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

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CONTENT

Abbreviations and Acronyms

CCCC	Climate Change Coordination Commission of the Kyrgyz Republic
CNR	construction norms and regulations
DEC	distributing energy companies
FAO	UN Food and Agriculture Organization
GHG	greenhouse gases
GDP	Gross Domestic Product
GWP	global warming potential
HPC	heat and power central station
HPP	hydro power plant
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
KP	Kyoto Protocol of the UNFCCC
KR	Kyrgyz Republic
LULUCF	land use, land-use change and forestry
MALR	Ministry of Agriculture and Land Reclamation of the Kyrgyz Republic
ME	Ministry of Emergencies of the Kyrgyz Republic
NAS	National Academy of Sciences of the Kyrgyz Republic
NSC	National Statistical Committee of the Kyrgyz Republic
NR	nature reserve areas
ODS	ozone-depleting substances regulated by the Montreal Protocol
SAEPF	State Agency for Environmental Protection and Forestry under the Government of the Kyrgyz Republic
SDW	solid domestic wastes
SFR	State Forest Reserve
SNC	Second National Communication under the United Nations Framework Convention on Climate Change
SRS	State Registration Service under the Government of the Kyrgyz Republic
TNC	Third National Communication under the United Nations Framework Convention on Climate Change
QA	quality assessment
QC	quality control
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WHO	UN World Health Organization
a.s.l.	above sea level
CH_4	methane
CO_2	carbon dioxide
CO	carbon monoxide
CO_2**-eq.**	carbon dioxide equivalent
HFC	hydrofluorocarbon
N2O	nitrous oxide
NOx	nitrogen oxide
NMVOC	non-methane volatile organic compounds
PFC	perfluorocarbons
SO_2	sulfur dioxide
SF_6	sulphur hexafluoride
Gg	gigagram, 1Gg = 10^9 gram
tce	ton of coal equivalent
toe	ton of oil equivalent

Executive summary

In line with the decisions of the UNFCCC Conferences of the Parties, the third National Communication consists of the following chapters: National circumstances, Inventory of anthropogenic emissions by sources and removal by sinks of greenhouse gases, Vulnerability and Adaptation, Analysis of mitigation, Other information relevant to achievement of the Convention goals, Constraints and gaps and related needs.

National circumstances

The Kyrgyz Republic is located in the center of the Eurasian continent in the north-east of the Central Asian region. Its total area is 199.95 thousand sq. km, and it stretches 900 km from the east to west, and 450 km from north to south.

All the varieties of landscapes and climatic conditions in the KR are grouped into four climatic zones: valleys and foothills - up to 1200 m, midland - from 1200 to 2200 m, alpine - from 2200 to 3500 m, and nival zones higher than 3500 m. above sea level.

Less than 20% of the country is suitable for comfortable living. The large systems of mountain ridges oriented in different directions led to a creation of several regions with a homogenous climate in each, and a notable difference between the regions.

The country has a sharp continental and mainly arid climate. It is partly smoothed by the mountain relief which gives increased cloud cover and precipitation. Kyrgyzstan's climate characteristics are related to its location in the northern hemisphere, in the center of the Eurasian continent at a distance from significant water bodies and close vicinity to deserts.

The temperature regime is noted for a significant increase of the temperature change speed. If during the whole observation period the average annual temperature rose in the country at 0.0104 °C/year, in 1960-2010 the rate more than doubled and amounted to 0.0248 °C/year, and it was already 0.0701 °C/year during 1990-2010.

Almost the same increase in the average annual temperature is observed in all climatic zones and at all altitudes. Within a year, the largest increase of the average annual temperature is observed during the cold months.

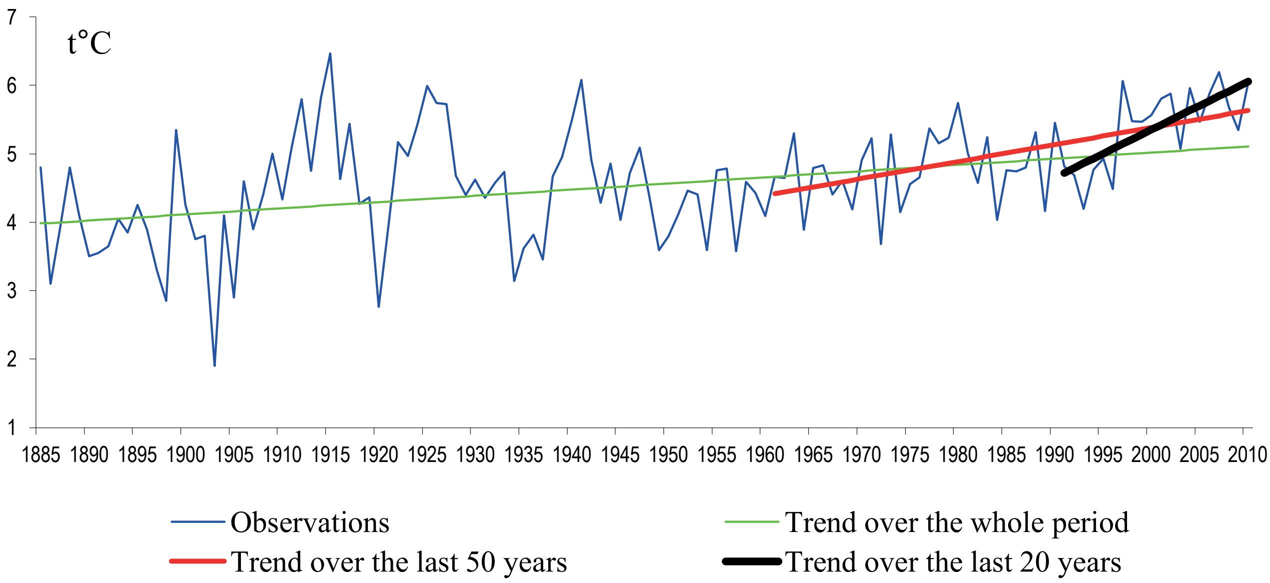


Fig. P.1. Changes of the average annual temperature. Source: Climate Profile of the Kyrgyz Republic.

The annual precipitation slightly changed (statistically insignificant), while some regions have seen the vivid changes, both up and down (Fig. P.2).

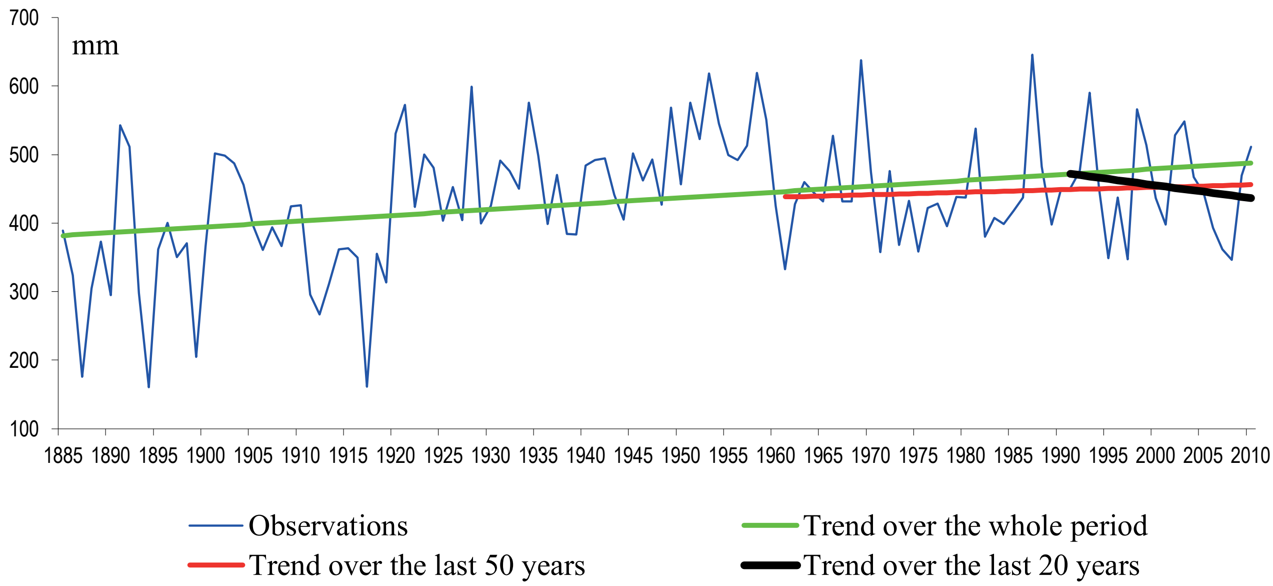


Fig. P.2. Overall trend of annual precipitation for instrumental observations period (1885-2010). Source: Climate Profile of the Kyrgyz Republic

As of January 1, 2014, the administrative-territorial system of Kyrgyzstan consists of 7 regions, Bishkek and Osh cities under the republican subordination, 31 cities, 40 districts (without city districts), 9 urban-type settlements, 3 townships, and 453 rural districts (ayil aimak)

The actual population in the Kyrgyz Republic as of January 1, 2016, is 6,019.5 thousand people, which is unevenly distributed across the country due to its mountainous terrain. They live and are occupied in economic activity mainly within the low mountains, intermountain basins and the relatively small mountain valleys. The most active population is concentrated within the settlements and the relatively small buffer zones of 5 km around them.

Agricultural lands make up about 53% of the whole republic. Most are the pastures - 85%. The arable lands make up about 12% of the land, 80% of which are irrigated.

There are 55 types of soil and non-soil formations represented in the republic, divided into 6 groups. In general, since 1990 to present, there has been a steady decline in soil fertility.

In the KR 30 woody plant species of all mid-altitude species groups occur in the natural environment: conifers, hardwood, softwood walnut, fruit, pome fruits, stone fruits and more than 17 species of shrubs. The most widespread are juniper and spruce forests (about half of the land area covered by forests). According to the national forest inventory (2008-2010), the forested area is 1123.04 thousand hectares, 5.62% of the total area.

According to the assessments in 2010, the water resources include the glaciers (about 390 km^3), surface runoff (about 50 km^3/year) and underground waters. According to the MALR, only 20-30% of the surface and underground water reserves are used.

In 2013, 8.3m^3 of water reserves was withdrawn from the natural sources, of which 0.11 km^3 are from aquifers. Of the total water consumed 93.8% was used for irrigation and agricultural water supply, 4% for household needs, and 1.4% for production needs. Over 30% of water used is lost under transportation due to a poor condition of the irrigation systems.

The water resources serve as a basis for the energy sector. In 2010, hydro accounted for 93.3% of all generated power. There are16 large and medium-sized HPPs in the KR with an installed capacity of 2949 MWt and an annual output of 10.406 bln. kWt/h. Today, 18% of the hydropower capacity is used in the KR (large HPP to 19.5% and small HPP to 4%).

The feasible reserves of 70 major coal deposits are estimated at more than 2.2 billion tons with the reserves balance of 750.7 million tce, as of 1 January 2006. During the whole mining development period, the maximum level of coal production was achieved in 1979, which then fell to 321.3 thousand tones starting from 1980.

The forecasts of undiscovered oil and gas reserves in the KR are around 289 million tce. Currently, the country manufactures only a small amount of oil and natural gas. The share of the domestic oil resources is 4.5%, of natural gas - about 6.5%.

The potential energy resources of alternative and renewable energy sources, actually accessible at the current technology development level, are presented by solar, wind and geothermal energy and biomass. Non-traditional and renewable energy sources also include the hydropower resources of the small streams. Unfortunately, the renewable energy resources are scarcely used in the country.

The socio-economic development during 1990-2010 can be divided into several stages (Fig. P.3). The first stage (1991-1995) saw a significant recession in the economic activity, particularly in industry. There was a sharp, almost two fold, decline in GDP up to 50.7% compared to 1990.Iin particular, industry fell to 33%; agriculture to 61.3%; construction to 45%; transport to 88.6%, and services 61.7%. The second phase (1996-2010) is characterized by the GDP growth in real terms. Together, the significant changes in the economic activity structure took place.

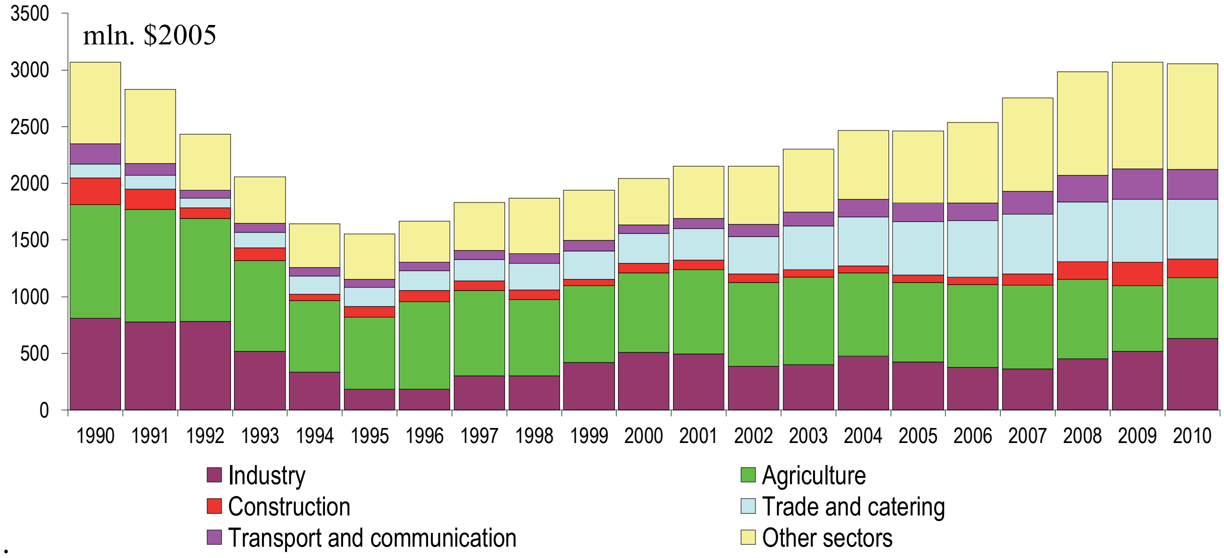


Fig. P.3. Change in real GDP from 1990 to 2010 in constant $2005. Sources: NSC, World Bank.

Similar changes were observed in the living standards of the population. According to the World Bank, GDP per capita in 1990 was 698.6 in $2005, decreased by1995 to the minimal range - 341.1 $2005, and increased to 6373 $2005 in 2014.

The average number of the population employed in the real economic sector (industry, agriculture, construction) changed insignificantly, fluctuating between 1-1.2 mln. people. Before 1999-2001, there was a redistribution of the labor resources, i.e. an outflow from the industrial and construction sector to agriculture. However, there has been the reverse trend after 2001.

During 1990 - 2010 the agriculture share in GDP declined from 46.2% (1996) to 17.5% (2010). Since 1996, a steady decline in the agriculture share in GDP has been observed. Crop production and animal husbandry make up the basis of agricultural contribution. Agriculture is highly dependent on the climate, especially in crop production, regarding the changes in temperature, precipitation and extreme weather conditions (frost, drought, hail, tornadoes, etc.). So, the crops yield is unstable and fluctuates from year to year.

In the agricultural production structure the dominating contributions are made by the private producers: farm enterprises - 61.5% and private farms (households) - 36%.

During 1990-2000, there was a sharp decline in the consumption of livestock products (dairy products, meat, poultry and eggs). Changes in the plant products consumption were less significant and multidirectional and there was a consumption slow growth after 2000.

The sharp decrease in the volumes of the industrial sector is observed only before 1995 followed by the significant fluctuations with a slight overall growth trend. These changes occurred due to the redistribution of production volumes between the individual sectors.

The physical, geographical (mountain relief, lack of waterways) and economic (underdevelopment and relatively high avian freight cost) conditions of the KR make the auto transport a dominant mode in the domestic transportation. The dynamics of cargo and passenger traffic is characterized by a sharp decline of volumes from 1990 to 1995 with a further increase, more important for the passenger traffic.

Inventory of anthropogenic GHG emissions from sources and removal by sinks

The GHG inventory was prepared based on the following methodology guides:

- Revised 1996 IPCC Guidelines for National Greenhouse Gas;
- 2000 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories;
- 2003 Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF)

In addition, the national regulatory documents on the inventory, specific emissions estimate, previous studies outcomes, obtained under the FNC and SNC preparation were used, as well as 2006 IPCC Guidelines and other sources, such as 2013 EMEP/EEA guidebook on inventory of air pollutant emission.

The legal framework is provided by the Government Resolution №369 of 2001 «On the Measures to Implement the United Nations Framework Convention on Climate Change» and the Law «On State Regulation and Policy in Greenhouse Gases Emission and Sink».

The inventory process was supervised by the Coordination Commission on Climate Change, a working body of which is the SAEPF. Technical support to the working body was provided by the Climate Change Center, which is a direct implementer of the inventory.

The main data inputs to the inventory were submitted by the following organizations:

- SAEPF;
- Ministry of Energy and Industry;
- National Statistics Committee;
- Kyrgyz National Agrarian University named after acad. K.I.Skryabin;
- State Land Management Institute, Kyrgyzgiprozem
- Ministry of Agriculture and Melioration;
- State Registration Service under the Government of the KR;
- The Rural Consultation Service of the KR.

The inventory covers the period from 2006 to 2010, with time series for 1990-2005 re-estimated. Re-estimate was stipulated by the following reasons:

a) Updating of the earlier published baseline data for the previous periods, which is a common practice for a number of organizations, e.g. the NSC;

b) Changes in the initial calculations assumptions accepted during the GHG inventory start-up discussions, such as:

- For coals the aggregated emission factors with two gradations (coal and lignite) should be used. Actually, the country has also used anthracite, but its volume is insignificant (under 1% in 2010) and not taken into account by the statistics bodies;
- The source categories recommended by the IPCC Guidelines should be used in the inventory. This data is available in the country. The task led to the categories increase in the energy sector, as compared to the previous inventory;
- For the emissions calculation, a need to preferably use the officially issued baseline data, even in case of significant discrepancies with informal assessments, e.g. for auto vehicle fuel;
- For the emissions and sinks calculation in land use, land-use change and forestry to use the developments of the National Forest Inventory 2010;

c) Need to check the previous calculations and provide the results' comparability in case of changes to the accounting system and calculations methodology.

d) The inventory included the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and the following precursor gases: carbon monoxide (CO), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOCs), sulfur dioxide (SO_2).

e) The initial data analysis defined that basically there are no PFCs and SF_6 emission in the country, and they were not further considered.

To convert GHG emissions into carbon dioxide equivalent (CO_2-eq.) the global warming potentials given in the 1995 IPCC AR were used (Table P.1).

Table P.1. The global warming potentials from the 1995 IPCC AR

GHG	Formula	GWP for 100 years
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
Hydrofluorocarbons (HFCs)-134a	CH_2FCF_3	1300

The inventory was carried out both at the national level and for the following basic administrative units: the Batken oblast (official statistics are available since 1999 when it was formed), the DDjalal-Abadoblast, the Issyk-Kul oblast, the Naryn oblast, the Osh oblast, the Talas oblast, the Chui oblast, Bishkek city, Osh city.

The inventory covers the following sectors and source categories:

1 Energy
- 1A Fuel combustion
  - 1A1 Power generation
  - 1A2 Industry and construction
  - 1A3 Transport
    - 1A3a Civil aviation
    - 1A3b Road transport
    - 1A3c Railways
    - 1A3d Water transport
  - 1A4 Other sectors
    - 1A4a Commercial/institutional
    - 1A4b Residential
    - 1A4c Agriculture
- 1B Fuel fugitive emissions
  - 1B1 Solid fuel
  - 1B2 Oil and nature gas
    - 1B2a Oil
    - 1B2b Nature gas

2 Industrial processes
- 2A Mineral substances
- 2B Chemical industry
- 2C Metal production
- 2D Other productions (food and drinks)
- 2F Consumption of halocarbons and sulfur hexafluoride
- 2G Blasting

3 Solvent use

4 Agriculture
- 4A Enteric fermentation
- 4B Manure storage systems
- 4C Rice cultivation
- 4D Agricultural soils
- 4F Agricultural residues incineration

5 Land use, land use change and forestry (LULUCF)
- 5A Woody biomass stocks
- 5B Soil emission and sink

6 Waste
- 6A Disposal of solid waste
- 6B Wastewater
  - 6B1Industrial water
  - 6B2 Domestic and commercial water

7 Information
- 7A International bunker (Aviation)
- 7B Biomass CO_2 emissions

To reduce the uncertainty of the inventory results the quality assurance procedures were conducted to ensure quality and quality assurance. The main elements of verification were:

- monitoring of the time series with an analysis of any strong changes in a nature of the time series;
- comparing of the results obtained with the preceding inventories, with the international data (mainly, the International Energy Agency) and the results of the other countries' inventories, particularly in the Central Asian region.

The total GHG emissions in 2010, accounting net emissions in the LULUCF sector, was 13,046 Gg CO_2-eq. compared to 28,712 Gg CO_2-eq. in 1990, i.e. it reduced more than by half (Fig. P.4, P.5).

After a strong fall from 1990 to 1995, the total GHG emissions increased slowly. But even in 2008-2010 it was significantly less than in 1990, to some extent reflecting the trends in the macroeconomic indicators, as well as changes in the economic shape. The total GHG emission in 2010 was only 45.4% of the emission in 1990. The emission reduction by sector in 2010 as compared with 1990 level was as follows: Energy - 66.8%, Industrial processes - 41.8%, Agriculture - 23.1%, Waste - 14.6%.

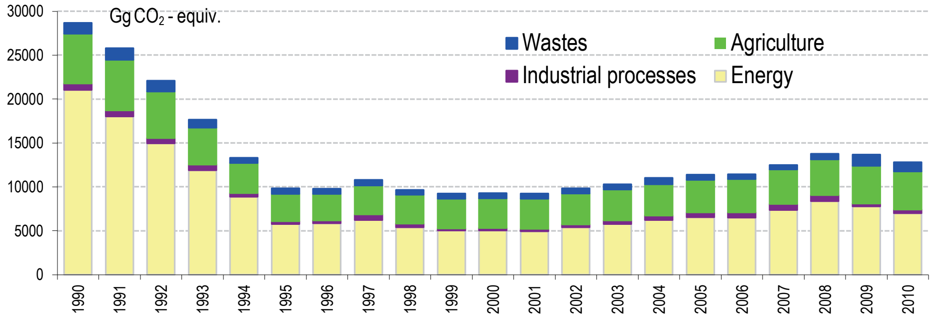


Fig. P.4. Change in total GHG emission for 1990-2010 by key source category. The following sectors are not given: Solvents due to lack of emissions, and LULUCF due to insignificant GHG net emission.

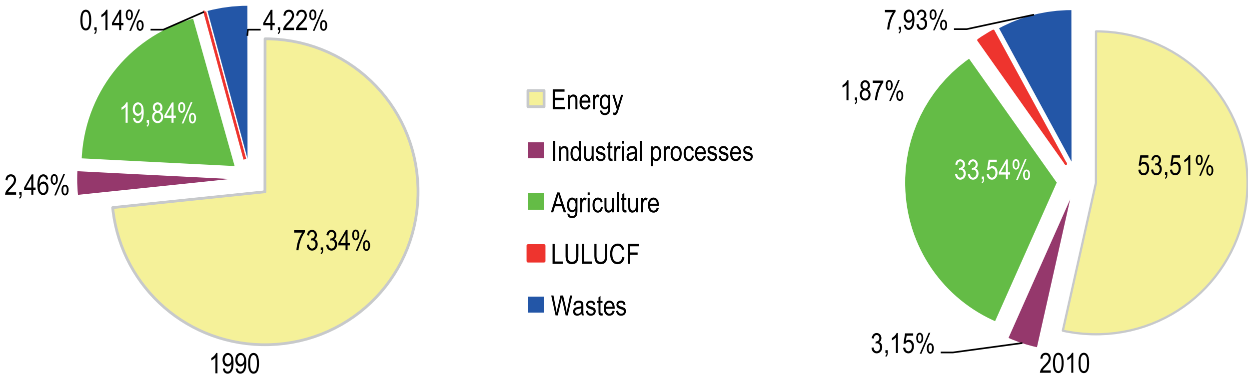


Fig. P.5. Comparative distribution of GHG emissions in the key sectors in 1990 and 2010. The share of net emissions is shown for the LULUCF sector.

Despite the fact that the contribution of the energy sector to the total emissions decreased most notably in comparison with other sectors, the highest emissions in 2010 were still observed in this sector, followed by agriculture, and waste and industrial processes sectors. The absorption in the LULUCF sector is about 800 Gg CO_2-eq., but soils emissions are also significant which determines the net emission of the LULUCF sector very small as a whole.

In the context of generally reducing GHG emissions relative to1990, a significant change is notable in the emissions structure, explained by the smallest emissions reduction in agriculture and waste management. It resulted in a significant increase in the emissions percentage in these sectors. Fig. P.6 shows the dynamics of emissions and sinks by GHG accounting LULUCF sector.

Also, the inventory findings reveal that all GHGs emissions, except HFC-134a, in 2010 decreased relative to 1990. The greatest decrease (almost 3 times) happened to carbon dioxide, reflecting a significant decrease in the energy sector contribution. The use of HFC-134a in refrigerating equipment has developed only in the last decade. Earlier, mainly the ozone-depleting substances were used in this sector.

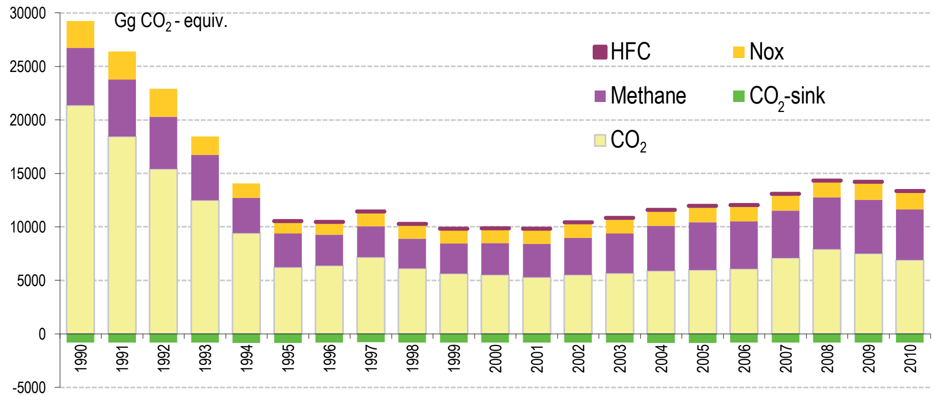


Fig. P.6. Change in global GHG emissions by gases. CO_2 emissions include LULUCF sector emissions.

Along with the overall decrease in emissions, the emissions structure in 2010 significantly changed compared to 1990 (Fig. P.7). The share of carbon dioxide emission decreased from 2/3 to less than half of the total emission. As a result, a share of the other gases emissions has increased, despite their absolute reduction.

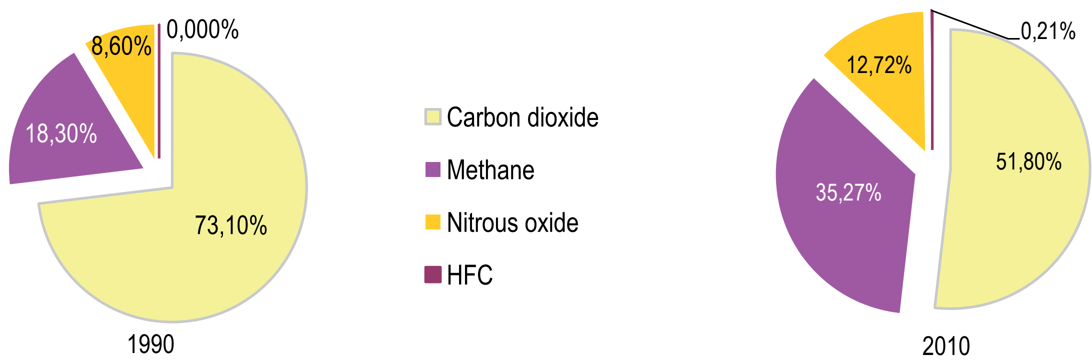


Fig. P.7. Comparative distribution of GHG emissions in 1990 and 2010.

To assess the country's input to global emissions and compare with the other countries, the specific GHG emission per capita have been estimated. As shown in Fig. P.8, specific emissions have fallen sharply since 1990 and recently only a slight growth tendency is seen at a fairly low level, slightly over 2 tons/person. In comparison, in 2011 in Kazakhstan the GHG emission per capita equated over 16.7 t/person.

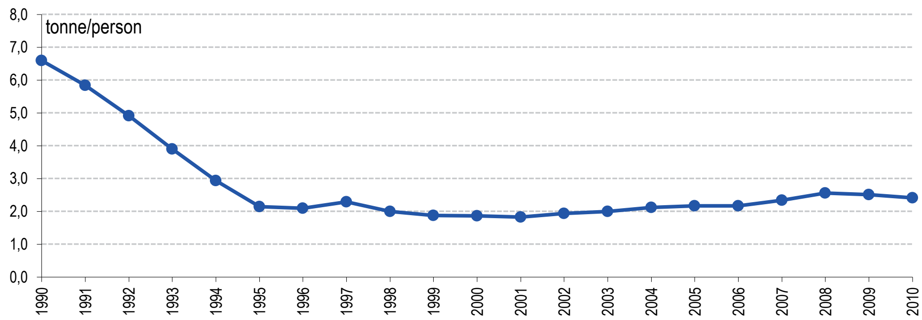


Fig. P.8. Trends in specific GHG emissions per capita

Additionally, two indicators are used for comparison with other countries: emission in kg CO_2–eq. per \$1,000 GDP (Fig. P.9) and specific GHG emissions per unit of consumed primary fuel resources (Fig. P.10). To ensure comparability of different years, \$1,000 of GDP is used in \$2005 (constant dollars). In terms of GDP, both the absolute values and values based on purchasing power parity have been used.

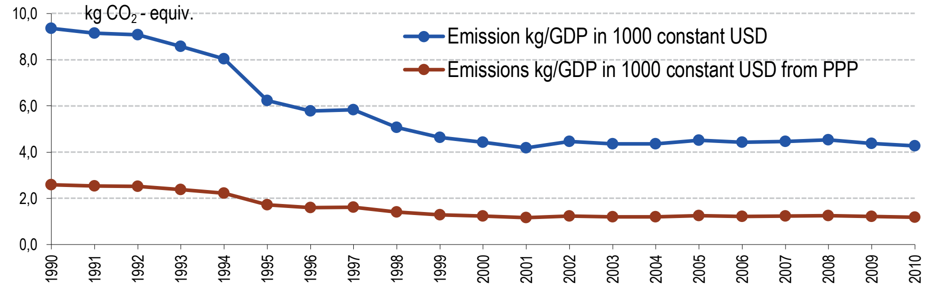


Fig. P.9. Trends in changes of specific GHG emissions in kg CO_2-eq. per $1,000 GDP (GDP re the World Bank)

If the trends in the specific GHG emission per capita and per GDP unit can still be considered acceptable in line with the sustainable development objectives (although, certainly, a gradual reduction of this parameter is more desirable), then the specific emissions by 1toe of primary fuel resources has a negative growth trend. This trend is most likely due to the outdated equipment used in the energy sector without timely renewals under a relatively small increase in GDP. Actually, Fig. P.10 reflects a negative trend of fuel resources efficiency for 1990-2010.

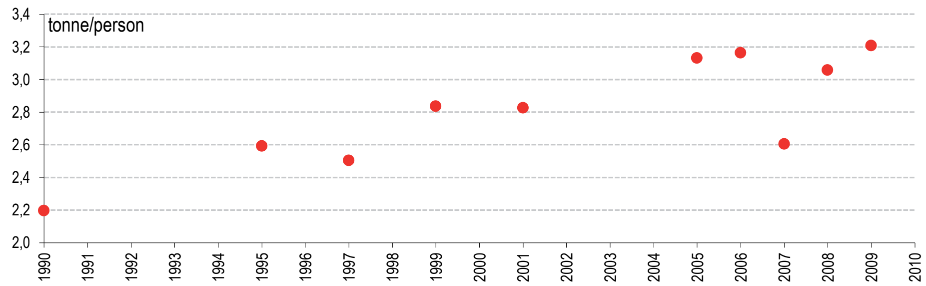


Fig. P.10. Trend in specific GHG emission. The calculation was made only for those years when the Fuel and Energy Balance was officially issued.

As might be expected, the precursor gases emissions, apart from NMVOC, occur mainly in the energy sector as a result of the fossil fuel combustion process (Fig. P.11). It is, therefore, clear that trends for nitrous oxide, carbon oxide and sulphur dioxide emissions are almost similar to that of carbon dioxide. The percentage of the energy sector for precursor gases are from 98.25 % to 99.0 % (except NMVOC), changing insignificantly over time.

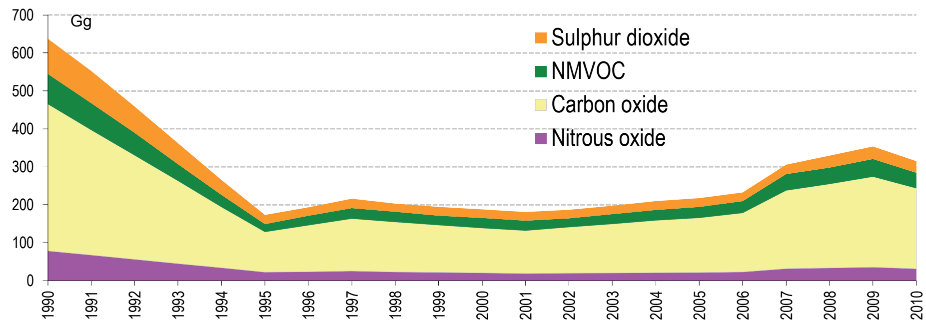


Fig. P.11. General trends in precursor gases emissions

In general, the precursor gases for the inventory period approximately halved, which shows an improvement of the ecological situation. At the same time, the contribution of nitrogen oxides decreased while that of carbon dioxide increased. The emissions structural changes are due to the changes in the consumed fuel structure.

The distribution of total GHG emissions (without sinks) in all sectors, except the Solvent use sector with no GHG emissions, is shown in Fig. P.12. Bishkek city contributes most significantly to the total GHG emissions, i.e. over one third of all emissions. This contribution is provided mainly by two sectors – energy and waste. The next largest contributors are the Chui, Djalal-Abad, Osh, Batken, Issyk-Kul, Naryn oblasts, Osh city and the Talas oblast. The significant contribution of the agricultural sector is characteristic for all oblasts, while the industrial sector contribution is significant only in the Chui oblast.

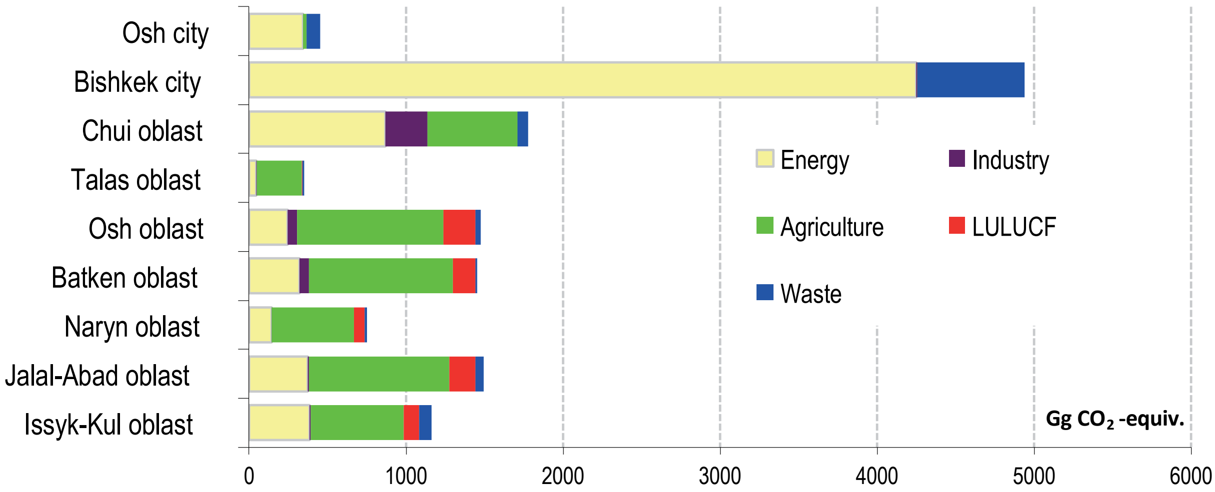


Fig. P.12. The regional distribution of total GHG emissions, by sector

Precursor-gas emissions are more unevenly distributed by the regions (Fig. P.13), as compared to GHG, as they are mainly emitted by the fossil fuel combustion process, most characteristic for Bishkek city.

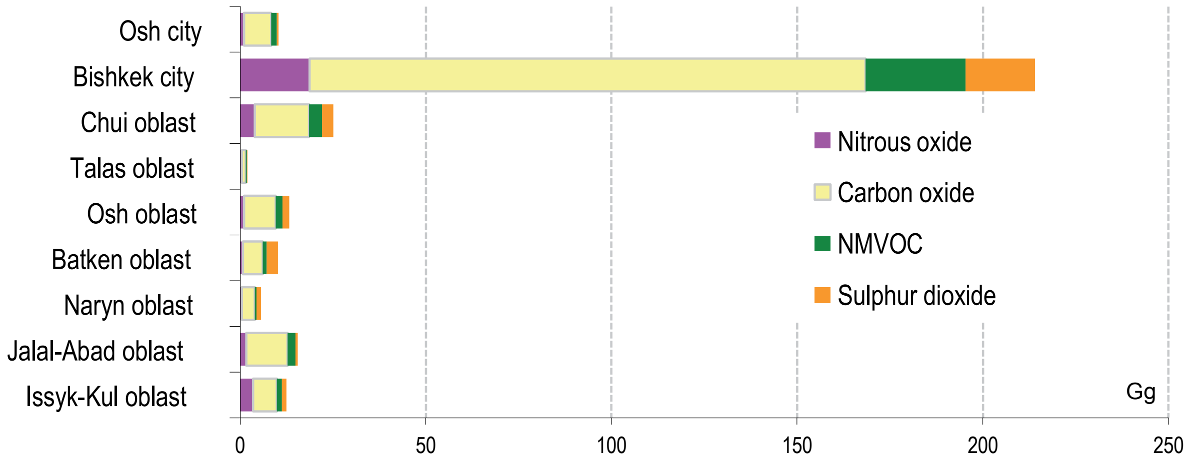


Fig.P.13. Regional distribution of total precursor gas emissions

Table P.2 demonstrates the regional distribution of GHG emissions, defining a geographical priority actions on reducing GHG emissions, as well precursor-gases emissions.

Table P.2. Regional emissions per capita

Region	GHG, tCO_2-eq./per.	Precursor gases, kg/pr.				
		NOx	CO	NMVOC	SO_2	total
Issyk-Kul oblast	2,63	7,83	14,44	3,08	3,08	28,44
Djalal-Abad oblast	1,46	1,60	10,93	2,02	0,60	15,15
Naryn oblast	2,89	2,02	13,07	2,05	4,59	21,74
Batken oblast	3,35	1,77	12,30	2,56	6,84	23,46
Osh oblast	1,32	0,98	7,61	1,60	1,71	11,90
Talas oblast	1,54	1,95	4,66	1,28	0,88	8,78
Chui oblast	2,20	4,95	18,08	4,21	3,83	31,06
Bishkek city	5,84	22,12	176,91	31,81	21,99	252,83
Osh city	1,74	3,98	28,42	5,56	1,82	39,78

Vulnerability and adaptation

Adaptation to climate change is vitally important as the climate will continue to change in the future under different scenarios considering the GHG volumes been emitted so far. Besides that, the emerging climate changes require effective adaptation measures.

The expected changes of global temperature, according to the IPCC Fifth Assessment Report, are given in summary in Table P.3. Regarding the regional assessments, the average annual temperatures in Kyrgyzstan will rise considerably, while the annual precipitation will remain practically unchanged.

Table P.3. Change in the average global surface air temperature by ensemble of climatic modeling in ^0C relative to the average of 1986-2005

Scenario	2046–2065		2081–2100	
	Average	Potential range	Average	Potential range
RCP2.6	1,0	0,4–1,6	1,0	0,3–1,7
RCP4.5	1,4	0,9–2,0	1,8	1,1–2,6
RCP6.0	1,3	0,8–1,8	2,2	1,4–3,1
RCP8.5	2,0	1,4–2,6	3,7	2,6–4,8

Climate change process is expected speedy (as already observed), since the warming in the northern hemisphere has arisen and will do more rapidly than the global average. It has been and will be more significant over the ground than over the oceans, with a very high degree of reliability.

A new set of scenarios has been used to assess the specific changes in climate, namely the Representative Concentration Pathways (RCP). The maps of average annual temperatures and annual precipitation distribution in the Republic were built based on the climatic modeling ensemble. The expected climate change will negatively impact the national economy (firstly, agriculture), the population health and natural ecosystems, identifying an urgent need for the adaptation activities.

The preparation process for adaptation activities consisted of two stages. In the first stage a general country document was developed – the Priority Directions for Adaptation to Climate Change in the Kyrgyz Republic till 2017.

The main goal of the Priority Directions was to establish the national resource mobilization policy to minimize the negative risks for the sustainable development of the KR. Additionally, the highest priority economic sectors, requiring the adaptation measures, have been identified considering the observed and expected climatic changes. For each priority sector the quantitative assessment of the economic losses was obtained under absence of timely adaptation (Table P.4).

The Priority Directions were developed involving the specialists from all key ministries and agencies, science, education, business and non-governmental organizations.

Sector	Damage, mln. $2005
Water resources	718
Agriculture	70
Energy	200
Emergencies	38
Healthcare	110
Forestry and biodiversity	94,8
Total:	1230,8

Table P.4. Assessment of economic losses, caused by climate change impacts, without appropriate adaptation measures for Scenario A2 in 2100. Source: Priority Directions for Adaptation to Climate Change in the Kyrgyz Republic till 2017.

In the second stage, the key ministries and agencies prepared the sectorial adaptation programs, based on the Priority Directions. These include an assessment of the sector's current state, vulnerability assessment and justification of adaptation measures, as well as the plans to estimate the required costs of the implementation.

Table P.5. Sectorial programs and plans

№	Ministry/agency	Sector	Order on approval
1	Ministry of Agriculture and Melioration	Water resources and agriculture	#228 от 31.07.2015
2	Ministry of Emergency Situations	Emergency situations	#692 от 7.07.2015
3	Ministry of Healthcare	Healthcare	#531 от 31.10.2011
4	State Agency on Environment Protection and Forestry	Forestry and biodiversity	#01-9/110 от 17.04.2015

Water resources

The surface runoff was modeled based on the glacial components for all the hydrological basins. The surface runoff modeling used digital elevation models, and the ground moisture conditions of the KR developed by the Institute of Water Problems and Hydropower of the NAS of the KR.

In Fig. P.14 the estimate of possible change in the surface runoff by all basins considering the glacial fluid loss is given. These data indicate a significant runoff reduction under all possible scenarios and options for precipitation changes. However, the range of the reduction is very wide. The decrease in the surface runoff will be the greater, the greater are the expected the surface temperature increase and precipitation decrease. For the most unfavorable scenario (RCP 8.5 Scenario and annual precipitation reduction by 5%), the runoff may be reduced by approximately 40%.

Estimation of surface runoff for selected hydrological basins showed small changes in the difference between the two, determined by the specific conditions of the runoff formation zone.

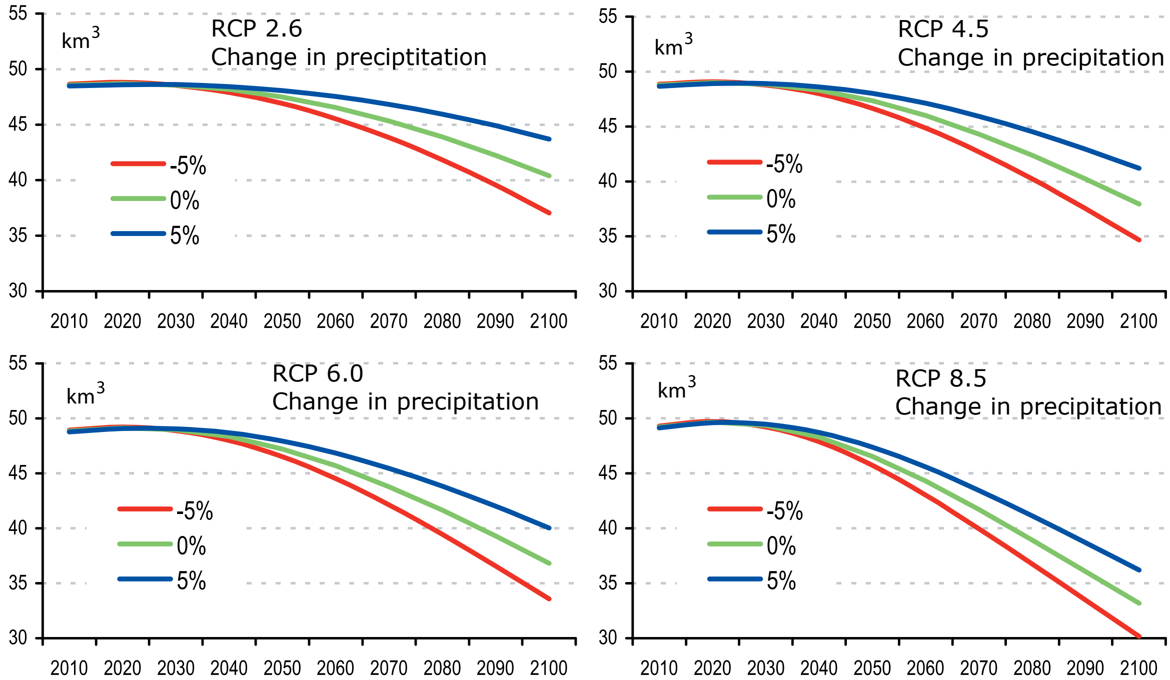


Fig. P.14. Change in surface runoff in all basins for different climatic scenarios considering the glacial water flow.

In addition to the volume of the surface runoff, the modeling included its supply, which refers to the probabilistic assessment of minimal and maximum values of runoff. Furter these assessments served as a basis for identification of the required adaptation measures, reflected in the sectorial plan in detail.

Agriculture

The agro-climatic conditions in the country are favorable for crop production. However, the northern regions are not warm enough for the standard crops ripening. The incomplete provision of food security has been observed over recent years (Fig. P.15). It is quite likely that the reason, apart from others, is the climate change impacts.

The unfavorable weather conditions (late spring and early autumn frosts, high temperatures, etc.), environmental pollution and uncomplimentary ameliorative conditions in a number of areas are a limiting factor for the full use of agro-climatic and land resources.

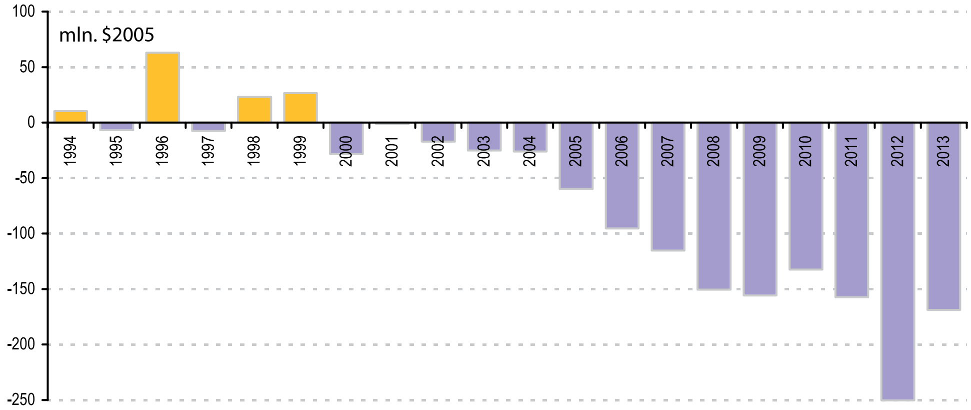


Fig. P.15. Food products import and export balance. Source: NSC

According to the NSC data, among all negative climatic impacts mostly affecting agriculture are drought and lack of water resources. Therefore, the quantitative assessment of humidification was conducted based on a humidity factor, i.e. ratio of atmospheric precipitation to evaporation capacity (Table P.6). The estimation showed that under the unfavorable climatic scenarios almost all the arable lands fall under desert and semi-desert areas.

Table P.6. Share of areas (%) with humidity from 0.13 to 0.30 (semi-arid) for 2000 and the climatic scenarios for 2100

№	Oblast	Area, km²	2000 г.	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
1	Chui	20025	15,48	27,91	30,64	32,01	37,19
2	Issyk-Kul	36823	8,86	12,19	13,68	14,47	17,78
3	Naryn	44958	8,29	13,31	16,41	18,05	24,82
4	Osh	29100	14,30	19,98	24,20	26,31	34,23
5	Talas	11441	23,94	29,51	32,53	34,03	39,56
6	Djalal-Abad	33273	14,07	18,99	21,50	22,80	27,85
7	Batken	16984	27,75	31,64	33,24	34,01	36,70
8	Kyrgyz Republic	192604	13,70	19,18	21,86	23,24	28,63

Assessment of the climate change direct impact on agricultural crop yields was carried out using the Standardized Precipitation Index (SPI). Re the SPI the potential climate change impact on crop yields can be identified using the standardized classification of drought intensity. As the index uses only the precipitation value, it cannot assess the impact on irrigated cultures. Therefore, an analysis was conducted on a definition of crop cultures, which productivity depends not only on irrigation, but on precipitation as well.

A statistically proven change in crop yield was obtained for the following kinds of agricultural crops::

- Grains (weight after processing);
- Wheat (weight after processing);
- Sugar beet (factory);
- Barley (weight after processing).

The SPI value can serve as a basic indicator to the introduction of the yield insurance system for the above listed cultures.

The livestock sector accounts for more than half of the total cost of agricultural products, therefore the efficiency of this sector is highly important for the KR. Climate change has a diverse impact on livestock management. Unfortunately, there are no credible national studies on all of its aspects. Based on the data by the Kyrgyz State Design Institute on Land Management ("KyrgyzGiprozem"), the vulnerability of pastures has been assessed.

The analysis was conducted on the monitoring data of dry edible mass and green mass yields for 1950-2012 for hayfields, spring-autumn pastures, summer pastures and winter pastures.

Detailed data on productivity was limited to regional and district level. In addition to the yield, data on the climatic factors observations (temperature and rainfall) and a number of animals (cattle, sheep and goats, horses) was used.

According to the statistical analysis, the following conclusions were made:

1. In the KR as a whole the yield of hayfields and pastures is low. The average yield is shown in Table P.7, the maximum yield of green mass was observed in the Djalal-Abad oblast - 25 centner/ha for the summer pastures in 2012, rather below of the yield in the developed countries. For example, in the Netherlands, the hay yield in rangeland is 120 centner/ha, in France - 45-50, in Germany - 60, Belgium - 80, and Denmark - 90 centner/ha of dry matter. Naturally, such a difference is in many ways explained by the climatic conditions, which are much less favorable to the KR. Additionally, the effective organization of pasture management in the developed countries contributes to it as well.

