FIRST NATIONAL COMMUNICATION

OF THE KYRGYZ REPUBLIC UNDER THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE

MINISTRY OF ECOLOGY AND EMERGENCIES
OF THE KYRGYZ REPUBLIC

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

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

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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
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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

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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

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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.

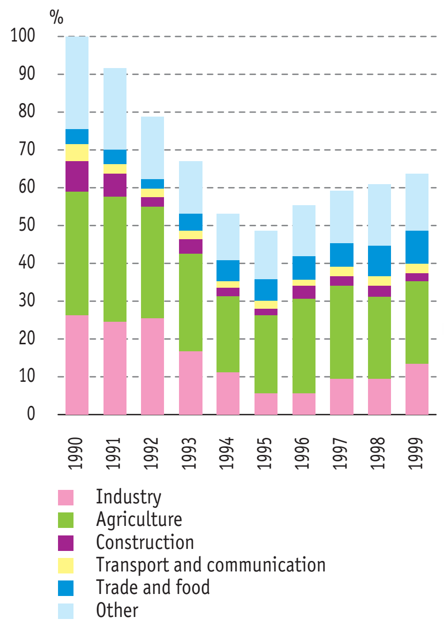
In spite of reduction of energy and water usage and also a considerable reduction in the use of fertilisers and other chemicals, it is possible to point out an increase in the harvest of basic crops.

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)

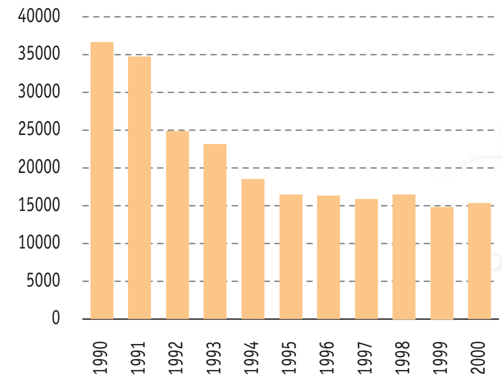
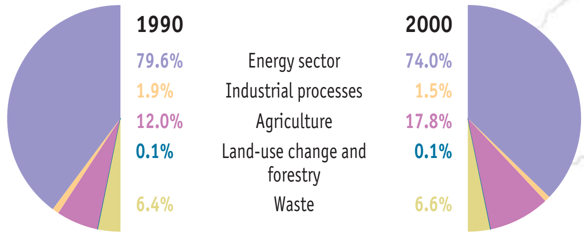


Figure S.3. Distribution of the total greenhouse gas emissions by sectors



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

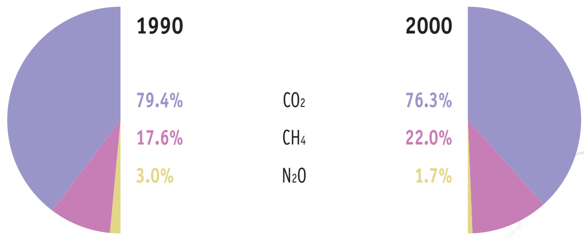


Table S.3 GHG emission forecast (in Gg)

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 hydropower, 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

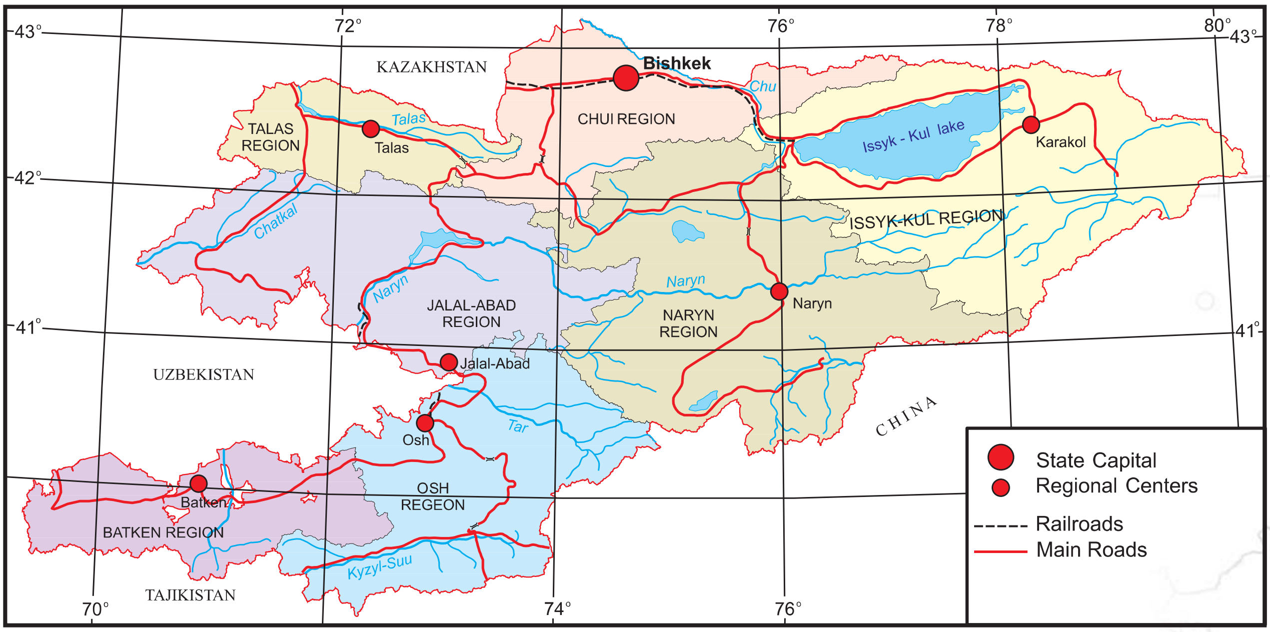
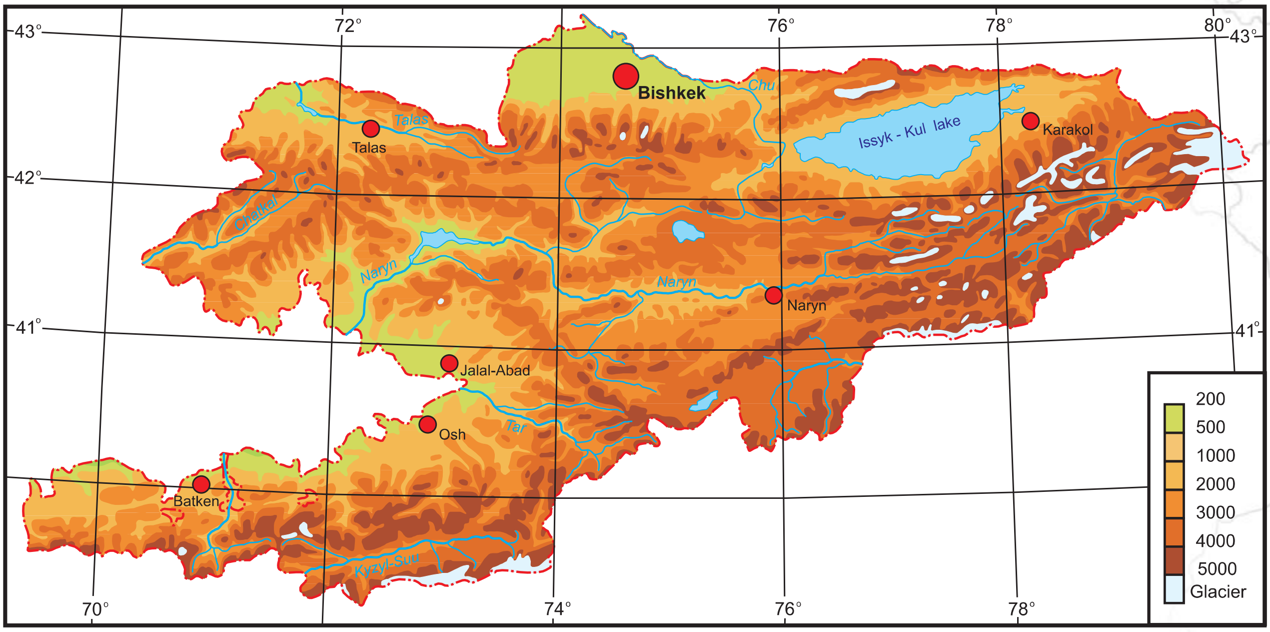


Figure 2.2. Physical map of the Kyrgyz Republic



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	USD per capita	-	1550	810	850	610	690	-	-	-	337	279
including:												
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	%	-	-	-	-	-	-	43.5	42.9	54.9	55.3	52.0
including:												
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,	years	68.5	68.76	68.27	66.78	65.42	65.49	66.65	66.77	67.15	68.28	68.5
including:												
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,	%	-	-	-	-	-	81.8	81.3	82.6	86.5	85.9	81.5
including:												
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	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
including:												
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 m², or 12.5 m² per resident. Meanwhile, 65% of population has a floor space less then 5 m² 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)

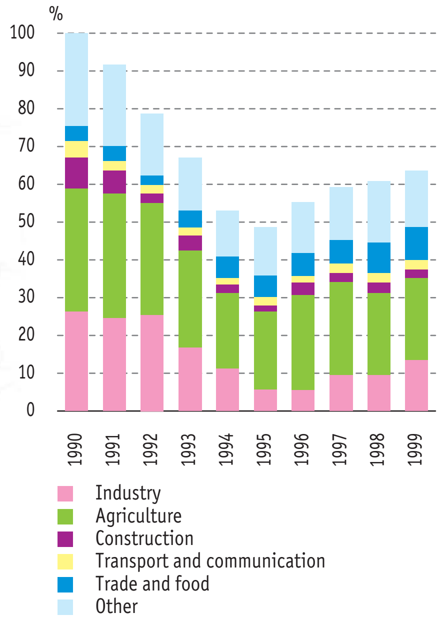
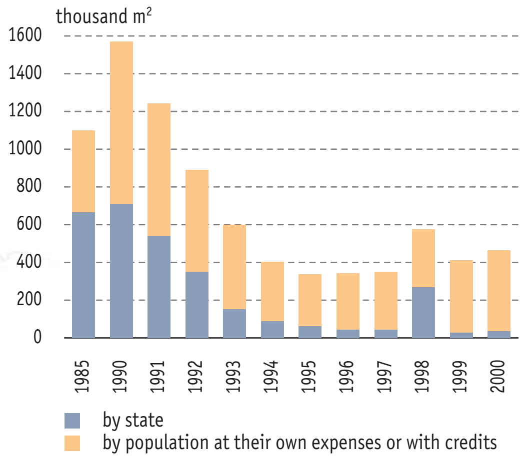


Figure 2.4. Volume of new public and private housing construction in the Republic



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.

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.

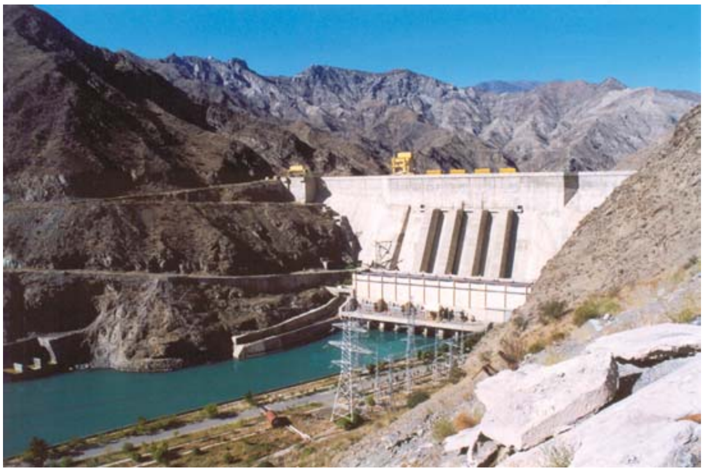
Table 2.4. Production and consumption of energy resources

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 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.

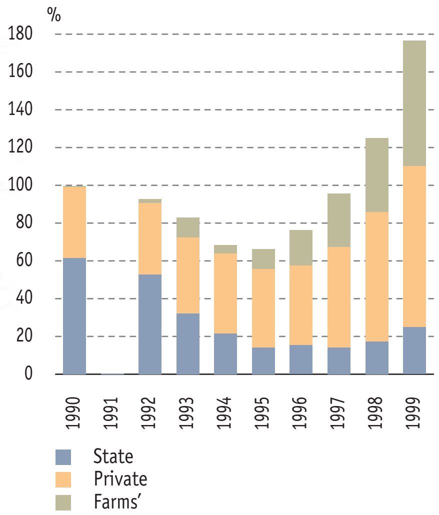


Kurpsai HPS. *Photo by V.Polynsky*

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.

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



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.

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.

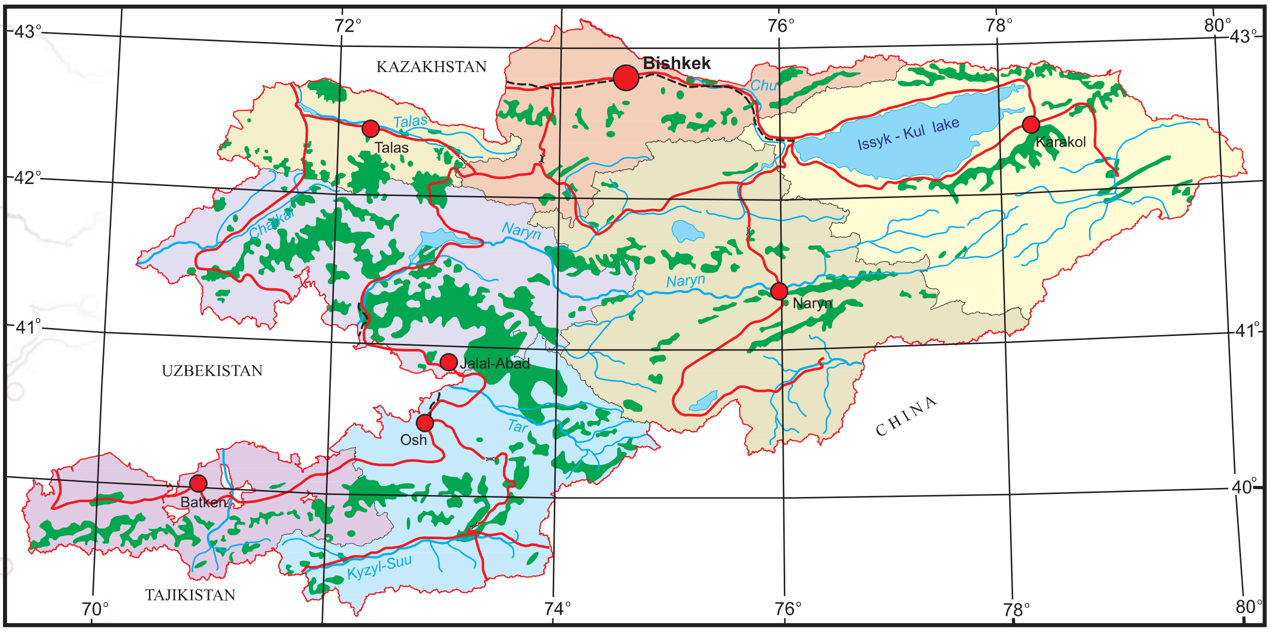
Irrigated land farming causes salinization and swamping of land. The total area of land affected by salinization and swamping exceeds 400 thousand hectares. Most of it is located in the Chui valley (223 thousand hectares) and valleys of the Internal Tien-Shan (128 thousand hectares).

Alamedin gorge. *Photo by V.Polynsky*

2.9 Forest resources

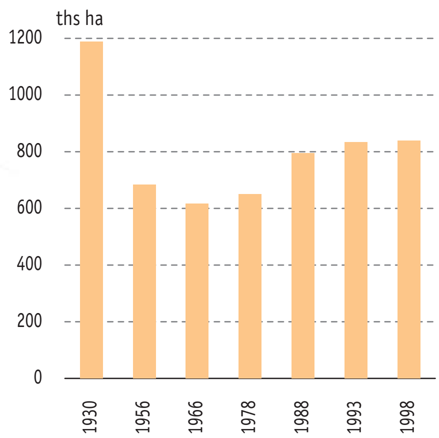
The total area of the state forest resources of the Kyrgyz Republic constitutes 2,6 million hectares (based on the registration conducted in 1998), including forest covered areas – 849.5 thousand hectares, shrubs covered areas – 342.6 thousand hectares. Forest zones account for 4.25% of the total territory 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

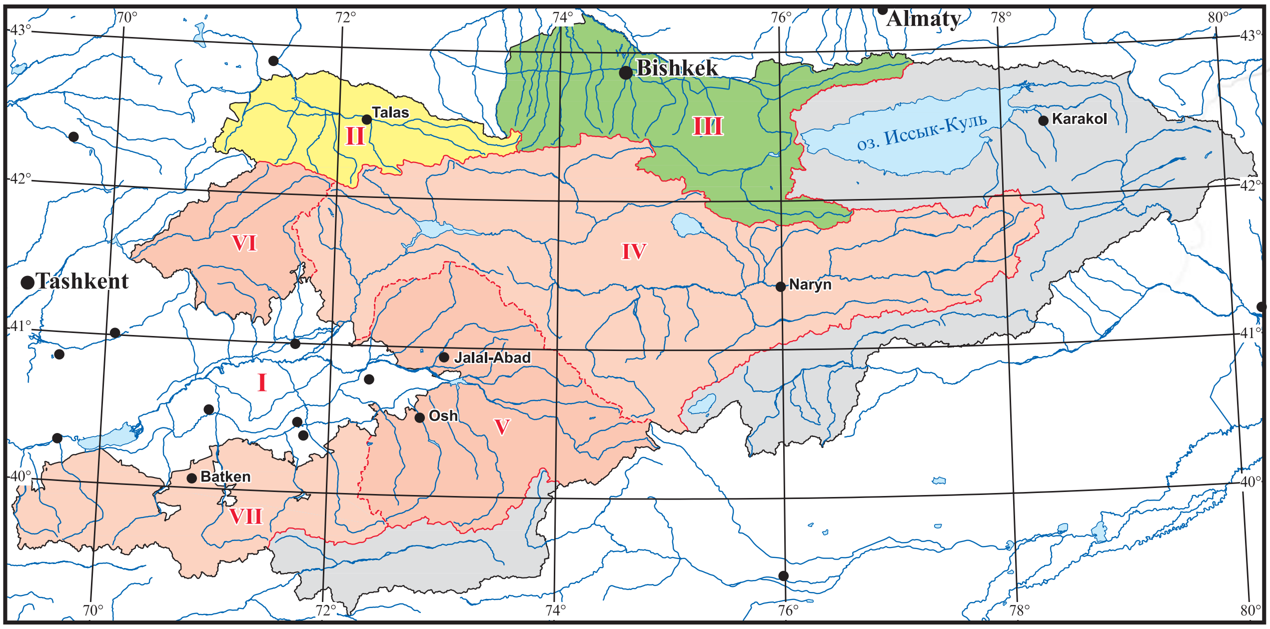
The territory of the Kyrgyz Republic is part of a closed basin of the Central Asia, which has no connection with the world's oceans. Water resources are vitally important and strategic not only for the Kyrgyz Republic, but also for the entire Central Asia. Possessing significant water reserves- more 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

