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).

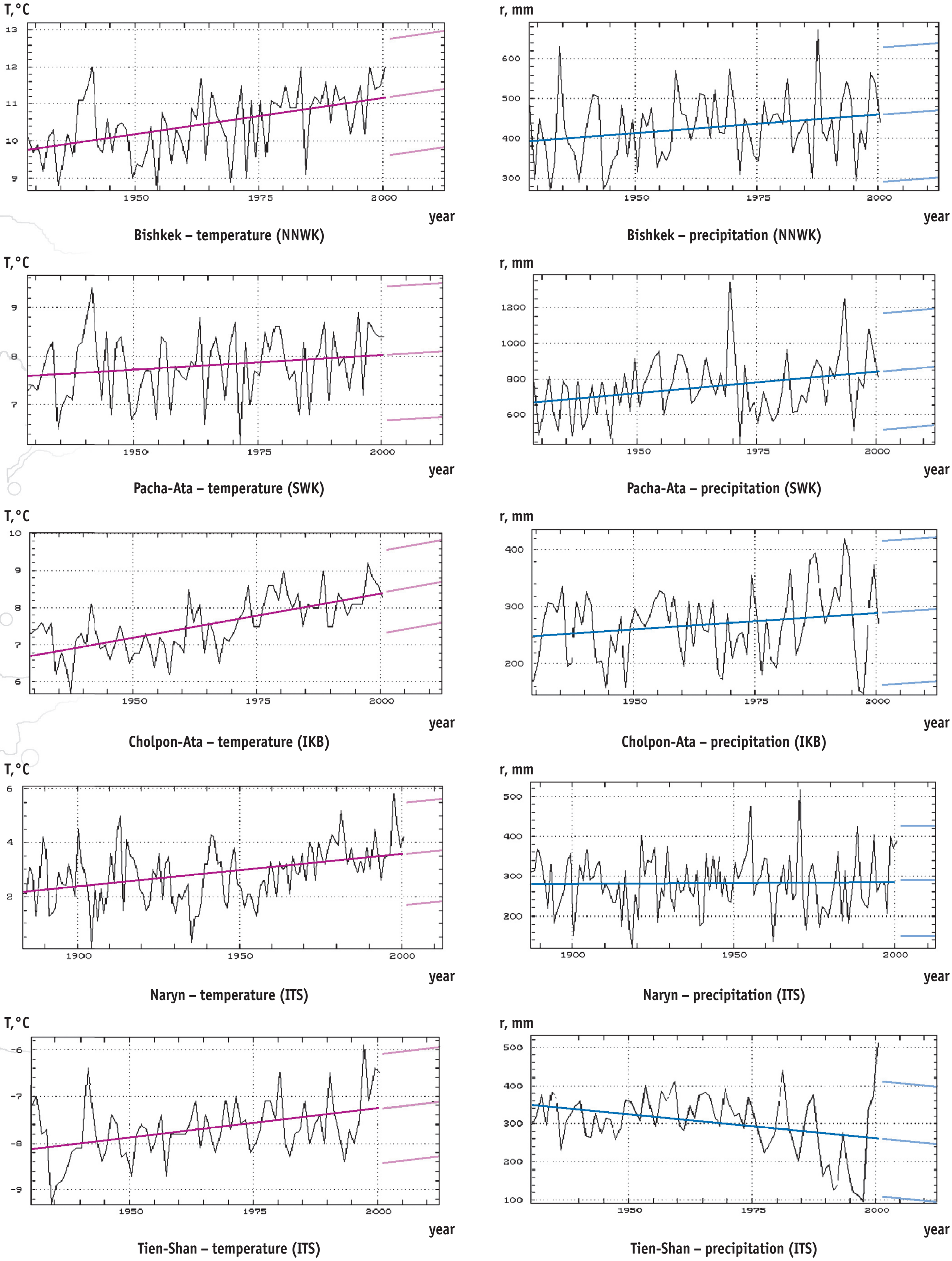
Linear trends of average monthly and annual air temperature and precipitation were estimated at 9 long-range (70-120 years) meteorological stations (MS) that are located in these areas at altitudes of 760 to 3,640 m. The data characterising general actual trends of air temperature and precipitation in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



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.