2. Changes in yields vary considerably by region (Table R.7). However, on the whole there is a slight increase in the yield of hayfields and pastures of all types (0.007 - 0.4 centner/ha per year).The highest growth is observed in the Batken and Chui oblasts, and the largest decline in yields - in the Naryn oblast. By absolute value the crop yield changes are not very high, the maximum yield increase is below 0.1 centner/ha per year (the Batken oblast), and the maximum decrease is below 0.09 centner/ha per year (the Naryn oblast).

Table P.7. Yield change by different types of pastures and hayfields for oblasts. Indexes: + growth, - decrease.

Oblast	Dry edible mass yield				Green mass yield		
	Hayfields	Spring-autumn pastures	Summer pastures	Winter pastures	Spring-autumn pastures	Summer pastures	Winter pastures
Batken	+	+	+	+	+	+	+
Jalal-Abad	+	+	+	+	+	+	+
Issyk-Kul	-	-	-	-	-	-	-
Naryn	+	-	-	-	-	-	-
Osh	-	+	-	+	+	+	+
Talas	+	+	+	+	-	+	+
Chui	+	+	+	+	+	+	+
Average in country	+	+	+	+	+	+	+
Average yield, c/ha	14,40	3,15	5,32	2,36	9,18	18,32	3,43

3. There is a clear growth tendency for all types of pastures and in all oblasts. Fig. P.16 shows a trend in the whole. The possible reasons are the pastures load lessening in early 80s and the climatic changes.

4. Two factors impact the yield – the load on pastures, expressed in a number of sheep head and temperature. At that, a pressure on the pastures has a more negative effect than the temperature. A temperature increase does not negatively impact on the winter pastures.

5. If we consider the pasture pressure in more detail, sheep have the greatest impact out of all agricultural livestock.

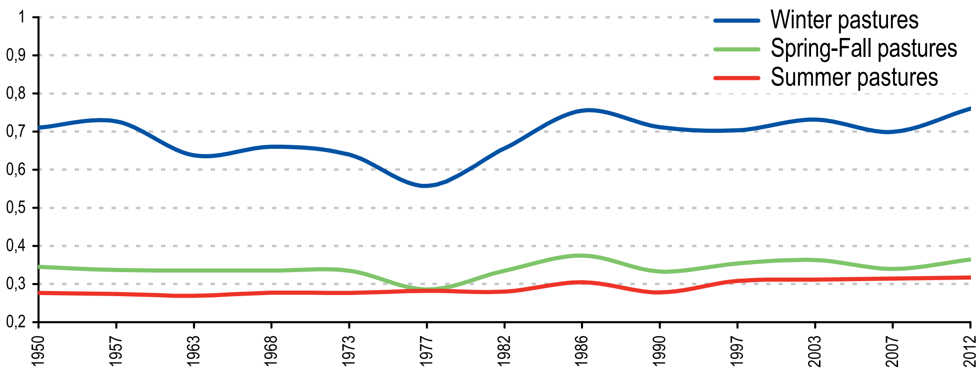


Fig. P.16. Trend of ratio of edible mass to green mass

Analysis of the soil humus content showed that the observed climate change and the practiced soil treatment technology reduce the humus content in all regions, except for the Chui oblast. This situation is a serious problem that jeopardizes the food security. To solve it, the radical transformation of agricultural practices and land use is required. The numerous benefits are provided by the advanced technologies in agricultural production and the soil resources management improving the content of organic carbon in soil, e.g., agroecology, organic farming, conservation agriculture and agroforestry. These methods provide higher soil fertility, increase the organic matter content, contribute to the preservation of plant cover, require less chemical fertilizers and promote crop rotation and biodiversity.

Climatic emergencies

As a mountainous country, the KR is particularly vulnerable to numerous natural disasters. Of the 70 global hazardous natural processes and phenomena types bringing the significant damage to the population, economic activities and infrastructure, over 20 befall in the country. The preventive adaptation measures in this sector can bring the significant economic benefits and minimize threats to the ecosystems, human health, economic development, property and infrastructure.

The occurrence of climate emergencies is closely associated with the extreme weather events. The observed phenomena analysis shows a marked increase in a number of hot days during a year and a number of days with extreme precipitation. According to global estimates of changes in extreme weather events, a further increase of their frequency is expected in the future. According with the expected climate changes, the major emergencies risks were identified based on the estimates of the occurrence probability.

Based on the studies, a distribution of severe wind remains almost unchanged, and regarding the landslides, a number of emergencies are projected to decrease. As for other kinds of emergencies, their increase is observed and estimated, reflected by the shift of a high probability to greater values. This growth is accompanied by a simultaneous increase in dispersion, i.e. spread between the maximum and minimal possible frequency of occurrence. The obtained dependencies help assess a probability of any number of emergencies for each year, i.e. assess the risk of its occurrence.

Healthcare

The sector vulnerability was assessed based on the statistical models linking mortality and diseases incidence with the climatic factors. For obvious reasons such an approach cannot provide an accurate assessment for long-term periods, which outlines a need for the regular updating of obtained assessments in the future.

The expected climate change impacts on population health are as follows:

- Increase of cardiovascular diseases: according to the prognostic assessment, by 2100 their number will increase by 10.5% compared to 2010, due to the increased temperature under the most unfavorable climatic scenario.
- Increase of intestinal diseases: according to prognostic studies by 2100 an incidence of infectious diseases, in particular acute intestinal infection among children under 1 year old, will increase by 18.2% (among boys) and 17.8% (among girls) compared to 2010.
- The high-risk areas for malaria outbreak have been identified with the average annual air temperature increase, especially in the southern region (Osh, Djalal-Abad and Batken oblasts).
- It is forecast that transmission infections will spread and increase due to the expanding of habitat area and active period. This will considerably increase the risk of diseases among the population transmitted by ticks, especially encephalitis.
- Potential health benefits of climate change: mortality and incidence of respiratory diseases are expected to fall in the winter period due to the lower precipitation. However, the climate change impacts due to increased weather variability can lessen these potential benefits. Therefore, interventions aimed at health protection can bring more benefits for public health.

Forest and biodiversity

The vulnerability of forests and biodiversity was assessed taking into account the adaptive capacity, which to a significant extent is determined by a possible shift speed to the optimal climatic conditions.

The vulnerability assessment was carried out based on the analysis of a shift of the optimal ecosystem existence areas with the expected climate change. As part of the preparation of the Priority Directions, the evolution of optimal vegetation existence areas was analyzed for the expected climatic changes. The analysis was conducted for the main forest tree species, which monitoring is satisfactory, as compared to vegetation other types. These are the Zeravshan juniper tree, semi-spheric juniper, Turkestan juniper tree, spruce and fir, and walnut.

The modeling outcomes for different climatic scenarios (RCP 2.6, RCP 6.0 и RCP 8.5) showed significant shifts of the climatic optimum areas, naturally depending on the climate scenario used. Moreover, a significant change was observed even under the most favorable climate scenario. The acquired information serves as a basis for improving the measures effectiveness to preserve and expand the existing areas occupied by the main forest tree species.

Adaptation measures

The key adaptation measures are given in the Priority Directions. They are more comprehensively described in the sectorial plans of the Ministry of Agriculture and Land Reclamation, Ministry of Emergencies, Ministry of Healthcare and State Agency for Environment Protection and Forestry.

Analysis of mitigation measures

The foremost contribution to the GHG reduction measures development was made by the following ministries and agencies of the KR: Ministry of Energy and Industry, Ministry of Transport and Communications, Ministry of Economy, Ministry of Agriculture and Land Reclamation, State Agency for Environment Protection and Forestry and the State Agency for Architecture, Construction and Housing and Utilities.

To assess the energy and emission scenarios under the different development scenarios the LEAP (Long-range Energy Alternatives Planning system, version 2014.0.1.9) and the developed in the KR SHAKYR model have been used.

The main goal of reducing GHG emissions for the short-term peroid is to fulfill the voluntarily commitments of the KR.

The country's contribution to the world GHG emissions from fossil fuels combustion in 2010 was 0.023%, with the population making up only 0.079% of the total global population. Thus, the GHG emission per capita in the KR is three times lower the average global indicators. Despite this, the Republic considers necessary to contribute to addressing the global challenge of climate change and has voluntarily obligated itself to reducing its GHG emissions by 20% by 2020 under the "business as usual" scenario with an adequate external support.

Recent estimates of climate change impacts under an increase in global temperatures over 2°C given in the IPCC Fifth Assessment Report and a report by the Potsdam Institute for Climate Impact Research [4.21] illustrate the disastrous significances of this increase. So, the ways to prevent the global temperature rise above 2°C have been considered for the longer-term prospects. The target was set to have in 2050 a specific emission not exceeding 1.23 t CO_2 per capita, or, no more than 1.58 t CO_2 per capita. These levels are the global average of CO_2 per capita indicators, under which a chance of not exceeding 2°C global temperature will be 66% and 50%, respectively.

Due to lack of long-term national demographic studies, the UN demographic scenarios were used as a basis. The Ministry of Economy of the KR have developed three macroeconomic scenarios based on a cyclical development presentation with alternating economic ups and downs (Fig. P.17).

The demographic and macroeconomic scenarios were combined as follows:

- Scenario 1 – low population growth/high economic growth;
- Scenario2 – average population growth/ average economic growth;
- Scenario3 – high population growth/low economic growth.

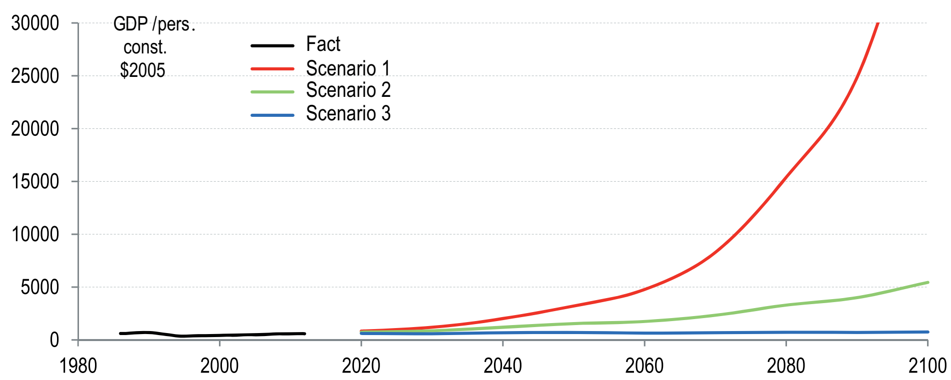


Fig. P.17. Retrospective data and long-term development scenarios

To make the further analysis easier, the assessments for all scenarios were made by dividing them into the following categories:

- Thermal power. Heating. Commercial/Institutional sector;
- Thermal power. Heating. Residential sector;

- Thermal power. Hot water. Commercial / Institutional sector;
- Thermal power. Hot water. Residential sector;
- Thermal power. Steam;
- Thermal power. Losses;
- Electrical power. All consumers, except for the Commercial / Institutional and Residential sectors;
- Electric power. Losses;
- Heating. Commercial / Institutional sector (combustion);
- Heating. Commercial / Institutional sector (electricity usage);
- Hot water and others. Commercial / Institutional sector (combustion);
- Hot water and others. Commercial / Institutional sector (electricity usage);
- Heating. Residential sector (combustion);
- Heating. Residential sector (electricity usage);
- Hot water and others. Residential sector (combustion);
- Hot water and others. Residential sector (electricity usage);
- Transport;
- Industrial and Construction (combustion);
- Farm (combustion);
- Fugitive emissions from fuels;
- Industrial Processes (specific emission);
- Farm, except for 4A, 4C, 4D (specific emission);
- 4B Manure storage systems;
- 4F Agricultural residues incineration;
- 6A SDW;
- 6B2 Municipal wastewater management;
- 6B1 Industrial wastewater management.
- LULUCF.

The following set of indicators was established for each category assessed:

- CO_2 emission;
- CH_4 emission;
- N_2O emission;
- Summed GHG emission;
- NOx emission;
- CO emission;
- NMVOC emission;
- SO_2 emission;
- power consumption (measurement unit – tce, toe and, where necessary, kWh).

As well, HFC-134a emissions were calculated for the Industrial Processes sector, and then added to the total GHG emissions.

In accordance with base data, the basic emissions scenarios were built for each source category, which were detailed for each of the indicators.

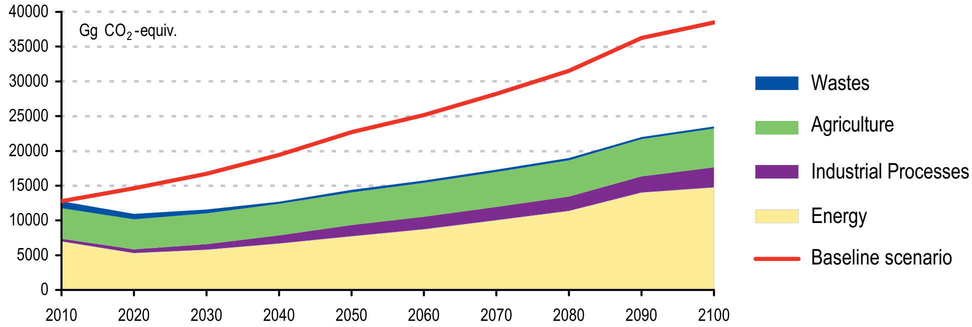
As suggested by the key ministries and agencies, a list of priority mitigation measures was formed:

- Reduction of thermal power losses;
- Complying with SCNR on energy efficiency of buildings;
- Increasing the energy efficiency of existing buildings;
- Reducing electrical power losses;
- Reducing gas leakage;
- Transport;
- Biomass;
- Solar power - electricity;
- Solar power – heat;
- Geothermal power;
- Hydropower (small HPP).

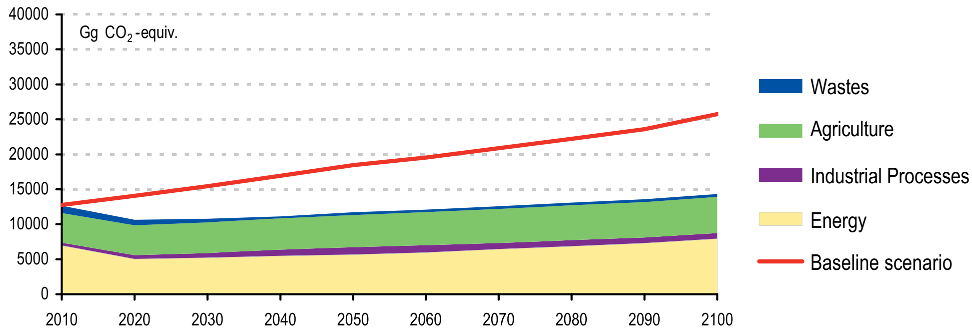
The amount of reducible power was identified for each measure, as well as the required costs broken down by existing (planned) and additionally required funding. The estimation results are given in Fig. P.18.

Fig.P.18. GHG emissions under different development scenarios

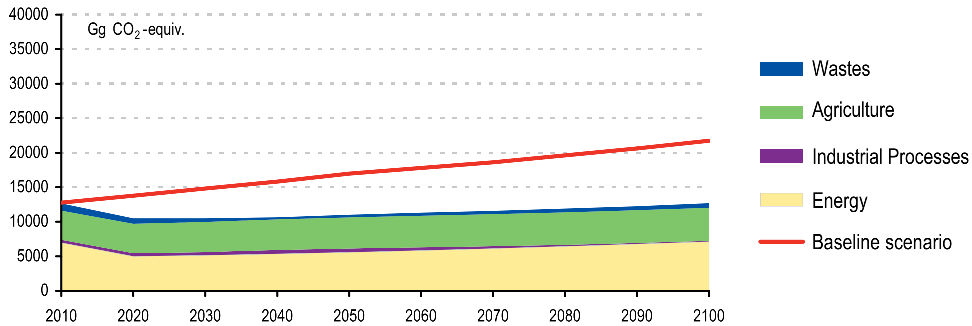
Development scenario with low population growth and high economic growth.



Development scenario with average population and average economic growth.



Development scenario with high population and low economic growth.



The economic situation does not enable the country to implement the planned mitigation measures entirely by the internal resources. According to the preliminary estimates, the Republic can reduce GHG emissions by the domestic resources by 51.5-52.7% by 2020, and in 2050 by 44.9- 8.2%, depending on the scenario of the demographic and economic development.

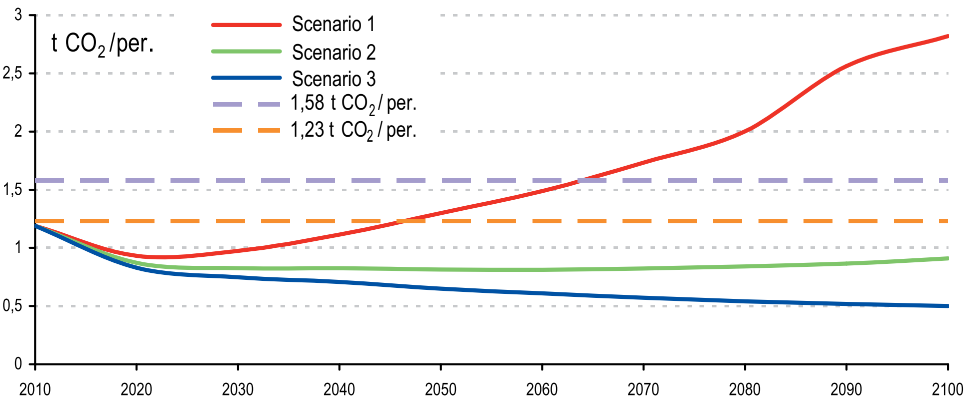


Fig. P.19. Dynamics of change in the specific CO_2 emission under scenarios with mitigation measures and targeted restrictions (Scenario 1: Low population growth - higher economic growth, Scenario 2: the average growth of population - the average economic growth, Scenario 3: High population growth - low economic growth)

The GHG emissions growth by the end of the century for Scenario 1 demonstrates the need for regular review and updating of the low-carbon strategy, depending on the new data availability.

Other information related to the achievement of the Convention goals

The analysis of the main strategic documents has shown that climate change issues in the Kyrgyz Republic are generally integrated in the sustainable development process. However, it is notable that the efficiency of the adopted documents often does not have a positive development and sustainability dynamics. In particular, there is no clearly defined organizational scheme of the financial and regulatory support for this activity, no a vertically-integrated system of monitoring on the undertaken efforts. Also insufficiently developed are the regulations that define the implementation mechanism of the climate actions, the financial and other resources required to address climate change are not allocated, especially at the level of ministries and branches.

The poorest population is particularly vulnerable to the climate change impacts, and about 70 % of the global poor are women. Accounting this, the main problems to be solved in the framework of gender-oriented measures under sustainable development have been defined.

The situation with the green technologies development and transfer was analyzed. There was a positive experience of technologies transfer of the MALR by the introduction of up-to-date resource saving technologies in agriculture (drip irrigation, greenhouses, etc.).

In addition, among the priorities of the Energy Saving Program of the Kyrgyz Republic till 2015 on the establishment of an economic and institutional environment to improve science, technology and innovation in the field of energy efficiency provides the following:

- Establishing of the centers of technology transfer and intellectual property management in the field of energy efficiency;
- Developing parks and innovation & technology centers on the basis of the country's leading technical universities, allowing the realization of the most efficient development of innovative and investment activities in the region by attracting investors;
- Establishing an assessment system and an innovation support database, the organization of competitions, the establishment of special awards and grants, scientific-technical and innovation exhibitions and conferences in the field of energy efficiency;
- Promoting cooperation between domestic scientists and inventors with foreign partners;
- To develop projects on a continuous and multi-level education system in the field of energy efficiency.

However, due to economic problems, the public funding is insufficient, and the current activities are conducted largely under the international programs and projects framework.

The systematic climate observations started in1883, with launching of the weather station in Karakol city. The number of meteorological stations further grew by mid-80s to more than 70 and then decreased significantly. Currently, there are 33 stations, of which 4 are automatic, and 3 avalanche ones and the Cholpon-Ata lake observatory with the research ships. Fifteen of these were designed for continuous observations, the data of which are required to develop the long-term trends of climate change.

The situation is similar with the hydrology observations, started in 1911. The hydrology posts "Alamedin" and "Soh" functioned during 1911-1915 and then observations were restored, and since 1925 started intensively developing. The Soviet time directories provide measurement data of hydrological characteristics at 427 posts. In the 1960s the observation network included 470 posts, and in the 1970s a number of hydro posts grew to 155 on the Chui, Talas, Tarim rivers basins and the Issyk-Kul Lake. On the Syr-Darya river basin (within the KR borders) there were151, i.e. the hydro posts total number was 306. In 1985, 149 hydrology posts functioned. Currently there are 77 hydro posts, 5 lake and 22 hydro chemical ones active on the rivers, lakes and water reservoirs.

The Global Climate Observing System includes 2 meteo stations in Kyrgyzstan – Naryn and Bishkek. The KR is also a member of the Global Atmosphere Watch, (GAW), which includes the Issyk-Kul weather station.

The significant work was carried out in the KR to strengthen the institutional capacity. In 2012, the Coordination Commission on Climate Change was established to manage and coordinate implementing of the commitments under the UNFCCC. The CCCC is headed by the First Vice-Prime Minister and the members are the heads of key ministries and agencies, representatives of science, education, business and non-governmental organizations.

The CCCC decisions, according to its competence, are obligatory for all government bodies, as well as enterprises, institutions and organizations under their subordination.

By its first decision, the Commission obliged all key ministries and agencies to appoint the focal points responsible for climate change adaptation and mitigation issues.

Since its establishment, the CCCC coordinates almost all climate change activities in the country. The Commission's experience has shown notably improved effectiveness of the coordination of national activities at all levels.

The higher capacity and awareness require a regular dialogue between all stakeholders in the sphere of climatic activities. Hence, in 2014 the SAEPF initiated the creation of a Climate Dialogue Platform of the Kyrgyz Republic. The distinctiveness of this platform is that its mechanisms provide multidisciplinary and comprehensive exchange of information, knowledge and experience among all stakeholders on a regular basis.

The CDP members are representatives of the public bodies on one side and, on the other, of a wide range of civil society organizations, of science and academia, private sector, and, thirdly, the active development partners of the KR among the international organizations and projects.

1 National Circumstances

1.1. General Description

1.1.1. Physical-geographical description

The Kyrgyz Republic is situated in the center of the Eurasian continent, in the North-Eastern part of the Central Asian region (Figure 1.1). It covers an area of 199.95 thousand square kilometers[1]. It stretches 900 km from east to west, and 450 km from north to south. Kyrgyzstan has borders with four countries: the Republic of Kazakhstan, the People's Republic of China, the Republic of Tajikistan and the Republic of Uzbekistan.

Figure 1.1. Location in Eurasia and map of administrative division of the Kyrgyz Republic

The Kyrgyz Republic is located within the Tien Shan and Pamir-Alai mountain ranges. A border pass with the Republic of Uzbekistan across the Naryn River is the lowest altitude (488 m a.s.l.)[2], and Pobeda Peak is the highest altitude (7,439 m a.s.l.). The average altitude above sea level is 2,630 m.

All the landscape varieties and natural climatic conditions are grouped into four climatic zones: Plain and Submontane Belt (valleys and foothills)– up to 1,200 m a.s.l.; Medium-Altitude Belt – 1,200 to 2,200 m a.s.l.; High-Mountain Belt (Alpine)– 2,200 to 3,500 m a.s.l.; and Nival Belt (permanent snow) – above 3,500 m a.s.l. (Figures 1.2 and 1.3).

1 Based on the land resources records by the SRS, as of January 1, 2012.

2 Data of the Shuttle radar topographic survey (SRTM) made in February 2000 by radar sensors SIR-C and X-SAR. Data Accuracy: latitude and longitude resolution - 90 m (3 arc seconds); height resolution - 1 m. (http://srtm.csi.cgiar.org/)

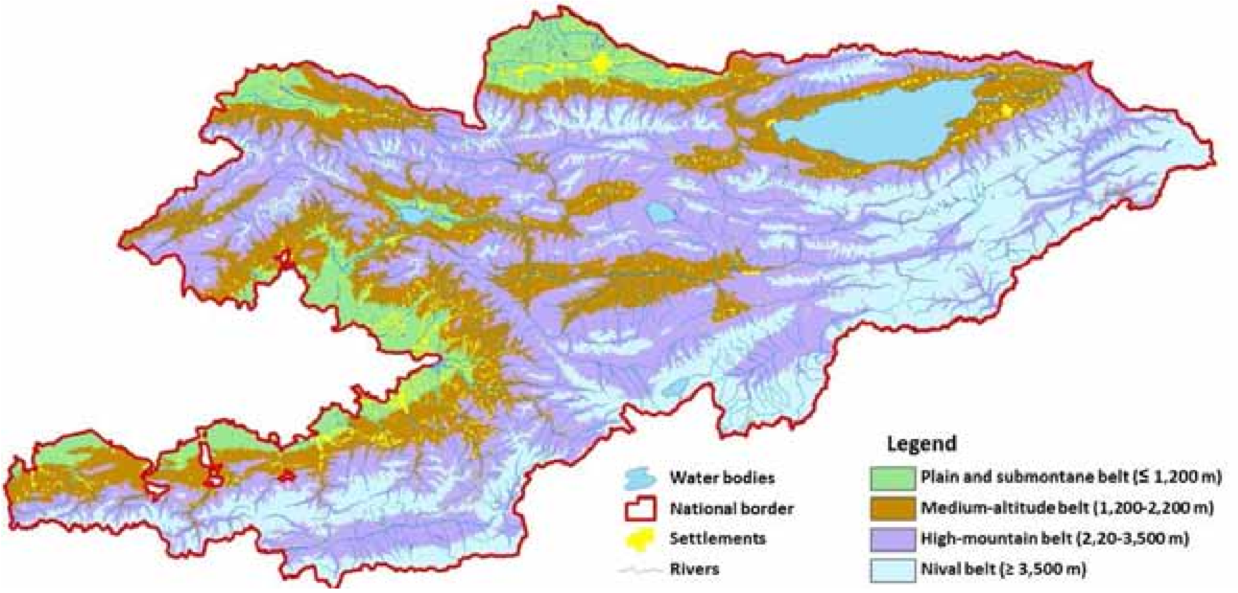


Figure 1.2. Physical and climatic zoning by altitude above sea level

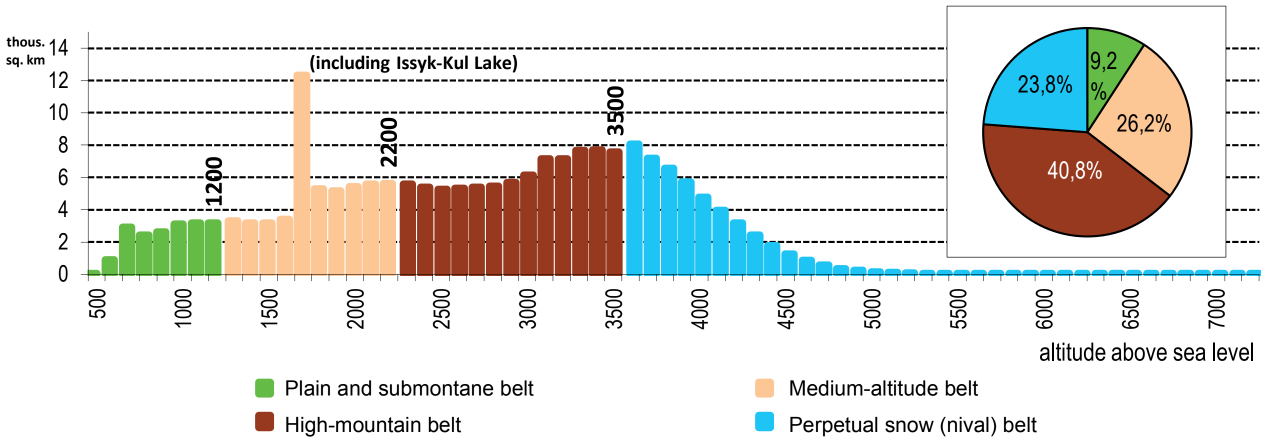


Figure 1.3. Distribution of territory by altitude. Source: Remote sensing data by SRTM

As seen from Figure 1.3, less 20% of the territory belongs to areas with comfortable living conditions.

Large mountain range systems oriented in different directions preconditioned the division of the territory into several regions noticeably different from each other in terms of their climate, which is quite uniform within each of them.

There are a total of four climatic regions in the Kyrgyz Republic: Inner Tien Shan, Northeast, Northwest, and Southwest (Figure 1.4).

Climate

The Kyrgyz Republic has an extreme continental climate, mostly arid, which is somewhat mitigated by increased cloudiness and precipitation due to the alpine relief. The natural climatic characteristics are determined by the country's location in the Northern Hemisphere, in the center of the Eurasian continent, remoteness from major water bodies, and the close proximity of deserts.

The temperature trends rise on land and in the Northern hemisphere are slightly higher than those on the water surface and in the Southern hemisphere [1.1]. This predetermines a somewhat higher temperature growth rate in the Kyrgyz Republic as compared to the global growth rates. Therefore, the impact of climate change on the Kyrgyz Republic is considerably higher than that for coastal countries and/or countries located in the Southern hemisphere.

The first meteorological station in Kyrgyzstan was opened in 1856 (the Issyk-Kul Lake shores). Systematic instrumental climate observations have been carried out since 1883 (Karakol weather station). The diagram in the box shows changes in the number of meteorological stations throughout the observation period (Figure 1.4). A sharp decrease in the number of weather stations in the late 90's of the past century was due to decreased public funding for the maintenance of the observation network.

Under the Third National Communication preparation, the data on climate change observed was processed under an approach that allows to get an estimation of average annual temperature trends for 1885-2010 (whereas the longest series of observations are less than 100 years), as well as increasing significantly the length of the trend estimates for separate isolated areas [1.2]. This approach helps eliminate constraints normally faced due to an inadequate number of observations, a small number of weather stations with long-term records, and on top of that, the gaps in observations.

The analysis proved a significance of the climate change already observed in the country. Thus, the average annual temperature over 1885-2010 has increased significantly (Figure 1.5). It should be noted that the rate of temperature change is not linear and has increased significantly in the recent decades. Although the average annual temperature growth rate over the entire period of observations was 0.0104°C/year across the country, it more than doubled during 1960-2010 reaching 0.0248°C/year, and reached 0.0701°C/year in 1990-2010.

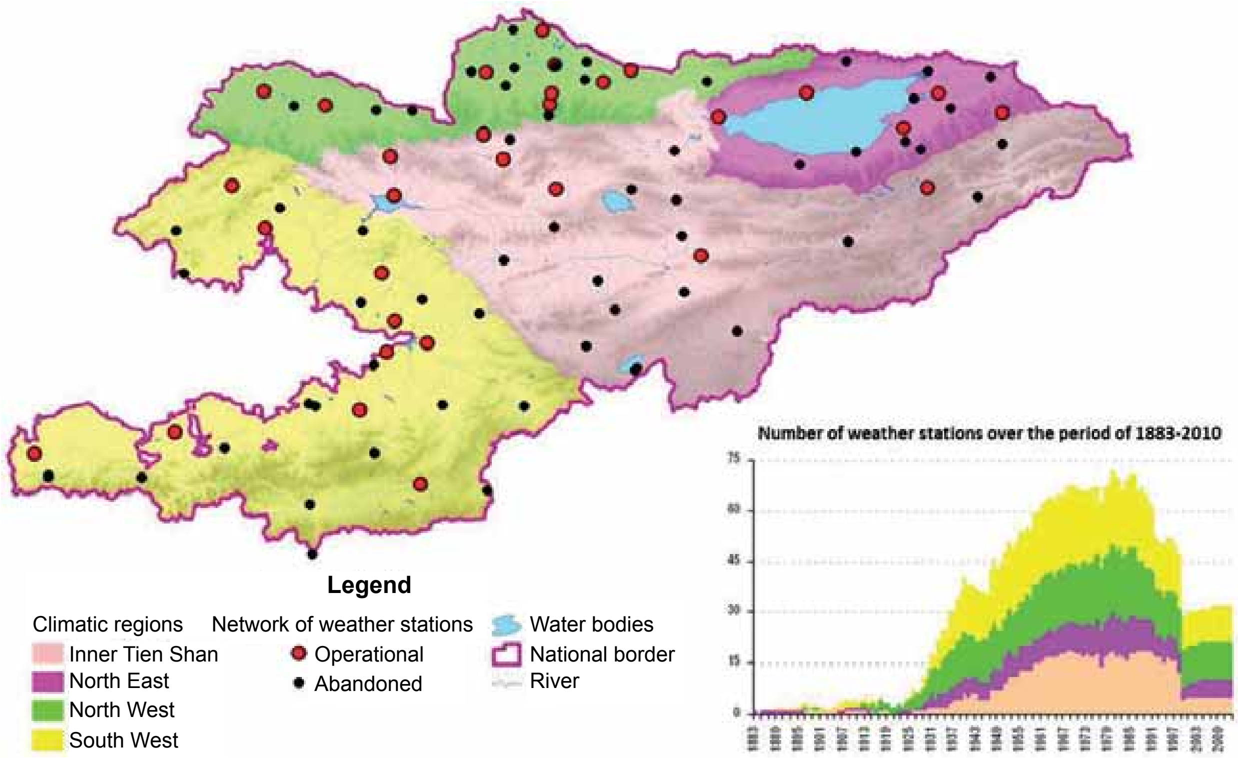


Figure 1.4. Climatic zoning and location of weather stations

Increase in the average annual temperature is observed in all climatic zones and regions across the country. Almost the similar increase in the average annual temperature is also observed at all altitudes. Figure 1.6 shows high-altitude trends for all four climatic regions.

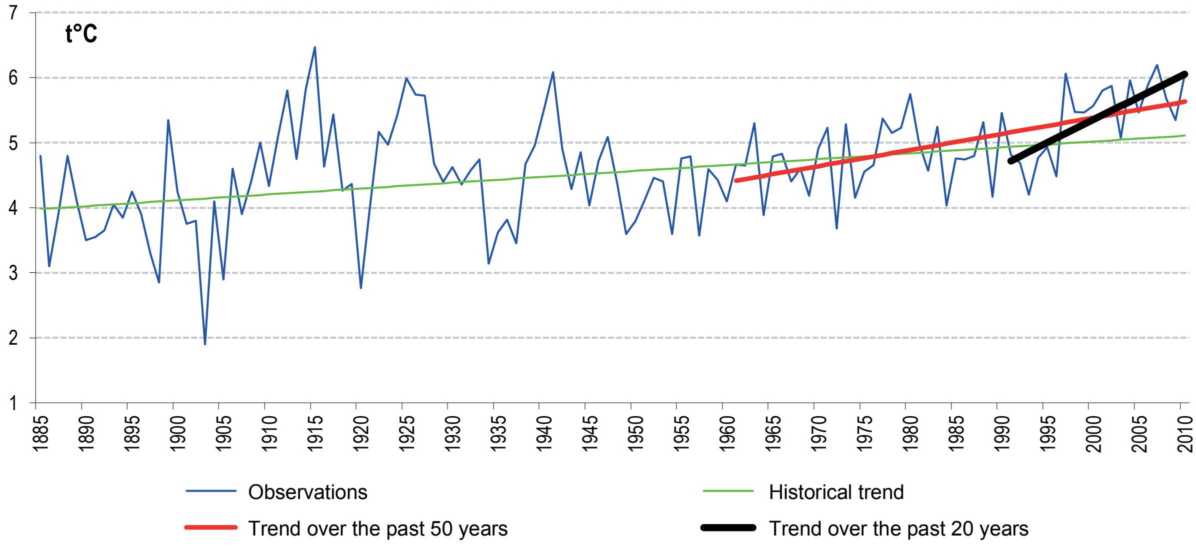


Figure 1.5. The change trend of average annual temperature. Source: Climate profile of the Kyrgyz Republic

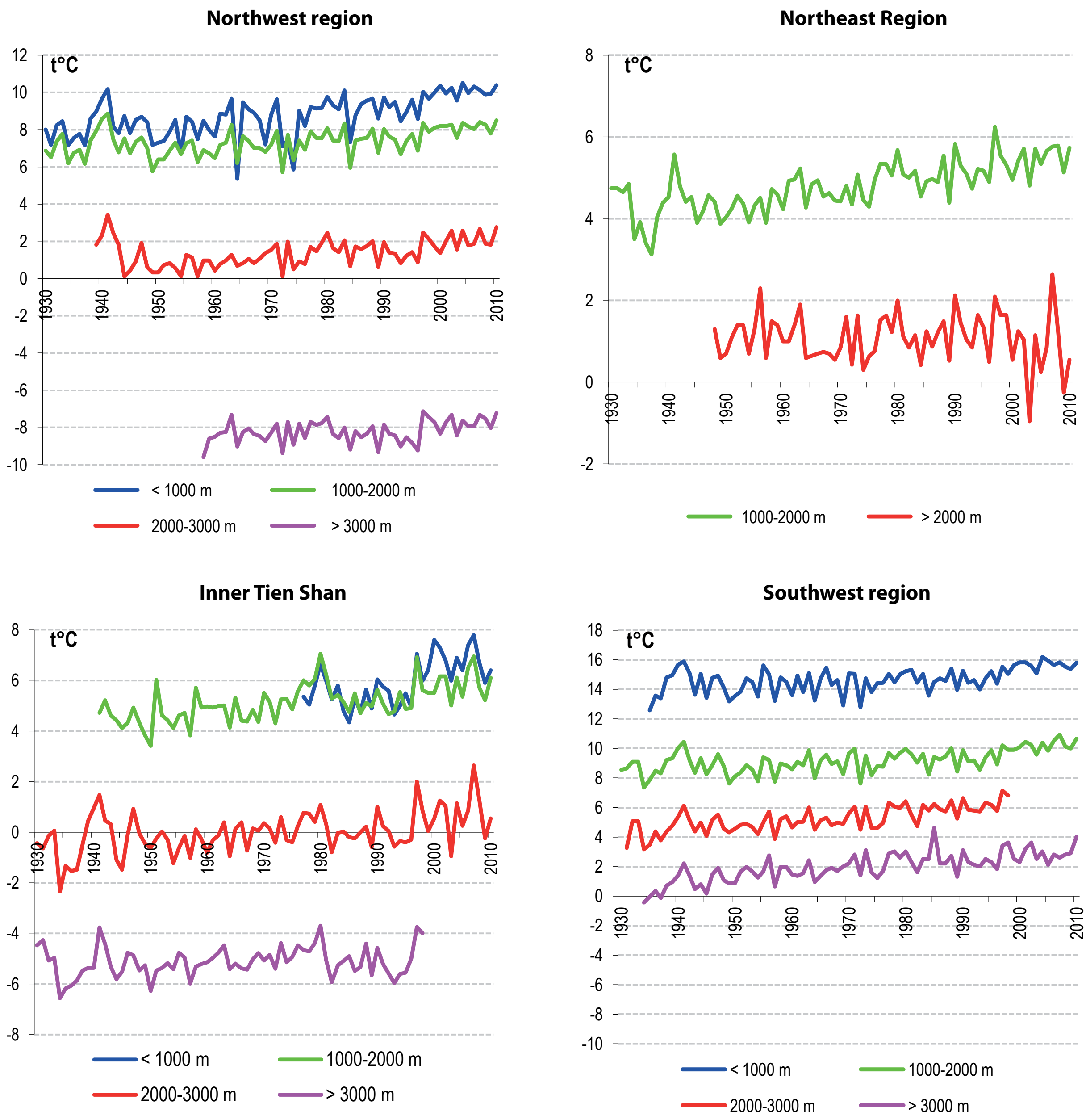


Figure 1.6. High-altitude trends for climate regions. Source: Climate profile of the Kyrgyz Republic

Figure 1.7 shows the distribution of the average annual temperature over the baseline period (1961-1990) and changes relative to the baseline period.

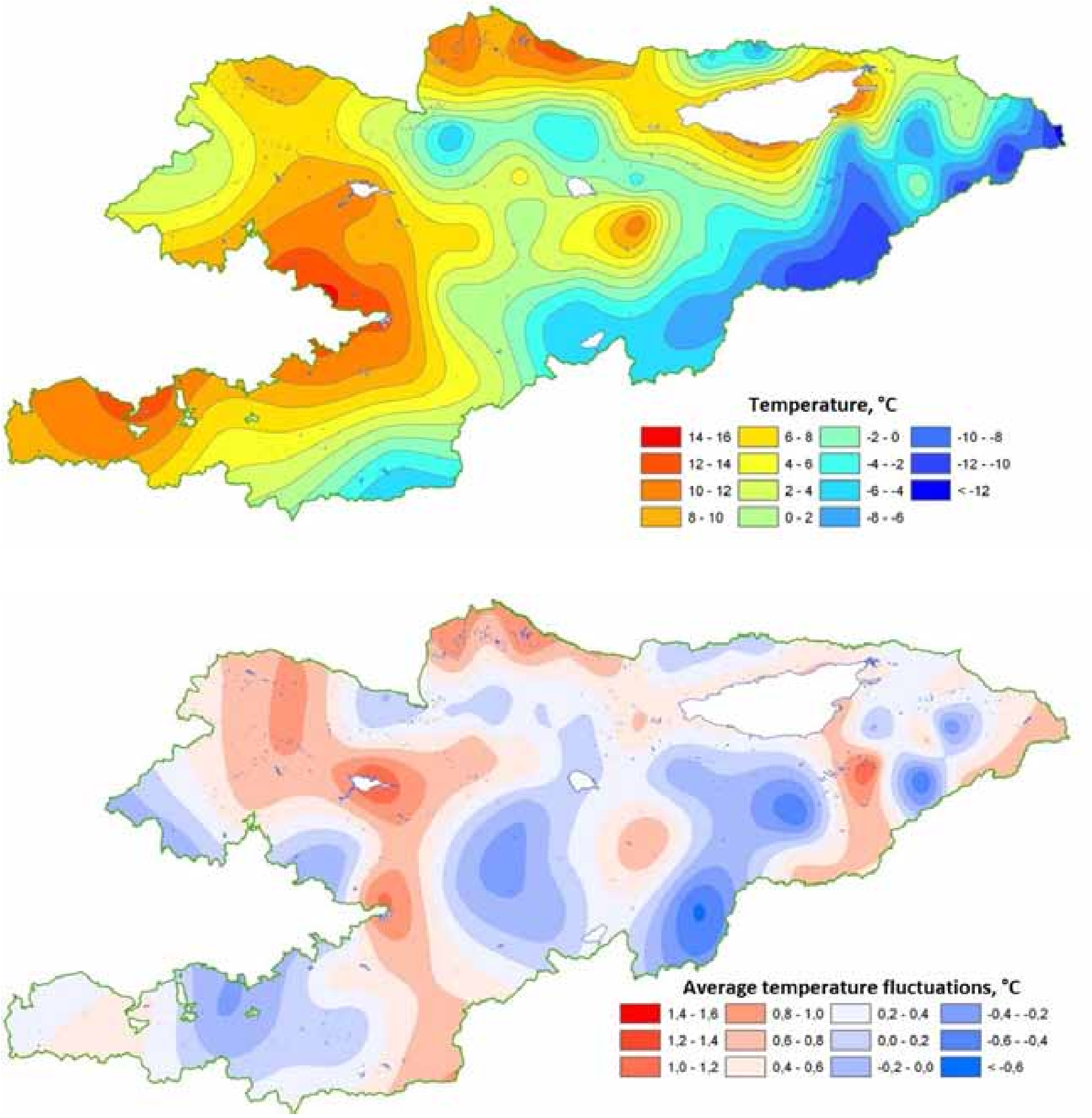


Figure 1.7. Distribution of average annual temperature across the territory of the country over the baseline period (top), and zones of different average annual temperature growth rates in °C over the last twelve years, as compared to the baseline period (bottom). Source: Climate profile of the Kyrgyz Republic

Figure 1.8 shows changes in the maximum and minimum monthly temperature growth rates in three cities: Bishkek, Naryn and Djalal-Abad. A similar pattern is observed at the other weather stations.

The similarity should be noted in the shape of changes in all the regions of the KR. The highest warming rate is observed for the winter months. Moreover, the lowest monthly temperatures get "warmer" much faster than the highest ones.

These seasonal changes result in a positive effect that is a change in the heating season duration. For example, the average heating season in Bishkek city lasted 159.6 days in 1930-1960, falling to 157.8 days in 1961-1990, and a further reduction to 142.7 days in 1991-2011.

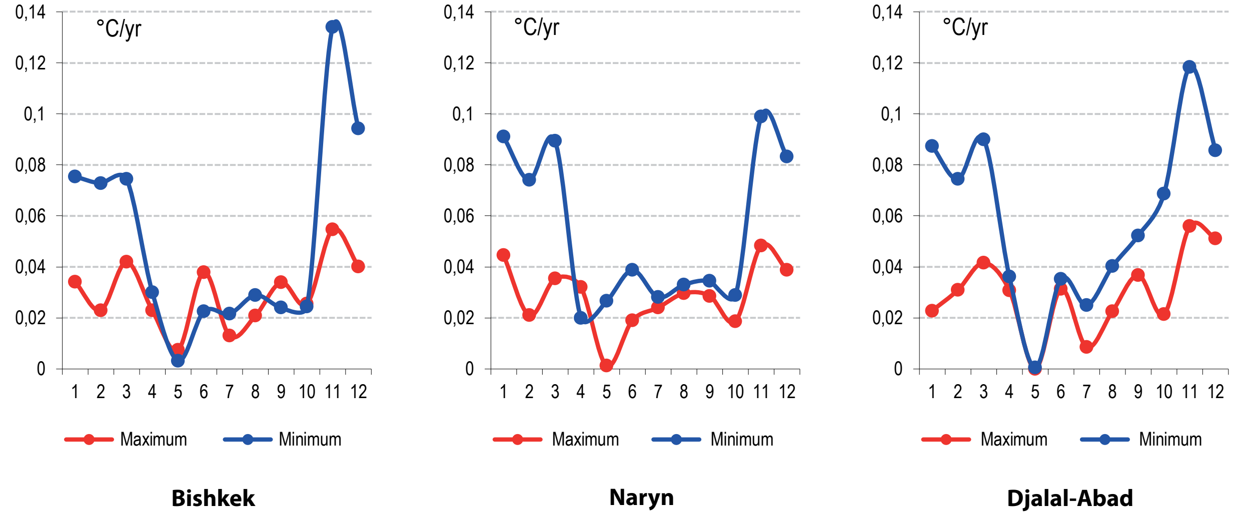


Figure 1.8. Changes in the maximum and minimum monthly temperature growth rates in 1991-2010 as compared to the period of 1960-1990. Source: Climate profile of the Kyrgyz Republic

Figure 1.9 shows the temperature gradient for different climatic regions. This information may be used to assess an altitudinal drift in different ecosystems or farmlands with a particular variation in temperature. The temperature gradient reflects a change in temperature by altitude. It should be noted that changes are nearly identical for all regions if the parallel shift along the vertical axis with latitude is not taken into consideration.

Figure 1.9. Temperature gradient by climatic regions. Source: Climate profile of the Kyrgyz Republic

In general, precipitation changed insignificantly, but in recent years there have been rather drastic changes in certain regions, both upward and downward. Also, the overall trend is downward in recent years (Figure 1.10).

Thus, annual precipitation in the country has slightly increased over the total period of observations (0.847 mm/year), but the growth rate has decreased significantly in the last 50 years (0.363 mm/year), and there has been even a slight downward trend in the last 20 years (-1.868 mm/year).

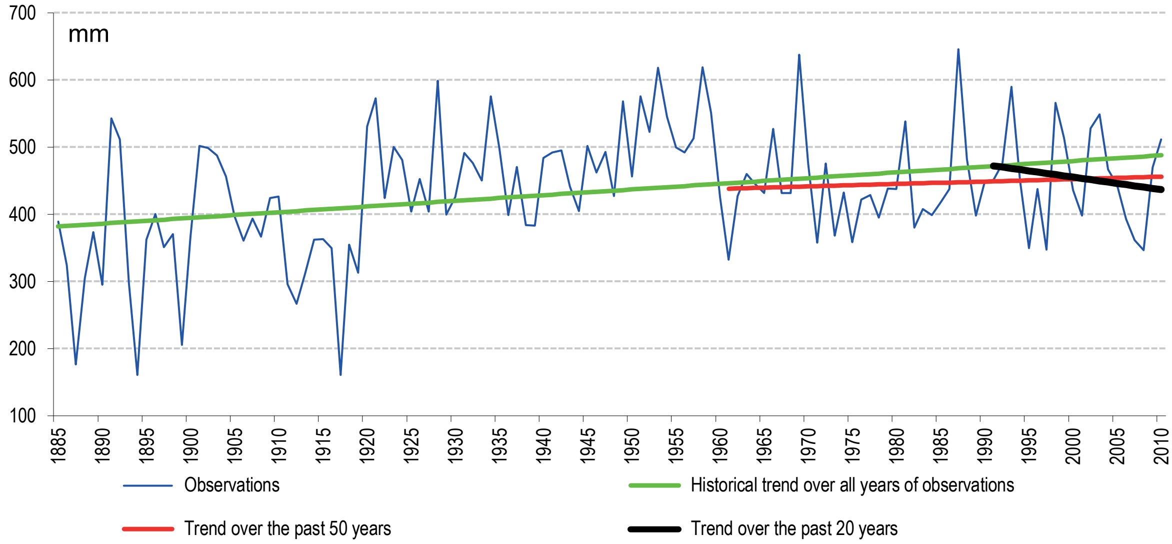


Figure 1.10. General trend of the annual average precipitation over the entire period of instrumental observations (1885-2010). Source: Climate profile of the Kyrgyz Republic

Figure 1.11 shows annual distribution of precipitation across the country over the baseline period, as well as changes relative to the baseline period.

