MINISTRY OF ECOLOGY AND EMERGENCIES
OF THE KYRGYZ REPUBLIC

FIRST NATIONAL COMMUNICATION OF THE KYRGYZ REPUBLIC UNDER THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE

Bishkek 2003

ББК 26.234.7
П-26

The First National Communication of the Kyrgyz Republic under the UN Framework Convention on Climate Change was prepared under supervision of the Ministry of Ecology and Emergencies of the Kyrgyz Republic within the GEF/UNDP project KYR/00/G31/A/1G/99 "Enabling the Kyrgyz Republic to prepare its first National Communication in response to its commitments to the UN Framework Convention on Climate Change" with financial support of the Global Environment Facility and assistance of the UN Development Programme.

The following institutions participated in the preparation of the First National Communication:

Ministry of Ecology and Emergencies
Ministry of Foreign Trade and Industry
Ministry of Agriculture, Water and Processing Industry
Ministry of Health
Ministry of Foreign Affairs
Ministry of Justice
Ministry of Transport and Communications
Ministry of Finance
Ministry of Education and Culture
Ministry of Internal Affairs
National Academy of Sciences
National Statistics Committee
State Forestry Department
State Energy Agency
Kyrgyz Housing Union
State Committee for Tourism, Sports and Youth Policies
State Planning Institute of Land Management "Kyrgyzgiprozem"
Biosphere Territory "Issyk-Kul"
Kyrgyz-Russian Slavic University
Kyrgyz Technical University
Kyrgyz State University of Construction, Transport and Architecture

Cover page photo from Internet.

П-26 First National Communication of the Kyrgyz Republic under the UN Framework Convention on Climate Change. Bishkek, 2003, 98 pp.
ISBN 9967-21-478-3

1805040500-03

ISBN 9967-21-471-6 ББК 26.234.7

PREFACE

On behalf of the Ministry of Ecology and Emergencies of the Kyrgyz Republic I have the honour of presenting the First National Communication of the Kyrgyz Republic prepared for the Conference of the Parties to the UN Framework Convention on Climate Change.

In January 2000, recognising the importance of the climate change issue and the necessity of joint efforts of states to mitigate its adverse effects internationally, the Kyrgyz Republic joined the UN Framework Convention on Climate Change.

The First National Communication describes a current state of Kyrgyzstan in terms of the climate change issue. The National Communication outlines climate change trends in Kyrgyzstan identified on the basis of available long-term hydro-meteorological observations. Scenarios of expected climate change were designed according to global climatic models. The results of the first national greenhouse gas inventory covering a period of 11 years (1990-2000) are also presented in the Communication. A vulnerability assessment of the environmental and economic system of Kyrgyzstan was conducted and adaptation measures in various sectors of the economy are suggested. Measures on greenhouse gas emissions abatement are coordinated with National Development Programmes. An action strategy matrix in several directions with economic evaluation of suggested measures was designed.

Kyrgyzstan considers this National Communication as a first step in the actual implementation of the UNFCCC in the Republic. The Communication suggests that Kyrgyzstan's influence on global climate change is minor, but the forecast economic development lacking the relevant measures will considerably magnify the impact. Besides, a number of important sectors of its ecological and economical system are highly vulnerable to the prospective climate change.

Therefore, Kyrgyzstan intends to continue further research in climate change, to the extent possible promote development and dissemination of emission reduction technologies, preserve and expand greenhouse gas removals by sinks. In addition, the Republic will consider climate change issues in its relevant social, economic and environmental programmes, co-operate in scientific, technical and education fields, enhance education and public awareness, and exchange information on climate change issues.

We are aware of the fact that these measures may require immense political, financial and organisational inputs. Kyrgyzstan as a developing country relies on the support of the UNFCCC parties and international organisations in implementation of these measures.

Minister of Ecology and Emergencies
of the Kyrgyz Republic

S.Chyrmashev

Bishkek,
December 2002

ACKNOWLEDGEMENTS

We express our gratitude to the Global Environment Facility and the United Nations Development Programme for their financial, technical and organisational assistance in preparing the country’s First National Communication on Climate Change.

We are grateful to the experts from the UNDP Country Office, the UNFCCC Secretariat, the Intergovernmental Panel on Climate Change, the UNDP/GEF National Communications Support Programme, other international organisations for their consulting, manuals and information resources provided, as well as for the software, which in many respects contributed to successful implementation of the current National Communication preparation.

We address our gratitude to all ministries and state bodies of the Kyrgyz Republic, which participated in the National Communication preparation, for assistance of their experts and provision of the necessary information.

We feel grateful to the co-ordinators of the working groups, all project participants, consultants, national and international experts who contributed a considerable amount of time and effort to collect, process, and analyse the extensive information necessary for preparing the National Communication.

National Project Director K.Januzakov

CONTENTS

ABBREVIATIONS

CLM	Combustive-lubricating Materials
FER	Fuel and Energy Resources
FES	Fuel and Energy Sector
GCM	Global Climate Model
GDP with PPP	Gross Domestic Product with Purchasing Power Parity
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GWP	Global Warming Potential
HPS	Hydroelectric Power Station
IPCC	Intergovernmental Panel on Climate Change
MV	Motor Vehicles
NCV	Net Calorific Value
NDS	National Development Strategy till 2010
NMVOC	Non-Methane Volatile Organic Compounds
NPRS	National Poverty Reduction Strategy (for 2003-2005)
NTRES	Non-Traditional and Renewable Energy Sources
TPS	Thermal Power Station
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organisation

SUMMARY

Introduction

This Communication has been prepared within the framework of the GEF/UNDP project # KYR/00/G31 “Enabling the Kyrgyz Republic to prepare its first National Communication in response to its commitments to the UN Framework Convention on Climate Change”.

The UN Framework Convention is a part of Millennium Goals stated in the Declaration of the Millennium. Sharing and supporting the goals of the world community, the Kyrgyz Republic declared these goals in its national legislation, namely, in the laws “On Environmental Protection” and “On Protection of the Atmosphere”, and “On Joining the UN Framework Convention on Climate Change”.

The First National Communication covers the following basic areas:

- GHG inventory by emission sources and removals by sinks of gases not controlled by the Montreal Protocol;
- main climate indicators forecast for Kyrgyzstan with the increase of GHG concentrations in the atmosphere on the basis of global climatic models;
- vulnerability assessment of the main sectors of the Kyrgyz economy and natural ecosystems on the basis of forecasted climate change and elaboration of adaptation measures;
- definition of potentials of GHG emission reduction and sinks increase, elaboration and assessment of measures aimed at mitigating the impact on climate;
- improvement of education and public awareness on climate change issues.

The year 1990 was taken as a base year.

Preliminary outcomes of accomplished activities were discussed and approved at interdepartmental workshops, in which representatives of all interested ministries, state bodies, organisations, NGOs of the Kyrgyz Republic, and international experts participated.

National Circumstances

The Kyrgyz Republic is located in the centre of the Asian continent, in the north-east of Central Asia between 39° and 43° north latitude and 69° and 80° east longitude. The Republic borders on Kazakhstan in the north, on China in the south-east and east, on Tajikistan in the south-east, and on Uzbekistan in the west. The length of the Kyrgyzstan’s borders is 4,508 km, its total area is 199,900 km^2. The highest point of the Republic is the Pobeda peak (7,439 m) and the lowest is 350 m above the sea level. The average height of the Republic above the sea level is 2,750 m. About 94% of the territory is located above 1,000 m, 90% – above 1,500 m, and 40% – above 3,000 meters above sea level. All natural features of Kyrgyzstan are determined by these high mountains – the climate, landscapes, soils, water resources, flora and fauna, as well as social and economic conditions of life.

The population density in the Kyrgyz Republic (24 persons per km^2) is relatively low, compared to that of other countries. However, only 19% of the total area of the Republic can be described as a habitable area (comparatively comfortable), 35% as habitable, but not prime living area, and the remaining 45% as inhospitable terrain, unsuitable for human habitation.

The Kyrgyz Republic is a unique region of Central Asia in term of biodiversity. There are more than 500 species of invertebrates, including 83 species of mammals, 368 species of birds, 28 species of reptiles, 3 species of amphibians, 75 species of fish, 3,000 species of insects, and more than 4,500 species of higher plants. A relatively small area of the Republic is represented by a significant diversity of biocenosis. 0.4 species of mammals, 1.8 species of birds, 0.14 species of reptiles, 0.23 species of fish account for 1,000 square km in Kyrgyzstan, while these figures are notably smaller in neighbouring countries.

The territory of the Kyrgyz Republic as a high mountain ecological system is especially susceptible to natural and anthropogenic influence. Nine out of twenty most dangerous natural processes are widespread in Kyrgyzstan. These are earthquakes, landslides, mudflows, floods, lakes in danger of bursting, stone falls, land-slips, under-flooding, and avalanches.

The Kyrgyz Republic is a typical high mountain country with an arid continental climate and a large temperature range. Along with this, separate parts of its territory differ dramatically from one another. Four climatic zones are clearly distinguished: North and Northwest Kyrgyzstan, Southwest Kyrgyzstan, Issyk-Kul basin, and Inner Tien-Shan. A significant climate-forming factor is high mountain ranges, predominantly of sub-latitude location, separated by deep valleys and basins.

Table S.1. General information on the Kyrgyz Republic

Indicator	Units of measurement	1990	1992	1994	1996	1998	2000
Population as of the end of year	mln people	4.42	4.53	4.52	4.66	4.81	4.91
Urban population	%	37.5	36.9	35.6	35.1	34.8	34.8
Population density	people per sq.km	22.1	22.6	22.6	23.3	24.0	24.6
Gross National Product	USD per capita	-	820	610	550	350	-
Gross Domestic Product, total	USD per capita	-	810	610	-	-	279
including:							
industry	%	26.4	32.1	20.5	11.1	16.3	-
agriculture	%	32.7	37.3	38.3	46.2	35.9	-
construction	%	7.7	3.9	3.4	6.0	4.5	-
transport and communications	%	4.8	2.6	4.1	4.1	4.1	-
trade and food production	%	4.0	3.5	9.7	10.4	12.6	-
Officially registered unemployed	%	-	0.5	1.6	3.1	2.2	3.0
Population literacy level	%	97.3	97.3	97.3	97.3	97.3	98.7
Life expectancy at birth	years	68.5	68.27	65.42	66.65	67.15	68.5
Infant mortality rate	per 1,000 life births	30.0	31.62	29.62	26.58	25.99	22.6
Population having access to safe drinking water,	%	-	-	-	81.3	86.5	81.5
including:							
Urban	%	-	-	-	98.4	95.0	99.1
Rural	%	-	-	-	73.7	74.2	72.1
Water consumption, total	mln m^3	8,993	8,953	8,257	6,871	6,420	4,976
including:							
industrial needs	mln m^3	623	526	277	153	138	48
irrigation and agricultural needs	mln m^3	8,076	8,143	7,671	6,359	5,963	4,749
household-drinking water needs	mln m^3	294	253	293	357	309	182

For the past 10 years, the economy of Kyrgyzstan has been in a deep recession. Since 1996 economic conditions have somewhat stabilised. The recession has affected the processing industry most significantly. In addition to the overall recession, the economy has undergone considerable structural changes. Instead of industrial-agricultural it has become extraction-agricultural. The main exporting industries are the mineral resources industry and power engineering.

There are abundant forecasted coal resources in the Kyrgyz Republic (approximately 5 billion tonnes) and the potential for hydro-energy from large and medium size rivers (18.5 million kW power and 140-160 billion kWh output). Industrially extracted reserves of oil and gas are located only in the Fergana valley.

There are great resources of practically unused alternative energy: solar energy (4.64 billion kWh, or 23.4 kWh per km^2), wind energy – 2 billion kWh, geothermal energy – 613 GJ annually (of which 27% is feasible for development), resources of bio-mass processing (livestock waste) could provide 1.6 billion m^3 of methane, the potential of small water currents is 1.6 million kW power, or 5-6 million kWh of output.

The fuel and energy sector of the Kyrgyz Republic cannot meet the demand for energy resources, which leads to dependence on import. The lack of mineral oils is determined by the lack of necessary volume of recoverable reserves. The insufficient coal extraction is caused by high transportation costs from the mines (in the south of the Republic) to the consumers (mainly in the north), reaching up to 300% of extraction costs, and also by the economic and functional depreciation of mining equipment etc. Rising energy demand dictates the necessity of developing the coal-mining industry, and the exploitation of new deposits, for example at Kara-Keche.

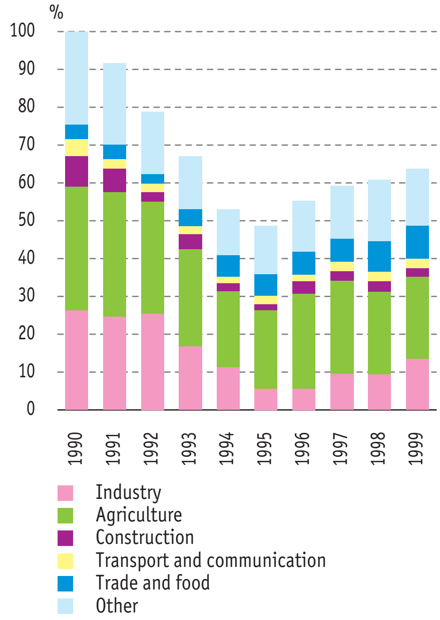
In spite of reduction of energy and water usage and also a considerable reduction in the use of fertilisers and other chemicals, it is possible to point out an increase in the harvest of basic crops.

Table S.2. Production and consumption of energy resources

Energy resources	Units	Years			
		1990	1995	1999	2000
Production	mln t.c.f.	6.60	2.80	2.40	2.81
Coal	mln tons	3.7	0.5	0.4	0.4
Oil	mln tons	0.15	0.09	0.08	0.08
Natural gas	bln m^3	0.1	0.04	0.02	0.03
Energy produced at including:	bln kWh	13.15	12.26	13.40	14.80
- HPS	bln kWh	8.95	11.1	12.4	13.6
- TPS	bln kWh	4.20	1.16	1.0	1.2
Consumption	mln t.c.f.	11.8	4.35	5.7	5.02
Coal	mln tons	4.8	1.2	1.0	1.2
Mineral oil	mln tons	0.003	0.039	0.14	0.15
Natural gas	bln m^3	2.1	0.9	0.6	0.7
Electric energy	bln kWh	7.6	7.12	8.70	8.70

t.c.f. – tons of conventional fuel

Figure S.1. Volume of GDP by sectors compared with 1990 (in percent)



Irrigated land farming is the most significant branch of agriculture in Kyrgyzstan: up to 70-75% of the total area under arable lands. Soils on the territory of Kyrgyzstan are prone to wind, water and pasture erosion, salinization, swamping, overgrowing by shrubs and other processes of degradation. Territories with strongly eroded soils account for 31% of the total agricultural area, medium eroded – 27.1%, and weakly eroded – 17%.

The total area of the state forests in the Kyrgyz Republic constitutes 2,601 thousand hectares (based on registration as of 1998), including forest covered areas – 849.5 thousand hectares, shrubs covered areas – 342.6 thousand hectares. Forests account for 4.25% of the Republic's territory. As a result of intensive forest use in the period of 1930-1988, forest cover decreased, including major forest-forming species – spruce, walnut, archa-tree.

At the present time despite some increase in the forest covered area, the process of forest senescence outstrips the process of forest recovery, and nowadays ripe and overripe forests account for 50% of the total reserve. Unique natural reserves of relic nut-fruit trees are under threat. Major forest-forming species are: coniferous – 36.4%; hard-leave – 4.5%; soft-leave – 1.9%; others – 57.2%.