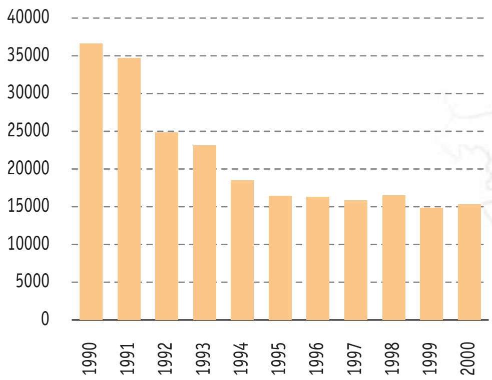
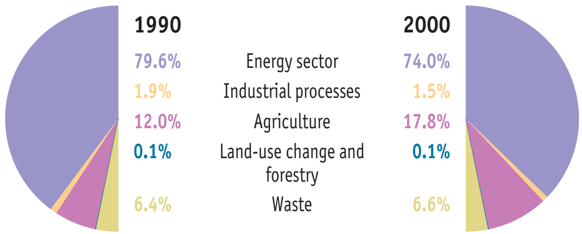
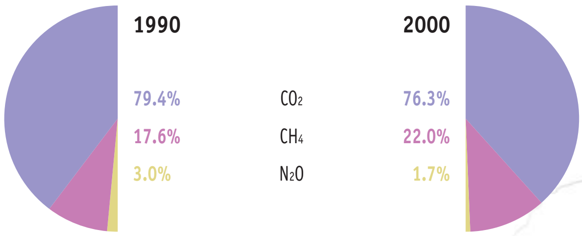


Figure 3.2. Distribution of total greenhouse gas emissions by sectors



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

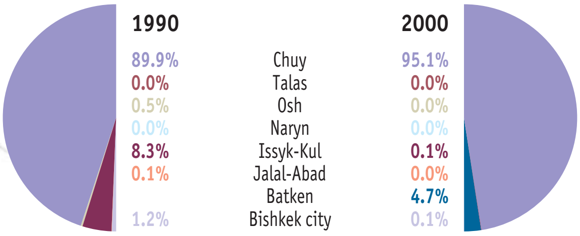


Figure 3.5. Distribution of NO_x emissions by oblasts and Bishkek city

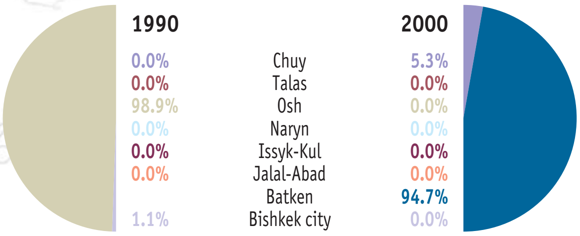


Figure 3.6. Distribution of CO emissions by oblasts and Bishkek city

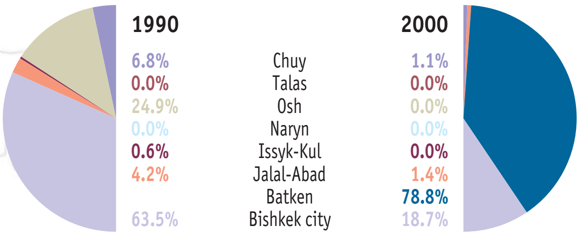


Figure 3.7. Distribution of NMVOC emissions by oblasts and Bishkek city

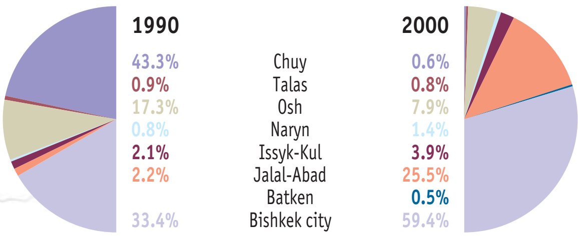
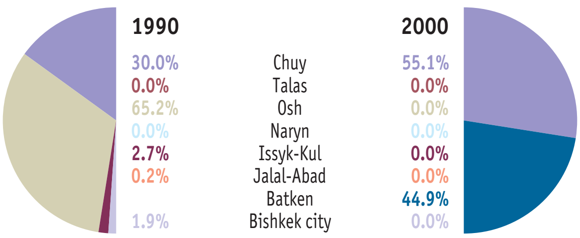


Figure 3.8. Distribution of SO_2 emissions by oblasts and Bishkek city



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

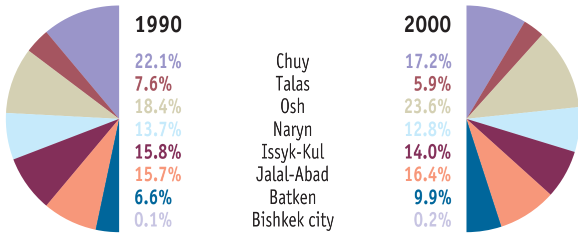
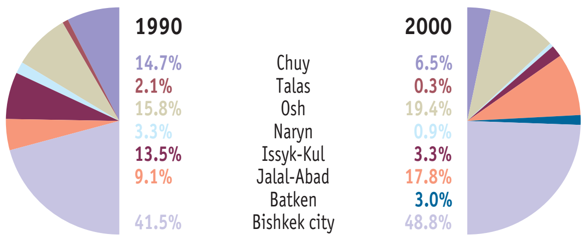


Figure 3.10. Distribution of methane emissions by oblasts and Bishkek city



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

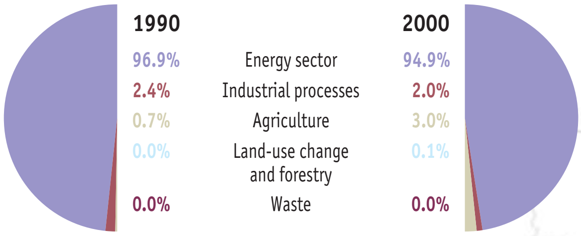
The allocation of methane emissions from industrial and household wastes, in essence, corresponds to allocation of urban population. Bishkek makes the largest contribution to total methane emission from waste; Naryn and Batken oblasts make the least contribution (Figure 3.10).

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.

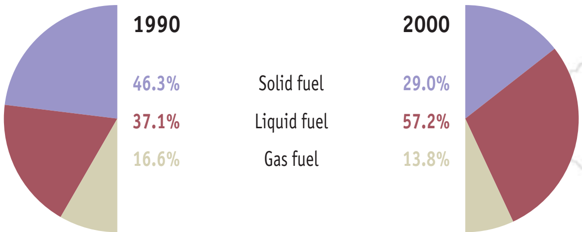
Figure 3.11. Contribution to the national CO_2 emission by sectors



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

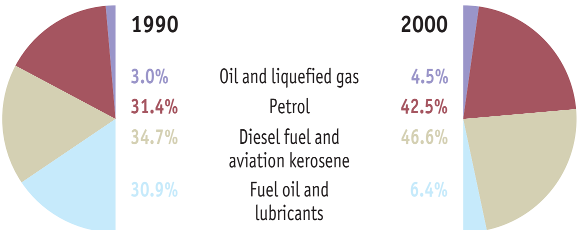
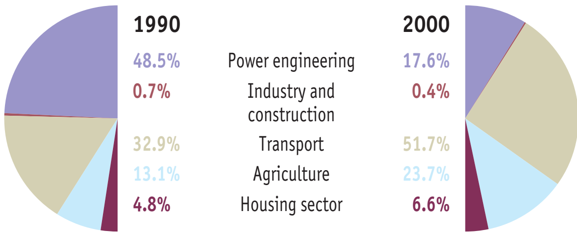


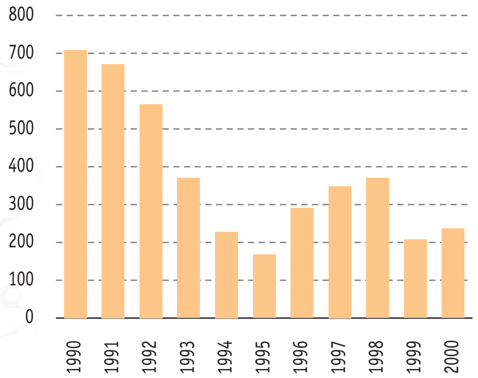
Figure 3.14. Structure of CO_2 emission by categories of the energy sector



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)



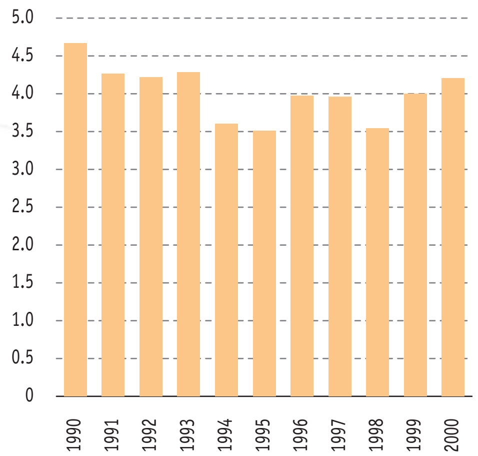
The production of minerals contributes a major share of CO_2 emission from industrial processes in Kyrgyzstan. In 1990, this share amounted to 98%, in 2000 to 95%. In this category CO_2 emission occurs owing to the production of cement, lime, and the manufacture and use of soda ash. The main contribution 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)

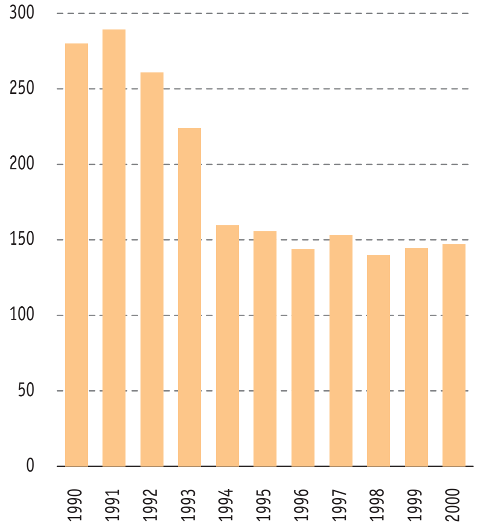
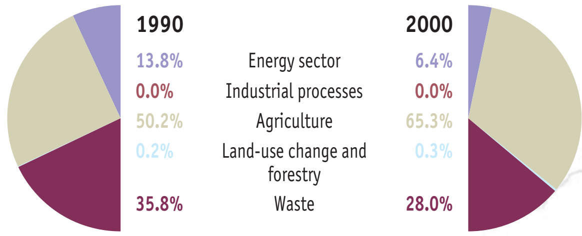


Figure 3.18. Allocation of methane emissions by economic sectors

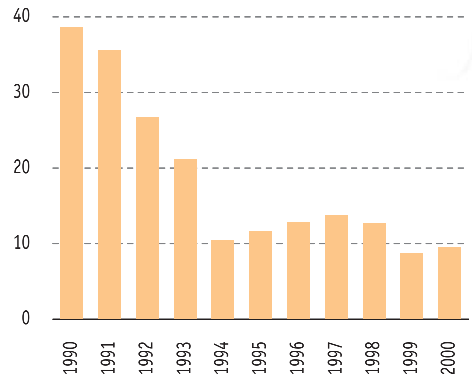


3.2.4.2. Energy sector

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%.

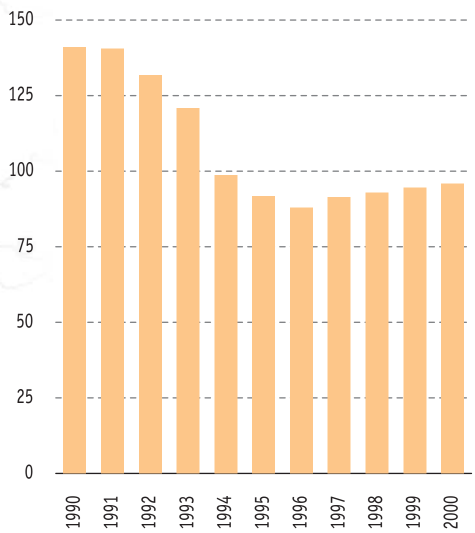
Figure 3.19. CH_4 emissions in the energy sector (in Gg)



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.

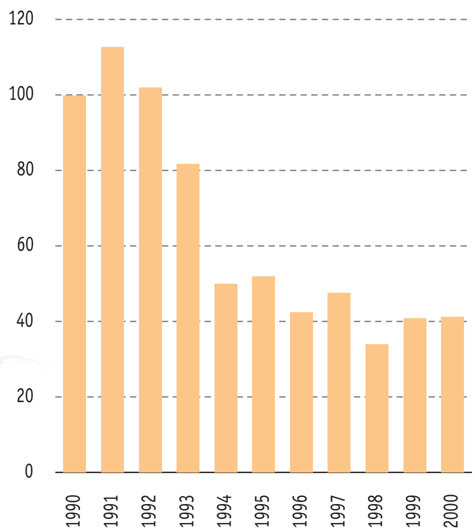
Figure 3.20. CH_4 emission in agriculture (in Gg)



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)

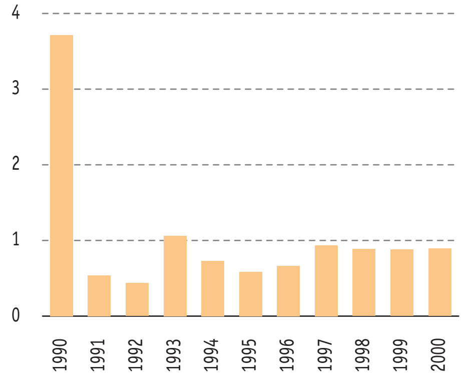
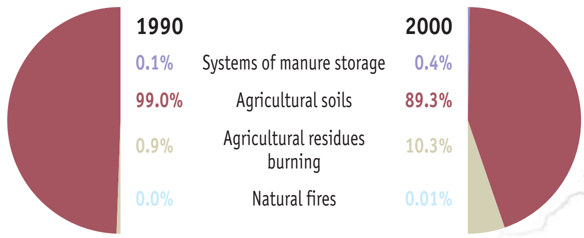
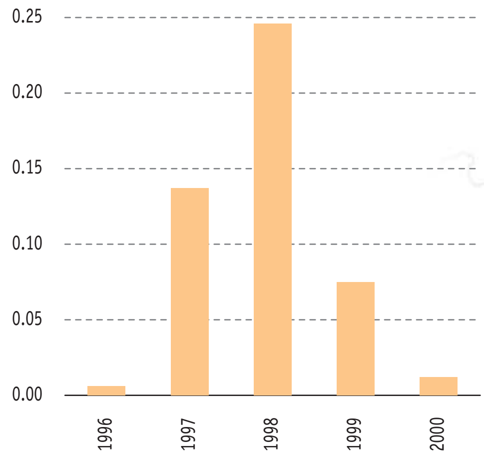


Figure 3.23. Break-down of nitrous oxide emission from agriculture by categories of sources in 1999-2000



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

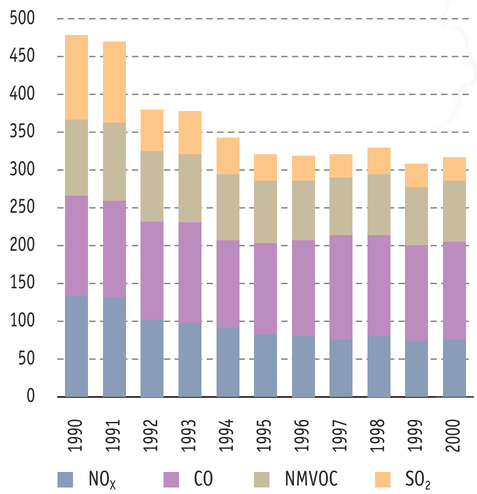
Figure 3.24. Dynamics of halogen emissions (in Gg)



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.

Figure 3.25. Emission dynamics of gases causing indirect greenhouse effects



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.

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

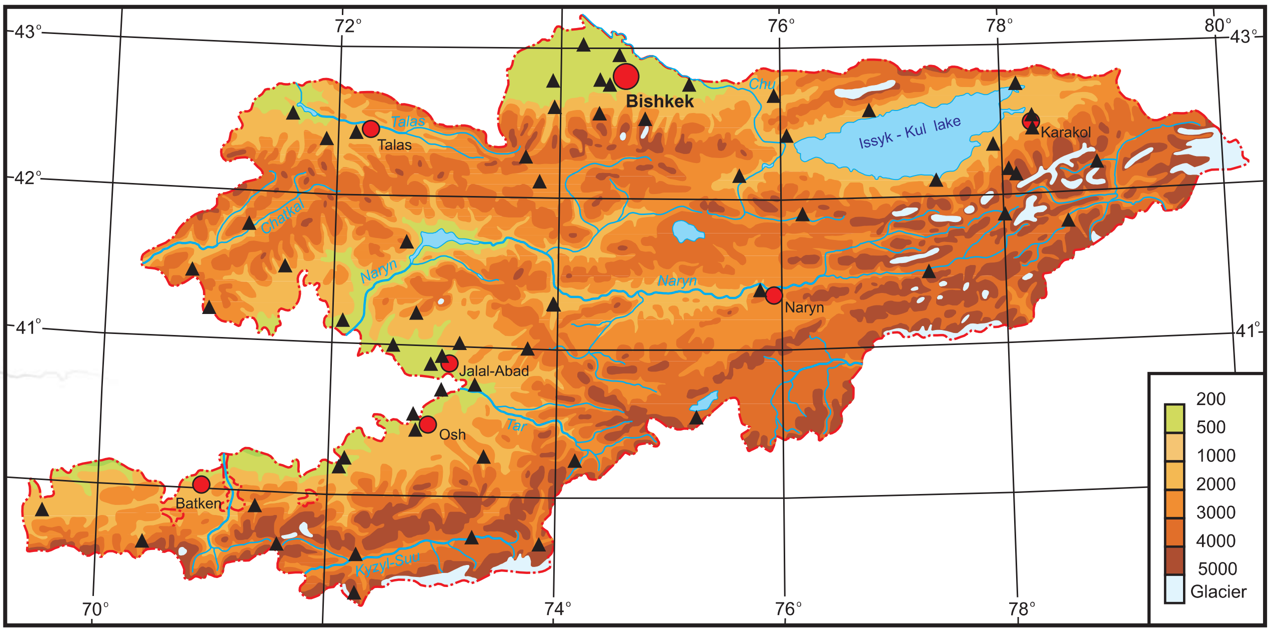
4.1. National Climate Observation Network

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



4.2. Observed climatic changes

Local climate changes, particularly in mountain areas, may significantly differ from global trends. Thus, according to the latest IPCC Assessment, during the last century the global average surface air temperature grew by 0.6±0.2°C, precipitation grew by 5-10% in most regions at middle and high latitudes of the Northern Hemisphere. The most intensive warming was registered in the periods 1910-1945 and 1976-2000. In 1946-1975, a fall of temperature was registered. The warmest years were the 1990's, with 1998 being the warmest.