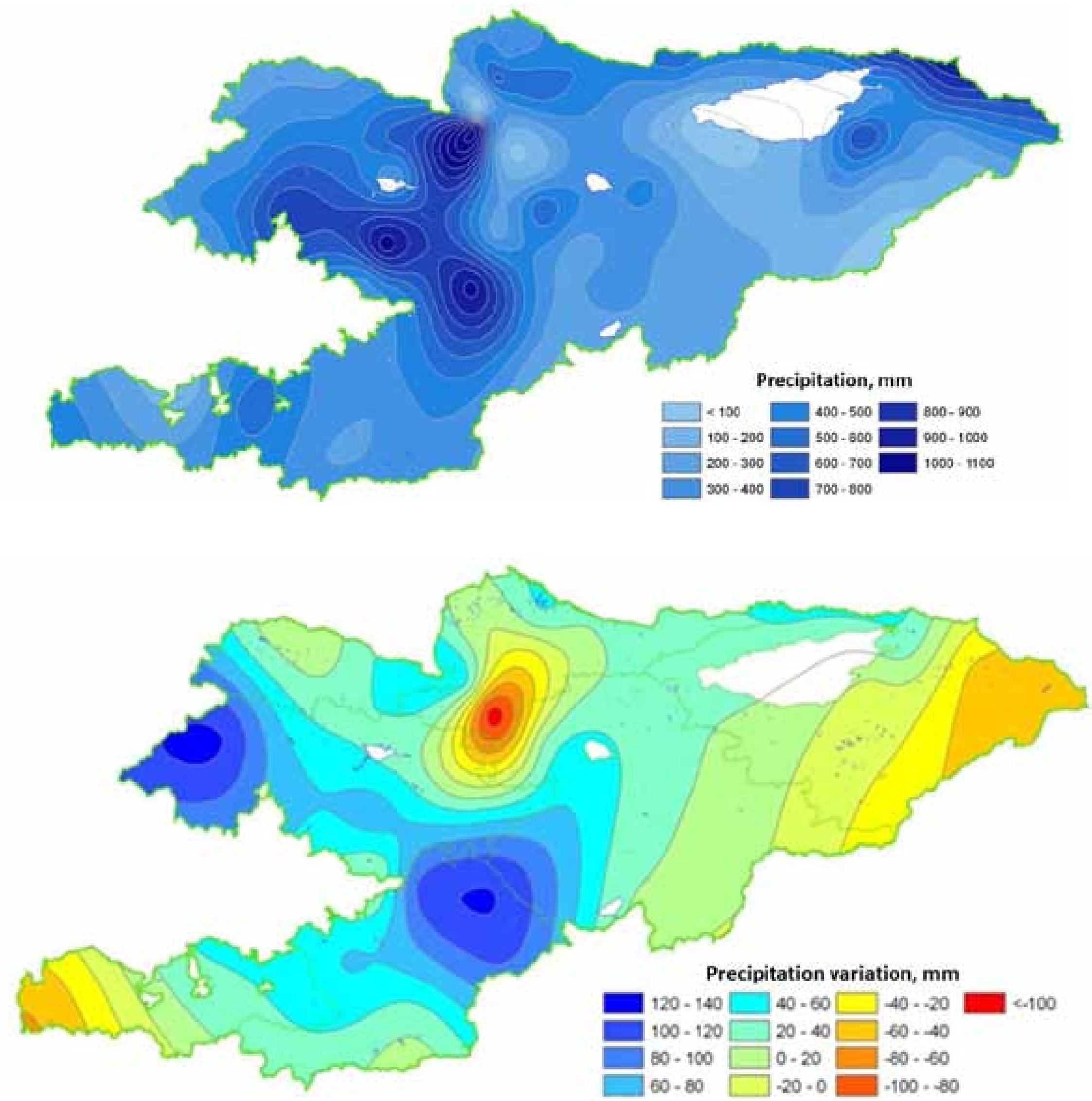


Figure 1.11. Distribution of the total annual precipitation across the country over the baseline period (1961-1990), and change in the total annual precipitation over the past 20 years as compared to the baseline period. Source: Climate profile of the Kyrgyz Republic

1.1.2. State Structure

According to the Constitution, the Kyrgyz Republic is a sovereign, democratic, legal, secular, and social state. Exercise of state power in the Kyrgyz Republic is based on the principle of separation into legislative, executive and judicial branches.

The first constitution was adopted at the twelfth session of the Supreme Council of the Kyrgyz Republic on May 5, 1993. Following the referendum on June 27, 2010, the current version of the Constitution was approved.

Public administration has three levels of administrative division. As of January 1, 2015, the system of administrative and territorial structure includes 7 regions(oblast) (see the inset map in Figure 1.1), Bishkek and Osh cities with a status of national subordination, and 40 districts (rayon), 31 cities, 9 urban settlements, 3 settlements of regional subordination, 453 rural districts (ayil aimak).

1.1.3. Demographics

The population of the Kyrgyz Republic, as of 1 January, 2016, is 6,019.5 thousand people. Regarding the country's mountainous terrain, the population distribution within the country is extremely irregular. The population mainly resides and carries out most of its economic activities on the low-hill terrain, in the intermountain basins and mountain valleys. The highest population activity is concentrated within settlements, as well as in a relatively small buffer zone of 5 km around settlements (Figure 1.12). The urban population share is 33.6%, of which 62.8% are of working-age (men: between the ages of 16-62, and women: between16-57). The rural population share is 66.4%, of which 59.2% are of working-age.

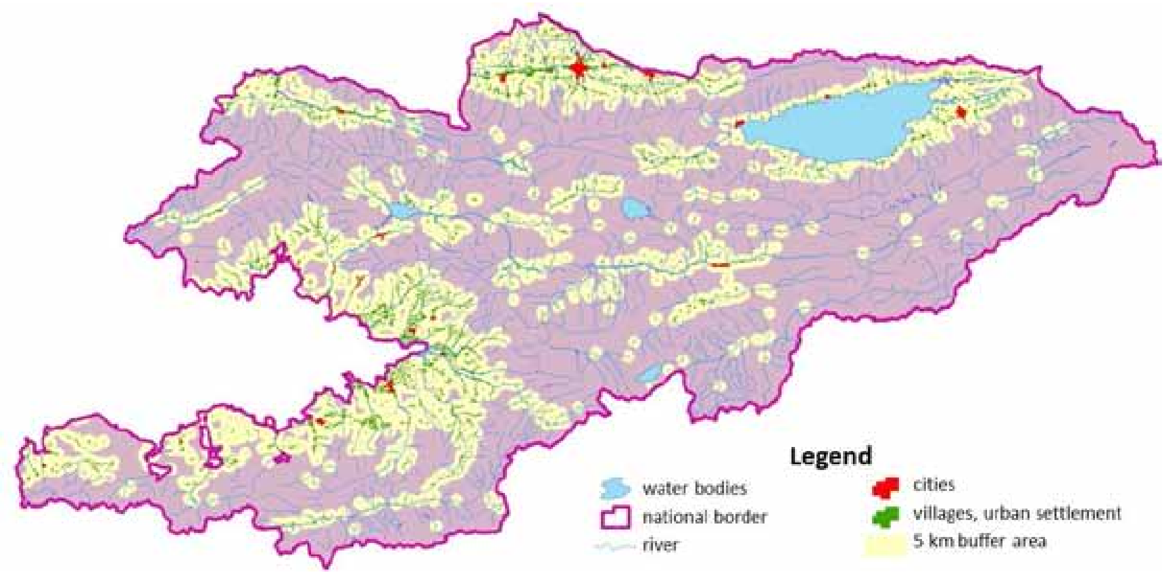


Figure 1.12. Population distribution in Kyrgyzstan

Over 2005-2014, the annual growth rate of the country's resident population increased from 1.0 % to 2.1 %, and averaged 1.4 % over the ten years.

Figure 1.13 shows the age structure of the urban and rural population of the Kyrgyz Republic in 2014. It also compares the size of male and female population of working age in 2005 and 2014. As seen from the figures, the size of the able-bodied population of the most active working age (20-30 years) has increased over the period under review. This does not take into account hidden labor migration to the member countries of the Eurasian Economic Community.

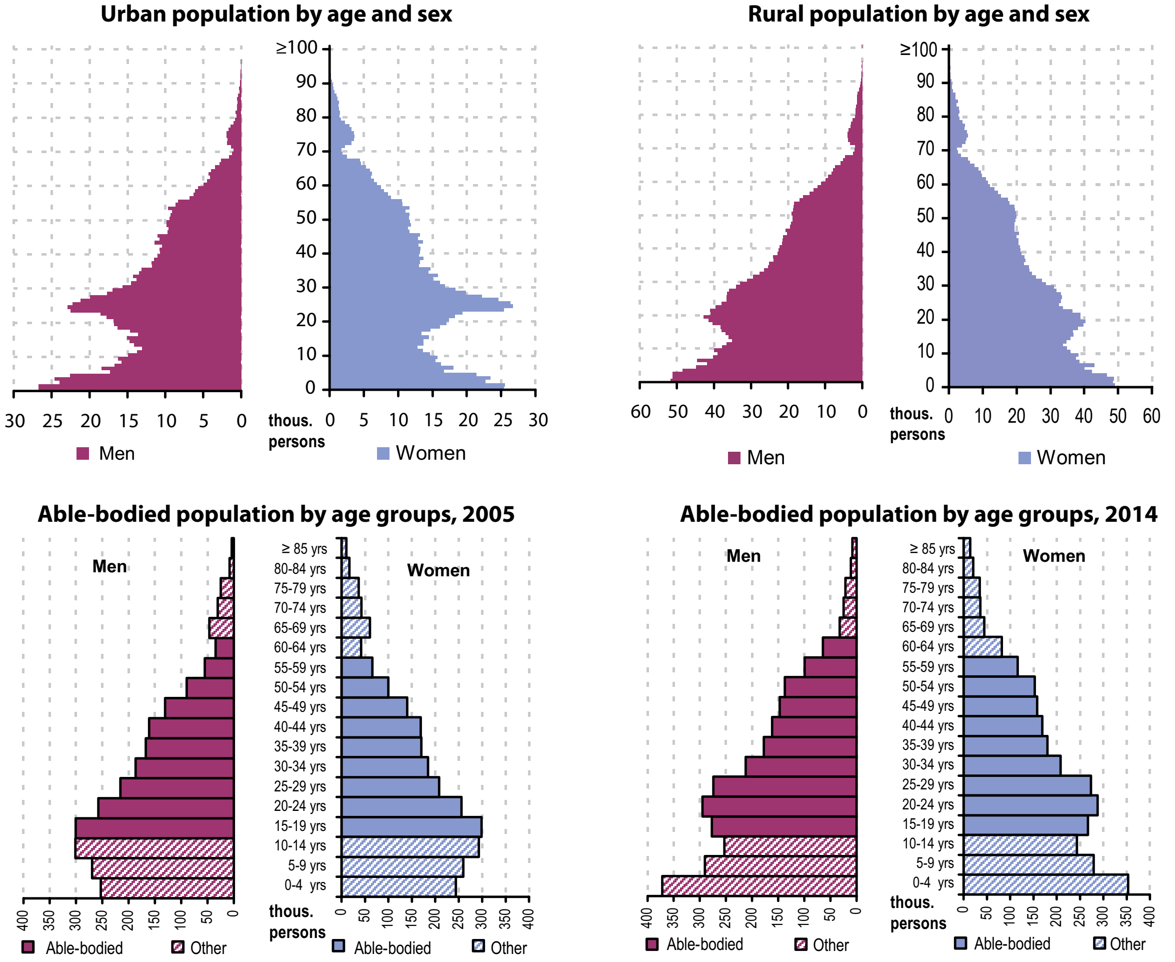


Figure 1.13. Distribution of the urban and rural population of the Kyrgyz Republic by sex and age groups (as of 2014), and comparison of the size of working-age population by age groups[3] and sex in 2005 and 2014. Source: National Statistics Committee of the Kyrgyz Republic (NSC)

Distribution of the population by administrative unit in the country is uneven. The population of regions such as Chui (including Bishkek), Osh (including the city of Osh) and Jalalabad is over one million (each). The population of other regions, such as Talas and Naryn, is less than 300 thousand.

Table 1.1 shows the overall demographic situation in the Kyrgyz Republic at the beginning of 2014.

Table 1.1. Demographic indicators of administrative units at the beginning of 2014 (in thousands of people). Source: NSC

Regions and cities of national subordination	Total population			Urban population			Rural population		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Batken region	469,7	238,7	231,0	110,4	55,1	55,3	359,3	183,6	175,7
Djalal-Abad region	1099,2	551,1	548,1	237,5	114,1	123,4	861,7	437,0	424,7
Issyk-Kul region	458,5	227,6	230,9	128,9	60,9	68,0	329,6	166,7	162,9
Naryn region	271,3	137,7	133,6	37,0	18,1	18,9	234,3	119,6	114,7
Osh region	1199,9	604,7	595,2	91,8	45,6	46,2	1108,1	559,1	549,0
Talas region	243,4	122,6	120,8	34,7	16,6	18,1	208,7	106,0	102,7
Chuy region	853,7	420,3	433,4	153,2	71,4	81,8	700,5	348,9	351,6
Bishkek	915,7	426,3	489,4	911,6	424,3	487,3	4,1	2,0	2,1
Osh	265,2	127,6	137,6	238,5	113,9	124,6	26,7	13,7	13,0

The level of delivery of housing and communal services to the population remains insufficient. At the same time, a level of improvement of urban and rural dwellings varies considerably. Figure 1.14 shows the dynamics of housing provision with public services for the cities and the countryside for the period of 2005 to 2013. As can be seen from the diagram, the situation has hardly changed since the release of the Second National Communication. At the same time, the situation has weakened by a number of parameters.

[3] Based on the land resources records by the SRS, as of January 1, 2012

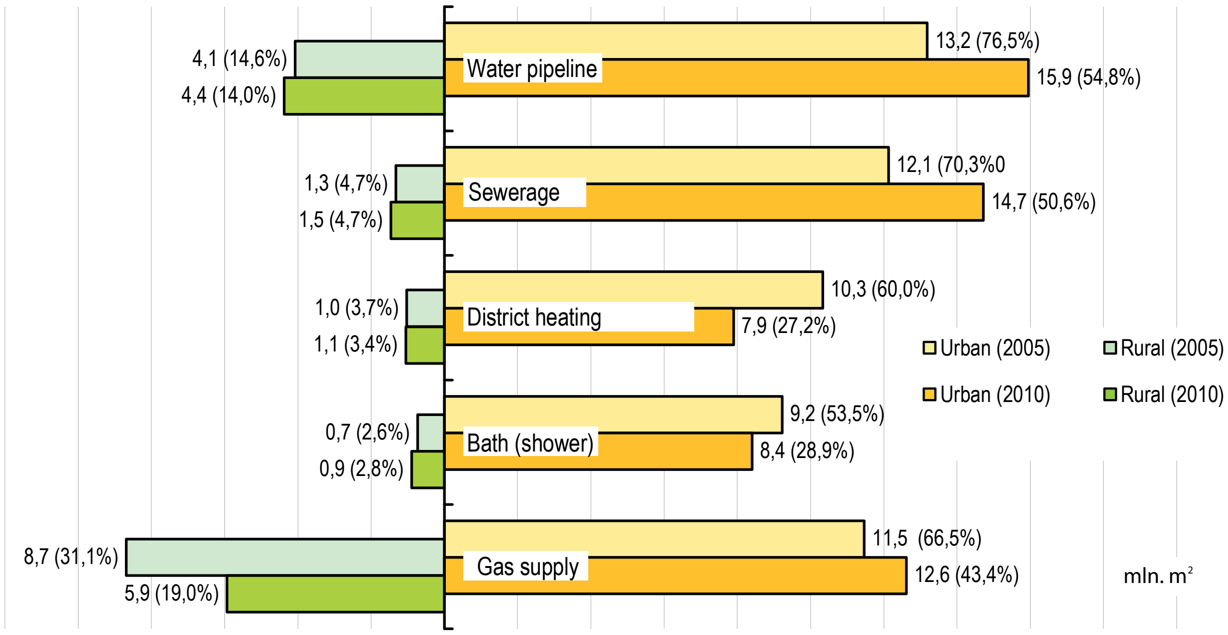


Figure 1.14. Changes in provision of residential stock with public utilities over 2005-2013. Source: NSC

The state of an access to clean water by sources is shown at Table 1.2.

Table 1.2. Water supply for the population in 2005 and 2013. Source: NSC

	Proportion,%	
	2005 г.	2010 г.
Population with access to safe drinking water, of which:	84,4	91,5
water pipe users	28,5	25,7
standpipe users	52,3	59,2
well users	3,7	6,6
Population using spring water	0,8	0,8
Population using irrigation ditches (aryk)	14,8	7,7

The share of water intake from open water bodies for domestic, household and practical needs remains quite large and poses a significant risk to public health. This sector requires significant investment for reconstruction of the majority of the utility networks in the settlements and surrounding areas.

1.2. Natural Resources

1.2.1. Land Resources

The overall land distribution in the Kyrgyz Republic is shown in Table 1.3

Table 1.3. Changes in the area of various categories of land resources (in thousand hectares). Source: SRS, SAEPF

Land categories	1995	2000	2005	2010
1. Total land, including the following categories:	19994,9	19994,9	19994,9	19994,9
– lands for agricultural purposes	11647,1	5788,2	5698,4	5679,7
– populated lands	137,4	231,7	250	266,4
– lands for industries, transportation, defense, communications and other purposes	888,8	227,5	221,8	222,7
– nature reserve areas	145,4	349,3	447,8	707,4
– forest reserve lands	1107,1	2634,3	2684,9	2617,2
– water reserve lands	93,7	767	767,3	767,3
– lands (undistributed lands)	5975,4	9996,9	9924,7	9734,2
2. Farmlands, including by type:	10781,2	10798,3	10780,5	10651,0
– arable land	1417,4	1367,5	1284,4	1276,3
including irrigated land	939,9	930,9	866,7	1020,9
– planted areas (perennial plants)	70,6	67,1	72,1	74,3
– deposits	20,1	21,5	35,4	38,9
– hayfields	170,6	177,0	199,5	197,5
– pastures	9111,1	9165,2	9189,1	9064,0
3. Forested areas, including:	1418,6	1423,0	1434,2	1398,1
– land of the SFR and NR	845,6	855,7	875,6	839,6
– land beyond the SFR and NR	277,0	277,0	277,0	277,0
– in the settlements	10,8	12,0	13,0	13,0
– protective plantings	215,3	210,3	197,0	197,0
– perennial plantings	69,9	67,9	71,5	71,5

The percentage of irrigated land in 2010 was 79.99% of the total arable land. There has been a steady decrease in arable area throughout the entire observation period. So, the total area of arable land decreased by 141.1 thousand hectares over this period. However, both the share (79.99%) and the total area of irrigated land have increased (81thousand ha). The area of fallow (derelict land) and hayfields has increased. The area of perennial crops has changed insignificantly.

In the KR there are 55 types of soil and non-soil formations divided into six groups. Figure 1.15 provides the map of soil groups.

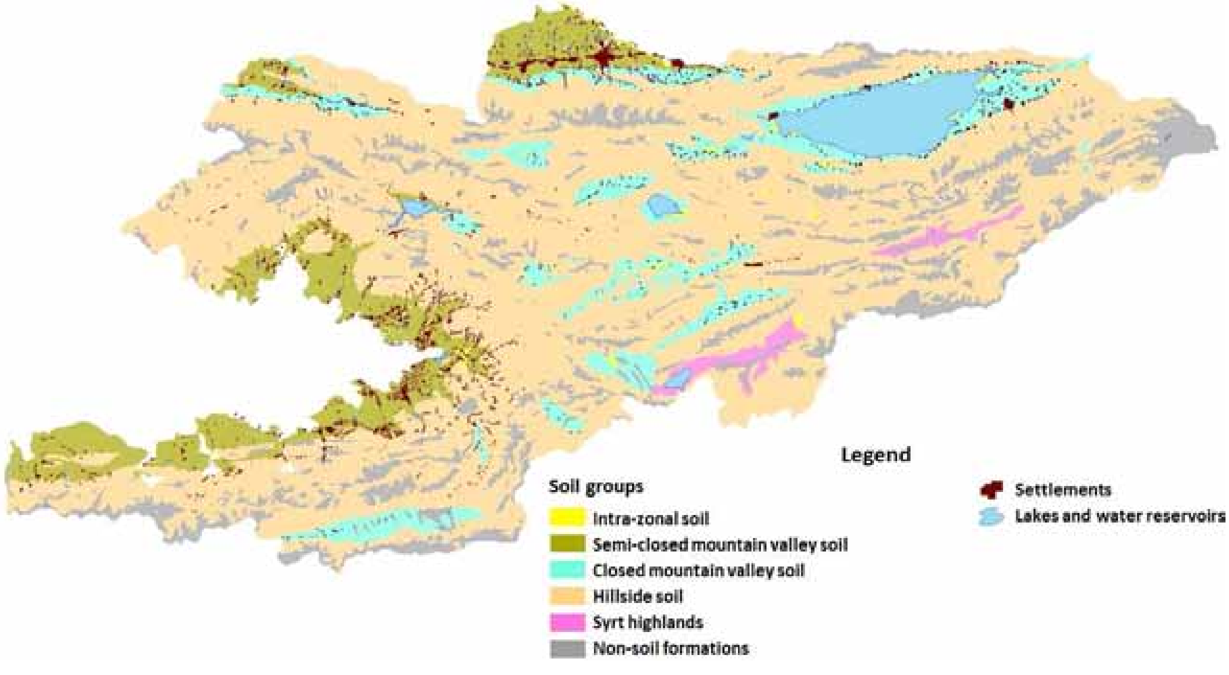


Figure 1.15. Soil groups in the territory of KR

In general, there has been a steady decline in soil fertility from 1990 to present. Figure 1.16 provides an assessment of the changes in soil fertility by major soil type.

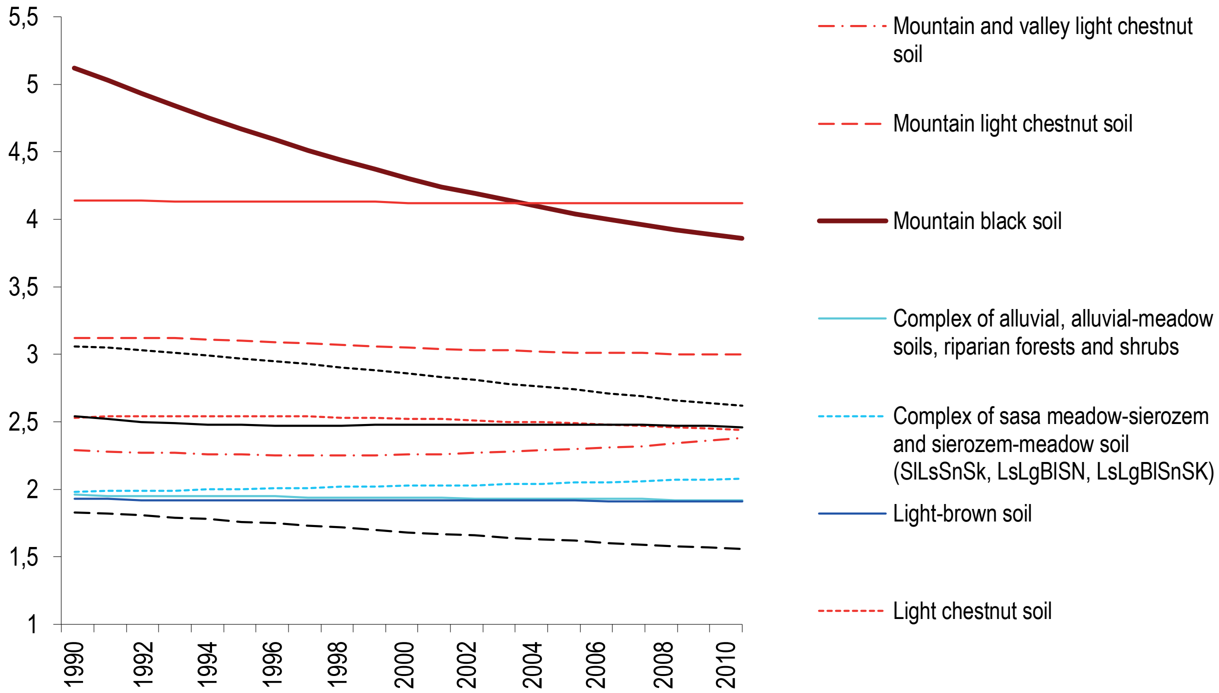


Figure 1.16. Changes in fertility (humus content as a % of soil weight) by main types of soil in farmland. Sources: National agrochemical station, Chui-Bishkek rural advisory service

1.2.2. Forest Resources

Thirty forest species of all the mid-latitude groups take place in the Kyrgyz Republic, including conifers, hardwood trees, softwood nut bearers, fruit, pome-fruit, and stone-fruit trees, as well as more than 17 species of shrubs. Various combinations of species provide a wide diversity of forest ecosystems, from juniper (Turkestan juniper) and fir forests in the highlands, to fruit and nut forests in the midlands, and riparian (floodplain) forests in the lowlands (Figure 1.17).

Juniper and spruce forests are most widespread (around half of the forested area). Nut bearers occupy around 10% of the area covered by forest.

Vertical stratification and the variety of climatic zones have, on the one hand, led to a wide diversity of tree species in the forest reserves, while, on the other, resulting in a low forest cover in the country.

According to the first national forest inventory (2008-2010), the forested area of the country is 1,398.1 thousand hectares. Of these, 839,6 thousand hectares are in the state forest reserve and nature reserves (specially protected nature conservation areas, NR), and 277.00 thousand hectares are outside the SFR and NR.

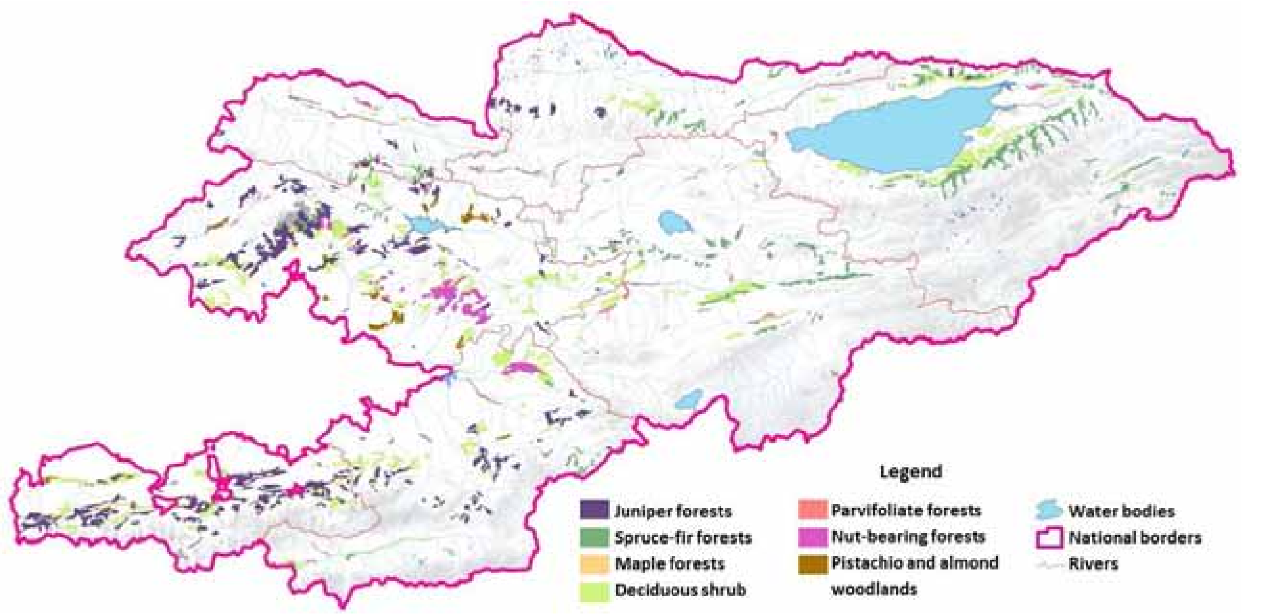


Figure 1.17. Base map of forests. Source: SAEPF

1.2.3. Water Resources

Water resources are used for irrigation, industrial and domestic water supply, as well as energy generation. The country's water resources are concentrated in glaciers, lakes, rivers and groundwater.

In 2010, the total estimated glacial volume was 390 km^3. According to the mathematical and cartographic model, the glacial volume has decreased by approximately 15% from the mid-70s of the last century to 2000.

There are 1,923 lakes in the Kyrgyz Republic. The Issyk-Kul, Son-Kul and Chatyr-Kul are the largest lakes. Water reserves in the lakes are estimated at 1,745 km^3. Of these 1,731 km^3 (or 99.2% of the total volume of all lakes) are concentrated in the Issyk-Kul Lake, the water of which is salty and unfit for water supply.

The mountainous terrain of the Kyrgyz Republic resulted in the formation of an extensive river network. There are around 5 thousand rivers and 2 closed lakes (Issyk-Kul and Chatyr-Kul). These lakes are the inland basins: their river runoff is approximately 3.5% of the total runoff. In 2010, the cumulative long-term annual average river runoff is estimated at 47.8 km^3 (Figure 1.18).

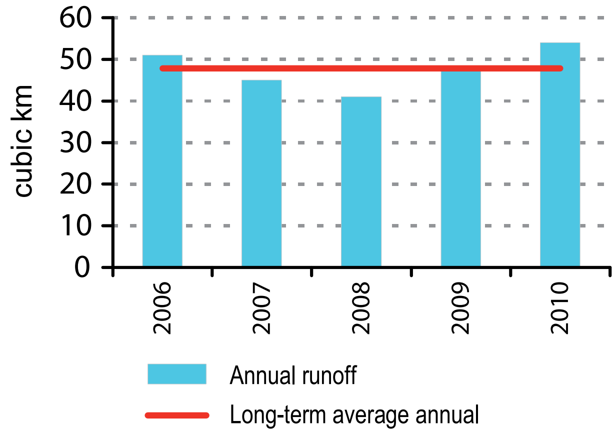


Figure 1.18. Annual river flow for 2006-2010. Source: MALR

Potential fresh groundwater reserves are estimated at 13 km³. They are mainly concentrated in the intermountain basins, the most reclaimed economically. The proven useful groundwater reserves by industrial category exceed 16 million m³ per day (over 5 km³ per year). Figure 1.19 shows changes in a balance of water resources over the past 20 years.

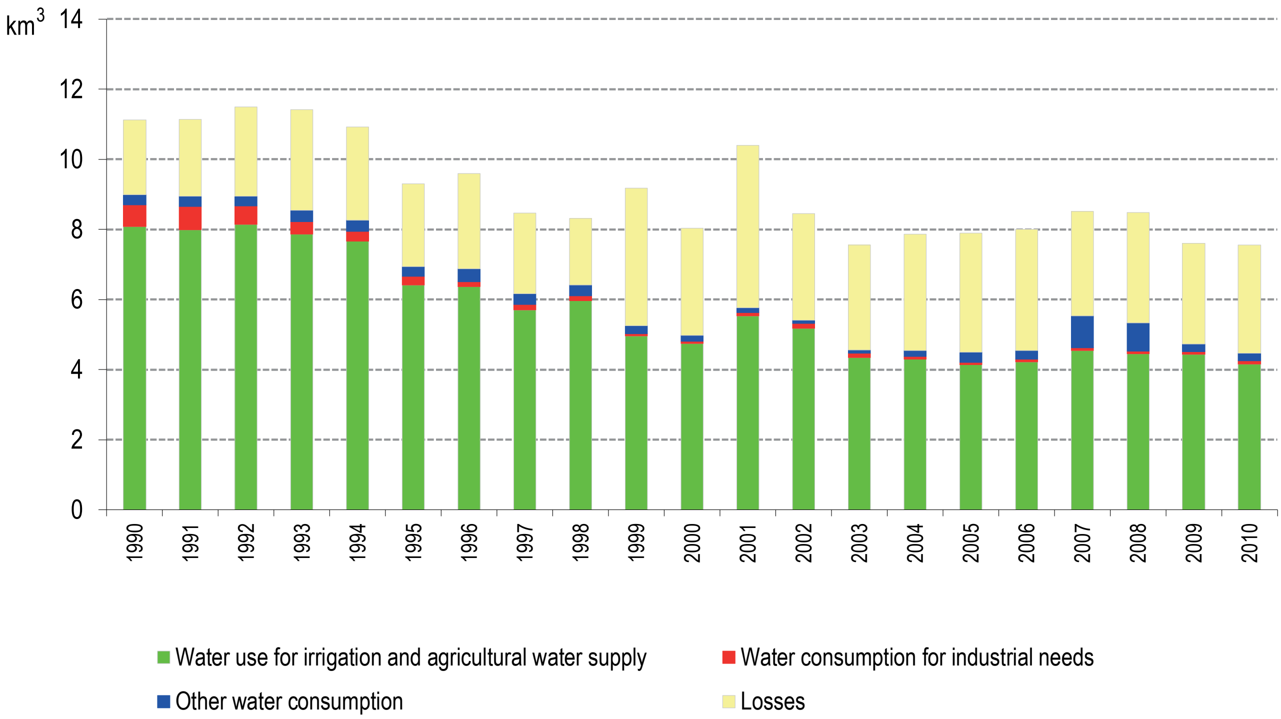


Figure 1.19. Water resources use over the period of 1990-2010. Source: NSC

In 2014, the total water intake in the Kyrgyz Republic was 1,327 m³ per capita.

1.2.4. Hydropower Resources

Based on the linear account of 268 rivers, 97 largest canals and 19 reservoirs, the total hydropower potential in 2010 (for a year of average water content) was estimated at 28.83 million KW of power and 245.52 billion KWh of gross electric power output (Figure 1.20), including a power generating capacity of 60 billion kWh.

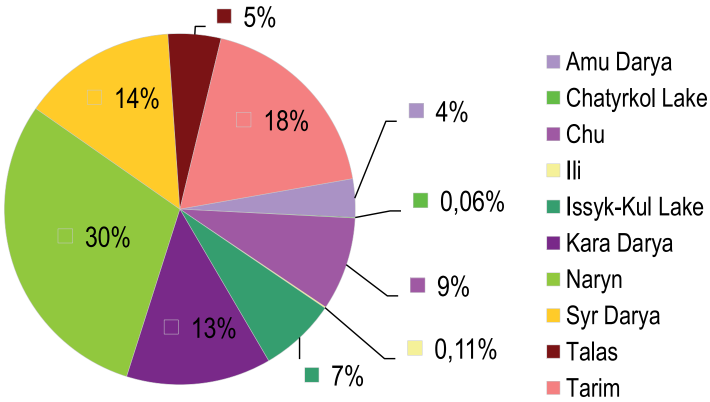


Figure 1.20. Contribution of water basins to the total hydropower potential of the Kyrgyz Republic, as of 2010

In Kyrgyzstan, there are 16 large and medium-sized hydropower plants with a total installed capacity of 2,949 MW and a cumulative annual output of 10.406 billion KWh. At present, 18% of the country's hydropower potential is already in use (19.5% for large hydropower plants and 4% for small HPPs).

The country is constructing two HPPs in the Mid-Naryn chain of power plants: Kambarata-1 and Kambarata-2. Upon the operational commissioning of these two plants, the total generating capacity will increase by 2,260 MW (77% of the existing generating capacity), which will increase the annual power generation by 6.312 billion KWh (61% of the current power output).

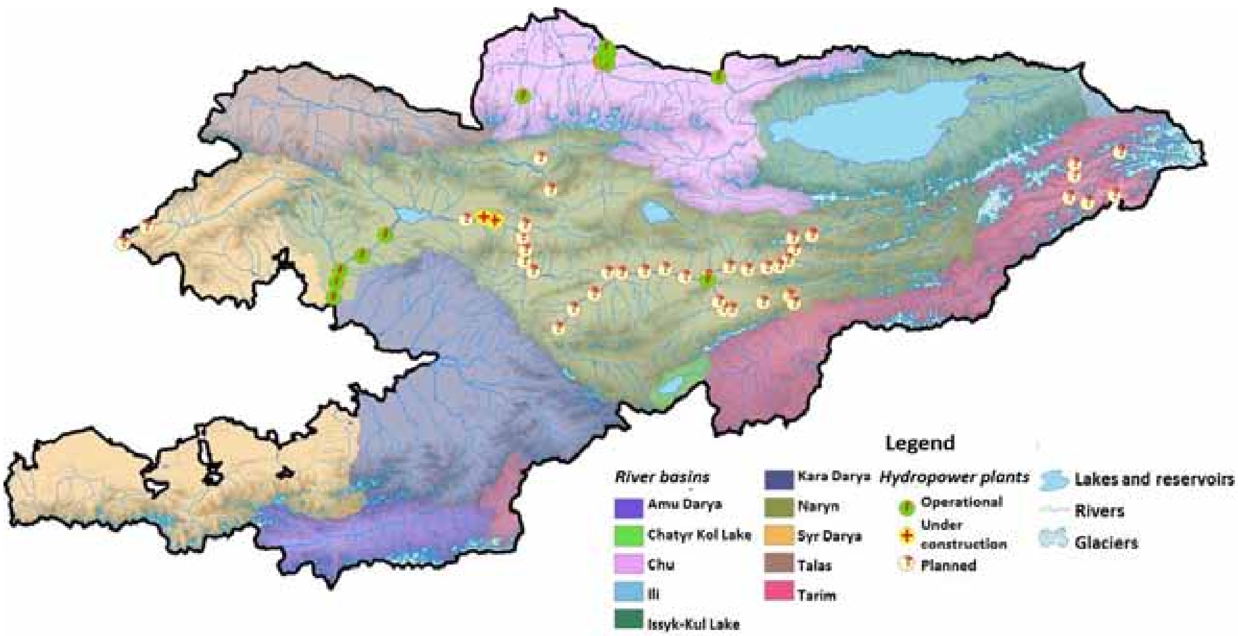


Figure 1.21. Hydropower resources. Source: National Energy Program of the Kyrgyz Republic for 2008-2010, and the Fuel and Energy Sector Development Strategy till 2025

Since the 20th century, 39 large and medium-sized HPPs have been constructed with a total generating capacity of 7,155 MW and annual power output of up to 23,625 billion KWh (Figure 1.21). The construction of all planned HPPs will increase the capacity up to 46% (up to 48.8% for large HPPs, and up to 21.3% for small HPPs).

1.2.5. Fuel and Energy Resources

Feasible reserves of 70 major coal deposits are estimated at more than 2.2 billion tons, whereas productive reserves of coal, as of January 1, 2006, were 1,316.9 mln. tons (750.7 mln. tce). Over the entire period of coal fields development, the highest output (4,508 thousand tons) was reached in 1979. Since 1980 it started to decrease gradually, up to 3,473 thousand tons in 1991. Since 1992, there was a sharp decrease in coal output, up to 321.3 thousand tons in 2006. There has been growth brewing since 2008. The main reasons that have influenced the coal output decline are of economic and organizational nature.

Up to the present, the national economy has been enduring a permanent shortage of coal. An underdeveloped railway network (the main transportation channel) and increased transportation costs significantly limit the sales markets.

The forecast for unexplored oil and gas reserves in the Kyrgyz Republic are about 289 million tons of coal equivalent. At present, oil and natural gas outputs are limited. Therefore, there are 15 oil and gas fields developed in the country with 11.6 million tons of recoverable oil reserves (16.6 million tce), and 4.9 billion cubic meters of commercial natural gas reserves (5.6 million tce). The domestic oil reserves meet 4.5% of domestic demand, while natural gas reserves meet approximately 6.5% of domestic demand.

Generally, the provision of the Kyrgyz Republic with fuel and energy resources was 69.12% (excluding woodfuel) in 2010.Table 1.4 shows the availability of fuel and energy resources.

Table 1.4. Availability of fuel and energy resources in 2010 (thous. tce). Sources: NSC

Type of fuel and energy resource	Opening balance	Balance at end of year	Output (generation/ production)	Import	Export	Availability of domestic resources, %
Coal	349,48	388,24	327,73	786,38	11,32	28,71
Woodfuel	0,36	0,38	3,95	0,00	0,00	100,00
Natural gas	0,00	0,00	26,30	313,54	0,00	7,74
Metallurgical coke	1,02	1,01	0,00	0,63	0,00	0,00
Fuel oil	40,53	68,20	59,97	176,00	30,11	25,68
Diesel fuel	128,61	49,69	55,33	359,44	33,87	18,32
Motor gasoline	89,73	93,43	22,77	631,50	2,69	3,47
Liquefied gas	0,99	0,92	0,00	16,25	0,06	0,00
Aviation kerosene	5,32	27,90	0,00	471,72	77,08	0,00
Neftebitum	7,68	1,25	0,00	46,19	0,00	0,00
Lubricants and petroleum oils	2,89	2,51	0,00	16,22	0,00	0,00
Electric power	0,00	0,00	4159,45	39,91	629,62	116,52
Total	626,60	633,53	4655,49	2857,79	784,75	69,12

During 1990-2010 there was a steady decline in the amount of electricity generated by thermal power plants (Figure 1.22). The thermal power plants generated 4.40 billion KWh (or 33%) of electricity in 1990; by 2000, their power output was 1.25 billion KWh (or 8.4%), and by 2010 it was 0.915 billion KWh (6.5% of the total output).

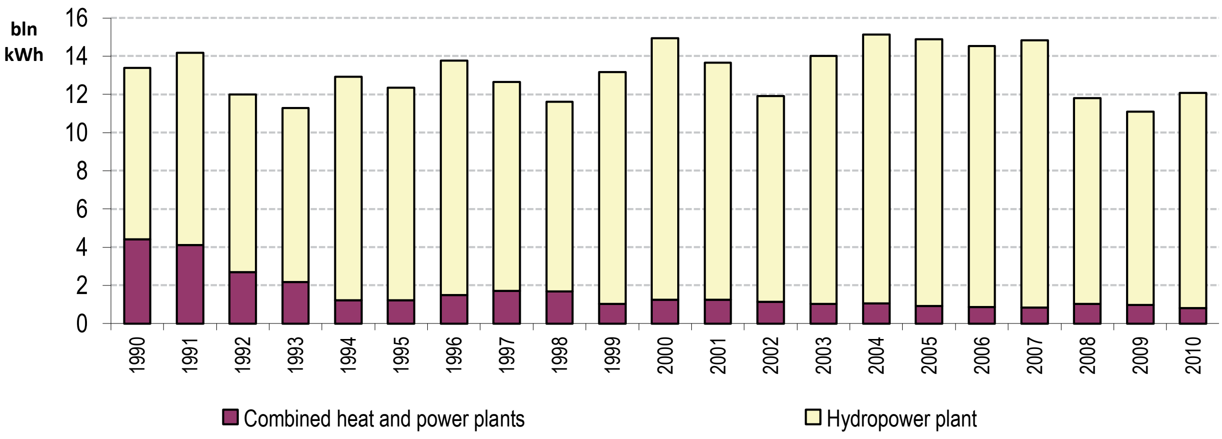


Figure 1.22. Power generation during 1990-2010. Source: NSC

The percentage of generated electricity losses in the structure of energy consumption is high. Consequently, the losses level did not exceed 13% in 1990-1992, in 1995-2008 it was over 30%, reaching 41.5% in 2001 and 40.7% in 2005.

Since 2009, there has been seen a reduction in losses (below 30%), although the total volume of such electricity losses exceeds the social sector consumption or total consumption in sectors such as agriculture, transport, and construction (Figure 1.23).

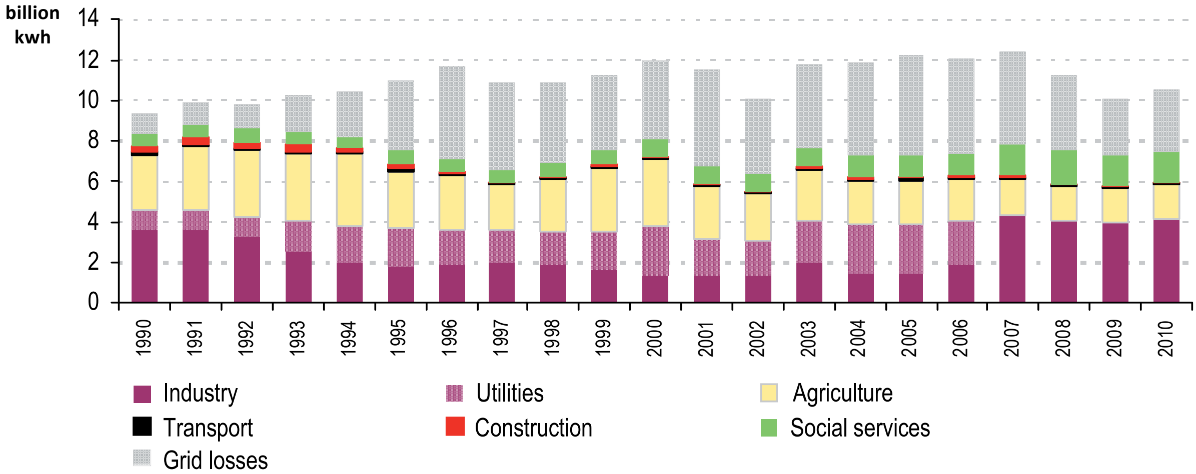


Figure 1.23. The electrical balance of the economic sectors for 1990-2010. Source: NSC

Alternative and Renewable Energy Sources

Potential resources in the national alternative and renewable energy sources, actually available at the current technology level, include solar, wind and geothermal energy, and biogas. Non-traditional and renewable energy sources include hydropower resources, as well.

The country has good climatic conditions for widespread solar energy consumption.

The prospects of wind power consuming in the KR are estimated as insignificant, as, in most cases, there are no conditions for the large industrial wind turbines use in the areas of economic activities and major part of the population. Of all the areas with a resident population and economic activities, the western part of the Issyk-Kul basin (Balykchy city) is the richest in wind resources. However, even in this area there are no adequate conditions for the economically feasible use of wind power (Figure 1.24).

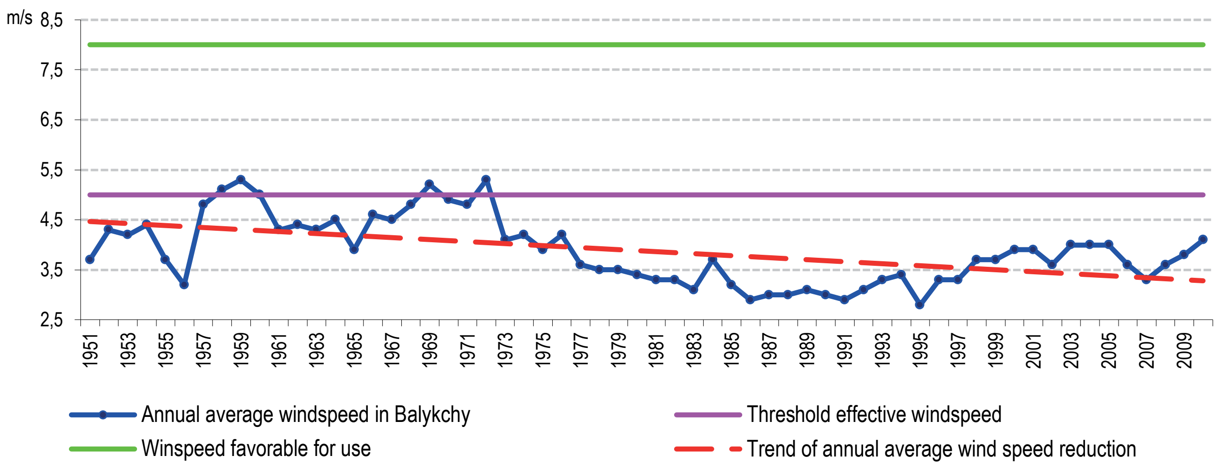


Figure 1.24. Annual average wind speed in the Balykchy city over the period of 1951-2010.

Preconditions for the wind turbines use at a scale meaningful for the country's total energy balance are observed in the alpine areas, such as watersheds. However, remoteness and inaccessibility of such sites for the major electricity consumers makes wind power development economically unjustified.

The geothermal energy potential is not considered in this Communication due to lack of information on its balance.

The total potential of biomass in the energy sector is relatively high (Table 1.5). All together, the main obstacle to the widespread biomass use in energy production is lack of a system of collection, transportation and storage of the necessary raw materials (agricultural waste) from a large number of small farms. The constraint for wider use of biogas plants in the communal sector is a general underdevelopment of the solid waste processing segment.

Table 1.5: Comparison of the biomass energy potential with the energy resources consumption in 2010. Source: NSC.

Type of fuel and energy resource	Measurement unit	Output (generation/ production
Motor gasoline	thousand tce	23
Diesel oil		55
Heavy fuel oil		60
Electricity		4159
Coal		328
Natural gas		26
		121,3
Livestock production		24,5
Crop production		50,8
Food industry		12,5
Municipal solid waste		29,0

1.3. Current State of Economy

1.3.1. General Trends

The social and economic development of the Kyrgyz Republic during 1990-2010 can be divided into the stages. At the initial stage (1991-1995), under conditions of a significant economic decline, especially in industry, a sharp decline in GDP to 50.7% by 1995 took place, as compared to 1990 (in 2005 prices). In particular, the gross industrial product collapsed to 33%; the gross agricultural product decreased to 61.3%; the gross construction output decreased to 45%; the gross output in the transport sector decreased to 88.6%; and the gross output in the services decreased to 61.7%. The second stage (since 1996 to present) is characterized by GDP growth in real estimate (in 2005 prices). The economic situation stabilized during these years. The dynamics of the consumer price index (Table. 1.6) and real GDP in 2005 prices (Figure 1.25) are illustrative of the state of the economy over 1990-2013.

Table 1.6: Consumer Price Index for 1993-2010. Source: NSC

Years	Consumer Price Index	Years	Consumer Price Index	Years	Consumer Price Index
1993	11,862	1999	1,359	2005	1,043
1994	2,807	2000	1,187	2006	1,056
1995	1,435	2001	1,069	2007	1,102
1996	1,320	2002	1,021	2008	1,245
1997	1,234	2003	1,031	2009	1,068
1998	1,105	2004	1,041	2010	1,080

Analysis of the contribution of various economic sectors to the national GDP shows that the share of agriculture in the GDP structure has been declining steadily in recent years. At the same time, the share of services has increased significantly.

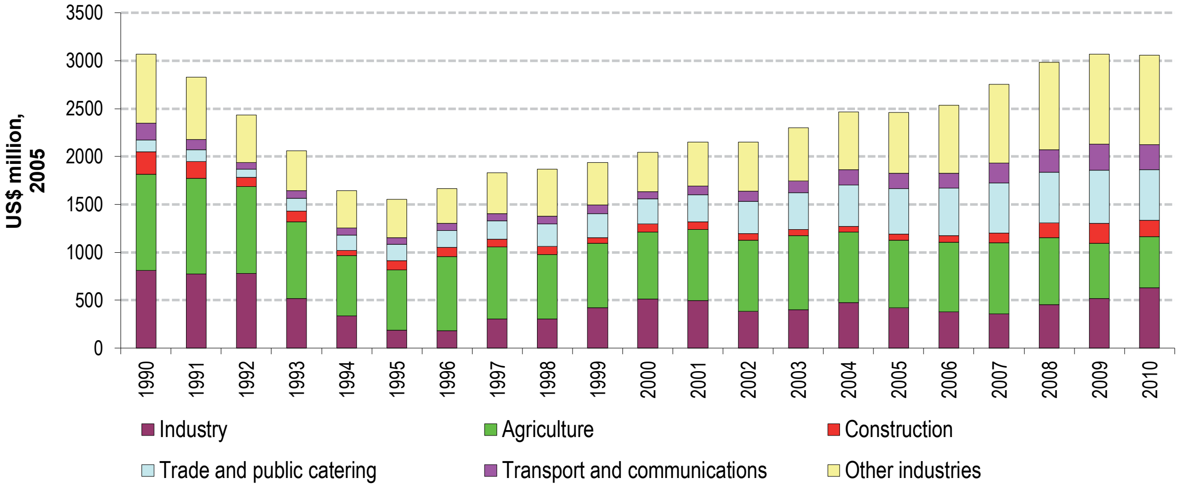


Figure 1.25. Evolution of the real GDP of the Kyrgyz Republic for 1990-2010 in 2005constant dollars. Source: World Bank

Table 1.7 illustrates the main indicators of the population's standard of living in the Kyrgyz Republic in 2010.