Water resources are vitally important and strategic not only for the Kyrgyz Republic, but also for the whole of the Central Asia. Possessing significant water reserves – more than 50 km^3/year of a surface river flow, 13 km^3/year of sub-surface water resources, approximately 1745 km^3 in lakes and 500-650 km^3 of fresh water in glaciers – Kyrgyzstan uses only 12 to 17% of surface runoff on its own needs. The main types of water use in Kyrgyzstan are for irrigation and agricultural needs. Sub-surface water use accounts for a relatively small part of the total water consumption and is primarily used for providing water to large settlements, for the needs of industrial production, and for economic and drinking purposes.

Greenhouse gas inventory by sources and removals by sinks

To achieve international comparability of inventory results, calculation methodologies approved and agreed upon by the Conference of the Parties were applied. Those included: IPCC Guidelines (Revised 1996 IPCC Guidelines, IPCC/UNEP/OECD/IEA, 1997), IPCC Good Practice and Uncertainty Management in National Greenhouse Gas Inventories, 2000, and IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual. Revised 1996. In the absence of default approaches, national methodologies of calculation and coefficients were applied. This is true for the following processes: production of stibium and mercury; core-mould casting, re-melting of cast iron and non-ferrous metals; glass production; blasting operations, usage of solvents, and mountain fires.

According to the Guidelines, the inventory was conducted by sectors: energy; industries; solvents; agriculture; land-use changes and forestry; waste. Emission of the following GHGs was taken into consideration: carbon dioxide, methane, nitrous oxide, nitric oxides, carbon oxide, NMVOCs, sulphur dioxide, and halogens. The greenhouse gas inventory was carried out for the period of 1990-2000 in Kyrgyzstan as a whole and, where appropriate, in the context of 7 oblasts (areas) and Bishkek city. In concordance with the IPCC Guidelines, the year 1990 was taken as a base year.

Inventory results, according to Guidelines statements, are expressed both in units of mass for certain GHGs and in relative units of CO_2 equivalent. The latter are applied to compare the contribution of various gases to total emissions and depend on the value of the global warming potentials.

The basic information for GHG emission assessment comes from statistics on fuel and energy resources consumption, the existence of GHG sources, volumes of production giving GHG emissions. The following information sources were used:

- official publications by the National Statistics Committee;
- internal information of ministries, state institutions and organisations;
- opinions, calculations, and information provided by national experts;
- information in mass media.

Total emissions of all greenhouse gases in Kyrgyzstan in the a base 1990 year amounted to 36,647 Gg of CO_2 equivalent, including 29,105.5 Gg of CO_2 emissions. Net emissions, taking CO_2 uptake into account, were 35,817 Gg. In 1990, specific GHG emissions were 8.28 tonnes per capita, of which CO_2 was 6.58 tonnes. The largest contribution to the Kyrgyzstan's GHG emissions comes from energy use, which makes up some 80% of emissions of all main GHGs in CO_2 equivalent, and 74% in 2000. The structure of main GHG emissions in CO_2 equivalent by sectors for 1990 and 2000 is shown in Figures S.3 and S.4. In the context of the overall reduction in fuel and energy use, the decrease in coal consumption was more significant than that of other kinds of fuel. This has led to a reduction in the share of coal in the consumption balance, and an increase of the liquid fuel share. The proportion of CO_2 emissions from burning local and imported coal remains rather stable and is about one half.

Greenhouse gas emissions and sinks forecast has been prepared on the basis of macroeconomic indicators forecast. The sectors of industrial processes and solvents were not taken into consideration in forecasting, since emission from sectors of industrial processes and solvents lies within the range of overall uncertainty of calculations.

Figure S.2. Total emission dynamics of the main GHGs (in Gg of CO_2 equivalent)

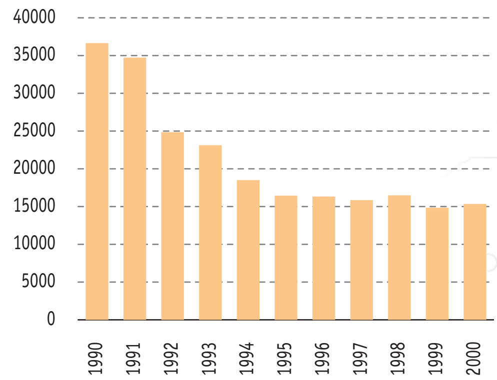
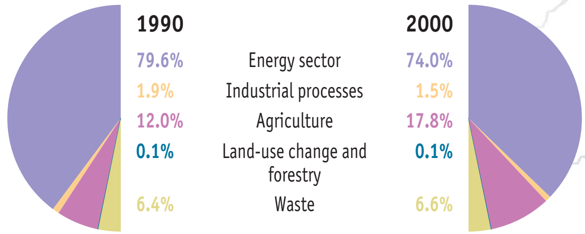


Figure S.3. Distribution of the total greenhouse gas emissions by sectors



The solvent sector is not mentioned here and further, as it makes an insignificant contribution to total GHG emissions.

Figure S.4. Share of the main GHGs in total emissions in 1990 and 2000

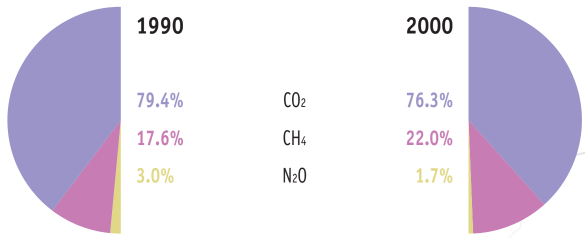


Table S.3 GHG emission forecast (in Gg)

Sector	Emissions (in Gg of CO_2 equivalent)			
	2000	2010	2020	2100
Energy sector	11,351	21,539	34,850	55,000
Agriculture	2,207	2,832	3,118	5,000
Land-use change and forestry	-983	-1,014	-1,045	-1,336
Waste	1,007	2,350	3,390	7,150
Total	13,582*	25,707	40,313	65,814

* Total emissions in 2000 do not coincide with actual emissions (see Appendix) due to non-consideration of relatively small (by emission volume) sectors and sources

Climate change research

The earliest meteorological stations on the territory of Kyrgyzstan were established in the late 19th century. By 1985, the network had reached the peak of its development and comprised 79 stations. Today, the Kyrgyzhydromet network includes 30 meteorological stations. Eight stations report to the WMO.

The following different climatic areas are clearly distinguished on the territory of Kyrgyzstan:

1. Northern, North-western Kyrgyzstan (NNWK);

2. South-western Kyrgyzstan (SWK);
3. Issyk-Kul basin (IKB);
4. Inner Tien-Shan (ITS).

The average annual temperature in Kyrgyzstan in the 20th century, taken over a 100 year period, has risen by 1.6°C, which is much higher than the global average one. At the same time warming considerably varied either by separate climatic zones and stations within zones, i.e. high-altitude zones. In the 20th century precipitation in Kyrgyzstan increased insignificantly – by 23 mm, or 6%.

Table S.4. Scenarios of warming for the territory of Kyrgyzstan by seasons and in average per year for 2050 and 2100 according to three models of MAGICC/SCENGEN for IS92a and IS92c emission scenarios

Emission scenario	Seasons of 2050					Seasons of 2100				
	W	Spr	S	F	Year	W	Spr	S	F	Year
HadCM-2 model										
IS92a	1.5	1.3	1.4	1.5	1.4	3.2	2.6	3.1	3.2	3.0
IS92c	1.5	1.2	1.5	1.5	1.4	2.3	1.7	2.5	2.4	2.2
UKTR model										
IS92a	2.2	2.5	1.9	2.0	2.2	4.5	4.8	4.2	4.1	4.4
IS92c	2.0	2.0	1.9	1.9	2.0	2.7	2.7	2.6	2.5	2.7
CSIRO2-EQ model										
IS92a	1.6	1.8	0.6	1.2	1.3	3.5	3.6	1.8	2.7	2.9
IS92c	1.6	1.6	0.9	1.3	1.3	2.1	2.1	1.3	1.7	1.8

Table S.5. Scenarios of precipitation trends for the territory of Kyrgyzstan by seasons and in average per year for 2050 and 2100 according to three models of MAGICC/SCENGEN for IS92a and IS92c emission scenarios

Emission scenario	Seasons of 2050					Seasons of 2100				
	W	Spr	S	F	Year	W	Spr	S	F	Year
HadCM-2 model										
IS92a	1.26	1.17	1.64	1.41	1.37	1.46	1.22	1.84	1.64	1.54
IS92c	1.15	1.09	1.25	1.23	1.18	1.26	1.09	1.06	1.24	1.16
UKTR model										
IS92a	1.11	1.04	1.43	1.16	1.19	1.24	1.05	1.46	1.17	1.23
IS92c	1.08	1.02	1.11	1.04	1.06	1.11	1.02	0.89	0.99	1.00
CSIRO2-EQ model										
IS92a	1.10	1.06	1.36	1.11	1.16	1.12	1.10	1.36	1.10	1.17
IS92c	1.02	1.05	1.07	1.0	1.03	1.02	1.03	0.80	0.93	0.94

In order to assess the future climate the scenarios designed on the basis of global climatic models (GCM) were applied. The MAGICC/SCENGEN software recommended by IPCC, was used for estimating climate scenarios in Kyrgyzstan for the period up to 2050 and 2100. This software helped estimate 12 scenarios relevant to 3 GCMs with various sensitivity levels and two options of GHG emission scenarios (IS92a – moderately high emissions with doubled CO_2 concentration by 2100, and IS92c – moderately low emissions with 35% concentration increase). They were also able to take into account (or not to take into account) the heat-alleviating impact of anthropogenic sulphate aerosols. Besides, two additional scenarios were forecast on the basis of the GRADS software.

According to the HadCM-2 model of average sensitivity in the case of moderately high IS92a emission scenario, a warming of 3°C is possible by 2100, taking the aerosol impact into consideration. Without such, warming would be 0.5°C greater. For the moderately low IS92c emission scenario, warming will be even less (2.4°C) and it will hardly depend on aerosol emissions. Rises in temperature are almost equally spread over the seasons, though according to both scenarios they are a little less in spring. However, one should not expect greater warming in winter than during other seasons.

By 2100 the overall range of warming scenarios equals a 1.8-4.4°C rise in average annual temperature and a 1.3-4.8°C rise in temperature in different seasons. The overall range of moistening scenarios will vary from an annual precipitation reduction of 6% to an increase of 54%. Seasonal scenarios vary from 20% reduction to 84% increase.

Vulnerability assessment and adaptation

Three major scenarios of expected development have been used for vulnerability assessment – climatic, demographic and economic. For assessment of macroeconomic indicators for the short term, Kyrgyzstan's national development programmes (National Development Strategy of Kyrgystan till 2010, National Poverty Reduction Strategy in Kyrgyzstan, etc.) were used. For the assessment of macroeconomic indicators for a longer period of time (until 2100) an analogy method was used. The results have been adjusted for economic activity structures, existence of natural resources and orientation at the global development tendencies considering national peculiarities, for instance, a further preferred development of hydro-power and renunciation of nuclear power.

The forecast of the total flow of Kyrgyzstan's major rivers (Naryn, Chu, Talas) was performed on the basis of modelling the balance of precipitation and evaporation taking into account the relief and types of water catchment area (forests, lakes, etc.). Vulnerability assessment of water resources independently implemented for the Kyrgyz Republic leads to the following conclusion: the expected change in water resources as a result of climate change is going to be favourable. The forecasted water supply is assessed as sufficient in the framework of basic development scenarios. However, it is a fact that the water resources of the Kyrgyz Republic are life supporting for the neighbouring states and that water supply problems already exist in a regional perspective. The acuteness of these problems will increase as time goes on, unless mitigation measures are taken. In other words, given the systemic vulnerability assessment of water resources, adaptation measures should be worked out, taking into account the interests of the neighbouring states.

The total energy potential of the Kyrgyz Republic is fairly high, which does not exclude certain problems. The existing oil and gas reserves do not satisfy Kyrgyzstan's needs for oil products. Coal deposits are located far from the major consumers, which significantly increases the cost of using local coal. Use of unconventional and renewable power sources is virtually absent.

Table S.6. Forecast of some economic indicators for the Kyrgyz Republic

Indicator	Unit	2000	2010	2020	2100
Population	million people	4.91	5.44	6.34	14.87
GDP with PPP	billion $	12.38	19.15	34.28	327.1
GDP with PPP, per capita	$/capita	2,521	3,520	5,407	22,000
Energy consumption, total	million t.o.e*	2.99	5.7	9.18	32.71
per capita	t.o.e./capita	0.61	1.05	1.45	2.2
per $1000 of GDP	t.o.e./$1000 GDP	0.24	0.3	0.27	0.1
including:					
- coal;	million t.o.e.	0.74	1.46	2.96	
- natural gas;	million t.o.e.	0.58	1.02	1.44	
- CLM (combustive-lubricating materials);	million t.o.e.	1.57	3.09	4.60	
- energy of TPS (thermal power station)	million t.o.e.	0.1	0.13	0.18	
- energy of NTRES	billion kWh	0	0.025	0.035	
- energy of small HPS	billion kWh	0.08	0.175	0.365	
Electricity generation, total	billion kWh	14.8	18.53	27.32	74.36
per capita	kWh/capita	3,014	3,373	4,309	5,000
per $1000 of GDP	kWh/$1000 GDP	1.20	0.97	0.80	0.20
Forest area	thousand ha	858.5	888.5	918.5	1,194

* t.o.e. – tons of oil equivalent

A programme for developing the energy sector of Kyrgyzstan should comprise the following measures:

- harmonising conditions of usage of rivers that are important for irrigation and hydro-power, taking into account the interests of all states of the region;
- creating prerequisites for a fuller use of hydro-power potential;
- reducing electric and thermal energy losses and introducing energy-saving technologies;
- increasing the share of renewable energy sources in the energy balance. Given world practice, it is hard to expect a substantial increase in the use of geothermal, solar and wind energy, etc. These constitute approximately 0.5% of world-wide capacity nowadays. Taking into consideration that waste processing accounts for 10% of energy in the entire world, it is necessary to expedite the development of this very trend;
- increasing the share of ecologically cleaner fuels;
- working out a development strategy for motorised transport, in particular public transport

A substantial relationship between sickness rates and climate change has been determined. Taking into consideration the forecasted climate change, a significant increase in the urolithiasis rate in Kyrgyzstan may be expected. A linear dependance has been found between common sickness appeals to the ambulance centres during the hot period of the year (May-August) and the level of oxygen partial pressure and temperature. Given the expected climate change (an increase of approximately 3°C) an increase in the ambulance call-out rate in the whole Kyrgyzstan could be more than 1%. The research of embryo development pathology has shown a sharp slow-down in their development with the temperature changes. The most serious damage occurs in the period when major embryo organs and systems are formed. Review of the research has shown that the expected climate change may cause an increase in common sicknesses, cardiovascular and broncho-pulmonary pathology, skin diseases and trauma rates. The mortality rate from ischemic heart disease may increase (particularly for elderly people). The expected climate change (increase in temperature and precipitation) will lead to an extension of the geographical distribution and incidence of infectious diseases: transmissible infections (malaria); tropical fevers; enteric infections (salmonellosis, escherichiosis, cholera, etc); parasitic diseases. In brief, measures aimed at adaptation to climate change could be grouped in two major directions: increase in the population's socio-economic living standards and improvement of the health care system.

Based on the scenarios of climate change the following changes in Kyrgyzstan's biodiversity may occur. Desert and steppe belts will significantly expand. However, it is not expected that belt shifts will lead to substantial loss in flora and fauna. This refers particularly to invertebrates and vertebrates, because they possess a natural adaptation to temperature increase, or will migrate. Their ecological niches will be replaced by species from other belts. There will be a loss of invertebrate species only for conservative geobionts (common gryllotalpa, acridae, ant-lion), which are adapted to inhabit only very specific types of soil. Herbivorous monophagus may possibly perish (bloody mite, shield bug), provided that some plants will fall out of the ecosystem because of the belt shift. The number of insect species is also expected to increase owing to xerophiles moving up from lower zones: Lepidoptera, Coleoptera, and Hymenoptera.