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

1. Northern, Northwestern Kyrgyzstan (NNWK);
2. Southwestern Kyrgyzstan (SWK);
3. Issyk-Kul basin (IKB);
4. Inner Tien-Shan (ITS).

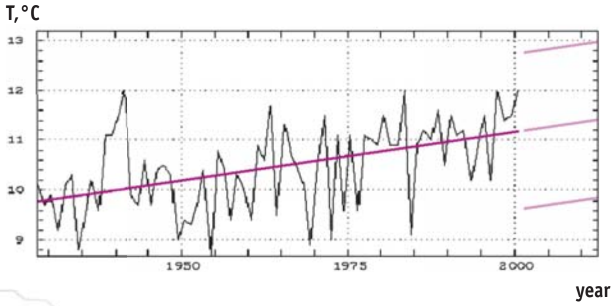
Linear trends of average monthly and annual air temperature and precipitation were estimated at 9 long-range (70-120 years) meteorological stations (MS) that are located in these areas at altitudes of 760 to 3,640 m. The data characterising general actual trends of air temperature and precipitation in the 20th century are shown in Table 4.1 and Figure 4.2.

Table 4.1. Values of linear trends of temperature (β_T°C/10 years) and precipitation ($\beta_r$mm/10 years) in the 20th century

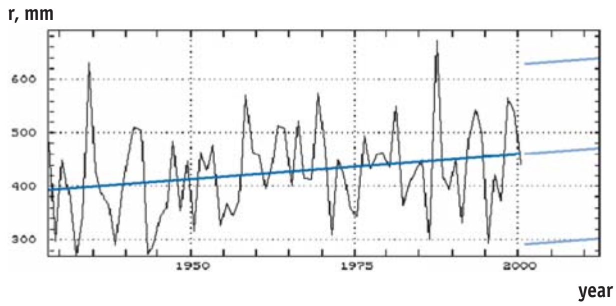
Area	Meteorological station	Z. m	β_T°C/10 years			$\beta_r$mm/10 years		
			Year	Jan	July	Year	Jan	July
NNWK	Bishkek	760	0.20	0.22	0.10	9.3	1.3	-1.1
	Baitik	1,570	0.08	0.17	0.05	3.1	1.2	0.4
SWK	Pacha-Ata	1,540	0.06	0.29	-0.01	23.9	1.6	3.6
	Sary-Tash	3,160	0.24	0.37	0.17	6.1	1.0	-0.5
IKB	Balykchy	1,660	0.23	0.21	0.29	0.5	0	-0.1
	Cholpon-Ata	1,640	0.24	0.36	0.15	5.9	0	0.1
ITS	Naryn	2,040	0.12	0.52	0.05	1.1	-4.8	-0.1
	Suusamyr	2,060	0.12	0.05	0.19	-16.7	-0.6	-1.4
	Tien-Shan	3,630	0.12	0.11	0.12	-12.6	-0.2	-4.4
Kyrgyzstan			**0.16**	**0.26**	**0.12**	**2.3**	**-0.1**	**-0.4**

As the table shows, the average annual temperature in Kyrgyzstan in the 20th century, on a 100-year time scale, has risen by 1.6°C, which is much higher than the global trend (0.6°C). The maximal warming was registered in winter (2.6°C), the minimal in summer (1.2°C). Moreover, warming considerably varied between separate climatic zones as well as between stations within zones, i.e. high-altitude zones. In NNWK warming range within 100 years was 0.8-2°C, in SWK 0.6-2.4°C, in IKB about 2.4°C, in ITS 1.2°C (the same at three stations). At most stations warming in winter turned out to be more notable than in summer. In Naryn, in January, it reached 5.2°C on a 100-year time scale. Trends of annual temperature values for 7 out of 9 stations are statistically significant, with 99% confidence probability, which means that temperature rise has exceeded the limits of random variation.

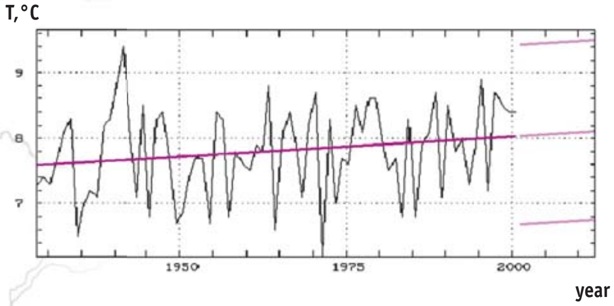
Figure 4.2. Changes in average annual air temperature and precipitation by weather stations for the period of instrumental observation in the 20th century



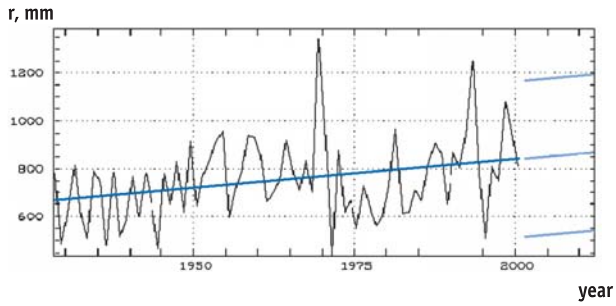
Bishkek – temperature (NNWK)



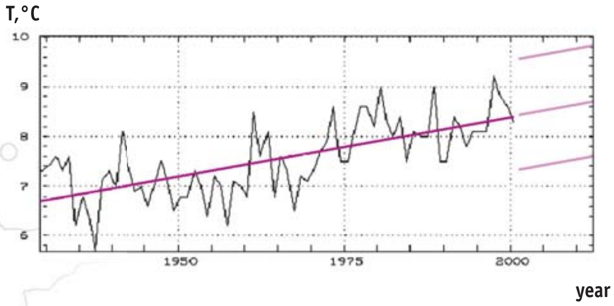
Bishkek – precipitation (NNWK)



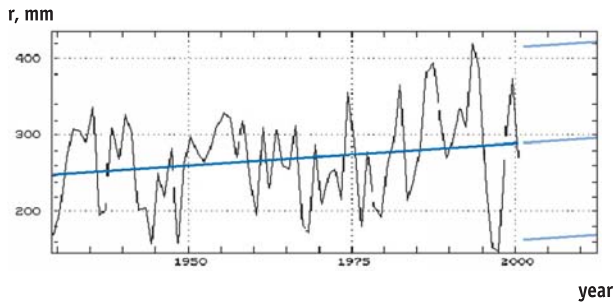
Pacha-Ata – temperature (SWK)



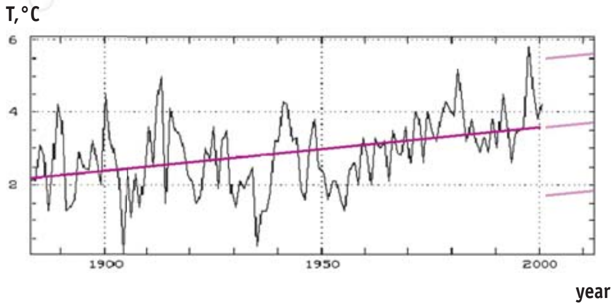
Pacha-Ata – precipitation (SWK)



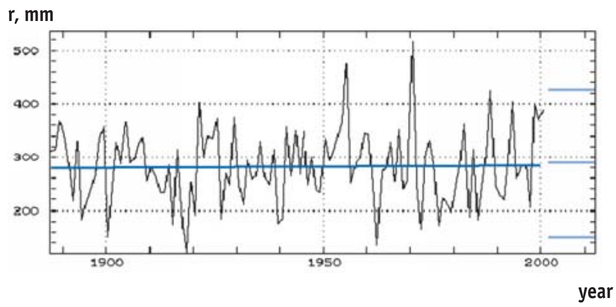
Cholpon-Ata – temperature (IKB)



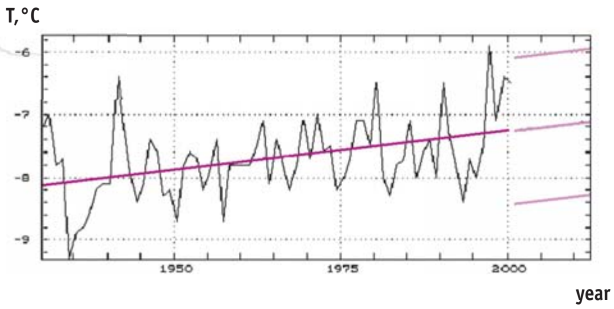
Cholpon-Ata – precipitation (IKB)



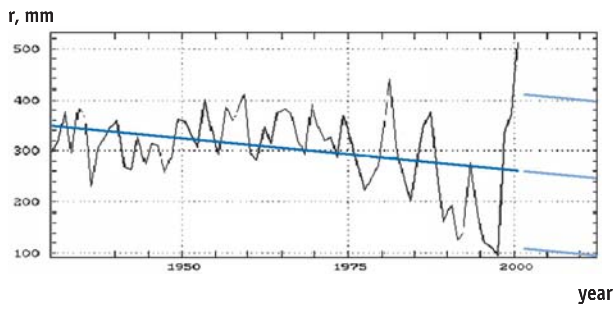
Naryn – temperature (ITS)



Naryn – precipitation (ITS)



Tien-Shan – temperature (ITS)



Tien-Shan – precipitation (ITS)

The dotted curve represents the actual temperature and precipitation variations, the straight line represents the calculated linear trend. The lines after 2000 are an extrapolation of trends to 2010 and the limits of confidence interval of variations (probability P=0.90).

Overall 20th century precipitation in Kyrgyzstan increased insignificantly – by 23 mm, or 6%. In three climatic areas, on a 100-year time scale, annual precipitation increased: in NNWK by 31-93 mm (6-22% of normal), in SWK – by 61-239 mm (16-32%), in IKB – by 5-60 mm (to 2%). In the Inner Tien-Shan, which occupies a considerable part of Kyrgyzstan's territory, the level either remained virtually the same (MS Naryn, increase by 11 mm/100 years) or considerably decreased – by 126-167 mm over the past 100 years, which is 41-47% of the norm (MS Suusamyr, Tien-Shan). At about half of all stations, annual β_r was statistically significant with 99% confidence probability.

Thus, for the orographically complex mountainous territory of Kyrgyzstan, instrumental observation registered a considerably higher warming than the global – average annual temperature in the 20th century rose by 1.6°C with changes in growth on the territory in the range of 0.6 to 2.4°C. Annual precipitation totals in average have undergone minor changes (23 mm, or 6%, increase). However, there is a distinct growth tendency of 1-2 to 20-30% in all climatic areas in Kyrgyzstan, except for the Inner Tien-Shan. Here, in the high-altitude zone, in some places precipitation notably decreased (by 41-47%), which considerably enhanced the aridity of the area.

4.3. Expected climate changes

The current level of world science does not yet allow forecasting of prospective climate even within one century. For its assessment climate scenarios (describing likely future climate system conditions) are applied. The scenarios in this report were designed on the basis of global climatic models (GCM). Spatial resolution of the models reaches 250 km horizontally and 1 km vertically. According to IPCC, in general the quality of climate projections with a GCM can be considered if not yet satisfactory, then at least encouraging, certainly in the context of a sub-continental climate and from seasonal to inter-decade resolution. None of the models and climatic scenarios may be declared the best in terms of high probability provided. It is essential for each area to have a number of climatic scenarios describing the whole range of possible future climatic conditions.

For estimating climatic scenarios in Kyrgyzstan for the period up to 2050 and 2100, MAGICC/SCENGEN software recommended by IPCC was used. The software helped to define 12 scenarios corresponding with 3 GCMs with various sensitivity levels, and two options of greenhouse gas emission scenarios (IS92a – moderately high emissions with doubled CO_2 concentration by 2100, and IS92c – moderately low emission with a 35% concentration increase). They take into account (or do not take into account) the warming-alleviating impact of anthropogenic sulfate aerosols. Besides, two additional scenarios were designed on the basis of the GRADS software.

Tables 4.2 and 4.3 show numerical values (obtained by MAGICC/SCENGEN) of six ΔT_a°C scenario temperature rise, calculated with account of aerosol influence and changes in R_a precipitation ratios compared to the 1961-1990 reference period. Diagrams demonstrating the results according to scenarios are illustrated in Figures 4.2 and 4.3. These data allow complete description of possible future climatic conditions in Kyrgyzstan.

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 aerosol impact into consideration. Without that, warming would be 0.5°C greater. For the moderately low IS92c emission scenario, warming will be even less (2.2°C) and is hardly dependent on aerosol emissions. Rises in temperature are almost equally spread over the seasons,

Table 4.2. Scenarios of warming (ΔT_a) 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 4.3. Scenarios of precipitation trends (R_a) 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

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.

The UKTR model predicts a higher level of warming by 2100: for IS92a annual ΔT_a=4.4°C. while for IS92c the level is much less – ΔT_a=2.7°C. Similarly, the seasonal spread of warming is quite even and there are only minor rises in winter temperature.

The CSIRO2-EQ model gives results almost identical to those anticipated by the HadCM-2 model. The former model 's distinctive feature is the notably higher temperature it forecasts for winter and spring compared to summer (approximately by 1.5% for IS92a).

Therefore, 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.

In Table 4.3 and Figure 4.4 it is convenient to read R_a precipitation change scenarios as a percentage increase (reduction) of precipitation compared to the reference period of 1961-1990 (by multiplying listed R_a figures by 100). According to HadCM-2 model, in the case of IS92a moderately high emissions, precipitation will increase by 54% annually by 2100. With IS92c moderately low emissions, precipitation increase will be less; however, it will remain considerable – 16%. It should be noted that precipitation is likely to increase in all seasons within the range of 6-84%.

Scenarios of precipitation increase in the HadCM-2 model are the highest, and they can be considered as the scenarios, which best alleviate warming in Kyrgyzstan, most of whose territory is arid.

The UKTR model provides scenarios of a lower precipitation increase by 2100. Precipitation will rise by 23% in the case of IS92a moderately high emissions and will remain the same in case of IS92c moderately low emissions. In addition, in the case of IS92c, in summer, precipitation reduction up to 89% compared to current precipitation (i.e. 11% lower) is even possible. Seasonal precipitation changes according to this model are within the range of 89-146%.

CSIRO2-EQ model forecasts the smallest precipitation change by 2100 compared to the current: 17% increase in case of IS92a, and 6% reduction in case of IS92c. According to this model, moistening scenarios are the most unfavourable for possible conditions of future warming.

Thus, by 2100 overall range of moistening scenarios will vary from annual precipitation reduction by 6% to its increase by 54%; seasonal scenarios in general vary from 20% reduction to 84% increase.

In conclusion, it is worth emphasising again that the above-mentioned climate scenarios should be used with caution considering a range of possible prospective climatic conditions. Annual warming could be between 1.8 and 4.4°C, and annual precipitation may vary from a small reduction (by 6%) to significant growth (by 54%). However, if a single scenario had to be chosen, a preliminary expert assessment for the entire territory of Kyrgyzstan by 2100 would state that it is reasonable to expect an average annual temperature increase by 2.5 to 3.0°C, and an increase in annual precipitation by 10-15% compared to normal precipitation in 1961-1990. This corresponds to climatic changes registered in 1900-2000 and the average scenario assessment of climatic changes by 2100 according to global climate models.

In the future it is necessary to conduct a more precise evaluation of perspective climate changes in Kyrgyzstan on the basis of a more comprehensive consideration of local mountain conditions of its territory.

Figure 4.3. Diagrams of seasonal (winter, spring, summer, fall) and annual warming scenarios for the period of 2050 to 2100 on the basis of data from Table 4.2.