Table 1.7. Indicators of living standards at the end of 2010, as compared to 2005. Source: NSC, WB

Indicator	Measurement unit	2005 г.	At the end of 2010
National economic indicators			
Nominal GDP *, including:	US$ million, 2005	2459,9	3055,8
Industry	% of GDP	17,3	20,7
Agriculture	% of GDP	28,5	17,5
Construction	% of GDP	2,7	5,5
Trade and public catering	% of GDP	19,2	17,3
Transport and communications	% of GDP	6,6	8,6
Other industries	% of GDP	25,7	30,4
GDP per capita	KGS thous.	20,2	42,4
KGS/USD exchange rate (end of year)	KGS/US$	41,1	45,96
Import	KGS million	45167,2	148597,9
Export	KGS million	27559,1	80632,1
Employment			
Number of the employed	thous. persons	2077,1	2243,7
Employment rate of the working-age population	%	59,5	58,6
Unemployment rate	%	8,1	8,4
Living standards			
Actual final per capita consumption	KGS thous.	18,8	39,5
Per capita income	KGS thous. per year	11,5	29,9
Average monthly wage per employee	KGS	2613	7189
Average monthly gross pension per pensioner, including compensations	KGS	775	2886
Minimum subsistence level, average per capita value, including:	KGS per month	1836,6	3502,7
Working-age population	KGS per month	2127,8	3905,4

Indicator	Measurement unit	2005 г.	At the end of 2010
Older that working-age population	KGS per month	1492,9	3146,9
Cost of the food basket with the minimum consumer budget	KGS per month	1336,9	2276,7
Gini coefficient (income-based)		0,433	0,371
Availability of durables in a household			
Availability per 100 households:			
TV sets	pcs	102	114
Cameras	pcs	8	11
Washing machines	pcs	50	59
Refrigerators	pcs	70	68
Vacuum cleaners	pcs	15	22
Passenger cars	pcs	10	17
Personal computers	pcs	2	5
Mobile phones	pcs	10	114

* - World Bank data

1.3.2. Agriculture

During 1990-2010, the share of agriculture in the country's GDP varied between 46.2% (1996) to 17.5% (2010). Overall, there has been a steady decline in the agricultural share in GDP since 1996.

The major contribution refers to crop and livestock products. The input of the agricultural services is negligible, along with those of the forestry and hunting sectors (Figure 1.26).

Agriculture is the most climate-sensitive sector, and its productivity, particularly in the arable sector, depends on the climate change indicators throughout the year: annual precipitation level, seasonal distribution of rainfall and moisture content during the growing season. Frosts, droughts, hail, whirlwinds and other weather phenomena have a significant impact on agriculture. Therefore, the yield of individual crops is unstable and fluctuates from year to year (Figure 1.27).

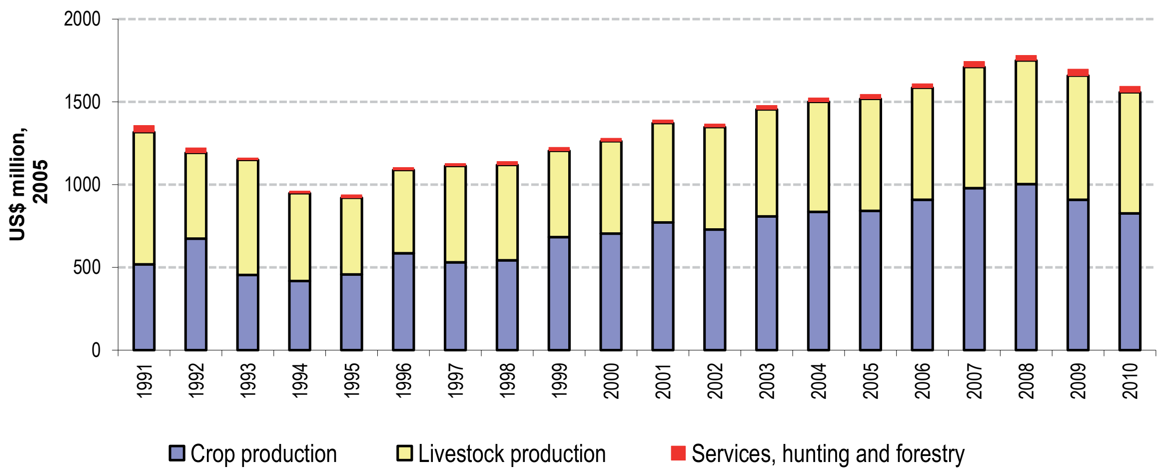


Figure 1.26. Gross output of agricultural products by category over 1991-2010.Source: NSC

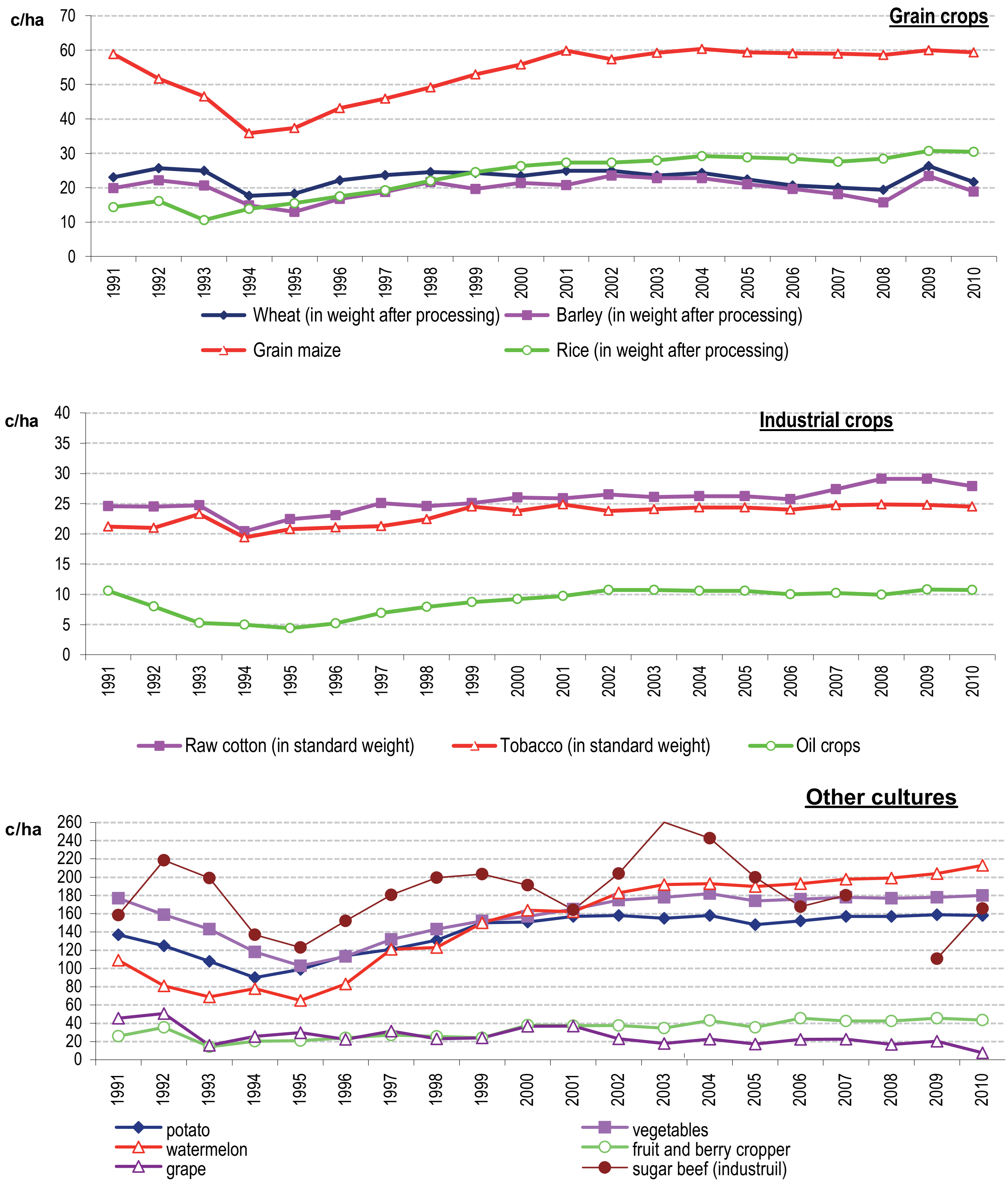


Figure 1.27. Dynamic of the major crop yields for 1991-2010.Source: NSC

At the same time, the dynamics of gross productivity reflects the overall development of the industry: both the crop production and livestock sectors show a steady growth trend.

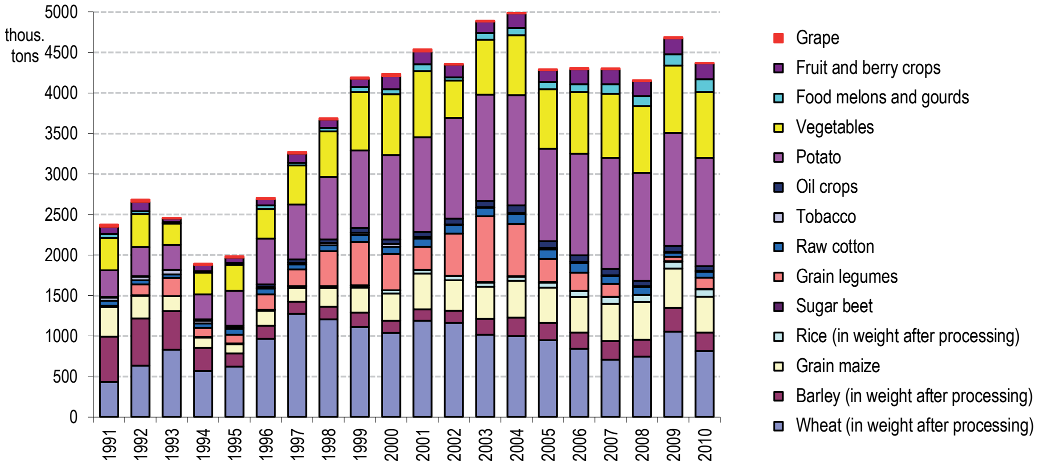


Figure 1.28. Output of the main crop products for 1991-2010.Source: NSC

Information on the output of the crop products (Figure 1.28) and livestock products (Figure 1.29) gives a fairly comprehensive knowledge of national agricultural actions.

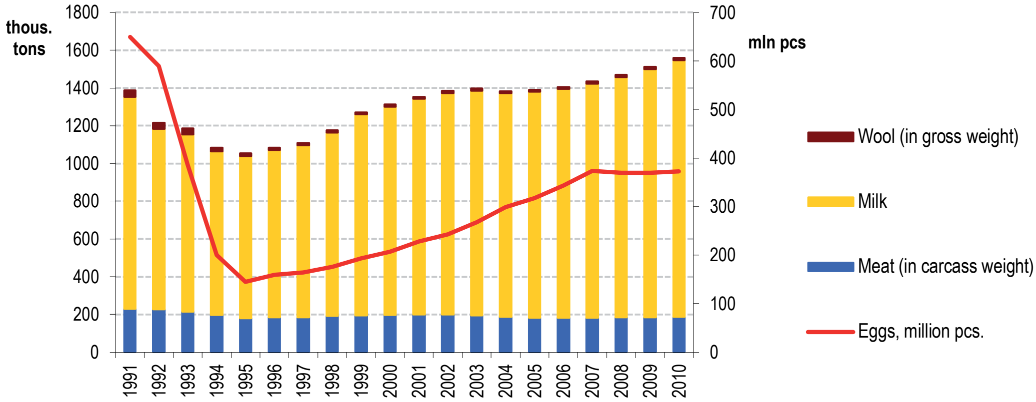


Figure 1.29. Output of major livestock products for 1991-2010.Source: NSC

In the overall agricultural production structure, the dominant contribution comes from the private manufacturers: farm enterprises – 61.5%, and private farms (households) – 36%. The contribution of farm enterprises is dominant in the crop production, whereas the contribution of private farms is prevalent in the livestock production (Figure 1.30).

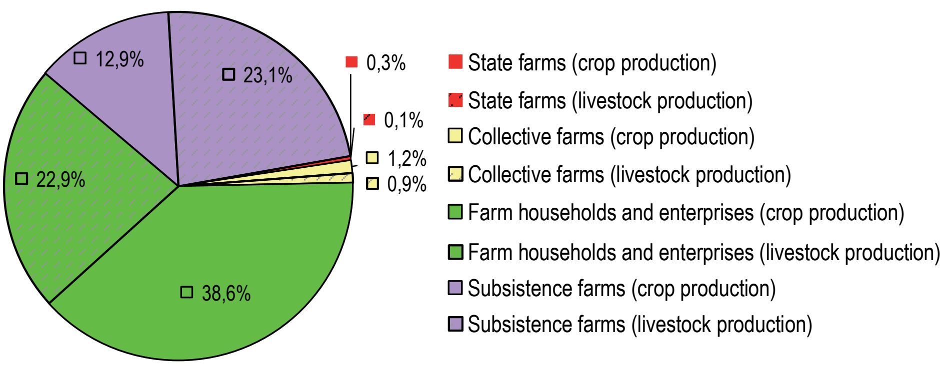


Figure 1.30. Contribution of various categories of farms to the agricultural output in 2010. Source: NSC

1.3.3. Food Supply

Since 1990 to 2000, a sharp drop in the consumption of livestock products (dairy products, meat and poultry, eggs) took place. In the other groups (potato, vegetables, fruits) a decrease in consumption was insignificant. The consumption of bread and cereal products remained stable for the whole period under consideration. The consumption of vegetable oil and other edible fats shows a small yet steady growth from1993-1994.

Figure 1.31 shows the average food consumption per capita in the KR in 1990-2010.

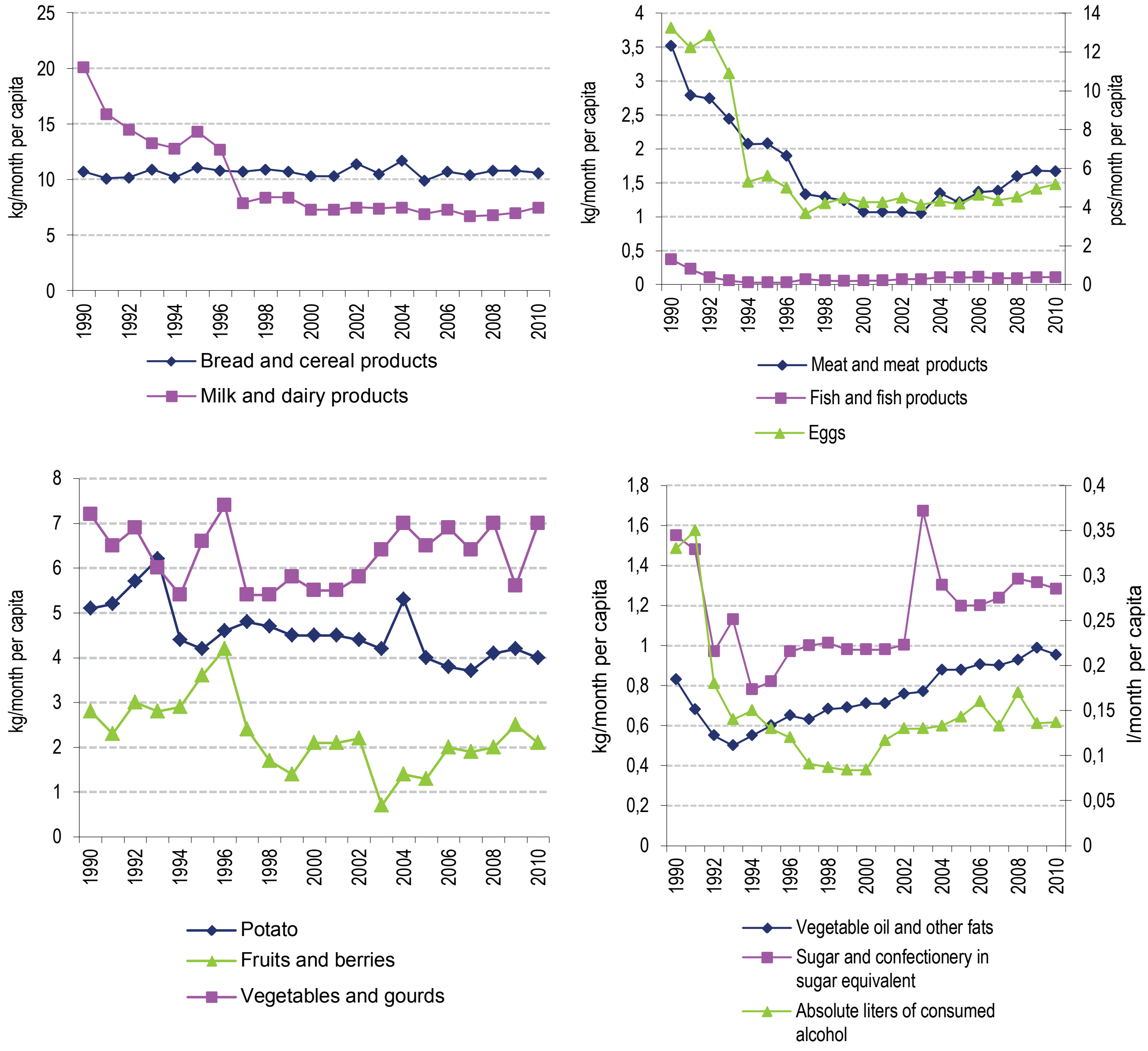


Figure 1.31. Consumption of major food groups per capita for 1990-2010.Source: NSC

In 2010, the average daily products consumption across the country (Figure 1.32) exceeded the minimum of WHO standard (2,100 kcal per day). However, in the regions such as Djalal-Abad (2,225.8 kcal per day) and Osh (2,210.8 kcal per day) the actual daily intake was lower than the officially recognized norm. The actual daily intake in the Naryn oblast (2,051.7 kcal per day) is lower than the minimum WHO standard.

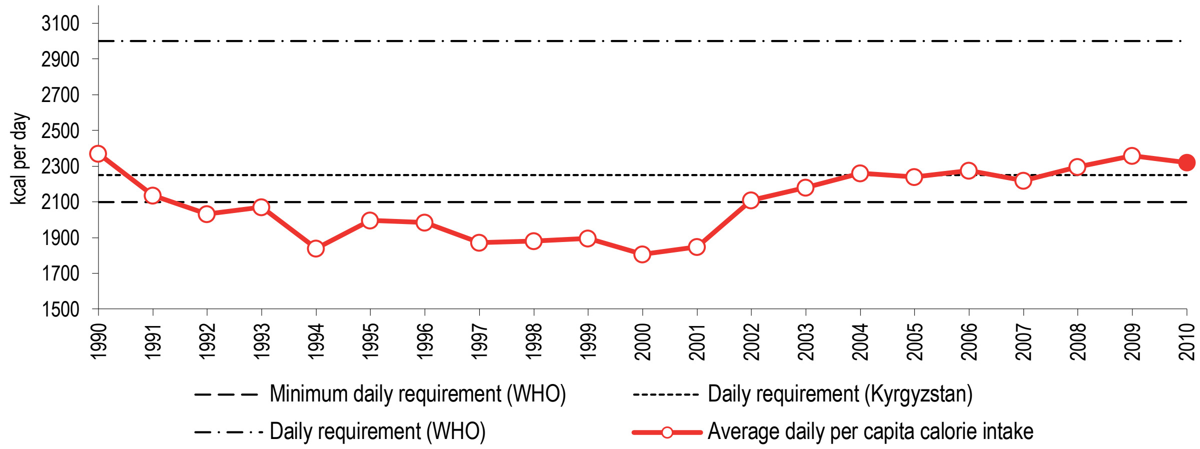


Figure 1.32. Changes in the calorie intake of the Kyrgyz population in 1990-2010. Source: NSC

1.3.4. Industry

Since 2005 to 2010, the total industrial output (in constant 2005 dollars) has increased from $2459,9 million to $3055,8 million. The industrial share in GDP has increased from 17.3% to 20.7%. Some redistribution of production volumes is observed between some branches.

Figure 1.33 provides the structure of industrial production in 2010.

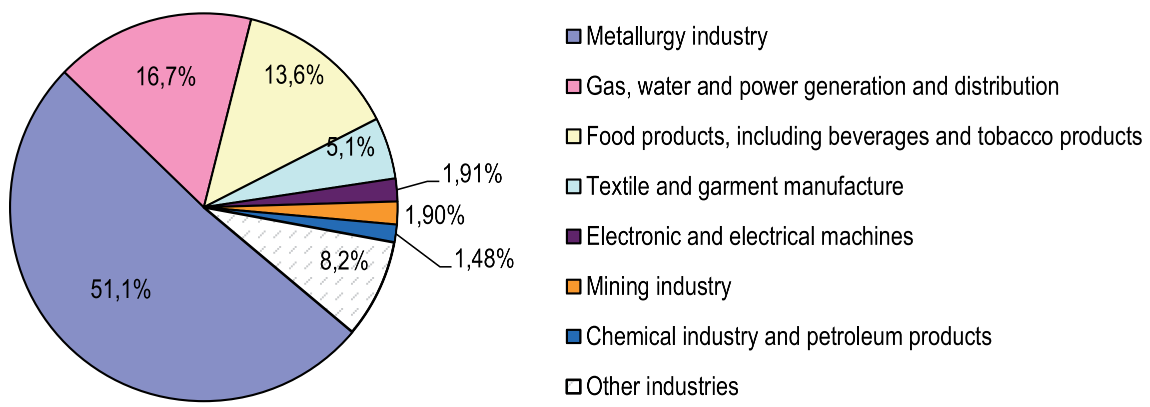


Figure 1.33. Structure of the manufacturing sector in the Kyrgyz Republic, 2010. Source: NSC

The share of the metallurgy industry increased from 38.4% to 51.1%, primarily due to the output of the gold mining and processing enterprise "Kumtor Operating Company". Shares of the energy sector and food industry fell insignificantly. The share of high-tech industries, such as machinery, electrical and electronic equipment, has dropped substantially, from 4.8% to 1.9%, and is now below 5% of the gross industrial output.

1.3.5. Transport

The physiographic (mountainous terrain, lack of navigable rivers) and economic (underdevelopment and relatively high cost of air transport) conditions of the Kyrgyz Republic determine the dominant role of road transport in domestic traffic. The scale of freight carried by water transport on the Issyk-Kul Lake is negligible. The situation in the structure of external transport has not changed since 2005. The main volume of northbound shipments (EEC, Europe) is carried by rail, whereas shipments in the south-east direction (China) are mostly made by road. Air transport plays an important role only in the passenger transportation.

The total length of the railways is 423.9 km. Most of them are located in the Chui region connecting KR with Kazakhstan. There are some short railway lines in the Osh, Djalal-Abad and Batken oblasts.

Pipeline transport consists of the main gas pipelines Bukhara – Tashkent – Bishkek – Almaty and Mailu-Suu – Djalal-Abad – Kara-Suu – Osh and the local gas distribution network.

Figures 1.34 and 1.35 show the dynamics of freight and passenger turnover. They do not include the private vehicles due to lack of statistics data.

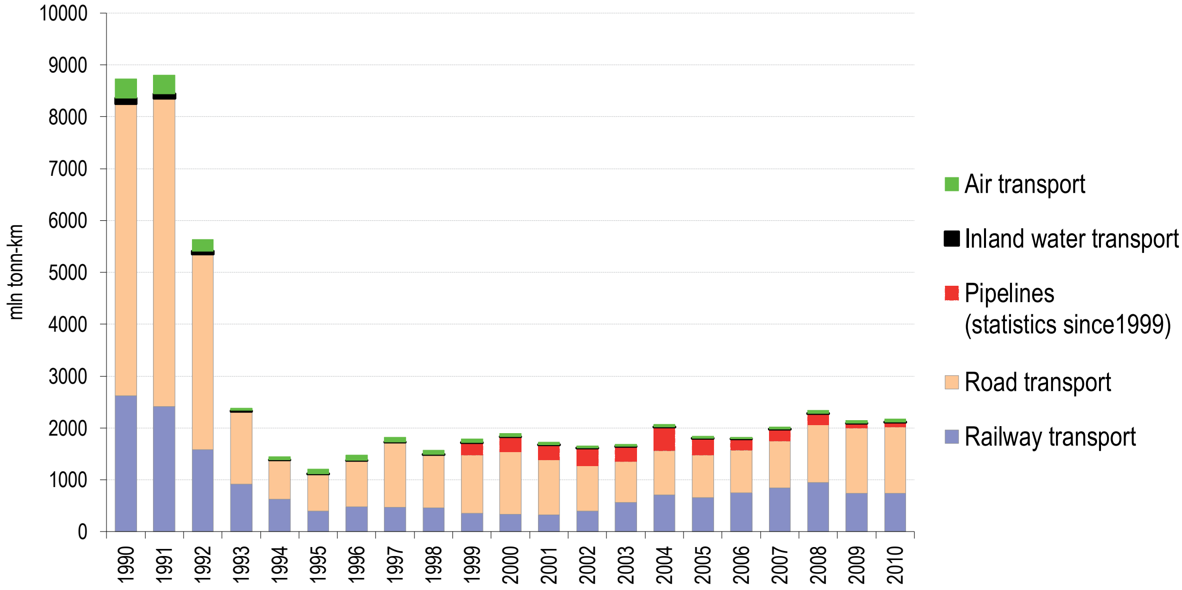


Figure 1.34. Dynamics of freight turnover for 1990-2010, by type of transport. Source: NSC

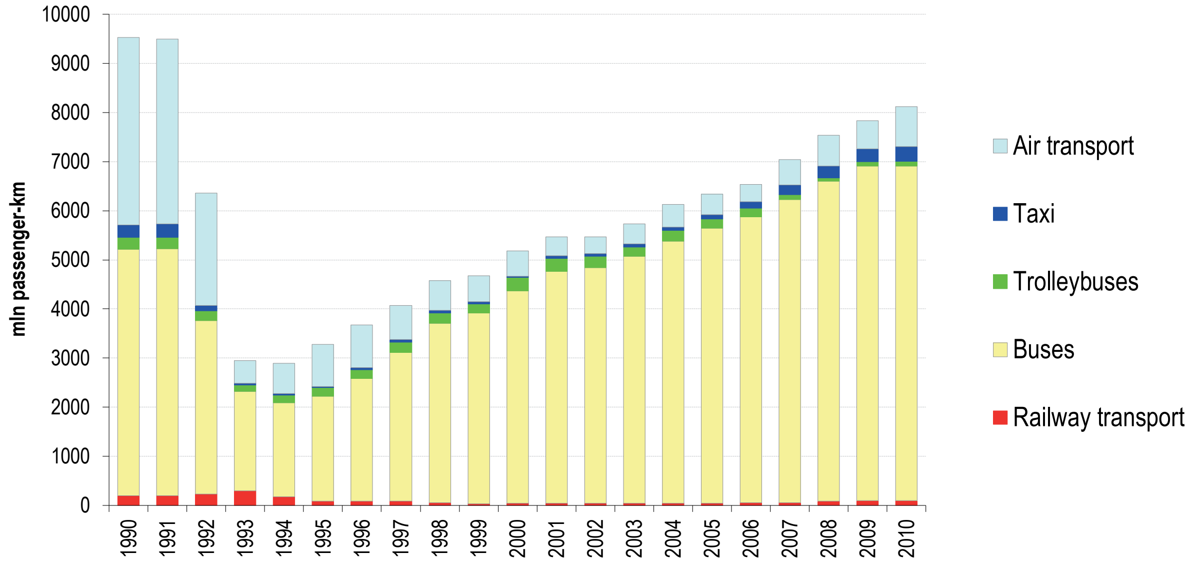


Figure 1.35. Dynamics of passenger traffic in 2010. Source: NSC

The Chui oblast and Bishkek city share in the total freight turnover increased from 46% (in 2005) to 56% (in 2010), whereas the passenger traffic over the same period changed negligibly (Figure 1.36).

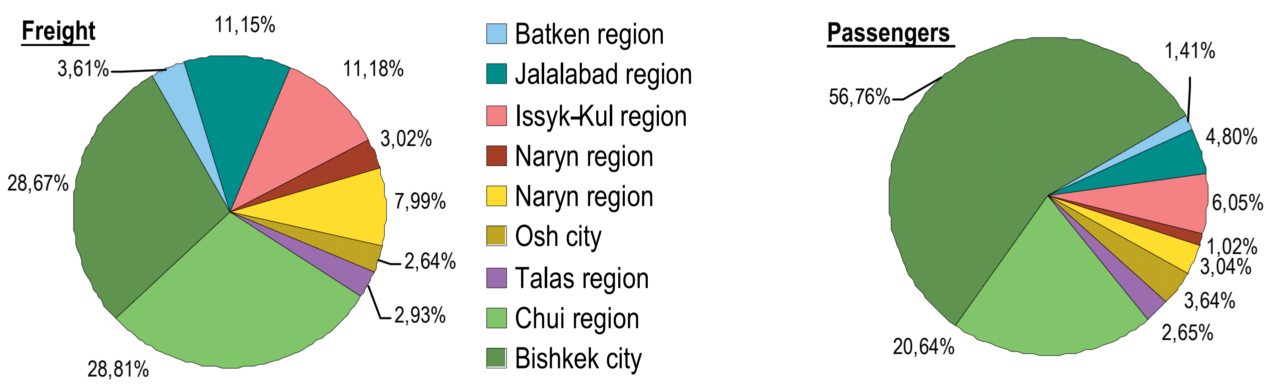


Figure 1.36. Distribution of the inland road freight and passengers transportation in the administrative areas in 2010. Source: NSC

2 Inventory of anthropogenic emissions from sources and removal of greenhouse gases by sinks

2.1. Background

2.1.1. Methodology

Methodologies for the assessment of GHG emissions and removals, quality assurance procedures and quality control, as well as for quantifying the inventory uncertainties were selected based on the following guidance:

- Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories
- Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories
- Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003.

Besides, this document used the national regulatory guidance documents on inventory, specific emissions calculation, resources and outcomes of previous studies, obtained under the national communications processes, as well as the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and other sources, such as 2013 EMEP/EEA guidebook on air pollutant emission inventory.

2.1.2. Legal and institutional framework

The inventory legal framework is provided by the KR Government Resolution "On Implementing Measures of the UN Framework Convention on Climate Change" and the Law "On the State Regulation and Policy on Greenhouse Gas Emissions and Removals".

In line with the Government of the Kyrgyz Republic Decree #783 (of November 21, 2012), the Coordination Commission on Climate Change is the chief governing body in charge to fulfill all national commitments under the UNFCCC, including GHG inventory preparation. The permanent working body of the CCCC is the SAEPF tasked to provide organizational, technical, informational and analytical support to the Coordination Commission, as well as monitoring on the implementation of its decisions.

2.1.3. The roles of the participating organizations

The general supervision of the GHG inventory preparation was carried out by the SAEPF. The Climate Change Centre was directly involved with a technical support for the CCCC working body and implementation of the inventory. The main input data for the inventory was submitted by the following organizations:

- National Statistics Committee;
- Ministry of Energy and Industry of the KR;
- Ministry of Agriculture and Land Reclamation of the KR;
- State Agency for Environment Protection and Forestry under the Government of the KR;
- Kyrgyz National Agrarian University named after acad. K.I.Skryabin;
- State Land Management Institute "Kyrgyzgiprozem" under the Ministry of Agriculture and Land Reclamation of the KR;
- State Registration Service under the Government of the KR;
- Rural Consultation Service of the KR, and others.

In case of lack or unavailability of national data, the international databases (UN FAO, World Bank and others) were used. The methodologies, basics, information sources used and the inventory developments were discussed at the regular meetings with a participation of the representatives from all relevant ministries and agencies, educational and research institutions, NGOs and business sector. In case of gaps in the input data, interpolated data was used, which algorithms are described in the relevant sections.

The information used consists of three key groups:

- Activities data, mainly refers to volumes of fuel consumed and to volumes of products manufactured;
- GHG emission and sinks coefficients for GHGs and precursors;
- Indicators specific to each GHG source and sink, such as a morphological composition of waste, etc.

The activity data is based on the public and/or sectorial statistics, as well as the enterprises' reports. The indicators of this group are contained in the officially issued sources or collected at the request of the ministries, departments and organizations.

The following were used as emission factors:
- IPCC Guidelines factors;
- Other international guides factors, e.g. "EMEP/EEA Air Pollutant Emission Inventory Guidebook" 2013 (Industrial processes sector);
- Factors used in the national inventory system and pollutants regulation, or those obtained by the previous studies (Industrial Processes and LULUCF sectors).

Specific indicators were assumed according to the IPCC Guidelines, national data available or calculated by means of proxy indicators using the scientific research outputs. When no other options were available, indices were determined by the expert assessment.

2.1.4. Time frame

The inventory covers the period from 2006 to 2010, with time series for 1990-2005 re-estimated. Re-estimate was stipulated by the following reasons:
- Updating of the earlier published baseline data for the previous periods, which is a common practice for a number of organizations, e.g. the NSC;
- Changes in the initial calculations assumptions accepted during the GHG inventory start-up discussions, such as:
  - For coals the aggregated emission factors with two gradations (coal and lignite) should be used. Actually, the country has also used anthracite, but its volume is insignificant (under 1% in 2010) and not taken into account by the statistics bodies;
  - The source categories recommended by the IPCC Guidelines should be used in the inventory. This data is available in the country. The task led to the categories increase in the energy sector, as compared to the previous inventory;
  - For the emissions calculation, a need to preferably use the officially issued baseline data, even in case of significant discrepancies with informal assessments, e.g. for auto vehicle fuel;
  - For the emissions and sinks calculation in land use, land-use change and forestry to use the developments of the National Forest Inventory 2010;
- Need to check the previous calculations and provide the results' comparability in case of changes to the accounting system and calculations methodology.

2.1.5. Coverage

The inventory included the following greenhouse gases:
- carbon dioxide (CO_2);
- methane (CH_4);
- nitrous oxide (N_2O);
- hydrofluorocarbons (HFCs);
- perfluorocarbons (PFCs);
- sulfur hexafluoride (SF_6).

and the following precursor gases:
- carbon monoxide (CO);
- nitrogen oxides (NOx);
- non-methane volatile organic compounds (NMVOCs);
- sulfur dioxide (SO_2).

The initial data analysis defined that basically there are no PFCs and SF6 emission in the country, and they were not further considered.

To convert GHG emissions into carbon dioxide equivalent (CO_2-eq.) the global warming potentials given in the 1995 IPCC AR were used.

GHG	Formula	GHG for 100 year period
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
Hydrofluorocarbons HFCs -134a	CH_2FCF_3	1300

Table 2.1. Global Warming Potential of GHG used

The inventory was carried out both at the national level and for the following basic administrative units:

- Batken oblast (official statistics are available since 1999 when it was formed);
- Djalal-Abad oblast;
- Issyk-Kul oblast;
- Naryn oblast;
- Osh oblast;
- Talas oblast;
- Chui oblast;
- Bishkek city;
- Osh city (official statistics available since 2000).

The inventory covers the following sectors and source categories:

1 Energy

1A Fuel combustion
1A1 Power generation
1A2 Industry and construction
1A3 Transport
1A3a Civil aviation
1A3b Road transport
1A3c Railways
1A3d Water transport
1A4 Other sectors
1A4a Commercial/institutional
1A4b Residential
1A4c Agriculture
1B Fuel fugitive emissions
1B1 Solid fuel
1B2 Oil and nature gas
1B2a Oil
1B2b Nature gas

2 Industrial processes

2A Mineral substances
2B Chemical industry
2C Metal production
2D Other productions (food and drinks)
2F Consumption of halocarbons and sulfur hexafluoride
2G Blasting

3 Solvent use

4 Agriculture

4A Enteric fermentation
4B Manure storage systems
4C Rice cultivation
4D Agricultural soils
4F Field burning of agricultural residues

5 Land use, land use change and forestry (LULUCF)

5A Woody biomass stocks
5B Soil emission and sink

6 Waste

6A Disposal of solid waste
6B Wastewater

6B1 Industrial water
6B2 Domestic and commercial water

7 Information

7A International bunker (Aviation)
7B Biomass CO_2 emissions

2.1.6. Quality assurance and quality control

Quality assurance and quality control was carried out in several stages.

The first stage verified the completeness, comparability and reliability of the baseline data. This was tested directly by the implementers, and then the test results were submitted to the inventory group team leader for re-checking.

At the second stage the inventory team leader checked the appropriate application of emission and sinks factors, as well as the selected calculation methodology.

The third stage was dedicated to verifying the calculation outcomes, which was primarily done by the experts and then by the team leader.

Finally, the baseline data and the results obtained were discussed at the workshops involving the independent experts from the specific sectors. Besides, analysis of the baseline data and results obtained was carried out at the regularly held working meetings of the inventory team.

The main elements of verification were

- monitoring of the time series with an analysis of any strong changes in a nature of the time series;
- comparing of the results obtained with the preceding inventories, with the international data (mainly, the International Energy Agency) and the results of the other countries' inventories, particularly in the Central Asian region.

2.2. Emission trends

2.2.1. General trends

The results for 1990-2010 time series are presented in the inventory. In accordance with the accepted scope of source categories, the data is given in table format in metric units (Gg) in Appendix 1 and in Gg CO_2-eq. in Appendix 2.

The total GHG emissions in 2010, accounting net emissions in the LULUCF sector, was 13,046 Gg CO_2-eq. compared to 28,712 Gg CO_2-eq. in 1990, i.e. it reduced more than by half.

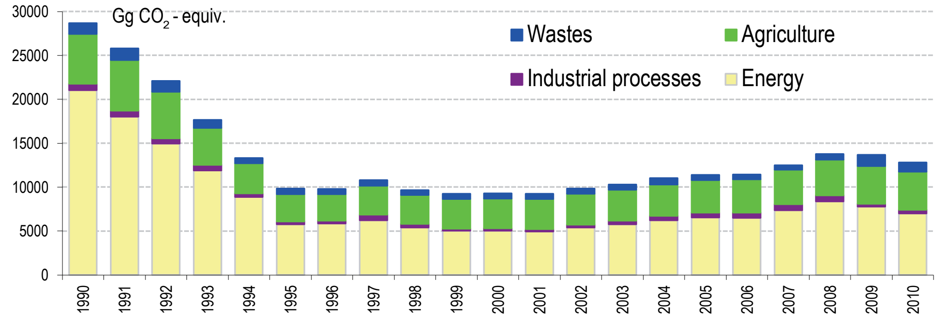


Fig. 2.1. Change in the total GHG emission for 1990-2010 by key source category. The following sectors are not given: Solvents due to lack of emissions, and LULUCF due to insignificant GHG net emission.

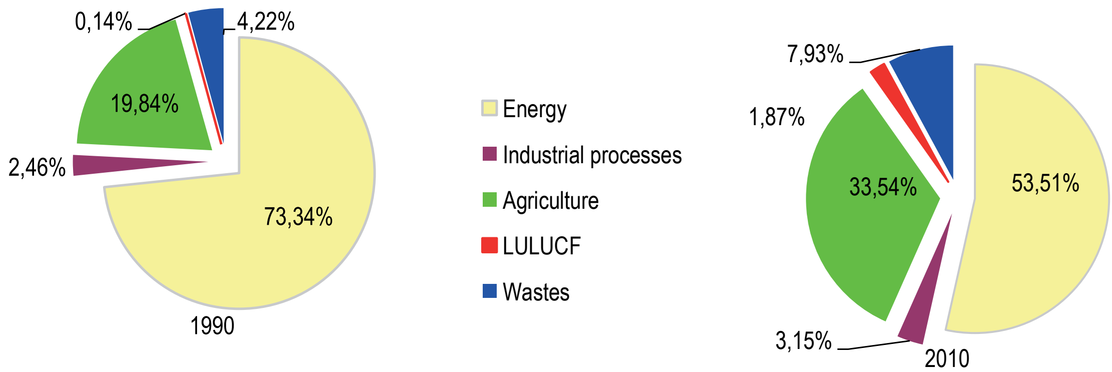


Fig. 2.2. Comparative distribution of GHG emissions in the key sectors in 1990 and 2010. The share of net emissions is shown for the LULUCF sector.

After a drastic fall from 1990 to 1995, the total GHG emissions increased slowly. But even in 2008-2010 it was significantly less than in 1990, to some extent reflecting the trends in the macroeconomic indicators, as well as changes in the economic shape. The total GHG emission in 2010 was only 45.4% of the emission in 1990. The emission reduction by sector in 2010 as compared with 1990 level was as follows:

- «Energy» – 66,8%;
- «Industrial processes» – 41,8%;
- «Agriculture» – 23,1%;
- «Waste» – 14,6%.

Despite the fact that the share of the energy sector in the total emission decreased most notably (from 73% in 1990 to 54% in 2010), still in 2010 the biggest emission was observed in this sector - 6981 Gg CO_2-eq. (53.5%), followed by Agriculture - 4376 Gg CO_2-eq. (33.5%), Waste - 1034 Gg CO_2-eq. (7.9%), and Industrial Processes - 411 Gg CO_2-eq (3.2%). The comparative distribution of GHG emission by sector in 1990 and 2010 is shown in Fig. 2.2. The absorption in the LULUCF sector is about 800 Gg CO_2-eq., but soils emissions are also significant that determines the net emission of the LULUCF sector very small as a whole.

In general, the inventory has shown a significant reduction in total GHG emission compared to the previous inventory, mainly due to the transport sector. It especially refers to the period from 1990 to 2000. Such a decline is explained by the approach to preferably use official information. Previously, the assessments in the transport sector used expert estimations of illegally imported and produced motor fuel in the country. However, these estimates have considerable uncertainty as a natural result of personalism. It was, therefore, decided in case of discrepancies between the official and expert estimates to use the official one and recalculate the total emission.

In the context of GHG emissions reducing relating to1990, it is worth noting the significant change in the emissions structure, which is explained by the lowest emissions reduction from agriculture and waste management. It resulted in a significant increase in the emissions share in these sectors.

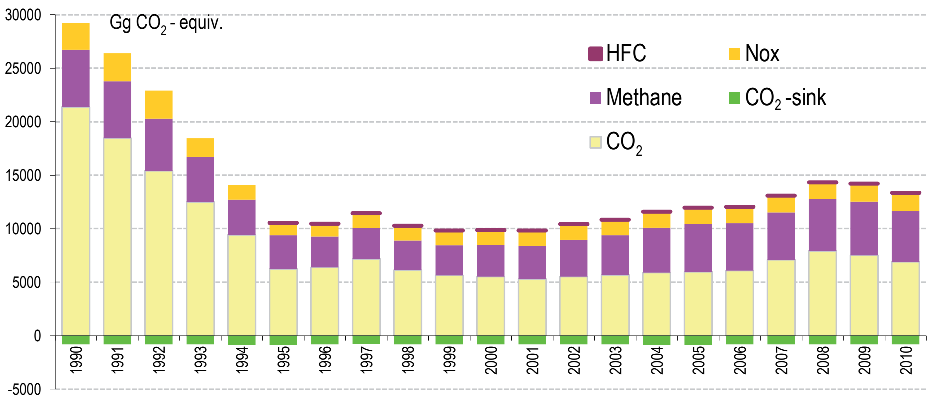


Fig. 2.3. Change in global GHG emissions by gases. CO_2 emissions include LULUCF sector emissions.

In 2010 carbon dioxide emission was 6922 Gg CO_2-eq. (51.8%), methane - 4713 Gg CO_2-eq. (35.3%), nitrous oxide -16991 Gg CO_2-eq. (12.7%), and HFC-134a - 28 Gg CO_2-eq. (0.2%). Carbon dioxide removal in 2010 was 804 Gg, and emission from soil - 558 Gg CO_2-eq. There were no perfluorocarbons and sulfur hexafluoride emissions.

All GHGs emissions, except HFC-134a, decreased in 2010 relative to 1990. The greatest decrease (almost 3 times) happened to carbon dioxide, which reflected a significant decrease in the energy sector contribution. The use of HFC-134a in refrigerating equipment has developed only in the last decade. Earlier, mainly the ozone-depleting substances were used in this sector.

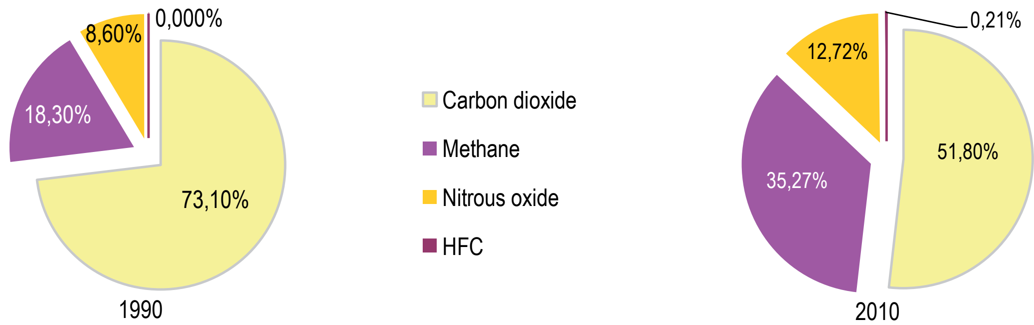


Fig. 2.4. Comparative distribution of GHG emissions in 1990 and 2010.

Along with the overall decrease in emissions, the emissions structure in 2010 significantly changed compared to 1990.The share of carbon dioxide emission decreased from 2/3 to less than half of the total emission. In a result, a share of the other gases emissions has increased, despite their absolute reduction.

To assess the country's input to global emissions and compare with the other countries, the specific GHG emission per capita have been estimated. As shown in Fig. 2.5, specific emissions have fallen sharply since 1990 and recently only a slight growth tendency is seen at a fairly low level, slightly over 2 tons/person. In comparison, in 2011 in Kazakhstan the GHG emission per capita equated over 16.7 t/person.

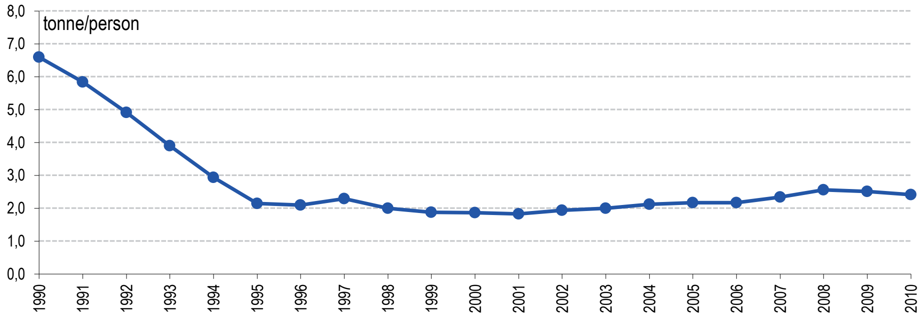


Fig. 2.5. Trends in specific GHG emissions per capita

Additionally, two indicators are used for comparison with other countries - emissions in kg CO_2–eq. per $1,000 GDP and specific GHG emissions per unit of consumed primary fuel resources. To ensure comparability of different years, $1,000 of GDP is used in $2005 (constant dollars). In terms of GDP, both the absolute values and values based on purchasing power parity have been used. It significantly alters the specific assessment for the developing countries by taking into account the differing price levels in different countries and allows for a valid comparison of indicators for the countries with different economic development levels. The corresponding figures for other countries are regularly published by the International Energy Agency (on emissions from the fossil fuels burning).

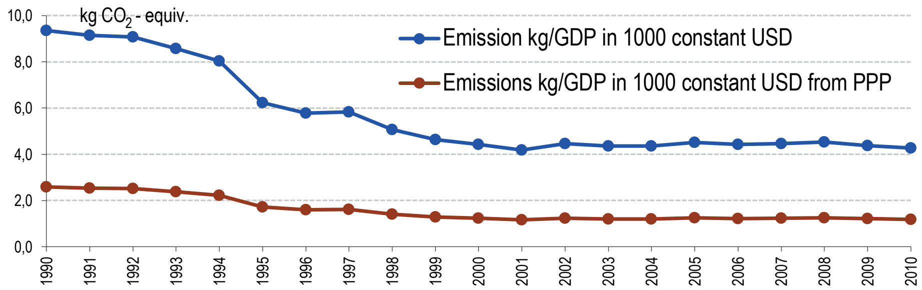


Fig. 2.6. Trends in changes of specific GHG emissions in kg CO_2-eq. per $1,000 GDP (GDP re the World Bank)

Fig. 2.7. Trend in specific GHG emission. The calculation was made only for those years when the Fuel and Energy Balance was officially published.

If the trends in the specific GHG emission per capita and per GDP unit can still be considered acceptable in line with the sustainable development objectives (although, certainly, a gradual reduction of this parameter is more desirable), then the specific emissions by 1toe of primary fuel resources has a negative growth trend. This trend is most likely due to the outdated equipment used in the energy sector without timely renewals under a relatively small increase in GDP. Actually, Fig. 2.7 reflects a negative trend of fuel resources efficiency for 1990-2010.

Figs. 2.8-2.18 show the emission trends structure by sector, and the comparative distribution of GHG and precursor gases emissions in 1990 and 2010. For each substance, only those sectors are shown that produce emissions of the gases under review.

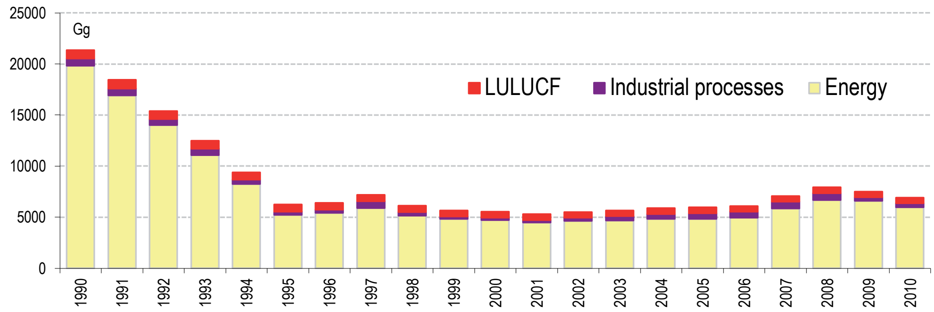


Fig. 2.8. Trends in the structure of carbon dioxide emissions (no emissions in other sectors).

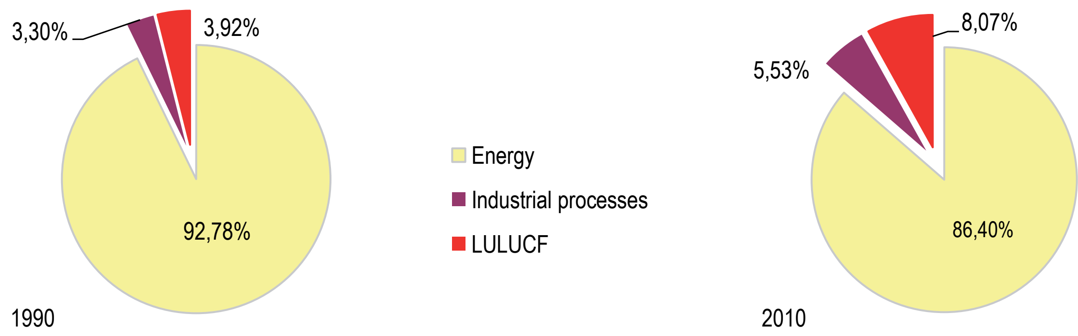


Fig. 2.9. The comparative distribution of carbon dioxide emissions in 1990 and 2010.

Carbon dioxide emissions occur in three sectors: energy, industrial processes and LULUCF. In 1990-2010 carbon dioxide was characterized by the relatively highest emission reductions among all the greenhouse gases connected with the changes in the country's economy and a significant decrease in the fossil fuels use. Carbon dioxide emission was the highest in 1990 at 21 369 Gg, by 2001 it reached a minimum of 5298 Gg, and in 2010 increased slightly to 6922 Gg. Some increase of CO_2 emissions by selected sectors is associated with a slightly smaller emission reduction compared to the energy sector. From 1990 to 2010, the absolute values of carbon dioxide emissions decreased in the energy sector from 19825 to 5980 Gg, in the industrial processes sector - from 706 to 383 Gg, and in LULUCF - from 837 to 558 Gg.