Climate change will also affect the forests. By 2100 the spruce forest density will have been increased to 0.5-0.6. At an altitude of 2,200-2,600 m spruce forests will occupy not only northern but also western and eastern slopes. About 37.2% of the total area under forests will be concentrated here. At an altitude of 2,600 m and higher forest density will go up sharply, which is connected with the significant temperature increase at this altitude.

Along with ample availability of water this will promote a further growth of areas under forests and emergence of spruce even on south-western slopes. At an altitude of 2,600 m and higher toward the tree line forests will occupy 57.7% of the total area. At these high places the spread of spruce coincides with the sub-belt of sufficient moisture. In case of a significant area under forest cover (27.2%) they could grow on shaded northern and north-eastern slopes at the top section of the belt at altitudes between 2,800 and 3,000 m. As a result of an increase in the sum of above-zero temperatures, by 2,100, there may be a boundary shift of the habitat zones for every type of archa-tree. Each of these (Zaravshan, semi-spherical and Turkestan) occupies a high-altitude zone. At an altitude of 1,400-2,300 m in the south-western region they may be an increase in bio-climatic productivity in an area with sufficient availability of water. Generally walnuts could move up by 100-150 m in response to climate change. However, given the influence of age structure (ripe and overripe forests account for 60%) and human-induced factors are barriers to such movement. Forest adaptation measures should include:

- sustainable preservation of forest ecosystems begins with an inventory of species and intra-species diversity on the basis of a single methodological approach and a well-developed method of forest genetic resources assessment,
- poverty alleviation among the population,
- participation of local communities in decision-making as far as their access to forest resources is concerned, based on community forest use.

For the plant-growing sector an increase in areas under crops is not expected. Output is likely to grow through an increase in crop yield per hectare. The forecasted increase is considered realistic, since it has already been achieved on individual farms.

Table S.7. Production forecast of major agricultural crops

Name of crops	2000			2100		
	Area (in 1,000 ha)	Crop yield (in centners/ ha)	Total yield (in 1,000 tons)	Area (in 1,000 ha)	Crop yield (in centners/ ha)	Total yield (in 1,000 tons)
Cereals, total	589.8	26.4	1,557.0	400-500	50-100	2,500-4,000
Sugar beet	23.5	191.4	449.8	30	400-600	1,200-1,800
Cotton	33.8	26.0	87.9	40	40	160
Tobacco	14.5	23.9	34.6	25	60	150
Oil-crops	57.1	9.4	53.45	70	N.A.	N.A.
Potato	68.9	151.8	1,046	70	300-500	2,100-3,500
Vegetables, total	46.9	159.3	747	50	300-500	1,500-2,500
Fruit and berries	42.6	37.8	161.0	60	90	540

N.A. = data not available

Table S.8. Changes in livestock and poultry (in thousands)

Name	1990	2000	2100
Cattle	1,205	947	2,000
Sheep and goats	9,972	3,799	10,000
Horses	313	354	600
Pigs	393	101	300
Poultry	13,900	3,100	12,000

Research suggests that pasture fodder is likely to be sufficient for required growth in heads of cattle. However, the majority of experts assume that there was an excessive pasture overload in 1990.

Strategy and measures of climate impact mitigation

As a developing country the Kyrgyz Republic does not have any obligation to reduce GHG emissions. However, in the framework of relevant mechanisms for implementing the goals of the UNFCCC and the Kyoto Protocol, the Kyrgyz Republic could – in collaboration with other countries and to the extent the economic situation allows – voluntarily undertake the commitment to prevent future GHG emissions.

Implementation of the main GHG emission reduction measures requires significant financial resources. Nevertheless, despite the current economic hardships, the country has the opportunity to carry out a number of GHG emission reduction measures that cost little or nothing. These are related to the emission reduction of such combustion products as sulphur dioxide, nitric oxide, carbon oxide, and other chemical substances and aerosols.

The Kyrgyz Republic is still to overcome such serious problems as:

- lack of effective regulatory bodies in the sphere of climate change;
- lack of stimulation mechanisms for the introduction of "clean technologies";
- reduction of current market and institutional barriers that prevent the implementation of economically worthwhile measures for GHG emission reduction.

The comprehensive implementation of such policies and measures in the form of an interrelated set of instruments for GHG emission reduction could make these actions more effective. This set of national instruments should include:

- organisation of effective government monitoring and control of GHG emissions as well as emission of other dangerous air pollutants;
- practical support of measures for GHG emission reduction by the government and society as a whole;
- periodic preparation and submission of National Communications and Inventories of GHG emissions and sinks to the Convention's Secretariat;
- improvement of the relevant legislation;
- introduction of such economic tools as differentiated taxes and tendered sale of emission permits, as well as reduction of subsidies that contribute to the emission of GHGs;
- co-ordination of efforts with different countries in the sphere of GHG emission reduction, including trade in emissions quota;
- access to the information, advanced technologies, and financial resources;
- public information campaigns about the problems of climate change and involvement of the public in solving these problems;
- support of scientific and applied research and human resource development.

The development of a fuel and energy sector, which provides for maximum energy independence of Kyrgyzstan, as well as sufficient and stable energy supply to consumers, represents the major goal of the Kyrgyz Republic's energy policy.

This policy envisages:

- further development of hydro-energy potential of the Naryn river by constructing Kambarata hydroelectric power stations with a total power of 2,260 MW;

- implementation of the Development Programmes for small and micro HPS and non-traditional energy sources (installation of photoelectric cells with a power of 2-3 MW; wind energy parks with a power of 1.0-1.2 million kWh);
- by the year 2005, increase of coal mining activities by up to 80% due to the expansion of open coal mining at the lignite deposit of Kara-Keche and increase of up to 30% of the mining rate of existing coal enterprises;
- by the year 2005, increase of oil extraction to 190,000 tons and natural gas to 30 million m^3 whereas the need for gas is 800 million m^3;
- transition to the use of renewable energy sources, reduction of low-grade coal import, increase of fuel efficiency by modernising fuel combustion systems; reduction of fuel expenditures in the heat and energy production;
- implementation of the strict energy saving policy; strengthening of accounting and control systems; reduction of commercial losses and non-production energy expenses;
- elaboration of legal mechanisms that stimulate consumers to save energy and increase the use of non-traditional energy sources;
- scientific and applied research into the development and implementation of new energy and resource saving technologies; GHG absorption technologies, modern means of GHG emission capture and instruments of GHG recording;
- improvement of public awareness about the ecological and social consequences of climate change, and about measures that are being undertaken, as well as involvement of the public in the implementation of these measures.

The potential for reduction of GHG emissions from heating lies in energy saving, which would allow energy consumption to be reduced by 15-20%. The recommended technologies of reducing GHG emissions are:

- built-in autonomous systems of solar energy supply;
- integrated building solutions aimed at energy efficiency increase;
- improvement of construction standards and control systems that monitor the observance of these standards by the buildings that are under construction.

Motor vehicles take up to 90% of all internal freight forwarding and passenger traffic in the Kyrgyz Republic. They are expected to become the preferred mode of transport for all kinds of freight. The exploitation conditions of vehicle fleet (mountain landscape, bad quality of roads, deterioration of vehicles, etc.) account for the increased GHG emission from traffic. Low cost measures, such as the improvement of state governance and control over the transport sector could be very effective in this sector.

The main GHG emission reduction measure in industry is reduction of energy use due to the introduction of energy saving technologies.

Carbon dioxide emission reduction in agriculture can be achieved through the discontinuance of agricultural waste combustion. Methane emission reduction is possible through the enhancement of manure collection and storage systems.

Methane capture from wastes and manure storage systems with biochemical methods will not only allow reducing GHG emission, but at the same time will provide farms with fuel and secure organic fertiliser.

In the national mitigation strategy the enhancement of sinks is of great importance. Planting new trees and creating new forests significantly contributes to carbon accumulation. Rehabilitating forestland, planting new trees, increasing forest productivity and reducing illegal tree logging will lead to a 50% increase of CO_2 sinks.

Education and public awareness on climate change issues

The experts of the project on climate change in Kyrgyzstan took active part in the development of the Concept of Continuous Environmental Education and standard programmes on ecology and safety of human activities. These courses are mandatory within education standards for all professions in higher educational institutions. They include teaching materials on the global climate change issues and its impact on population health.

To enhance public awareness on climate change issues and to provide experts, schools, academic institutions with expertized materials in the relevant areas the following publications were prepared by the project teams:

- "Climate and Environment" (book);
- Three issues of the Information Bulletin "Enabling the Kyrgyz Republic to Prepare its First National Communication in Response to its Commitments under the UNFCCC", both in electronic and hard copy versions;
- "Sustainable Development of Environmental and Economic Systems under the Climate Change Conditions" (manual on sustainable development issues);
- A thematic collection of articles covering climate change issues;
- "Kyrgyzstan and UNFCCC" web-site developed and published in the Internet.

Six video clips have been prepared and broadcasted by the main television channels in Kyrgyzstan. Moreover, several debates and four round-table discussions have been arranged for ecological TV programmes. Finally, information on the main climate change issues was regularly highlighted in many popular newspapers in Kyrgyzstan.

Civil sector experts were actively involved in activities under this climate change project – those were experts from schools, academic and research institutions, NGOs (about 100 people).

Climate change issues, objectives and outcomes of the project were discussed at more than 40 round-tables, seminars, and conferences on environmental problems and sustainable development organised by different organizations and NGOs.

Within the framework of the project five workshops with wide community and NGOs participation were conducted with the purpose of informing them about the goals and tasks of the project, preliminary results, and the project in general.

Prospects and further activities

- Improvement of climate models, regional circumstances taken into consideration
- Development and implementation of adaptation measures with respect to the ecosystems and economic sectors that are most susceptible to climate change
- Development and implementation of GHG emission reduction measures and enhancement of sinks
- Institutional capacity building in order to carry out the commitments of the Kyrgyz Republic under the UNFCCC
- Improvement of education and public awareness on climate change issues in order to involve the general public in the decision-making process
- Stimulation of climate change research.

1. INTRODUCTION

This Communication has been prepared within the framework of the GEF/UNDP project #KYR/00/G31 “Enabling the Kyrgyz Republic to prepare its first National Communication in response to its commitments to the UN Framework Convention on Climate Change”.

The Framework Convention is a part of International Development Goals, which have been defined in the Declaration of the Millennium. Sharing and supporting the goals of the world community the Kyrgyz Republic declared the above goals in its legislation, namely, in the laws “On Environmental Protection” and “On Protection of the Atmosphere”. The law of the Kyrgyz Republic “On Joining the UN Framework Convention on Climate Change” was approved by the Legislative Assembly of the Jogorku Kenesh (Parliament) of the Kyrgyz Republic on 10 November 1999, by the Peoples’ Representatives Assembly of the Jogorku Kenesh of the Kyrgyz Republic on 17 January 1999, and signed by the President of the Kyrgyz Republic on 14 January 2000.

As a Party to the UN Framework Convention on Climate Change, the Kyrgyz Republic should, on a regular basis, submit the results of its greenhouse gas emission inventories and any other relevant information. On the whole, the first National Communication has been prepared in order to assess the current situation in Kyrgyzstan in the light of the Framework Convention.

The First National Communication covers the following basic areas:

- GHG inventory by emission sources and removals by sinks not controlled by the Montreal Protocol;
- Forecast of the main climate indicators for Kyrgyzstan in case of an increase of GHG concentrations in the atmosphere using global climatic models;
- Vulnerability assessment of the main sectors of the Kyrgyz economy and natural ecosystems on the basis of forecasted climate change and elaboration of adaptation measures;
- Assessment of the emission reduction potential and GHG sinks increase, elaboration and assessment of measures aimed at mitigating the impact on the climate;
- Enhancement of education and public awareness.

Following the IPCC recommendations, the year 1990 was taken as a base year.

Preliminary outcomes were discussed and approved at the following interdepartmental workshops, in which representatives of all interested ministries, state bodies, organisations, and NGOs of the Kyrgyz Republic participated, as well as the international experts from Kazakhstan:

- “Greenhouse Gas Inventory” (11-14 July 2002, Lake Issyk-Kul)
- “Vulnerability Assessment and Adaptation”, and “Development of Climate Impact Mitigation Measures for the National Strategy” (22-26 July 2002, Lake Issyk-Kul)
- “Discussion of the Draft of the First National Communication of the Kyrgyz Republic on Climate Change” (5 November 2002, Bishkek).

2. NATIONAL CIRCUMSTANCES

2.1 General information about the Kyrgyz Republic

The Kyrgyz Republic (Kyrgyzstan) is located in the centre of the Asian continent, in the north-east Central Asia between 39° and 43° north latitude and 69° and 80° east longitude. The Republic borders Kazakhstan to the north, China to the south-east and east, Tajikistan to the south-east, and Uzbekistan in the west. The length of the Kyrgyzstan's borders is 4,508 km, its total area is 199,900 km^2. The highest point of the Republic is the Pobeda Peak (7,439 m) and the lowest – some 350 m above sea level – is located in the south-west of Kyrgyzstan. The average height of the Republic is 2,750 m above sea level with about 94% of the territory higher than 1,000 m, 90% more than 1,500 m, and 40% more than 3,000 m above sea level.

Table 2.2 General information about the Kyrgyz Republic

Administrative unit	Population, (in thousands)	Territory, (in thousand km^2)
Batken oblast	393.1	17.0
Jalal-Abad oblast	893.7	33.7
Issyk-Kul oblast	417.8	43.1
Naryn oblast	254.6	45.2
Osh oblast	1,211.0	29.2
Talas oblast	203.6	11.4
Chui oblast	765.6	20.2
Bishkek city	768.0	0.1

It should be underlined that all natural features of Kyrgyzstan: its climate, landscapes, soils, water resources, flora and fauna, as well as social and economic conditions of life are determined by these high mountains.

The Kyrgyz Republic possesses relatively large reserves of natural resources – 75% of forecasted reserves of coal and 39% of potential reserves of hydro-energy for the whole of Central Asia, of which only 1% is used. Natural gas and oil resources, including those extracted for industry, are relatively insignificant. Non-conventional energy sources are almost non-existent. A significant proportion of fuel resources is imported.

When the population density in the Kyrgyz Republic (24 persons per km^2) is compared to that of other countries, it looks like there is more than enough space for all social and economic funcions. However, it should be noted that only 19% of the total area of the Republic could be described as a habitable area (comparatively comfortable), 35% – as habitable, but not prime living area, and the remaining 45% – as inhospitable (inhabitable).

The Kyrgyz Republic is a unique region in Central Asia from the point of view of biodiversity. There are more than 500 species of invertebrates, including 83 species of mammals, 368 species of birds, 28 species of reptiles, 3 species of amphibians, 75 species of fishes, 3,000 species of insects, and more than 4,500 species of higher plants. A relatively small area of the Republic is presented by a significant biodiversity: 0.4 species of mammals, 1.8 species of birds, 0.14 species of reptiles, 0.23 species of fishes fall into 1,000 square km in Kyrgyzstan, while these figures are somewhat smaller in neighbouring countries.

