development were organized under this Ministry. It consists of the national coordinators on the UN environmental conventions.

CHAPTER 2. Possible Climate Change and Its Impacts

The most part of the territory of Kazakhstan is deserts and semi-deserts that are rather vulnerable to climate change. Redistribution of precipitation and both the increase of frequency and intensity of droughts against the background of the air temperature increase will result in especially adverse consequences in agriculture, forestry, and water resources of the country. Possible influence of climate change on human health can be negative because of strengthening heat stress, especially in southern areas, and distribution of many kinds of diseases as well.

2.1 Climate Observation

Systematic observation, development of data archives and researches related to the climate system and intended to further the understanding and to reduce or eliminate the remaining uncertainties regarding the causes, effects, magnitude and timing of climate change are among the common commitments of Parties of UNFCCC. Therefore, Kazakhstan's NAP UNFCCC includes support of state climate observation network.

Climate records are essential to development of strategies to mitigate potentially adverse effects of climate change and assessment of climate impact. Climate observations and investigations are carried out according to the recommendation of the World Climatic Program (WCP) of the World Meteorological Organization (WMO). Currently meteorological observations are maintained on 251 stations in Kazakhstan. There are 35 Reference Climate Stations in Kazakhstan. Annually issued National Report on State of Environment of the Republic of Kazakhstan includes analysis of climate abnormality based on the data observed.

The Republican Hydrometeorological Data Fund collects and manages climate information. Climate databanks created in Kazhydromet and KazNIIMOSK are used in applications and research efforts. Climate trends and variability detection is based on the collected data.

2.2 Observed Climate Change

Meteorological observations at some stations in Kazakhstan started more than 100 years ago. This allowed estimation of a regional climate change over the period.

Surface air temperature. The tendency of increase of average seasonal and annual air temperatures was observed during last centenary period in Kazakhstan (Table 2.1 and Figure 2.1). Maximal

TABLE 2.1 LINEAR TREND COEFFICIENTS FOR MEAN ANNUAL TEMPERATURES AND PRECIPITATION AVERAGED OVER THE TERRITORY OF KAZAKHSTAN FOR THE PERIOD 1894–1997

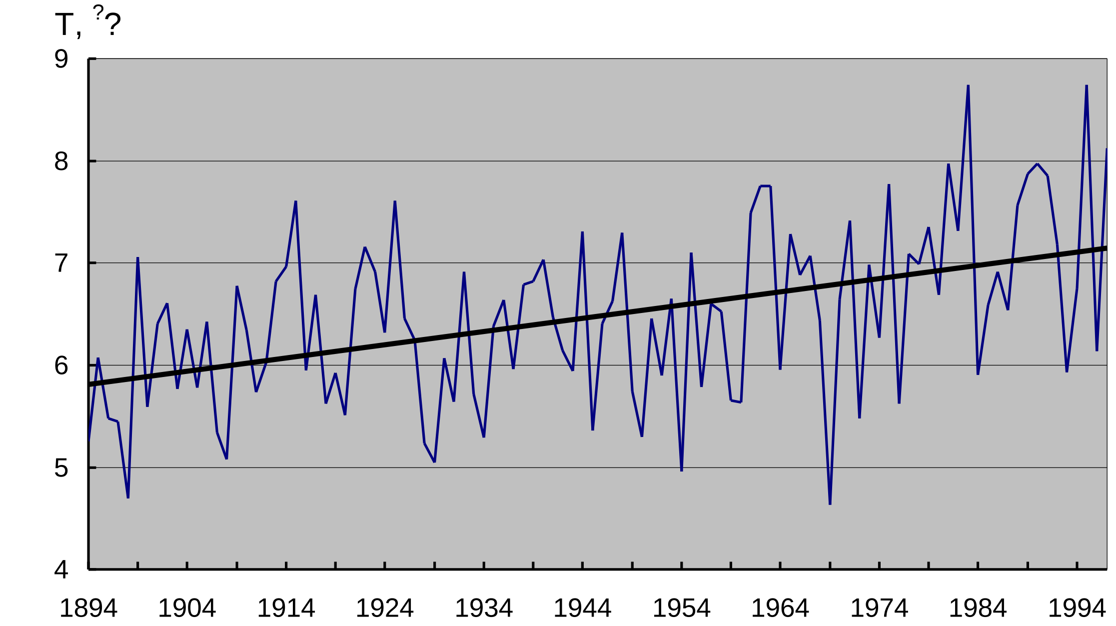
Period	Temperature, °C/100 years	Precipitation, mm/100 years
Winter	1.8	-7
Spring	1.9	3
Summer	0.8	1
Autumn	0.7	1
Annual	1.3	-17

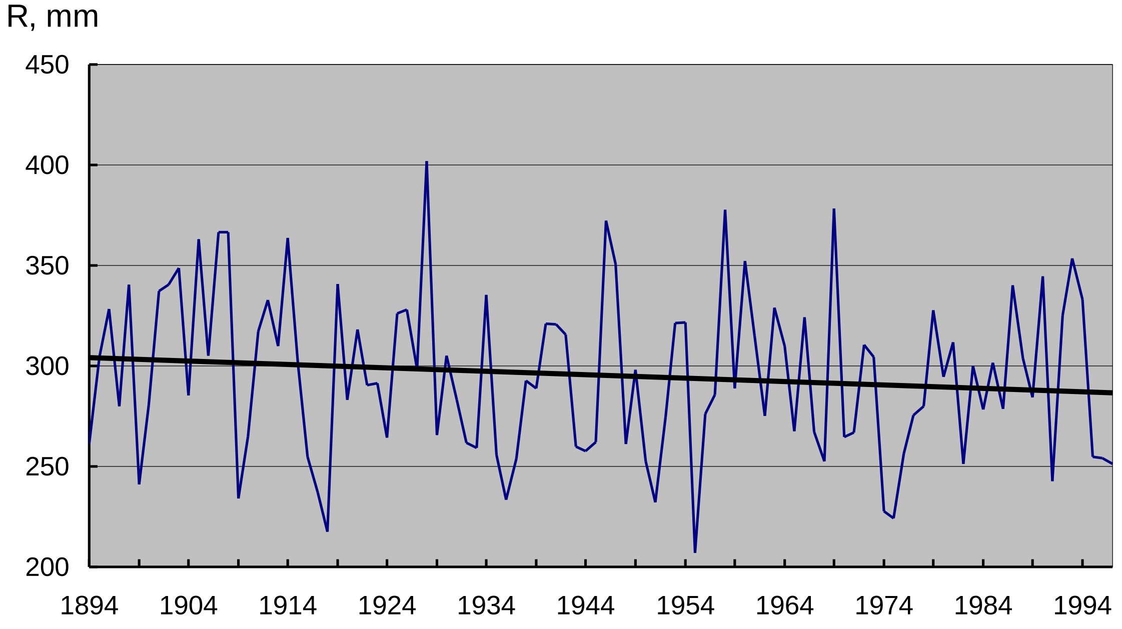
warming occurs in the spring period. Over the region, the mean annual surface temperature rose by about 1.3 °C during 1894–1997.

The comparison between average temperatures for 1961–1990 and for previous three decades has shown that this period has appeared warmer, especially in northern part of the region in winter and spring. As well as on a global scale, the warmest years for Kazakhstan were during the eighties. The highest temperatures during last years were observed in 1995, however the anomaly of temperature of this year has not exceeded the extreme value, which was observed in 1983.

Precipitation. A negative trend of the total precipitation for the period 1894–1997 was observed over the territory of Kazakhstan. The decrease in annual precipitation, and in winter precipitation over the region was low. The increase in spring rainfall, and in summer and autumn and winter rainfall was slight as well (Table 2.1). Compared to 1931–1960, the average long-term annual sums of precipitation for the period 1961–1990 practically have not changed. Such regime of rainfall on the background of significant temperature rise is an evidence of increase in climate aridness over the most part of Kazakhstan within last century.

FIGURE 2.1 TIME-SERIES AND LINEAR TREND OF MEAN ANNUAL SURFACE AIR TEMPERATURE (T) AND SUM OF PRECIPITATION (R) AVERAGED OVER THE TERRITORY OF KAZAKHSTAN FOR 1894-1997





2.3 Expected Climate Change

Regional climate change scenarios were prepared from General Circulation Models (GCM) outputs, that were promoted within the framework of United States Country Studies from National Center for Atmospheric Research. The following model outputs were used: GFDL and GFDL-T – equilibrium and non-equilibrium models of Geophysical Fluid Dynamics Laboratory (University of Princeton, USA); UKMO – equilibrium model of the Meteorological Agency the United Kingdom; CCC – equilibrium model of the Canadian Climate Center; GISS – equilibrium model of the Goddard Institute of Space Studies (USA).

Under doubling CO_2 conditions that are expected to occur by 2050–2075 average annual and average monthly temperatures over Kazakhstan are projected to increase considerably according to the considered GCMs. Precipitation change scenarios are less conclusive. According to most models an annual increase of precipitation is expected, according to some others rainfall would be similar to those at present or will decrease (Table 2.2). All models predict also various rainfall changes on seasons.

The results of the analysis show a range of possible temperature increase over the region. According to the "maximal warming" scenario (UKMO) changes in annual average air temperature and the sum of precipitation are expected to be 6.9 °C and –12%, respectively, under double CO_2 conditions.

The highest temperature rise and significant decrease in rainfall is expected to occur in winter and summer. Under the "minimal warming" scenario (GISS) the increase in average annual temperature is expected to be 4.5 °C. This scenario implies an increase in the annual sum of precipitation by 28% on average. In the other scenarios, the growth of average annual temperature is expected to be 4.9–6.9 °C accompanied with increase in precipitation by 2–24%. Most of the models predict the maximum temperature increase in the winter months.

TABLE 2.2 CHANGES IN AVERAGE ANNUAL TEMPERATURE AND SUM OF PRECIPITATION OVER THE TERRITORY OF KAZAKHSTAN ACCORDING TO CONSIDERED GCMS

GCM	Changes in Average Annual Temperature, °C	Changes in Annual Sum of Precipitation, %
GISS	4.5	28
GFDL	4.9	24
UKMO	6.9	-12
CCC	6.9	2
GFDL-T	4.9	7

To select the GCMs for creating climate change scenarios, regional model outputs for the present climate were compared with observed climate data. From comparison, the GFDL model was found to give the best estimate of the observed climate.

2.4 Vulnerability Assessment

Assessment of the potential climate change impact on the ecosystems and some economy sectors was conducted on the base of the developed regional scenarios.

2.4.1 Humidity Zones

According to the GCM calculation results, the global-scale surface temperature increase leads to the precipitation increase in the high and moderate latitudes. However, in some regions considerable temperature increase can result in aridity. About two thirds of Kazakhstan's territory are located in arid and semi-arid zones. That is why even slight change of the main climate characteristics can lead to the irreversible consequences. Complex assessment of the temperature and precipitation change impact on the humidity extent of the Kazakhstan territory allowed determining the possible shifts of the natural landscape zone borders.

According to the IPCC classification, under the present climate conditions the plain territory of Kazakhstan involves three humidity zones: arid, semi-arid, and sub-humid. Arid zone coincides with the desert landscape zone, semi-arid – with the semi-desert zone. Sub-humid zone conforms to the steppe zone. Figure 2.2 and Table 2.3 present ratios between the humidity zone areas of the plain territory of the region under the present climate conditions and under CO_2 concentration doubling.

The data of the Table 2.3 show that all the models predict the humidity conditions worsening in the region under the climate change, as the arid and hyper-arid zone areas will extend, and the semi-arid zone area will reduce. According to the scenario of minimum warming, the humidity zones boundaries will shift to the north for about 50-100 km, and for 350-400 km – under the maximum warming scenario.