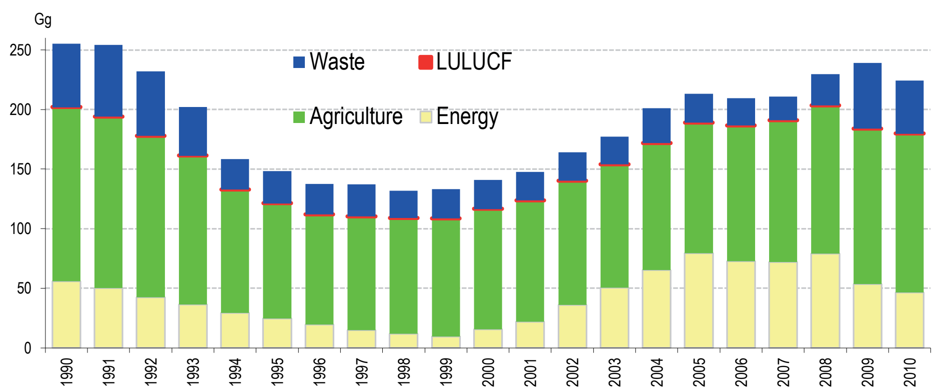


Fig. 2.10. Trends in the structure of methane emissions (no emissions in other sectors).

Methane emission takes place in four sectors - energy, agriculture, LULUCF and waste. After a reduction of the total methane emissions during 1990-1998 from 255 to 132 Gg further, contrary to the GHG emission general trend, it increased steadily and almost returned to the 1990 level (in 2010 it amounted to 224 Gg). This unexpected result is due to the relatively small reduction in the agriculture sector's activity (in 1990 it was 146 Gg, and in 2010 - 133 Gg) and in the waste sector (in 1990 it was 53 Gg, and in 2010 - 45 Gg), as well as a slight decrease in emissions in the energy sector (in 1990 it was 56 Gg, and in 2010 - 47 Gg). The reasons for an unexpectedly small emissions reduction in the energy sector, with a significant reduction of activities, will be considered further under the sector analysis. As a result, as shown in Fig. 2.11, a methane emission distribution among sectors in 2010 remained almost unchanged relative to 1990.

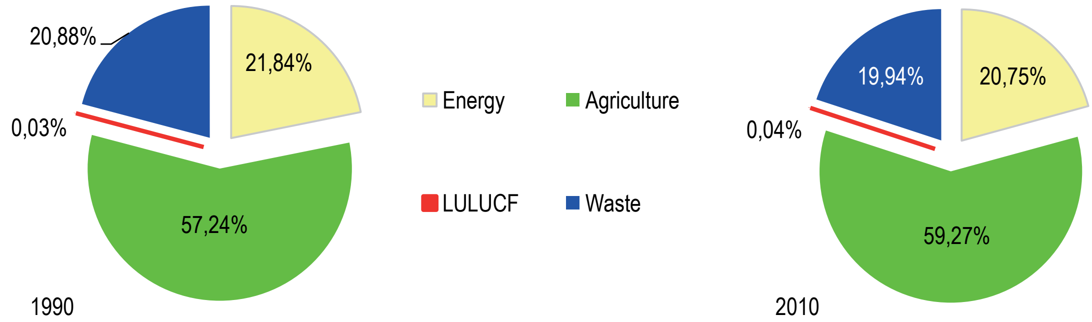


Fig. 2.11. The comparative distribution of methane emissions in 1990 and 2010.

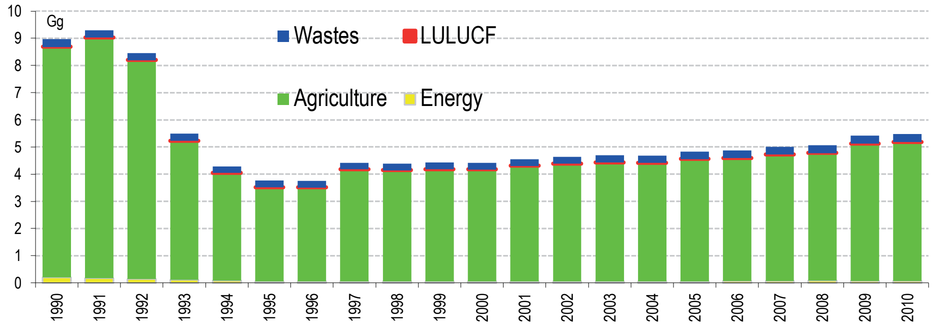


Fig. 2.12. Trends in the structure of nitrous oxide emissions (no emissions in other sectors).

Fig. 2.13. The comparative distribution of nitrous oxide emissions in 1990 and 2010.

Emission of nitrous oxide occurs in four sectors - energy, agriculture, LULUCF and waste. In general, the nitrous oxide emissions decreased from 9.0 Gg in 1990 to 5.5 Gg in 2010. The energy sector's emissions decreased most significantly from 0.2 Gg in 1990 to 0.07 Gg in 2010. In the LULUCF and waste sectors emission increased slightly in 2010 compared with 1990 (LULUCF - Gg 0.0004 in 1990 to 0.0005 Gg in 2010, and in the waste sector - from 0.296 Gg in 1990 to 0.305 Gg in 2010). However, the contribution of these sectors to the total nitrous oxide emissions is insignificant. Given that the main contributor to nitrous oxide emissions is the agriculture sector at more than 90% (Fig. 2.13), the overall reduction of these emissions versus 1990 was less than, for example, carbon dioxide. This situation is due to the fact that the economic decline after 1990s affected least the agriculture sector. The emissions distribution by sector in 1990 and 2010 remains practically unchanged.

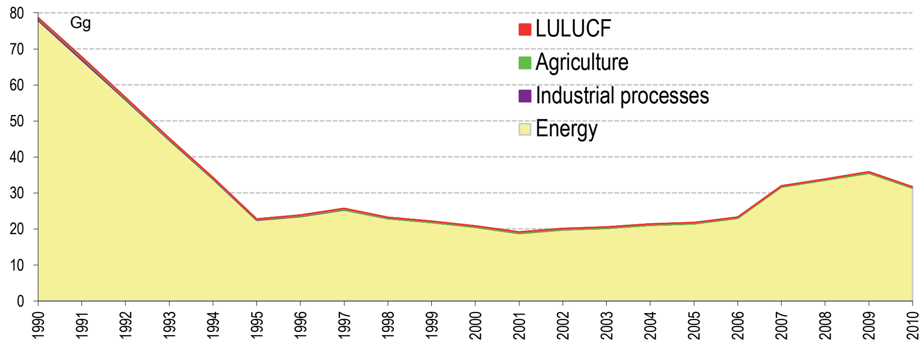


Fig. 2.14. Trends in the structure of nitrogen oxide emissions (no emissions in other sectors).

The emission of nitrogen oxides is observed in the following four sectors - energy, industrial process, agriculture and LULUCF. However, throughout the inventory period 1990-2010, more than 99% of nitrous oxide emissions are emitted by the energy sector. Therefore, the decreasing trend in the total emissions of nitrogen oxides (from 78.7 Gg in 1990 to 31.7 Gg in 2010) is largely determined by trends in the energy sector. A smaller reduction was observed in nitrogen oxide emissions in 2010 compared with 1990 (60%) and also compared to the same reduction in carbon dioxide emissions (70%), which is due to structural changes in the energy sector.

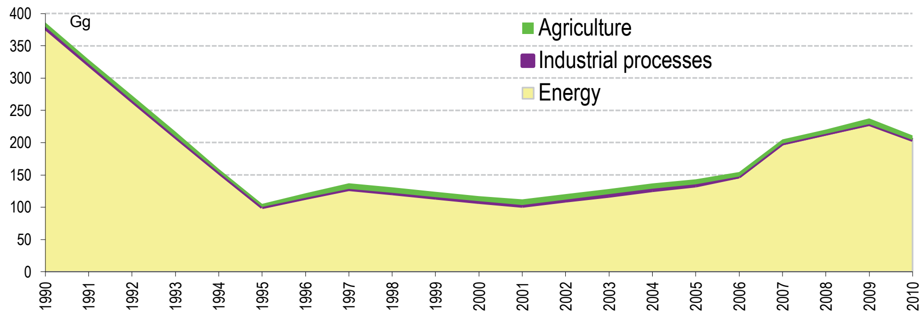


Fig. 2.15. Trends in the shape of carbon monoxide emissions (no emissions in other sectors)

Emissions of carbon monoxide are observed in three sectors - energy, industrial processes and agriculture. However, similar to nitrogen oxides, during 1990-2010 about 97% of carbon monoxide emissions came from the energy sector. Therefore, the decreasing trend in total emissions of carbon monoxide (from 386.3 Gg in 1990 to 211.2 Gg in 2010) is almost entirely determined by trends in the energy sector. A smaller reduction in emissions of carbon monoxide in 2010 compared with 1990 (46%) against the same reduction of carbon dioxide emissions is also due to structural changes in the energy sector.

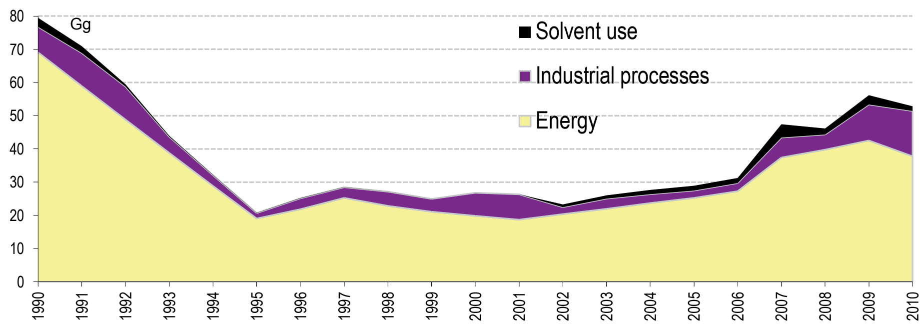


Fig. 2.16. Trends in the structure of NMVOC emissions (no emissions in other sectors)

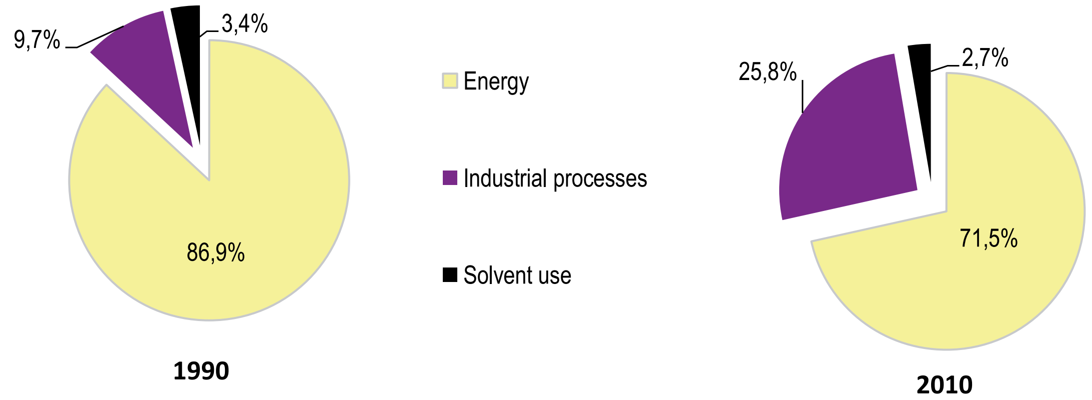


Fig. 2.17. The comparative distribution of NMVOC emissions in 1990 and 2010.

NMVOC emission arises in four sectors - energy, industrial processes, solvent use and agriculture. Unlike other precursor gas emissions, NMVOC is distributed more evenly across the sectors with some changes over time. The largest contributor to the total emission of NMVOC in 1990 and 2010 was the energy sector with 80% and 63% respectively. But the distribution of emissions vary greatly from year to year. For example, the input from the industrial processes sector was 22% in 2001, and from agriculture - 25%, while the energy sector was only 53%. Then by 2010, the input from the agriculture sector decreased to 11.8%. The total emission of NMVOC in 1990 amounted to 86.4 Gg. Following a reduction to 25.6 Gg in 1995, it consistently increased, reaching a maximum value of 65.1 Gg in 2009.

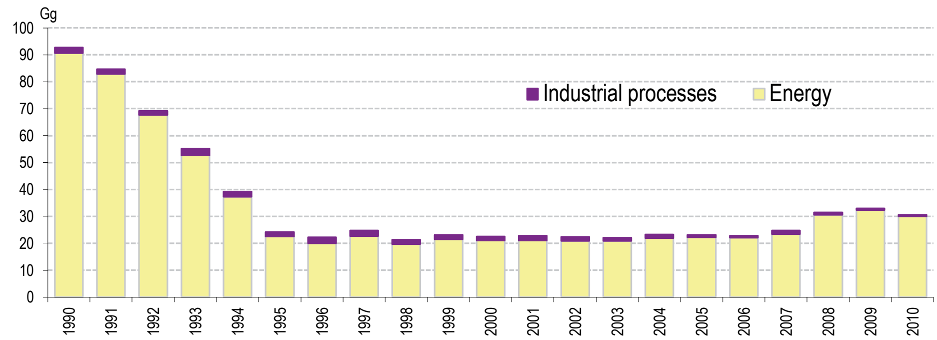


Fig. 2.18. Trends in the structure of sulfur dioxide emissions (no emissions in other sectors)

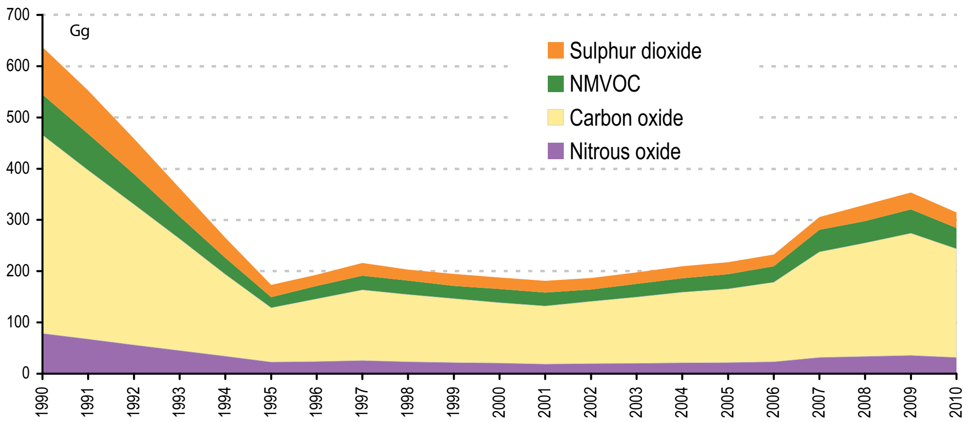


Fig. 2.19. General trends in the precursor gases emissions.

The emission of sulfur dioxide takes place in two sectors - energy and industrial processes, but the main emitter is the energy sector - from 97.8% in 1990 to 98.3% in 2010. For obvious reasons, trends in sulfur dioxide emissions almost completely follow the trends observed in carbon dioxide emissions. Total emissions of sulfur dioxide decreased almost three times, from 92.6 Gg in 1990 to 30.6 Gg in 2010. Emission cuts in the industrial processes sector were even more significant - from 2.02 Gg in 1990 to 0.52 Gg in 2010, almost 4 times.

As might be expected, precursor gases emissions (except NMVOCs) mainly occurred in the energy sector in a burning process of fossil fuels. Thus, it is clear that the trends for nitrogen oxides, carbon monoxide and sulfur dioxide emissions are almost identical to the carbon dioxide trend. The share of the energy sector for precursor gases ranges from 98.25 to 99.0% (except NMVOCs), varying slightly from year to year, therefore, graphical illustration of their distribution is not given.

In general, the precursor gases for the inventory period approximately halved from 637.4 Gg in 1990 to 314.8 Gg in 2010. The contribution of nitrogen oxides decreased from 12.3% in 1990 to 10.06% in 2010, carbon dioxide increased from 60.6% in 1990 to 67.2% in 2010, NMVOC increased slightly from 12.5% in 1990 to 13.0% in 2010, sulfur dioxide decreased from 14.5% in 1990 to 9.7% in 2010. The structural changes in emissions are due to changes in the structure of consumed fuel.

2.2.2. Energy sector

The energy sector accounts for the emission of all greenhouse and precursor gases resulting from combustion in stationary and mobile sources, and fugitive emissions from all fuels, regardless of the nature of use (energy and non-energy).

The sector includes the following source categories:

- 1A Fuel Combustion;
  - 1A1 Energy;
  - 1A2 Manufacturing industries and Construction;;
  - 1A3 Transport;
    - 1A3a Civil aviation;
    - 1A3b Road transport;
    - 1A3c Railroads;
    - 1A3d Water transport;
  - 1A4 Other sectors;
    - 1A4a Commercial/institutional;
    - 1A4b Residential;
    - 1A4c Agriculture;
- 1B Fugitive emissions from fuels;
  - 1B1 Solid fuels;
  - 1B2 Oil and natural gas;
    - 1B2a Oil;
    - 1B2b Natural gas.

2.2.2.1. Basic assumptions

The main source of basic information for the emissions calculation in the energy sector is the Fuel and Energy Balance, regularly issued by the NSC since 2005. The Fuel and Energy Balance was issued in 1990, 1995, 1997, 1999 and 2001. For other years the balance was not issued and emissions for the missing years were calculated based on interpolated data. Additional information, not reflected in the balance, was received from the relevant ministries and departments.

The Kyrgyz Republic consumes its own nationally produced coal, as well as imports from the Republic of Kazakhstan and the Russian Federation. According to the characteristics and volume of different types of coal of the Republic of Kazakhstan given in the publication [2.2], coals imported from Kazakhstan are sub bituminous and attributed to fossil fuels. According to the Ministry of Energy and Industry data, coal imported from the Russian Federation also belongs to sub bituminous fossil fuels.

In line with an average coal calorific value of the major fields determined in the directory [2.3], they belong to the stone or brown coals (lignite). For the baseline calculation of emissions, as well as sectoral approaches, data on the annual distribution of local coal as bituminous and brown was used. Local stone coal is further classified by its emission characteristics as sub-bituminous coals, and brown coals as lignite.

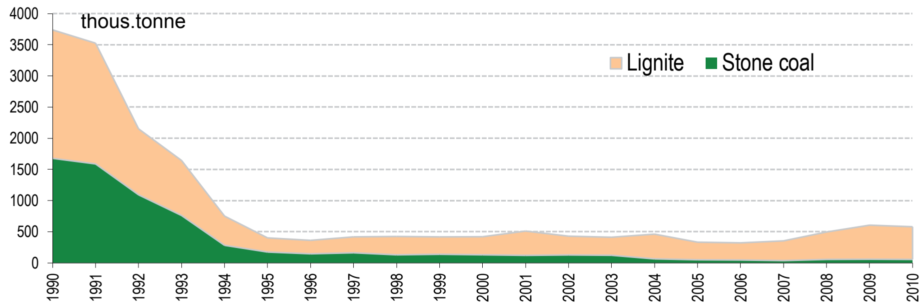


Fig. 2.20. Dynamics of change in the production of coal and lignite. Source: Ministry of Energy and Industry of the KR

The Fuel and Energy Balance provides information on the use of light distillates, whose technical characteristics, in accordance with Regalement 0272-016-00149452-2002, are further classified as naphtha.

For natural gas, traditionally measured in m^3, a conversion factor of 1 million M^3 = 33.70374 TJ is used, accounting the conversion factors used by the NSC. Of all types of burned agricultural residues, the cotton biomass residues are the largest quantities used. According to [2.4] a ratio of cotton dry biomass residues to its production is 1.2 - 3. For the calculations, an average value of 2.1 is taken. A proportion of cotton combustible residues averages are estimated about 62%.

Emission factors for methane, nitrous oxide, nitrogen oxides, carbon monoxide and non-methane volatile organic compounds were adopted from Tables 1-7 - 1-11 Chapter 1.4.2, 1996 IPCC.

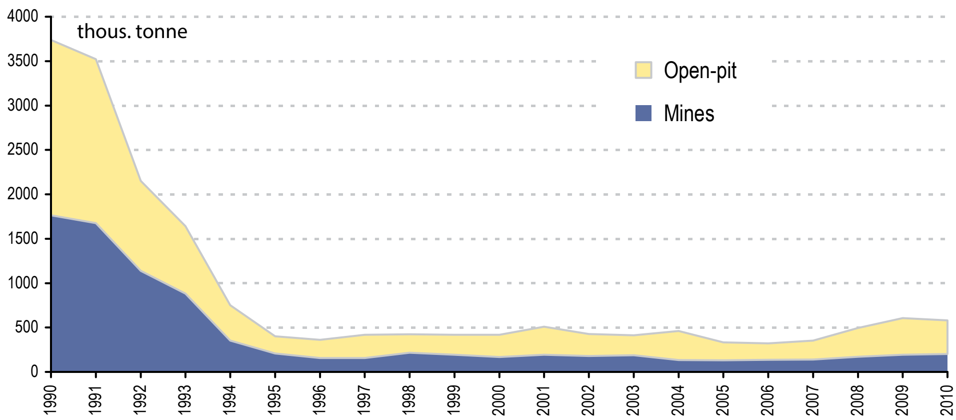


Fig. 2.21. Dynamics of change in underground and open-pit mining of coal. Source: Ministry of Energy and Industry of the KR

The coefficient for sulfur dioxide emission is defined by (Table 7):

$$EF = 2000 * s * (100 - r) * (100 - n), \text{ kg } SO_2/\text{tonne}$$

where s - is sulfur content in the fuel. The calculation of the sulfur content in local coal is based on an assessment of the average weight for the sulfur content by acting mining enterprises (Source: List of valid licenses for coal. The State Agency for Geology and Mineral Resources under the Government of the KR, 12/04/2013) based on information on selected mine fields in the directory [2.3];

r - sulfur content in ash. Adopted by the Revised Guidelines for the National Inventories, Greenhouse Gas Emissions, v.3, 1996 IPCC, for coal - 5%, for brown coal - 30%;

n - cleaning systems' effectiveness.

The official statistics items do not fully correspond to the sectors division given in the IPCC Guidelines. Therefore the emissions calculations used the contingent equivalents of fuel and energy balance issued by the NSC and the inventory sectors by the IPCC Guidelines (Table 2.2).

Table 2.2. Accordance of the IPCC Guidelines sectors and Fuel and Energy Balance articles

	IPCC Guidelines sector	Articles of Fuel and Energy Balance
1A	Fuel burning	
1A1	Energy production	Transformation to other types of energy
1A2	Industry and construction	Production of industrial product, construction, installation and drilling works
1A3	Transport	
1A3a	Air transport	Other types of transport
1A3b	Road transport	Auto cargo transport Auto passenger transport
1A3c	Railway	Cargo railway, passenger, highway and railway
1A3d	Water transport	Cargo water transport
1A4	Other sectors	
1A4a	Commercial and institutional sector	Municipal, cultural and domestic needs

	IPCC Guidelines sector	Articles of Fuel and Energy Balance
1A4b	Residential	Sale for population
1A4c	Agriculture	Agricultural works
1A5	Other	Other works and needs

Articles in the Fuel and Energy Balance are given as of the date of the balance issued in 2004. Before 2005 the balance was prepared in another format.

A more detailed breakdown of the sectors according to the IPCC Guidelines is impossible due to inconsistency between the Fuel and Energy Balance and international requirements.

Regarding other fuel types, the removal to other distribution articles was used, as the sectorial approach to fuel consumption, used by the national balance, does not correspond to the IPCC Guidelines breakdown by consumption types.

2.2.2.2. Trends in fossil fuel consumption

Overall trends in the fuel and energy resources consumption (except hydropower production, not considered as GHG emissions source) in the Kyrgyz Republic for the period since 1990 largely coincide with the trends in the main macroeconomic indicators. After a sharp drop in consumption with more than 20,000 TJ in 1990 to 5000 TJ in 1995, some stabilization is observed at this level (Fig. 2.22).

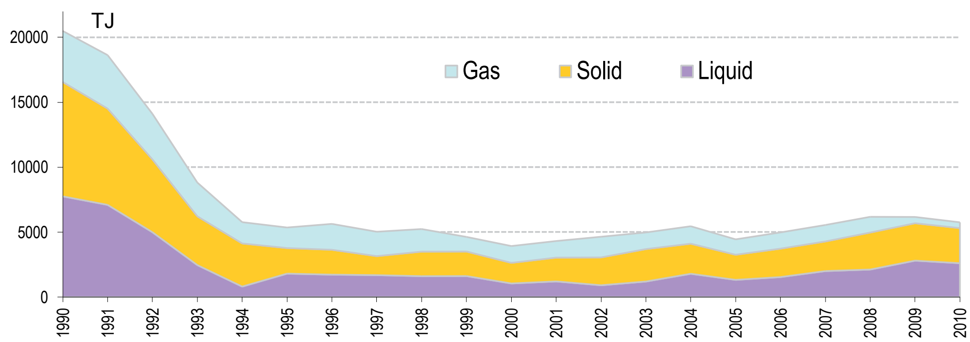


Fig. 2.22. The distribution of fossil fuel consumption by type. Source: NSC

The consumption trends are to some extent different for the various fuels. Natural gas consumption consistently fell throughout the period under review (1990-2010), while the consumption of solid and liquid fuels after a sharp fall before1995, it then increased slowly but steadily. In1990, the share of liquid and solid fuels and natural gas accounted for37.8%, 43.0% and 19.2%, respectively. In 2010, the shares accounted for 45.3%, 46.9% and 7.8%, respectively. A consumption of liquid and solid fuel in 2010, compared to 1990, decreased approximately 3 times, a consumption of natural gas decreased more than 8 times over the same period. It should also be noted that according to national experts, there is a significant probability that the actual consumption of liquid fuels after 1990 was slightly higher than the official data due to informal imports and production in the country. The greatest discrepancy is probably observed during 1990-2000.

Fig. 2.23. Changing availability of energy resources by main object of accounting. Source: NSC

Over the reporting period there have been significant changes in the energy resources availability (Fig. 2.23), which can be considered positive in terms of energy security. Against the general decline in the resources use, there was a significant decrease in imports due to an increase in domestical mining. The resource imports share decreased from 59% in 1990 to 31% in 2010. Import replacement was due to an increase in the domestic minng from 16% to 42%, and electricity production, which increased from 18% in 1990 to 31% in 2010.

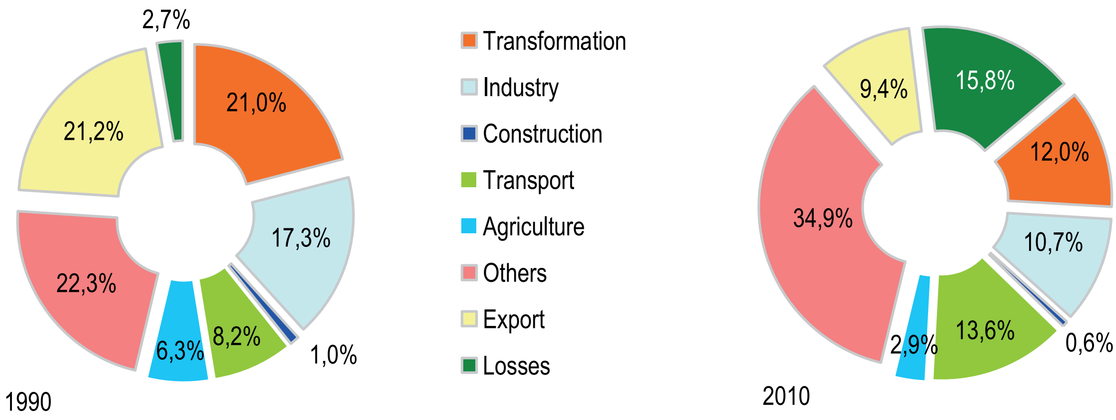


Fig. 2.24. Changes in the energy resources distribution. «Other» includes the resources cost for municipal, cultural and household needs, sale to population and others. Source: NSC

The distribution of energy resources also changed significantly (Fig. 2.24). Firstly, it is important to note a decrease in exports from 21% in 1990 to 9% in 2010, as well as an increase in the cost of public transport, cultural and household needs and sale to the population. A significant increase in losses from 3% in 1990 to 16% in 2010 is worth of attention. Figure 2.25 presents the trends in imports and the domestic production of the main fuel and energy resources, which actually reflects changes in a provision of the national energy security.

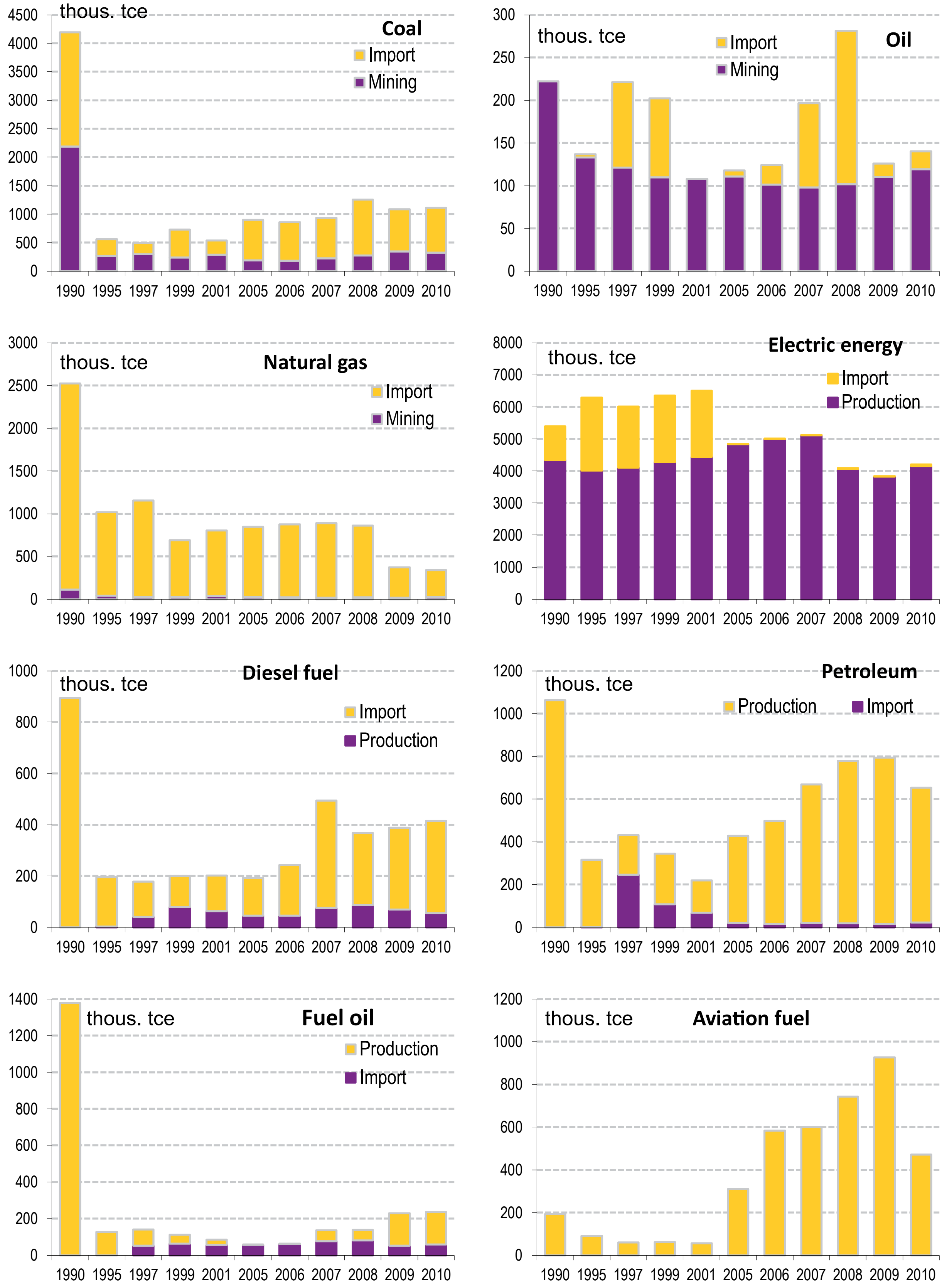


Fig. 2.25. Trends in imports and domestic production of the main fuel and energy resources (for aviation fuel given only import, because of no domestic production). Source: NSC

2.2.2.3. Basic approach

Assessment of CO_2 emissions in the baseline approach for 1990-2010 was carried out in line with the IPCC Guidelines. The main sources of GHG emissions in the baseline approach (Reference) are burning of (sub-bituminous) coal, lignite, coke, natural gas, liquefied natural gas, oil and oil products, and biomass. The determination of consumption by fuel type for the basic approach was performed based on the following data:

- the extraction volumes of primary fuels (production of secondary fuels is not considered);
- the imported volumes of primary and secondary fuels;
- the amount of exported primary and secondary fuels;
- the volume of international transport fuel (bunker);
- net changes in fuel stocks (difference between the fuel remnants at the end and beginning of a year).

The NSC accounts all these indicators in its regular reporting. However, regarding coal, there is no separate accounting by type (coal and lignite). Since 2005, separate accounting was conducted only for domestic and imported coal, without division by coal or lignite. As to the separate coal types, only fragmented departments' accounting is conducted.

The calculation by the baseline approach is not a necessary element of the inventory, as its results are not included in a summary table of GHG emissions and sinks. The basic approach is needed to verify the results and identify inaccuracies at the follow-up levels.

Firstly, the calculation results for the baseline approach serve as a basis for the assessment under a comparison with the International Energy Agency estimates for the Kyrgyz Republic (Fig. 2.26).These are carried out for the fossil fuel combustion sector which allows identifying the key differences in assessment methods. Since the fossil fuel sector is generally the largest part of total GHG emissions in the country, this verification can detect major deviations in the inventory, as a whole. In general, deviations are small, except for 1990-1995, which had a significant discrepancy. The reason is a lack of Fuel and Energy Balance over the years, demanding a use of linear interpolation for the missing data.

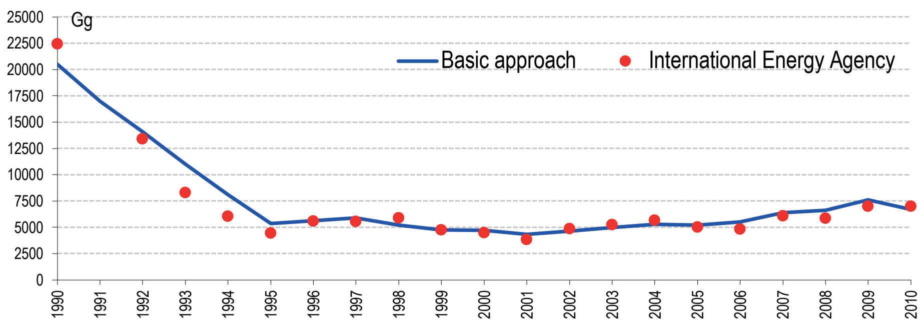


Fig. 2.26. CO_2 emission assessment results compared with the International Energy Agency assessment

Secondly, the results of the emissions assessment by the basic approach is a basis for verification when compared with the source category approach, which eliminates the inaccuracies associated with double counting or an underestimation for certain types of fuel combusted in the energy sector.

A comparison of the emission assessments by basic approach and by source category helped eliminate some inaccuracies and finally gave satisfactory results, an average error was about 4%.

2.2.2.4. Approach by source category

Based on the IPCC Guidelines (1996, 2000), an approach to source categories in the energy sector, as a data source for GHG emissions calculation for 1990-2010, was a distribution section of the fuel and energy balance, regularly issued by the NSC. The missing baseline data for 1991-1994, 1996, 1998, 2000 and 2002-2004 was restored by linear interpolation accounting the physical volume index of a relevant category of economic activity.

To assess GHG emissions by the source category approach the IPCC Tier 1 method was mainly used, with the default factors. The calculations utilized emission factors similar to those of the baseline approach. Emissions other than CO_2 emission from fuel combustion are also calculated by source category by Tier 1 and the default factors of the IPCC Guidelines.

GHG emission calculations for the source category approach are the data on the volume and type of fuel consumed by the types of economic activities in the country.

2.2.2.4.1. Energy sector as a whole

Trends in GHG emissions by individual source categories in the energy sector are shown in Fig. 2.27.

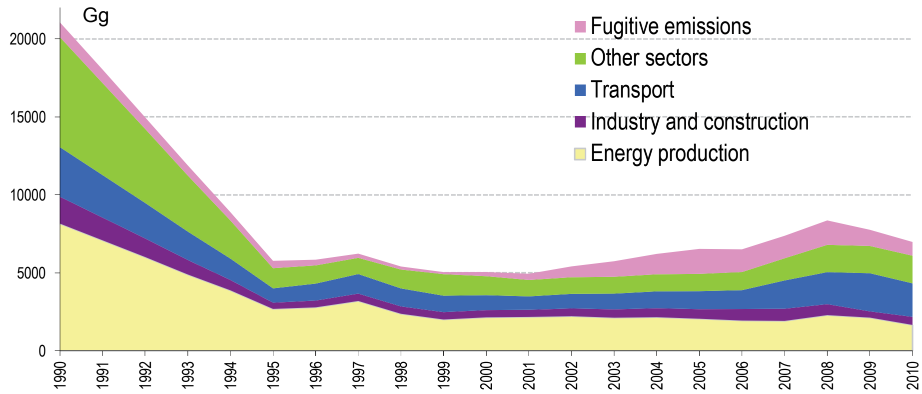


Fig. 2.27. General trends of GHG emissions in the energy sector

GHG emissions from energy sector in comparison to other sectors most dramatically decreased during the 1990 - 1995 followed by a slight increase, because this sector is a major consumer of fossil fuels, which is characterized by a sharp decrease in consumption (see Fig. 2.22). The total GHG emissions of the sector in 2010 amounted to 33.1% of 1990 emissions. Simultaneously, with emissions cuts, its distribution to individual source categories has significantly changed. The share of GHG emissions in the energy production category was 39% in 1990, then by 1997 had risen to 51%, finally decreasing consistently and reaching 21% by 2010. The share of emissions in the industry and construction category was 8% in 1990 and by 2000 had increased to 9%, decreasing to 6% by 2010. The share of emissions in the transport category steadily grew over the entire period under review, from 15% in 1990 to 38% in 2010. The share of emissions in the other sectors category in 1990 was 33.5%, and decreased to 16% in 1997, with a consequent increase in 2010 to 23%. Emissions by the fugitive emissions from fuels category in 1990 amounted to 4.5% of the total emissions and for a long time did not significantly change, but after 2000, there was a sharp increase and by 2005 emissions peaked at 24.5% before decreasing to 11% in 2010. As a result, in 2010 the transport category became the category with the highest emissions, whereas in 1990 the highest emissions were observed in the energy category.

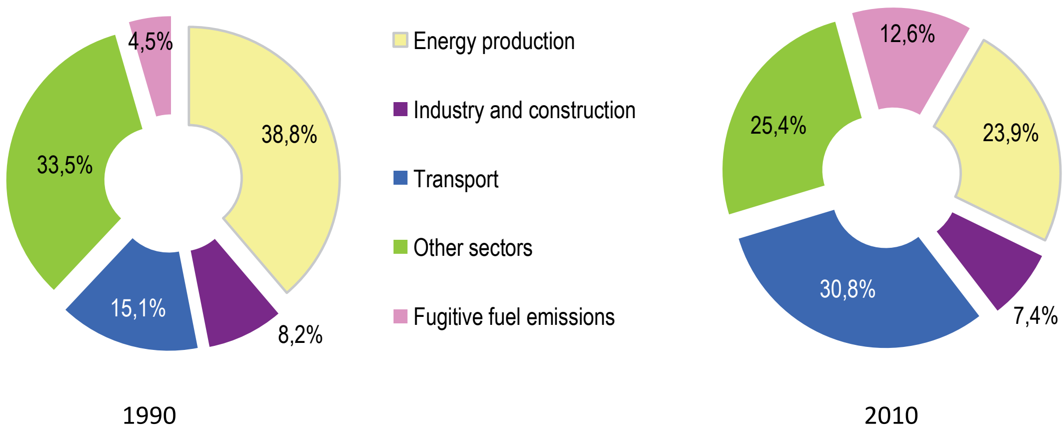


Fig. 2.28. Changes in GHG emissions distribution by sector, %

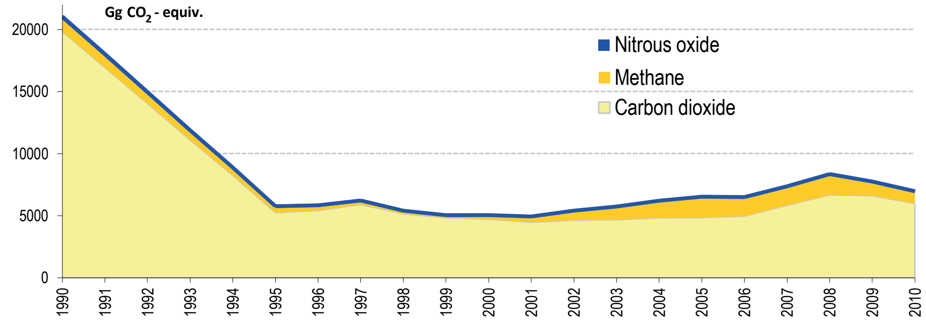


Fig. 2.29. Emissions trends by selected GHG in the Energy sector. Share of mono-nitrogen oxide emissions is hardly seen (less than 0.34%).

The three GHG emissions take place in the energy sector (Fig. 2.29), but the main emitter is carbon dioxide. With a decrease in absolute emissions of all GHGs, there were some changes in the distribution of the individual gases. The proportion of carbon dioxide emissions slightly decreased in the total emissions of the energy sector from 94.1% in 1990 to 85.7% in 2010. The share of methane emissions increased from 5.6% in 1990 to 25.5% in 2005, then decreased to 14.0% in 2010. Mono-nitrogen oxide emissions share increased from 0.29% in 1990 to 0.32% in 2010.

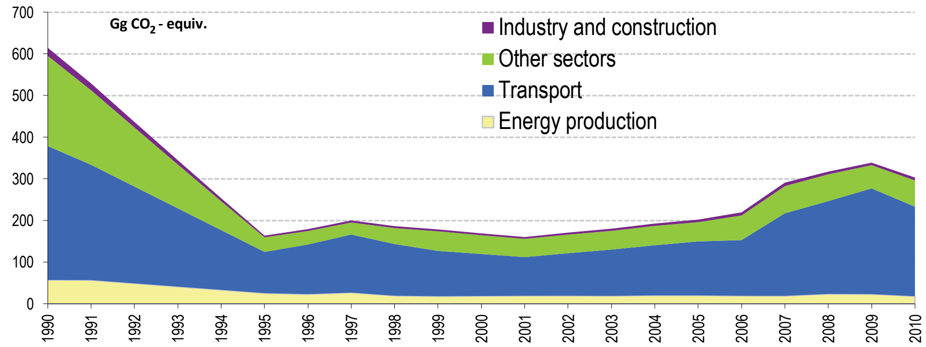


Fig. 2.30. Trends in precursor gas emissions in the Energy sector, Gg

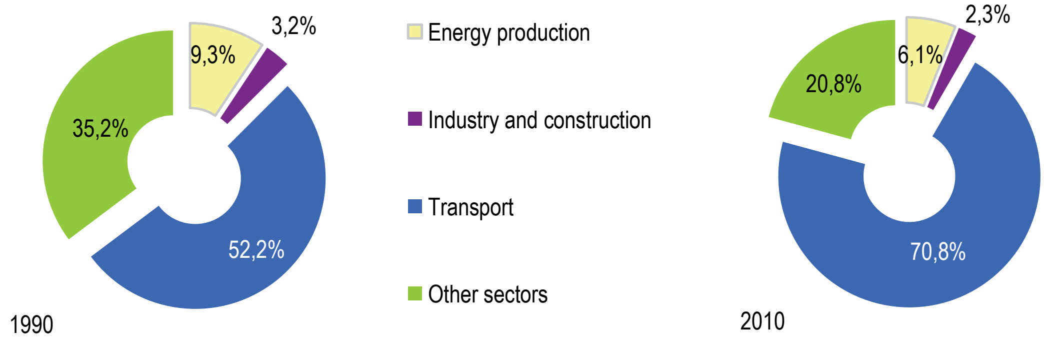


Fig. 2.31. Change in distribution of total precursor gas emissions in the Energy sector by selected source category,%

Trends in the emissions of precursor gases in the energy sector, shown in Fig. 2.30, for obvious reasons largely coincide with the trends in GHG emissions, but the overall reduction in total emissions was not as significant as for GHG. The total emission of precursor gases in 2010 amounted to 55.1% of the emissions in 1990. In general, with a significant reduction in emissions, their distribution by individual source category slightly changed. The share of precursor gas emissions in energy production category was 9.6% in 1990 and by 2001 had risen to 12.5%, followed by a successive decrease to 6.2% in 2010. The share of emissions in the industry and construction category was 3.3% in 1990, and then decreased to 2.4% in 2010. The share of emissions in the transport category consistently grew over the entire period under review, from 54.0% in 1990 to 72.5% in 2010. The share of emissions in the other sectors category was 36.4% in 1990, and then decreased to 21.3% in 2010. During the 1990-2010 period, emissions from the other sectors category wildly fluctuated, probably due to changes in the fuel consumption by the population. There were no emissions of precursor gases in the fugitive emissions from fuels category. During the entire period under review, 1990-2010, the category with the highest emissions was transport.

The trends for emission changes by selected precursor gas are shown in Fig. 2.32 and Fig. 2.33.

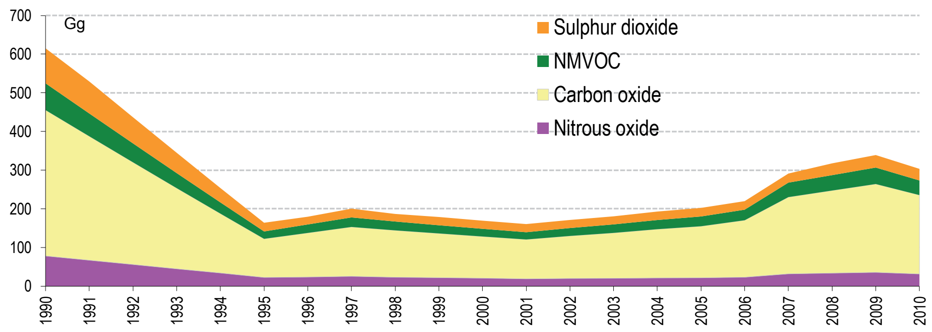


Fig. 2.32. Emissions trends by selected precursor gases in the Energy sector

With a decrease in absolute emissions across all gases, there were some changes in the distribution of emissions by certain gases. The proportion of emissions of mono-nitrogen oxides slightly decreased from 12.7% in 1990 to 11.2% in 2010. The proportion of carbon dioxide emissions increased slightly from 61.3% in 1990 to 66.5% in 2010. Emissions of NMVOC remain virtually unchanged - in 1990 it was 11.2%, and in 2010 - 12.5%. The proportion of emissions of sulfur oxides decreased from 14.7% in 1990 to 9.8% in 2010.

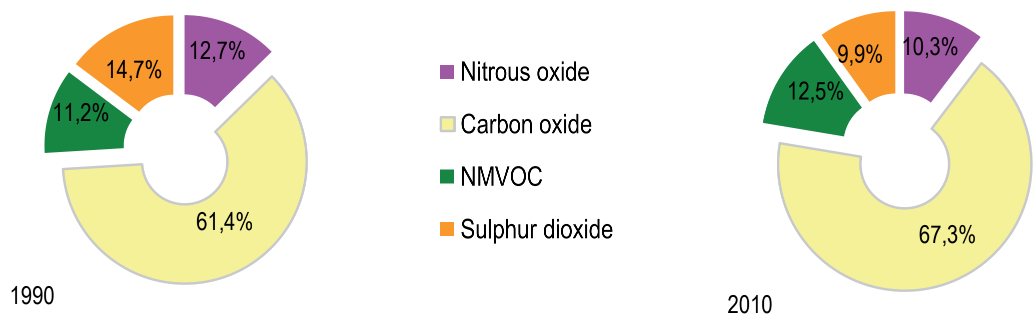


Fig. 2.33. Change in the emissions distribution by selected precursors gases in the Energy sector, %

2.2.2.4.2. Energy production

Out of all sources usually covered by the Energy production category, there are only enterprises for heat and electric power production, emitting three GHG - carbon dioxide, methane and mono-nitrogen oxide. GHG emission trends are shown in Fig. 2.34, and precursor gas emissions in Fig. 2.35.

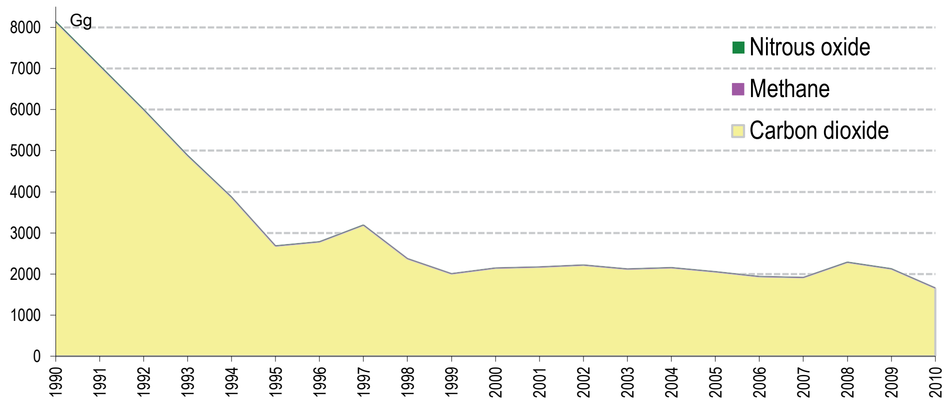


Fig. 2.34. Trends in selected GHG emissions from the Energy Production category. Mono-nitrogen oxide and methane emissions are small and hardly seen.

Carbon dioxide makes the main part, about 99.6% of GHG emissions, a contribution of methane and mono-nitrogen oxide is negligible (about 0.035% and 0.36%, respectively). The distribution of separate GHG emissions changes slightly. Only some decline may be noted in a proportion of methane emissions and a similar increase in a proportion of mono-nitrogen oxide, due to the changes in a composition of the fuel consumed.

For precursor gases an outweigh of the mono-nitrogen oxides and sulfur dioxide emissions was observed, while the carbon monoxide and NMVOC emission was relatively small. During 1990-2010, against a backdrop of total emissions reduction in the Energy production category, there were some changes in the contributions of separate gases. The mono-nitrogen oxides emissions share decreased from 39.7% in 1990 to 27.1% in 2010, carbon monoxide - from 3.57% in 1990 to 2.00% in 2010 and NMVOC - from 0.96% in 1990 to 0.52% in 2010. A proportion of sulfur dioxide increased from 55.7% in 1990 to 70.4% in 2010. These changes are explained by an increased use of lignite instead of coal.