Figure 2.1. Administrative map of the Kyrgyz Republic

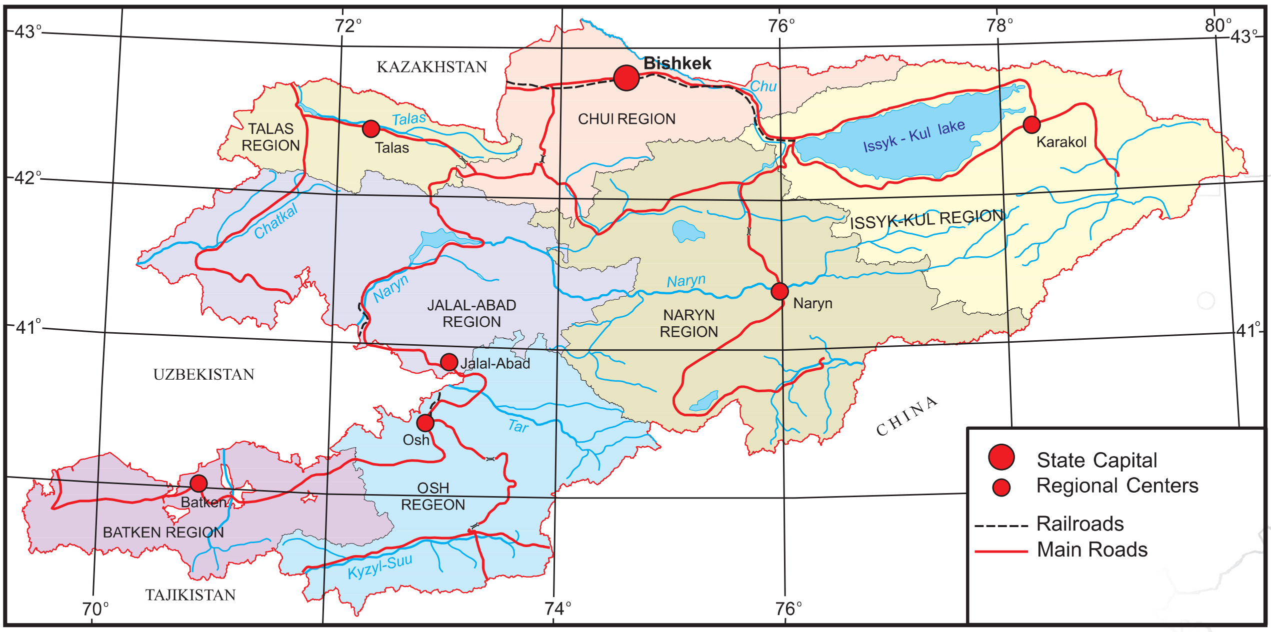
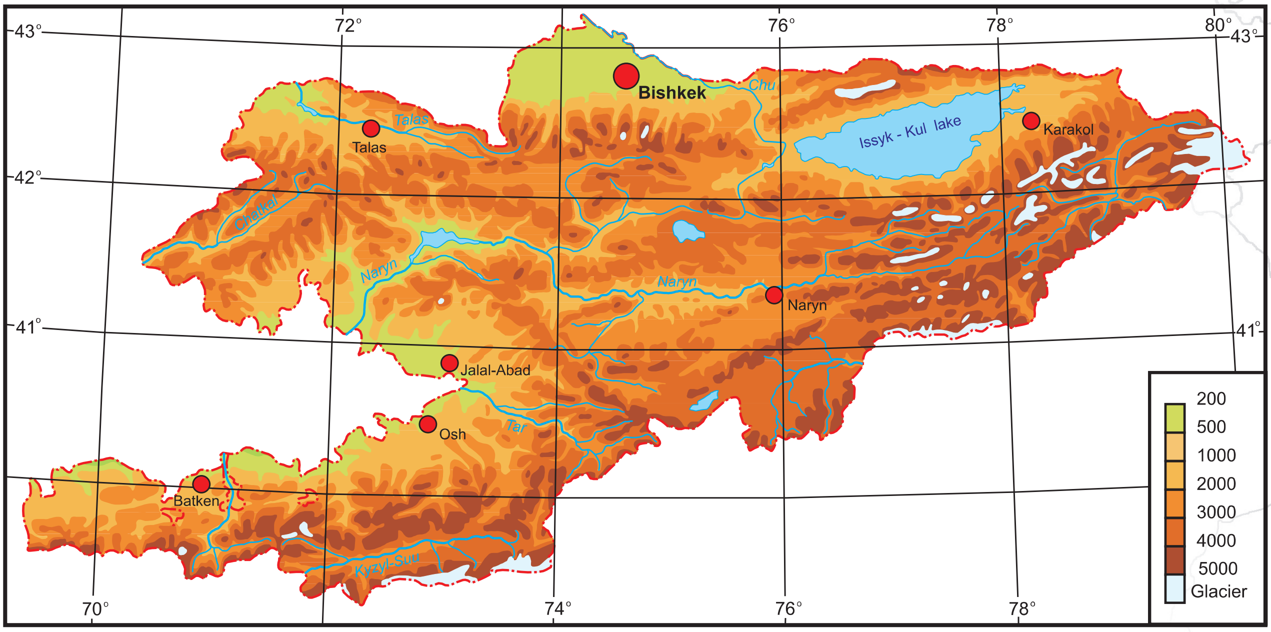


Figure 2.2. Physical map of the Kyrgyz Republic



The territory of the Kyrgyz Republic as a high-mountain ecological system is especially vulnerable to natural and human influence. Nine out of 20 most dangerous natural processes in the world are widespread in Kyrgyzstan. These are earthquakes, mudflows, avalanches, landslides, floods, rockslides, lakes in danger of bursting, under-flooding, and snow-slips.

Table 2.2 General information about the Kyrgyz Republic

Indicator	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Population as of the end of the year	ths people	4,424.9	4,502.4	4,528.4	4,505.1	4,525.0	4,595.8	4,661.0	4,731.9	4,806.1	4,867.4	4,907.6
Annual population growth	%	-	1.72	0.57	-0.52	0.44	1.54	1.40	1.50	1.54	1.26	0.82
Urban population	%	37.5	37.4	36.9	36.0	35.6	35.5	35.1	34.9	34.8	34.7	34.8
Migration outflow	ths people	4.9	33.8	77.4	120.6	51.1	18.9	11.7	6.7	5.5	9.9	22.5
Population density	people per km^2	22.1	22.5	22.6	22.5	22.6	23.0	23.3	23.7	24.0	24.3	24.6
Gross National Product	USD per capita	-	1160	820	850	610	700	550	480	350	300	-
Gross internal product, total including:	USD per capita	-	1550	810	850	610	690	-	-	-	337	279
industry	%	26.4	27.5	32.1	25.1	20.5	12.0	11.1	16.5	16.3	21.7	
agriculture	%	32.7	35.3	37.3	39.0	38.3	40.6	46.2	41.1	35.9	34.8	
construction	%	7.7	6.3	3.9	5.4	3.4	6.1	6.0	4.5	4.5	3.0	
transport and communication	%	4.8	3.3	2.6	3.6	4.1	4.2	4.1	3.9	4.1	4.2	
trade and food	%	4.0	4.2	3.5	6.5	9.7	11.0	10.4	10.5	12.6	12.9	
Gross internal product taking into account Purchasing Power Parity	USD per capita	-	3,239	2,776	2,328	1,712	1,880	1,745	2,170	2,317	2,573	-
Annual inflation rate	% as of the previous year	-	113.0	2,132.7	1,029.9	162.1	132.1	134.8	113.0	116.8	139.9	110.0
Effectiveness of energy consumption for commercial needs	equivalent kg of oil per 100 USD of GDP	-	-	-	236.6	367	207.2	213.9	196.3	209.4	284.1	276.5
Poverty rate, total including:	%	-	-	-	-	-	-	43.5	42.9	54.9	55.3	52.0
urban area								30.3	22.2	42.2	42.4	43.9
rural area								49.6	55.3	62.4	60.0	56.4
Official unemployment rate	%	-	-	0.5	0.6	1.6	2.2	3.1	2.2	2.2	2.8	3.0
Literate rate of population	%	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	98.7	98.7
People having higher education	% of population above 15	-	-	9.4	9.4	10.8	10.8	10.8	10.8	10.8	10.5	10.5
Life expectancy at birth, including:	years	68.5	68.76	68.27	66.78	65.42	65.49	66.65	66.77	67.15	68.28	68.5
men		64.2	64.59	64.21	62.51	61.14	61.26	62.45	62.52	63.07	64.47	64.9
women		72.6	72.74	72.17	71.10	69.92	69.92	71.00	71.17	71.32	72.18	72.4
Infant mortality	per 1,000 alive-born people	30.0	29.71	31.62	32.87	29.62	27.71	26.58	28.61	25.99	22.68	22.6
Number of doctors	per 100,000 of population	-	341.24	334.95	311.84	309.64	320.8	329.35	305.78	301.0	287.4	-
Population having access to safe drinking water, including:	%	-	-	-	-	-	81.8	81.3	82.6	86.5	85.9	81.5
urban area							95.5	98.4	99.7	95.0	92.8	99.1
rural area							73.9	73.7	72.0	74.2	74.5	72.1
Water consumption, total including:	mln m^3	8,993	8,954	8,953	8,535	8,257	6,942	6,871	6,163	6,420	5,251	4,976
industrial needs		623	674	526	347	277	254	153	142	138	61	48
irrigation and agricultural needs		8,076	7,991	8,143	7,870	7,671	6,410	6,359	5,706	5,963	4,960	4,749
practical and drinking needs		294	249	253	289	293	279	357	316	309	208	182

2.2 Climate

The Kyrgyz Republic is a typical high mountain country with an arid continental climate and large temperature range. Along with this, separate parts of its territory differ dramatically from one another due to a wide range of natural factors, thus causing a mix of natural conditions, resulting in considerable inter-regional differences. Four climatic zones are clearly distinguished: North and Northwest Kyrgyzstan, Southwest Kyrgyzstan, the Issyk-Kul basin, and the Internal Tien-Shan. Up to four vertical climatic zones can be distinguished: lowland (from 500-600 to 900-1,200 m above sea level), middle mountain (from 900-1,200 to 2,000-2,200 m), high mountain (from 2,000-2,200 to 3,000-3,5000 m), and nival (3,000-3,500 and above). A significant climate-forming factor is high ranges, predominantly of sub-latitude location, separated by deep valleys and basins. A description of different types of valleys is given below that takes into account about 75% of the population and the main agricultural and industrial production that is concentrated in the most suitable for life low- and middle mountains.

Chui valley within Kyrgyzstan boundaries is limited in the south by the northern slopes of the Kyrgyz Ala-Too with summits of up to 4,800 m – to the east extending into the Kungey Ala-Too -, to the north by the Chu river and Zail Ala-Too. To the west the flat lands of the valley adjoin the Betpak-Dala desert plateau and Muyun-Kuna sands. The normal yearly precipitation in different climatic zones of the valley ranges from 300 to 500 mm/year. The normal precipitation is gradually increasing as the land becomes higher in the vicinity of the Kyrgyz Range. Precipitation is sharply irregular during the year, with the main volume falling in Spring and Autumn. The climate is highly varied with long hot summers, and relatively short but cold winters. The average temperature of the hottest month (July) is +24.4°C with its maximum of +43°C. The average temperature of the coldest month (January) is -5.0°C with its minimum of -38°C. The wind pattern plays one of the main roles in the climatic characteristics of the Chui valley. Westerly winds, which the valley is open to, are usually gusty and quite powerful. They precede precipitation, temperature decrease, and frosts in spring and fall.

Fergana valley is an intermountain basin between the Tien-Shan range in the north and the Gissaro-Alay in the south. The valley is flat and triangular in shape, limited by the Turkestan and Alay ranges in the south, Kuramyn and Chatkal ranges in the north-west, and Fergana range in the north-east. The valley's climate is continental: arid with very warm summers and fairly mild winters. The average temperature of the hottest month (July) is +25.4°C with its maximum of +38°C. The average temperature of the coldest month (January) is -3.4°C with its minimum of -29°C. The normal yearly precipitation in the central lower part of the basin is 100-120 mm, with an increase in the west of up to 500 mm.

Issyk-Kul valley is located to the east of the Chui valley and surrounded by the Kungey Ala-Too range to the north and Terskey Ala-Too to the south. The region is referred to as a high mountain area. The larger part of the territory is located from 2,500 to 3,000 m above sea level. The region's territory consists of two different types of surface: Lake Issyk-Kul and the high mountain spaces or 'syrts', located to the south of the Terskey Ala-Too range. The basin's climate is moderate, mitigated by the vast water basin of the unfreezing lake with cool winters and moderate warm summers. The average temperature of the hottest month (July) is +18.2°C with its maximum of +34°C. The average temperature of the coldest month (January) is -4.5°C with its minimum of -23°C. A permanent wind blows across the lake's surface and up the mountains, causing responsive movements from the slopes of neighbouring ranges. The norm of precipitation ranges from 120 to 420 mm/year for different areas of the basin. The syrts' climatic conditions are characterised by severe, constant winds, high nebulosity, and low temperatures. The winter is cold and prolonged. The average temperature of the hottest month (July) is +10°C with its maximum of +24°C. The average temperature of the coldest month (January) is -20°C with its minimum of -42°C. The normal yearly precipitation is about 250-300 mm/year.

Talas valley is a geographically isolated area, which is situated in the north-west part of the Republic, and delineated by the Kyrgyz range to the north, the border with Kazakhstan to the west and north-west, and Talas Ala-Too range to the east and south. The average temperature of the hottest month (July) is +20.3°C with its maximum of +40°C. The average temperature of the coldest month (January) is -7.5°C with its minimum of -38°C. The normal yearly precipitation is 300 mm/year.

Naryn valley is one of the largest within the Inner Tien-Shan. It stretches east-west for more than 200 km. It is a narrow long intermountain corridor. The width of the Naryn valley in the upper reaches does not exceed 5-7 km, and widens to the bottom up to 20-25 km. The valley forms a separated Togustoruss basin in the most western point, at the Fergana range foothill. The Naryn valley is located at 2,250 m above sea level in the east and 1,300 m in the west. The valley is limited by mountain ranges: Kekerimtau and the South Kavak, Bauralbas, Kaptakas and Jetim to the north, and Jamantau, Baibichetau, Karatau, Alamyshyk and Naryntau to the south. The Naryn valley's climate is continental with sharp temperature changes. The average temperature of the hottest month (July) is +12.4°C with its maximum of +35°C. The average temperature of the coldest month (January) is -17.1°C with its minimum of -38°C. The normal yearly precipitation ranges from 200 to 500 mm/year.

2.3 Population

The permanent population in the Kyrgyz Republic at the end of 2000 was 4.9 million people. The average population growth rate for the last 10 years is about 1.0% per year. The main indicators of living conditions in the Kyrgyz Republic are presented in Table 2.3.

According to the official statistics, 65% of the population lives in rural areas. A significant part of the rural population migrates to big cities because of the lack of well paid jobs. Thus, according to the statistics of the Ministry of Public Health, the actual number of Bishkek residents increased by 50% recently.

Table 2.3. Main indicators of living standards in Kyrgyzstan

Indicator	Unit of measurement	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Human development index		0.908	0.873	0.715	0.699	0.676	0.676	0.688	0.696	0.701	0.706	0.719
Life expectancy index		-	-	0.722	0.705	0.683	0.683	0.693	0.698	0.702	0.7	0.725
Education index		-	-	0.870	0.867	0.855	0.859	0.862	0.869	0.879	0.888	0.895
Income index		-	-	0.552	0.526	0.490	0.487	0.508	0.521	0.523	0.529	0.539
Number of privately-owned passenger cars (M1)*	Per 1,000 persons	40.2	41.3	36.6	34.2	36.9	41.2	35.4	35.4	37.1	36.7	36.8
Number of TV sets	Per 100 families**	94	89	86	80	73	66	58	58	51	48	41
Number of radio sets	- // -	89	86	82	77	70	62	55	55	49	47	39
Number of tape-recorders	- // -	53	57	56	54	51	47	44	44	39	37	31
Number of refrigerators	- // -	82	63	60	57	52	48	43	42	39	37	33
Number of washing machines	- // -	86	88	87	85	80	76	71	70	66	63	58
Number of electric vacuum-cleaners	- // -	35	-	-	33	32	30	27	27	24	23	20
Number of sewing-machines	- // -	66	61	59	57	55	52	49	48	47	45	43
Number of cameras	- // -	22	22	21	20	19	19	15	14	13	12	11
Number of motorcycles and scooters	- // -	13	13	12	11	10	9	8	8	7	7	6
Number of bicycles and motorised bicycles	- // -	69	68	65	60	53	46	39	38	32	31	24
Number of home phones, total, incl.:	Per 1,000 persons	50	-	57	57	61	62	60	61	61	61	61
urban		101	-	-	121	129	133	120	132	132	133	134
rural		19	-	-	22	23	23	22	22	22	22	22

* According to the classification of the United Nations Economic Commission for Europe (UNECE), M1 is a vehicle with a motor designed for transportation of passengers and with 8 seats other than the driver seat for an unspecified fully loaded mass (passenger cars).