TABLE 2.3 HUMIDITY ZONES' AREAS OF THE FLAT TERRITORY OF KAZAKHSTAN UNDER THE CURRENT CLIMATE CONDITIONS AND UNDER THE CLIMATE CHANGE SCENARIOS (PERCENTAGE)

Humidity Zones	1951–1980	GFDL	GISS	UKMO	CCC	GFDL-T
Hyper-Arid	—	—	4.9	37.8	34.5	22.1
Arid	48.9	58.8	48.2	42.3	40.3	38.2
Semi-Arid	23.5	33.8	25.2	19.9	20.6	29.5
Sub-Humid	27.6	7.4	21.7	—	4.6	10.2

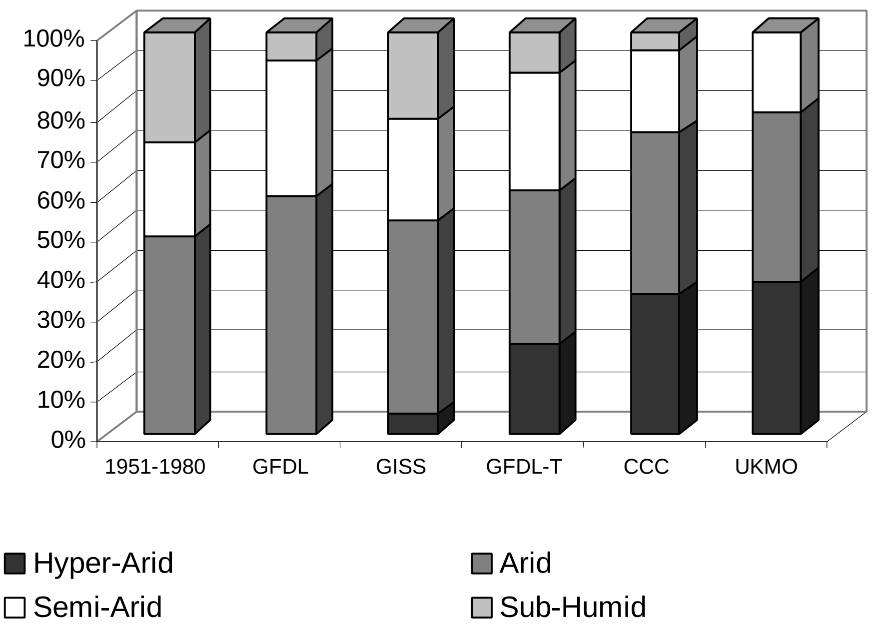
All the models predict the humidity conditions worsening in the region. The sub-humid zone area, where in Kazakhstan the grain-crops are cultivated under the actual climate conditions, will be reduced by 6 to 23%. Under the UKMO scenario, which predicts the maximum warming, the sub-humid zone disappears from Kazakhstan's territory, and the hyper-arid zone arises, which will occupy 38% of the Republic's area. Such a nature of climate change will definitely affect the economy and natural resources of the country.

Besides that, the soils of these zones are exposed to the degradation, which happens as the result of poor land management, and due to climate change. As the studies showed, in Kazakhstan the desertification occurs not only in semi-desert zones, but also in the steppe sub-humid zone, which is the main country's granary, where many desertification features of anthropogenic nature have taken place already. Combination of climate change and the anthropogenic impacts can accelerate these processes considerably in the near future.

2.4.2 *Wheat Production*

Most part of the arable land in Kazakhstan is located in the zone of risk agriculture. Therefore, the yield of wheat, which is one of the main grain crops, can be especially vulnerable to the expected climate change. Spring wheat yield could decrease by 27% under climate change. According to the

FIGURE 2.2 HUMIDITY ZONES PERCENTAGE UNDER THE CURRENT CLIMATE AND CLIMATE CHANGE SCENARIOS



scenario of maximum warming, the yield decrease can reach 70% in some regions. Winter wheat yield can slightly increase, but its cultivation will be possible only on limited areas.

2.4.3 Grasslands

Studies of grassland vegetation vulnerability, without taking into account the effects of the CO_2 fertilizer effect on the biomass growth, have shown that 10-40% increase in grassland vegetation productivity can be expected in spring due to precipitation increase. However, in the second part of the vegetation period the considerable temperature increase will negatively affect natural grasslands. According to the scenario of maximum warming, grassland vegetation productivity will decrease by 30-90% for this period. The plants with the surface root system, which heavily rely on precipitation, will be particularly vulnerable.

2.4.4 Sheep Breeding

Sheep breeding productivity assessment was carried out for the south and southeast regions of Kazakhstan. It was estimated that expected climate change in general would have the negative impact on the sheep-breeding productivity due to both grassland yield decrease and the direct impact of increase in duration of stable hot weather periods on the sheep. According to the different scenarios, these periods duration will increase by 27-57 days. Lambs' output will decrease by 5-25%, and wool productivity will reduce by 10-20%.

2.4.5 Water Resources

Kazakhstan is one of the regions of limited water availability. Kazakhstan's water resources total approximately 121 billion m^3 or 24 thousand m^3 per one square kilometer. The water resources mainly consist of surface water. A surface water resources vulnerability assessment was conducted on case studies for the North and East Kazakhstan river basins: Tobol, Uba, Ulba, Irtysh, and Ishim. The vulnerability assessment with the use of incremental climate change scenarios showed that the present amount of surface water resources might be stable if the air temperature increase by 2-3 °C would be compensated by 20% precipitation increase. The results of the water resources vulnerability assessment with the use of GCM scenarios are presented in Table 2.4. Surface water resources of the Ishim river basin can be most vulnerable. According to the scenario of maximum warming, the surface water resources of the Ishim river basin will be reduced by 73%. The reduction is expected to be 34-37% under the other scenarios. The surface water resources of the other basins will be reduced by 9-29% under the all considered scenarios with the exception the scenario of minimum warming. According to this scenario the surface water resources increase is expected to be about 6% in the most of river basins.

TABLE 2.4 CHANGE IN NORTH AND EAST KAZAKHSTAN SURFACE WATER RESOURCES UNDER POSSIBLE CLIMATE CHANGE

River Basin	Natural Surface Water Resources, million m^3	Surface Water Resources Change under Climate Change Scenarios, %	
		Minimum Warming	Maximum Warming
North Kazakhstan			
Irtysh	29,140	6	-27
Ishim	2,546	-34	-73
Tobol	1,850	25	-9
East Kazakhstan			
Irtysh	33,660	6	-27
Uba and Ulba	8,889	6	-23

Vulnerability studies with the use of outputs of non-equilibrium global circulation model GFDL-T show that in the nearest future under slight temperature increase the surface water resources can increase (in the basins of mountain rivers Uba and Ulba) or their reduction can be insignificant. However, as the climate aridity increases, the tendency for surface water resources reduction predominates. Annual runoff redistribution can occur as well: during the low water period the runoff will increase, during the high water it will decrease. The high flooding probability will also decrease.

The territory of Kazakhstan has a great variety of runoff formation conditions. The study conducted does not cover the whole territory. Particularly, the basins of the glacial-fed rivers are not studied. Therefore, the above results of the water resources vulnerability assessment should not be disseminated throughout the territory of Kazakhstan without the additional studies of water objects in the other regions.

CHAPTER 3. National Greenhouse Gas Emission Inventory

In accordance with Articles 4 and 12 of the United Nations Framework Convention on Climate Change each Party must include in the National Communication national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases, not controlled by the Montreal Protocol "to the extent its capacities permit, using comparable methodologies." The year 1990 is recommended by the UNFCCC to be used as a reference year for the Annexes 1 and 2 countries. For these countries, the UNFCCC requires annual reporting of greenhouse gas inventories, for all others, including Kazakhstan, the 1994 data are recommended to be included into the national communications.

This chapter provides a summary of anthropogenic greenhouse gas emissions and sinks in Kazakhstan in 1990 and 1994, as well as a brief description of the methodologies used to estimate them and the associated uncertainties. The 1990 inventory was compiled with the technical and financial support of the U.S. Country Studies Program. Interim results were presented in a number of articles and synthesis reports published within the framework of the program. Estimation of greenhouse gas emissions and sinks in 1994 and refinement of the 1990 inventory were made under the Netherlands Climate Change Studies Assistance Programme.

3.1 Methodology

The main greenhouse gases are water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and ozone (O_3), which may have either natural or anthropogenic origin. Some other compounds, which are products of human industrial activity, such as chlorofluorocarbons (CFCs) and their substitutes, hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs) and some other compounds are also greenhouse gases. However, the FCCC excludes those gases, since their production and consumption is regulated by the Montreal Protocol.

There are some other gases, such as carbon monoxide (CO), nitrogen oxides (NO_X) and non-methane volatile organic compounds (NMVOC), although not direct greenhouse gases, do contribute indirectly to the greenhouse effect by creating tropospheric ozone, which absorb thermal radiation of the Earth surface. Therefore, these gases should be subjects for an inventory. According to the IPCC assessments as of the end of 1980s, the contribution of carbon dioxide emissions to the enhanced greenhouse effect was estimated at 66%, methane – 17%, nitrous oxide – 5%, the rest 12% was attributed to chlorofluorocarbons.

The main requirement in conducting national GHG inventories is to apply the calculating methodologies agreed upon and adopted by the Conference of the Parties, which ensures international comparability and compatibility of results. The IPCC Guidelines of 1995 were taken as the methodological basis for estimating GHG emissions and sinks while conducting the national GHG inventory. In some cases original methodology was applied (e.g., for calculating emissions from the carbide production) or methodology slightly different from that of the IPCC (for estimating the carbon dioxide absorption by forests). Nevertheless, the main requirements for the methodology of national GHG inventory development were observed.

In accordance with the IPCC Guidelines, Kazakhstan's inventory is divided into five main categories: Energy Activities, Industrial Processes, Agriculture, Land Use Change and Forestry, and Waste Management. The national GHG inventory represents emission data on three gases with a direct greenhouse effect: carbon dioxide, methane and nitrous oxide; and on three gases with an indirect greenhouse effect: carbon monoxide, oxides of nitrogen and non-methane volatile organic compounds[1].

Two approaches were used to estimate emissions of carbon dioxide, the most significant greenhouse gas. In the first case, CO_2 emissions were estimated for each fuel type, based on the total national consumption, and then the values were summed (top down). In the second approach, emissions were estimated for separate sectors and source categories, and then emissions were also summed (bottom up). Usage of these two approaches in the Kazakhstan's inventory allows in the first case to judge about the fuel spectrum of the carbon dioxide emissions, and in the second case – about the sector distribution. In both approaches, the default IPCC emission factors for each fuel type were used. Preliminary estimation shows that difference between the two approaches is about 10%.

Methane emissions were calculated for the fuel industry and for agriculture. To evaluate the amount of emissions from coal mining and hydrocarbon fuel extraction the amount of extracted fuel was multiplied by the emission factor, which depends upon the type of coal mining or upon the stage of fuel processing in the oil and gas sector. Methane emissions from livestock were evaluated by multiplying the livestock population (cattle, sheep, etc.) by the corresponding emissions coefficients. The type of plantations flooding, the area, and rice vegetation period were taken into account for estimation of methane emissions from rice production.

Nitrous oxide emissions from fossil fuel combustion were obtained by multiplying the energy content of coal, oil products, and gas consumed by the corresponding emission factors, given in the IPCC Guidelines. Emissions of indirect greenhouse gases such as carbon monoxide and nitrogen oxides

1 NMVOC emissions were estimated only for 1990

were not calculated, but were taken directly from the national statistical reports since these gases are toxic and are therefore recorded due to the regulations of the Republic of Kazakhstan. NMVOC emissions were possible to estimate only for internal combustion engines in 1990. They were based on the information provided by the Ministry of Transport and Communications.

Data used in the initial GHG emissions inventory for 1990 were provided by the Ministries of Energy, Industry, and Agriculture. Later on, the results of the inventory were refined. In the presented inventory, additional information of the Statistics Agency of the Republic of Kazakhstan about the fuel consumption in 1990 was taken into account.

For the 1994, inventory data were obtained from the Statistics Agency of the Republic of Kazakhstan, Ministry of Energy, Industry and Trade, and Ministry of Agriculture. Due to rapidly changing institutional and economical conditions of the transition period and difficulties in data collection structures, initial data for 1990 and 1994 were not always congruent.

Hence, 1990 CO_2 emissions in the category "Industry" were underestimated due to lack of information on individual subsectors. Transport and residential sector data for 1994 were more detailed than for 1990. Moreover, in the 1994 inventory some categories, for which there is no sufficient substantiation of calculation methodology, were not included. This concerns category "Forest and Grassland Conversion" and calculations of emissions caused by carbide production. On the other hand, for the year 1994 emissions from industrial wastewater could be calculated since required data had been obtained.

Additionally, certain differences in the degree of the initial data comprehensiveness, differences in the information sources, as well as structural reorganization of the economy, that occurred from 1990 through 1994, resulted in that the results of the two inventories on individual subcategories are not comparable. Nevertheless, total emissions and emissions from the main categories are quite comparable and to a certain extent reflect the decline of the national economy during the period of 1990–1994. Furthermore, the GHG inventories both for 1990 and for 1994, are subjects to an improvement and will be updated in light of new data and calculation methodologies.

The IPCC recommends to present the inventory results in both real units and relative units of CO_2-equivalent. The latter are used to compare the various gases emissions contribution to the total emissions and depend upon the value of the global warming potential (GWP).

TABLE 3.1 GLOBAL WARMING POTENTIALS

Greenhouse Gas	Chemical Formula	Lifetime (years)	Global Warming Potential (Time Horizon)		
			20 years	100 years	500 years
Carbon Dioxide	CO_2	Variable	1	1	1
Methane	CH_4	12±3	56	21	6.5
Nitrous Oxide	N_20	120	280	310	170

Source: IPCC (1995).