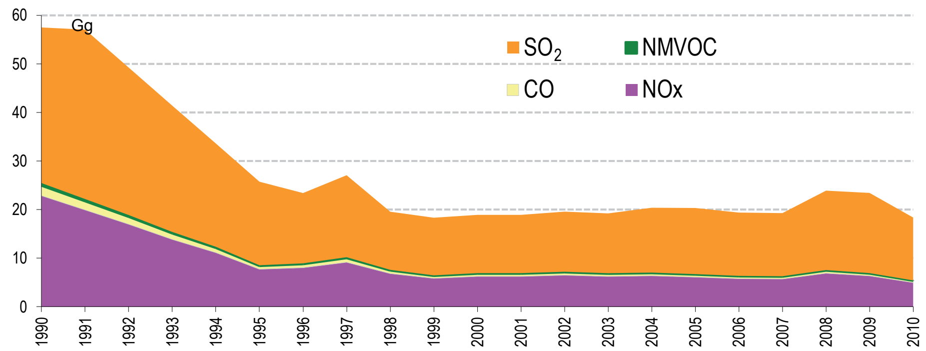


Fig. 2.35. Trends by selected precursor gases emissions in the Energy Production category

2.2.2.4.3. Industry and construction

The Industry and Construction category includes the sources for iron and steel production, non-ferrous metals, chemicals, pulp&paper and typographical production, food and tobacco industries, mineral production, machine-building enterprises, mining and textile industries, and construction. In absence of an official recording, a breakdown into these sub-categories has not been made. Emissions of three GHG occur in this category - carbon dioxide, methane and nitrous oxide. GHG emission trends are shown in Fig. 2.36, and emissions of precursor gases in Fig. 2.37.

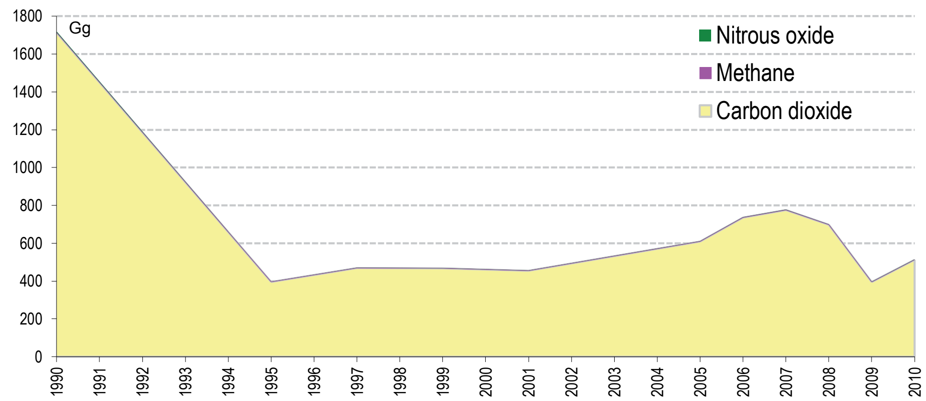


Fig. 2.36. Emissions trends by selected GHG for the Industry and Construction category. Emissions of mono-nitrogen oxide and methane are small and not seen.

Carbon dioxide forms the main part of GHG emissions at about 99.6%, a contribution of methane and mono-nitrogen oxide are negligible (about 0.16% and 0.21%in 1990 and about 0.12% and 0.26% in 2010 respectively).

The precursor gases emission is more evenly distributed across the separate gases compared to the GHG. During 1990-2010 amidst a general emissions reduction from the sector (by almost three times), some changes are observed in the separate gases contribution. The mono-nitrogen oxides emissions share decreased from 24.4% in 1990 to 22.0% in 2010, carbon monoxide - from 6.23% in 1990 to 4.22% in 2010 and NMVOC - from 40.7% in 1990 to 35.0% in 2010, while a proportion of sulfur dioxide increased from 28.6% in 1990 to 38.7% in 2010 due to the increased use of lignite instead of coal.

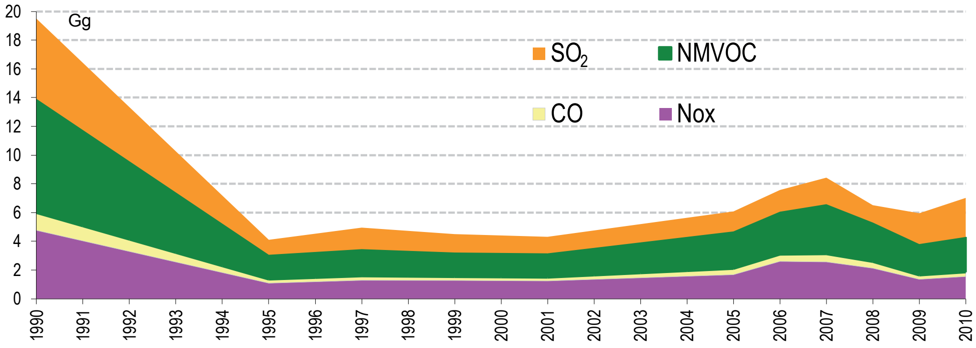


Fig. 2.37. Trends in selected precursor gas emissions in the Industry and Construction category

2.2.2.4.4. Transport

In line with the IPCCC Guidelines, the Transport category includes all types of passenger and freight transport, as well as motorcycles, with their further breakdown into types of used catalysts, and by carrying capacity of road transport - into light and heavy. International transport (for the Kyrgyz Republic it is only the civil aviation) forms a separate article 7A of the international bunker. Military flights were not included in the category and are not taken into account.

In accordance with the national conditions (current fuel accounting system in the Fuel and Energy Balance) this category is divided into the following sub-categories

- Civil aviation;
- Road transport;
- Railroads;
- Water transport.

A more detailed breakdown under the IPCCC guides is impossible due to lack of baseline data. The transport category counts both emissions of the main GHG, as well as precursor gases. This category, as seen from the aforementioned results, is a main source of GHG emissions in the energy sector.

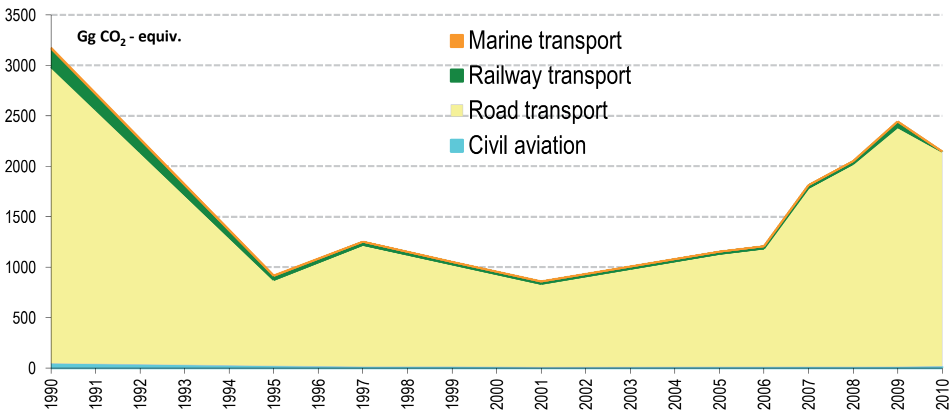


Fig. 2.38. General GHG emission trends in the Transport category

GHG emissions from the transport category after a reduction of more than three times during 1990-1995, varied at about 1000 Gg CO_2-eq. until 2006. Then, starting from 2006, it rose to a level above 2,000 Gg CO_2-eq. From Fig. 2.38 it is seen that most of the GHG emissions trends are defined by the road transport sub-category, whose contribution in 1990 was 92.5%, and even increased to 99.0% by 2010. The input of other categories in the total emissions is negligible. The emissions share in the civil aviation sub-category decreased to 0.88% in 2010 compared to 1.5% in 1990. The railways share in 1990 was 5.78%, and in 1990 - 0.08%. The emissions share of the water transport subcategory was low in 1990 at 0.2%, and further reduced to 0.01% by 2010.

The transport category mainly accounts for about 99.3% of carbon dioxide over the whole period from 1990 to 2010. The contribution of other GHG is insignificant. The proportion of methane emissions is about 0.43%, and nitrous oxide - 0.27%. And besides, this distribution hardly changed as a structure of the fuel used remained unchanged too.

2.2.2.4.5. Other sectors

The Other sectors category, consistent with the national circumstances, is divided into the following sub-categories:

- Commercial / Institutional;
- Residential;
- Agriculture.

The Agriculture sub-category includes the mobile sources (such as vehicles and farm equipment), as well as the stationary sources (such as pumps, drying equipment, etc.) used for agricultural purposes. The other sectors category accounts for emissions of both GHG and precursor gases.

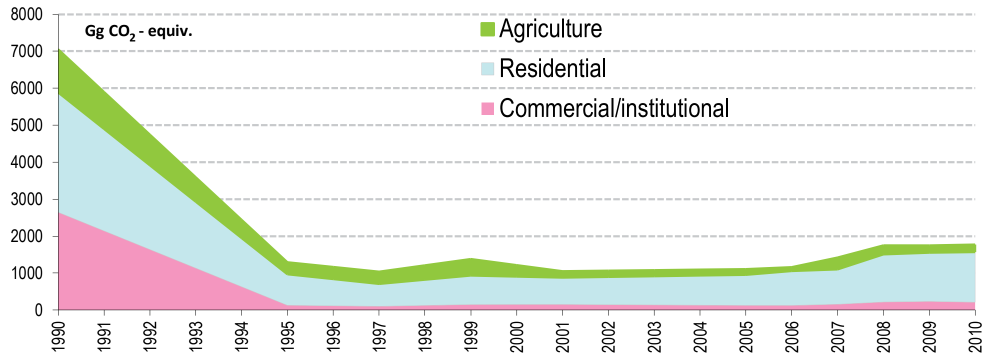


Fig. 2.39. General trends of GHG emissions from the Other Sectors category

The reduction of GHG emissions in this category was most significant during 1990-1995 from 7053 Gg CO_2-eq. down to 1771 Gg CO_2-eq., .i.e. emissions in 2010 accounted for about 25% of emissions in 1990. After reduction to 1293 Gg CO_2-eq. by 1995, the emissions remained almost at the same level until 2006, and only later grew slowly. The greatest reduction in emissions was observed in the Commercial/ Institutional sub-category from 2645 Gg CO_2-eq. in 1990 to 212 Gg CO_2-eq. This happened most likely due to a sharp reduction in a number of social and cultural institutions. A less significant reduction was observed in the Residential subcategory, in which the emissions share increased steadily, despite a reduction in the absolute values, and in Agriculture subcategory, where the emissions share ranged from 9 to 32%.

As a result of the changes in the GHG distribution by subcategory (Fig. 2.40), a share of GHG emissions in Residential subcategory rose to 76.5% in 2010 compared to 45.9% in 1990, with a decrease in the Commercial/institutional subcategory from 37.5% in 1990 to 11.9% in 2010, and Agriculture - from 16.6% in 1990 to 11.6% in 2010.

Carbon dioxide emissions prevail in the Other sectors category. Its share amounted 96.7% in 1990, and decreased slightly to 94.6% in 2010. Methane share increased from 2.9% in 1990 to 4.9% in 2010, and of nitrous oxide - from 0.42% in 1990 to 0.52% in 2010.

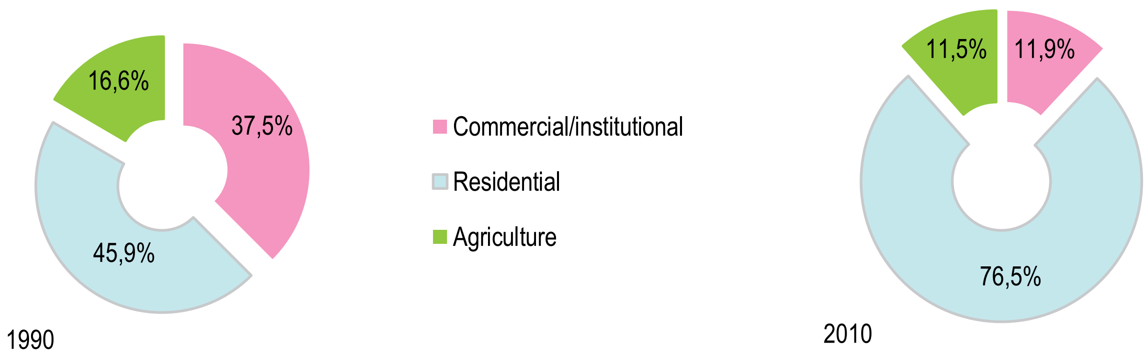


Fig. 2.40. Changes in the total GHG emissions distribution in the Other Sectors category by separate source category, %

2.2.2.4.6. Fugitive emissions from fuels

The Fugitive emissions from fuels category includes all intentional and unintentional emissions of GHGs from the production, handling and processing, storage and transportation of fuel to the point of end use. This source category, in accordance with national circumstances, is broken down into sub-categories:

- Solid fuels;
- Oil and natural gas.

The Fugitive emissions from fuels category, in accordance with IPCC Guidelines, cover only methane emissions. Emissions from precursor gases are missing.

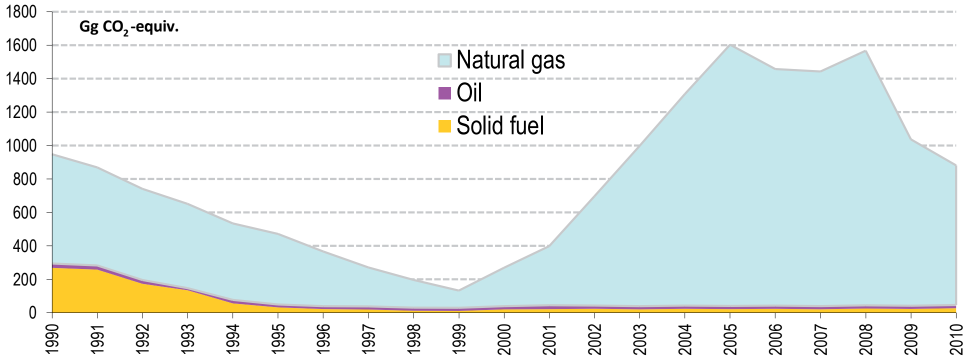


Fig. 2.41. General trends in methane emissions for the fugitive emissions from fuels category

Until 1999, changes in the Fugitive emission from Fuels category fully correlate with the domestic production volume (solid fuel and oil) and the consumption volume (natural gas). For the Solid fuel and Oil sub-categories such a correlation can also be seen in the following years. The emission of natural gas sub-category sharply increased since 1999 and reached its peak in 2005 (1,561 Gg CO_2-eq.), and then decreased slightly. As a result, in 2010 a part of the natural gas sub-category was the largest in the category at 95% (Fig. 2.42).

This unexpected increase in emissions from natural gas was due to a significant increase in losses thru transportation and distribution, which significantly exceeded the values in previous years for the Kyrgyz Republic and the similar figures for other countries. Trends in natural gas losses are shown in Fig. 2.43. Not all gas losses may be technical but commercial. Unfortunately, objective information was not available. The losses distribution by type and reference to specific distribution sectors should be clarified under the future GHG inventories.

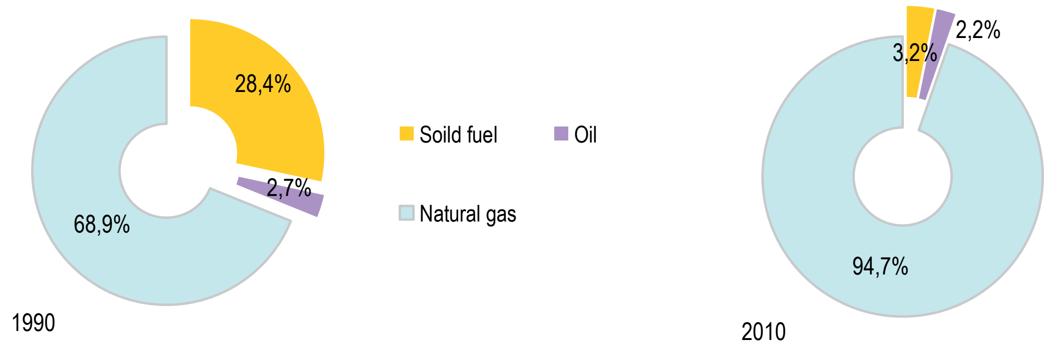


Fig. 2.42. Changes in the GHG emissions distribution in the Fugitive Emissions from Fuels category, %

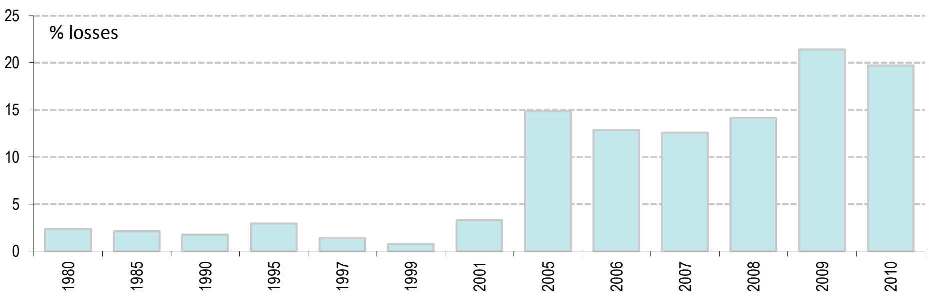


Fig. 2.43. Change in natural gas losses as a percentage of the distribution volume. Source: NSC

2.2.2.5. Key categories and sources

As different sources have different uncertainties levels, their contribution to the inventory total uncertainty is different. Obviously, the greater effect will be obtained by reducing uncertainty in the sources that are the primary contributors to the overall uncertainty. And so, to improve the inventory it is necessary to define sources, where a selection of methodology is important for possible areas of applications of the inventory.

2.2.2.5.1. Key categories in the emissions level

Tables 2.3 - 2.5 show the results of defining the key categories in the "1A Fuel Combustion" category by the level of emissions based on the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories of the IPCC in 2000. As it follows from the results, the key categories for carbon dioxide and nitrous oxide are all sub-categories:

- Transport;
- Other sectors;
- Industry and construction;
- Energy production.

For methane:

- Transport;
- Other sectors

Table 2.3. Identification of key categories for carbon dioxide in "1A Fuel Combustion" category

Source categories	Emissions in 2010, Gg	Level	Total inventory level
1A3 Transport	2914,7	0,431	0,431
1A4 Other sectors	1682,7	0,249	0,679
1A1 Energy production	1659,1	0,245	0,924
1A2 Industry and construction	512,5	0,076	1,000
	6768,9	1,000	

Table 2.4. Identification of key categories for methane in 1A "1A Fuel Combustion" category

Source categories	Emissions in 2010, Gg	Level	Total inventory level
1A4 Other sectors	3,462	0,875	0,875
1A3 Transport	0,439	0,111	0,986
1A2 Industry and construction	0,029	0,007	0,994
1A1 Energy production	0,024	0,006	1,000
	3,954	1,000	

Table 2.5. Identification of key categories for nitrous oxide in 1A "Fuel Combustion" category

Source categories	Emissions in 2010, Gg	Level	Total inventory level
1A3 Transport	0,040	0,468	0,468
1A4 Other sectors	0,021	0,240	0,708
1A1 Energy production	0,020	0,237	0,945
1A2 Industry and construction	0,005	0,055	1,000
	0,086	1,000	

Tables 2.6-2.8 show the results of identifying the key subcategories by the level of emissions for the "1A3 Transport" category. As it follows from the assessment, for all GHGs the key subcategory is "1A3b Road Transport", which is the largest contributor to the total emissions of the sector.

Table 2.6. Identification of the key subcategories for carbon dioxide 1A3 "Transport" category

Source categories	Emissions in 2010, Gg	Level	Total inventory level
1A3b Road transport	2112,3	0,990	0,990
1A3a Civil aviation	18,4	0,009	0,999
1A3c Railways	1,7	0,001	1,000
1A3d Water transport	0,2	0,000	1,000
	2132,7	0,315	

Table 2.7. Identification of the key subcategories for methane in 1A3 "Transport" category

Source categories	Emissions in 2010, Gg	Level	Total inventory level
1A3b Road transport	0,43309	0,999	0,999
1A3a Civil aviation	0,00014	0,000	1,000
1A3c Railways	0,00011	0,000	1,000
1A3d Water transport	0,00002	0,000	1,000
	0,43337	0,110	

Table2.8. Identification of the key subcategories for nitrous oxide in 1A3 "Transport" category

Source categories	Emissions in 2010, Gg	Level	Total inventory level
1A3b Road transport	0,01772	0,968	0,968
1A3a Civil aviation	0,00057	0,031	0,999
1A3c Railways	0,00001	0,001	1,000
1A3d Water transport	0,00000	0,000	1,000
	0,01830	0,212	

2.2.2.5.2. Key category trends

Tables 2.9 - 2.11 show the calculation of the identification of the key categories in 1A "Fuel combustion" category by trends, based on the IPCC 2000 Good Practice Guidelines and Uncertainty Management in National Greenhouse Gas Inventories. It follows from the results that the key categories for:

- carbon dioxide are 1A4 "Other sectors", 1A2 "Industry and Construction" and 1A3 "Transport";
- methane are 1A4 "Other sectors", 1A1 "Energy Production" and 1A2 "Industry and Construction";
- nitrous oxide are all key categories.

Table 2.9. Identification of key categories for carbon dioxide in the 1A "Fuel combustion" category

Source categories	Emissions in 1990, Gg	Emissions in 2010, Gg	Trends	Contribution to trend	Total level
1A4 Other sectors	6866,3	512,5	0,792	50,000	50,000
1A2 Energy production	1712,8	1682,7	0,477	30,090	80,090
1A3 Transport	3154,9	1659,1	0,253	15,997	96,087
1A1 Energy production	8136,7	2914,7	0,062	3,913	100,000
	19870,8	6768,9	1,584	100,000	

Table 2.10. Identification of the key categories for methane in the 1A "Fuel combustion" category

Source categories	Emissions in 1990, Gg	Emissions in 2010, Gg	Trends	Contribution to trend	Total level
1A4 Other sectors	8,928	0,024	2,242	46,108	46,108
1A1 Energy production	0,177	3,462	2,222	45,707	91,815
1A2 Industry and construction	0,132	0,439	0,254	5,228	97,043
1A3 Transport	0,645	0,029	0,144	2,957	100,000
	9,882	3,954	4,862	100,000	

Table 2.11. Identification of the key categories for nitrous oxide in the 1A"Fuel combustion" category

Source categories	Emissions in 1990, Gg	Emissions in 2010, Gg	Trends	Contribution to trend	Total level
1A4 Other sectors	0,085	0,005	0,866	50,000	50,000
1A2 Industry and construction	0,012	0,021	0,395	22,783	72,783
1A1 Energy production	0,067	0,040	0,255	14,739	87,522
1A3 Transport	0,027	0,020	0,216	12,478	100,000
	0,190	0,086	1,733	100,000	

Tables 2.12 - 2.14 show the calculation of identifying the key sub-categories by trends in the 1A3 "Transport" category. From the results it follows that the key sub-categories for all gases are 1A3a "Civil aviation" and 1A3b "Road Transport".

Table 2.12. Identification of the key sub-categories for carbon dioxide in the 1A3 "Transport" category

Source categories	Emissions in 1990, Gg	Emissions in 2010, Gg	Trends	Contribution to trend	Total level
1A3a Civil aviation	46,81	2112,33	1,443	50,000	50,000
1A3b Road transport	2918,79	18,41	1,356	46,971	96,971
1A3c Railways	182,93	1,69	0,085	2,931	99,902
1A3d Water transport	6,42	0,25	0,003	0,098	100,000
	3154,94	2132,68	2,887	100,000	

Table 2.13. Identification of the key sub-categories for methane in the 1A3 "Transport" category

Source categories	Emissions in 1990, Gg	Emissions in 2010, Gg	Trends	Contribution to trend	Total level
1A3a Civil aviation	0,0003	0,4331	1,486	50,000	50,000
1A3b Road transport	0,6314	0,0001	1,457	49,022	99,022
1A3c Railways	0,0123	0,0001	0,028	0,946	99,968
1A3d Water transport	0,0004	0,0000	0,001	0,032	100,000
	0,6445	0,4334	2,971	100,000	

Table 2.14. Identification of the key sub-categories for nitrous oxide in the 1A3 "Transport" category

Source categories	Emissions in 1990, Gg	Emissions in 2010, Gg	Trends	Contribution to trend	Total level
1A3a Civil aviation	0,00132	0,01772	1,332	50,000	50,000
1A3b Road transport	0,02368	0,00057	1,249	46,899	96,899
1A3c Railways	0,00148	0,00001	0,080	3,000	99,899
1A3d Water transport	0,00005	0,00000	0,003	0,101	100,000
	0,02654	0,01830	2,663	100,000	

2.2.2.5.3. Key sources in the 1A1 "Energy production" sub-category by level of emissions

Based on the key sources selection criteria (IPCC 2000 Good Practice Guidelines and Uncertainty Management in National Greenhouse Gas Inventories), the Thermal Power Plant (TPP) in Bishkek city was identified as all gases key source in the energy production sector. Its contribution to the total emissions in Bishkek and the country as a whole by the 1A1 "Energy Production" sub-category is shown in Table 2.15. The TPP emissions in 1990 were about half of the total emissions of the sub-category in the country, while in 2010 it increased to 60-80%. The increase could happen both from an emissions reduction from other sources and from the sources restructuring, i.e., a transfer to other line ministries and agencies. The NSC exercise, oriented to the departmental/sectoral distribution of sources, rather than to actually undertaken actions, does not help to clarify the situation. The next inventory's steps should be undertaken to improve the situation.

Table 2.15. Defining key source parameters

	CO_2	CH_4	N_2O	NOx	CO	НМЛОС	SO_2
1990							
Emissions from the Thermal Power Plant	4193,7	0,0777	0,0329	11,889	1,133	0,295	18,5
Emissions in KR	8136,7	0,177	0,067	22,84	2,052	0,554	32,02
Share of KR, %	**51,54**	**43,89**	**48,95**	**52,04**	**55,22**	**53,21**	**57,78**
2010							
Emissions from the Thermal Power Plant	1293,1	0,015	0,017	3,98	0,282	0,071	10,63
Emissions in KR	1659,1	0,0242	0,02	4,97	0,3669	0,0949	12,93
Emissions in Bishkek	1326,5	0,0159	0,017	4,05	0,2932	0,074	10,83
Share of KR, %	**77,9**	**62,36**	**83,11**	**80,089**	**76,915**	**74,859**	**82,19**
Share in Bishkek, %	**97,5**	**94,9**	**97,88**	**98,31**	**96,24**	**96,08**	**98,13**

2.2.2.5.4. Uncertainty

According to 1996 IPCC Guidelines, Vol. 1, Table A1-1, the uncertainties in the activity data and emission factors for the Energy sector for carbon dioxide are7%. In this case the total uncertainty is 9.9%.

For methane emission by fossil fuels combustion (oil, natural gas and coal) the uncertainty for activity data and emission factors is respectively 55% and 20%. The total uncertainty will be 58.5%.

For nitrous oxide emission by fossil fuels combustion, the uncertainties for the activity data and emission factors will be about 50%, according to the Second National Communication of the Kyrgyz Republic.

The differences in the uncertainty level by different source categories are insignificant.

2.2.3. Industrial processes sector

The "Industrial processes" sector accounts the emissions from industrial processes and product use, except for those related to combustion for power production, mining, fuel processing and transporting that are already accounted in the "Energy" sector.

The sector, in accordance with the IPCC Guidelines and national conditions, includes the following source categories:

- 2A Minerals;
  - 2A1 Cement production;
  - 2A2 Lime production;
  - 2A5 Roof bitumen production;
  - 2A6 Road asphalt production;
  - 2A7 Sheet glass production;
  - 2A8 Non- sheet glass production;
- 2B Chemical Industry;
  - 2B5 Plastic production;
- 2C Metal production;
  - 2C1 Iron and steel production;
  - 2C2 Ferroalloys production;
  - 2C3 Aluminum production;
  - 2C4 Antimony production;
  - 2C5 Mercury production;
  - 2C6 Plumbum production;
  - 2C7 Copper production;
- 2D Other industry (food and drink);
- 2F Consumption of halocarbons and sulfur hexafluoride;
- 2G Blasting works.

In fact, of all the GHG in the Industrial processes sector, only carbon dioxide and hydrofluorocarbons emissions are taken into account, namely HFC-134a (CH_2FCF_3). Other greenhouse gas emissions are negligible and consequently not shown in the results. Of precursor gases, the carbon monoxide, nitrogen oxides, sulfur dioxide and NMVOC emissions are taken into account.

2.2.3.1. Basic assumptions

The main sources of initial data used to calculate the GHG and precursor gases emissions were:

- The NSC data on the manufacture of industrial products in physical terms, export and import of products and materials in real terms, and data of the Fuel and Energy Balance of the KR;
- Current resource, guidance, methodology, regulatory and technical materials;
- Data of ecological passports of the industrial enterprises of the KR.

The emission factors recommended by the IPCC Guidelines have generally been used. The cases of the national coefficients usage are specified separately for each source category.

The calculation of cement production emissions used the following assumptions:

- It was accepted that the clinker contains 65% CaO, and that 100% of CaO was derived from carbonate material;
- Emissions from cement production account for 2% of emissions from the clinker production;
- Portland cement makes up the major part of all cement produced;
- Clinker accounts for 95% of the total cement volume.

The calculation of lime production emissions used the following assumptions:

- In absence of official national data on the technology used and the composition of the used raw materials, it is assumed that 85% of the produced lime has a high content of calcium and 15% of dolomitic lime;
- To obtain 1 ton of CaO, calcination of 1,785 tons of $CaCO_3$ is needed, which releases 0.785 ton CO_2 in case of full calcination;
- The accepted emission factor for calcite lime is 0.75 tons of CO_2/ton of lime; for dolomitic lime - 0.77, according to the Second National Communication of the Kyrgyz Republic.

The calculation of the bitumen usage emissions used the Fuel and Energy Balance as an input data. The data on the bitumen volume consumed as a material for industrial production (construction, installation and drilling), non-fuel needs, for transport, municipal and household needs and sold to the population have been used.

The bitumen volume was conditionally divided into roofing bitumen and bitumen used as road asphalt in a proportion of 5% to 95%. The same conditional division of bitumen was used in the inventory in SNC.

The roofing and bitumen roofing materials production includes the saturation or application of a protective layer on the paperboard. The main process stages consist of the bitumen storage, its oxidation, saturation, and applying a coating layer with mineral grit. Based on data of the 2013 EMEP/EEA guides on inventory of air pollutants emission, it is assumed that all bituminous mixtures used for roofing materials production are oxidized. Emission factors from the use of bitumen were adopted according to the IPCC Guidelines.

In recent years, considerable changes took place in the glass products nomenclature. Regarding official data provided by the NSC, the following glass products are currently manufactured:

- Glass sheet, thous. m^2;
- Float glass with matte and polished surface (liquid glass), kg;
- Formed and processed glass sheet, thous. m^2;
- Glass containers for drink, thous. pcs;
- Glass containers for the transportation and packaging of pharmaceutical commodities, thous. pcs;
- Other glass items, including technical ones, thous. pcs;

Given the changed range of glass items, the following assumptions were used:

- Data on glass sheet, formed and processed glass are combined. To convert data from sq. m. to tons the method used in SNC was applied – 4 mm thick one square meter of glass weighs 10 kg. In the same way the data on float glass with matte and polished surface are calculated;
- The data on containers for drink, goods transportation and packaging and other glass items, including the technical ones, are combined and referred to as container glass (the share of glass items for transportation and other items is 5%). The average weight of an item referred to as container glass is accepted at 0.4 kg (based on the standard bottles and cans weight);
- In advance of emissions assessment, the glass sheet production was recalculated from sq. meters to tons. The average share of broken glass was accepted at 0.175, and for container glass – 0.45;
- For all types of glass the CO_2 emission factor was accepted at 0.21 kg CO_2/kg glass.

Emissions sources accepted for the chemical industry were the small industries processing plastic, operating mainly on heating and forming, resulting in NMVOC emissions only.

The country's metallurgy industry is mainly represented by enterprises producing antimony, mercury and gold. Additionally, this sector includes the production of the secondary smelt of steel, cast iron and non-ferrous scrap. Gold producing companies use hydrometallurgical processes that do not result in the greenhouse and precursor gases emission, and, so, will not be considered further. The emissions from sources for antimony and mercury production, secondary metals smelting and blasting, the national emission factors were used specified in SNC and based on the enterprises' ecological passports.

In line with the food products range by the NSC, the base data for emissions calculating in other manufacturing (food and drink) category is grouped according to the similar emission factor of NMVOC:

- Fresh bread;
- Cakes, confectionery and cakes, crackers and biscuits, confectionery and storable pastries;
- Butter of all types, sugar;
- Meat and the edible offal of cattle and poultry;
- Strong drinks;
- Beer, wine.

The emissions calculated from the other production (food and drinks) category used emission factors from the IPCC Guidelines.

The Kyrgyz Republic has no domestic production of halocarbons and sulfur hexafluoride, they imported only with equipment, and emissions can take place with equipment letdown and further refilling. Hydrofluorocarbons, namely HFC-134a, is mainly used as a refrigerant in cooling equipment (stationary and mobile air conditioners and refrigerators). Refilling of the refrigerant is carried out by a large number (several hundreds) of small service providers and individuals. The accounting is also complicated by the fact that the import of HFCs required for refilling is not controlled by the customs and other organizations. Also the amount of HFC released from the broken equipment is not recorded. Therefore, for the HFC emissions estimation, projections from the US Environmental Protection Agency website were used.

Sulfur hexafluoride has been used in recent years, mainly in the gas-insulated breakers of 245 F1 F3, S1 145, SF1, AIV-110 type and others. Regarding to the users information no failure of switches and refilling of sulfur hexafluoride was recorded, for the inventory period, and respectively, the domestic consumption and emission is absent.

The volume of perfluorocarbons usage and emissions in the country is not officially monitored and, by the expert estimates, is insignificant, so, PFC emissions were not taken into account in the inventory.

2.2.3.2. Industrial development trends

The trends in industrial development in the Kyrgyz Republic for the period of inventory are shown in Fig. 2.44.

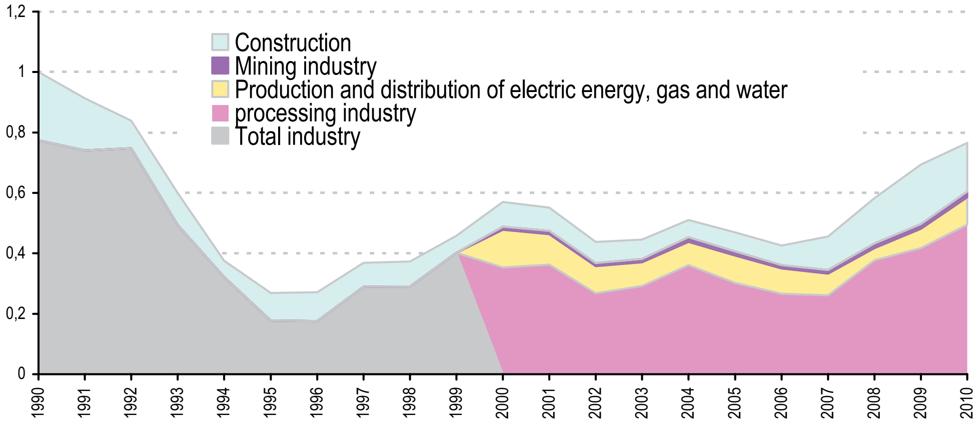


Fig. 2.44. Changes in industrial production in financial terms re 1990 (1990 accepted as 1). Since 2000 the official registration system has changed, reflecting in the presentation format. Source: NSC

It is difficult to select the trends in the industrial processes sector in terms of the accepted classification for the inventory, because the national statistics system is some different. The volume of industrial production (Fig. 2.44) also includes contributions from the mining industry, which is not included in the inventory due to the actual absence of GHG emissions, from the production and distribution of electricity, gas and water. This was estimated in the energy sector emissions, as well as in construction. It is easy to trace a characteristic for the country tendency with a sharp down from 1990 to 1995, followed by a growth, more significant in comparison with the other sectors and the general trend for the country.

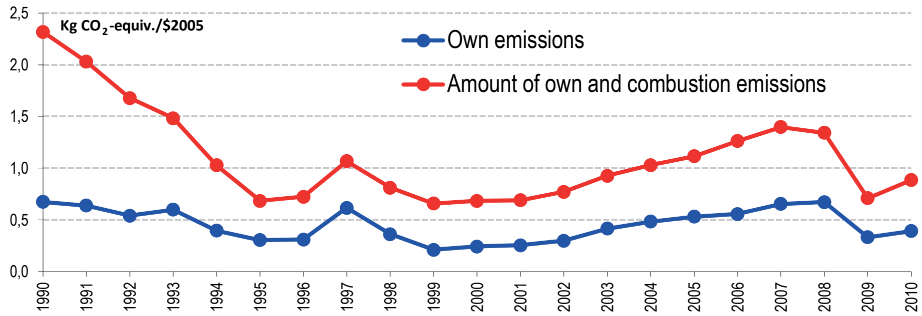


Fig. 2.45. Trends in Industrial sector emissions per unit of production. The own emissions refer to GHG emissions from industrial processes, accounted in Section 2. Combustion emissions come from fossil fuel combustion in industry, accounted in Section 1A2.

Despite the significant structural changes in the national economy, the lasting significant contribution of the industrial sector to the economy is worth noting (Fig. 2.44), as well as a slight tendency for the reduction of their own emissions within the sector per production unit (Fig. 2.45). For comparison, in Kazakhstan for 2009, specific emissions from the sector amounted to 3,436 kg of CO_2-eq./$2005, while emissions from fuel combustion fell significantly during 1990-1995, which then grew, although slowly. In accordance with the ongoing structural changes in the national economy, namely a reduction of more energy-intensive engineering industries with a growth in the light manufacturing, a sharp reduction of specific GHG emissions should be expected, as well as the continuing reduction of specific emissions from fuel combustion since 1995. Hence, the industrial processes sector has a significant potential to reduce GHG emissions by an application of the innovative technologies and energy efficient equipment.

2.2.3.3. Industrial Processes sector in general

GHG emissions trends by individual source categories in the industrial processes sector are shown in Fig. 2.46.

GHG emissions here slightly decreased, as compared with other sectors. Following a reduction of 1990-1995, the sharp fluctuations in emissions were observed, sometimes reaching the values of 1990. The total sector emissions are largely determined by the Minerals category, which, in turn, is determined by the cement production. In fact, it is fluctuations in the cement production that lead to changes in the sector's emissions. Despite an increase in a number of enterprises producing cement, from two in 1990 (of which the Kant Cement Factory produced over 90%), up to four in 2010, the basic volume of cement is still produced at one plant. Changes in the GHG emissions distribution by source category are not very significant:

Minerals: 1990 - 98.3%, 2010 - 92.7%;

Metal production: 1990 - 0.68%, 2010 - 0.50%;

Consumption of halocarbons and sulfur hexafluoride: 1990 - 0%, 2010 - 6.84%;

Blasting works: 1990 -1.00%, 2010 - 0%.

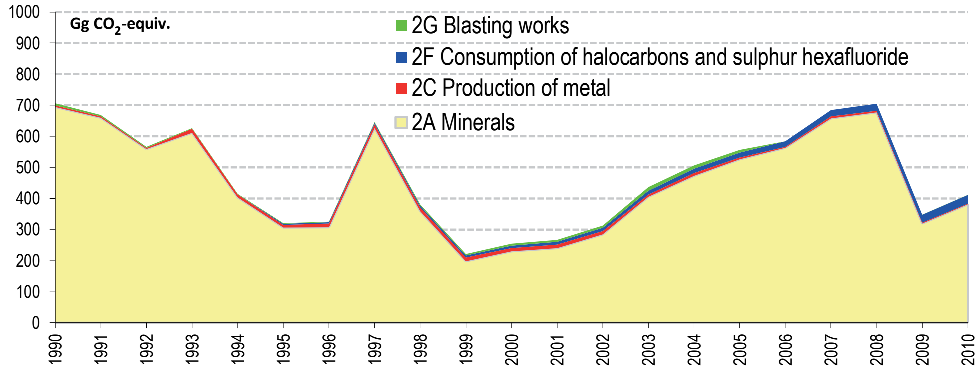


Fig. 2.46. GHG emissions by source category from the Industrial Processes sector. The categories where GHG emissions observed are listed only.

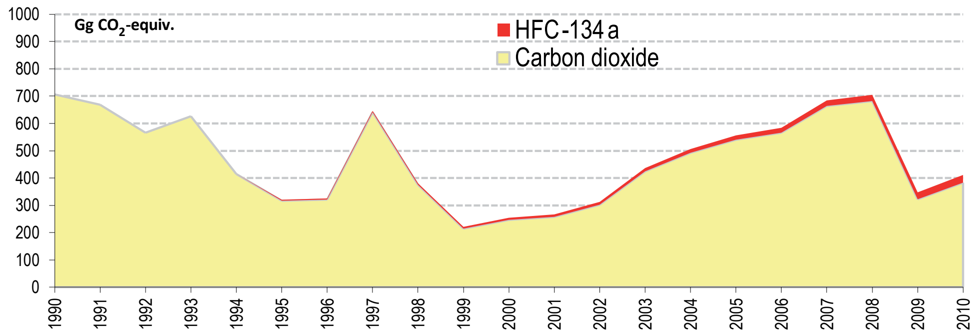


Fig. 2.47. Trends in GHG emissions by separate gases in the Industrial Processes sector

GHG emission trends for the selected gases in the Industrial Processes sector are similar to the trends of GHG emissions by source category (Fig. 2.47).

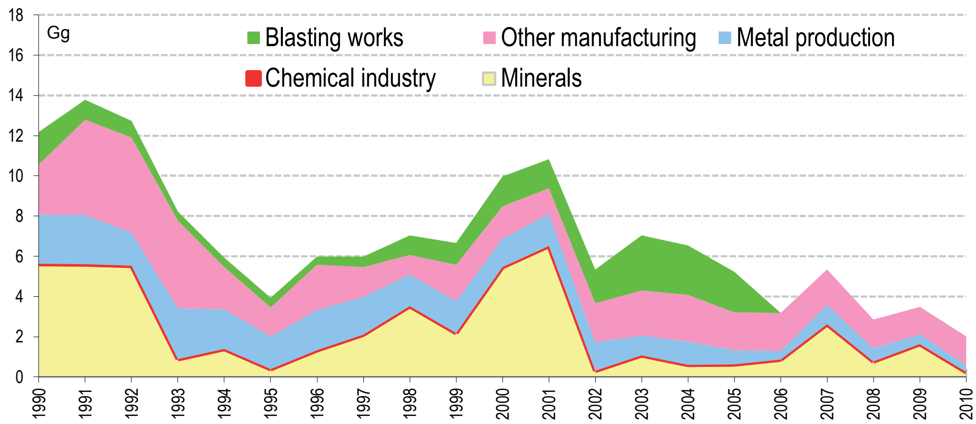


Fig. 2.48. Trends in emissions of precursor gases for source categories in the Industrial Processes sector.

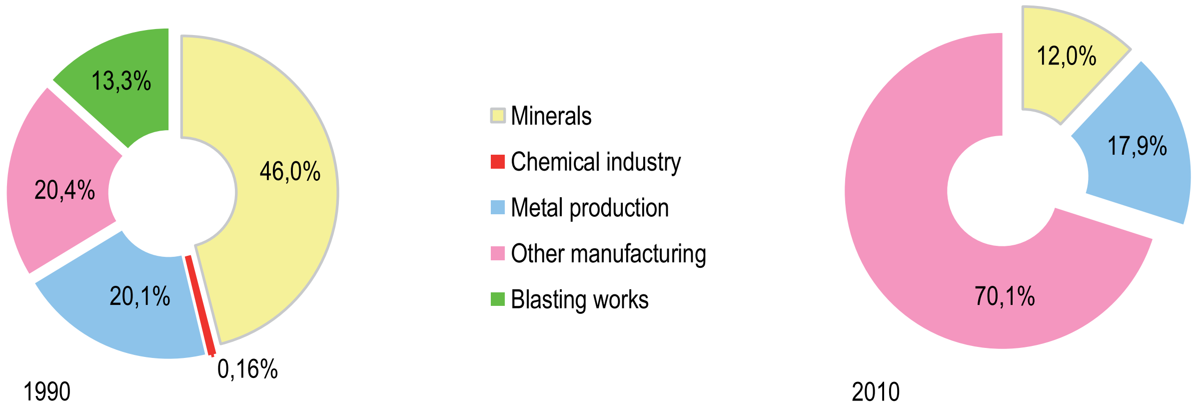


Fig. 2.49. Distribution of precursor gas emissions by source categories

Figures 2.48 and 2.49 present the trends and distribution of precursor gas emissions by source categories in the Industrial Processes sector. The most intense changes were observed for the Minerals category, determined by a change in the volume of cement production. The Chemical industry category has practically no emissions. In the Metal production category, a steady decline in emissions can be seen as a result of reductions in production and secondary smelting of metals. The Other Manufacturing category had the greatest emissions in 2010, not due to the growth of their own emissions, but to reduced emissions in other categories.

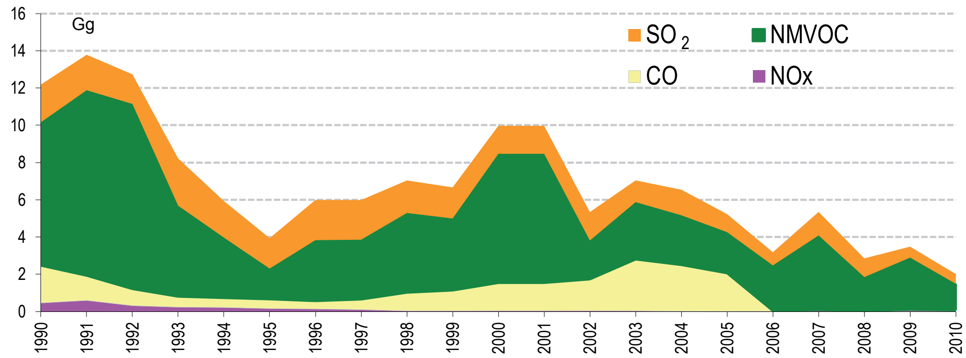


Fig. 2.50. Trends in the precursor gases emissions by gas in the Industrial Processes sector.

Figures 2.50 and 2.51 show the trends of precursor gases emissions by gas in the Industrial Processes sector. The total precursor gases emission from the sector decreased from 12.18 Gg in 1990 to 2.00 Gg in 2010. It is notable that after a characteristic sharp drop in emissions between 1990 and 1995, the subsequent years, in contrast to other sectors, saw a tendency for further emissions reduction. With an absolute reduction in the precursor gases emissions, carbon monoxide (51 times) and nitrogen oxides (18 times) emissions reduced most hard. Dramatic changes in the NMVOC emission, as well as greenhouse gas emissions, were bound to the Minerals category, which is explained not by changes in the cement production, but in the volume of bitumen used.

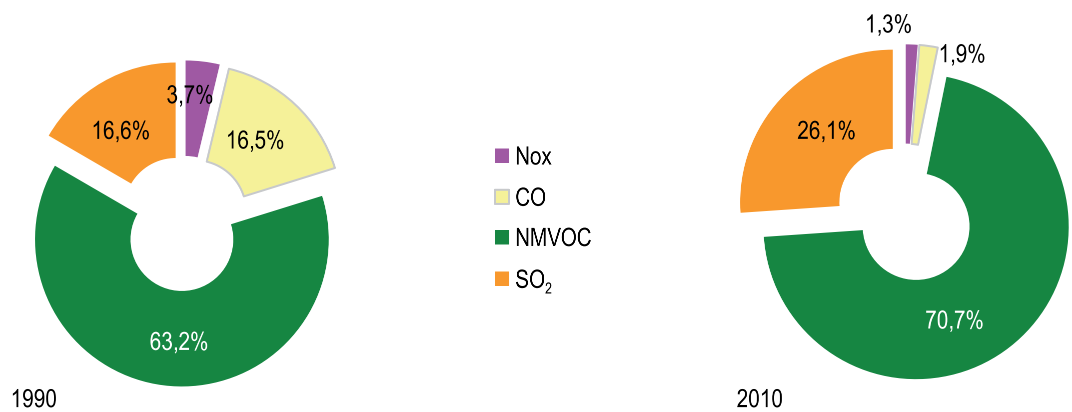


Fig. 2.51. Distribution of precursor gas emissions by gas

2.2.3.4. Key categories and sources

2.2.3.4.1. Key categories by emission level

Table 2.16 shows the identification of key categories in the Industrial Processes sector by the emissions level based on the 2000 IPCC Guidelines. The figures show that a key category for carbon dioxide is Minerals.

Table 2.16. Identification of key categories for carbon dioxide in the Industrial Processes sector

Source categories	Emissions in 2010, Gg	Level	Total level
2A Minerals	381,042	0,994604	0,9946035
2C Metal production	2,067	0,005396	1
2B Chemical industry	0,000	0	0
2D Other manufacturing (food and drinks)	0,000	0	0
2G Blasting works	0,000	0	0
	383,109	1,000	

For another gas, HFC-134a, a key category is the 2F Consumption of halocarbons and sulfur hexafluoride category, since the HFC emission occurs only here.

Tables 2.17 and 2.18 show the assessment results of the key categories for the Minerals and Metal production categories for carbon dioxide. The estimation shows that for the Minerals category quite expected key sub-category is Cement production, and for Metal production the key subcategories are mercury and antimony production.

Table 2.17. Identification of key sub-categories for carbon dioxide in the Minerals category

Source categories	Emissions in 2010, Gg	Level	Total level
Cement production	375,292	0,9849	0,9849
Lime Production	4,650	0,0122	0,9971
Non-sheet glass production	1,093	0,0029	0,99998
Sheet glass production	0,007	0,00001	1,0000
Roofing bitumen production	0,000	0	1,0000
Road asphalt production	0,000	0	1,0000
	381,042	1,000	

Table 2.18. Identification of key categories for carbon dioxide in the Metal Production category

Source categories	Emissions in 2010, Gg	Level	Total level
Mercury production	1,8061	0,8736	0,8736
Antimony production	0,2023	0,0978	0,9714
Iron and steel production	0,0590	0,0285	1
Ferroalloys production	0,0000	0	1
Aluminum production	0,0000	0	1
Lead production	0,0000	0	1
	2,0674	1,000	

2.2.3.4.2. Key categories by trend

Tables 2.19 - 2.21 show estimation identifying the key categories in the Industrial processes sector by trends, based on the 2000 IPCC Guidelines. The assessment shows that, accounting the available data for carbon dioxide, the key categories are Minerals and Metal production.

For the Minerals and Metal production categories all source categories, for which input data is available, are key by trends.

Table 2.19. Identification of key categories for carbon dioxide in the Industrial Processes sector

Source categories	Emissionsin 1990, Gg	Emissionsin 2010, Gg	Trends	Contribution to trend	Total level
2A Minerals	694,329	381,042	0,02106	0,887651	88,7651
2C Metal production	4,832	2,067	0,00266	0,112349	100
	706,207	383,109	0,02372		

Table 2.20. Identification of key sub-categories for carbon dioxide in the Minerals category

Source categories	Emissionsin 1990, Gg	Emissionsin 2010, Gg	Trends	Contribution to trend	Total level
Non-sheet glass production	0,004	1,093	0,005216	0,31947	31,9475
Sheet glass production	1,649	0,007	0,004294	0,26299	58,2468
Cement production	685,326	375,292	0,003869	0,23701	81,9475
Lime production	7,350	4,650	0,002947	0,18052	100
	694,329	381,042	0,016328		

Table 2.21. Identification of key sub-categories for carbon dioxide in the Metal Production category

Source categories	Emissionsin 1990, Gg	Emissionsin 2010, Gg	Trends	Contribution to trend	Total level
Mercury production	0,0000	1,80613	2,04167	0,5	50
Antimony production	4,2267	0,20231	1,81573	0,44467	94,4668
Iron and steel production	0,6050	0,05900	0,22594	0,05533	100
	4,8317	2,0674	4,0833	1,0000	

2.2.3.4.3. Uncertainty

According to the 1996 IPCC Guidelines, Volume 1, Table A1-1, the uncertainties for the activity data and emission factors for carbon dioxide in the Industrial Processes sector is 7%. The total uncertainty in this case is 9.9%.