** An average family for that period consisted of 4.7 persons.

A high level of literacy characterises the population of the Republic – more than 98%. More than 10% of the population older than 15 years of age possesses a graduate degree.

The officially registered unemployment rate is 3.0%, whereas the actual one is 11.5%, of which 62% are women.

The housing resources are 61,340 thousand m^2, or 12.5 m^2 per resident. Meanwhile, 65% of population has a floor space less then 5 m^2 per resident. The poverty rate is 56.4% of the whole population, and the trend indicates a continual increase.

According to the main medical indicators of health (sickness and mortality rates, number of doctors and medical institutions, etc.), the Kyrgyz Republic is about average among the Central Asian republics.

2.4 Main economic indicators

For the last 10 years the economy of Kyrgyzstan has undergone changes common for all CIS countries in many respects. After the period of gradual growth and relative welfare until 1991, the economic recession followed till 1996. Since 1996 economic conditions have somewhat stabilised. The recession has affected the processing industry most significantly. In addition to the overall recession, the economy of Kyrgyzstan has undergone considerable structural change – in the first place the growth in the share of the extraction industry compared to the share of the processing industry. Thus, the economy changed from industrial-agricultural into extraction-agricultural. Light industries and processing industries have almost entirely been reoriented to the domestic market. Only recently there were attempts initiated to introduce the output of woollen, knitting and clothing industries to external markets, once being widely exported out of the Republic. The basic exporting industries are mineral resource industry and power engineering.

The GDP increase, marked since 1996, has been de facto based on the launching of the gold-mining industry "Kumtor", which provides about 16% of GDP. Figure 2.3 shows GDP volume by sectors compared to 1990 in percent.

Figure 2.3. GDP volume by sectors compared to1990 (in percent)

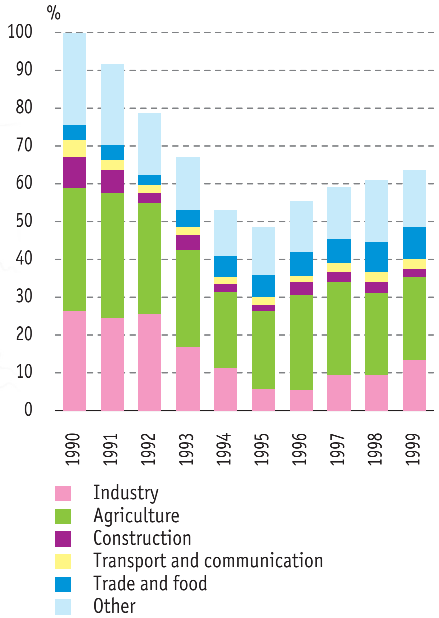
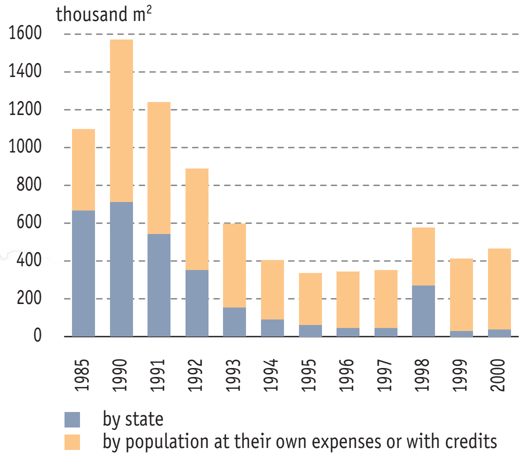


Figure 2.4. Volume of new public and private housing construction in the Republic



2.5 Construction

Almost all regions of permanent settlements fall into the climatic zones, for which building norms do not provide strict heat losses requirements. Such an approach to civil construction does not seem good in the context of the present project. Experimental calculations and energy saving measures (to reduce heat losses) in the panels of multi-storied apartment buildings carried out with TACIS financial and organisational support, revealed that relatively simple changes in construction technologies could reduce heat losses in the housing sector in the wintertime by 15%. Probably, similar conclusions can be implied with regard to industrial construction. Changes in the volume of housing construction are presented in the Figure 2.4.

2.6 Energy

The Kyrgyz Republic possesses significant probable reserves of coal (about 5 billion tons) and potential sources of hydropower of large and medium size rivers (18.5 million kWh on power and 140-160 billion kWh on output). Among 290 million tons of hydrocarbons, 110 million tons fall within the Fergana valley, 50 million tons – Alay valley, 30 million tons – Eastern-Chuy valley, 25 million tons – Issyk-Kul valley and 75 million tons – Naryn valley. Gas resources are valued at 6.5 billion cubic meters, and mineral oil – 12 million tons. Only Fergana valley has industrially recoverable resources of mineral oil and gas.

There are great potential resources of practically unused alternative energy: solar energy – 4.64 billion kWh or 23.4 kWh per km^2; wind energy – 2 billion kWh; geothermal energy – 613 GJ per year, of which 27% is feasible for development; resources of bio-mass processing (livestock waste) – 1.6 billion m^3 of methane, potential of small rivers – 1.6 million kW on power or 5-8 million kWh on output.

Table 2.4. Production and consumption of energy resources

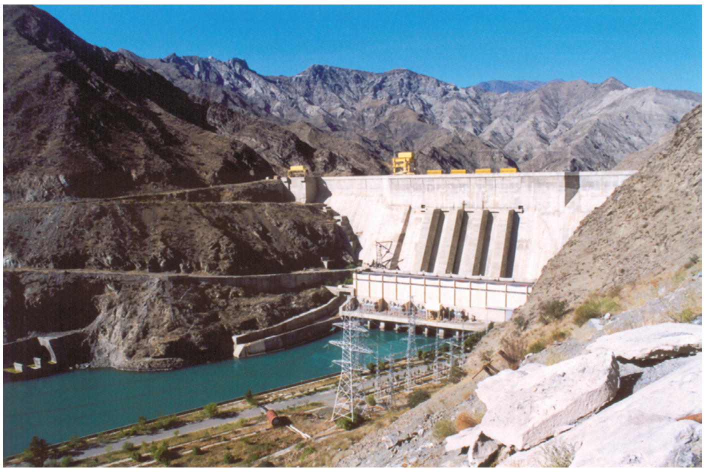
Energy resources	Unit	1990	1995	1999	2000
Production	**mln t.c.f.**	**6.60**	**2.80**	**2.40**	**2.81**
Coal	mln tons	3.7	0.5	0.4	0.4
Mineral oil	mln tons	0.15	0.09	0.08	0.08
Natural gas	bln m^3	0.1	0.04	0.02	0.03
Electric energy, including:					
HPS	bln kWh	8.95	11.1	12.4	13.6
TPS	bln kWh	4.20	1.16	1.0	1.2
NRES		-	-	-	-
Consumption	**mln t.c.f.**	**11.8**	**4.35**	**5.7**	**5.02**
Coal	mln tons	4.8	1.2	1.0	1.2
Mineral oil	mln tons	0.003	0.039	0.14	0.15
Natural gas	bln m^3	2.1	0.9	0.6	0.7
Electric energy	bln kWh	7.6	7.12	8.70	8.70

t.c.f. – tons of conventional fuel

The fuel and energy sector in Kyrgyzstan cannot meet the demand (see Table 2.4). In spite of the great availability of domestic resources, the country is significantly dependent on imports, which reduces the effectiveness of its economy.

The situation with mineral oil is accounted for by the lack of the necessary volume of recoverable reserves in Kyrgyzstan. The main reason for sufficient coal production is, first of all, high tariffs on coal haulage from production site (the south of Kyrgyzstan) to consumers (generally – the north), which amount to 300% of the production cost. In addition, economic and functional depreciation of mining and shaft equipment etc are high. Nevertheless constantly increasing demand for energy resources necessitates development of the coal-mining industry, and exploitation of new deposits, for example the large deposit at Kara-Keche.

It is assumed that Kyrgyzstan's dependence on energy import will not be significantly reduced in the near future. At the present time electricity is the only energy resource produced in the Republic in sufficient supply, both for domestic use and for export. Development of this branch in the last few years has been accompanied by an increase of the energy share produced by hydropower stations (up to 92.3%) and decrease of the electric energy share produced by thermoelectric power stations.



Kurpsai HPS. *Photo by V.Polynsky*

2.7 Agriculture

During the past 10 years agriculture underwent changes that in many respects are common to the economy of the Kyrgyz Republic as a whole. However, the recession in agriculture was not as significant as in industry, and during last years strong growth has been observed. The growth is a result of the change in the ownership structure in agriculture. In spite of the reduction of energy and water usage and also a considerable reduction in the use of fertilisers and other chemicals, it is possible to point out an increase in the harvest of basic crops.

Recently some negative factors have been clearly identified along with this positive factor and they demand taking immediate measures. Transition to a new economic system led to the emergence of new tendencies in agriculture towards de-industrialisation, using primitive manual labour with minimal product processing at most farms. At present, agriculture has become a sector that employs a low-income and poor segment of the population, this situation threatens future sustainable development of this sector.

Figure 2.5. Volume of agricultural production by types of proprietorship (1990 – 100%, no data available for 1991)

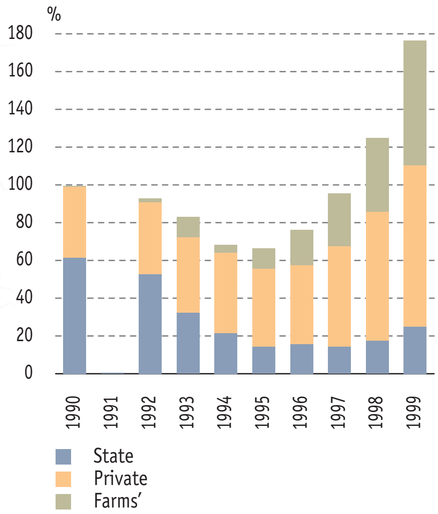


Table 2.5. Agricultural products by basic crops (thousand tons), livestock (thousand heads of cattle) and poultry (mln heads)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Plant growing											
Sugar-beet including											
Factory-made	1.7	12.7	135	220	114	107	190	206	429	536	450
Mangel-wurzel	19.2	21.8	17.4	11.1	5.1	1.2	2.2	0.6	1.1	1.3	2.6
Potatoes	356	326	362	308	311	432	562	678	774	957	1046
Rice	2.1	2.5	2.8	2.4	3.9	6.7	9.2	11.7	11.0	15.1	19.0
Oats	15.3	11.7	12.1	8.1	7.3	3.2	3.2	2.7	3.1	4.6	2.8
Wheat	482	434	634	831	566	625	964	1274	1204	1109	1039
Barley	592	556	582	477	288	159	166	152	162	180	150
Maize for grain	406	364	281	184	129	116	182	171	228	308	338
Cotton	80.8	-	-	-	-	74.5	73.1	62.4	77.8	86.9	87.9
Tobacco	53.9	-	-	-	-	17.6	17.9	25.7	28.1	29.8	34.6
Oil-yielding crops	0.0	-	-	-	-	20.1	34.9	37.8	43.8	57.9	53.4
Vegetables	487	-	-	-	-	318	368	479	556	720	747
Cattle breeding											
Cattle	1,205	1,190	1,122	1,062	920	869	848	885	911	932	947
Sheep and goats	9,972	9,525	8,742	7,322	5,076	4,275	3,716	3,805	3,811	3,806	3,799
Pigs	393	358	247	169	118	114	88	92.6	105	105	101
Horses	313	320	313	322	299	308	314	325	335	350	354
Camels	308	283	291	272	284	193	187	155	152	128	170
Donkeys	15.1	14.2	16.7	20.9	20.3	23.4	21.8	28.2	27.2	31.3	35.2
Poultry of all sorts	13.9	13.6	10.4	6.9	2.2	2.0	2.1	2.3	2.7	3.0	3.1

2.8 Land Resources

The Kyrgyz Republic is located at the apex of three large soil-climatic phases of Eurasia: Turan, Western Asian and Central Asian. A complex mountain relief and the interaction of many natural factors have lead to the formation of a great variety of soils (from desert and subtropical zones to Arctic).

The structure of Kyrgyzstan's topsoil is presented by the following soil zones that are located from lower altitudes to the higher ones: desert, desert-steppe, dry steppe, steppe, mountain-forest-meadow-steppe, mountain-meadow, meadow-steppe sub-alpine and alpine, upland steppe and desert. The soils of Kyrgyzstan are divided into two large groups:

- soils of mountain depressions and 'syrt' uplands;
- soils of mountain slopes.

The structure of land resources is presented in Table 2.6.

Table 2.6. Distribution of land resources by end use (in thousand hectares)

End Use	1985	1990	1995	1997	1998	1999
Land within the administrative boundaries – total	19,994.5	19,994.5	19,994.5	19,994.5	19,995.1	19,995.1
including:						
Agricultural use	16,064.9	16,026.2	11,647.1	7,677.3	7,139.4	5,995.7
including: arable	1,289.3	1,295.7	1,299.1	1,300.8	1,260.1	1,261.7
landperennial plantation	44.1	44.7	44.4	42.0	41.7	40.1
Industry and other non-agricultural use	906.7	904.1	888.8	236.8	238.6	234.7
Nature reserves	27.2	40.7	146.4	314.7	350.0	350.0
forest resources	1,082.9	1,072.3	1,107.1	2,383.0	2,601.0	2,617.4
water resources	96.1	97.0	93.7	93.6	93.3	93.4
reserve lands	1,409.1	1,440.0	5,719.9	8,304.1	9,294.3	10,419.3
lands pertaining to settled areas	51.9	58.5	137.4	153.1	179.4	200.6
other lands	355.7	533.7	254.1	831.9	99.1	84.0

Irrigated land farming is the most significant branch of agriculture in Kyrgyzstan: up to 70-75% of the total area under arable lands. At the same time soils on the territory of Kyrgyzstan are prone to wind, water and pasture erosion, salinization, swamping, overgrowing by shrubs and other processes of degradation. Soils of foothill and middle-mountain valleys are dominated by water erosion (linked with irrigation), while the western parts of the Issyk-Kul basin, Kochkor and Altai valleys and Tash-Rabat valley are dominated by wind erosion. On mountain slopes there is widespread pasture erosion and also combinations of water, wind and pasture erosion. Territories with strongly eroded soils account for 31% of the total agricultural area, medium eroded 27.1%, and weakly eroded 17%. Non-eroded soils constitute only 3.5%. The rest of the territory is presented by soils with a combination of various levels of erosion.