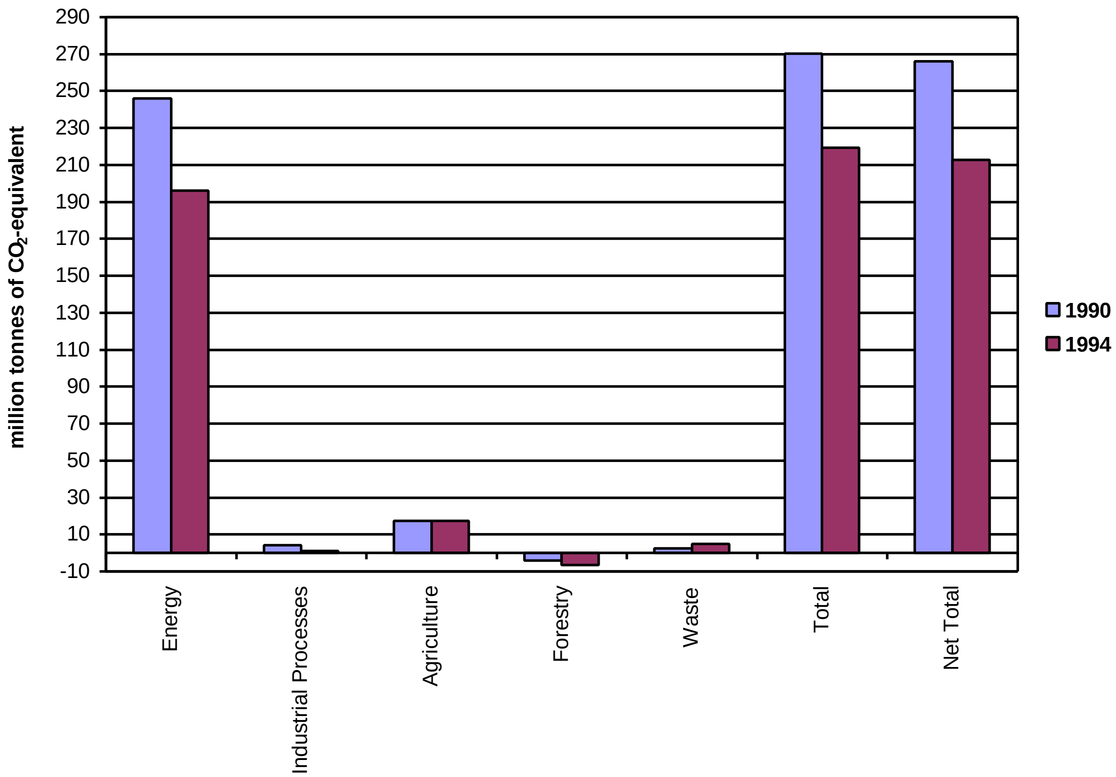
A GWP is defined as the ratio of radiative forcings, accumulated during a certain period of time, caused by emissions of unit mass of the particular greenhouse gas and of the reference greenhouse gas (in this case CO_2). Radiative forcing is the forcing of greenhouse gases concentration increase affecting the changes in the "Earth–atmosphere" energy balance. Hence, by definition, the GWP of carbon dioxide equals to 1. The GWP of a greenhouse gas takes into account instantaneous radiative forcing due to an incremental concentration increase and also the gas lifetime in the atmosphere. Although any time period can be chosen for comparison, in Kazakhstan's inventory 100-year GWPs, recommended by the IPCC, were used. The GWPs for some greenhouse gases according to the IPCC data are given in Table 3.1.

3.2 Total Greenhouse Gas Emissions

This section provides an overview of the greenhouse gas inventory in Kazakhstan for 1990 and 1994. Below, in sections 3.4 to 3.6, data for each gas are presented in more detail.

Figure 3.1 shows total emissions of the most important greenhouse gases by five main categories, recommended by the IPCC: Energy Activities (includes all types of activity related to extraction, transportation, processing and combustion of organic fuels); Industrial Processes; Agriculture; Land Use Change And Forestry and Waste Management. Table 3.2 presents emissions of direct greenhouse gases broken down in a number of main subcategories in CO_2-equivalent. Outcomes of the inventory for all greenhouse gases in absolute units are given in Table 3.3. According to the results of the inventory, total net greenhouse gas emissions in 1990 were about 266 million tonnes of CO_2-equivalent, and in 1994 – about 213 million tonnes. Thus, total GHG emissions in Kazakhstan during this period declined by more then 20% of the baseline level. Specific GHG emissions in Kazakhstan amounted to over 15.9 tonnes per capita, from this amount about 13.6 tonnes are attributed to CO_2.

FIGURE 3.1 TOTAL EMISSIONS OF DIRECT GREENHOUSE GASES IN 1990 AND 1994



Analysis of the results, presented in Tables 3.2 and 3.3 and in Figure 3.1, shows that the most important source of GHG emissions in Kazakhstan is energy activities, which contributed 246 million tonnes of CO_2-equivalent in 1990 and 196 million tonnes in 1994, or 92.4% and 92.2%, respectively. In the "Energy Activities" category, about 84% attributed to emissions from fuel combustion and 7% – to fugitive emissions from the production, transmission, and processing of fuels. Emissions from categories "Industrial Processes" (emissions not associated with fuel combustion in industry), "Agriculture" and "Waste" amounted to 1.6%, 6.5%, and 0.9% in 1990 and 0.5%, 7.9%, and 2.2% in 1994, correspondingly. Absorption of carbon dioxide by forests amounted to about 2.0% in 1990 and 3.7% in 1994 of the total CO_2 emissions. The main sources of the second most important greenhouse gas – methane, are the underground coalmines (40.4% and 27.9% of the total methane emissions in 1990 and 1994, respectively) and agriculture (44.7% in 1990 and 43.5% in 1994).

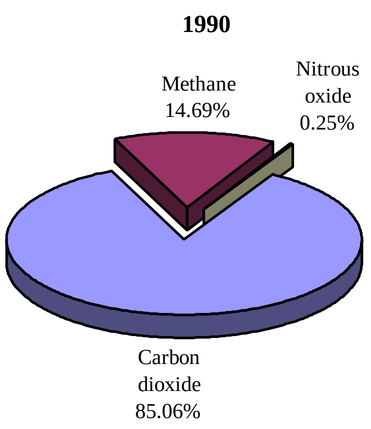
Figure 3.2 illustrates the relative contributions of the three greenhouse gases to total emissions for 1990 and 1994. Carbon dioxide contributes over 80% to total greenhouse gas emissions, the share of methane is about 15-18%, and nitrous oxide's share is less than 1%.

TABLE 3.2 DIRECT GHG EMISSIONS IN 1990 AND 1994 (1,000 TONNES OF CO_2-EQUIVALENT)

Greenhouse Gas Source and Sink Categories	CO_2		CH_4		N_2O		Total	
	1990	1994	1990	1994	1990	1994	1990	1994
1 Energy activities	226,040	178,252	19,236	17,735	651	40	245,927	196,000
Fuel combustion	226,040	178,252	252	39	651	40	226,943	178,304
Fugitive emissions	NA	NA	18,984	17,695	NA	NA	18,984	17,695
2 Industrial processes	4,349	1,014					4,349	1,014
Carbide production	211						211	
Cement production	4,138	1,014					4,138	1,014
3 Solvents	NA	NA	NA	NA	NA	NA	NA	NA
4 Agriculture			17,493	17,387			17,493	17,387
Enteric fermentation	NA	NA	14,553	14,850	NA	NA	14,553	14,850
Animal wastes	NA	NA	1,722	1,096	NA	NA	1,722	1,096
Rice cultivation	NA	NA	1,218	1,441	NA	NA	1,218	1,441
5 Land use change & forestry	-4,011	-6,627	21		3		-3,987	-6,627
Changes in forest and other woody biomass stocks	-4,627	-6,627					-4,627	-6,627
Forest and grassland conversion	616		21		3		640	
6 Waste			2,352	4,811			2,352	4,811
Solid waste	NA	NA	2,289	3,354	NA	NA	2,289	3,354
Wastewater	NA	NA	63	728			63	728
Net national emissions	**226,378**	**172,638**	**39,102**	**39,933**	**654**	**40**	**266,134**	**212,611**

Notes:
NA = not applicable;
CO_2 emissions from biomass burning are not included in national totals, according to the IPCC metho dology;
Empty cells mean not estimated;
Individual values may not add up to totals due to rounding.

FIGURE 3.2 PERCENTAGE SHARE OF MAJOR GREENHOUSE GAS EMISSIONS IN 1990 AND 1994



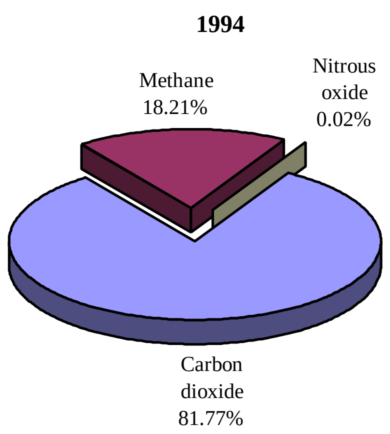


TABLE 3.3 GREENHOUSE GAS EMISSIONS IN 1990 AND 1994 (1,000 TONNES)

Greenhouse Gas Source and Sink Categories	CO_2		CH_4		N_2O		NO_X		CO		NMVOC	
	1990	**1994**	**1990**	**1994**	**1990**	**1994**	**1990**	**1994**	**1990**	**1994**	**1990**	**1994**
1 Energy activities	226,040	178,252	916.0	844.5	2.1	0.13	1,198	165.49	2,966	57.19	260.3	
Fuel combustion	226,040	178,252	12.0	1.9	2.1	0.13	1,198	165.49	2,966	57.19	260.3	
Energy and transformation industries	94,211	74,043			1.0		253	165.03	39	40.77		
Industry	48,187	52,262			0.4		43		623			
Transport	32,471	15,097	6.0		0.6		474		2,016		260.3	
Small combustion	31,171	30,704	0.2				83		167			
Other		6,145										
Biomass	3,182	404	6.0	1.9	0.1	0.13	345	0.47	121	16.42		
Fugitive emissions	NA	NA	904.0	842.6	NA	NA	NA	NA	NA	NA		
Coal mining	NA	NA	752.0	529.9	NA	NA	NA	NA	NA	NA		
Oil and natural gas	NA	NA	152.0	312.7	NA	NA	NA	NA	NA	NA		
2 Industrial processes	4,349	1,014							134		NA	NA
Carbide production	211										NA	NA
Cement production	4,138	1,014									NA	NA
3 Solvents	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
4 Agriculture			833.0	828.0			NA	NA	NA	NA	NA	NA
Enteric fermentation	NA	NA	693.0	707.1	NA	NA	NA	NA	NA	NA	NA	NA
Animal wastes	NA	NA	82.0	52.2	NA	NA	NA	NA	NA	NA	NA	NA
Rice cultivation	NA	NA	58.0	68.6	NA	NA	NA	NA	NA	NA	NA	NA
5 Land use change & forestry	-4,011	-6,627	1.0		0.01		0.1		8		NA	NA
Changes in forest and other woody biomass stocks	-4,627	-6,627									NA	NA
Forest and grassland conversion	616		1.0		0.01		0.1		8		NA	NA
6 Waste			112.0	229.1								
Solid waste	NA	NA	109.0	159.7	NA	NA	NA	NA	NA	NA		
Wastewater	NA	NA	3.0	34.7			NA	NA	NA	NA		
Industrial	NA	NA		29.3			NA	NA	NA	NA		
Domestic and commercial	NA	NA	3.0	5.4			NA	NA	NA	NA		
Net national emissions	**226,378**	**172,638**	**1,862.0**	**1,901.6**	**2.11**	**0.13**	**1,198.1**	**165.5**	**3,108.0**	**57.2**	**260.3**	

tes:
NA = not applicable;
CO_2 emissions from biomass burning are not included in national totals, according to the IPCC methodology
Empty cells mean not estimated
Individual values may not add up to totals due to rounding.

3.3 Carbon Dioxide Emissions

The main source of carbon dioxide emissions is the energy activities, namely combustion of fossil fuels. Figure 3.3 shows the relative sector contributions to carbon dioxide emissions in 1990.

3.3.1 Energy Activities

Fuel combustion activities in Kazakhstan in 1990 produced 226 million tonnes of carbon dioxide (Table 3.2). Of this, from the use of coal, diesel fuel, fuel oil and natural gas was emitted 65, 10, 10 and 8 per cent, respectively. The other carbon dioxide emissions were caused by the use of other fuels, first of all by gasoline. In 1994 carbon dioxide emissions in this category amounted to 178 million tonnes. The relative contributions of various sectors to CO_2 emissions in 1990 are presented in Figure 3.4.