2.2.4. Solvents sector

Solvent use can be accompanied by the evaporation of various non-methane volatile organic compounds, which are subsequently oxidized in the atmosphere. Solvent use is a separate category because the nature of this source requires a somewhat different approach to the emissions assessment compared to the other source categories, as a methodology for calculating the NMVOC emission in this sector is not provided in the IPCC Guidelines.

The methodology used for estimating emissions of non-methane volatile organic compounds represented in the 2013 EMEP/EEA guide for inventory of air pollution emission. In this guide the Use of solvents and other products sub-category brings together 6 positions of selected nomenclature of air pollution sources (SNAP) and is divided into 5 sub-categories. Except the fifth sub-category –Utilization of other products, which refers to fluorinated gases, nitrous oxides and ammonia to be assessed beyond the Solvent use sector, these sub-categories are the following:

- SNAP 0601: use of paints;
- SNAP 0602: degreasing, dry-cleaning and electronics;
- SNAP 0603: chemical products manufacturing and processing, including the processing of polyester, polyvinylchloride, polyurethane foam, paints and inks manufacturing, glues and adhesives, as well as textile dressing;
- SNAP 0604: other use of solvents and related activities, including the activities such as coating of glass wool and mineral wool, printing industry, fat and oil extraction, uses of glues and adhesives, wood protection, domestic solvent use (other than paint application) and vehicle underseal treatment and vehicle dewaxing.

2.2.4.1. Basic assumptions

The types of substances used as a solvent, primarily include mineral spirits and kerosene (liquid paraffin). White spirit is used as a solvent for extraction, cleaning, and degreasing, as well as in aerosols, paints, antiseptics, polishes, varnishes, and asphalt products. Typically, about 60% of the total consumption of mineral spirits is accounted for by varnishes and paints. White spirit is the most widely used solvent in the paint industry.

Paint usage is the primary emission source of NMVOC. There are two main categories of emissions from the use of paint solvents:

1. The application of decorative coatings:
    - The use of colors in a building;
    - Use of paints for architectural use and by construction companies in the furniture manufacture;
    - Domestic solvent use for other purposes.

2. The application of industrial coatings: Paint application
   - The use of colors in the manufacture of automobiles;
   - Car repairs;
   - Coil coating;
   - Boat building;
   - Wood (stain, creosote);
   - Other industrial applications of paint (road markings and others.)
   - Regrettably, the NSC does not classify the use of colors in different areas.

Most paints contain an organic solvent which must be removed by evaporation after the paint has been applied to a surface to dry the paint. Unless captured and either recovered or destroyed, these solvents can be considered to be emitted into the atmosphere. Some organic solvent may be added to coatings before application and will also be emitted. Further solvent is used for cleaning coating equipment and is also emitted.

The proportion of organic solvent in paints can vary considerably. Traditional solvent paints contain approximately 50 % of organic solvents and 50 % of solids. In addition, more solvent may be added to further dilute the paint before application. High solids and water paints both contain less organic solvent — typically less than 30 % — while powder coatings and solvent-free liquid coatings contain no solvent at all.

Source category is not the key, and, so, for an estimate the Tear 1 was selected using the national factors identified in the SNC.

To calculate the NMVOC emissions used in painting (in industry, automobile refinishing, and domestic use) an average emission factor was accepted out of the coefficients by use type from the 2013 EMEP/EEA guides.

Table 2.22. Average emission factor for various kinds of paints used

Emissions source	Percentage of use in KR	Emission factor, kg/tonne of paint
Other kinds of industrial paint application	10	500
Automotive refinish paints	10	280
Automotive refinishing	10	600
Application of paints in the exterior and interior finishing of buildings	30	300
Application of paints for domestic use	50	400
Average weighted coefficient		354,4

When using solvents and paints, 100% of the solvents contained in paints is released into atmosphere. Part of the solvent, from 50 to 80%, vaporizes in the first hour, followed by 20% over the next hour, and a further 10% for each hour of the next three hours.

NMVOC emissions takes place mainly under the painting process by the solvent evaporation.

According to the 2013 EMEP/EEA Guidebook , a solvent content in paint with a conventional solvent content is 40 to 70%.

2.2.4.2. Sector emissions

The trend in NMVOC emissions from the Solvent Use sector is shown in Fig. 2.52. Changes in the NMVOC emissions is somewhat different from changes in emissions in other sectors and from the general macroeconomic trends in the country. After a sharp drop in emissions in 1990-1995, the reduction process continued until 2001. In 2001-2007, a sharp increase was observed in emissions, and then a period of relative stability started at a level approximately half of 1990. Moreover, a growth was observed both in the paint production and the use of solvents, paints and varnishes. Geographically, the growth relates mostly to Bishkek city and the Chui oblast.

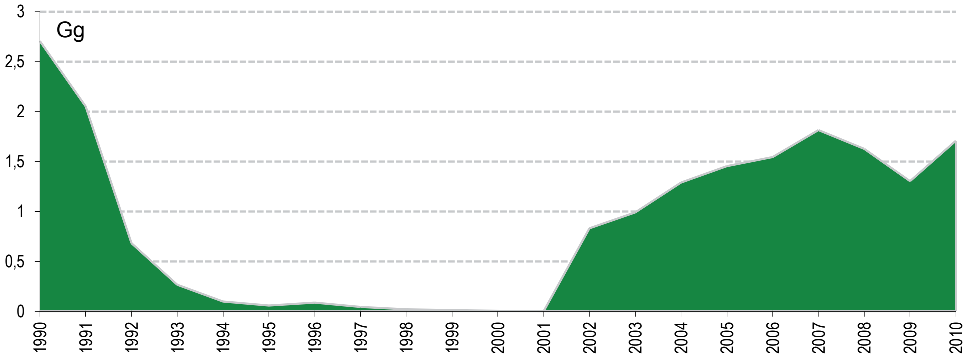


Fig. 2.52. Trends in NMVOC emissions from the Solvents sector

2.2.4.3. Key source categories and uncertaintyь

Key source category emissions are not shown up in the sector, because there is no division by category.

The fossil carbon share in NMVOC emissions, adopted by default based on the limited publications on national analysis on NMVOC composition, is 60% by weight (IPCC 2006). The share of fossil carbon may vary within 50-70% by weight. So, the uncertainty is about 10%. National data on fossil carbon share should have a lower uncertainty of about 5%. However, no research has been conducted in the Kyrgyz Republic to determine the fossil carbon share.

The resulting uncertainty in NMVOC emissions is about 50%. The uncertainty can be reduced by developing a detailed inventory of the emissions main sources. In the countries where the inventory is developed, the uncertainty is reduced to 25%.

2.2.5. Agriculture

The Kyrgyz Republic, as a mountainous country, has a relatively low part of land suitable for plowing, which determines the development of agriculture with a substantial share of livestock.

The agriculture sector emits methane and nitrous oxide, as well as precursor gases - carbon monoxide and NMVOC s. The sector, in accordance with the IPCC guidelines and national circumstances, includes the following source categories:

- 4A Enteric fermentation;
  - 4A1 Cattle;
    - 4A1a Dairy cattle;
    - 4A1b Non-dairy cattle;
  - 4A2 Yak;
  - 4A3 Sheep;
  - 4A4 Goats;
  - 4A5 Camels;
  - 4A6 Horses;
  - 4A7 Donkeys;
  - 4A8 Pigs;
  - 4A9 Poultry.
- 4B Manure storage systems
  - 4B1 Cattle;
    - 4B1a Dairy cattle;
    - 4B1b Non-dairy cattle;
  - 4B2 Yak;
  - 4B3 Sheep;
  - 4B4 Goats;
  - 4B5 Camels;
  - 4B6 Horses;
  - 4B7 Donkeys;
  - 4B8 Swine;
  - 4B9 Poultry.
- 4C Rice Cultivation;
- 4D Agricultural soils;
  - 4D1 Direct emissions from agricultural soils (including greenhouse farming and excluding grazing);

4D2 Direct emissions associated with the use of animal products;

4D3 Indirect emissions from agricultural soils, which may be associated with various nitrogen-containing substances in agriculture;

4F Burning of agricultural residues.

There are no savanna areas in the country and peat soil areas are insignificant, so, emissions from savannas burning and cultivated peat soils were not considered.

2.2.5.1. Basic assumptions

The GHG calculations in the Agriculture sector were conducted were based on data provided by the NSC and the Department of Chemicals, Quarantine and Plant Protection of the MALM. These initial data was compared and correlated with the UN FAO data.

The IPCC 1996 Guidelines for National Greenhouse Gas Inventories was used as the methodological basis. There are no studies on a definition of national emission factors, so, the calculations used the Tear 1 method and the default emission factors of the Guidelines.

The specifics of the national accounting system define some basic assumptions.

The national statistics does not divide cattle into dairy and non-dairy, but the conditional division by sex is accepted.

The Republic has no inventory of manure storage systems, and records of manure management are not kept. In determining the manure storage systems, due to the fact that the country practices both the stabling of cattle and grazing at pasture, the shares were determined by the recommendations of experts. The share of manure storage systems (stabling of cattle and grazing pastures) has been identified as 60 and 40%, respectively, for the categories of «Dairy cattle», «Non-dairy cattle,»»Yaks», «Sheep», «Goat»»Horse», «Donkey», «Camel». 100% of pigs and poultry are kept in pens on a farm.

As the main crops, with the field burnt residues, the following were identified: wheat, barley, rye, oats, rice, vegetables, tobacco, and oilseeds. The percentage of biomass burned in the fields by selected cultures was determined based on the recommendations of the national consultants of the Kyrgyz National Agrarian Academy named after acad. K.I. Skryabin.

2.2.5.2. Trends in agricultural development

Fig. 2.53 shows the changing share of the agricultural sector in GDP, and Fig. 2.54 shows the volume of agricultural production in comparable prices. As seen from the trend, an increase in the agriculture share during the period from 1990 to 1996 is associated with decline in agricultural production compared to other sectors of the economy. In general, the trend of consistent decline in the agriculture share, with a slight stabilization of production after 1996, characterizes a lack of development of the sector, despite the fact that the majority of the working population is employed here.

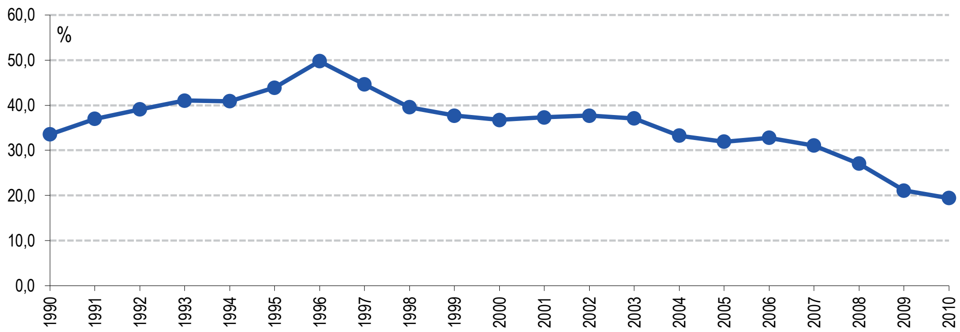


Fig. 2.53 Share of agriculture in GDP. Source: World Bank

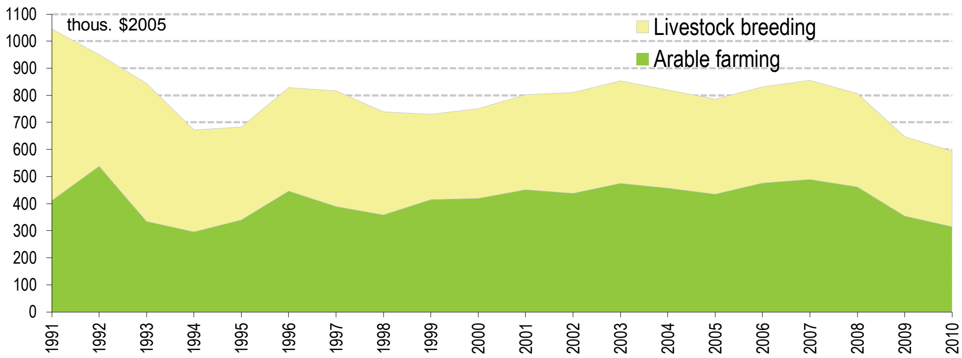


Fig. 2.54. Volume of agricultural production. Source: NSC

The intense changes in the volume of agricultural production were largely determined by the changes in volume of crop production. These changes are most likely caused by the climatic reasons. The size of agricultural production already depends to a large extent on the current climate change.

One of the main factors determining the emissions from the agriculture sector is a number of livestock and poultry. During 1990-1995, changes in the number coincide with the general trends of a sharp reduction in the economic activity. Since 1995, there has been a consistent increase in all categories of livestock except for pigs, which is similar to the general economic trends. A reduction of a number of pigs cannot be explained by economic factors, and a natural decline in consumption is as a result of changes in the ethnic composition of the population. The exceptional growth of poultry is notable, especially the sharp rise in 1997.

Fig. 2.55 shows trends in specific GHG emissions per unit of production in the Agriculture sector, which is one of the performance efficiency indicators. Compared to Kazakhstan, where the specific emissions from the Agriculture sector for 2009 (excluding emissions from fuel combustion) accounted for 26.979 kg CO_2 -eq./1 $2005, a situation in the KR looks quite safe. But it is notable that there are no obvious declining trends in specific emissions in agriculture, moreover, in recent years a considerable growth has been seen.

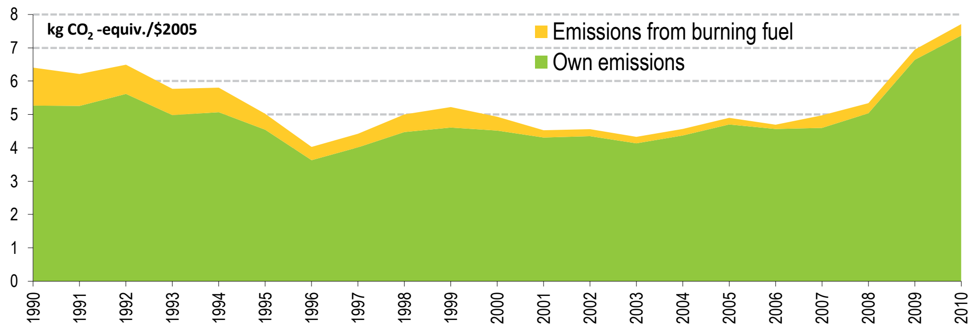


Fig. 2.55. Specific GHG emissions per unit of production in Agriculture sector

2.2.5.3. Emission trends in Agriculture sector

GHG emission trends by source category in the Agriculture sector are given in Fig. 2.56. The assessment of different categories contribution to the sector total emissions are given in Fig. 2.57.

As compared with other sectors, GHG emissions from the Agriculture sector have slightly decreased. During 1990 -1996 it reduced from 5417 Gg CO_2-eq. in 1990 to 3007 Gg CO_2-eq. in 1996. In subsequent years, there was a consistent increase in the emission reaching its maximum of 4376 Gg CO_2-eq. in 2010 - about 81% of 1990 emissions. The total emission over the inventory period is mainly determined by the Enteric Fermentation and Agricultural Soils categories. The contribution of other source categories to the total emissions is negligible. It is lack of growth in agricultural production with a significant emissions increase that led to the negative trend in the specific emissions growth (Fig. 2.56).

Changes in distribution of GHG emissions by source categories in the Agriculture sector are insignificant.

The volume of methane emissions from the Enteric Fermentation and Manure Storage Systems categories are directly dependent on a number of livestock, whose contribution to the emission varies. The emissions distribution for the individual types of livestock is given in Tables 2.23 - 24. In 2010 there was a significant increase in emissions from dairy cattle and a decrease in those of sheep and goats compared to 1990.

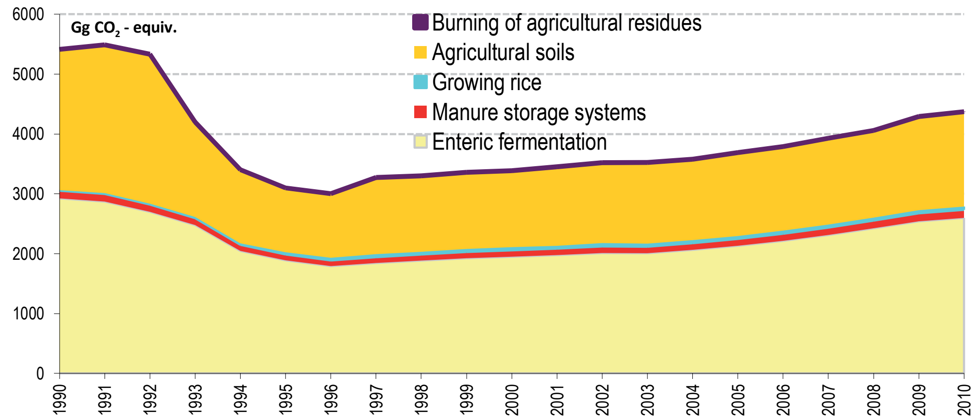


Fig. 2.56. GHG emission trends by source categories in Agriculture sector

Table 2.23. Distribution of methane emissions in the Enteric fermentation and Manure storage system categories by types of livestock in 1990

Types of livestock	Number of livestock, thous.	Enteric fermentation, %	Manure storage system, %
Dairy cattle	506,159	29,441	58,542
Non-dairy cattle &yak	754,252	30,331	12,462
Sheep and goats	9969,374	35,795	16,472
Pigs	393,447	0,2825	6,5008
Horses	312,676	4,0416	5,6312
Donkeys	14,1	0,1012	0,1398
Camels	0,2	0,0066	0,0042
Poultry	1251,668	0,0000	0,2482

Table 2.24. Distribution of methane emissions in Enteric fermentation and Manure storage system categories by type of livestock in 2010

Type of livestock	Number of livestock, thous.	Enteric fermentation, %	Manure storage system, %
Dairy cattle	666,129	43,610	72,880
Non-dairy cattle &yak	661,03	29,920	10,332
Sheep and goats	5036,089	20,352	7,8712
Pigs	59,713	0,0483	0,9333
Horses	378,223	5,5026	6,4435
Donkeys	68,57	0,5542	0,6430
Camels	0,337	0,0125	0,0067
Poultry	4749,815	0,0000	0,8908

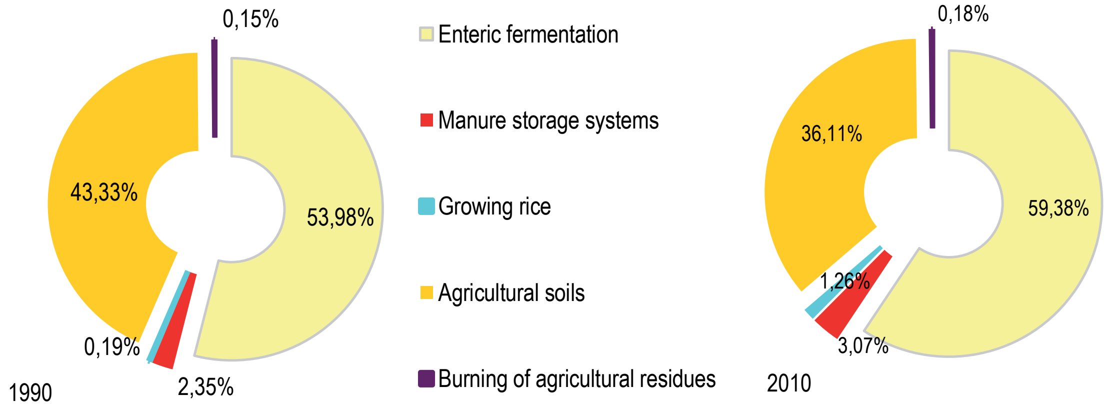


Fig. 2.57. Distribution of GHG emission by categories, %

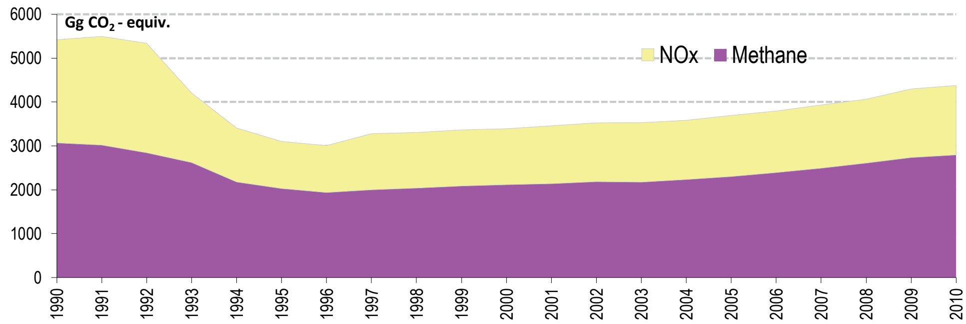


Fig. 2.58. GHG emission trends by gases in the Agriculture sector

Trends in GHG emissions by gases are given in Fig. 2.58. These changes are quite small - the methane emission has increased from 56.6% in 1990 to 63.8% in 2010, while nitrogen oxides emissions have also decreased sequentially from 43.4% in 1990 to 36.2% in 2010. Some fluctuations in the nitrogen oxides emission were determined mainly by changes in emissions in the Agricultural soils category due to changes in the amounts of mineral nitrogen fertilizers.

Fig. 2.59 shows the trends in precursor gases emissions by gases in the Agriculture sector. The nature of trend is completely different from all other trends considered in this inventory. The emissions have not reduced; there is even a slight upward trend. However, if emissions that happen only in the Field burning of agricultural residues sector are considered, where the activity is only to some extent dependent on the economic condition, the nature of the changes becomes clear. The main contribution to the total precursor gases emissions during the inventory period was made by carbon monoxide (96%).

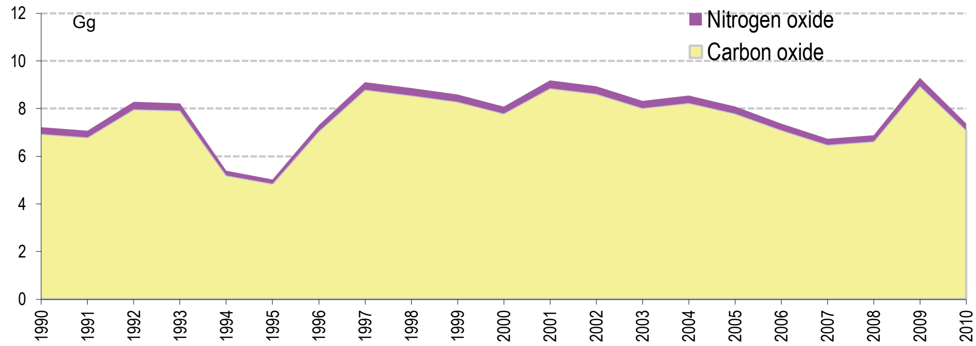


Fig. 2.59. Precursor gases emission trends in Agriculture sector

2.2.5.4. Key categories and sources

2.2.5.4.1. Key categories by emission level

Tables 2.25 - 2.26 show the results of identifying the key categories in the Agriculture sector by the emission level based on the IPCC 2000 Guidelines.

It is seen that the key categories for methane are the following:

- 4A "Enteric fermentation";
- 4B "Manure storage systems".

4D "Agricultural soil" category is obviously basic for nitrous oxide, with emissions of 5.0965 Gg against the total sector's emissions of 5.1041 Gg.

For the source category 4D "Agricultural soils» all three sub-categories are key for nitrous oxide (Table 2.26).

Table 2.25. Key categories for methane in the Agriculture sector

Source categories	Emissions in 2010, Gg	Level	Total level
4A Enteric fermentation	123,7240	0,930067	93,0067
4B Manure storage system	6,3981	0,048096	97,8163
4C Rice cultivation	2,6344	0,019803	99,7967
4F Field burning of agricultural residues	0,2705	0,002033	100,0
	133,026		

Table 2.26. Key sub-categories for nitrous oxide in 4DAgricultural soils category

Source sub-categories	Emissions in 2010, Gg	Level	Total level
4D3 Indirect emission from agricultural soils	2,56085	0,502469	50,2469
4D1 Direct emission from agricultural soils	1,8534	0,363659	86,6129
4D2 Direct emission from livestock production	0,68228	0,133871	100
	5,09653		

2.2.5.4.2. Key categories by trend

Tables 2.27-2.28 show the assessment on the key categories by trend in the Agriculture sector based on the IPCC 2000 Guidelines. It follows that the key categories for methane are 4A "Enteric fermentation", 4B "Manure storage systems" and 4C "Cultivation of rice".

The key sub-categories for nitrous oxide for source category 4D "Agricultural soils" are 4D3 "Indirect emissions from agricultural soils" and 4D1 "Direct emissions from agricultural soils".

Table 2.27. Key categories for methane in the Agriculture sector

Source category	Emissions in 1990, Gg	Emissions in 2010, Gg	Trends	Contribution to trends	Total level
4A Enteric fermentation	139,256	123,724	0,025557	49,99241	49,99241
4B Manure storage system	6,0523	6,39809	0,007316	14,31061	64,30302
4C Cultivation of rice	0,498	2,6344	0,018002	35,21436	99,51738
4F Field burning of agricultural residues	0,26415	0,27045	0,000247	0,482619	100
	146,0705	133,026	0,051121	100	

Table 2.28. Key sub-categories for nitrous oxide in the 4D"Agricultural soils" category

Source sub-category	Emissions in 1990, Gg	Emissions in 2010, Gg	Trends	Contribution to trends	Total level
4D3 Indirect emission from agricultural soils	3,312027	1,853404	0,0453167	50	50
4D1 Direct emission from agricultural soils	0,911041	0,682285	0,0437904	48,31589	98,31589
4D2 Direct emission from livestock production	4,24933	2,560846	0,0015264	1,684111	100
	8,472399	5,096536	0,0906334		

2.2.5.4.3. Uncertainty

Table 2.29. Uncertainties related to emission factors and activity data, %

GHF	Source category	Uncertainty			Main sources
		emission factors	activity data	total	
CH_4	Enteric fermentation	25	10	26,9	Emission factors
CH_4	Manure storage system	20	10	22,4	Emission factors
CH_4	Rice cultivation	75	25	79	Emission factors
CH_4	Field burning of agricultural residues	50	50	70,7	Emission factors, baseline data on combustible volumes
N_2O	Manure storage systems	20	25	32	Emission factors
N_2O	Agricultural soils	20	45	49	Emission factors
N_2O	Burning agricultural residues	20	45	49	Emission factors, baseline data on combustible volumes

2.2.6. Land use, Land Use Change and Forestry sector

The LULUCF sector takes stock of the following greenhouse gas emissions - carbon dioxide, methane and nitrous oxide, as well as the precursor gases - nitrogen oxides and carbon monoxide. Moreover, the sector is the only one that considers the multidirectional motion of carbon dioxide - both the carbon dioxide emissions into the atmosphere from the soil and the flow of carbon dioxide back into the soil.

The sector, in accordance with the IPCC Guidelines and national circumstances, includes the following source categories:

- 5A Woody biomass stocks;
- 5 B Emissions and sinks from soils.

2.2.6.1. Basic assumptions

The national land classification system includes agricultural and non-agricultural land and in accordance with the intended purpose is divided into 7 categories of land use:

- agricultural land (farm land);
- settlements land (cities, towns, and villages);
- land for industries, transport, communication, defense and other purposes;
- protected nature areas land;
- forest reserve land;
- water reserve land;
- reserve (undistributed) land.

According to the IPCC Guidelines, the information on carbon dioxide emissions/sinks is presented only for the managed land. So, forest land is divided into the managed and unmanaged forest areas. The managed forests are defined as forests, in which intervention and human activity is undertaken to fulfill the productive, environmental and social functions. The managed forests include the high altitude zones up to 2,500 m a.s.l., namely:

- Forests of SFR and NR;
- Forests beyond SFR and NR;
- Settlements trees and shrubs;
- Protective plantations;
- Perennial plantations.

The unmanaged forests are located at altitude over 2,500 m a.s.l. and include:

- Forests of SFR and NR;
- Forests beyond SFR and NR.

Fig. 2.60 presents the changing trends in the managed and unmanaged forests areas in the KR. The share of the unmanaged forest areas increased slightly from 13.8% in 1990 to 18.6% in 2010, while the managed forest areas have decreased, to some extent can characterizing the efficiency of the forestry management.

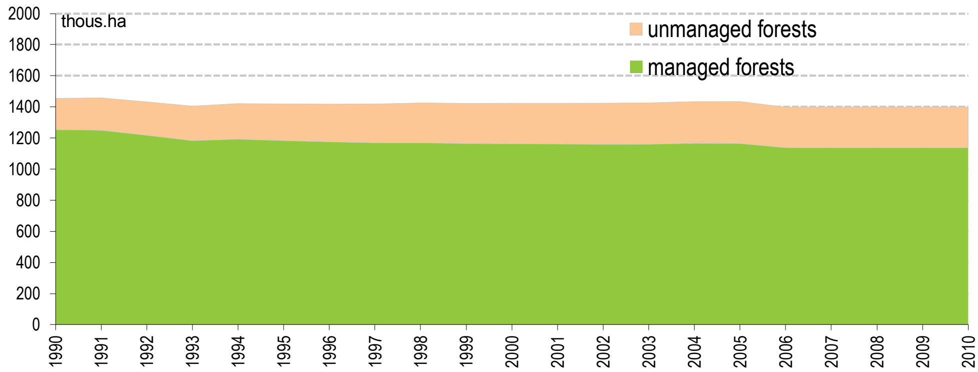


Fig. 2.60. Change trends in the managed and unmanaged forests area. Source: SAEPF

Forestry accounting consists of the following separate, independent and complementary activities - forestry management and the national forest inventory.

Prior to1995, the state forests were managed by the forestry management companies of Russia and Kazakhstan. Since 1995, the forestry management is conducted by the state forestry management service of KR. The national forest inventory has been carried out by SAEPF since 2008, by a statistical method of setting a network of sample areas or tracts (groups of test areas) throughout the country regardless of their form of ownership and departmental affiliation. They are arranged in a regular grid of 10x10 m by latitude and longitude, in accordance with the international standards, focusing on the Global Forest Resources Assessment of the FAO methodology.

Forest management is conducted by a selective-statistical method, establishing circular plots of a 500x500 m grid in the SFR and PN territory. Under collecting the field data, the instrumental measurement of tree taxation parameters is used.

Currently, throughout the country there are two grids of permanent plots for the forest resources accounting - sample plots of forest management in the SFR and PN forests, and the test areas of the national forest inventory.

According to the 2003 IPCC Good Practice Guidelines for LULUCF, the forest areas are stratified by the climate zones.

The default classification scheme is based on the ground height data, average annual temperature, average annual precipitation, a ratio of average annual precipitation and potential evapotranspiration, and the frost probability.

Table 2.30. Stratification of forest areas by climatic zones

#	Climatic zones according to the IPCC Guidelines	Oblasts
1	Boreal mountain systems	Issyk-Kul, Naryn
2	Temperate mountain systems	Jalal-Abad, Talas and Chui
3	Tropical mountain systems	Batken, Osh

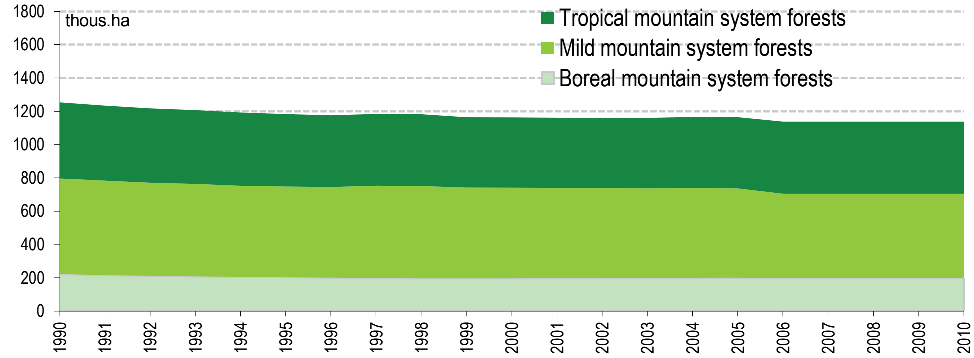


Fig. 2.61. Change trends in the managed forest areas by climatic zones. Source: SAEPF

The data source on the wood subtraction (cutting of fuelwood, commercial timber, etc.) was both the accounting data by the SAEPF (for SFR) and the FAO data.

The calculations were based on the national factors of biomass growth rates, developed by the Forest and Walnut Institute of the NAN for the FNC and SNC inventories.

Emissions calculations, conditioned by changes in land use, include estimates of emissions and sinks related to three processes:

- changes in carbon stocks in the soil and bedding of exploited (mineralized) soils caused by land use change;
- CO_2 emissions from virgin (organic) soils of the land where farming has been initiated;
- CO_2 emissions from liming of soils used for agricultural purposes.

Evaluation of agricultural land based on the annual summary «Report on lands and their division by categories, ownership, land users" is given in Fig. 2.62.

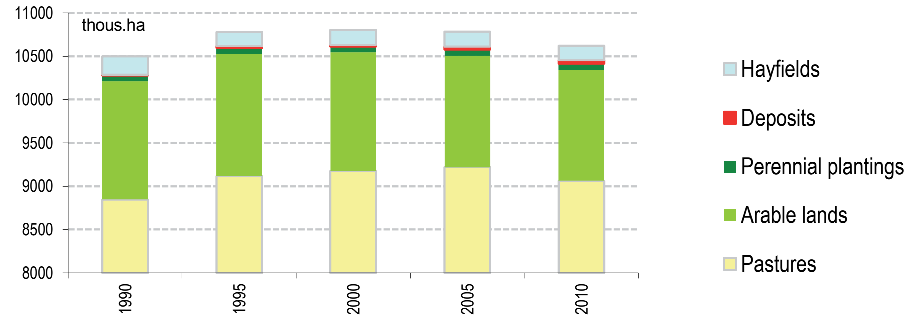
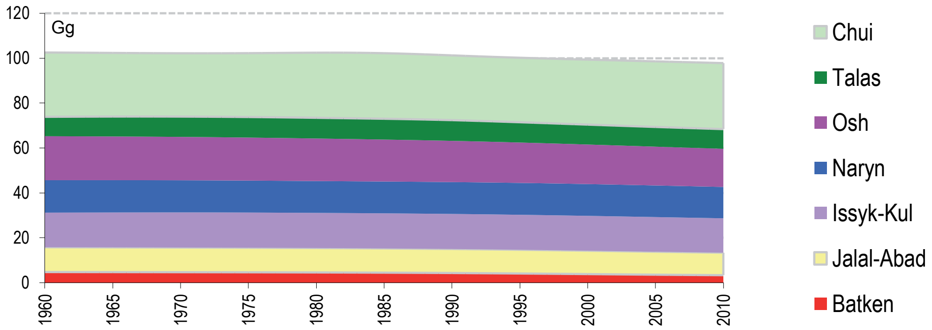


Fig. 2.62. Change dynamics in agricultural land areas. Source: NSC

According to the State Enterprise "Kyrgyzgiprozem" under the MALM, there is no conversion of forest and grassland in the country on a noticeable scale (i.e., the virgin lands have not been involved to agriculture), and soil liming has not been carried out since 1990. Consequently, the structure of agricultural land does not undergo any significant changes that may significantly affect the emissions calculations outcomes. Hence, it can be assumed that a main source in calculating of the soil emissions and sinks is a technology change in land use on cropland.

CO_2 emissions estimate was based on an assessment of carbon stocks changes. Carbon stocks are calculated by a conversion factor based on the evaluation of the humus content in the soils of different types (1 g of carbon ~ 1.724 g of humus according to State Regalement 23740-79, «General Provisions», p. 1.6.).

Only negative trends are observed in the soil carbon content. A steady decline in carbon has been observed, and consequently, a decrease in the fertility of cultivated soil, typical to all oblasts (Fig. 2.63). A positive trend is observed in the Chui oblast and, to a smaller extent, in the Talas oblast. This can be attributed primarily to a restoration of the natural soils under a temporary pause in their exploitation. A significant decrease was observed after 1990, which determines a need for a transition to the modern cultivation methods that do not lead to fertility decrease. As seen from Fig. 2.63, initial data is collected for 1960 - 2010 to get a more accurate assessment of the trends.



Fir. 2.63. Change in carbon content in the cultivated soils by the regions/oblasts, thousand ha.

The main sources of basic information for estimation of emissions/sinks from soils were the Kyrgyzgiprozem, the SRS and the Republican Soil-Agrochemical Station.

It is notable that the data on the humus content in the soils has significant time gaps. And it has inadequate geographical coverage even within a single soil type dominant in a particular area. However, excluding the temporary irregularity, the initial data brought in a fairly wide coverage of soil types. The total area covered by the humus data was 91.08% out of the exploited soil areas. Due to the time and spatial fragmentation of the initial data, interpolation has been used for the missing observations. As an interpolation method, the nonparametric approach using core grade was taken, which allows the dependencies processing with arbitrary and not pre-specified non-linearity.

Table 2.31. Exposure of cropland area on the humus content in the soil by regions

Oblast	Number of soil types	% coverage of cropland area
Batken	3 of 7	88,92
Jalal-Abad	5 of 20	69,99
Issyk-Kul	5 of 9	93,50
Naryn	6 of 16	93,74
Osh	4 of 16	90,34
Talas	5 of 6	99,999
Chui	10 of 16	95,95

2.2.6.2. Emission trends in LULUCF sector

Trends in the GHG emissions by the source categories (5A "Woody biomass stocks», 5B «Emissions and sinks of the soil») in the LULUCF sector are shown in Fig. 2.65, as well as net emission accounting sinks - in Fig. 2.64.

LULUCF GHG emission, as compared with other sectors, has some particularities– it is not directly related to a change of the economic state in the country, but depends only on the methods and quality of the economic activity in forestry and agriculture.

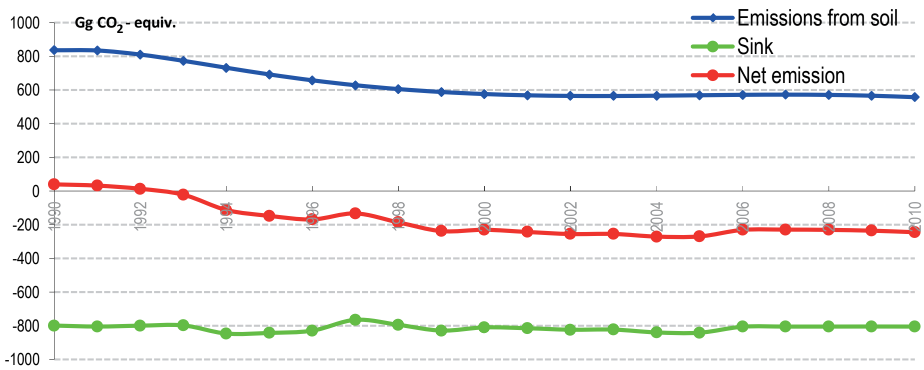


Fig. 2.64. Emission trends in the LULUCF sector

Carbon dioxide emissions from the soil decreased slightly during 1990-2000 and stabilized slightly below 600 Gg CO_2-eq. It is possibly due to the soil treatment technologies improved afterward 2000, but also possibly due to a decline has reached the physical limit of soil depletion under the existing cultivation technologies. CO_2 absorption remained generally at the same level during the whole inventory period. Net emissions after 1993 are negative, indicating a positive impact of the sector on the total emission in the KR.

The trends in GHG emissions by separate gases (carbon dioxide, methane and nitrous oxide) in the LULUCF sector are shown in Fig. 2.65.

CO_2 emission is mainly observed in the sector. Its contribution was 96.11% in 1990 and by 2010 increased to 99.15% due to a growth in CO_2 net emissions. Methane and nitrous oxide emissions are small. In 1990 they accounted for 3.58% and 0.785%, and in 2010, 0.308% and 0.0675%, respectively. The amount of nitrous oxide emissions are negligible and, therefore, are not shown in Fig. 2.65.

Methane and nitrous oxide emissions in the sector are caused by in-situ burning of forest biomass, as well as exported fuel wood. Carbon dioxide emissions from in-situ burning and exported fuel wood were accounted for in Section 7.

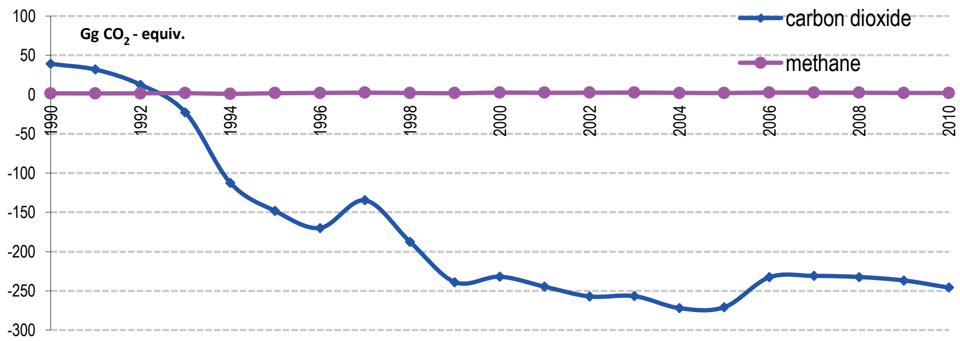


Fig. 2.65. Emission trends by selected GHG in the LULUCF sector. Nitrogen oxide emissions are not given due to their insignificance.

Fig. 2.66 shows trends in precursor gas emissions in the sector. Notably, there is serial emission growth, albeit at a very low level compared to the total emissions of the sector. Intense changes in emissions (for carbon monoxide and oxides of nitrogen) are probably related to complexity of estimating the volume of in-situ burned biomass and exported fuel wood, as the timber volume is well taken into account only by the SFR.

Basically, carbon monoxide emissions have been observed throughout the inventory period (about 98%) and only a small part of the total precursor gases emissions is comprised of nitrogen oxides emissions (about 2%).

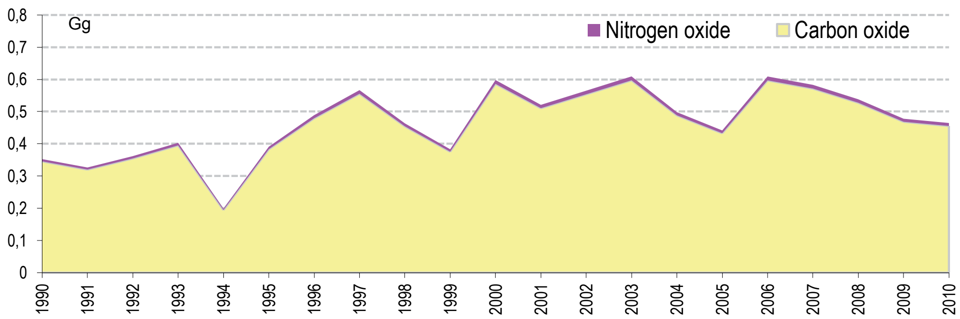


Fig. 2.66. Emission trends of precursor gases in LULUCF sector.

2.2.6.3. Key source categories and uncertainty

Key source categories have not been identified, as the sector has two fairly equal categories. Key sources in the categories were not identified due to their large number and lack of appropriate accounting.

Uncertainty in sinks is based on the results of the First National Forest Inventory of the KR, held in 2008 - 2010. According to the estimates, the uncertainty is 10%.

According to the expert assessment of uncertainty of a national factor of biomass expansion, they account for 30%, and the carbon stocks change - for 20%. Thus, the total estimate of sinks uncertainty is 37.4%.

The major uncertainties for soils affecting the inventory results are as follows:

- Cartographic transformations when working with "Land use" and "Soil maps" and layers of administrative borders - 5%. The basic error in determining the map areas appear on distortions in a choice of geographical projections in the cross-linking of individual pages, on the map applying for selection of soil types by the land-use categories, as well as on the precision limits embedded in the maps and a digital terrain model;

- Cross-assessment of mapping and reporting data - 5%. Under comparing the cartographic analysis results to the reporting data the small mistakes inevitably arise;
- Error in averaging humus content in the soil - 15%. Data on the humus content for time-series is provided not by a single value, but at by an interval, i.e., 2-3%. Selecting the average value was corrected, if data available, on the same soil type in the same year on areas with similar climatic conditions;
- Exposure of data on all types of humus content in soil from the sample - 10%. In collecting and processing data on the humus content a significant expansion of a scope of the soil types was reached. However, in 2 oblasts it was less than 90%, in 3 oblasts - from 90% to 95% and in 2 oblasts - over 95% of the exploited soil;
- Interpolation errors - 30%. The errors arise not so much due the interpolation algorithm error been used, but because of the extreme irregularity of available observations of the soil humus content.

Overall rating of uncertainty for estimating emissions/sinks from soils is 35.5%.

2.2.7. Waste sector

The Waste sector accounts for the emission of two GHG – methane and nitrous oxide. Emissions of precursor gases do not occur in this sector. The sector, according to IPCC guidelines, includes the following source categories:

6A Solid waste disposal (SWD);
6B Waste water handling;
6B1 Industrial water;
6B2 Domestic and commercial water.

2.2.7.1. Basic assumptions

The baseline formation for the SWD source category is the NSC official data on the volumes of disposed solid domestic waste (Fig. 2.67). It is worth noting that there is no connection between the SWD volume and the population living standards observed in many other countries. Significant fluctuations in the amount of disposed waste may be explained by the functioning of the waste disposal and recording system. According to expert estimations for the "Snow and other garbage" category, it was accepted that only half of this category refers to SWD by its morphological composition.

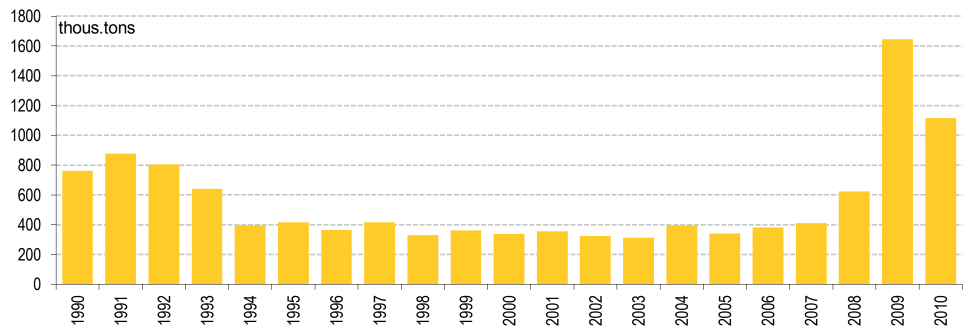


Fig. 2.67. SWD at landfills (dumps). Source: NSC

Considering that the country has no landfills for industrial waste (except for tailings, tailings pond, etc.) it can be assumed that a certain amount of industrial waste is still placed on landfills, but not officially taken into account, and it is insignificant by the expert estimates.

Since the annual disposal value of solid waste is accounted by the NSC in cubic meters and only since 2010, a number of disposed wastes are given in tons. Re-estimation uses the waste density. During 1990-2010 only fragmentary data on SWD density is available, which led to a need for interpolation. The interpolation used a nonparametric approach with a core grade.

The situation is similar for the morphological composition. Regular observations of a morphological structure are not carried out in the country, and a nonparametric interpolation was used to recover the missing data.

According to expert estimations, all landfills refer to the unmanaged ones. Out of those, the Bishkek and Osh cities landfills were assigned to the landfills over 5 m deep, all others referred to the unmanaged landfills (dumps) with a depth below 5m.

Considering that no research has been conducted to identify the constant of the methane formation speed required for the use of the «First generation decay method", and given a lack of historical data on the waste amount and its morphological composition until 1990, methane emissions estimation was made by the Lack method, as recommended by IPCC Guidelines.

SWD in landfills is not practiced, except in case of accidental self-ignition. Methane from the organic fraction storage is not captured and used.

Wastewater, both municipal and industrial, is mainly discharged into a centralized sewerage system. Generally, industrial wastewater is cleaned together with the settlements' municipal sewage (Fig. 2.68). The main methods of the wastewater management plants are mechanical and biological refining. Heavily contaminated wastewater from the separate industrial enterprises is pre-refined in the sewage processing plants before entering the communal system. GHG emissions from wastewater management plants are not captured and not used. As a result of missing national data, the emission factors were adopted by the IPCC recommendations. The NSC official data were used as a data source to calculate the emissions in the «Wastewater management» source category.

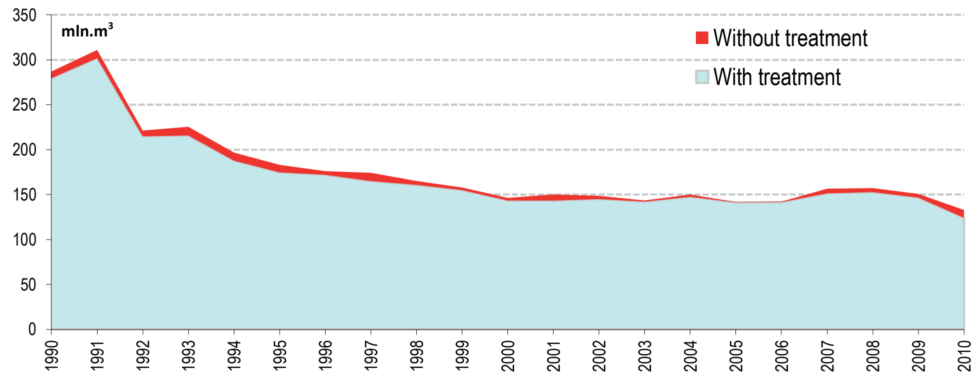


Fig. 2.68. Volume of wastewater transitory through drainage pipes. Source: NSC

A reduction in the waste water volume discharged in drainage pipes (Fig. 2.68) is explained by a significant decrease in water consumption by major consumers – the industries and population (Fig. 2.69). As a result, if at the beginning of the 90s a share of water transitory through drainage pipes was below one third of the total consumption, then by the end of the inventory period it almost doubled, which from an environmental point of view is considered as a positive trend.

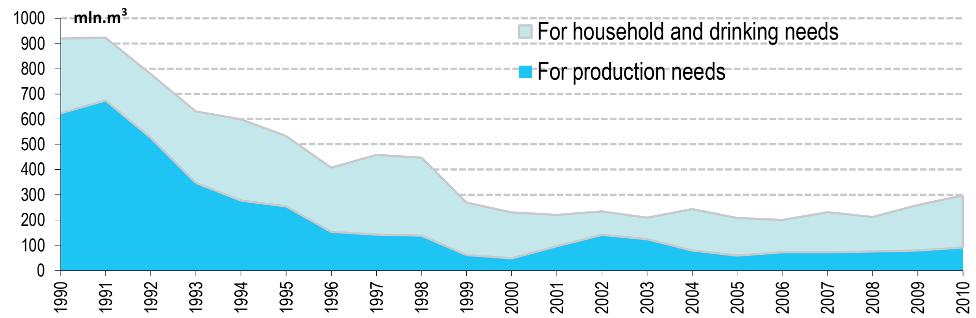


Fig. 2.69. Volumes of consumed water for domestic and industrial needs. Source: NSC

2.2.7.2. Emissions trends in the Waste sector

Trends of GHG emissions by individual sources categories in the «Waste» sector are shown in Fig. 2.71.