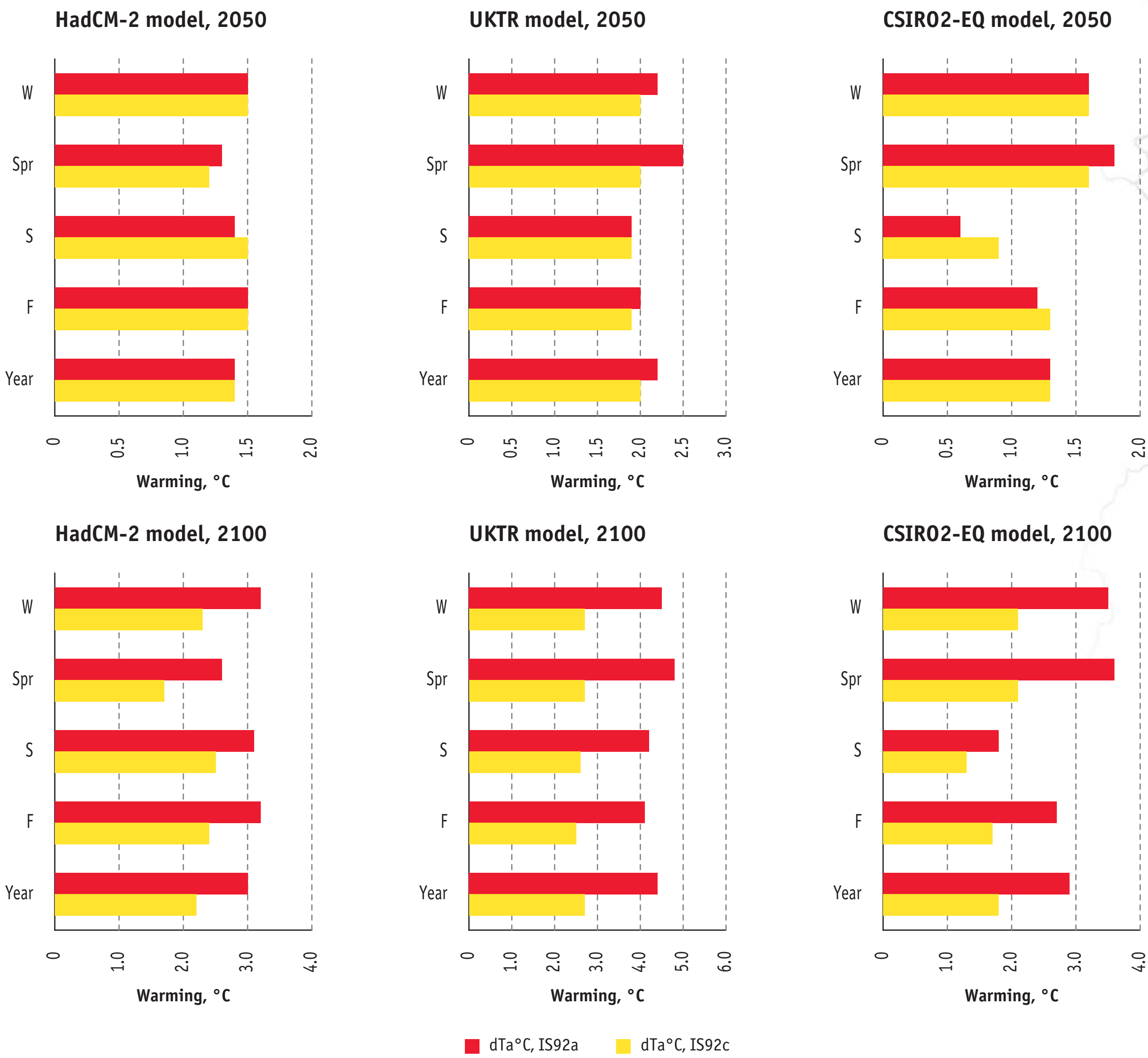
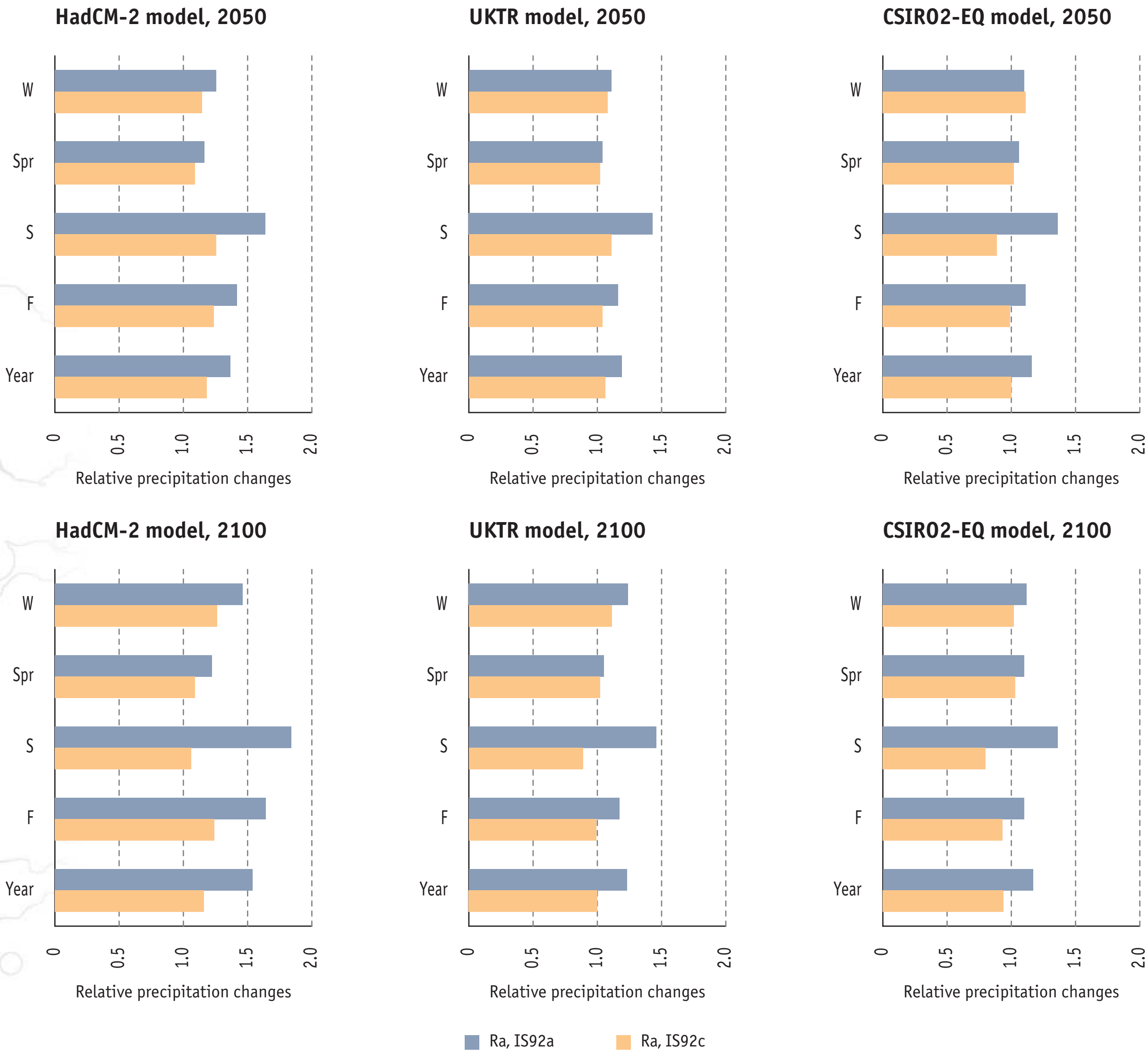


Figure 4.4. Diagrams of seasonal (winter, spring, summer, fall) and annual scenarios of moistening changes for the period of 2050 to 2100 on the basis of data from Table 4.3.



5. VULNERABILITY ASSESSMENT AND ADAPTATION

When assessing vulnerability, the most unfavourable scenarios out of all possible were considered in all sections from the point of view of a certain section.

5.1. Basic scenarios

Three major scenarios of expected development have been used for vulnerability assessment – climatic, demographic and economic.

A climatic scenario is a logical continuation of the expected climate assessment by means of GCM with the purpose of rendering climatic conditions concrete in a form suitable for forecast and analysis of vulnerability to an expected climate change.

The Kyrgyz Republic is small in terms of latitude (454 km) and longitude (925 km), so horizontal distances do not have a significant influence on changes in climatic conditions across the territory. By contrast, relief and orography – not taken into account by GCMs – play a major role.

In order to assess the country's vulnerability, a change of climatic factors in different areas has been considered. Two major factors constitute the basis for defining agro-climatic zones in the Republic: thermal conditions and the availability of water. The sum of active air temperatures for the period between the dates of an average daytime temperature steadily rising above 0°C, 5°C and 10°C in spring and fall serves as an indicator of thermal conditions. The altitude of thermal belts within the regions was determined on the basis of the sums of above-zero temperatures for the period between the dates of an average daytime temperature steadily rising above 10°C. The availability of water was assessed on the basis of total precipitation. The calculation results are as follows:

1. Thermal resources

Northern, North-Western Kyrgyzstan. The sums of above-zero temperatures with an average diurnal temperature passing 0°C will increase by 550-850°C, and the duration of a warm period will increase by 20-42 days. When passing 5°C the sums of above-zero temperatures will increase by 350-700°C, and the duration of a period with an air temperature above this limit may increase by 24-42 days. When passing 10°C the sums of above-zero temperatures will increase by 130-600°C, and the duration of the growing season will increase by 24-43 days. The boundaries of thermal belts will shift upwards by 200-400 m at the altitude of 600-1,400 m compared to the existing ones. At the altitude of 1,600-2,600 m the boundaries of thermal belts will not change.

North-Eastern Kyrgyzstan. When passing 0°C the sums of above-zero temperatures will increase by 550-800°C, and the duration of a period with an air temperature above this limit will increase by 23-33 days. Above 5°C the sums of above-zero temperatures will increase by 400-650°C and the duration of a warm period will increase by 26-32 days. When passing 10°C sums of above-zero temperatures will increase by 90-500°C, and the duration of the growing season will increase by 23-63 days. The boundaries of thermal belts in the western part of the Issyk-Kul basin will shift upwards by 200 m at the altitude of 1,600 m compared to the existing ones, and at the altitude of 1800 m the boundaries of thermal belts will not change. The boundaries of thermal belts in the eastern part of the Issyk-Kul basin at the altitude of 1,600-2,600 m will not change compared to the existing ones.

Inner Tien-Shan. When passing 0°C sums of above-zero temperatures will increase by 500-700°C, the duration of a period with an air temperature above this limit will increase by 15-36 days. When passing 5°C the sums of above-zero temperatures will increase by 350-650°C, and the duration of a warm period will increase by 16-36 days. When passing 10°C sums of above-zero temperatures will increase by 70-550°C, and the duration of the growing season will increase by 18-56 days. The boundaries of thermal belts in the northern part of the Tien-Shan region will shift upwards by 200 m at the altitude of 1,600 m. The boundaries of thermal belts at the altitude of 1,800-2,400 m will not change. The boundaries of thermal belts in the central part of the Tien-Shan region will shift upwards by 200-400 m at the altitude of 1,200-1,800 m, whereas at the altitude of 2,000-2,800 m they will not change. The boundaries of thermal belts in the south-eastern part of the Inner Tien-Shan will not change at the altitude of 2,800-3,000 m.

South-Western Kyrgyzstan. When passing 0°C sums of above-zero temperatures will increase by 500-900°C, the duration of a period with an air temperature above this limit will increase by 21-36 days. When passing 5°C the sums of above-zero temperatures will increase by 400-750°C, and the duration of a warm period will increase by 20-33 days. When passing 10°C sums of above-zero temperatures will increase by 300-600°C, and the duration of the growing season will increase by 18-38 days. The boundaries of thermal belts will shift upwards by 200-600 m at the altitude of 600-2,400 m. At the altitude of 2,400-2,800 m the boundaries of thermal belts will not change.

2. Moisture resources

According to the moisturising scenario an increase in annual precipitation by 17% throughout all the 4 climatic zones is possible. At that, the greatest increase in precipitation will occur in the summer in Northern, North-Western, South-Western Kyrgyzstan and in the Inner Tien-Shan. In North-Eastern Kyrgyzstan the biggest amount of precipitation is expected to occur in the autumn.

Table 5.1. Demographic development in the Kyrgyz Republic until 2100

#	Period	Population by the end of the period (in thousands)	Growth rate (in %)
1	2000 – 2010	5,444	1.5
2	2010 – 2020	6,344	1.5
3	2020 – 2030	7,267	1.4
4	2030 – 2040	8,192	1.2
5	2040 – 2050	9,040	1.0
6	2050 – 2060	9,986	1.0
7	2060 – 2070	11,031	1.0
8	2070 – 2080	12,185	1.0
9	2080 – 2090	13,460	1.0
10	2090 – 2100	14,868	1.0

A demographic scenario. Until the year 2050 the assessment of the American Census Bureau has been used. The assessment for the following decades is based upon the suggestion that the population growth rate in the Republic will remain at the level of 2050, which will most probably result in a slight overvaluation of the amount of population and subsequently in stricter conditions when analysing vulnerability.

An economic scenario. For assessment of macroeconomic indicators for a short period of time national development programmes in Kyrgyzstan (National Development Strategy of Kyrgyzstan for 2001-2010, National Poverty Reduction Strategy, etc) have been used. For assessment of macro-economic indicators for a longer period of time (a century) an analogy method has been used, that is, major macroeconomic indicators in the Republic in 2100 are expected to reach the level that developed countries had in 2000. The results have been adjusted for the current economic structure, the existence of natural resources and an orientation at global development tendencies considering national peculiarities, for instance, a further preferred development of hydro-power and renunciation of nuclear power.

Only those indicators that are required for GHG emission and vulnerability assessment have been considered. Indicators referring to the agricultural development are presented in Tables 5.3 and 5.4 of this chapter. Forecast results are presented in Table 5.2.

Table 5.2. Some economic indicators for the Kyrgyz Republic

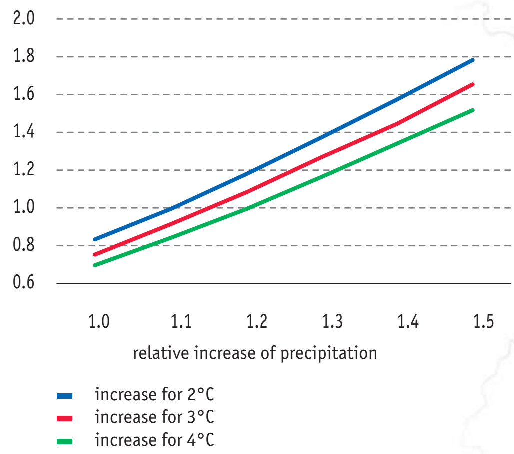
Indicator	Unit	2000	2010	2020	2100
Population	million people	4.91	5.44	6.34	14.87
GDP with PPP	billion $	12.38	19.15	34.28	327.1
GDP with PPP, per capita	$/capita	2,521	3,520	5,407	22,000
Energy consumption, total including:	million t.o.e.*	2.99	5.7	9.18	32.71
- coal;	million t.o.e	0.74	1.46	2.96	
- 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	million t.o.e	0.1	0.13	0.18	
Energy consumption, per capita	t.o.e./person	0.61	1.05	1.45	2.2
Energy consumption, per $1000 of GDP	t.o.e./$1000 GDP	0.24	0.3	0.27	0.1
Electricity generation	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 hectares	858.5	888.5	918.5	1,194

* t.o.e. – tons of oil equivalent

5.2. Water resources

A forecast of the total flow of Kyrgyzstan's major rivers (Naryn, Chu, Talas) for a combination of different conditions is presented in Fig.5.1. This forecast has been made based on precipitation and evaporation balance modelling taking into account the relief and types of water catchment area (forests, lakes, etc.)

Figure 5.1. Assessment of change in runoff of the major rivers in the Republic depending on precipitation and temperature relative to the current state. The value 1 stands for the total runoff level based on the existing long-term observations.



As shown in Fig.5.1, given the expected climate change, flow may change to between 0.7 and 1.8 out relative to the existing level. It should be noted that in fact the magnitude of flow is somewhat underestimated, because faster glacier melting is not taken into account. Most of the rivers in the Republic have a snow-and-glacier type of alimentation, and should the temperature go up, their flow will increase, which has been observed over the last few years. During the period from 1973 to 2000 the total river flow increased by 6.3% compared to the preceding period (from 48.9 to 51.9 km^3). In the next 20 years a further increase in flow by 10% has been forecasted based on the worked-out models (up to 55.5 km^3).

At the present time the Kyrgyz Republic utilises no more than 10 km^3 for its own needs. Calculation of water consumption for 2100 that was carried out on the basis of the models indicates that water consumption in the Republic will not exceed 20 km^3 with any development scenario.

Consequently, a 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 has been 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 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. Analysis of the regional situation and/or the water-basins of trans-boundary rivers, as well as working out adaptation measures considering economic and political interests and socio-economic situation of all countries involved, goes well beyond the scope of this project. However, the following national actions aimed at mitigation of the general water situation in the region, primarily taking into account the interests of the Kyrgyz Republic, are obviously called for:

Political measures:
- to determine the Republic's quotas from trans-boundary waters, which will suffice for meeting the Republic's future needs.

Instrumental measures:
- to create an integrated information and analytical system for managing the land and water resources in the Republic;
- to create and develop a water market;
- to increase the efficiency of irrigation systems and introduce modern irrigation technologies;

Social measures:
- to encourage and develop a water-saving attitude among the population;
- to involve local communities in water resource management.

Institutional measures:
- to improve water resource management bodies;
- to create target financial and investment structures.

The listed measures have already been discussed in analogous wording and included into different documents on recommendations of the branch development.

5.3. Energy sector

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 the Republic's need for oil products. Coal deposits are located far from the major consumers, which significantly increases the cost of using local coal. Thus, with respect to these energy products continuing dependence on import should be expected. Use of unconventional and renewable energy sources is virtually absent.

The overall fuel and energy sector does not heavily depend on the climate. There is little likelihood that the decrease in fuel consumption for heating because of general warming will live up to the expectations, since it does not imply a change in diurnal and annual amplitudes. A decrease in thermal losses by industrial and civil buildings, as well as managing temperature conditions in communal buildings and apartment houses, has by far a more significant potential for reduction in heat consumption.

Taking into consideration the conclusions of Section 5.2 another conclusion can be drawn namely that climate change will be favourable for hydro-electric engineering. An increase in annual flow will enlarge the potential of the branch. Changes in the pattern of annual flow distribution may affect derivative power stations and lead to a lower rate of use of the installed capacity of these stations. A change in annual flow distribution will not affect pressurised HPSs.

Therefore, the expected climate change will not have a direct negative impact on Kyrgyzstan's overall energy supply. However, this does not exclude that certain measures will be taken for ensuring a more sustainable development of power engineering, which takes ecological factors into account. A programme for developing the power-engineering complex of Kyrgyzstan should comprise the following measures:

- harmonising the 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 the 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. Based on 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 use 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, especially public transport.

5.4. Population health

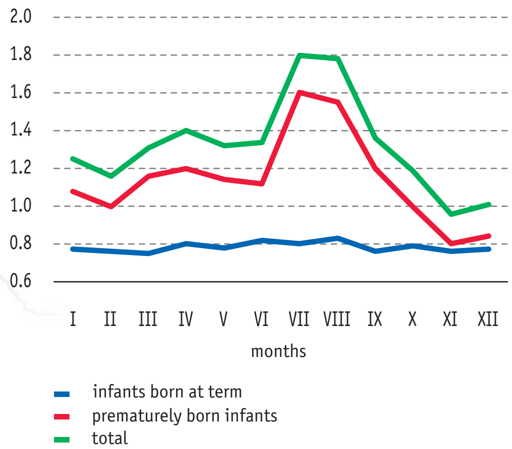
A significant amount of research is known about proving that climate affects one's health. In the context of this project a supplementary analysis of medical statistics has been conducted in order to establish a quantitative relationship between temperature increase and the state of health, given the conditions of the Kyrgyz Republic. This research is not complete, since the impact of other factors was not taken into account.