According to the data of the International Energy Agency (IEA), Kazakhstan in 1993 was the largest emitter of energy related CO_2 per GDP in the world and per capita Kazakhstan was 13th largest emitter.

FIGURE 3.3 PERCENTAGE SHARE OF CO_2 EMISSIONS FROM MAIN SECTORS – 1990

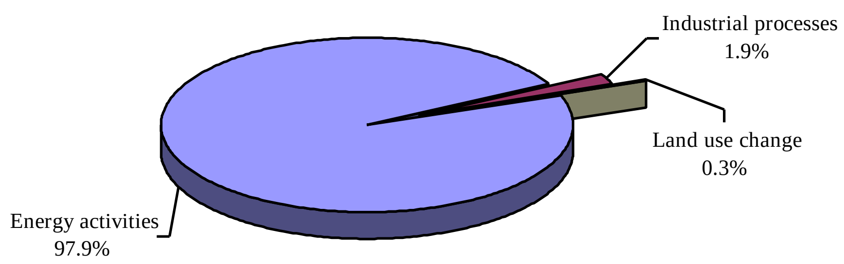
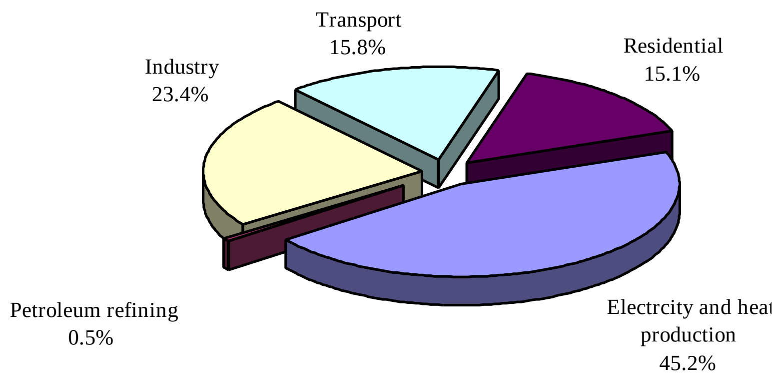


FIGURE 3.4 CO_2 EMISSIONS FROM FUEL COMBUSTION – 1990



Energy-Producing and Oil and Gas Sector

Energy production sector is the main source of CO_2 emissions in this category. Emissions form this sector amount almost to a half of total emissions from fuel combustion. In absolute terms carbon dioxide emissions form enterprises of the Ministry of Energy equaled to 93 million tonnes in 1990 and to 74 million tonnes in 1994. The main feature of Kazakhstan's energy sector is a predominance of coal in the fuel balance and coal has the highest carbon emission factor per a unit of energy content in a fuel. The share of emissions from the coal combustion in 1990 was 80.9%, from the burning of fuel oil and gas – 9.7% and 9.4%, correspondingly. Of eleven enterprises of the oil and gas sector in 1990, practically, only three of them – oil refineries, emitted carbon dioxide. In absolute terms CO_2 emissions from these refineries in 1990 amounted to 1 million tonnes. For 1994 this figure was rather underestimated due to the shortage of data, therefore, these estimates are subjects to revision.

Industrial Processes, Transport and Residential Sector

In 1990 the share of carbon dioxide emissions from industrial sources was about 23%, while transport and residential sector shares were approximately equal, each of them amounting to 15% of the total CO_2 emissions. Data for these categories are subjects to refinement.

In Kazakhstan's inventory separate estimations of carbon dioxide emissions from road, railroad, water and air transport, as well as from construction and agricultural machinery were made. In 1990, CO_2 emissions from transport amounted to 32 million tonnes. Fuel structure of these emissions is as follows: 59.3% was caused by the combustion of diesel fuel, 35.8% – of gasoline, 4.6% – of kerosene, and 0.3% – of aviation fuel. In 1994, CO_2 emissions from transport amounted to 15 million tonnes. The reason for a such difference between the 1990 and 1994 estimations is that the 1990 initial statistical data on the consumption of almost all diesel fuel and gasoline were attributed to the transport sector which resulted in overestimation of emissions from this source.

In Kazakhstan's residential sector, ten different fuel types were used in 1990. The fossil fuel use by the residential sector in 1990 resulted in 31 million tonnes of carbon dioxide emissions. Of this, 86.5% was generated by the combustion of coal, 6.9% – of gas, 4.9% – of residual fuel oil and 1.7% – of other fuels. In 1994, CO_2 emissions from the residential sector amounted to 30 million tonnes.

3.3.2 *Non-Energy Activities*

According to the IPCC classification, non-energy processes include all types of activity not associated with the fuel consumption. The main categories that produce CO_2 emissions are "Industrial Processes" and "Forestry and Land Use Change". Contribution of these sources to the total CO_2 emissions equals to about 2%.

For the first category, carbon dioxide emissions from cement and carbide production were assessed. In the first case, the IPCC default factor was used for estimation. In the second category, estimation was performed on the basis of the chemical process of carbide production. For CO_2 emissions estimation from the latter source an original methodology was applied. CO_2 emissions from industrial processes in 1990 totaled to 4.3 million tonnes, from which 4.1 million tonnes or 95% were caused by cement manufacture and 0.2 million tonnes (5%) – by carbide production. For 1994, emissions from carbide production were not estimated.

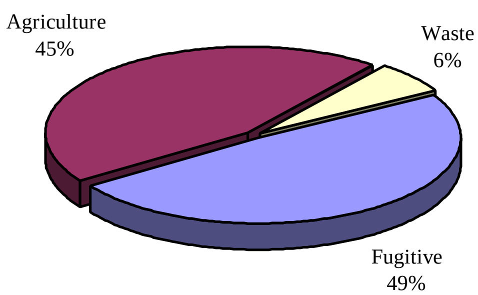
In the "Forestry and Land Use Change" category forest fires were considered as a source of CO_2 emissions, although this source is not covered by the IPCC methodology.

According to the estimations, carbon dioxide emissions caused by the forest fires were 616.2 thousand tonnes, 32.9% of which were caused by burning itself and 67.1% – by the residual biomass decomposition at firesides. Such estimation for 1994 was not performed.

3.4 Methane Emissions

Methane emissions amounted to 1.86 and 1.90 million tonnes in 1990 and 1994, respectively. It should be noted that the calculated emissions for 1990 were slightly underestimated because emissions from the oil and gas sector were not taken into account. Figure 3.5 illustrates the relative sector contributions to methane emissions for the year 1990. The main sources of methane emissions in Kazakhstan are extraction and processing of coal, oil, and gas – 49% and 44%, agriculture – 45% and 44%, and waste – 6% and 12% in 1990 and 1994, respectively.

FIGURE 3.5 CONTRIBUTION OF DIFFERENT CATEGORIES TO TOTAL METHANE EMISSIONS – 1990



3.4.1 *Fugitive Emissions*

According to the estimates, methane emissions from extraction, transportation, processing and utilization of oil and gas in 1990 amounted to 152 thousand tonnes, of which 95% emitted from gas systems, and 5% are oil-related emissions. This figure in 1994 amounted to 313 thousand tonnes. Such a difference can be explained by the fact, that methane emissions from oil loaded into tankers and processed at oil refineries, as well as emissions generated during transportation and distribution of natural gas, were estimated for the 1994, but were not estimated for 1990. Methane emissions from coal mining were obtained by summing emissions from underground and surface mines. The total amount of methane emitted to the atmosphere in Kazakhstan in 1990 as a result of coal mining equaled to 751.7 thousand tonnes, of this 84% are from underground mining and 16% – from surface mining. Total fugitive emissions in Kazakhstan amounted to 904 and 843 thousand tonnes in 1990 and 1994, correspondingly. In 1990, 83% was emitted by the coal industry and 17% – by the oil and gas sector; in 1994, this ratio changed to 63% and 37%, respectively.

3.4.2 *Agriculture*

Cumulative methane emissions from agriculture totaled to 834 thousand tonnes in 1990 and to 828 thousand tonnes in 1994. Of this amount, 93% (92% in 1994) was from livestock and 7% (8% in 1994) was from rice fields. Emissions from livestock amounted to 775 thousand tonnes in 1990 and to 759 thousand tonnes in 1994. Emissions were mainly from enteric fermentation – 89% in 1990 (93% in 1994) with animal waste contributing 11% in 1990 (7% in 1994). 37.1% of livestock methane emissions in 1990 were produced by meet cattle, 31.3% – by dairy cattle, 24.4% – by sheep breeding, 4.2% – by horse breeding, and 3.0% was contributed by pig breeding, poultry farms and camel breeding. Anaerobic (without air) decomposition of organic substance at periodically flooded rice fields with the total area of 120 thousand hectares caused 58.2 thousand tonnes of methane emissions in 1990 and 68.6 thousand tonnes in 1994.

3.4.3 *Waste Management*

According to the IPCC default factors / data, per 10 million of Kazakhstan's urban population in 1990 there were 1,847 thousand tonnes of waste, 80% of which was disposed on land. Taking into account carbon content fraction in wastes and actual decomposition fraction it was assessed that in 1990 methane emissions from solid waste accounted to 109 thousand tonnes. Only 10% of wastewater were anaerobically decomposed in the wastewater treatment facilities, which caused 3 thousand tonnes of methane emissions. Total methane emissions in Kazakhstan from waste management in 1990 (not including industrial wastes) accounted for 112 thousand tonnes, 97% of which from solid waste disposal and 3% from wastewater treatment. Emissions from industrial wastewaters were not included into the 1990 inventory, by were estimated in the inventory for 1994. Methane emissions from the “Waste Management” category in 1994 amounted to 229 million tonnes, 85% of which fall to solid wastes, and 15% to liquid wastes.

3.5 Other Emissions

In Kazakhstan's 1990 inventory cumulative emissions of nitrous oxide, carbon monoxide, oxides of nitrogen and NMVOC were estimated, which amounted to 2; 3,108; 1,198 and 260 thousand tonnes, correspondingly. For 1994, N_2O, CO and NO_X emissions were estimated only for a few sources. Emissions of non-methane volatile organic compounds for 1994 were not estimated. The main source of indirect greenhouse gases is transport (Table 3.3).

3.6 Carbon Dioxide Sinks

Carbon dioxide uptake by forests in 1990 amounted to 4.6 million tonnes that makes up approximately 2% of total GHG emissions in Kazakhstan. The amount of wood harvest reduced considerably in 1994 in comparison with 1990. With the unchanged forest area, this resulted in increase of CO_2 uptake by the biomass stocks in 1994 to 6.6 million tonnes, which represents 3.7% of total emissions in 1994.

3.7 Uncertainty Assessment

According to the results of the uncertainty assessment of the Kazakhstan's inventory, errors of the emission estimations, associated with errors in initial statistical data for the energy sector is estimated to be equal to 5-20%, except for the residential sector, where errors may exceed 20%. For the energy production sector, which is responsible for almost a half of all GHG emissions, error does not exceed 5%.

Fugitive emissions were estimated with the level of uncertainty of 60%. Methane emissions from enteric fermentation in the livestock breeding were estimated with the 25% error. For the rest categories, the level of uncertainty varies from 20 to 80%.

3.8 Carbon Dioxide Emission Projection

At the moment, it is difficult to provide a reliable long-term projection of GHG emissions. Baseline scenario of CO_2 emissions, that is the emissions dynamics, which assumes no mitigation measures to be implemented, for Kazakhstan, as a transitioning country, will not be consistent with long-term trends. This projection will be determined, first of all, by long-term projections of the Kazakhstan's economy development and of the energy use efficiency, construction of these projections, in its turn, is a rather complicated task. A projection of CO_2 emissions from the energy-

TABLE 3.4 CO_2 EMISSIONS FROM ENERGY PRODUCTION SECTOR (MILLION TONNES)

Actual emissions		Projected emissions				
1990	1994	2000	2005	2010	2015	2020
94	74	67	83	93	118	129

producing sector until 2020 was constructed with the use of the energy planning model ENPEP, developed by Argonne National Laboratory (USA). In a general view, the projection of CO_2 emissions is based on the long-term projection of socio-economical development. It is a function macro-economic indicators such as GDP, energy use efficiency in industry (specific energy consumption per GDP), demand on different types of energy-carriers and factors of CO_2 emissions caused by the use of these energy-carriers. In other words, some assumptions in projecting of the economy development, structure and volumes of energy use in the national economy are inevitable. The CO_2 emissions projection was made according to the maximum energy demand projection. In accordance with the preliminary estimations, CO_2 emissions in 1996–1998 reduced on about 40% of the 1990 level. The CO_2 emission projection (Table 3.4 and Box 2 – baseline scenario) shows that emissions will reach the level of 1990 by the year 2011, and by 2020 will exceed base level on 37%. Total GHG emission projections will be constructed with taking into account new macro-economic projections.