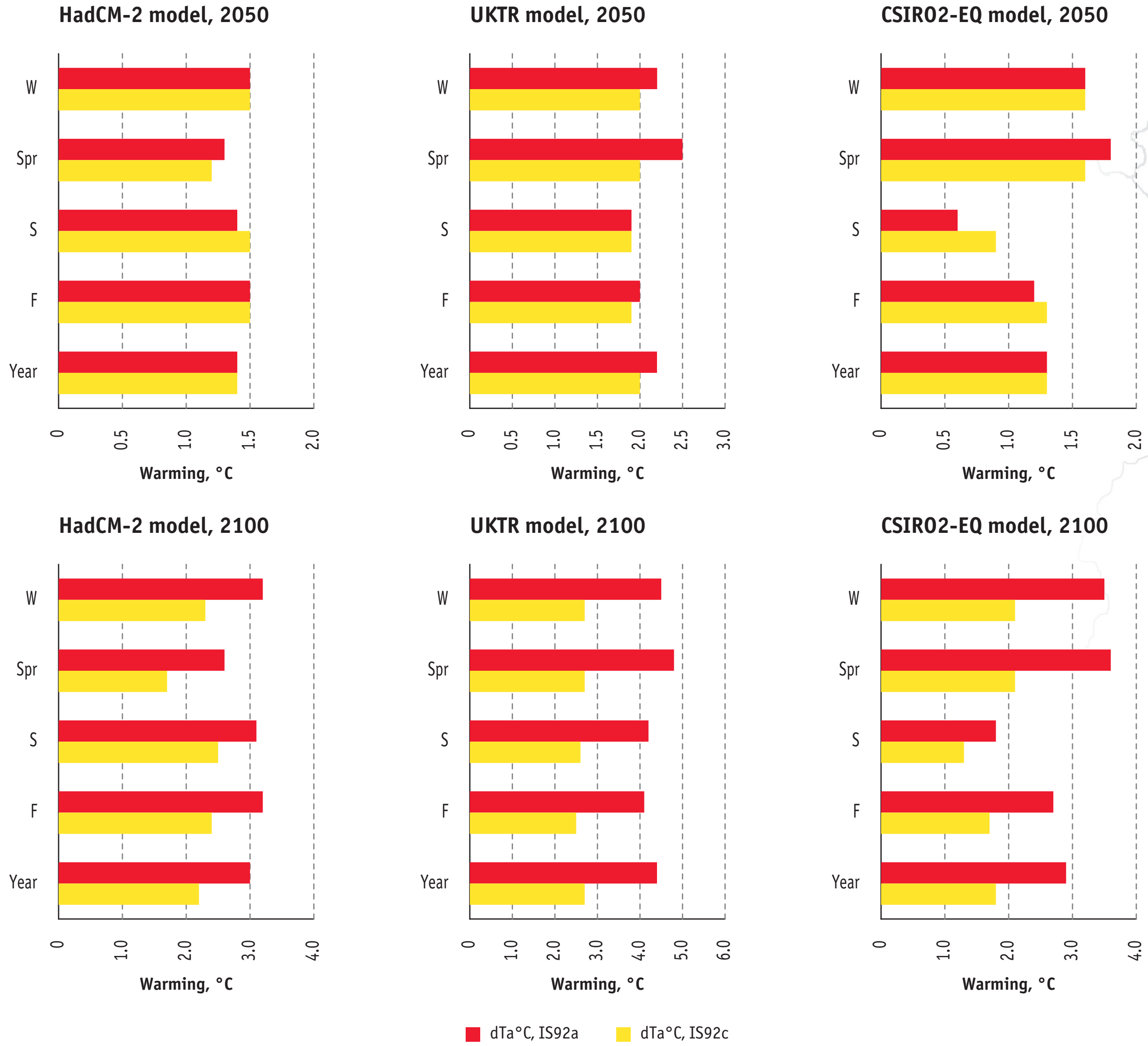
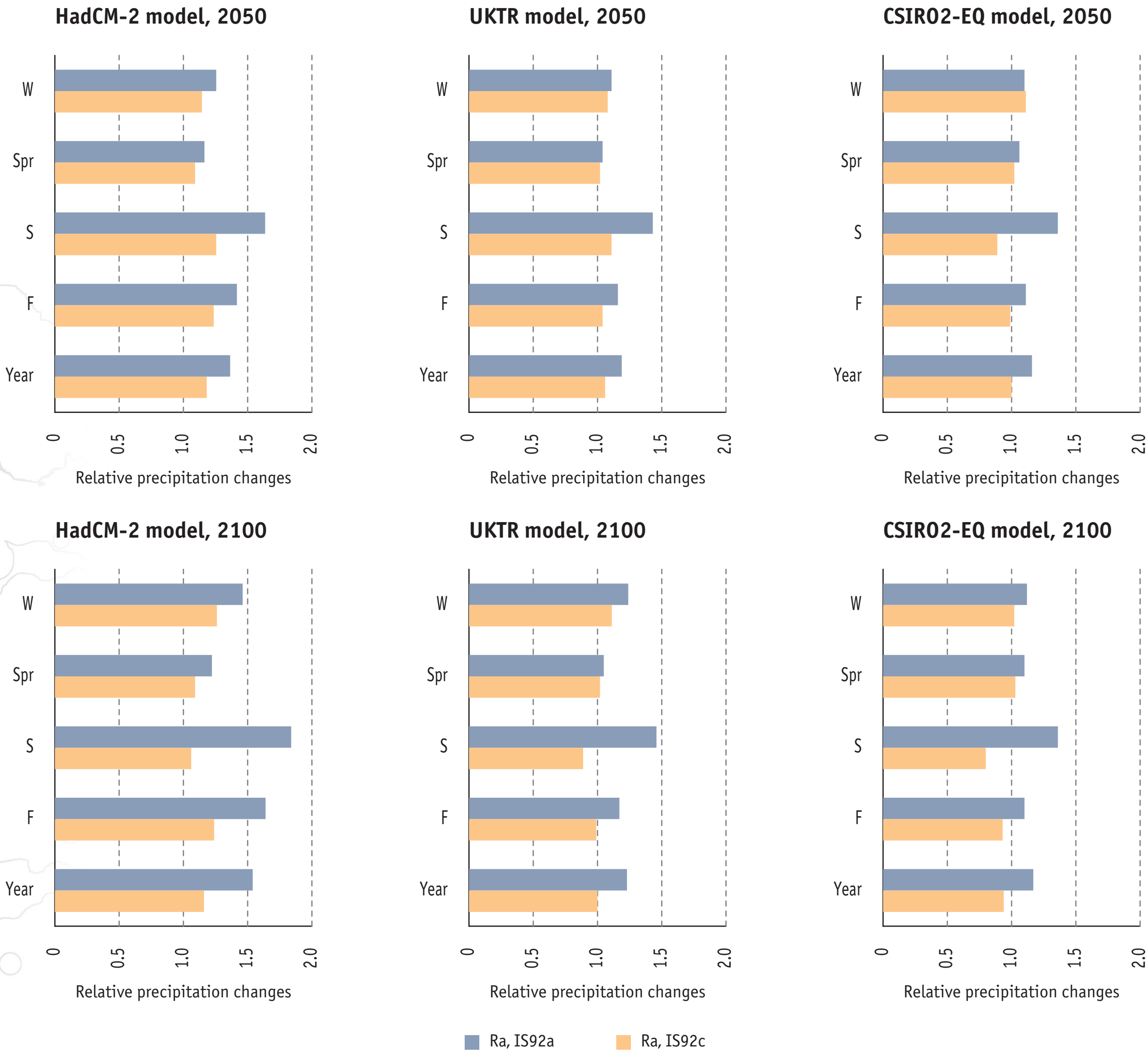