Non-infectious diseases

A significant correlation between the urolithiasis rate and temperature has been determined. The disease rate in the south of Kyrgyzstan (Osh, Jalal-Abad oblast) is twice as high as in the north (Issyk-Kul, Naryn oblast) for adults and 7 times as high for children. Taking into consideration the forecasted climate change a significant increase in the urolithiasis rate in the Republic may be expected. An average annual temperature in the south and in the north is 11.7 and 4.9°C respectively, based on long-term observations.

A linear association has been found between the number of times during the hot season (May-August) that the ambulance service was contacted for general medical problems on the one hand, and the level of partial oxygen pressure and temperature on the other. Given the expected climate change (increase by approximately 3°C) the increase in ambulance call-out rate in the whole Kyrgyzstan could be more than 1%.

Figure 5.2. Distribution of the absolute number perinatal mortality cases relative to the time of conception



The research of embryo development pathology has shown that if the temperature changes a sharp slow-down in their development occurs. The most serious damage is observed in the period when major embryo organs and systems are formed. Research conducted in the city of Bishkek has shown that a high temperature, even if it is short-lived, may lead to a negative impact on a foetus if it coincides with critical stages of gestation (Fig.5.2). This pressure is first of all connected with a decrease in oxygen partial pressure during the hot time of the year, which may result in foetal hypoxia. The research has also shown that perinatal death rate for both term and prematurely born infants is higher if they were conceived during the period from July to August.

Review of the research has shown that the expected climate change may cause an increase in common illnesses, cardiovascular and broncho-pulmonary pathology, skin diseases and trauma rates. The mortality rate from ischaemic heart disease may increase (particularly for elderly people).

Infectious diseases

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.

At the present time the southern regions of the Republic that have a higher temperature account for a greater proportion of infectious diseases – 30% higher than in the north. The research on association of enteric disease rates with the environmental temperature, taking Bishkek as an example (1999-2001), has shown that under the expected climate change the average increase for the entire Republic may be more than 8%.

The territory of the Kyrgyz Republic is within the zone where malaria is prevalent. Taking into account the average warming and increase in precipitation, the area in which mosquitoes can spread malaria within the Republic will increase. Simultaneously, the warm periods will become longer, which will result in extended activity of mosquitoes. All this may lead to a dramatic increase in malaria rates unless stringent preventative measures are taken.

Along with warming and active trans-boundary connections the danger of bringing mosquito-born hemorrhagic fevers (HF) into the territory of Kyrgyzstan increases – Dengue HF, Chikungunya HF, yellow fever.

There is data available about the extension of natural plague breeding grounds. The study of newly found breeding grounds has shown that plague pathogens have taken root in the middle mountains and foothills with an active involvement of mouse-like rodents and their fleas. At the present time land which can harbour plague accounts for 16.3% of the Republic’s territory.

A warmer climate may lead to a longer period when Ixodes and Gamasid mites are active, which carry mite-borne rickettsiosis (family of a mite-borne spotted fever), hemorrhagic fevers (Crimean-Congo HF) and encephalitis. At the present time due to modern anti-epidemic and anti-parasitic activities within the Republic single cases of these infections have been registered, but their number may grow in proportion to an increase in the activity of mites.

As far as acute enteric diseases are concerned, the greatest danger comes from cholera. At the present time the lowest prevalence rate – namely 1.8% – was observed in lakes and ponds of the Central Tien-Shan, which stands out for its severe climate. An increase in the number of positive samples commences in March and reaches the highest point in July and August. Data analysis of Lake Issyk-Kul illustrates a direct correlation between prevalence and water temperature.

Echinococcosis and alveococcosis infections may occur all throughout the year, but the risk is higher during the warm period.

Geohelminthosis will have a more epidemiological significance: ascaridiasis and trichocephalosis (whipworm, Trichuris trichiura), which need to mature in the soil before the invasion stage. Cumulative temperatures in degrees/days equal to 300 are needed for the development of ascarid oncospheres in order to reach the invasion stage.

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.

5.5. Biodiversity

Based on the climate change scenarios the following changes in the Republic's biodiversity may occur.

Northern, North-Western Kyrgyzstan

Desert and steppe belts will significantly expand. The upper bound of a desert belt will rise by 400 m; the steppe belt by 250 m; the forest-meadow belt by 150 m and the sub-alpine belt by 100 m.

Areas under ephemeral wormwood desert plants will slightly grow at the cost of fescue and feathergrass steppes. Savannoids will prevail in a steppe belt that will supersede meadow-steppes and high-grass meadows. Plant community productivity will increase in steppe and desert ecosystems. Intensive glacier and snow melting will lead to sub-alpine, alpine and nival belt extension. Xeromesophyte and xerophyte species will dominate the highland ecosystems of Kyrgyzstan.

Belt shift will not result in a loss of invertebrates and vertebrates, because they possess a natural adaptation to temperature increase, or will be migrating. Their ecological niches will be replaced by species from other belts.

Golden eagle. *Photo by V.Polynsky*

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.

South-Western Kyrgyzstan

The upper bound of the desert belt will move upwards by 200 m; the steppe belt by 250 m; the forest-meadow belt by 150 m; the upper bound of sub-alpine and alpine belts will not change.

Areas under deserts will expand due to the upper bound's upward shift. Ephemeral wormwood communities will replace savannoids. Savannoids will replace high-grass meadows and shrubs. Desert landscapes will remain desert as before, similarly steppes will remain steppes. Increase in temperature and annual precipitation level will result in the growth of ephemers and ephemeroids – annual and perennial plants with a short, usually vernal development period (Tulipa spp., Gagea spp., Bromus).

Climate change will affect the diversity of neither invertebrates nor vertebrates. All representatives of the animal world in the Western Tien-Shan zone possess natural adaptation abilities, which allow them to adapt to an increase in both moisture level and temperature due to changing natural habitats (space adaptation) and diurnal changes (time adaptation). In the Alai valley zone warming will cause xerophyte species (carpenter bee, Meria wasp, etc.) to move to higher altitudes. The number of insect species is also expected to grow owing to xerophiles moving from lower zones: Lepidoptera, Coleoptera, and finally Hymenoptera. After various grass species move upwards, Lepidoptera and Hymenoptera antophiles (pollinators) will also appear there.

North-Eastern Kyrgyzstan

The upper bound of desert and steppe belt will move upwards by 200 m; the forest-meadow by 150 m; whereas the bounds of alpine and sub-alpine belts will not change.

Issyk-Kul basin deserts will extend at the cost of caraganas and steppes. Increase in air temperature and vernal precipitation will lead to grass mesophytisation of desert communities. Annual plants (ephemers) and perennial plants (ephemeroids) will be more widespread. Background plants of desert ecosystems will remain prevalent among grass species. They are for the most part thermophiles adapted to high air and soil temperature.

Under certain conditions a reduction of marsh biotopes is possible, where marsh birds build their nests. The number of musk-rats will go down. Natural climatic belt shift upwards and desert ecosystem extension will not lead to losses of invertebrate species, since the Issyk-Kul region is dominated by the widespread palearctic (carpenter-ant, horntail, etc.), boreal (red ant, bombus proteus, etc.) and European Western-Siberian (blackvein, machaon, etc.) species. A vertical ecosystem shift may affect only specifically local indigenous Lepidoptera and Coleoptera species.

Inner Tien-Shan

The upper bound of desert and steppe belt will move upwards by 200 m; the forest-meadow by 120 m; the bounds of alpine and sub-alpine belts will not change.

Plants of cryophyte deserts and steppes will not undergo significant changes. The vegetation of intermountain valley deserts and foothill valleys of the Inner Tien-Shan will feature wormwood communities. Background plants of cryophyte deserts will remain dominant among grass species. They are for the most part thermophiles adapted to high air and soil temperature.

Vertebrate animals will not suffer and will completely adapt to new conditions. A very rich endemic insect fauna will be preserved. There are very many endemic types in this biome. As a result of xerophyte desert and steppe ecosystem extension all insects related to it will be preserved.

Adaptation measures should include the following activities:

- rational use of nature's potential;
- introduction of modern pasture and hayfield rotation systems;
- preservation and recovery of the most important ecosystems, landscapes, animal and plant species to the state of natural sustainable reproduction;
- extension of particularly protected natural territories (PPNT): reserves, national parks, game-reserves, botanical gardens, zoos, nurseries;
- establishment of genofunds;
- organisation of biological monitoring service.

5.6. Forest resources

Spruce forests

The upper and lower bounds of spruce distribution will not change significantly. By 2100, the forest density will have increased to 0.5-0.6. This change will not be similar everywhere, which is connected with the availability of water and the warming-up of slopes. With lack of water and significant exposure to heat, spruce will occupy only the northern flanks at an altitude of 2,000-2,200 m. At an altitude of 2,200-2,600 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. High water availability and temperature increase will promote a further growth of areas under forest cover and emergence of spruce even on south-western slopes. At an altitude of 2,600 m and higher until the tree line forests will occupy 57.7% of the total area. In 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 the shaded northern and north-eastern slopes at the top section of the belt at altitudes between 2,800 and 3,000 m. The fairly weak natural recovery of spruce forests is connected with their age structure, biological peculiarities and forest-growing conditions.

Archa-tree forests

As a result of the increase in the sum of above-zero temperatures there may be a boundary shift of the habitat zones for every type of archa-tree (Zaravshan, semi-spherical and Turkestan) by 2100, each of which has its own preferred altitude. Thus, an increase in the sum of above-zero temperatures from 210°C at an altitude of 2,600 m to 462°C at an altitude of 1,600 m and in the duration of the growing season from 33 to 40 days all types of archa-tree will move up by 150-200 m. Nevertheless, the area under archa-forest cover might fall by 2100 because of high morbidity and low seed-bearing (non-climatic factors).

Nuciferous forests

At an altitude of 1,400-2,300 m in the south-west of Kyrgyzstan there may be a bio-climatic productivity increase in areas with sufficient water availability. In dry steppe and semi-desert regions at an altitude of 800-1,400 m (pistachio savannoids and amygdaloids) bio-climatic productivity will remain virtually unchanged, and may only worsen as a result of a human-induced factors. Generally, walnut trees could move up by 100-150 m in response to an increase in the sum of active temperatures by 438°C, an increase in water availability and in the duration of the growing season by 30 days. However, the influence of age structure (ripe and overripe forests account for 60%) and human factors has not been taken into consideration.

Walnut forest, Sary-Chelek. *Photo by V.Polynsky*

Adaptation measures

In the context of human pressures and intensive recreation, the forest ecosystem of Kyrgyzstan could be preserved most of all as a result of organisation and expansion of nature reserves. By 2100 the forest-covered areas should be restored to 340,000 hectares, which is 6% of the Kyrgyzstan's territory. For this 3.4 thousand hectares of different kinds of trees will have to be planted each year.

In order to preserve forest ecosystems in a sustainable manner it is necessary to conduct an inventory of species and intra-species diversity, along with a single methodological approach and a well-developed method of forest genetic resource assessment. Another major way of sustainable preservation of forest ecosystems, as well as improvement of natural resource management, is poverty alleviation among the population. It is essential for local communities to participate in decision-making as far as their access to forest resources is concerned, based on community forest use.

In addition to measures of preservation and development of natural forest systems development of cultivated plantations, for instance industrial poplar plantations (up to 10,000 hectares annually) are needed.

Finally, subordinate legislation and implementation provisions will have to be worked out for the Forest Code (adopted in June 1999), the National Forestry Development Vision and the National Forest Programme.

5.7. Agriculture

The two major agriculture objectives are to provide food independence of the country and to develop export-oriented agricultural production. These will take into account climatic and demographic scenarios, expected water supply and the limitations of agricultural areas, whose growth may not be significant considering the conditions in Kyrgyzstan.

Plant growing

Estimation for the plant-growing sector does not suggest an increase in areas under crops. The expected production output will be achieved through an increase in crop yield. The expected crop yield increase should be quite realistic, for it has already been achieved on certain individual farms (Table 5.3).

Table 5.3. Estimated production 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

In 2100, as has been the case in the past, grain and leguminous crops will account for as much as 50% of all cultivated areas. In the future the areas under cereals are likely to be reduced, with a gradual increase in crop yield to 35 centners/hectare initially, and later even up to 50-100 centners/hectare. The total yield will be sufficient to meet the needs of the entire Kyrgyzstan. Areas under corn will reach 55-60 thousand hectares with a gradual yield increase to over 80 centners/hectare. Towards 2100 seeds of domestic high-yield hybrid corn will be used with a potential crop capacity of 100-150 centners/hectare.

Given the climate change, sugar beet production may be extended to Issyk-Kul and Naryn oblasts with areas under crops of up to 30 thousand hectares. The crop yield increase will be achieved due to introduction of foreign sorts and hybrids along with domestic ones. The former will be as follows: “Roksana” of the French “Sukden” firm; “Record” of the Danish “Maribo” firm; “Bianca”, “Dora”, and “Gala” of the German “KWS” firm, and others. An increase in sugar beet yield to 600 centners/hectare and its total yield up to 1,800 thousand tons will fully meet the demand.

The area under cotton will level off at 40 thousand hectares. An increase in the crop yield to 40 centners/hectare is expected to provide an opportunity to pull gross productivity up to 160 thousand hectares by 2100. This could be achieved by means of advanced cropping technology, efficient seed-growing, completion of sort selection work with the new domestic varieties Kyrgyz 5 and Kyrgyz 7, and introduction of the best wilt-resistant sorts with the greatest possible yield of cotton fibre.

Areas under tobacco are expected to reach 25 thousand hectares.

To increase potato yield there is an intention to switch to virus-free seed-potatoes, to establish a nation-wide biotechnological potato centre with subsidiaries in the major potato-growing regions of Kyrgyzstan.

With respect to vegetable, fruit, and berry growing, horticulture and viticulture priority will be given to increasing crop yield and variety by means of importing high-yield seeds. Horticulture and viticulture, however, may also increase the volume of production by extending their cropping zones upward by 150-200 m in accordance with changes in favourable climatic zones.

Animal husbandry

Actual and required indices of this sector are presented in Table 5.4

Table 5.4. 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

We will now look at how the expected climate change will directly influence domestic animals and forage reserve supplies for the required amount of livestock. It has been determined that even if pasture fodder is in abundance sheep fatness is decreasing as a result of a continuous exposure to high temperatures. As the research has shown, despite their high endurance as far as heat is concerned, they lose weight when the number of hot days exceeds 6 or more out of 10. In the south of the Republic where a long-lasting sultry weather encompasses not only summer months, but also the end of spring and the beginning of fall, mostly sheep are raised, which are adapted the most to local conditions. Obviously, similar measures will be required in the north of Kyrgyzstan.

In connection with the expected shift of the beginning of vegetation to an earlier period time the period of spring parturition will also shift by 15-20 days. At that, the average number of unfavourable days for lambs remains at the same level. According to the climatic scenario, a shift in the time when spring shearing commences is expected to be about 12 to 30 days.

In connection with the forthcoming warming and stress factors for animals that might ensue it becomes necessary to pay a serious attention to an accurate organisation of preventive measures of combating these animal diseases. As a result of temperature and moisture increase there is more likelihood that infectious animal diseases will break out, also among their carriers (dogs, cats, wild and domestic poultry). Such diseases as foot-and-mouth, brucellosis, a hoof form of sheep necrobacillosis, soil infections (anthrax, emphysematous carbuncle, etc.) and parasitic diseases (mange, ringworm, hypodermatosis) are expected to grow. To prevent them it is necessary:

- to carry out a timely and efficient veterinary-sanitary supervision;
- to organise anti-epizootic, preventive, quarantine and other activities for preventing contagious and non-contagious diseases (vaccination, immunisation, isolation, disinfection, etc.);
- to maintain an appropriate sanitary state of the pasture areas and watering places;
- to organise mobile medical and preventive stations on summer pastures.

As can be seen in Table 5.4, the required livestock growth looks quite realistic and close to the growth in 1990. However, most of the experts assume that there was an excessive pasture overload in 1990, which requires certain measures to be taken. Table 5.5 demonstrates a potential enhancement of pastures.

Table 5.5. Annual potential value of pasture resources in the Kyrgyz Republic with different yield based on the live sheep weight assessment

Season	Pasture land (in 1,000 ha)*	Pastures with a low yield			Pastures with an enhanced yield		
		Dry Matter Yield (in kg/ha)	Number of sheep per hectare**	Resource value, in mln USD	Dry Matter Yield (in kg/ha)	Number of sheep per hectare	Resource value, in mln USD
Spring	1,200	400	2.6	27	550	3.4	37
Summer	3,800	800	3.3	228	1,200	5.0	380
Autumn	1,200	400	2.6	18	550	3.4	25
Winter	2,000	150	1.5	23	250	2.5	35
Total	**8,200**			**296**			**477**

* 10% out of the total pasture are not productive;

** taking into account the necessity of 80 kg/per head in the spring and autumn when raising young animals and 50 kg in the wintertime

At the present time the existing pastures may be considered low-yield pastures. Apparently, pastures with an enhanced capacity may completely provide the required amount of livestock.

Key measures of natural pasture improvement:

- using an optimal pasturing load; for this purpose monitoring and further training of pasture users are needed;
- introducing pasture rotation, which may increase pasture capacity by 20-30% due to productivity growth and improved top-soil. The area of hilly, lowland pastures and non-steep slopes should be divided into permanent plots by means of a fence or other types of hedges and stone barriers. Given a more complex relief, a barrier is not that essential in case there are natural boundaries, such as arroyos, rivers, divides, rocky formations, trees, etc. They can be used as boundary marks for the purpose of plots and pasture rotation. Areas susceptible to a significant erosion must be excluded from use;
- controlling deleterious (non-edible, perilous and noxious) weeds and bushes;
- improving pastures with seeds of appropriate types of grass.