CHAPTER 4. Measures on Greenhouse Gas Emissions Reduction and Adaptation to Climate Change

Greenhouse gas mitigation and adaptation measures were evaluated and developed in accordance with Kazakhstan's long-term national priorities which are to improve its people's welfare, based on sustainable development, improvement of infrastructure, increase in economic growth and preservation of the environment.

Implementation of actions like these is a comprehensive mission of a national scope and requires coordinated actions of ministries and government agencies, non-government organizations and the public. In Kazakhstan, as in any transition country, climate change is only a priority to the extent that it is related to the general national conception of the sustainable development and preservation of the environment.

Tables 4.1 and 4.2 present the sectoral priorities for mitigation and adaptation measures that were recommended to be included in the national action plan for the UNFCCC.

TABLE 4.1 PRIORITY SECTORS AND MEASURES ON CLIMATE CHANGE MITIGATION

Priority sectors and subsectors	Measures
Energy	To develop enabling mechanisms to implement the energy-saving policies
Energy production	To improve efficiency of fuel utilization at power stations To include renewable sources of energy into the energy balance To increase the natural gas share in the energy balance
Energy consumption	To increase the energy efficiency of energy savings in the industry Energy saving in residential sector and district heating improvements
Agriculture	To increase the livestock productivity and to optimize the livestock population To take less productive land out of crop rotation, to intensify grain production
Forestry	To increase the area covered by forests

TABLE 4.2 PRIORITY SECTORS AND MEASURES ON ADAPTATION TO CLIMATE CHANGE

Priority sectors	Measures
Agriculture	Clarification and drafting of legislation for transition of the agricultural sector of the Republic to a market economy
	Improvement of less productive lands in arid and semi-arid zones and reduction of soil erosion
	Development and distribution of long-term forecasts on agricultural pest and disease outbreaks for planning, procurement and pesticides utilization purposes
	Establishment and maintaining at the modern level regional centers on genetic varieties for spring and winter wheat
Water resources	To support development of modern technologies for the sectors of economy, which use water resources
	To implement water-saving measures
	To mitigate the negative impact of the water resources vulnerability to the sectors of the economy
	To implement nature conservation measures
	To reduce social losses
	To increase the decision-making efficiency

4.1 Evaluating and Developing Measures

Selection of the priority GHG mitigation and adaptation measures for each sector was based both on expert judgments from the lead agencies and on results of Kazakhstan Country Studies work. The team also evaluated existing programs and plans to identify measures that could be integrated into the national action plan. This information was discussed at several expert meetings. The final decision about high-priority GHG mitigation and adaptation measures and options was made at the scoping meeting of the NAP UNFCCC development. Stakeholders from different ministries and departments took part in that meeting.

Several criteria were used to screen and evaluate mitigation and adaptation measures. The main criteria used to select mitigation measures included opportunities for integration with current sectoral and sustainable programs, the extent of the GHG mitigation potential, the cost of emissions abatement, the cost effectiveness of implementation, other environmental impacts, and ease of implementation.

Criteria used to evaluate adaptation measures included the priority of the measure for Kazakhstan, the effectiveness of the measure both in current and expected climate, the existence of other benefits stemming from the measure, implementation costs, and administrative, legislative, market and other barriers.

Kazakhstan's energy development programs focus on energy savings in the electric power, district heating, and industry sectors. All of these sectors are significant sources of GHG emissions. Therefore, they were assessed to be included into the NAP UNFCCC. The methods of technology assessment include conducting a review of technology performance and implementation analysis of renewable energy (hydropower, wind systems, and solar energy) and energy efficiency in industry and power generation. An in-depth evaluation, including a cost-benefit analysis, of chosen mitigation measures has been completed for selected measures in the energy production sector and district heating based on the ENPEP model and the NREL methodology for the Economic Evaluation of Energy Efficiency and Renewable Technologies.

An in-depth evaluation, including a cost-benefit analysis, of several selected adaptation measures has also been conducted in priority sectors. The methodology used is a cost-effectiveness analysis that incorporates several tools – including tables and decision matrices – for screening, evaluating, and selecting adaptation measures for sectors vulnerable to climate change. This methodology was provided through the US Country Studies Program.

4.2 Proposed Greenhouse Gases Mitigation Measures

Kazakhstan has a high potential for reducing the amount of the GHG emissions. In the energy sector, which is the main source of GHG emissions, it is determined by the high energy-output ratio in the industry and the high energy-saving potential in all sectors of the economy. Non-energy sectors have certain reduction potential as well.

Guided by the priorities, set forth at the NAP UNFCCC development seminar, basing upon estimation of costs and GHG emissions mitigation potential for specific scenarios, as well as having analyzed barriers for their implementation, certain priority actions were proposed to be included into the NAP UNFCCC. At the given stage priority actions were chosen basing on the time frames provided in the Plan of Priority Actions of the Ministry of Ecology and Natural Resources, adopted by the Government.

4.2.1 Energy Sector

The GHG mitigation measures in the energy sector are directly connected with the overall energy sector development strategy and the National Program on Energy-Saving. The mitigation action plan in the energy sector will focus on electric power, district heating, households and industry. These subsectors were chosen on the basis of the following criteria: they have high rates of energy consumption, they have a viable future, they are important to the economic development of Kazakhstan, or they have export potential.

Table 4.3 presents a summary of the specific mitigation measures and information about current pilot projects in energy sector. Costs for some measures are preliminary; they are currently under determination. The annual reduction in gases is given in amounts of the specific greenhouse gas in question.

BOX 1. Energy Saving Potential

A significant factor to reduce CO_2 emissions will be implementation of comprehensive fuel-saving or energy-saving measures. The energy-saving potential is immerse in Kazakhstan. The absolute value of the energy-saving potential is calculated as the difference between the specific energy intensity in Kazakhstan and that in developed countries multiplied by the value of the gross domestic product (GDP). The specific energy intensity of the GDP in Kazakhstan equals to 1.03 tce / 1,000 USD; specific energy intensity (average weighted) in the OECD countries equals to 0.39 tce / 1,000 USD. If the level of the specific energy intensity in the developed countries being achieved, the absolute energy-saving potential of the Republic of Kazakhstan will amount to 61.51 million tce, it means prevention of about 170 million tonnes of CO_2 emissions.

In Kazakhstan, in co-operation with USAID, the National Energy-Saving Program was developed and approved by the Resolution of the Government, provisions of the Program being taken into account in assessing the perspective demand for electricity.

Implementation of actions already outlined in the National Energy-Saving Program of the Republic of Kazakhstan could allow to reduce the fuel consumption by 25% as the result of implementation of the short and medium-term action program and by 40% – as the result of implementation of the long-term program.

The first stage of realization of the energy-saving potential (1995–2000) should be provided primarily through streamlining nominal regime operations of enterprises and eliminating direct waste in energy utilization. This stage will not require any substantial investments. The desired impact will be achieved by proper organizational and technical arrangements. The following-up periods will require crucial r estructuring.

Thus, energy-saving potential due to elimination of direct waste of electricity and thermal energy is estimated to amount to 0.7 million tonnes of coal equivalent, the emissions abatement potential amounting to 2.1 million CO_2, in the electricity and energy generation – over 10 million tonnes of CO_2 (3.7 million tonnes of coal equivalent) with 2.7 million tonnes of CO_2 emissions reduction due to lowering electricity consumption for the electricity transportation along the grid-lines, due to rehabilitation of the existing equipment – about 1 million tonnes CO_2. Cumulative energy-saving potential requiring minimum implementation costs is estimated as 15.8 million tonnes CO_2.

TABLE 4.3 SUMMARY OF PRIORITY MEASURES IN ENERGY SECTOR

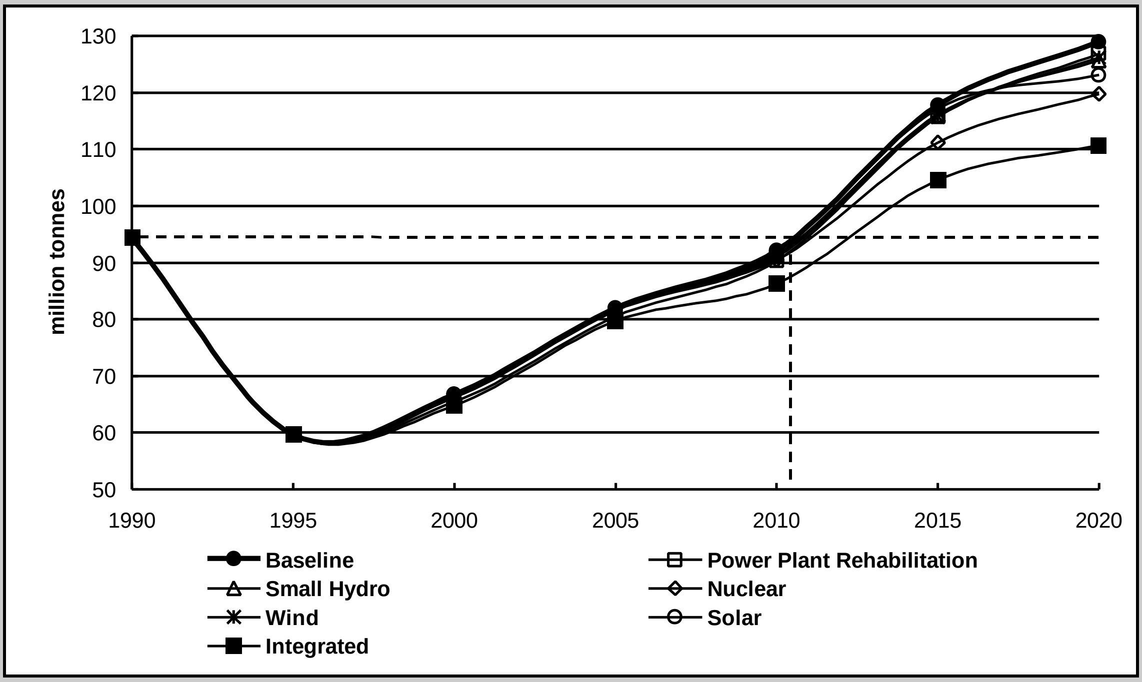
Measures	Annual CO_2 Reduction Potential, million tonnes		Annual CH_4 Reduction Potential, million tonnes		Cumulative CO_2 Reduction over 2000–2020, million tonnes	Total Funding Required, million USD
	2005	2020	2005	2020		
Development of mechanisms to implement the Law on Energy-Saving	NA	NA	NA	NA	NA	0.5
Energy efficiency increasing at fossil-fuel power plants, energy saving and district heating improvement:						
Modernization and rehabilitation of power plants	1.76	2.33	0.17	0.19	40	1,061
Energy saving and district heating system improvement:						
pilot phase	TBD	0.08	TBD	TBD	0.16	0.814 by 1999[a]
set of measures	TBD	0.70	TBD	TBD	TBD	TBD
Small hydro	0.14	3.74	0.02	0.28	20	578
Wind	0.63	3.13	0.07	0.22	29	0.482 by 1999[a] 937
Solar:						
Thermal systems	0.6	0.6	—	—	—	931
Photovoltaic systems	0.20	1.74	0.02	0.37	18	
Utilization of associated gas	TBD	2.7	TBD	TBD	TBD	TBD

Notes:
[a] pilot phase implementation with GEF support;
TBD = to be determined;
NA = not applicable.

BOX 2. GHG Mitigation Analysis

In the mitigation analysis, various energy-generating technologies were evaluated using the ENPEP model of the Argonne National Laboratory (USA). Taking into account availability of the natural resources in Kazakhstan, existing research and technical works, and expert studies of the Ministry of Energy, various energy-generating technologies were evaluated with regard to their possible contribution to the reduction of CO_2 emissions and costs of emission abatement. Among these options were extension and rehabilitation of cogeneration power plants, use of nuclear, wind, solar energy, and extended use of hydro energy. Almost all of considered technologies (except nuclear energy) have been included either in the Energy Saving Program or in programs on energy development measures. All technologies were evaluated against the baseline scenario, which is a scenario without any mitigation measures taken into account.

FIGURE. CO_2 EMISSIONS FOR THE BASELINE AND MITIGATION SCENARIOS



As it could be seen at the picture, according to the baseline scenario CO_2 emissions reduction will reach about 40% of the 1990 level by 1998. The baseline CO_2 emissions projection shows that the emissions will reach the 1990 level in 2011 and exceed this level on 37% in 2020. Development of the nuclear-based energy sector may result in the most significant reduction in the CO_2 emissions. According to the "Nuclear power station" scenario, in comparison with the baseline scenario, the annual emissions abatement will amount to 1.9%, 3.8%, and 7.1% in the years 2010, 2015, and 2020 correspondingly. Power plants rehabilitation may reduce the CO_2 emissions to 1,609 Gg in 2000 and to about 2,330 Gg in 2020, which equals to 2% of the baseline level. The "Small Hydro" and "Wind" scenarios' annual CO_2 emissions reduction potential equals to 0.2 and 2.6% in 2000 and 2020 correspondingly. The total annual potential for CO_2 emissions reduction due to implementation of all the options ("Integrated scenario") considered increases from 3% in 2000 to 11% in 2020.