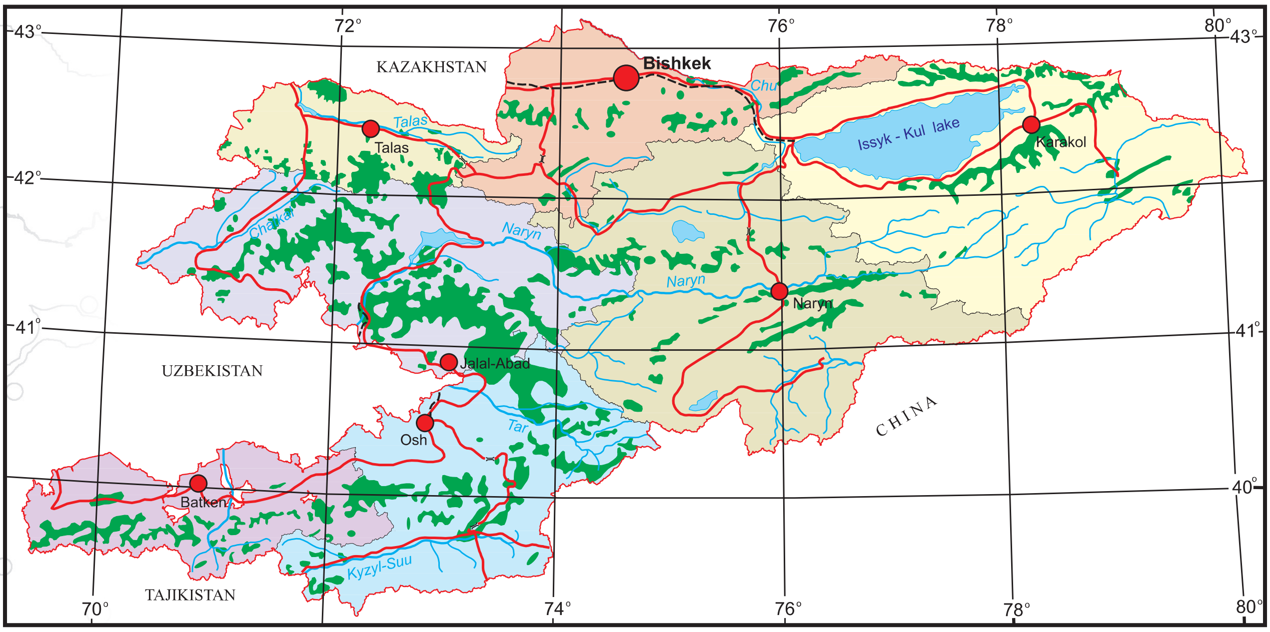
Irrigated land farming causes salinization and swamping of land. The total area of land affected by salinization and swamping exceeds 400 thousand hectares. Most of it is located in the Chui valley (223 thousand hectares) and valleys of the Internal Tien-Shan (128 thousand hectares).

Alamedin gorge. *Photo by V.Polynsky*

2.9 Forest resources

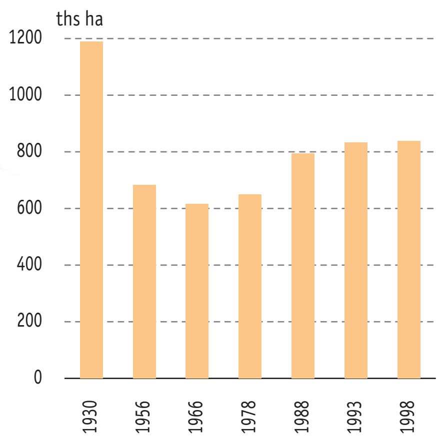
The total area of the state forest resources of the Kyrgyz Republic constitutes 2,6 million hectares (based on the registration conducted in 1998), including forest covered areas – 849.5 thousand hectares, shrubs covered areas – 342.6 thousand hectares. Forest zones account for 4.25% of the total territory of Kyrgyzstan. As a result of an intensive forest use within the period from 1930 to 1988 forest covered areas decreased, including major forest-forming species – spruce, walnut, archa tree.

Figure 2.6. Map of forest distribution on the territory of the Kyrgyz Republic



At the present time despite some increase in the forest-covered area, the quality of forests leaves much to be desired. According to the data from the last registration there is a tendency for forest senescence in the region. The process of forest senescence outstrips the process of forest recovery, and nowadays ripe and overripe woods account for 50% of the total reserve.

Figure 2.7. The dynamics of change in forest-covered areas in the Republic



Unique natural reserves of relic nut-fruit trees are under threat. Annually grown planting material of wood species numbered 20 million is supposed to hypothetically provide an increase in forest covered areas of about 10-15 thousand hectares, but inappropriate application of growing technology, damage caused by cattle and other human-induced factors result in the situation when forest recovery is very slow. Acclimatisation of forest species during the first year of growing is on average 70%, and during the second and third years of growing is not more than 65%.

Major forest-forming species are: coniferous – 36.4%; hard-leaf – 4.5%; soft-leaf – 1.9%; others – 57.2%.

2.10 Water resources

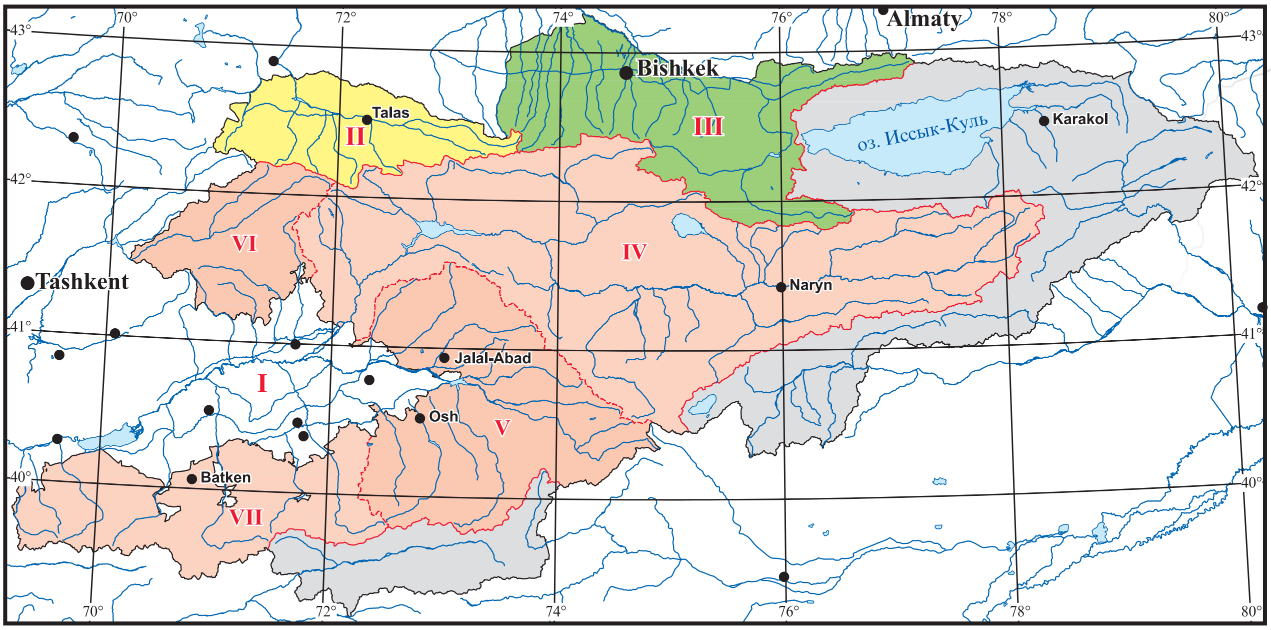
The territory of the Kyrgyz Republic is part of a closed basin of the Central Asia, which has no connection with the world's oceans. Water resources are vitally important and strategic not only for the Kyrgyz Republic, but also for the entire Central Asia. Possessing significant water reserves- more than 50 km^3/year of surface river flow, 13 km^3/year of subsurface water resources, approximately 1,745 km^3 in lakes and 500 to 650 km^3 of fresh water in glaciers, Kyrgyzstan spends only 12 to 17% of surface flow on its needs.

The greatest part of the river network belongs to the Aral Sea basin and pertains to the system of the largest rivers of Central Asia: the Syrdarya, the Amudarya, the Chu, and the Talas. Rivers flowing into the drainless Lake Issyk-Kul may also relatively belong to this group. The river network in the south-east of the Republic belongs to the Tarim river basin. In Kyrgyzstan the mountain area of river flow formation accounts for 87% of the total territory, while the area of flow dispersion accounts for 13%.

View from Korona peak. *Photo by V.Polynsky*

Major rivers of Kyrgyzstan are the Naryn (water discharge in the upper reaches amounts to 90 m^3/sec and in the vicinity of the mouth 429 m^3/sec); the Chu (average discharge of 53 m^3/sec); the Talas (average discharge where it leaves Kyrgyzstan – 33 m^3/sec); the Jargalan (average discharge 22 m^3/sec); the Ton (average discharge 10 m^3/sec); the Kyzyl-Suu (western) (average discharge approximately 65 m^3/sec); the Sary Jyz (average discharge on the border with China reaches 140 m^3/sec).

Figure 2.8. Major hydrological basins



I – Syrdarya river; II – Talas river; III – Chu river; IV – Naryn river (Syrdarya); V – Karadarya (Syrdarya);
VI – rivers forming the northern border of the Fergana Valley; VII – rivers forming the southern borders of the Fergana Valley.

There are 1,923 lakes with the total area of 6,836 km^3 in Kyrgyzstan, the largest of which are Issyk-Kul (surface area – 6,236 km^2), Sonkul (surface area – 275 km^2) and Chatyr-Kul (surface area – 175 km^2).

The total energy potential of 252 large and medium rivers of the Republic is estimated at 18.5 million kWh in terms of capacity and 162.5 billion kWh in terms of generating electric power.

The main types of water resources use in Kyrgyzstan are irrigation and agricultural needs. Underground water use accounts for a relatively small part of the total water consumption and is primarily used for providing water to large populated areas, for the needs of industrial production, and for economic and drinking purposes.

3. GREENHOUSE GAS INVENTORY BY SOURCES AND REMOVALS BY SINKS

As a Party to the United Nations Framework Convention on Climate Change, in its National Communication the Kyrgyz Republic should provide information on results of its greenhouse gas inventory of emissions by sources and removals by sinks. In order to achieve international comparability of inventory results, IPCC requirements apply. In preparing a GHG inventory calculation methodologies approved and agreed upon by the Conference of Parties must be used. The methodological basis for calculations of GHG emissions and removals by sinks agrees with the IPCC Guidelines (Revised 1996 IPCC Guidelines, IPCC/UNEP/OECD/IEA, 1997) and the IPCC Good Practice and Uncertainty Management in National Greenhouse Gas Inventories, 2000. The default factors applied in our calculations were taken from the IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, Revised 1996. In the absence of default approaches, it was permitted to apply national calculation methods and coefficients.

According to the Guidelines, the inventory was designed by sectors: energy, industries, solvents, agriculture, land-use changes and forestry, and waste. Emissions of the following GHGs were taken into consideration: carbon dioxide, methane, nitrous oxide, nitrogen oxides, carbon monoxide, non-methane volatile organic compounds (NMVOCs), sulphur dioxide, and halogens. Greenhouse gas inventory was implemented during the period of 1990-2000 in the Republic as a whole and, where appropriate, in the context of the 7 oblasts (provinces) and Bishkek city. In concordance with IPCC Guidelines, the year 1990 was taken as a base year.

Inventory results, according to Guidelines statements, are expressed both in mass units for certain GHGs and in relative units of CO_2 equivalent. The latter are applied to compare the contribution of various gases to total GHG emissions and depend on the value of their global warming potentials (GWP).

Carbon dioxide's GWP was assumed as the unit; potentials of other gases were defined in relation to that. Though any period may be chosen for comparison, 100 years (as recommended by IPCC) was applied as a period for GWP calculating in the national inventory (see Table 3.1).

Table 3.1. Global warming potentials of the main greenhouse gases

Greenhouse gas	Chemical formula	Period of existence, years	GWP for the period of:		
			20 years	100 years	500 years
Carbon dioxide	CO_2	Changeable	1	1	1
Methane	CH_4	12	63	23	7
Nitrous oxide	N_2O	114	275	296	156

Note: in addition, GWP for halogens not controlled by the Montreal Protocol were defined
Source: Climate Change 2001. The Scientific Basis, IPCC, 2001.

3.1. Methodologies and data sources

The information base for GHG emission assessment is information on fuel and energy resources use, the existence of GHG sources, volumes of production giving GHG emissions. The following information sources were used:

- Official publications by the National Statistics Committee;
- Internal information of ministries, state institutions and organisations;
- Information provided by national experts.
- Data in mass media.

Information on similar items sometimes varies by different sources. Therefore, all information sources were ranged by level of reliability. The highest degree of information reliability was given to official publications by state statistics bodies, and further in descending order:

- Internal information of ministries, state institutions and organisations;
- Information provided by national experts;
- Data obtained through calculations;
- Data in mass media.

3.1.1. Energy sector

In the overall economy, the energy sector is the largest GHG emission source in all countries around the world. The Kyrgyz Republic is no exception. The following items were included in the energy sector:

1. Coal consumption in the following areas of the economy:

    - in energy sector – energy production in the fuel and energy sector;
    - in industry and construction – heat power production for technological needs and heat supply;
    - in commercial and housing sectors – heat supply for municipal and public buildings, state housing and private sector.

2. Use of cokes in foundries and blacksmith manufacturing.

3. Consumption of natural and liquefied gas in the following areas:

    - in energy sector – energy production in the fuel and energy sector;
    - in industry – heat power production for technological needs;
    - by motor vehicles;
    - in the housing sector.

4. Liquid fuel consumption:

    - black oil fuel as additive to bituminous coals in power engineering;
    - aviation kerosene in civil aviation;
    - petrol, diesel oil and lubricants for motor vehicles, marine transport, construction and agriculture machines and mechanisms.

Most combustive-lubricating materials (CLM) are imported. Permanent domestic demand and differences in prices for CLM (compared to prices in neighbouring countries) make them very attractive in terms of smuggling, the volume of which, by estimation, exceeds legal imports 2 to 3 times. Therefore, official statistical data cannot serve as information base for the assessment of GHG emissions from CLM. Instead, CLM consumption was estimated on the basis of amount of technically operable MV units, taking into consideration the average annual run and/or average annual period of functioning, as well as normal CLM consumption per 100 km of run and/or per one hour of functioning. Average values of run or period of functioning were assumed taking into consideration types and categories of MVs, machines and mechanisms. CLM consumption standards are estimated by basic norms adopted in the Republic, with modifications depending on conditions of primary service.

Dry bio-mass in the form of wood and dry manure is conventionally used in domestic conditions as fuel. GHG emission from dry bio-mass is not included into the total amount; data on this are mentioned only as supplementary information.

3.1.2. Industrial processes

Industry in Kyrgyzstan includes the following GHG sources:

- Mineral products – production of cement, construction lime, glass, bitumen, and pitch mineral;
- Chemical industry – manufacture of polyethylene film and plastic wares;
- Metal production – stibium, mercury, re-fusion of ferrous and non-ferrous metals;
- Food industry.

The following GHGs emerge due to industrial processes: CO_2, NO_X, CO, NMVOC, SO_2.

For GHG emission assessment in the Kyrgyz Republic, default factors and methodologies recommended by the Guidelines were mainly used. For technological processes not reflected in the Guidelines, additional research was conducted to calculate GHG emissions. Those processes were as follows: production of stibium and mercury; core-mould casting, re-fusion of cast iron and non-ferrous metals; glass production; blasting operations.

A rather great variety of food products and absence of standard factors for all types of products required aggregation of food products into groups of produce with similar gas composition and similar specific emission factors.

3.1.3. Solvents

Chloride-derived carbohydrates are used in the Republic as solvents; those are trichloroethylene, perchloroethylene, dichloroethane and other. In accordance with national methodologies, it is assumed in the assessment of emissions from solvents that all of their volume passes to atmosphere when used, i.e. emission from solvents is equal to their use. Calculations were conducted only for 1995-2000, since official registration of imported halogenated derived carbohydrates had not been carried out earlier.