Figure 4.4. Diagrams of seasonal (winter, spring, summer, fall) and annual scenarios of moistening changes for the period of 2050 to 2100 on the basis of data from Table 4.3.



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 macro-economic 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.

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

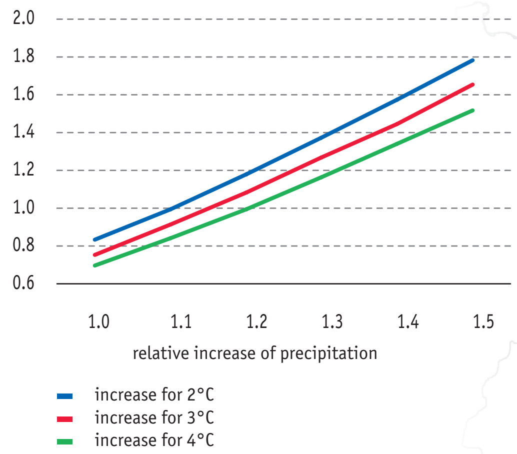
* t.o.e. – tons of oil equivalent

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.

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

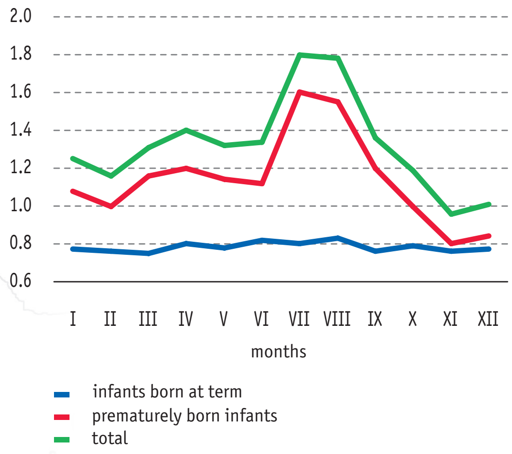
A significant amount of research is known about proving that climate affects one's health. In the context of this project a supplementary analysis of medical statistics has been conducted in order to establish a quantitative relationship between temperature increase and the state of health, given the 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;
- 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.

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**

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

ANNEX 1.
SUMMARY REPORTS FOR NATIONAL GREENHOUSE GAS INVENTORIES

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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