Total cumulative CO_2 emissions reduction potential for the period 2000–2020 is about 158 million tonnes. Costs of implementation of all the measures would amount to about 5 billion USD. Rehabilitation of power plants and introduction of small hydro power plants are the most cost effective measures. Nuclear energy development is the most expensive one, but it has high GHG emissions mitigation potential.

Below a short description of measures to reduce the GHG emissions in the energy sector proposed to be included into the NAP UNFCCC is given.

Designing Enabling Mechanisms to Implement the Law on Energy-Saving

One of the major barriers to development of energy-efficient and energy-saving technologies and renewable energy in developing and transition countries is the lack of the legislative framework or properly fine-tune enabling mechanisms for its implementation. In the case of Kazakhstan, the legislative framework is formed by the Law of the Republic of Kazakhstan on Energy-Saving adopted in December 1997. This Law declaratively covers all the aspects of energy saving in both energy production and energy consumption sector, including increase of energy efficiency and development of renewable energy. The Low defines the framework for governing the energy-saving policies at the national level. As of today, however, the enabling mechanisms for implementation of the Law have not yet been fully developed, which is one of the priority objectives of the Energy-Saving Program implementation and the priority line in the GHG emissions reduction.

Enabling mechanisms for implementation of the Law should be developed in several stages. It should cover establishment of an authorized and implementing agency, development of the regulatory framework, designing details for the program implementation at the level of certain regions, the program implementation and monitoring, as well as replication of the learned experience in other regions of Kazakhstan. To develop the program design and implementation Kazakhstan will require technical support from international and donor institutions. Total cost required is estimated about 500,000 USD.

Energy Efficiency Increasing at Fossil-Fuel Power Plants, Energy Saving and District Heating Improvement

The most effective modern trends in *energy efficiency increasing at fossil fuel power plants* are as follows:

- further development of cogeneration of electricity and heat on the combined cycle (to replace the divided condensed cycle of electricity and heat generation). It could be achieved by construction of new power plants with modern efficient equipment; replacement of condensation turbines by thermal ones at operating power plants; and transference of condensation turbines for the lowering vacuum regime (that is, their modernization);
- improvement of thermal schemes of power plants and, in particular, establishment of steam and gas power plants through both construction of new power plants and construction of gas turbine block “superstructures” at the existing steam-turbine power plants.

According to the GHG mitigation assessment, these measures will allow to reduce annual CO_2 emissions by 1.6 million tonnes by the year 2005 and by approximately 2.3 million tonnes by the year 2020. Cumulative CO_2 emission reduction for the whole period will amount to 40 million tonnes. This scenario is characterized by relatively low cost of CO_2 emissions reduction. To implement the whole program of improving the efficiency of fuel utilization at the power plants, presented in the Strategy for the energy sector development, will require 400 million USD by the year 2005, amounting to 1 billion USD by the year 2020. This option was included as the main priority for medium and short-term measures in the electricity generation sector.

Studies showed that some of the best opportunities for *energy-efficiency savings and district heating improvement* and consequent CO_2 reductions come from improvements in heating boilers, district-heat distribution pipelines, heating system controls in buildings, and building insulation. The existing opportunities to save 25-35% are technically feasible and economically cost-effective.

According to studies on selected typical particular boiler house in Almaty (Box 3), implementation of such

BOX 3. The Pilot Project in Heat and Hot Water Supply

The GEF project "Capacity Building to Reduce Key Barriers to Energy Efficiency in Heat and Hot Water Supply" started in Kazakhstan in July 1998. The objective of this project is to remove barriers towards greater energy efficiency in hot water and heat supply in Kazakhstan, thereby lowering overall fossil fuel consumption and reducing the need for new fossil fuel based district heating plants and the associated greenhouse gas emissions. The project objectives shall be achieved by means of: (a) development of the consumption payment-based measurement system, which will be attractive for consumers; (b) study and demonstration of technical, economic, institutional and other possibilities of developing the energy system in heat and water supply; (c) capacity building in economic and financial projects analysis needed for further financing of the energy efficiency raising projects. The project development budget is 814,000 USD, UNDP/GEF share in the project funding amounts to 602,000 USD, the government of RK has agreed to contribute to the project 212,000 USD in kind. Expected duration of this project is 24 months.

The project, which have been completed with support of the USAID, was aimed to develop project proposal for improving energy efficiency at the particular Northeast Boiler House in Almaty, Kazakhstan. The project is being proposed for consideration as a GHG mitigation measure. As a result of the project, a list of possible energy efficiency and energy saving options for the boiler house was prepared and the options were prioritized in accordance with established screening procedure. The project consists of (1) installation of a gas turbine cogeneration system, (2) installation of automation and monitoring equipment, (3) installation of heat recording equipment, and (4) energy efficiency upgrades of the steam and hot water heating distribution system. The technology retrofits have a high potential for replication throughout Kazakhstan. It was estimated that the total cumulative CO_2 emissions reduction for the period of 2010–2020 due to similar measures introduction is about 50% of the baseline case or about 1 million tonnes.

measures in supply side as installation of a gas turbine cogeneration system, and automation and monitoring equipment, installation of heat recording equipment, and energy efficiency upgrades of the steam and hot water heating distribution system could reduce CO_2 emission reductions by about 40% annually. The technology retrofits replication throughout Kazakhstan could lead to about 1 billion tonnes by the year 2020.

To estimate the total amount of CO_2 emissions reduction potential and the funds required for whole set measures both in supply and demand sides the pilot GEF project has been recently initiated (see Box 3).

Increasing of the Use of Renewable Energy

Small Hydro Power Plants

The energy sector development strategy up to the year 2030 outlines river basins and regions most promising for constructing small hydro power plants. Even at the present moment it is feasible to construct about 23 small hydro power plants with the 600 MW total capacity and annual production of 1.3–1.5 TWh. Besides, about 300 channels for small hydro power plants were identified for the possibility of establishing facilities with the total capacity of 1,600 MW and annual production of 5 TWh.

With the implementation of this measure, a GHG emission annual reduction potential is estimated at 0.2 and 3.7 million tonnes by the years 2000 and 2020 correspondingly. Small hydro power plants is the only option able to result in reducing the electricity prices and saving funds up to 0.4 billion USD during the period from 2005 through 2020, or 24 million USD every year in comparison with the baseline scenario. Total sum of all the necessary funds required to install all the small hydro power plants projected by the energy sector development strategy will amount to about 17 million USD in 2005 and to 578 million USD in 2020. Development of hydro energy has positive social impact. Thus, for instance, it will allow increasing the electricity stock in the Southern and SouthEastern parts of Kazakhstan experiencing great deficit of electricity.

The Government's Plan of Priority Actions – as one of the priority tasks of including small rivers hydro-energy resources into the Kazakhstan energy balance – identifies creation of infrastructure and construction of five demonstration small power plants in four oblasts of Kazakhstan: South-Kazakhstan, Almaty, East-Kazakhstan, and Zhambyl. Implementation of these measures is estimated to cost 10 million USD.

Wind Energy

According to the research works performed, nine regions were identified in Kazakhstan as the most suitable for development of the wind energy – these are the regions characterized with the wind speed exceeding 8 m/s. As for the wind resources of the Dzhungar Gate, the wind speed there sometimes exceeds 60 m/s. As one of the priorities, additional 7 wind power plants can be proposed with the 530 MW cumulative capacity and annual production of 1.8–2.0 TWh. In addition to opportunities of installation of large wind facilities there is a considerable potential small wind power facilities market with the capacity range from 3 to 50 kW, first of all, in the zones of decentralized water supply, in the remote areas characterized with the high costs of delivery of fuel for electricity and heating supply.

GHG emissions reduction potential of this measure is estimated to be from 0.7 to 3.1 million tonnes. Required funds total to 223 million USD and 1 billion USD by the years 2000 and 2020 correspondingly. Developing wind energy is one of the most supported and sustainable options for the long-term energy sector development program in Kazakhstan. Its development, though, requires strong governmental support. According to the energy sector development strategy, economies of scale are envisaged to reduce the cost of producing this type of energy and to move it closer to the traditional sources.

Solar Energy

According to the estimates, implementation of the measures aimed to develop *photovoltaic technology* at the initial stage may annually reduce the amount of the GHG emissions by 0.9% of the baseline scenario. Installation of solar plants, besides, could reduce imports of electricity in the Southern regions. At the same time, it is a rather expensive option. The sphere of utilization of these plants, therefore, will be limited to remote and difficult to access areas and to consumers requiring small capacities.

Solar water heaters with the capacity of 1 kW in average per day may heat 80 liters of water to 40°. On the basis of these figures, the ultimate CO_2 emission reduction can be estimated as 331.7 tonnes/year. It is very promising and feasible option. The *Government Plan of Priority Actions provides for implementation of actions* aimed to develop solar energy, envisages identification of priority regions for development of solar energy and designing pilot projects.

Increasing the Natural Gas Share in the Energy Balance

At present, the amount of associated gas burnt in flares at oil fields is estimated to be approximately 740 million m^3. Experts estimate the mitigation potential of associated gas utilization for energy purposes to be 2.7 million tonnes of CO_2 per year. Among the other priorities, the *Plan for Priority Actions* of the Ministry of Ecology declares projects for utilization of associated gas at the "Prorva" and "Kumkol" deposits through designing and constructing gas-turbine units using associated gas. Implementation of these plans will require attracting funds from both foreign owners of corresponding deposits and budgets of local and central governments.

BOX 4. Dzhungar Gate wind power plant project

The objective of the full-scale GEF project "Removing Barriers for Wind Power Production in Kazakhstan", which has been implementing since June 1997, is to remove barriers to commercial scale, grid-connected wind power production in Kazakhstan thereby reducing the need for new fossil fuel based power plants and the associated greenhouse gas emissions. The project is expected to achieve this goal by: (i) strengthening institutional capacity for research, planning and technology transfer related to wind power production; (ii) reducing the uncertainties on costs and various technical issues related to wind power production; and (iii) demonstrating the feasibility of wind power production in Kazakhstan: and draw attention of the potential future on the results of these studies in order to get the necessary political and financial support to move towards larger commercial scale applications. Expected CO_2 reduction in the result of the project implementation is about 150 Gg per year.

Energy Consumption Sector

All the reviewed above actions, many of which relating to the energy generation sector, have certain energy consumption actions closely connected with them. The major consumers of energy in Kazakhstan are the industrial complex, municipal and utility services and agriculture. A significant factor to reduce the energy consumption in the industrial and utilities sectors – and thus to reduce the CO_2 emissions – is to implement the complex of fuel- and energy-saving measures (see Box 2).

The most energy-intensive industries in Kazakhstan are mineral fertilizer production and ferrous metallurgy; energy efficiency increasing measures in these sectors, therefore, could be seen as the most important actions for the energy consumption sector. In this area, the deep-in analysis of mitigation technologies and design of specific pilot projects for industrial enterprises is required. Technical programs in the housing and utilities sector envisage a complex of energy saving and district heating systems improvement measures. This complex of measures will include installation of the heat and gas consumption control and recording systems in the housing sector, automation of the heating systems through installation of thermostats, improvement of isolation of buildings and adoption of new construction standards for newly constructed dwelling industrial buildings. The UN Development Program / Global Ecological Fund project having been implemented since July 1998 represents the first pilot stage of capacity building measures aimed to increase the efficiency of utilization of energy in the central heating and hot and cold water supply systems in Kazakhstan (see Box 3).

BOX 5. Development of the Technology Transfer Mechanisms

Main objectives for possible technology cooperation framework (TCF) are determining the most effective domestic activities and the mechanism of supporting domestic activities to develop sustainable businesses and markets to support development, adaptation, and use of energy efficiency and renewable energy technologies. This mechanism should also provide communicating climate change technology cooperation needs to international donors and securing funding for renewable energy and energy efficiency projects.

First step in the TCF development was determination of priority areas and technologies. By the time consensus within the country on the priority for international cooperation to achieve reductions in greenhouse gases has been achieved. Priority selection was made at the first national scoping meeting on the NAP UNFCCC development (Almaty, April 1997). To draft technology cooperation framework, the priorities were specified at the scoping meeting on TCF development (Almaty, October 3, 1997). The outputs of the meeting were presented by team members during the workshop hold by NREL to further develop the matrixes (Golden, November 17-21, 1998).

The priority areas selected for increasing the use of renewable energy and energy efficiency technologies are as follows.