3.1.4. Agriculture

GHG emissions were estimated for the following main sources:

- Animal husbandry and poultry farming, which includes emissions due to enteric fermentation of farm animals and cattle (or livestock), as well as emissions resulting from gathering, storing and using animal and poultry waste (manure and guano);
- Rice cultivation (in inundated rice fields);
- Agricultural lands (emissions due to using fertilisers and growing certain crops);
- Field burning of agricultural residues;
- Natural fires in the mountains.

The following GHG emissions were defined: CO_2, CH_4, N_2O, NO_X, and CO.

Calculations for all sources, except natural fires in mountains, are implemented with methodologies recommended by IPCC using national factors. A specific approach was used in calculating emission in the case of natural fires in mountains.

3.1.5. Land-use change and forestry

Land-use change and forestry encompasses three types of activities leading to GHG emissions and removals by sinks; changes in forest and other woody bio-mass stocks; forest and grassland conversion; abandonment of managed lands.

At present there is no forest and grassland conversion into ploughed fields, as most of lands suitable for this purpose are already being used.

3.1.6. Waste

The waste sector comprises GHG emissions emerging from solid waste disposal, domestic and industrial wastewater purification.

In the Kyrgyz Republic, solid waste is disposed only in non-controlled dumps. According to expert estimations, waste produced by the population living in cities is disposed in non-controlled deep dumps. The population living in urban-type communities disposes wastes in non-controlled shallow dumps. Waste produced by the village population was not taken into consideration when emission volume was being estimated. The displacement rate method was applied to define the value of methane emissions.

Calculations of the value of methane emissions from domestic, communal sewage and sludgy waste, as well as emissions of nitrous oxide from anthropogenic sewage were performed according to standard methodologies.

3.2. Greenhouse gas emissions

3.2.1. Total greenhouse gas emissions

A brief description of GHG inventory results in the Kyrgyz Republic for 1990-2000 by sectors and categories of sources is presented in the Annex. Total emissions of all greenhouse gases in Kyrgyzstan in the base year 1990 amounted to 36,647 Gg in CO_2 equivalent, including 29,105.5 Gg of CO_2 emissions. Net emissions taking CO_2 absorption into account were 35,817 Gg. In 1990, specific GHG emissions were 8.28 tons per capita, 6.58 tons out of which was CO_2. The dynamics of total emission of main greenhouse gases (Figure 3.1) to a certain extent reflect the economic circumstances of Kyrgyzstan. The largest contribution to total GHG emissions is from energy sector, which makes up about 80% of 1990 emissions of all main GHGs in CO_2 equivalent, and 74% in 2000. The structure of main GHG emissions in CO_2 equivalent by sectors for 1990 and 2000 is demonstrated in Figures 3.2 and 3.3.

Figure 3.1. Dynamics of total emissions of main greenhouse gases in Gg of CO_2 equivalent

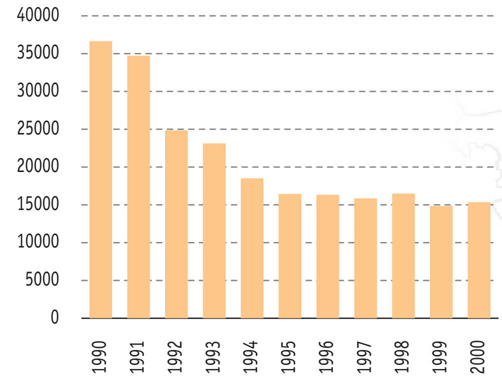
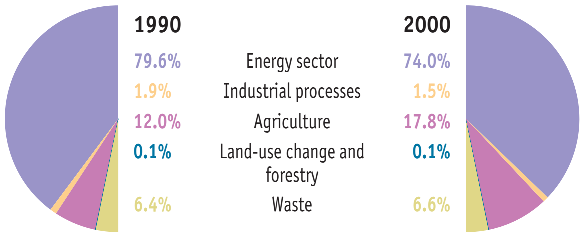
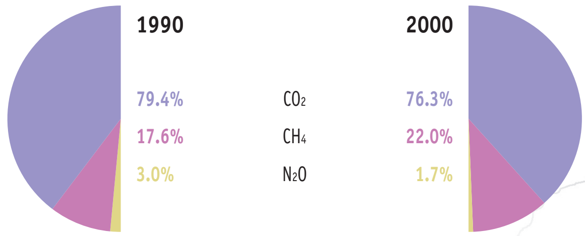


Figure 3.2. Distribution of total greenhouse gas emissions by sectors



Solvent sector is not shown here and further, as its contribution to total GHG emissions is insignificant.

Figure 3.3. Share of the main GHGs in total emission in 1990 and 2000



3.2.2. Emissions of greenhouse gases by oblasts

For industrial processes, proportion of GHG emission volumes by oblasts and Bishkek city in 1990 and 2000 is shown in Figures 3.4 to 3.8.

Figure 3.4. Distribution of CO_2 emissions by oblasts and Bishkek city

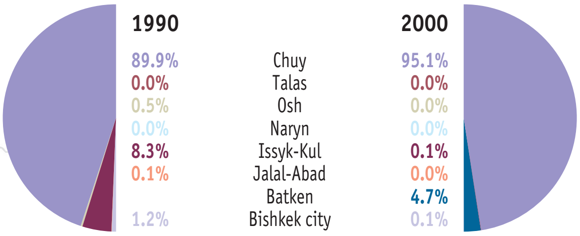


Figure 3.5. Distribution of NO_x emissions by oblasts and Bishkek city

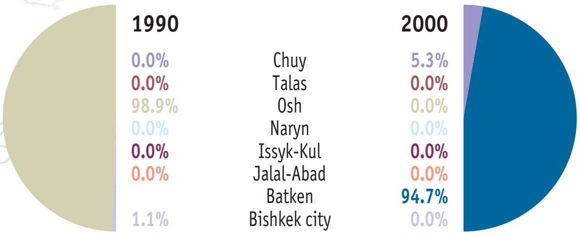


Figure 3.6. Distribution of CO emissions by oblasts and Bishkek city

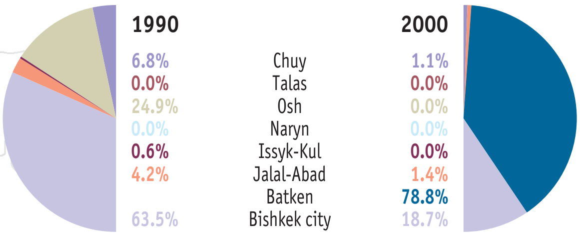


Figure 3.7. Distribution of NMVOC emissions by oblasts and Bishkek city

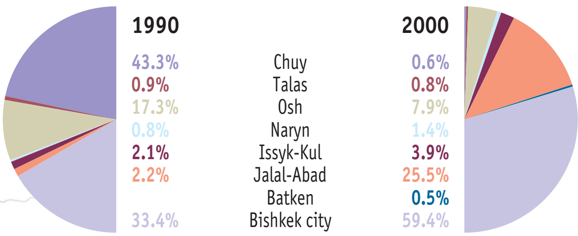
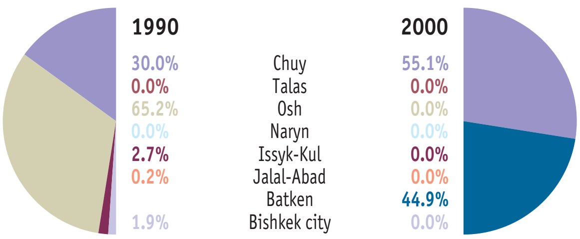


Figure 3.8. Distribution of SO_2 emissions by oblasts and Bishkek city



Changes in the proportions of NO_x and SO_2 emissions by oblasts – more precisely, the share of Osh oblast – between 1990 and 2002 are conditioned by the fact that, in 2000, the new Batken oblast (hosting the Haidarkan mercury metallurgical complex, a large GHG emission source) was split off from Osh oblast.

Changes in the distribution of CO_2 and, to some extent, NO_x, are related to a dramatic fall in industrial production in Bishkek, especially in machine building, in the early 1990s. This led to reduction of emissions from re-melting of ferrous and non-ferrous metals in Bishkek.

The main source of NMVOC emissions (up to 98%), both in 1990 and 2000, was the production of paving asphalt. In 1990, the main contribution to total NMVOC emission volume was made by Bishkek city, Chuy and Osh oblasts. The reason for this was road rehabilitation of the Bishkek, and Jalal-Abad sections of the Bishkek – Osh road.

Figure 3.9. Distribution of GHG emissions in agriculture by oblasts and Bishkek city in CO_2 equivalent

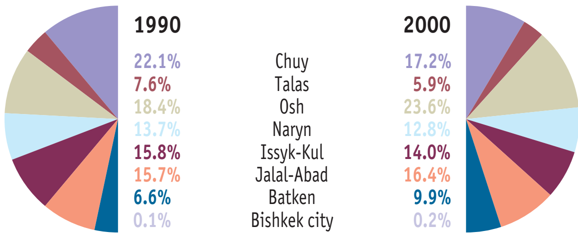
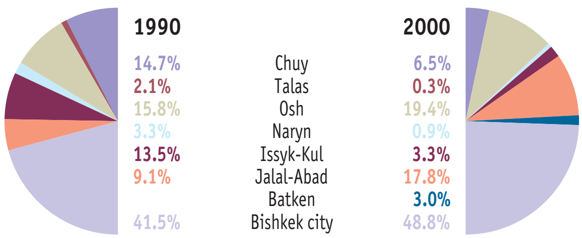


Figure 3.10. Distribution of methane emissions by oblasts and Bishkek city



The shares of oblasts in the total GHGs from agriculture with direct effect varies insignificantly (see Figure 3.9).

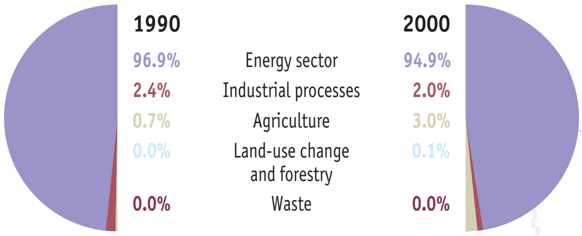
The allocation of methane emissions from industrial and household wastes, in essence, corresponds to allocation of urban population. Bishkek makes the largest contribution to total methane emission from waste; Naryn and Batken oblasts make the least contribution (Figure 3.10).

3.2.3. Carbon dioxide emissions

3.2.3.1. Total emissions

The contribution of different economic sectors to total CO_2 emissions is shown in Figure 3.11. The main source of carbon dioxide emission in Kyrgyzstan, as in many other countries, is the energy sector (96.9% in 1990 and 94.9% in 2000); more precisely, the burning of various kinds of fossil fuel, such as coal, natural gas and oil products.

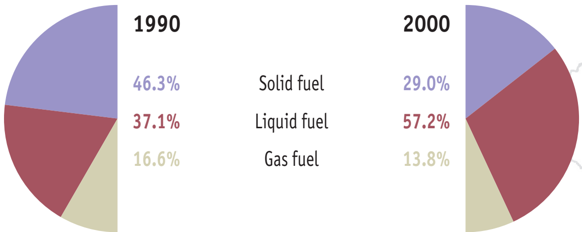
Figure 3.11. Contribution to the national CO_2 emission by sectors



3.2.3.2. Energy sector

In the Kyrgyz Republic, CO_2 emissions from burning various kinds of fuel have comparable shares (Figure 3.12). Distribution of CO_2 emissions from different kinds of fuel reflects the structure of fuel and energy consumption, which considerably changed within 10 years (see Table 3.2).

Figure 3.12. CO_2 emissions from various kinds of fuel in 1990 and 2000



In the context of the overall reduction in fuel and energy consumption, the decrease in coal use was more significant than that of other kinds of fuel, which led to a reduction in the share of coal in the balance of consumption, and an increase of liquid fuel share. The proportions of CO_2 emissions from burning local and imported coal remained almost stable and are equal to approximately 1:2.

Table 3.2. Comparative data on consumption of dilerent kinds of fuel in the energy sector

Fuel	Units	Consumption	
		1990	2000
Solid fuel	thousand tons	4,809	1,171
Liquid fuel	thousand tons	3,394	1,996
Gas fuel	million m^3	2,076	679

The structure of CO_2 emissions from burning liquid fuels is shown in Figure 3.13.

The structure of CO_2 emission by categories of sources is shown in Figure 3.14.

Figure 3.13. CO_2 emissions from liquid fuels in 1990 and 2000

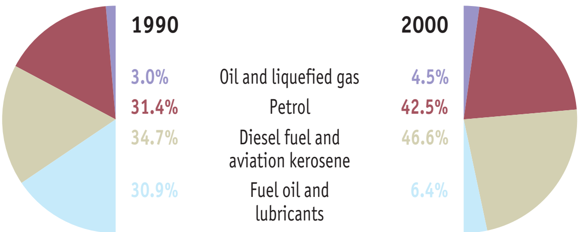
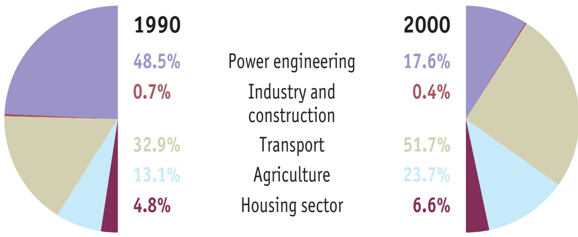


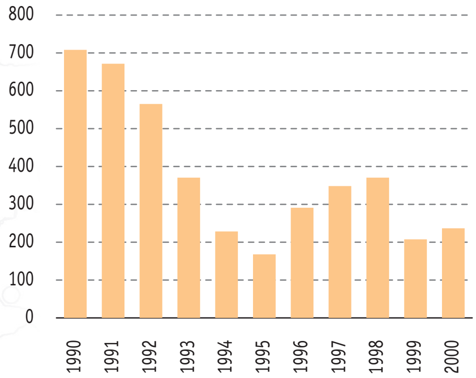
Figure 3.14. Structure of CO_2 emission by categories of the energy sector



3.2.3.3. Industrial processes

The dynamics of CO_2 emissions in the industrial sector is shown in Figure 3.15. The dynamics of CO_2 emissions from industrial processes in general reflects the condition of the industrial sector – steady reduction until 1995 and a relatively stable condition since 1996, without trends for either clear and stable growth or stagnation.

Figure 3.15. Dynamics of CO_2 emissions from industrial processes (in Gg)



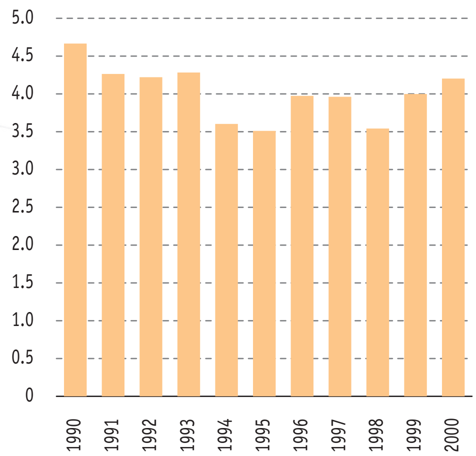
The production of minerals contributes a major share of CO_2 emission from industrial processes in Kyrgyzstan. In 1990, this share amounted to 98%, in 2000 to 95%. In this category CO_2 emission occurs owing to the production of cement, lime, and the manufacture and use of soda ash. The main contribution to total emissions is made by cement production; it exceeded 99% both in 1990 and in 2000. The rest of emission accounts for the production of lime, production and usage of soda.

CO_2 emissions from metal production amounted to 2% of total emission in 1990 and 5% in 2000. Cast iron and steel production abruptly fell between 1990 and 1994, mercury production remained stable from 1993 to 2000 (apart from a slight reduction in 1994 and 1995), stibium production was fairly stable until 1998, but in 2000 underwent a 5-fold reduction. Within the total CO_2 emissions from metal production in 1990, the emissions from metal re-melting amounted to just under 81%, and those from stibium production to 19% (in 1990 no mercury was produced). In 2000, CO_2 emissions from mercury production constituted up to 94% of total emissions from metal production. Emissions from stibium and ferrous metals were 4% and 2% respectively.