6. ASSESSMENT OF STRATEGIES AND MEASURES OF MITIGATING THE IMPACT ON THE CLIMATE

6.1. Mitigation strategy for Kyrgyzstan's impacts on the climate

As a developing country, the Kyrgyz Republic does not have any obligations to reduce GHG emissions. However, in the framework of the relevant mechanisms for implementing the goals of the Convention and the Kyoto Protocol, the Kyrgyz Republic could – in collaboration with other countries and as the economic situation allows – voluntarily undertake a commitment to prevent future GHG emissions. In this regard, a strategy of climate change mitigation, centred on limiting GHG emissions, was developed. In order to increase its efficiency, the strategy of climatic effect mitigation was integrated with the national and sectoral development strategies, which provides for the reduction of both GHG emission and human poverty. This approach as much as possible promotes the sustainable development of the country and the fulfilment of its obligations under the UN Framework Convention on Climate Change.

Implementation of the main emission reduction measures requires substantial financial resources. Nevertheless, despite the current economic hardships, the country has the opportunity to carry out a number of GHG reduction measures that cost little or nothing. These are related to the reduction of such combustion products as sulphur dioxide, nitric oxide, carbon oxide, other chemical substances and aerosols. An additional benefit is the improvement of ambient air quality at both local and national levels, and consequently reduction of negative health impacts on people, animals, plants and ecosystems.

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 hinder the implementation of economically worthwhile measures for GHG emission reduction.

The Kyrgyz Government's recent decision to start the ratification process of the Kyoto Protocol (part of the UNFCCC) can serve to overcome the barriers that hamper the implementation of policies and measures for GHG emission reduction. The comprehensive implementation of such policies and measures in the form of a set of interrelated instruments for GHG emission reduction could make these actions more effective. This set should include the following:

- The organisation of effective government monitoring and control of GHG emissions as well as emission of other dangerous air pollutants;
- Practical support of GHG emission reduction measures by government and society as a whole;
- Periodic preparation of National Communications and Inventories of GHG Emissions and Sinks and their submission to the Convention's Secretariat;
- Improvement of the relevant legislation;
- Introduction of economic instruments, such as differentiated taxes and tendered sale of emission permits, 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 information, to advanced technologies, and to 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 of human resource development.

6.2. Specific mitigation measures

6.2.1. Energy production

GHG emissions from energy production constitute about 35% of the total GHG emissions. Considerable potential for GHG emission reduction is concentrated in this sector.

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

- In the electricity branch: further development of the river Naryn's hydro-energy potential by constructing the Kambaratinsk Hydro-electric Power Station (HPS) with a total capacity of 2260 MW; implementation of the Development Programmes for HPS and non-traditional energy sources (NTES) that provide for the reconstruction of the existing cascade of Alamedin and Kemin small HPS; rehabilitation and reconstruction of other small HPS with a total power of 10 MW and the output of 84.6 million kWh; construction of several new small HPS with a total power of 68 MW and output of 281 million kWh; installation of photo-electric cells with the power of 2-3 MW and output of 5.3-7.9 million kWh; micro HPS with a total power of 2-2.5 MW and output of 8.6-10.8 million kWh; wind energy parks with a power of 1.0-1.2 million kWh;
- In the coal industry: by the year 2005, increase of coal mining activities by up to 80% due to expansion of open coal mining at the lignite deposit of Kara-Keche, and increase by up to 30% of mining rate of existing coal enterprises;
- In the oil and gas industry: by the year 2005, increase of oil extraction to 190 thousand tonnes and natural gas to 30 million cubic meters, whereas the need for gas is 800 million cubic meters.

The development of Kyrgyzstan's hydro-energy and non-traditional energy sources is of considerable interest, both for energy sector development and simultaneous GHG emission reduction. The main reasons are their renewable nature coupled with their current low utilisation rate, their obvious ecological advantages in comparison with non-renewable fuels, and the high potential capacity of the country's main rivers.

A thoroughly planned policy of developing its energy sector would allow the Kyrgyz Republic to become the biggest electricity producer in the region. The industry would not only be able to fully meet the current electricity needs of the population, but also allow for switching to all-electric cooking and heating, thereby replacing the organic fuels which currently take up the greater part of energy consumption. Due to strict policy of energy saving and introduction of new technologies it should be possible to keep the growth in energy consumption below the growth of GDP.

In the future, considerable shifts in the structure of energy use are expected to take place due to the increase of the electricity share from 24% in 1990 to 55% in 2020. The share of natural gas will decrease from 22% to 12% by 2005 and to 10% in 2020. The share of residual oil will also drop sharply from 12% in 1990 to 1% in 2020.

Two basic scenarios of energy production are being elaborated within Kyrgyzstan's development programme. Scenario (A) gives priority to the development of the hydro energy sector and other renewable energy sources, while the other scenario (B) concentrates on the development of the (non-renewable) fuel-energy sector, aiming instead at the increase of coal mining activities and the expansion of the thermal-electric share in energy production.

Comparative evaluation of GHG emissions under both scenarios demonstrates the efficiency of energy sector development under the scenario A (see Table 6.1). The table shows that the proposed Scenario A allows a considerable reduction of GHG emissions from 11,214 Gg in 2000 to 9,284 Gg in 2020. Implementation of Scenario B, by contrast, would lead to an increase of GHG emissions to 28,752 Gg. Energy sector development according Scenario B would take GHG emissions back to the 1990 level by 2020.

The reduction of GHG emission requires the following actions to be undertaken:

- transition to the use of renewable energy sources, reduction of low-grade coal import, increase of energy efficiency by modernising fuel combustion systems; reduction of fuel use in the heat and energy production;

Table 6.1. Comparative evaluation of CO_2 emissions under different scenarios of the country's energy sector development for the period 2000-2020

Indicator	2000		2005		2010		2015		2020	
	A	B	A	B	A	B	A	B	A	B
Electric energy production (in bln KWh), including	14.767	13.609	15.192	14.408	18.61	15.93	21.002	17.185	23.033	24.89
HPS	13.557	12.4	13.825	12.19	17.026	13.505	19.176	13.505	20.095	18.155
TPS	1.21	1.209	1.367	2.2	1.584	2.4	1.826	3.5	2.107	6.7
Fuel consumption, including										
Coal, mln. tons	0.93	1.1	0.95	1.83	1.25	2.38	1.527	3.1	1.55	4.8
Gas, bln. m^3	0.570	0.71	0.8	0.93	0.8	1.24	0.8	1.52	0.8	1.75
Oil residue, mln. tons	0.13	0.2	0.155	0.7	0.16	1.1	0.165	1.6	0.17	1.8
Oil, mln. tons	0.188	0.3	0.69	0.7	0.79	0.8	0.8	1	0.93	1.1
Electric energy, bln. kWh	2.49	7.9	10.57	10	13.8	12.7	15.36	13.3	16.9	18.1
CO_2 emission, Gg	**11,214**	**8,580**	**10,410**	**14,274**	**9,750**	**18,584**	**10,536**	**21,390**	**9,284**	**28,752**

- introduction of a strict energy saving policy; strengthening of monitoring and control systems; reduction of non-technical losses in fuel and energy use;
- elaboration of legal mechanisms that stimulate consumers to save energy and increase the use of non-traditional and renewable energy sources;
- scientific and applied research on development and implementation of new energy and resource saving technologies; GHG abatement technologies, modern means of GHG emission capture and instruments of GHG measurement;
- communication to the public about ecological and social consequences of climate change, and about measures that are being undertaken against it, as well as involvement of the public into implementation of these measures.

6.2.2. Buildings and other structures

The heating of buildings accounts for 13-30% of the total GHG emissions in the Kyrgyz Republic. By the year 2000, the volume of construction went down by 90% compared to 1990. The buildings that are being constructed do not fully meet the construction requirements with respect to energy efficiency and energy conservation. Traditions, social barriers, lack of finance, and almost complete absence of the technologies recommended for the reduction of wastes and GHGs represent major barriers that hamper full-scale realisation of the potential for energy efficiency increase.

The following main measures are recommended:

- 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 application of these standards in the buildings that are under construction.

6.2.3. Transport

The transportation sector, especially its automobile part, accounts for about one third of the total GHG emissions. Motor vehicles take up to 90% of all internal freight forwarding and passenger traffic in the Republic, and they are expected to become the preferred mode of transport for all kinds of freight. The exploitation conditions of the vehicle fleet (mountain landscape, bad quality of the roads, deterioration of vehicles etc.) account for the increased GHG emissions. Therefore, the reduction of GHGs from the transportation sector represents one of the primary tasks in the overall GHG emission reduction policy. Low-cost measures could be very effective in this sector. For example, the introduction of a new, locally patented system of electronic ignition that will cost about $20 to each consumer, and will ultimately save up to 15% on fuel and will reduce up to 30% of GHG emissions. This will require the start-up of production for this device at one of the currently inactive machine factories that have all the necessary equipment and some starting capital.

Other measures of GHG emission reduction include:

- enhancement of state governance and control over the automobile transport sector aimed at GHG emission reduction;
- development of public transport and the road network;
- fuel cell automobiles;
- hybrid electro-mobiles.

6.2.4. Industry

Kyrgyzstan's industry accounts for about 4% of GHG emissions. In recent years this figure dropped to 1.2%, and no significant increase of GHG emission from this sector is expected in the future. Nevertheless, the industrial sector has great potential for GHG emission reduction.

Such measures should include:

- reduction of energy use and GHG emissions due to the introduction of energy saving technologies and re-use of secondary raw materials and wastes;
- enhancement of storage and utilisation of materials that replace halogen containing substances; use of alternative technologies and materials with low GWP;
- optimisation of industrial processes.

6.2.5. Agriculture

The contribution of agriculture to the emission of carbon dioxide has grown from 7.3% in 1990 to 17.3% in 2000. Reduction of carbon dioxide emissions in agriculture can be achieved through the discontinuance of agricultural waste combustion. In the total structure of methane emission, agricultural methane emissions have grown from 50.4% in 1990 to 65.3% in 2000. Here, methane emission reduction is possible through the enhancement of manure storage systems. The share of this sector in total methane emissions constitutes up to 10.5%.

Measures of GHG emission reduction include:

- development of bio-technologies for crop yield increase (including energy crops);
- discontinuance of agricultural waste combustion;
- use of manure to get bio-gas and fertilisers;
- expansion and enhancement of informational and educational services to farmers;
- facilitation of seed-growing and cattle breeding, as well as adequate provision with modern equipment and fertilisers;
- strengthening of state inspections;
- enhancement of land cultivation systems in agriculture to decrease energy consumption and prevent soil erosion.

6.2.6. Waste

Annual methane emission of 34-112 Gg constitutes 25-39% of the total GHG emissions. If the emissions from manure storage systems in agriculture are added, then the total share of methane emissions makes up 33-45% of the total GHG emissions and reaches 130 Gg a year, which corresponds with the country's 10% forecasted natural gas needs in 2020.

Methane capture from waste and manure storage systems with biochemical methods will not only allow reducing GHG emissions, but also will simultaneously provide farms with fuel and secure organic fertiliser.

The following measures need to be undertaken:

- stimulating systems of collection, sorting and processing of domestic and agricultural waste;
- introducing modern bio-technologies of waste processing;
- supporting scientific research in the sphere of waste processing;
- strengthening government control.

6.2.7. Development of sinks

The development of sinks is an important element in the National Climate Strategy.

Kyrgyzstan's forestry sector is connected to the regulation of land use and other macroeconomic strategies that facilitate the use of forest land for other types of land use (for example farming, pasturing, and manufacturing).

Planting new trees in existing forests and creating new woods are important for carbon uptake. The National Forestry Strategy envisages an increase of forestland of up to 6% by 2025. Rehabilitating forests, planting new trees, increasing forest density and productivity, and reducing illegal tree cutting are expected to lead to a 50% increase of CO_2 sinks.

The potential of forest rehabilitation and planting in Kyrgyzstan is estimated at about 1,200 thousand hectares. If the planned measures are carried out, then the total CO_2 sink in forests will amount to about 1,336 Gg a year, 30% of which will be attributable to afforestation, and 70% to existing forests.

Beside the rehabilitation of natural forests, the development of industrial plantations of fast-growing trees such as poplar is promising for Kyrgyzstan.

6.3. Evaluation of basic GHG reduction measures

Table 6.2 illustrates the cost analysis for specific measures that can lead to the reduction of GHG emissions to the atmosphere if implemented within the framework of national development programmes. Lacking financial resources could jeopardise the implementation of these measures. Therefore, the country should try to involve all interested parties, including domestic and foreign investors.

Analysis of the data reveals the significant potential of GHG emission reduction if these measures are actually carried out.

Table 6.2. Assessment of planned measures for GHG reduction

Specific measures	Total cost (in mln. dollars)	State contribution (in mln. dollars)	Lacking resources (in mln. dollars)	GHG emission reduction (in Gg)
1. Energy sector:				
1.1. Improving electricity supply to Osh & Batken obasts: • completion of 220 kV HVL Alay-Batken, 220/110/1kV SS Aygul/Tash; • reconstruction of 220 kV DF SS Alay, reconstruction of 110 kV SS Batken, Batken oblast	 3.6 3.1	 3.6 3.1	 0.0 0.0	
1.2. Transformer replacement for 220 kV SS Uzlovaya in Osh city	1.4	1.4	0.0	
1.3. Reconstruction of 110 kV SS Izbasken in Jalal-Abad oblast	0.5	0.5	0.0	
1.4. Construction of 500 kV SS Datka with 220 kV HVL	44.3	0.0	44.3	
1.5. Construction of 220 kV HVL Frunzenskaya – Ala Archa	16.4	0.0	16.4	
1.6. Construction of 500kV HVL Toktogul HPS – Kambarata – Kemin with SS Kemin	327.7	0.0	327.7	
1.7. Construction and reconstruction of objects: • Toktogul HPS • Kurpsay HPS • Tashkumyr HPS • Shamaldy-Sai HPS • Uch-Kurgan HPS • Reconstruction of TPS Bishkek • Kambarata HPS –1; 2	 1.3 1.3 2.9 4.7 4.3 8 323.4	 1.3 1.3 2.9 4.7 4.3 8 0.0	 0.0 0.0 0.0 0.0 0.0 0.0 323.4	
1.8. Rehabilitation, (re)construction of small HPS: • rehabilitation of HPS "Issyk-Ata" • construction of 7 small HPS in Batken oblast with a total power of 20 MW; • construction of Sokuluk HPS-1, power 1200 kW; • rehabilitation of HPS in Bashkaindy, power 1600 kW; • construction of HPS in Minkush, power 1000 kW • rehabilitation of HPS "Chaek", power 800 kW; • reconstruction of KA HPS; • construction of HPS on Nayman canal in Naukat rayon; • construction of HPS "Kudurgu", power 800 kW	 6.5 21.6 0.9 1.3 0.9 0.9 0.7 0.5 0.9	 6.5 0.0 0.0 0.0 0.0 0.0 0.7 0.5 0.0	 0.0 21.6 0.9 1.3 0.9 0.9 0.0 0.0 0.9	
1.9. Organisation of series manufacture of the electronic ignition system "Zhel-Argy" for motor vehicles	1.0	0.5	0.5	610
1.10. Buildings and other structures. Organisation of heat saving measures				210
Energy sector total:	**778.04**	**39.3**	**738.8**	
2. Agro-industrial sector (includes agriculture and the industry that processes agricultural products):				
2.1.Stimulation of environment friendly manufacturing: • organisation of seminars on clean technologies; • modernisation of equipment of the Ministry of Agriculture and Water Resources' Inspection Service, and timely action against random and agro-chemical emissions; • product quality control	4.1	4.1	0.0	
2.2. Stimulation of intensive methods of agricultural development through: • training for farmers and rural inhabitants on implementation of new production techniques; • completion of irrigation systems rehabilitation and irrigation network management reform within the WB and ADB- sponsored projects. General overhaul and maintenance of water supply facilities.	 70.2 26.8	 22.7 20.2	 47.5 6.6	
2.3. Food and processing industry development: • formation of agricultural production and processing associations; • formation of a nation-wide system of commodity and raw material exchange engaged in distributing agro-industrial products; • enlargement of credit facilities for the food and processing industry	 0.1 0.2 19.1	 0.1 0.0 19.1	 0.0 0.2 0.0	
Agro-industrial sector total:	**120.6**	**66.35**	**54.3**	
3. Waste processing:				
3.1. Biogas production from waste of animal husbandry and urban domestic waste.	1.6	0.8	0.8	130
4. Sinks development:				
4.1. Expansion of forest area to 340,000 ha by 2025	272	136	136	1336
Total:	**1,172.3**	**242.3**	**929.8**	

DF – distributive facility HVL – high-voltage line SS – substation

7. IMPROVING EDUCATION AND PUBLIC AWARENESS ON CLIMATE CHANGE ISSUES

Enhancing public awareness and knowledge of the climate change problem, its anthropogenic impacts and its adverse consequences are of great importance to promoting effective measures and developing new governmental policies in this area.

Development and implementation of measures toward education and public awareness of climate change issues, promotion of public access to information on climate change, training of scientific, technical and management personnel – all these are among the Kyrgyz Republic's commitments to the UN Framework Convention on Climate Change and the Arhus Convention.

To achieve the above-mentioned purposes, the Concept of Continuous Environmental Education is being developed in Kyrgyzstan. Global climate change has been distinguished in the Concept as one of the most important applied environmental issues. The panel of the UNDP/GEF Project on Climate Change in Kyrgyzstan took active participation in the process of developing both the Concept of Environmental Education and standard programmes on Ecology and Safety of Human Activities. These are mandatory within education standards for all professions acquired via higher education. The standards are designed to study global warming issues and their impact on human activities.

7.1. Education and training

The system of education and training in the Republic comprises the following institutions: pre-schools and other educational centres, elementary, general and secondary schools, lyceums, gymnasiums, vocational schools, technical schools, colleges, universities, and institutions and other centres for post-graduate education (advanced training) and graduate schools (master's, doctor's degrees).

Curricula of pre-school and general education institutions include courses that, in a comprehensible way, cover climate formation conditions, the main climatic factors, and their importance to the environment.

For the purpose of providing information to schools, higher education institutions, interested experts and the wider community, the Project Panel has prepared the following items for publication:

- Climate and Environment (paperback);
- three issues of the Information Bulletin 'Enabling the Kyrgyz Republic to Prepare its First National Communication in response to its Commitments to the UN Framework Convention on Climate Change', both in electronic and hard copy versions;
- Sustainable Development of Environmental and Economic Systems Under Conditions of Climate Change (manual on sustainable development issues), a thematic collection of articles covering climate change issues.