1. Power Plant Carbon Efficiency Program (Fuel Switching, Combined Cycle Gas, Improved Heat Rate)
2. Energy Saving and District Heating Improvements
3. Small Hydro
4. Wind Power
5. Solar Thermal and PV Systems

Preliminary results on TCF development was presented at the Third UNFCCC Conference of Parties in Kyoto.

4.2.2 *Non-Energy Sector*

Priorities for reducing the GHG emissions not related to burning fuel were selected pursuant to the national programs and development strategies in the area of agriculture, forestry, ecology and environment protection. The information on mitigation measures in the non-energy sector is presented further below.

Increase of the CO_2 Uptake from the Atmosphere

The main opportunities for increasing the CO_2 uptake exist at the limited part of the Kazakhstan's territory between 51° and 57° N where about 40 million ha of arable lands and 10 million ha of forests are located.

Afforestation and Forest Preservation

In 1990 the forest covered 3.7% (9.6 million ha) of total territory of Kazakhstan. Based on the data available, Kazakhstan's forests sequestered 4,011 Gg of CO_2. According to the Program "Forests of Kazakhstan", forest cover should be increased to 4.6% of the country by 2010, and to 5.1% by 2020. The areas (about 3.8 million ha) are to be planted mostly with mixed softwoods. This would eventually increase sequestration by forests up to about 6,000 Gg of CO_2. The cost of implementing this option is estimated as 35 million USD. Foreign investment would be necessary to implement this measure.

Projects, approved by the Government for further development – "Organization of the Ecological and Resource Monitoring of Forests" and "Afforestation and Reforestation for the Sake of Biodiversity and Biocenosis Restoration and Preservation (at the area of 200 thousand hectares)" could be seen as pilot projects in increasing the CO_2 uptake from the atmosphere.

Converting Low Productive Lands into Grasslands and Rangelands

Soil and climatic conditions of the majority of regions in the northern oblasts of Kazakhstan support sustainable production of grain. In some regions, wheat is grown not only in the steppe and arid-steppe zones, but even in the desert-steppe zone on light-chestnut and gray-brown desert soils. The soil and climate of that area allows a wheat yield of no more than 0.5-0.6 Mg ha^{-1}. Reducing arable areas at less productive lands with corresponding intensification of grain production will be economically profitable, the proper conditions being observed. The available areas should be planted with perennial grassy and bushy vegetation for 7 or 8 years. After that, carbon will re-accumulate in the soil. The expected range of annual carbon re-accumulated in the soil varies from 308.7 Gg to 674.9 Gg depending upon the square of reduced arable area.

Less productive rangelands and grasslands between 45° and 51° N also possess certain CO_2 sinking potential. Extensive exploitation of natural resources without taking into account the balance interrelation between exploitation and preservation has resulted in various degree of degradation of over 60 million ha of rangelands, including 48 million ha because of uncontrolled grazing. There are two ways to bring these lands into economic utilization: to convert degraded pastures into planted grasslands, or to allocate these lands for natural restoration. In the first case, certain funds will have to be invested in order to have high productive planted grasslands in three years. Second option requires no additional costs, but it is too long, since the agrocenosis restoration period in deserts and semi-deserts takes over 50 years.

Methane Emissions Reduction

In 1990, agriculture-caused methane emissions accounted for approximately 8% of the total GHG emissions, or for over 45% of the total methane emissions in Kazakhstan. Measures like increasing the livestock productivity and optimization of the livestock population, biogas utilization, optimization of areas covered with rice would allow to reduce up to 20% of the methane emissions. Development and implementation of a project for improving the organic waste collection, utilization and storage systems, including wastes of husbandry complexes have been included into the Government Priority Action Plan for 1998–2000.

In 1990, almost 48% of the total methane emissions in Kazakhstan were produces by the coal-mining industry. At present, methane practically is not used any longer as a raw material for petroleum industry, some minor amount is burnt in various energy-producing systems, the rest being released to the atmosphere. Utilization of methane from the Karagandy basin coalmines has been included into the Government Priority Action Plan.

4.3 Proposed Adaptation Measures

Study results showed high vulnerability of the wheat production and water resources of Kazakhstan to potential climate change impacts, therefore the adaptation measures in these sectors were assessed. Priority adaptation measures were selected on the basis of the results of the study, performed in KazNIIMOSK. Experts from the Kazakh Academy of Agricultural Science and Agricultural Research Center of the Ministry of Science / Academy of Science of the Republic of Kazakhstan being involved.

In developing and assessing the adaptation measures, flexibility and cost-effectiveness were taken as the main criteria. Flexibility means that adaptation measures should also take into account the wide range of potential climate change in the region, as well as the fact, that in the coming decades there may be no any significant impact of climate change to ecosystems and natural resources. Cost-effectiveness means, that the benefit is greater than costs. If adaptation measures are of high costs, they should be able to generate profit even under the existing climatic conditions, or the costs of these measures should not be significant in case there will be no benefits for several decades.

All the proposals to be included into the NAP UNFCCC will be efficient and useful even if under a wide range of potential climate change including no climate change. Under the climate changes, however, the need in the timely implementation of these measures impetuously grows.

4.3.1 Wheat Production

Four directions were chosen as priority for the work. While selecting the most priority options in addition to the main criteria the costs of the options and possible barriers to their implementation were taken into account. Adaptation costs were estimated basing on expert judgments. Table 4.2 presents the main information on the chosen priority measures. Cost estimates vary from 19.6 million USD for establishment and maintenance of the regional gene centers to 565 million

USD for soil erosion reduction. Costs for pests control and seed banks establishment were estimated on the basis of costs in the USA and converted to costs in Kazakhstan using purchasing power parity adjustments and sizing of effort appropriate for Kazakhstan. Costs of transition to a free market were estimated based on the World Bank loan to Kazakhstan. Costs for soil erosion control were based on actual costs of 100,000 USD for a 3,000 ha test site, and assuming these costs would be applied to the entire wheat sowing area of 16 to 18 million hectares.

1. Development and distribution of long-term forecasts on agricultural pest and disease outbreaks for planning, procurement, and pesticides utilization purposes. It is necessary to have timely and reliable forecasts of this kind even under the existing climate in order to undertake the required protection measures or, vice versa, to save funds in case of a lack of the necessity to treat plants and insects. Under climate change, increase in frequency of pests and diseases outbreak is expected, and, therefore, need for this kind of forecasts will grow.

2. Establishment and maintaining at the modern level regional centers on genetic varieties for spring and winter wheat. Centers like these have already been established at the Southeast and North of the country. Overall amount of research in the field of the gene fund preservation in 1997 totaled to 15.8 thousand USD, which is clearly not enough to ensure the proper level of support for these works. Special attention should be focused on ensuring financial and administrative support to strengthen operations of these centers, since under the climate change the country will especially require to maintain sufficient fund of both existing and new wheat varieties.

3. Clarification and drafting of legislation for transition of the agricultural sector of the Republic to a market economy. Agricultural sector in Kazakhstan clearly requires legislative support during the transition to a market economy even at present, under the existing climatic condition. Under less favorable and less stable climate, however, which may present at the territory of Kazakhstan in the future, maintaining food security and sustainability of agricultural economy will be even more dependent on well-thought laws, regulating relations between farmers, private sector and the state.

4. Improvement of low productive lands in arid and semi-arid zones and reduction of soil erosion. About 22 million ha of arable lands from the total area of 32.7 million ha is located on the slopes up to 2 degree. Cultivation practices of dividing the land plot into square fields (production fields) 2 km x 2 km – that is 400 ha without taking into account the relief of the arable area, lead not only to deflation, but to increase of water erosion. At present, there exist a number of pilot proposals developed by leading research institutes of Kazakhstan. The proposals concentrate at changing management and land use patterns to reduce and minimize soil loss from wind and water erosion by

TABLE 4.4 ADAPTATION MEASURES IN WHEAT PRODUCTION

Priority Actions	Investments, million USD
Clarification and drafting of legislation for transition of the agricultural sector of the Republic to a market economy	50.0
Improvement of less productive lands in arid and semi-arid zones and reduction of soil erosion	565.0
Development and distribution of long-term forecasts on agricultural pest and disease outbreaks for planning, procurement and pesticides utilization purposes	322.8
Establishment and maintaining at the modern level regional centers on genetic varieties for spring and winter wheat	19.6

cultivating the land along natural contours, planting buffer strips of herbaceous and woody plants, and maintaining a constant crop cover. This expertise should be replicated as soon as possible and the country's research potential should be used for landscape and ecological designing.

Full-scale implementation of all these measures at all cultivated lands will clearly require substantial financial resources, but nevertheless these costs will be recovered in the future even if the climate does not change. Under climate aridization, the need to control erosion and to raise the soil productivity through implementation of the complex of the above listed measures will only grow and effectiveness of the proposed measures will increase. The shift to agrolandscape agriculture may be implemented through a long period of time and independently for all territories.

4.3.2 Water Resources

For Kazakhstan as a whole, the proposed strategy of water resources sector adaptation comprises implementation of measures that can be divided into six groups:

- measures to support development of modern technologies for the sectors of economy, which use water resources;
- water-saving measures;
- measures to mitigate the negative impacts of water resources vulnerability to sectors of economy;
- nature conservation measures;
- social losses reduction measures;
- measures to expedite the decision-making process.

Full practical implementation of adaptation measures will require significant investments and long time period. Priority of measures that allow increasing the water resources available for economic activity on the territory of north and east Kazakhstan was assessed for the basins of Irtysh, Ishim and Tobol rivers. Main indicators of the chosen adaptation measures are given in Table 4.5.

TABLE 4.5 MEASURES TO INCREASE THE AVAILABLE WATER RESOURCES IN THE BASINS OF IRTYSH, ISHIM, AND TOBOL RIVERS

Measure	Priority	Additional Amount of Water, million m^3	Estimated Investments, million USD
Irtysh River Basin			
Runoff regulation	1	3,610	182
Water saving	2	1,699	3,470
Runoff diversion	3	250	1,071
Increasing use of underground water	4	402	3,304
Total		5,961	8,027
Ishim River Basin			
Runoff regulation	1	135	90
Water saving	2	132	107
Runoff diversion	3	105	126
Increasing use of underground water	4	43	309
Total		415	632
Tobol River Basin			
Water saving	1	301	574
Increasing use of underground water	2	55	635
Total		356	1,209

In setting up the priorities, preference was given, first of all, to the measures able to provide more water, to need less expenditures and not to require runoff diversion from the outside. On the basis of this estimate, adaptation measures for the Irtysh and Ishim river basins are ranged as follows: runoff regulation, a complex of water-saving measures, runoff shift, increasing underground water takeoff. For the Tobol river basin, from the two aggregated measures considered – water saving and underground water takeoff, – the priority is given to water saving.

4.4 Education, Training, Public Awareness and NGOs

One of the general obligations of UNFCCC Parties is development of educational and public awareness programs on climate change and its effects, providing public access to information on climate change issues, and public participation, including NGOs, in addressing climate change and developing adequate responses. In Kazakhstan, as well as in many countries, the general public do not have a good understanding of the implications of climate change and the potential benefits of response measures in order to take part in the activity to achieve the ultimate objective of the Convention.

Therefore, the aim of educational and public awareness programs is informing the general public about the benefits of mitigation and adaptation measures, which are accompanied by other positive environmental effects. They lead to decline of harmful emissions into the atmosphere, increase in the agricultural productivity, and improve fresh water supply for population. Besides, additionally many social problems will be solved, new workplaces will be created, and unfavorable climate change impacts on human health will be decreased.

The public in Kazakhstan does not have good understanding of the implications of climate change and the potential benefits of response measures. Therefore, the programs of public awareness, public education, and media campaigns in newspapers, magazines, radio, and TV are an important part of the work under the UNFCCC.

The program of education and public awareness are divided into four parts: 1) educational programs for secondary schools, high education and training for teacher of secondary schools;
2) popularization campaign in mass media: 3) conducting workshops for general public and ecological NGOs;
4) conducting national workshops for the officials, policy and decision makers, who are responsible for plan development in different sectors of economy that influence on climate or depend on it.

To obtain the basic professional knowledge on clymatology is possible in several universities of Kazakhstan. There is education course related to climatology in Kazakh State University. This course is planned to be added and extended by information on the latest climate change study results.

It is planned to put into education courses on ecology the climate change questions in the following universities that introduced programs on environment issues. These are Kazakh National Technical University, Pavlodar State University, Kazakh Woman's Pedagogical Institute, Almaty State University and others. Program on climate change issues is expected to develop for courses on geography and natural history lessons.

Climate change study results in Kazakhstan are published in the quarterly science and technical journal "Hydrometeorology and Ecology" issued by Kazhydromet. The public can obtain information on climate change study activities from the newspaper "Ecocourier" issued by the Ministry of Environment and Natural Resources and from other periodical issues.