3.2.3.4. Land-use change and forestry

The dynamics of CO_2 emissions from forest and grassland conversion are shown in Figure 3.16. On the whole, the land-use change and forestry sector reflects natural carbon cycle trends. CO_2 removals in forests and other woody bio-mass stocks increase slowly but surely, while emissions from conversion have no clear trend. At the same time removal exceeds emission more than two times, but is more than 30 times less than national CO_2 emission (in 1990).

Figure 3.16. Dynamics of CO_2 emissions from forest and grassland conversion (in Gg)



3.2.4. Methane emissions

3.2.4.1. Total emissions

Owing to its high global warming potential, methane is the second important greenhouse gas after carbon dioxide. The dynamics of total CH_4 emissions in Kyrgyzstan are shown in Figure 3.17. Distribution of emissions over economic sectors is shown in Figure 3.18. Methane emissions do not take place from industrial processes and solvent use.

Figure 3.17. Dynamics of CH_4 emissions (in Gg)

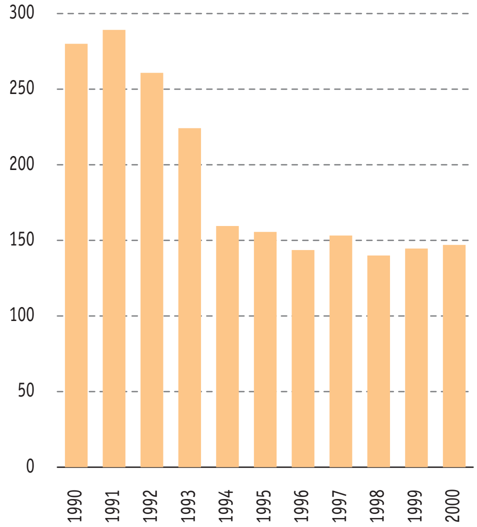
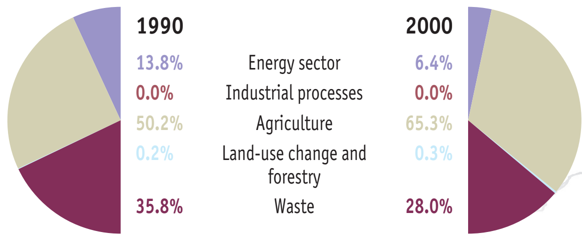


Figure 3.18. Allocation of methane emissions by economic sectors

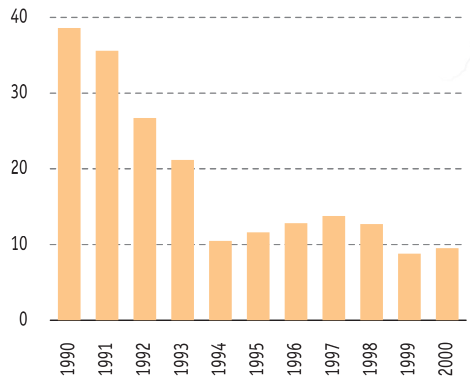


3.2.4.2. Energy sector

Total annual methane emissions in Kyrgyzstan's energy sector steadily decreased in the course of the 1990s (Figure 3.19), which is related first of all to the reduction in economic indicators in this sector.

In the energy sector methane is released at fuel combustion and at coal, oil and gas extraction, processing, transportation and storage. The main sources in the energy sector are activities related to coal, oil, oil products and gas extraction, processing, and storage. Such activities made up about 95% (36.65 Gg) of total emissions in the energy sector in 1990. Methane emissions from fuel combustion were approximately 5% (1.98 Gg). The biggest contribution (about 60%) to methane emissions in the energy sector is made by natural gas extraction, transportation, and storage. Most of the remainder comprises extraction, transportation, and processing of coal. The share of oil and oil products extraction, transportation, and storage amounts to less than 0.1%.

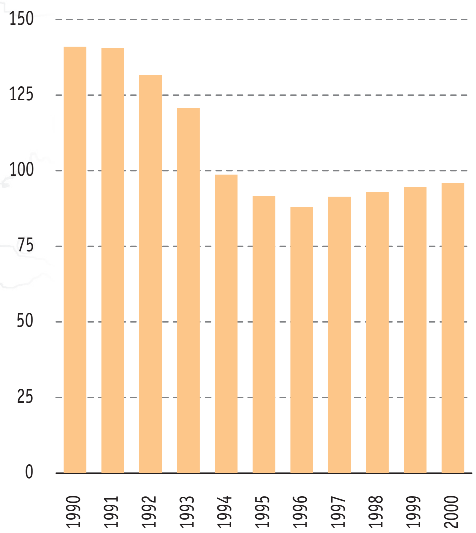
Figure 3.19. CH_4 emissions in the energy sector (in Gg)



3.2.4.3. Agriculture

Sources of methane in agriculture are animal husbandry, poultry farming, rice cultivation, on-the-field burning of agricultural (stubbly) residues, natural forest fires. In turn, in animal husbandry and poultry farming enteric fermentation and manure are taken into consideration. The dynamics of methane emissions from agriculture in 1990-2000 are shown in Figure 3.20. Most part (about 85%) of total methane emission in the sector falls at animal enteric fermentation. The share of emissions from systems of manure and guano collection, storage and usage makes up 12-13%, the share of emission from rice cultivation is small – 0.35 to 2.67%. About 0.875 to 2.033% of the total methane emissions from agriculture falls at methane emissions from field burning of agricultural residues. The share of methane emissions from natural forest fires is negligible.

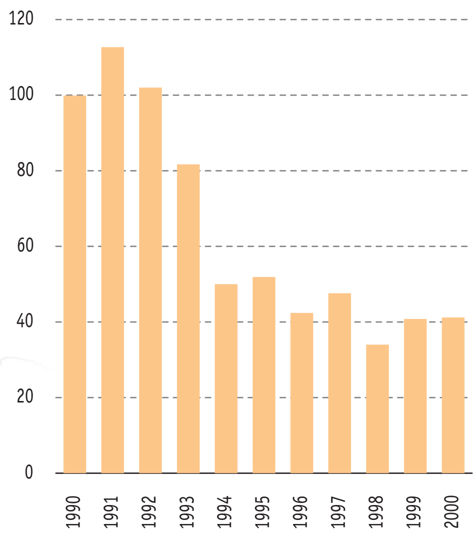
Figure 3.20. CH_4 emission in agriculture (in Gg)



Methane emissions from animal husbandry make up about 95% of total emissions in the agricultural sector. Most part of methane emission falls at enteric fermentation of cattle – 53 to 66%, while 24 to 41% is from sheep and goats, and 5-8% from horses.

The maximum contribution to emissions from systems of manure and guano collection, storage and usage falls at cattle, namely 86-90%; the other shares are: sheep and goats 4-7%, horses 2-3%, pigs 1-2%, and poultry 0-1%.

Figure 3.21. CH_4 emissions from waste (in Gg)



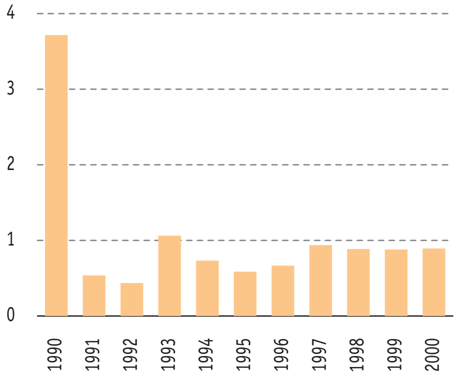
3.2.4.4. Waste

The dynamics of methane emissions from industrial and household waste is shown in Figure 3.21. The share of emissions from solid domestic waste amounts to 78-90% of the total emission in the sector, the share of methane emissions from industrial sewage fell from 18% in 1990 to 2% in 2000, while the share of emissions from domestic sewage rose from 2 to 8%. The reduction in methane emissions is related to the deterioration of the waste collection system.

3.2.5. Nitrous oxide emission

The dynamics of total nitrous oxide emission is shown in Figure 3.22. Within the whole, observed period the total annual N_2O emissions remained relatively stable, with insignificant growth since 1997. Sources of N_2O emissions are power engineering, agriculture, waste, land-use change and forestry. A major contribution to the total nitrous oxide emission comes from agriculture and waste (waste water purification).

Figure 3.22. Dynamics of N_2O emissions (in Gg)



The relatively high 1990 emissions of nitrous oxide are explained by the intensive use of mineral fertilisers in that year.

3.2.6. Halogen emissions

Halogens have a high GWP, and even with low absolute emissions their emissions in CO_2 equivalent may prove to be notable. Unfortunately, only general data on halogen usage are available in the Republic, and then without allocation by substances. Moreover, those data have only been registered since 1995. Halogen emission dynamics are shown in Figure 3.24.

3.2.7. Emissions of other gases

Other gases causing indirect greenhouse effects are NO_x, CO, NMVOC, and SO_2. Emission of some or all of these gases occurs in almost all sectors. Emission dynamics of gases causing indirect greenhouse effects are shown in Figure 3.25. 80-90% of total emission of other gases falls at the energy sector, while the rest falls at industrial processes.

Figure 3.23. Break-down of nitrous oxide emission from agriculture by categories of sources in 1999-2000

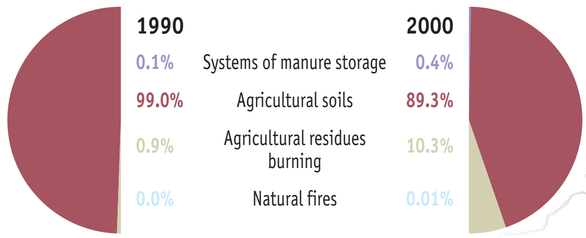


Figure 3.24. Dynamics of halogen emissions (in Gg)

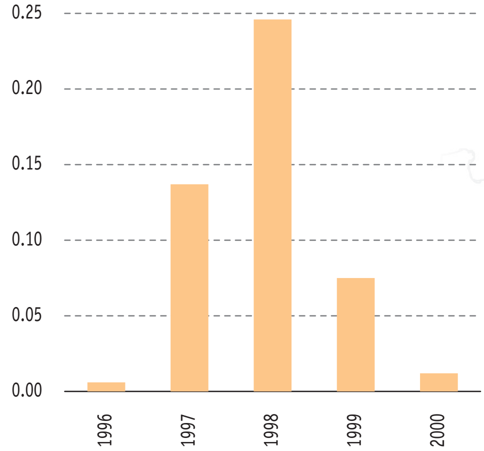
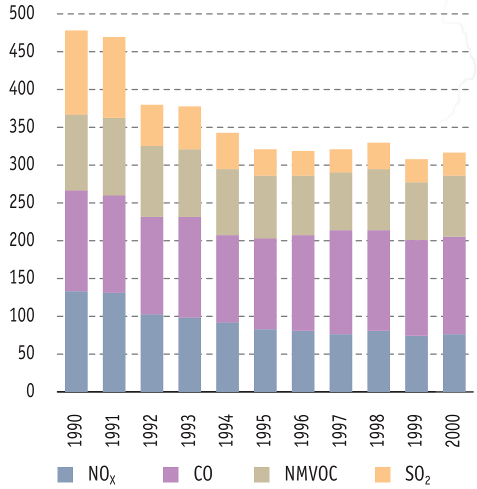


Figure 3.25. Emission dynamics of gases causing indirect greenhouse effects



3.3. Greenhouse gas emissions forecast

The forecast of greenhouse gas emissions and sinks has been prepared on the basis of the forecast of macroeconomic indicators, as described in section 5.1.

In the energy sector, the proportion of fuel consumption and GHG emission in 2010 and 2020 are assumed to be similar to the national proportion in 2000. For 2100, the proportion is considered to be similar to those in developed countries in 2000, i.e. considerably lower, taking into account the use of emission reduction technologies. In the absence of such technologies, emissions from the energy sector will exceed 140,000 Gg.

The sectors of industrial processes and solvents were not taken into consideration in forecasting, since emissions from sectors of industrial processes and solvents lie within the general uncertainty margin, in comparison with other sectors.

In the agricultural sector, only the contribution from the main source – emissions from enteric fermentation – was considered. Contributions from other sources were not, since they are less than the uncertainty of calculation. Moreover, it is worth noting that the practice of burning agricultural residues – the second, most important source of emissions in agricultural sector – is likely to be abandoned. Cattle head and number of poultry were used according to Table 5.4. Cattle head in 2010 and 2020 was defined through interpolation.

In the sector of land-use change and forestry, emissions from soils and from forest and grassland conversion were not taken into consideration due to their insignificant value and assumed absence of expected drastic changes. GHG absorption due to land use are considered to be constant, at the level of those in 2000. Sinks from change in woody bio-mass are assumed according to changes in woodland (see Table 5.2).

Emissions from the waste sector are assumed to be proportional to the size of the population. The effectiveness of the waste collection system in 2010 is assumed to be corresponding to that in 1993, while in 2020 and 2100 it is considered to be equal to that in 1990, taking into consideration that about 10% of waste in 2100 is expected to be processed.

Table 3.3. GHG emission forecast (in Gg)

Sector	Emission, Gg of CO_2 equivalent			
	2000	2010	2020	2100
Energy sector	11,351	21,539	34,850	55,000
Agriculture	2,207	2,832	3,118	5,000
Land-use change and forestry	-983	-1,014	-1,045	-1,336
Waste	1,007	2,350	3,390	7,150
Total	13,582*	25,707	40,313	65,814

* Total emissions in 2000 do not coincide with the actual emission (see Appendix) due to non-consideration of relatively small (by emission volume) sectors and sources.

3.4. Uncertainty in the emissions and sinks assessment

Greenhouse gas emissions in many categories of emission sources may be assessed only to some degree of certainty. It is obvious that the uncertainty for different sectors varies depending on the different levels of basic data precision. The results of the uncertainty assessment of GHG emissions and sinks for the Kyrgyz Republic are shown into Table 3.4.

Table 3.4. Uncertainty of emissions and sinks assessment

Sector	Uncertainty, %
Energy sector	±10
Industrial processes	±10
Solvents	-10 ...+100
Agriculture	
enteric fermentation	±22
systems of manure/guano collection, storage and usage	±25
rice cultivation	±10
natural mountain fires	±80
on-the-field burning of agricultural residues	±50
agricultural lands	±80
Land-use change and forestry	
emissions	±22
removals	±29
Waste	
solid domestic waste	±20
sewage	±50

4. CLIMATE CHANGE RESEARCH

4.1. National Climate Observation Network

The earliest meteorological stations on the territory of Kyrgyzstan were established in the late 19th century. However, systematic observation in the network of state stations and observation posts under unified methodology and programmes was initiated only in the 1930s. By 1985, the network had reached the peak of its development and comprised 79 meteorological stations, including 7 special avalanche stations, 7 air-meteorological, 3 upper-air stations, 9 hydrological, 1 water-balance station, 3 lake observation stations and 149 hydrological observation posts. Five stations were equipped to conduct actinometrical observation.

Later on, the network was cut down due to economic reasons, particularly after 1990. Today the Kyrgyzhydromet network includes 30 meteorological stations – those are 1 upper-air station, 3 avalanche stations, 8 combined hydrological, 1 lake observatory, and 75 hydrological posts. At three stations actinometrical observation is being carried out. Eight stations report to the World Meteorological Organization (WMO). The technical equipment of the Kyrgyzhydromet network and its divisions does not meet modern requirements due to the absence of modern hydro-meteorological equipment and other facilities.

Most hydro-meteorological information in the recent past has been compiled in annual publications, tables, and even observation booklets. A slow process of updating the existing network was recently initiated, mainly owing to assistance by WMO and other international organisations.

Figure 4.1. Location of main meteorological stations in the Kyrgyz Republic