The Kyrgyz-Russian Slavic University trains experts in meteorology and climate studies. Professions related to environmental protection, ecology and nature management, which might be oriented to climate change issues, can be acquired at the following higher education institutions in Kyrgyzstan:

- Kyrgyz National University
- Kyrgyz State University of Construction, Transport and Architecture
- Kyrgyz Mining University
- International University of Kyrgyzstan
- Kyrgyz State Pedagogical University
- Bishkek Humanities University
- Kyrgyz Technical University
- Issyk-Kul, Osh, and Jalal-Abad Universities

7.2. Mass media

Press, radio and television are the main mass media in the Kyrgyz Republic. According to public awareness assessment conducted in the country's regions, television is the main source of information on environmental issues. Within the framework of the present project on climate change, six videos have been prepared and shown on the main television channels in Kyrgyzstan. Moreover, several debates and four round-table discussions on television have been conducted. Finally, information on the main climate change issues has been published in the country's popular newspapers.

7.3. Other information sources

Other information sources can be found in the major public libraries in Kyrgyzstan, the UNDP library in Bishkek, and the libraries of leading universities. Materials include publications by IPCC, WMO, the Conferences of Parties to the UN-FCCC, National Communications on Climate Change of different countries, information provided by Kyrgyzstan's ministries and other state bodies, information from/ about the country's major enterprises, opinions of national and international experts etc. The Internet is a good channel to receive information on climate change issues. Information is selected and stored in electronic form at the Project Implementation Unit. There is a web-site on the Kyrgyzstan and UNFCCC Project, where project results and all necessary information on climate change issues are stored.

7.4. Environmental organisations

Environmental non-governmental organisations (NGOs) play a vital role in public awareness and environmental education, and they can contribute to solving environmental problems, mainly at the local level. At present, there are about 200 environmental NGOs in the Kyrgyz Republic. Some of them are engaged in ecological education and attitude development, the rest implement activities in the field of environmental protection. Thus, NGOs have taken measures to clean up ecologically vulnerable natural areas, to organise a Keep your City Clean campaign, and to plant trees. They have also carried out demonstration projects in the area of alternative (i.e. renewable) energy sources.

The adoption by Kyrgyzstan of the Arhus Convention on access to information on the environment provides new prospects for the dialogue between governmental bodies and public organisations. However, at present, NGOs do not pay adequate attention to climate change issues. Only some of them are concerned with climate change problems, but the implementation of some measures is not feasible without broad public involvement (for instance, separate collection of wastes). Therefore, measures on enhancing non-governmental organisations' involvement in this area are needed.

Civil sector experts have been engaged in the present project 's implementation – those were experts from schools, higher education and research institutions (more than 100 people), including ten experts from NGOs.

Climate change issues, the purposes of the current project and its results have been discussed in more than 40 round-tables, seminars, and conferences on environmental problems and sustainable development organised by various NGOs.

Within the framework of the project itself, five workshops with extensive community and NGO participation were conducted with the purpose of informing them about the goals and tasks of the project, the results of particular stages, and of the project as a whole.

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ANNEX

1990 Summary Report for National Greenhouse Gas Inventory (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Halogens
Total National Emissions and Removals	**29105**	**-830.16**	**280.03**	**3.7160**	**133.84**	**132.21**	**100.30**	**113.19**	
Energy	**28195**		**38.634**	**0.2892**	**132.58**	**93.624**	**84.210**	**111.91**	
A Fuel Combustion (Sectoral Approach)	28195		1.9825	0.2892	132.58	93.624	84.210	111.91	
1 Energy Industries	11988		0.2498	0.1008	34.456	3.1359	0.8357	49.645	
2 Manufacturing Industries and Construction	706		0.01	0.0103	2.5858	0.7185	0.1508	3.9504	
3 Transport	5060		1.0849	0.0443	47.050	60.807	77.335	5.2087	
4 Other Sectors	10441		0.6378	0.1338	48.490	28.962	5.8889	53.103	
B Fugitive Emissions from Fuels	0		36.65	0	0	0	0	0	
1 Solid Fuels	0		14.04	0	0	0	0	0	
2 Oil and Natural Gas	0		22.61	0	0	0	0	0	
Industrial Processes	**708.2**				**0.1845**	**8.737**	**16.085**	**1.2806**	
A Mineral Products	694.5						5.3700	0.4160	
B Chemical Industry							0.0201		
C Metal Production	13.7				0.1845	8.7369	0.0554	0.8646	
D Other Production							10.640		
F Consumption of Fluocarbons and Sulfur Hexaluoride									
Agriculture	**197.5**		**141.04**	**3.2003**	**0.9533**	**25.450**			
A Enteric Fermentation			122.33						
B Storage Systems			17.258	0.0046					
C Rice Cultivation			0.48						
D Agricultural Soils				3.1684					
E Natural Fires in Mountains			0.0	0.0000	0.0000	0.0000			
F Field Burning of Agricultural Residues	197.5		0.9695	0.0274	0.9533	25.450			
Land-Use Change & Forestry	**4.7**	**-830.16**	**0.5025**	**0.0035**	**0.1249**	**4.3971**			
A Change in Woody Biomass Stocks		-749.97							
B Forests and Grassland Conversion	4.7		0.5025	0.0035	0.1249	4.3971			
C Abandonment of Managed Lands		-80.18							
D CO_2 Emissions from Soils	0.0023								
Waste			**99.85**	**0.2230**					
A Solid Waste Disposal			78.31						
B Sewage Water Cleaning			21.54						
Memo Items:									
International Bunkers	**403.0**		**0.00**	**0.01**	**1.71**	**0.57**	**0.28**	**0.13**	
CO_2 Emission from Biomass	**84.3**		**1.35**	**0.09**	**0.34**	**1.18**			

NOTE: Empty cells mean not applicable
Zero cells mean not estimated

1991 Summary Report for National Greenhouse Gas Inventory (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Halogens
Total National Emissions and Removals	**27914**	**-843.71**	**289.19**	**0.5371**	**130.63**	**128.86**	**102.09**	**107.76**	
Energy	**27072**		**35.571**	**0.2711**	**129.46**	**94.229**	**85.769**	**106.49**	
A Fuel Combustion (Sectoral Approach)	27072		1.9788	0.2711	129.46	94.229	85.769	106.49	
1 Energy Industries	10765		0.2166	0.0995	31.349	2.7318	0.7274	49.870	
2 Manufacturing Industries and Construction	664.29		0.0094	0.0097	2.4360	0.6643	0.1396	4.0679	
3 Transport	5112.0		1.1075	0.0440	47.689	61.801	78.989	5.2692	
4 Other Sectors	10531		0.6454	0.1179	47.987	29.032	5.9132	47.280	
B Fugitive Emissions from Fuels			33.592						
1 Solid Fuels			13.027						
2 Oil and Natural Gas			20.565						
Industrial Processes	**671.41**				**0.1842**	**7.3048**	**16.319**	**1.2741**	
A Mineral Products	659.95						5.328	0.416	
B Chemical Industry							0.0178	no	
C Metal Production	11.463				0.1842	7.3048	0.0442	0.8581	
D Other Production							10.929	no	
F Consumption of Fluocarbons and Sulfur Hexaluoride									
Agriculture	**166.45**		**140.51**	**0.0348**	**0.8748**	**23.304**			
A Enteric Fermentation			121.87						
B Storage Systems			17.032	0.0045					
C Rice Cultivation			0.7200						
D Agricultural Soils				0.0061					
E Natural Fires in Mountains			0.0000	0.0000	0.0000	0.0000			
F Field Burning of Agricultural Residues	166.45		0.8878	0.0242	0.8748	23.304			
Land-Use Change & Forestry	**4.2648**	**-843.71**	**0.4593**	**0.0032**	**0.1141**	**4.0186**			
A Change in Woody Biomass Stocks		-763.52							
B Forests and Grassland Conversion	4.2625		0.4593	0.0032	0.1141	4.0186			
C Abandonment of Managed Lands		-80.183							
D CO_2 Emissions from Soils	0.0023								
Waste			**112.65**	**0.2280**					
A Solid Waste Disposal			92.150						
B Sewage Water Cleaning			20.500						
Memo Items:									
International Bunkers	**111.95**		**0.0008**	**0.0032**	**0.4744**	**0.1581**	**0.0791**	**0.0355**	
CO_2 Emission from Biomass	**67.950**		**1.0900**	**0.0700**	**0.2700**	**0.9500**			

NOTE: Empty cells mean not applicable
Zero cells mean not estimated

1992 Summary Report for National Greenhouse Gas Inventory (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Halogens
Total National Emissions and Removals	**18727**	**-859.15**	**260.84**	**0.4360**	**102.35**	**128.74**	**94.365**	**55.218**	
Energy	**17942**		**26.70**	**0.1680**	**100.94**	**89.665**	**81.868**	**54.042**	
A Fuel Combustion (Sectoral Approach)	17942		1.7429	0.1680	100.94	89.665	81.868	54.042	
1 Energy Industries	5331.7		0.0765	0.0450	15.788	1.5309	0.3827	17.877	
2 Manufacturing Industries and Construction	651.35		0.0091	0.0095	2.3760	0.6232	0.1313	4.0620	
3 Transport	4934.2		1.0638	0.0422	46.177	59.868	75.759	5.1398	
4 Other Sectors	7025.0		0.5934	0.0713	36.603	27.643	5.5950	26.963	
B Fugitive Emissions from Fuels			24.953						
1 Solid Fuels			8.0670						
2 Oil and Natural Gas			16.886						
Industrial Processes	**565.28**				**0.1831**	**4.9642**	**12.496**	**1.1761**	
A Mineral Products	557.50						5.6700	0.3290	
B Chemical Industry							0.0093		
C Metal Production	7.7882				0.1831	4.9642	0.0260	0.8471	
D Other Production							6.7909		
F Consumption of Fluocarbons and Sulfur Hexaluoride									
Agriculture	**215.21**		**131.74**	**0.0399**	**1.1103**	**30.134**			
A Enteric Fermentation			113.93						
B Storage Systems			15.905	0.0041					
C Rice Cultivation			0.7600						
D Agricultural Soils				0.0058					
E Natural Fires in Mountains	0.062841		0.0010	0.0000	0.0003	0.0088			
F Field Burning of Agricultural Residues	215.21		1.1470	0.0300	1.1100	30.125			
Land-Use Change & Forestry	**4.2216**	**-859.15**	**0.4546**	**0.0031**	**0.1130**	**3.9778**			
A Change in Woody Biomass Stocks		-778.97							
B Forests and Grassland Conversion	4.2193		0.4546	0.0031	0.1130	3.9778			
C Abandonment of Managed Lands		-80.183							
D CO_2 Emissions from Soils	0.0023								
Waste			**101.95**	**0.2250**					
A Solid Waste Disposal			86.010						
B Sewage Water Cleaning			15.940						
Memo Items:									
International Bunkers									
CO_2 Emission from Biomass	**65.990**		**1.0600**	**0.0700**	**0.2600**	**0.9200**			

NOTE: Empty cells mean not applicable
Zero cells mean not estimated

1993 Summary Report for National Greenhouse Gas Inventory (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Halogens
Total National Emissions and Removals	**17652**	**-874.26**	**224.18**	**1.0627**	**99.341**	**132.59**	**88.563**	**56.753**	
Energy	**17029**		**21.188**	**0.1621**	**98.790**	**90.545**	**82.989**	**54.422**	
A Fuel Combustion (Sectoral Approach)	17 029		1.7550	0.1621	98.790	90.545	82.989	54.422	
1 Energy Industries	5265.5		0.0915	0.0471	15.472	1.4145	0.3651	21.554	
2 Manufacturing Industries and Construction	639.35		0.0086	0.0094	2.2965	0.5462	0.1158	4.0729	
3 Transport	5078.1		1.0845	0.0434	47.624	61.705	77.079	5.3471	
4 Other Sectors	6046.6		0.5704	0.0622	33.398	26.879	5.4294	23.448	
B Fugitive Emissions from Fuels			19.433						
1 Solid Fuels			6.4536						
2 Oil and Natural Gas			12.980						
Industrial Processes	**370.52**				**0.1835**	**3.2876**	**5.5740**	**2.3312**	
A Mineral Products	354.21						0.3930	0.2080	
B Chemical Industry							0.0071		
C Metal Production	16.306				0.1835	3.2876	0.0129	2.1232	
D Other Production							5.1610		
F Consumption of Fluocarbons and Sulfur Hexaluoride									
Agriculture	**248.06**		**120.79**	**0.6764**	**0.2530**	**34.723**			
A Enteric Fermentation			103.63						
B Storage Systems			14.841	0.0035					
C Rice Cultivation			1.000						
D Agricultural Soils				0.639					
E Natural Fires in Mountains	0.0001		0.000	0.000	0.000	0.000			
F Field Burning of Agricultural Residues	248.06		1.322	0.034	0.253	34.723			
Land-Use Change & Forestry	**4.2834**	**-874.26**	**0.4613**	**0.0032**	**0.1146**	**4.0360**			
A Change in Woody Biomass Stocks		-794.08							
B Forests and Grassland Conversion	4.2811		0.4613	0.0032	0.1146	4.0360			
C Abandonment of Managed Lands		-80.183							
D CO_2 Emissions from Soils	0.0023								
Waste			**81.740**	**0.2210**					
A Solid Waste Disposal			69.260						
B Sewage Water Cleaning			12.480						
Memo Items:									
International Bunkers									
CO_2 Emission from Biomass	**64.030**		**1.0200**	**0.0700**	**0.2500**	**0.9000**			

NOTE: Empty cells mean not applicable
Zero cells mean not estimated

1994 Summary Report for National Greenhouse Gas Inventory (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Halogens
Total National Emissions and Removals	**14624**	**-891.05**	**159.51**	**0.7327**	**90.525**	**115.55**	**87.253**	**47.783**	
Energy	**14228**		**10.481**	**0.1483**	**89.420**	**87.060**	**83.531**	**45.976**	
A Fuel Combustion (Sectoral Approach)	14 228		1.6548	0.1483	89.420	87.060	83.531	45.976	
1 Energy Industries	3679.4		0.0543	0.0416	11.236	0.9150	0.2335	17.598	
2 Manufacturing Industries and Construction	589.95		0.0076	0.0087	2.0690	0.4152	0.0892	3.5376	
3 Transport	5145.6		1.1035	0.0441	48.182	62.431	78.510	5.3848	
4 Other Sectors	4813.0		0.4895	0.0539	27.934	23.299	4.6979	19.456	
B Fugitive Emissions from Fuels			8.8259						
1 Solid Fuels			3.1817						
2 Oil and Natural Gas			5.6442						
Industrial Processes	**228.42**				**0.1828**	**2.0791**	**3.7223**	**1.8072**	
A Mineral Products	217.84						0.2324	0.1273	
B Chemical Industry							0.0017		
C Metal Production	10.582				0.1828	2.0791	0.0034	1.6799	
D Other Production							3.4847		
F Consumption of Fluocarbons and Sulfur Hexaluoride									
Agriculture	**164.42**		**98.651**	**0.3827**	**0.8259**	**23.012**			
A Enteric Fermentation			83.912						
B Storage Systems			12.621	0.0026					
C Rice Cultivation			1.2400						
D Agricultural Soils				0.3580					
E Natural Fires in Mountains	0.2029		0.0030	0.0000	0.0009	0.0258			
F Field Burning of Agricultural Residues	164.22		0.8750	0.0220	0.8250	22.986			
Land-Use Change & Forestry	**3.6038**	**-891.05**	**0.3880**	**0.0027**	**0.0964**	**3.3954**			
A Change in Woody Biomass Stocks		-810.87							
B Forests and Grassland Conversion	3.6015		0.3880	0.0027	0.0964	3.3954			
C Abandonment of Managed Lands		-80.183							
D CO_2 Emissions from Soils	0.0023								
Waste			**49.990**	**0.1990**					
A Solid Waste Disposal			41.100						
B Sewage Water Cleaning			8.8900						
Memo Items:									
International Bunkers	**33.864**		**0.0002**	**0.0010**	**0.1435**	**0.0478**	**0.0239**	**0.0107**	
CO_2 Emission from Biomass	**58.150**		**0.9300**	**0.0600**	**0.2300**	**0.8100**			

NOTE: Empty cells mean not applicable
Zero cells mean not estimated

1995 Summary Report for National Greenhouse Gas Inventory (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Halogens
Total National Emissions and Removals	**12693**	**-901.87**	**145.63**	**0.5862**	**82.811**	**120.98**	**82.730**	**35.059**	
Energy	**12290**		**11.609**	**0.1120**	**81.066**	**83.494**	**79.507**	**33.333**	
A Fuel Combustion (Sectoral Approach)	12290		1.6237	0.1120	81.066	83.494	79.507	33.333	
1 Energy Industries	4397.7		0.0703	0.0458	13.225	1.1219	0.2884	21.206	
2 Manufacturing Industries and Construction	140.60		0.0028	0.0020	0.6249	0.3322	0.0677	0.8051	
3 Transport	4725.7		1.0361	0.0409	43.902	56.910	74.106	4.7858	
4 Other Sectors	3025.8		0.5145	0.0232	23.314	25.130	5.0448	6.5355	
B Fugitive Emissions from Fuels			9.9852						
1 Solid Fuels			1.7351						
2 Oil and Natural Gas			8.2501						
Industrial Processes	**167.84**				**0.1821**	**1.955**	**3.2228**	**1.7259**	
A Mineral Products	157.82						0.3655	0.0928	
B Chemical Industry							0.0014		
C Metal Production	10.019				0.1821	1.9550	0.0025	1.6331	
D Other Production							2.8534		
F Consumption of Fluocarbons and Sulfur Hexaluoride									
Agriculture	**231.47**		**91.685**	**0.2537**	**1.4693**	**32.223**			
A Enteric Fermentation			76.741						
B Storage Systems			11.886	0.0023					
C Rice Cultivation			1.8000						
D Agricultural Soils				0.2110					
E Natural Fires in Mountains	3.6333		0.0444	0.0003	0.0093	0.3314			
F Field Burning of Agricultural Residues	227.84		1.2140	0.0400	1.4600	31.892			
Land-Use Change & Forestry	**3.5112**	**-901.87**	**0.3781**	**0.0026**	**0.0939**	**3.3080**			
A Change in Woody Biomass Stocks		-821.69							
B Forests and Grassland Conversion	3.5089		0.3781	0.0026	0.0939	3.3080			
C Abandonment of Managed Lands		-80.183							
D CO_2 Emissions from Soils	0.0023								
Waste			**51.940**	**0.2180**					
A Solid Waste Disposal			45.430						
B Sewage Water Cleaning			6.5100						
Memo Items:									
International Bunkers	**174.08**		**0.0012**	**0.0049**	**0.7378**	**0.2459**	**0.1230**	**0.0552**	
CO_2 Emission from Biomass	**71.220**		**1.1400**	**0.0800**	**0.2800**	**1.0000**			