In April 1997, Kazhydromet hold the first national workshop on climate change national action plan. Representatives from Russia, Kyrgyzstan, the USA, and the Netherlands took part in plenary meetings. The main results of the workshop were identifying of priorities of the NAP and informing of the general public as well as policy and decision makers on the problems of climate change and possible GHG emission reduction measures.

A network of ecological NGOs in Kazakhstan is actively expanded. However, only some of them have climate change projects. In 1997, the NGO “Ecoproject” prepared two telecasts on climate change problems. In 1998, another NGO “Ana Umity” started to implement a project in Aralsk district called “The light, born by the wind” financed jointly by the SGP / GEF and NGO “Isar”. The task of the project is to install a wind turbine for the maternity home in the town of Aralsk. The project includes a program on ecological education for the public and managers of the Aralsk region.

The role of NGOs will grow in the future. It is evident that a sufficient part of the work in the area of climate change on GHG reduction such as reforestation, using of renewable sources of energy, methane utilization and so on can be implemented by local NGOs. The other sphere of their activity can be participation in political dialogue with the government on different matters related to prices or tariffs on energy, demonstration projects, and clean energy. NGO activities can be realized in energy efficiency improvement projects, removing barriers for renewable energy using, and development of legislative base for introduction of the national policy in the area of global ecology issues.

4.5 Follow-Up Activities

Formulating, implementing and regularly updating national programs containing measures to mitigate climate change and facilitate adequate adaptation to climate change impacts are the general commitments of all Parties in accordance with the Article 4 (1b) of the UNFCCC. These measures should be implemented on a constant base in all sectors of economy including energy, transport, industry, agriculture, forestry, water resources, and waste management.

Initially a Governmental Committee was organized by the Prime Minister’s order in 1994. It was responsible for coordination of works on the UNFCCC in Kazakhstan. Main Administration for Hydrometeorology (Kazhydromet) was designated as a head organization for this Committee. In 1997, the Ministry of Ecology and Natural Resources became a coordinator of the works. In March 1998, the Committee was reestablished and a new Interagency Commission was organized with expanded functions in 1998. Officials from the following ministries and departments were nominated to the Commission: Ministry of Energy, Industry and Trading, Ministry of Agriculture, Ministry of Foreign Affairs, Agency for Strategic Planning, Ministry of Foreign Affairs, Ministry of Transport and Communications, and some others. The Commission is headed by the Minister of Ecology and Natural Resources.

The basic task of the Commission is a coordination of the following types of activity:

- enabling the fulfillment of Kazakhstan's obligations under the UNFCCC;
- participating in the sessions of the subsidiary bodies and Conferences of the Parties of the Convention.

The functions of the Commission are as follows:

- approving the projects on GHG mitigation in the frame of Joint Implementation;
- considering and directing to the Government National Communications to the UNFCCC,
- participating in the development of the legislative and other normative acts of Kazakhstan on the issues of climate protection;
- introducing appropriate proposals on questions (particularly, approving of the NAP) requiring the decision of the Government.

The list of the projects in the NAP is defined by the long-term national development strategy "Kazakhstan – 2030". The time frame of the NAP implementation is defined by the general commitments of the UNFCCC Parties. On the other hand the steps undergoing by the Government with the regard to the decision of the signing the Kyoto Protocol will request to define and certify of the planning GHG emissions for the period of 2000–2008.

Clean Development Mechanism defined by the Article 12 of the Kyoto Protocol assists Kazakhstan as a Party not included in Annex 1 in achieving sustainable development and in contributing to the ultimate objective of the Convention. It implies banking projects in developing countries. At the same time CDM enables Parties included in Annex 1 to achieve compliance with their quantified GHG emission limitation and reduction commitments under Article 3. Therefore, at the beginning of the NAP realization the preparatory stage for projects will take place. The aim of this works is to define a potential of GHG emission reduction in Kazakhstan and to estimate costs of 1 tonne CO_2 emission reduction. CDM create an opportunity for developed countries to start technology transfers as early as 2000, instead after 2012, as it was defined earlier.

State budget financing of the NAP project is still difficult because of the transition period to a marked economy. However, the Government of Kazakhstan can finance 15-20% of the NAP projects expenses and to provide further fulfilling the obligations taken under the Convention and Kyoto Protocol. These financial resources can be drawn from Kazakhstan's fund for environmental protection, which consists of receipts from payment for pollution, taxes for waste removal, compensation for ecological consequences of activities of enterprises, fines for damaging the environment, etc. Additional financing can come from other branch funds.

There are, yet, few sources of private and NGO financing in Kazakhstan.

Investments can also be made within the framework of USIJI and AIJ, and from international organizations (USAID, ADB, and others). Some large projects on energy conservation and energy saving, wind energy, utilization of methane and others are within the project area of GEF and can be funded on the grant basis.

The implementation of the NAP required conducting workshops for specialists on energy, managers of different enterprises, and public, professional education in climate change area, and arranging information companies in mass media.

Besides, for the realization of Kazakhstan's obligations on UNFCCC, it is planned to continue scientific, socio-economic and others studies, to carry out observations of climate system, to support of created climate data bases, which are necessary for understanding of climate change causes. These are tasks of research institutes and groups. Climate change monitoring is a task of the National Meteorological Service and must be financed both by the government and international organizations.

Studies and assessments of measures on adequate adaptation to climate change will also be continued. For the moment, adaptation is recognized to be important as mitigation measures in effort to combat climate change. Adaptation assessments of the Caspian Sea coastal zone and mudflow and snow avalanche study for the mountains of the South and Southeast of the country are being developed within the Netherlands Climate Change Studies Assistance Programme during 1998–1999.

The NAP UNFCCC projects development and monitoring will be conducted by a special entity – National Ecological Center for Sustainable Development under the Ministry of Ecology and Natural Resources. This group is responsible for the development of strategies, action plans, and projects on all international conventions ratified by the Republic of Kazakhstan.

References

1. Central Administration for Geodesy and Cartography under the USSR Council of Ministers, 1982: *Atlas of Kazakhstan*. Cartography, Moscow, USSR, 1, pp. 82. (in Russian).

2. Gitay H., I.R. Noble, O.V. Pilifosova, 1998: Middle East and Arid Asia. In: *The Regional Impacts of Climate Change. An Assessment of Vulnerability. A Special Report of IPCC Working Group II* [Watson, R.T., M.C. Zinyowera, H.R. Moss, D.J. Dokken (eds.)]. Cambridge University Press, Cambridge, UK, pp. 231-252.

3. Goskomstat, 1996: *Kazakhstan Regional Statistical Yearbook for 1991-1994*. Goskomstat of the Republic of Kazakhstan, Almaty, Kazakhstan, pp. 549, (in Russian).

4. IDK, UNDP, 1998: *Report on the Human Development. Kazakhstan 1997.* Institute for Development of Kazakhstan, United National Development Programme, Almaty, Kazakhstan, pp. 103, (in Russian).

5. IPCC, 1995: *Climate Change 1994: Radiative Forcing of Climate Change and an Evaluation of the IPCC IS92 Emission Scenarios.* Report of the IPCC Scientific Assessment Working Group I [Houghton, J.T., L.G. Meira Filho, J. Bruce, H. Lee, B.A. Callander, N. Harris, and K. Maskel (eds.)]. Cambridge University Press, Cambridge, UK, 339 pp.

6. Kazakh Academy of Agricultural Sciences, 1994: *Conceptual Program of the Republic of Kazakhstan Agricultural and Industrial Complex Development for 1993-1995 till 2000.* Kazakh Academy of Agricultural Sciences, Almaty, Kazakhstan, pp. 314, (in Russian).

7. KazNIIMOSK, 1995: *Greenhouse Gases and the Regional Climate Change of the Republic of Kazakhstan.* Final Report on the scientific research work, No 0196 PR 00737, Almaty, Kazakhstan, pp. 195, (in Russian).

8. KazNIIMOSK, 1995: *Inventory of Kazakhstan Greenhouse Gas Emissions.* Final Report. Results from the U.S. Country Studies Program. Almaty, Kazakhstan, pp. 157.

9. KazNIIMOSK, 1996: *Assessment of the greenhouse gases emission reduction options.* Final Report on the scientific research work, No 0196 PR 00737. Kazakh Research Institute for Environment Monitoring and Climate, Almaty, Kazakhstan, pp. 96, (in Russian).

10. Mizina, S.V., I.B. Eserkepova, O.V. Pilifosova, S.V. Dolgikh, and E.F. Gossen, 1996: Model-Based Climate Change Vulnerability and Adaptation Assessment for Wheat Yields in Kazakhstan. In: *Adapting to Climate Change. Assessment and Issues* [Smith, J.B., N. Bhatti, G.V. Menzhulin, R. Benioff, M. Campos, B. Jallow, F. Rijsberman, M.I. Budyko, R.K. Dixon (eds.)]. Springer-Verlag, New York, NY, pp. 148-163.

11. Monocrovich, E., D. Danchuk, O. Pilifosova, O. Semenov, T. Temertekov, Z. Korneeva, E. Gossen, A. Starsev, G. Papafanasopulo, and N. Inozemtseva, 1996: Inventory of Kazakhstan Greenhouse Gas Emissions and Sinks: 1990. In: *Greenhouse Gas Emission Inventories. Interim Results from the U.S. Country Studies Program* [Braatz, B.V., B.P. Jallow, S. Molnar, D. Murdiyarso, M. Perdomo, J.F. Fitzgerald (eds.)]. Kluwer Academic Publishers, Dordrecht, the Netherlands, pp. 289-297.

12. Monocrovich, E., O. Pilifosova, E. Gossen and A. Startsev, 1995: GHG Emissions from Agriculture, Land Use Change and Forestry in Kazakhstan. *Idojaras,* 99, pp. 345-352.

13. Monokrovich, E.I., O.V. Pilifosova, D.Y. Danchuk, and G.A. Papafanasopulo, 1996: Estimating the Potential of Greenhouse Gas Mitigation in Kazakhstan. Special Issue: Methods for Assessing Greenhouse Gas Mitigation for Countries with Economies in Transition. *Environmental Management,* 20, Supplement 1, pp. S57-S64.

14. Pilifosova, O., I. Eserkepova, S. Mizina, P. Kozhametov, G. Chichasov, L. Lebed, S. Dolgikh, V. Golutsov, I. Skotselyas, V. Lee, K. Berentaev, N. Fedorova, E. Gossen, 1996: Vulnerability and Adaptation Assessment for Kazakhstan. In: *Vulnerability and Adaptation to Climate Change. Interim Results from the U.S. Country Studies Program* [Smith, J. B., S. Hug, S. Lenhart, L. S. Mata, I. Nevesova and S. Toure (eds.)]. Kluwer Academic Publishers, Dordrecht, the Netherlands, pp. 161-181.

15. Pilifosova, O., S. Mizina, I. Eserkepova, G. Chichasov, A. Shamen, 1997: Kazakhstan. In: *National Climate Change Action Plans: Interim Report for Developing and Transition Countries* [Benioff, R., E. Ness, J. Hirst (eds.)]. Enviro-Management &Research, Inc., Arlington, Virginia, pp. 94-109.

16. Pilifosova, O., D. Danchuk, T. Temertekov, S. Izdebsky, T. Mandaria, 1997: Mitigation Technologies and Measures in Energy Sector of Kazakhstan. *Applied Energy*, 56, pp. 341-350.

17. Pilifosova, O., D. Danchuk, T. Temertekov, S. Mizina, I. Eserkepova, 1997: *Mitigation Assessment for Kazakhstan. In: Global Climate Change Mitigation Assessment: Results for 14 Transitioning and Developing Countries* [Meyers, S., B. Golberg, J. Sathaye, K. Simeonova (eds.)]. Dordrecht / Boston / London, Kluwer Academic Publishers, pp. 97-108

18. Pilifosova, O., I. Eserkepova, S. Dolgih, 1997: Regional Climate Change Scenarios under Global Warming in Kazakhstan. *Climatic Change,* 36, pp. 23-40.

19. Shamen, A. (ed.), 1997: Proceedings of Workshop and International Conference on Climate Change. *Hydrometeorology and Ecology*, 3, pp. 254, (in Russian).

20. Statcommittee of the RK, 1997: *National Counting of the Republic of Kazakhstan (Statistical Collection) 1990-1996*. Statistical and Analysis Committee, Almaty, Kazakhstan, pp. 86, (in Russian).

21. Statcommittee, 1998: *Kazakhstan Brief Statistical Year Book for 1997*. Statistical and Analysis Committee under the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, Almaty, Kazakhstan, pp. 163, (in Russian).

22. UNEP, OECD, IEA, IPCC, 1995: *The IPCC Guidelines for National Greenhouse Gas Inventories*. Hadley Centre, Meteorological Office, Brackell, UK, Volumes 1, 2, and 3.