NOTE: Empty cells mean not applicable
Zero cells mean not estimated

1996 Summary Report for National Greenhouse Gas Inventory (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Halogens
Total National Emissions and Removals	**12832**	**-917.00**	**143.99**	**0.6663**	**79.630**	**127.46**	**77.526**	**33.225**	**0.0055**
Energy	**12220**		**12.816**	**0.1090**	**77.316**	**77.164**	**71.466**	**30.930**	
A Fuel Combustion (Sectoral Approach)	12220		1.5129	0.1090	77.316	77.164	71.466	30.930	
1 Energy Industries	4754.6		0.0771	0.0475	14.213	1.2354	0.3174	19.908	
2 Manufacturing Industries and Construction	144.25		0.0030	0.0020	0.6539	0.3634	0.0740	0.7343	
3 Transport	4222.6		0.9241	0.0367	39.195	50.779	66.097	4.2725	
4 Other Sectors	3098.5		0.5087	0.0229	23.255	24.787	4.9780	6.0150	
B Fugitive Emissions from Fuels			11.303						
1 Solid Fuels			1.5376						
2 Oil and Natural Gas			9.7654						
Industrial Processes	**290.86**				**0.1811**	**2.0042**	**6.0598**	**2.2951**	**0.0055**
A Mineral Products	276.44						1.2028	0.1636	
B Chemical Industry							0.0015		
C Metal Production	14.427				0.1811	2.0042	0.0003	2.1315	
D Other Production							4.8552		
F Consumption of Fluocarbons and Sulfur Hexaluoride									0.0055
Agriculture	**317.01**		**87.994**	**0.3414**	**2.0270**	**44.550**			
A Enteric Fermentation			72.623						
B Storage Systems			11.521	0.0022					
C Rice Cultivation			2.1600						
D Agricultural Soils				0.2832					
E Natural Fires in Mountains	0.0104		0.0001	0.0000	0.0000	0.1799			
F Field Burning of Agricultural Residues	317.00		1.6900	0.0560	2.0270	44.370			
Land-Use Change & Forestry	**3.9745**	**-917.00**	**0.4280**	**0.0029**	**0.1063**	**3.7448**			
A Change in Woody Biomass Stocks		-836.82							
B Forests and Grassland Conversion	3.9722		0.4280	0.0029	0.1063	3.7448			
C Abandonment of Managed Lands		-80.183							
D CO_2 Emissions from Soils	0.0023								
Waste			**42.750**	**0.2130**					
A Solid Waste Disposal			37.560						
B Sewage Water Cleaning			5.1900						
Memo Items:									
International Bunkers	**209.90**		**0.0015**	**0.0059**	**0.8896**	**0.2965**	**0.1483**	**0.0665**	
CO_2 Emission from Biomass	**70.570**		**1.1300**	**0.0800**	**0.2800**	**0.9900**			

NOTE: Empty cells mean not applicable
Zero cells mean not estimated

1997 Summary Report for National Greenhouse Gas Inventory (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Halogens
Total National Emissions and Removals	**12055**	**-927.01**	**153.20**	**0.9378**	**76.537**	**135.75**	**78.170**	**30.744**	**0.1373**
Energy	**11320**		**13.764**	**0.0960**	**74.095**	**76.436**	**71.420**	**28.358**	
A Fuel Combustion (Sectoral Approach)	11320		1.4979	0.0960	74.095	76.436	71.420	28.358	
1 Energy Industries	4315.6		0.0762	0.0366	12.598	1.1795	0.3044	17.334	
2 Manufacturing Industries and Construction	139.01		0.0030	0.0019	0.6484	0.3826	0.0777	0.7925	
3 Transport	4200.6		0.9247	0.0363	39.024	50.617	66.173	4.2430	
4 Other Sectors	2664.5		0.4940	0.0212	21.825	24.257	4.8652	5.9889	
B Fugitive Emissions from Fuels			12.266						
1 Solid Fuels			1.9513						
2 Oil and Natural Gas			10.315						
Industrial Processes	**348.20**				**0.1798**	**2.0309**	**6.7501**	**2.3861**	**0.1373**
A Mineral Products	333.21						2.0090	0.1973	
B Chemical Industry							0.0009		
C Metal Production	14.987				0.1798	2.0309	0.0032	2.1887	
D Other Production							4.7370		
F Consumption of Fluocarbons and Sulfur Hexaluoride									0.1373
Agriculture	**382.78**		**91.422**	**0.6409**	**2.1561**	**53.549**			
A Enteric Fermentation			74.921						
B Storage Systems			12.007	0.0022					
C Rice Cultivation			2.4400						
D Agricultural Soils				0.5794					
E Natural Fires in Mountains	1.5083		0.0216	0.0002	0.0051	0.1792			
F Field Burning of Agricultural Residues	381.27		2.0320	0.0590	2.1510	53.370			
Land-Use Change & Forestry	**3.9621**	**-927.01**	**0.4266**	**0.0029**	**0.1060**	**3.7332**			
A Change in Woody Biomass Stocks		-846.82							
B Forests and Grassland Conversion	3.9598		0.4266	0.0029	0.1060	3.7332			
C Abandonment of Managed Lands		-80.183							
D CO_2 Emissions from Soils	0.0023								
Waste			**47.59**	**0.1980**					
A Solid Waste Disposal			42.800						
B Sewage Water Cleaning			4.7900						
Memo Items:									
International Bunkers	**115.56**		**0.0008**	**0.0033**	**0.4898**	**0.1633**	**0.0816**	**0.0366**	
CO_2 Emission from Biomass	**81.680**		**1.3120**	**0.0900**	**0.3200**	**1.1400**			

NOTE: Empty cells mean not applicable
Zero cells mean not estimated

1998 Summary Report for National Greenhouse Gas Inventory (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Halogens
Total National Emissions and Removals	**13003**	**-944.41**	**139.97**	**0.8862**	**79.868**	**135.07**	**80.430**	**34.240**	**0.2456**
Energy	**12247**		**12.670**	**0.1106**	**77.415**	**77.164**	**72.646**	**31.898**	
A Fuel Combustion (Sectoral Approach)	12247		1.5232	0.1106	77.415	77.164	72.646	31.898	
1 Energy Industries	4602.8		0.0734	0.0461	13.781	1.1985	0.3071	19.597	
2 Manufacturing Industries and Construction	135.87		0.0031	0.0018	0.6576	0.4159	0.0843	0.6757	
3 Transport	4231.3		0.9387	0.0367	39.201	50.855	67.293	4.2238	
4 Other Sectors	3277.5		0.5080	0.0260	23.775	24.694	4.9614	7.4015	
B Fugitive Emissions from Fuels			11.147						
1 Solid Fuels			1.6209						
2 Oil and Natural Gas			9.5256						
Industrial Processes	**370.47**				**0.1282**	**1.1074**	**7.7846**	**2.3418**	**0.2456**
A Mineral Products	356.41						3.4108	0.2131	
B Chemical Industry							0.0006		
C Metal Production	14.058				0.1282	1.1074	0.0014	2.1287	
D Other Production							4.3718		
F Consumption of Fluocarbons and Sulfur Hexaluoride									0.2456
Agriculture	**382.08**		**92.897**	**0.5660**	**2.2304**	**53.463**			
A Enteric Fermentation			76.341						
B Storage Systems			12.355	0.0023					
C Rice Cultivation			2.1600						
D Agricultural Soils				0.5027					
E Natural Fires in Mountains	0.7172		0.0075	0.0000	0.0044	0.0805			
F Field Burning of Agricultural Residues	381.36		2.0330	0.0610	2.2260	53.382			
Land-Use Change & Forestry	**3.5420**	**-944.41**	**0.3814**	**0.0026**	**0.0948**	**3.3372**			
A Change in Woody Biomass Stocks		-864.23							
B Forests and Grassland Conversion	3.5398		0.3814	0.0026	0.0948	3.3372			
C Abandonment of Managed Lands		-80.183							
D CO_2 Emissions from Soils	0.0023								
Waste			**34.020**	**0.2070**					
A Solid Waste Disposal			29.560						
B Sewage Water Cleaning			4.4600						
Memo Items:									
International Bunkers	**160.09**		**0.0011**	**0.0045**	**0.6785**	**0.2262**	**0.1131**	**0.0507**	
CO_2 Emission from Biomass	**87.560**		**1.4000**	**0.1000**	**0.3500**	**1.2300**			

NOTE: Empty cells mean not applicable
Zero cells mean not estimated

1999 Summary Report for National Greenhouse Gas Inventory (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Halogens
Total National Emissions and Removals	**11258**	**-967.18**	**144.55**	**0.8800**	**75.152**	**125.53**	**76.911**	**30.078**	**0.0746**
Energy	**10723**		**8.7741**	**0.1008**	**72.694**	**76.015**	**71.428**	**28.392**	
A Fuel Combustion (Sectoral Approach)	10723		1.4898	0.1008	72.694	76.015	71.428	28.392	
1 Energy Industries	3259.1		0.0530	0.0341	9.7936	0.8258	0.2130	14.730	
2 Manufacturing Industries and Construction	122.96		0.0028	0.0017	0.5893	0.3669	0.0744	0.6035	
3 Transport	4141.9		0.9219	0.0358	38.377	49.814	66.120	4.1266	
4 Other Sectors	3199.5		0.5121	0.0292	23.934	25.009	5.0206	8.9327	
B Fugitive Emissions from Fuels			7.2842						
1 Solid Fuels			1.5610						
2 Oil and Natural Gas			5.7232						
Industrial Processes	**207.50**				**0.0695**	**0.4190**	**5.4834**	**1.6853**	**0.0746**
A Mineral Products	194.37						2.1389	0.1161	
B Chemical Industry							0.0005		
C Metal Production	13.140				0.0695	0.4189	0.0016	1.5692	
D Other Production							3.3424		
F Consumption of Fluocarbons and Sulfur Hexaluoride									0.0746
Agriculture	**323.43**		**94.579**	**0.5631**	**2.2821**	**45.327**			
A Enteric Fermentation			77.767						
B Storage Systems			12.648	0.0023					
C Rice Cultivation			2.4400						
D Agricultural Soils				0.4978					
E Natural Fires in Mountains	0.0323		0.0004	0.0000	0.0001	0.0583			
F Field Burning of Agricultural Residues	323.40		1.7240	0.0630	2.2820	45.269			
Land-Use Change & Forestry	**3.9992**	**-967.18**	**0.4306**	**0.0030**	**0.1070**	**3.7681**			
A Change in Woody Biomass Stocks		-886.99							
B Forests and Grassland Conversion	3.9969		0.4306	0.0030	0.1070	3.7681			
C Abandonment of Managed Lands		-80.183							
D CO_2 Emissions from Soils	0.0023								
Waste			**40.77**	**0.2130**					
A Solid Waste Disposal			36.820						
B Sewage Water Cleaning			3.9500						
Memo Items:									
International Bunkers	**118.11**		**0.0008**	**0.0033**	**0.5006**	**0.1669**	**0.0834**	**0.0374**	
CO_2 Emission from Biomass	**100.70**		**1.6100**	**0.1100**	**0.4000**	**1.4100**			

NOTE: Empty cells mean not applicable
Zero cells mean not estimated

2000 Summary Report for National Greenhouse Gas Inventory (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Halogens
Total National Emissions and Removals	**11702**	**-982.94**	**147.03**	**0.8931**	**75.567**	**129.61**	**79.304**	**31.788**	**0.0121**
Energy	11102		9.4704	0.1048	73.184	74.914	70.272	30.232	
A Fuel Combustion (Sectoral Approach)	11102		1.4796	0.1048	73.184	74.914	70.272	30.232	
1 Energy Industries	3622.7		0.0559	0.0387	10.954	0.9194	0.2354	16.609	
2 Manufacturing Industries and Construction	121.21		0.0027	0.0016	0.5723	0.3468	0.0704	0.6084	
3 Transport	4032.3		0.9038	0.0349	37.303	48.445	64.905	3.9834	
4 Other Sectors	3325.4		0.5172	0.0295	24.354	25.203	5.0614	9.0311	
B Fugitive Emissions from Fuels			7.9908						
1 Solid Fuels			1.5685						
2 Oil and Natural Gas			6.4222						
Industrial Processes	**236.80**				**0.0944**	**0.4793**	**9.0321**	**1.5569**	**0.0121**
A Mineral Products	225.35						5.3372	0.1355	
B Chemical Industry							0.0004		
C Metal Production	11.452				0.0944	0.4793	0.0012	1.4215	
D Other Production							3.6933		
F Consumption of Fluocarbons and Sulfur Hexaluoride									0.0121
Agriculture	**359.12**		**95.939**	**0.5813**	**2.1761**	**50.254**			
A Enteric Fermentation			78.628						
B Storage Systems			12.833	0.0023					
C Rice Cultivation			2.5600						
D Agricultural Soils				0.5189					
E Natural Fires in Mountains	0.4895		0.0065	0.0001	0.0021	0.0543			
F Field Burning of Agricultural Residues	358.63		1.9120	0.0600	2.1740	50.200			
Land-Use Change & Forestry	**4.2031**	**-982.94**	**0.4526**	**0.0031**	**0.1125**	**3.9603**			
A Change in Woody Biomass Stocks		-902.76							
B Forests and Grassland Conversion	4.2008		0.4526	0.0031	0.1125	3.9603			
C Abandonment of Managed Lands		-80.183							
D CO_2 Emissions from Soils	0.0023								
Waste			**41.17**	**0.2040**					
A Solid Waste Disposal			37.130						
B Sewage Water Cleaning			4.0400						
Memo Items:									
International Bunkers	**113.06**		**0.0008**	**0.0032**	**0.4792**	**0.1597**	**0.0799**	**0.0358**	
CO_2 Emission from Biomass	**110.45**		**1.7700**	**0.1200**	**0.4400**	**1.5500**			

NOTE: Empty cells mean not applicable
Zero cells mean not estimated

ANNEX 2.
TOTAL EMISSIONS OF GASES WITH DIRECT GREENHOUSE EFFECT WITH ACCOUNT OF GWP

Sector	CO_2	CH_4	N_2O	Total
1990				
Energy	28,195.1	888.6	85.6	29,169.3
Industrial Processes	708.2	0	0	708.2
Agriculture	197.5	3,243.9	947.3	4,388.7
Land-Use Change & Forestry	4.7	11.5	1.0	17.2
Waste	0	2,296.6	66.0	2,362.6
Total	29,105.5	6,440.6	1,099.9	36,646.0
1991				
Energy	27,072.0	818.1	80.2	27,970.3
Industrial Processes	671.4	0	0	671.4
Agriculture	166.4	3,231.7	10.3	3,408.4
Land-Use Change & Forestry	4.3	10.6	0.9	15.8
Waste	0	2,588.4	67.5	2,655.9
Total	27,914.1	6,648.8	158.9	34,721.8
1992				
Energy	17,945.2	614.1	49.7	18,609.0
Industrial Processes	565.3	0	0	565.3
Agriculture	215.3	3,030.1	11.8	3,257.2
Land-Use Change & Forestry	4.2	10.5	0.9	15.6
Waste	0	2,344.8	66.6	2,411.4
Total	18,730.0	5,999.5	129.0	24,858.5
1993				
Energy	17,029.5	487.3	48.0	17,564.8
Industrial Processes	370.5	0	0	370.5
Agriculture	248.1	2,778.2	200.2	3,226.5
Land-Use Change & Forestry	4.3	10.6	0.9	15.8
Waste	0	1,880.0	65.4	1,945.4
Total	17,652.4	5,156.1	314.5	23,123.0
1994				
Energy	14,228.0	241.0	43.9	14,512.9
Industrial Processes	228.4	0	0	228.4
Agriculture	164.4	2,269.0	113.4	2,546.8
Land-Use Change & Forestry	3.6	8.9	0.8	13.3
Waste	0	1,149.8	58.9	1,208.7
Total	14,624.4	3,668.7	217.0	18,510.1
1995				
Energy	12,289.8	267.0	33.2	12,590.0
Industrial Processes	167.8	0	0	167.8
Agriculture	231.5	2,108.8	75.2	2,415.5
Land-Use Change & Forestry	3.5	8.7	0.8	13.0
Waste	0	1,194.6	64.5	1,259.1
Total	12,692.6	3,579.1	173.7	16,445.4

Sector	CO_2	CH_4	N_2O	Total
1996				
Energy	12,219.9	294.9	32.3	12,547.1
Industrial Processes	290.9	0	0	290.9
Agriculture	317.0	2,023.8	100.9	2,441.7
Land-Use Change & Forestry	4.0	9.8	0.8	14.6
Waste	0	974.0	63.0	1,037.0
Total	12,831.8	3,302.5	197.0	16,331.3
1997				
Energy	11,319.7	316.6	28.4	11,664.7
Industrial Processes	348.2	0	0	348.2
Agriculture	382.8	2,102.7	189.7	2,675.2
Land-Use Change & Forestry	4.0	9.8	0.8	14.6
Waste	0	1,094.6	58.6	1,153.2
Total	12,054.7	3,523.7	277.5	15,855.9
1998				
Energy	12,247.5	291.4	32.9	12,571.8
Industrial Processes	370.5	0	0	370.5
Agriculture	381.4	2,136.7	167.5	2,685.6
Land-Use Change & Forestry	3.5	8.8	0.8	13.1
Waste	0	782.5	61.3	843.8
Total	13,002.9	3,219.4	262.5	16,484.8
1999				
Energy	10,723.4	201.8	29.9	10,955.1
Industrial Processes	207.5	0	0	207.5
Agriculture	323.4	2,175.3	166.6	2,665.3
Land-Use Change & Forestry	4.0	9.9	0.9	14.8
Waste	0	937.7	63.0	1,000.7
Total	11,258.3	3,324.7	260.4	14,843.4
2000				
Energy	11,101.9	217.8	31.1	11,350.8
Industrial Processes	236.8	0	0	236.8
Agriculture	359.1	2,206.6	172.0	2,737.7
Land-Use Change & Forestry	4.2	10.4	0.9	15.5
Waste	0	946.9	60.4	1,007.3
Total	11,702.0	3,381.7	264.4	15,348.1

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