GHG emissions from the «Waste» sector sharply declined in 1990-1994 (since 1210 to 613.1 Gg CO_2-eq.), then slowly decreased until 2007 (504.5 Gg CO_2-eq.), and significantly increased (1000 Gg CO_2-eq.) in recent years.

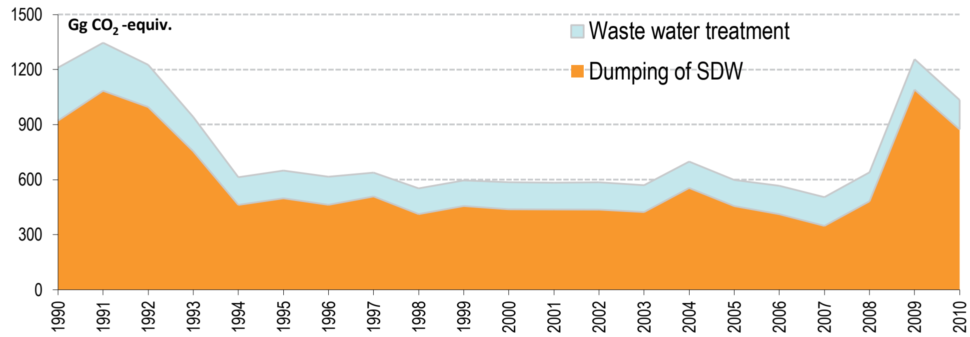


Fig. 2.70. GHG emissions trend by sources categories in the Waste sector

The contribution of SDW category increased from 76.1% in 1990 to 84.5% in 2000, with a corresponding reduction in the contribution from the Waste water handling category.

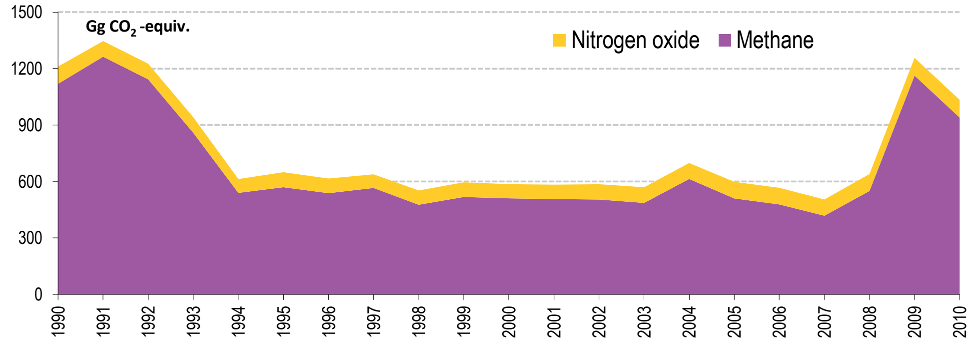


Fig. 2.71. Emissions trend by selected GHG in the Waste sector

Trends in GHG emissions by selected gases are shown in Fig. 2.72. Methane emissions decreased gradually from 91.8% in 1990 to 82.9% in 2007, with an increase to 90.9% by 2010, while the opposite is true for the nitrogen oxides emissions. Changes in the GHG emissions ratio is determined by a significant increase in the volume of solid waste disposal, and accordingly an increase in methane emissions in recent years.

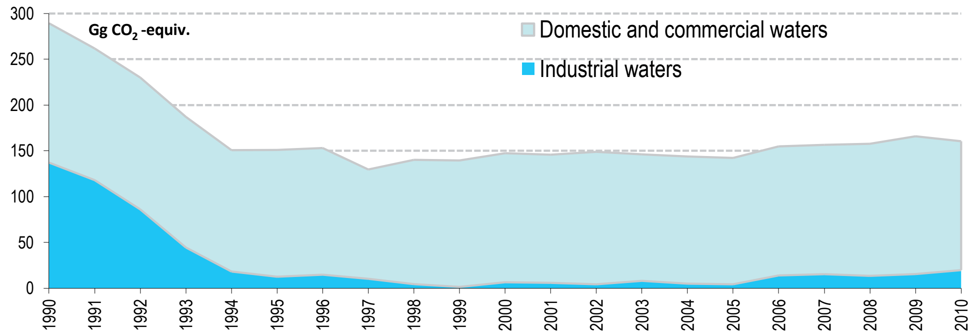


Fig. 2.72. Trends of GHG emissions by subcategory in Waste water management category

The change in GHG emissions for Waste water handling category (Fig. 2.73) is almost identical to the changes in total GHG emissions for the country. There was a sharp reduction in emissions in the first years (from 289.2 Gg CO_2-eq. in 1990 to 150 Gg CO_2-eq. in 1995), followed by a slow growth at about halved level of 1990 emissions. In 2010 the emissions totaled 160.5 Gg CO_2-eq. Most intensely, the emissions in the Industrial water sub-category reduced from 137.2 Gg CO_2-eq. in 1990 to 12.6 Gg CO_2-eq. in 1995. As a result, the contribution from the Industrial water sub-category in 1990 was 47.4% of total emissions category. In 2010 it was only 12.4% reflecting the structural changes in the national economy.

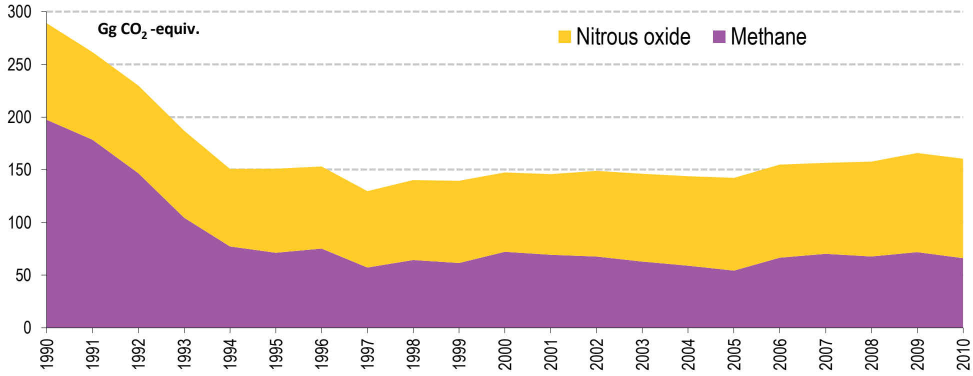


Fig. 2.73. Trends of GHG emissions by selected GHG in the Waste water category

The ratio of separate GHG emissions in the Wastewater handling category did not change as much as the ratio of emissions between individual subcategories. In 1990, emissions of methane and nitrous oxide accounted for 68.3% and 31.7%, and in 2010, 41.1% and 58.9%, respectively

2.2.7.3. Uncertainty

National estimates of uncertainty for the waste sector are unavailable. So, the default emission estimations have been used. According to the IPPC Guidelines, uncertainty for the default methane emissions accounts for 67% of emission factor and for the activity data - 33%. Accordingly, the total uncertainty is 75%. Estimations for the industrial processes have been used for nitrous oxide due to a similarity of initial data and a nature of the emitting processes. For of emission factors the uncertainty is adopted at 35% and for the activity data 35%. The total uncertainty for nitrous oxide is 49.5%.

Table 2.32. Uncertainty assessment, %

GHG	Category	Emissions factor	Activity data	Total uncertainty
CH_4	SWD	67%	33%	75%
CH_4	Sewage water management	67%	33%	75%
N_2O	Sewage water management	35%	35%	49,5%

2.2.7.4. Key source categories

From Table 2.33 it follows that the key for carbon dioxide and nitrous oxide are the following sub-categories:

- SWD;
- Domestic sewage water.

Table 2.33. Identification of key categories for carbon dioxide in "Industrial processes" sector

Source categories	Emissions in 2010, Gg	Level	Total level
SDW disposal	41,61	0,9298	0,9298
Household sewage water	2,199	0,0491	0,9789
Industrial sewage water	0,9438	0,02109	1
	44,753	11,3173	

2.2.8. Emission by the regions

Assessment of the regional emissions distribution is based on the current official statistics. The main source of base data, the Fuel and Energy Balance of the Kyrgyz Republic, is issued since 2005 and is broken down by the oblasts and cities with a national status as shown in Table 2.34.

№	Title	Code
1	Issyk-Kul oblast	41702
2	Djalal-Abad oblast	41703
3	Naryn oblast	41704
4	Batken oblast	41705
5	Osh oblast	41706
6	Talas oblast	41707
7	Chui oblast	41708
8	Bishkek city	41711
9	Osh city	41721

Table 2.34. Administrative-territorial units. Source: State Classificatory "System of Designation of Administrative and Territorial Units of the Kyrgyz Republic, NSC, 2012

More detailed data by the districts and cities of regional sub ordinance are not available. Therefore, further in this section, a regional breakdown of GHG and precursor gases emissions/ sinks is made only for 2010. The required data on all sectors (e.g, Energy sector) and years is not available, it is issued only for the whole country.

2.2.8.1. Total emissions by the regions

The distribution of total GHG emissions (without sinks) in all sectors, except the Solvent use sector with no GHG emissions, is shown in Fig. 2.74 and Fig. 2.75. Bishkek city contributes most significantly to the total GHG emissions, i.e. over one third of all emissions (4940 Gg CO_2 -eq. or 35.6%), and this contribution is mostly made by two sectors - Energy (4259 Gg CO_2 -eq.), and Waste (682 Gg CO_2 -eq.). The next largest contributors are the Chui oblast - 12.8%, the Djalal-Abad oblast - 10.8%, the Osh oblast - 10.6%, the Batken oblast - 9.2%, the Issyk-Kul oblast - 8.4%, the Naryn oblast - 4% , Osh city - 3.3% and the Talas oblast - 2.5%. In all regions there is a significant contribution from the Agriculture sector, while the contribution of the Industry sector is significant only in the Chui region.

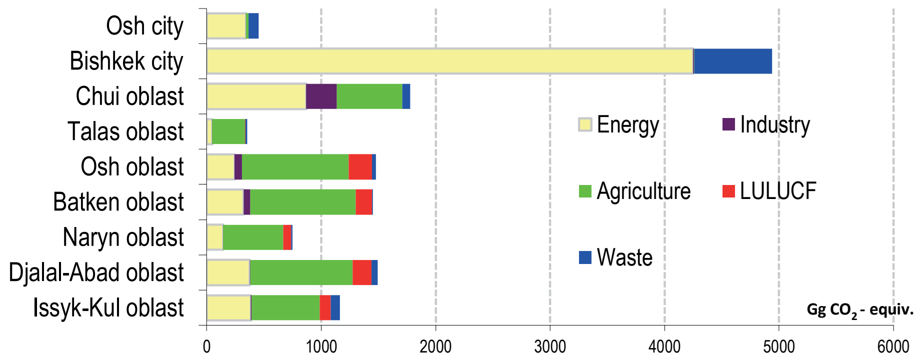


Fig. 2.74. Regional distribution of total GHG emissions by sector

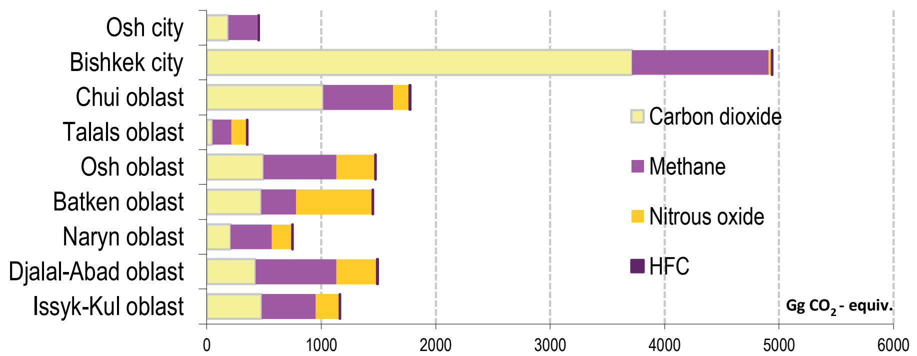


Fig. 2.75. Regional distribution of total emissions by GHG

The distribution of GHG emissions is largely determined by the distribution by the sectors. Carbon dioxide emissions are almost entirely determined by the Energy sector, and the methane emissions - by the Waste sector.

The distribution of precursor gas emissions by the regions is more uneven than that for GHG, since their emission occurs mainly in the processes of fossil fuel combustion, most characteristic for Bishkek city (Fig. 2.76). The share of Bishkek city in the total precursor gases emissions s over 214 Gg or 69.4%, followed by the Chui - 8.1%, the Djalal-Abad - 5%, the Osh - 4.3%, the Issyk-Kul oblasts - 4.1% , Osh city - 3.3%, the Batken - 3.3%, the Naryn - 1.8% and the Talas oblasts - 0.6%.

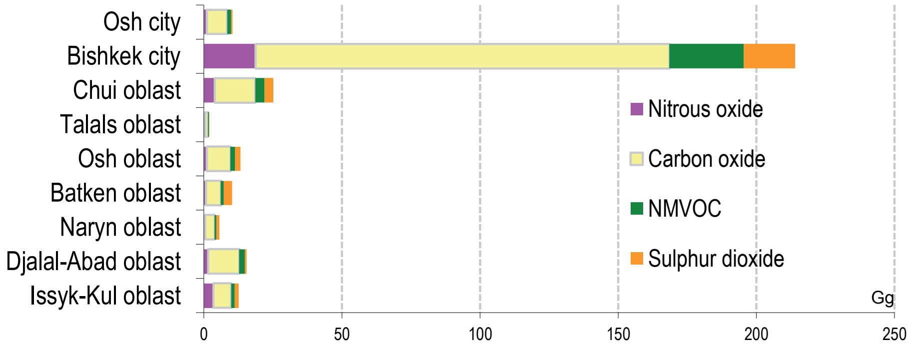


Fig. 2.76. Regional distribution of total precursor gases emissions

Table 2.35. Regional emissions per capita

Region	total GHG, CO_2-eq./person	Precursor gases, kg/person				
		NOx	CO	NMVOC	SO_2	сумма
Issyk-Kul oblast	2,63	7,83	14,44	3,08	3,08	28,44
Jalal-Abad oblast	1,46	1,60	10,93	2,02	0,60	15,15
Naryn oblast	2,89	2,02	13,07	2,05	4,59	21,74
Batken oblast	3,35	1,77	12,30	2,56	6,84	23,46
Osh oblast	1,32	0,98	7,61	1,60	1,71	11,90
Talas oblast	1,54	1,95	4,66	1,28	0,88	8,78
Chui oblast	2,20	4,95	18,08	4,21	3,83	31,06
Bishkek	5,84	22,12	176,91	31,81	21,99	252,83
Osh city	1,74	3,98	28,42	5,56	1,82	39,78

TTable 2.36. Regional emissions per 1 km²

Region	Total GHG, CO_2-eq./1 km²	Percursor gases, kg/1 km				
		NOx	CO	NMVOC	SO_2	Total
Issyk-Kul oblast	26,95	80,18	147,85	31,54	31,59	291,16
Jalal-Abad oblast	44,33	48,55	331,91	61,21	18,30	459,97
Naryn oblast	16,58	11,61	74,98	11,78	26,35	124,72
Batken oblast	85,39	45,08	313,83	65,33	174,46	598,71
Osh oblast	50,58	37,36	291,17	61,37	65,64	455,54
Talas oblast	30,93	39,08	93,67	25,79	17,74	176,28
Chui oblast	87,97	197,89	723,19	168,50	153,05	1242,63
Bishkek city, kt/1 km²	29,06	110,13	880,91	158,40	109,48	1258,93
Osh city, kt/1 km²	24,43	55,69	398,09	77,92	25,43	55,71

Table 2.35 shows the regional distribution of GHG emissions, defining the geographical priorities of actions to reduce GHG and precursor gases emissions. Table 2.36 shows the regional distribution of emissions per 1 km², characterizing the environmental situation, as precursor gases are the key pollutants.

2.2.8.2. Emission in Energy sector by region

The largest contributor of GHG emissions is the Energy sector and, therefore, Bishkek city has the greatest potential to reduce emissions (4,249.7 Gg CO_2 -eq., or 60.9% of total emissions), followed by the Chui oblast, which accounts for 868.8 Gg CO_2 -eq., or 12.4% of total emissions, the other regions contribution is negligible and does not exceed 5.5% (Fig. 2.77). The major GHG sources for Bishkek city are the «Energy», «Transport» and «Residential» categories. It should be noted that significant emissions are characteristic for the «Fugitive emissions from fuels" source category, most of which are the completely preventable loss of natural gas (Section 2.2.2.4.6).

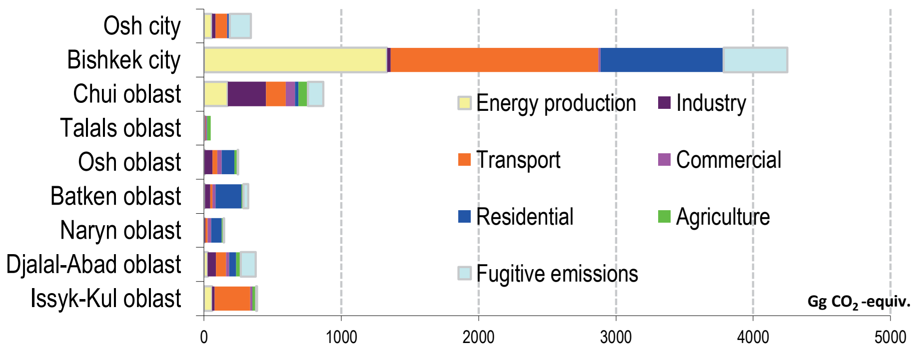


Fig. 2.77. Regional distribution of emissions by source categories in the Energy sector

To determine the sources with the greatest GHG emissions reduction potential shows the regional distribution of GHG emissions by selected GHG is show in Fig. 2.78. For all regions, the greatest contribution is made by carbon dioxide - 85.8%, followed by methane - 13.9% and nitrous oxide - 0.3%, which is typical for the sources with the fossil fuels combustion.

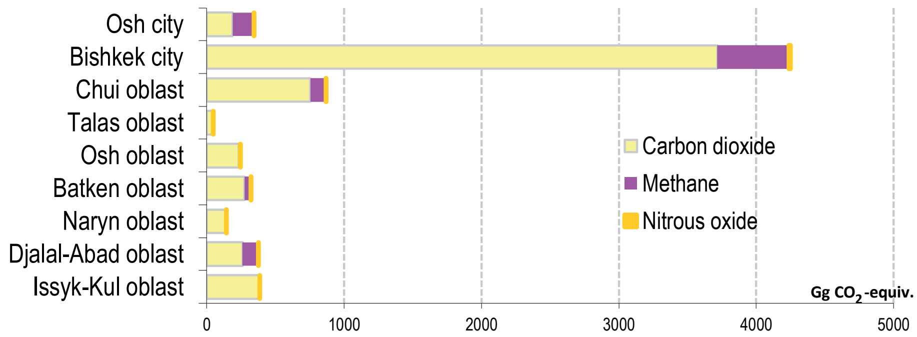


Fig. 2.78. Regional distribution of GHG emissions by gases in the Energy sector

Fig. 2.79 presents the regional distribution of emissions by precursor gases, which is even more unequal than the GHG distribution. By the sum of the gases a share of Bishkek city accounts for 213.7 Gg or 71.4%, followed by the Chui oblast - 21.5 Gg or 7.2%, the Issyk-Kul oblast - 4.8%, the other regions share does not exceed 4% .

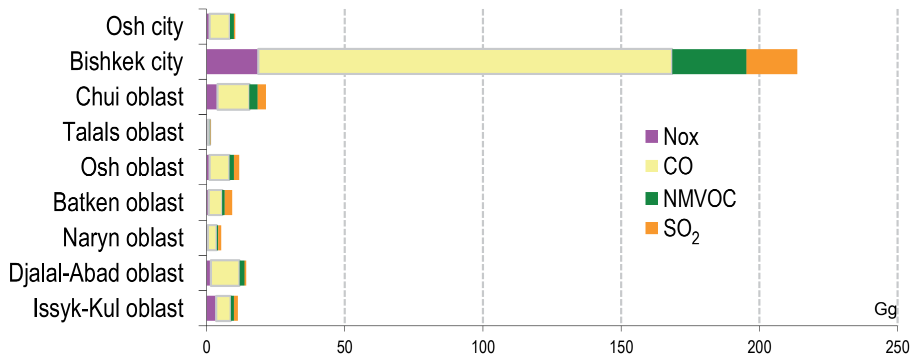


Fig. 2.79. Regional distribution of precursor gas emissions for the Energy sector

2.2.8.3. Emissions in the Industrial Processes sector by the regions

The largest GHG emissions from industrial processes and, accordingly, with the greatest potential to reduce emissions ,belongs to Chui oblast (266 Gg CO_2 -eq., or 60.9% of total emissions), followed by the Osh and Batken oblasts, accounting for 63.3 Gg CO_2 -eq. or 15.5% and 60.0 Gg CO_2 -eq. or 14.6%, respectively. The contribution of other regions does not exceed 1.5% (Fig. 2.80). This distribution mainly reflects the location of the cement production enterprises, which are the major emitters of carbon dioxide. The contribution of carbon dioxide in industrial processes is predominant (93.1%). Another GHG - HFC-134a is more evenly distributed across the regions, but its contribution to the total emission of the sector is small - 6.9%.

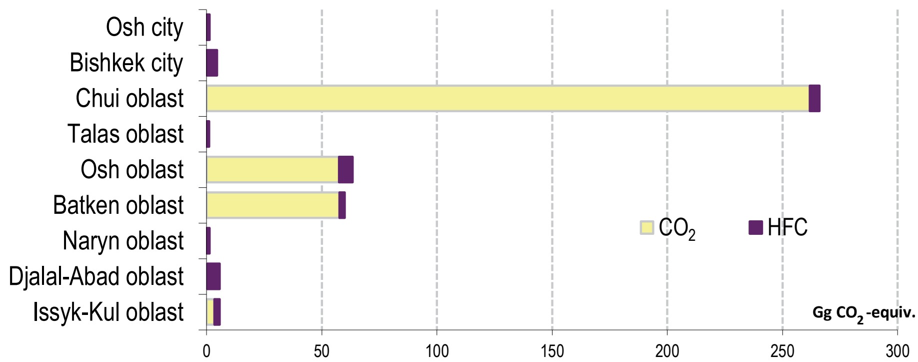


Fig. 2.80. Regional distribution of GHG emissions by gases in the Industrial processes sector

Fig. 2.81 presents the regional distribution of precursor gases emissions, which are more evenly distributed across the regions, except for relatively lower emissions in Osh city. By the amount of gases a share of the Chui oblast is 0.48 Gg or 24.0%, followed by the Batken oblast - 0.42 Gg or 20.7%, Bishkek city - 0.30 Gg or 14.7%, the Djalal-Abad oblast - 0.22 Gg or 11.1%, the Issyk-Kul oblast - 0.19 Gg or 9.4%, the Talas oblast - 0.16 Gg or 7.8%, the Osh oblast - 0.16 Gg or 7.5 %, the Naryn oblast - 0.09 Gg or 4.6%, and Osh city - 0.01 Gg or 0.25%.

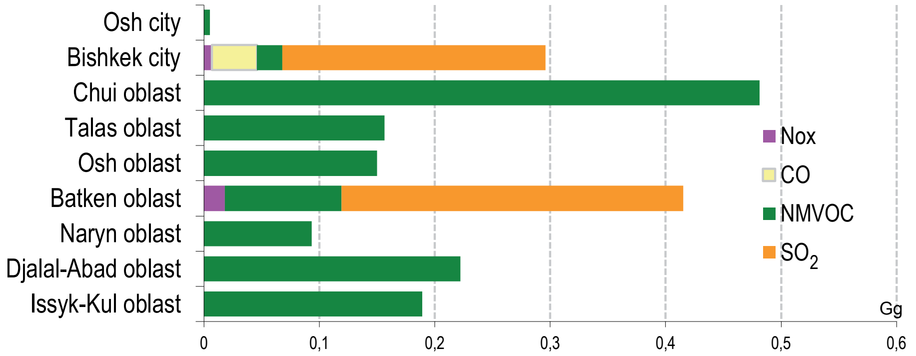


Fig. 2.81. Regional distribution of precursor gas emissions in the Industrial processes sector

2.2.8.4. Emission in the Agriculture sector by the regions

Fig. 2.82 shows the regional GHG distribution by the source categories in the Agriculture sector. The largest GHG emissions in the sector are accounted for the Osh oblast - 932.4 Gg CO_2 -eq. or 19.6% of total emissions, followed by the Batken oblast - 917.5 Gg CO_2 -eq. or 19.6%, the Djalal-Abad oblast - 893.7 Gg CO_2 -eq. or 18.8%, the Issyk-Kul oblast - 595.0 Gg CO_2 -eq. or 12.5%, the Chui oblast - 574.5 Gg CO_2 -eq. or 12.1%, the Naryn oblast - 522.6 Gg CO_2 -eq. or 11.0% and the Talas oblast - 288.1 Gg CO_2 -eq. or 6.1%. For obvious reasons, the contributions of Bishkek and Osh cities into the total GHG emissions of the sector are insignificant.

The main contribution to the emission come from "Enteric fermentation" and «Agricultural soils" source categories, which accounted for 2,597.8 Gg CO_2 -eq. and 1952.8 Gg CO_2 -eq., or 54.7% and 41.1% respectively. Emission of the "Enteric fermentation" and "Manure storage systems" source categories are proportional to the domestic animals number (Table 2.37). The "Manure storage systems" and "Agricultural residues incineration", source categories for which really significant emission reductions are possible, are only 134.4 Gg CO_2 -eq. and 8.0 Gg CO_2 -eq., or 2.83% and 0.17% respectively; i.e. only 3% of the total GHG emissions in the Agriculture sector.

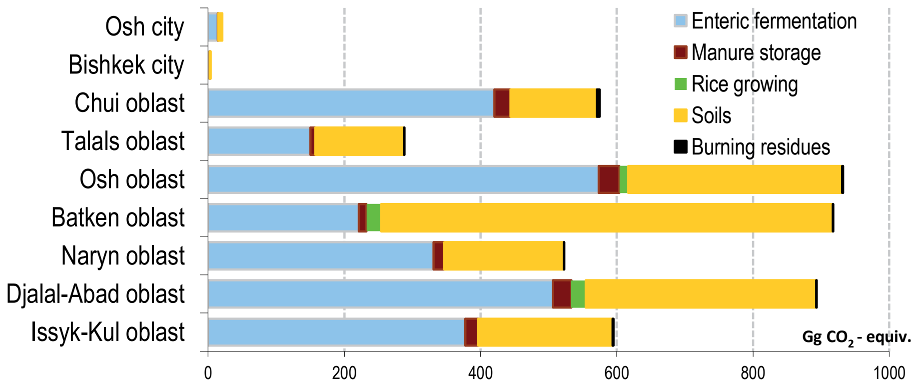


Fig. 2.82. Regional distribution of emissions by selected GHG in the Agriculture sector

Table 2.37. Livestock and poultry by regions for 2010, per thous. head. Source: NSC

	Batken oblast	Djalal-Abad oblast	Issyk-Kul oblast	Naryn oblast	Osh oblast	Talas oblast	Chui oblast	Bishkek	Osh
Cattle	184,9	266,6	133,5	115,9	308,5	65,4	248,9	1,1	9,0
Cows	93,7	142,7	70,9	59,6	157,3	33,1	119,9	0,3	4,0
Pigs	9,0	0,4	0,0	0,1	0,3	0,8	48,2	0,3	0,1
Sheep and goats	771,5	1090,1	916,0	454,2	972,6	483,1	559,3	4,3	16,0
Horses	81,1	53,9	93,2	6,5	82,4	23,3	47,7	0,3	0,5
Domestic poultry	790,5	848,3	171,8	251,3	766,1	242,5	1680,4	28,8	29,6

Fig. 2.83 presents a regional emissions distribution by selected GHG. Whereas methane emissions are determined by a number of livestock and poultry, nitrous oxide depends on the mineral fertilizers application. Methane emissions are 58.8% of the sector total emissions, and nitrous oxide emissions are 41.2%.

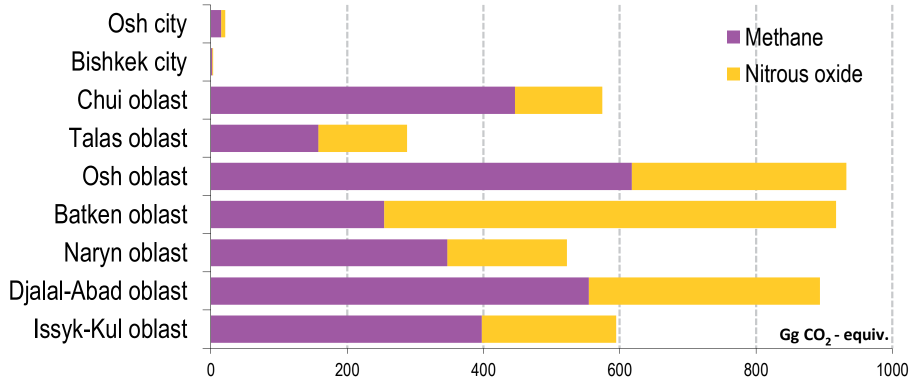


Fig. 2.83. Regional distribution of GHG emissions in the Agriculture sector

The precursor gases emission in the Agriculture sector befalls only in the Agricultural residues incineration source category. Hereafter, a small emission volume is understandable, since an amount of the agricultural residues incinerated is small and can be completely terminated without a loss to the economic activity (Fig. 2.84).

The inputs of Bishkek and Osh cities to the precursor gases total emissions in this sector are missing.

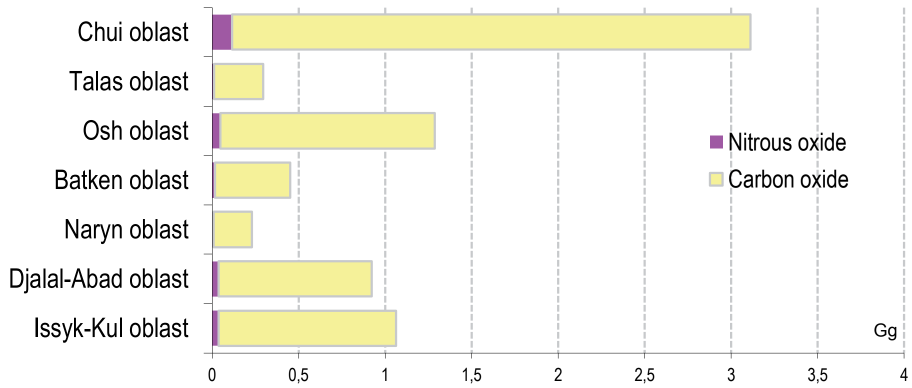


Fig. 2.84. Regional distribution of precursor gas emissions for the Agriculture sector

2.2.8.5. GHG emission/sinks in the LULUCF sector by the regions

In this sector only dioxide emissions and sinks takes place (Fig. 2.85). Only in the Chui oblast the carbon dioxide sink is observed. For all other regions the carbon dioxide emissions from soils were observed during 1990-2010. Total net emissions for 2010 are negative, i.e., sink exceeds emission by 284.8 Gg. This is typical only for the last few years.

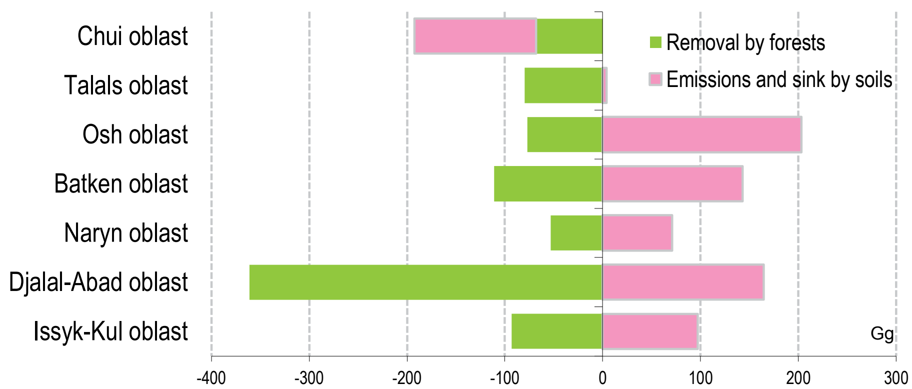


Fig. 2.85. The regional distribution of carbon dioxide emissions and sinks for the LULUCF sector

In addition to carbon dioxide, in the LULUCF sector the precursor gases are also emitted by the wood residues incineration in situ. However, volumes and emissions of burnt residues are insignificant (less than 1 Gg) and therefore are not shown.

2.2.8.6. Emission in the Waste sector by region

Fig. 2.86 shows the regional distribution of GHG emissions by source category for the Waste sector. The largest GHG emissions in the sector refer to Bishkek city - 682.4 Gg CO_2 -eq. or 65.7% of total emissions, followed by Osh city - 87.5 Gg CO_2 -eq. or 8.4%, the Issyk-Kul oblast - 78.3 Gg CO_2 -eq. or 7.5%, the Chui oblast - 67.8 Gg CO_2 -eq. or 6.5%, and Jalal-Abad oblast - 54.2 Gg CO_2 -eq. or 5.2%, emissions from other regions are negligible and do not exceed 3.3%. The main contribution to the emission comes from the SWD source category, which accounts for 873.7 Gg CO_2 -eq. or 84.1%. The main potential for emissions reduction also falls to this source category.

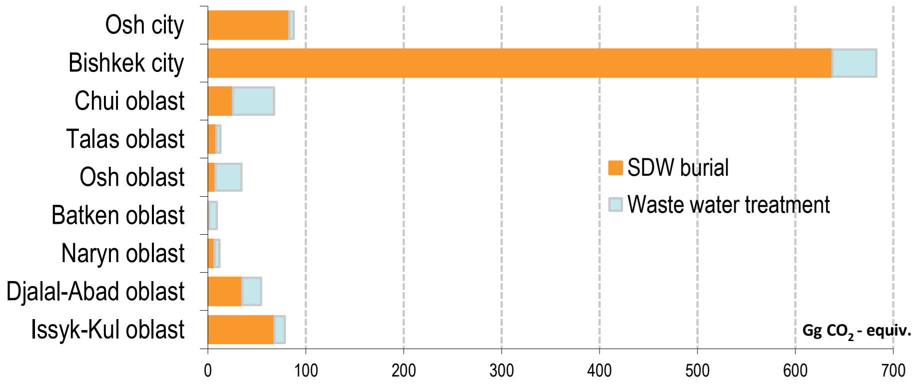


Fig. 2.86. Regional distribution of emissions by source category in the Waste sector

Fig. 2.87 shows the regional distribution of emissions by selected GHG. Methane emissions are defined by the SWD source category and to a lesser extent by Wastewater management source category. The nitrogen oxide emissions are defined only by the Wastewater management source category. Methane emission is 939.7 Gg CO_2 -eq. or 90.5% of the total sector emissions, and nitrogen oxide emissions - 99 Gg CO_2 -eq. or 9.5%.The distribution of methane emissions by regions corresponds with the overall GHG distribution. The highest emission of nitrogen oxide in the Waste sector is observed in the Osh oblast - 24 Gg CO_2 -eq., followed by the Djalal-Abad oblast – 17.8 Gg CO_2 -eq., Bishkek city – 14.8 Gg CO_2 -eq. and Chui oblast – 14.1 Gg CO_2 -eq. In other oblasts emissions of nitrogen oxide do not exceed 8 Gg CO_2 -eq.

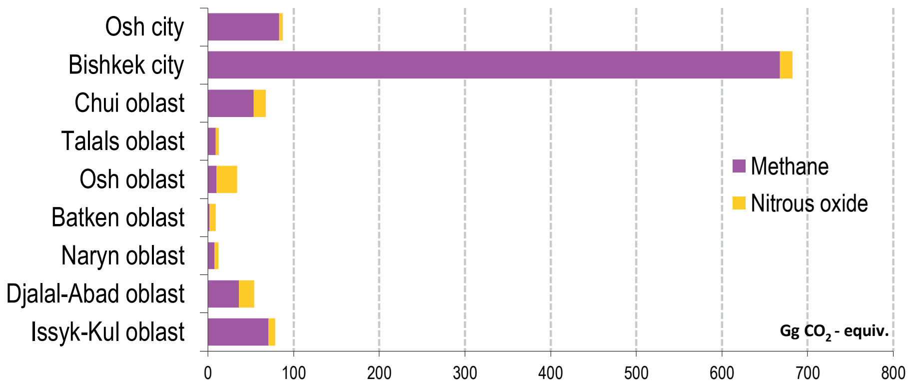


Fig. 2.87. Regional distribution of emissions by GHG in the Waste sector

The precursor gases emission is practically not available in the Waste sector.

3 Adaptation

3.1. Background

Climate change is taking place at a rate unprecedented in the past human history, and this trend is to continue in the coming decades. According to the IPCC Fifth Assessment Report [3.1], the climate will change in the future as a result of the past, present and future anthropogenic GHG emissions and the impacts will endure for centuries, even if GHG emissions stopped completely.

Hence, the adaptation measures are essential under any scenario of economic development and levels of mitigation activities. The adaptation process consists of the following stages:

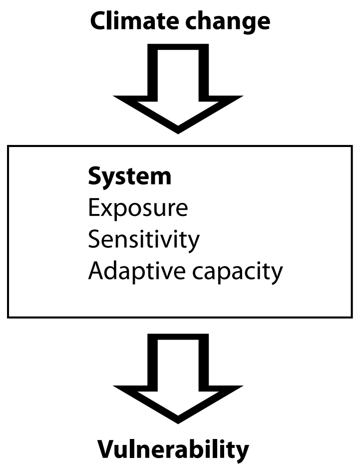
a. Assessment of impacts, vulnerability and risks taking into account the interconnection of the factors. A primary assessment is required in order to understand the extent of climate change impact on natural resources, i.e., on the water resources availability, affecting agriculture and food security in turn. The impact level on the population and the economic sector should also be assessed, including their adaptive capacity.

b. Adaptation planning. The identification of adaptation measures with a concurrent costs and benefits estimation for selecting the priorities. Planning should account the activities comprehensiveness to avoid duplication and ensure sustainable development.

c. Implementation of adaptation measures. Measures should be implemented at all possible levels, i.e. national, regional and local, and by different means, with the projects, programs, policies or strategies. The measures implementation can take place both as a separate process and integrated into sustainable development plans.

d. Monitoring and evaluation of adaptation measures. Monitoring and evaluation should be carried out throughout the adaptation process. The knowledge and information obtained should be used to support the effectiveness of the future actions.

Formerly, a fairly simple scheme was considered to assess the climate impacts on different systems (population, livelihoods, ecosystems species, ecological functions, services and resources, infrastructure, or economic, social and cultural assets), which was an immediate assessment of the system's response to climate change. Recently, the IPCC has expanded the understanding of the climate changes mechanism.



In accordance with the above structure, the system, which is affected by climate change, has certain properties:

- Exposure – the system's location in area and conditions that could be impacted;
- Sensitivity - the extent to which climate change or variability negatively or positively affect the system.
- The effects may be direct (e.g., changes in crop yield with changing climatic factors) or indirect (e.g., damage caused by an increase in the frequency of coastal flooding due to a sea level rise);

Adaptive capacity - the ability of systems, institutions, individuals, etc. to adapt to the climate change impacts, i.e. the ability to use their own capabilities or to respond to consequences in order to reduce potential damage.

The differences in the mechanisms of the impact assessment are due to a need to address the non-climatic factors and uneven development processes.

These differences form the differential vulnerability caused by climate change. The bottom line is that vulnerability is rarely brought about by a single cause. It is rather a product of various overlapping processes that generate inequalities in socio-economic status and the income level, as well as the exposure degree. Consequently, the further vulnerability assessment will take into account additional non-climatic factors, where possible.

3.2. Climate change

The observed climate changes are given in Chapter 1. A reliable assessment of the expected changes is more difficult due to considerable uncertainty arising mainly from the strong dependence on an efficiency of the global mitigation actions. The climate models now more accurately reproduce a number of important climate factors. So, the expected changes assessment is usually represented as a set of scenarios of anthropogenic impacts. The expected climate change in the KR will follow more rapidly (as observed already), since the warming process in the northern hemisphere was and will be more rapid than the global average. Additionally, it has been, and will be, more significant over the land than over the oceans, with a very high certainty degree.

The IPCC Fifth Assessment Report used a new set of scenarios, namely, the Representative Concentration Pathways (RCP). They correspond to the different future anthropogenic GHG emissions during this century. Differences in emissions are associated with the multiple potential ways of socio-economic development of the world. The main difference from the previous RCP scenarios is the use of a variety of defining characteristics (IPCC Special Report. Emissions Scenarios [3.2]).

The RCP scenarios differ by the specific climatic factor - radiation exposure. For example, the RCP 4.5 scenario assumes that by 2100 the radiate imposing will increase by 4.5 W/m^2 due to anthropogenic GHG emissions. The previous scenarios were based on the different options of economic and demographic development and the projected levels of mitigation actions. For the users, it is easier to select from the 4 new scenarios than from the previous 40 with a very indistinct set of socio-economic conditions. However, in fact the new scenarios indirectly include the elements of development options (or rather the development results).

A summary of the estimation based on the Coupled Model Intercomparison Project Phase 5 (CMIP5) is shown in Table 3.1.

Table 3.1. Change in average global surface air temperature by CMIP5 ensemble in ^{0}C re 1986-2005. Source: Climate Change 2013. Physical Science Basis. IPCC [3.1]

Scenario	2046–2065 гг.		2081–2100 гг.	
	Average	Probable series	Average	Probable series
RCP2.6	1,0	0,4–1,6	1,0	0,3–1,7
RCP4.5	1,4	0,9–2,0	1,8	1,1–2,6
RCP6.0	1,3	0,8–1,8	2,2	1,4–3,1
RCP8.5	2,0	1,4–2,6	3,7	2,6–4,8

The figures in Table 3.1 are the global ones. In fact, a significant differentiation of the expected climatic indices is projected for the different regions.

Change of surface temperature trends against the 1986-2005 level and the precipitation amount in the Central Asian region, based on the CMIP5 ensemble, are shown in Fig. 3.1. The diagrams illustrate the temperature rise with different speed under all scenarios, and actual stabilization of precipitation for all scenarios.

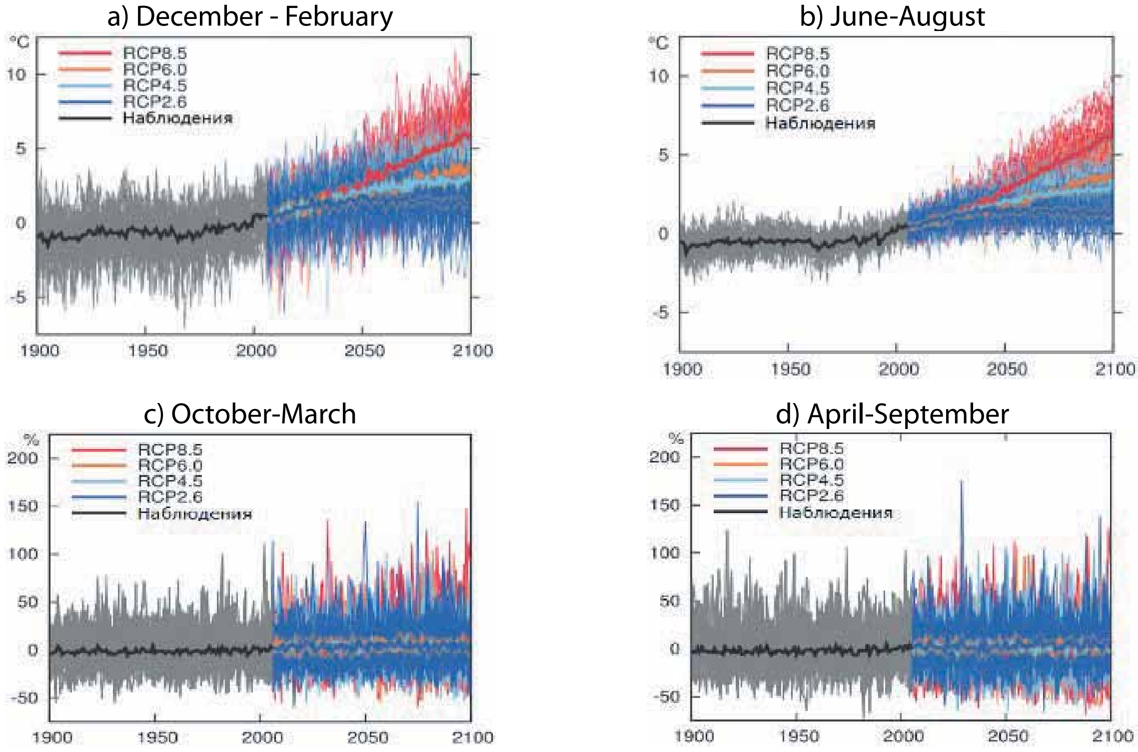


Fig. 3.1. Seasonal trends of surface air temperature (°C) and annual precipitation amount (mm) re 1986- 2005 in the Central Asian region. Source: Climate change, 2013: The Physical Science Basis. IPCC [3.1]

Appendix 3 shows the map of surface atmosphere temperature and of annual precipitation amount for RCP4.5 scenario (as an average rate of temperature increase) and for RCP8.5 scenario (most unfavorable) in the Kyrgyz Republic for 2030 and 2070. Maps are made according to the data of the University of California, Berkeley, web portal (http://www.worldclim.org) and the Research Programme on Climate Change, Agriculture and Food Security (http://www.ccafs-climate.org/). A full ensemble of models has been used with further calculation of the average values by the ensemble. It covers the whole Central Asian region, including Kyrgyzstan, plus one degree of latitude and longitude from the north, south, east and west. The resolution was selected in 2.5 arc minutes, as maintaining a balance between the map particularity and complexity of data processing.

As seen, the significant changes in amount and distribution of the annual precipitation are not expected. A large part of the country, according to the IPCC definition by an annual precipitation amount, still refers to an arid zone, and the main area relates to a semi-arid zone.

The precipitation level is expected to remain stabilized with a simultaneous substantial temperature increase, especially for RCP8.5 scenario. The expected climate changes are uncomplimentary for the national economy (especially agriculture), health and nature systems, predetermining a necessity for the adaptation measures implementation.

3.3. Setting-up adaptation actions

The adaptation policies development process was divided into two stages. In the first stage, the Priority Directions for Adaptation to Climate Change in the Kyrgyz Republic till 2017 (the Priority Priorities) was prepared and approved by the Government of the Kyrgyz Republic on October 2, 2013 #549 [3.5]. The document defines the key vulnerable sectors and the action areas for the country on the whole.

The Priority Priorities goal was to establish a national policy to mobilize resources aimed to minimize the negative risks and to use the potential of climate change for the sustainable development through the adaptation measures implementation in the sectors most vulnerable to climate change.

In the follow-up development strategies, the economic sectors activities should be harmonized with adaptation to climate change. The adaptation measures should be developed based on the analysis of the climate change risks, vulnerability assessment of the economic sectors, environment and population.

The Priority Directions is the first step towards a development of the system of inclusive planning and adaptation measures implementation in the framework of an inter-agency and cross-sectoral approach, involving all stakeholders in the adaptation projects development.

The main elements of adaptation activities include:

- the legal frameworks improvement;
- the institutional framework improvement and ensuring cross-sectoral integration in adapting to climate change;
- financial and economic mechanisms improvement, including the mobilization of external funding for the priority adaptation measures;
- improving information tools to provide monitoring of the climate change process and climate risk assessment;
- involvement of civil society in the climate change adaptation process;
- increasing the scientific capacity to adapt to climate change;
- organization and promotion of cross-border cooperation on climate change adaptation.

The priorities development process identified the highest priority sectors for adaptation, given the already observed and the expected climate change. The climate change scenarios [3.2] assessment was based on the Climate Profile of the Kyrgyz Republic [3.6]. Quantitative vulnerability estimates were obtained for each priority sector and adjusted to a specific amount of damage, i.e., expected economic losses in an absence of timely adaptation actions (Table 3.2).

Table 3.2. Estimated economic losses in an absence of adaptation measures under A2 scenario in 2100. Source: Priority Directions for Adaptation to Climate Change in the Kyrgyz Republic till 2017 [3.5]

Sector	Damage, mln. $2005
Water resources	718
Agriculture	70
Energy	200
Emergency situations	38
Healthcare	110
Forest and biodiversity	94,8
Total:	1230,8

The Priority Directions were developed with an involvement of the specialists from all key ministries and institutions of the Kyrgyz Republic, scientific and academic community, and NGOs.

The priorities development was followed by the second stage. The CCCC Decision of February 2013 obliged all key ministries and agencies to start a preparation of the sectoral adaptation plans and programs based on the Priority Directions. Sectoral plans and programs (Table 3.3) include an assessment of the sector current state, vulnerability assessment and justification of the adaptation measures and the actual plans with the estimated costs required for the implementation.

Table 3.3. Sectoral adaptation programs and plans

№	Ministry/agency	Sector	Decree on approval
1.	Ministry of Agriculture and Land Reclamation	Water resources and agriculture	No 228,31.07.2015
2.	Ministry of Emergency Situations	Emergencies	No 692, 7.07.2015
3.	Ministry of Healthcare	Healthcare	No 531, 31.10.2011
4.	State Agency for Environment Protection and Forestry	Forest and biodiversity	No 01-9/110, 17.04.2015

Upon a completion of the sectoral strategies, a number of quantitative indicators, apart from the usual comments, were set for each measure (Table 3.4), which facilitates many subsequent actions, such as the priority actions definition, monitoring of compliance, etc. The definition of the loss reduction indicators is sometimes impossible, even theoretically, for each distinct measure. For example, measures on awareness raising, capacity building, etc. isolated from the other measures do not lead to a reduction of losses. Such actions usually have a multiplicative effect on many other measures. Therefore, in some cases, the economic losses reduction was determined only for a group of separate measures that have some commonality in terms of economic losses reducing.

Table 3.4. Sample of design of the sectoral adaptation strategies after revision

Measure	Costs			Loss reduction	
	Domestic resources	External support	Total	By domestic resources	By external support
1					
2					
…					

Each sectoral strategy contains a complete set of measures to reduce the economic losses. Since the economic loss indicators are given for 2100, each strategy is actually developed for this period. Naturally, the losses in total cannot be reduced, only partially. The economic losses that cannot be reduced by the adaptation measures belong to the category that should be regulated under the proposed «loss and damage» mechanism.

The implementation terms of the separate measures in the sectoral policies are not addressed, as the performance of most of them depends not only on the domestic actions, but also on the external support timing. Only the validity periods of the sectoral strategies (3-5 years) were identified. The strategies are expected to be reviewed regularly taking into account the updated information, primarily by the climatic, demographic and macroeconomic scenarios, as well as the country's experiences on the vulnerability assessment, the economic losses and the adaptation measures implementation.

3.4. Sectoral vulnerability assessments

3.4.1. Methodology

To obtain more accurate results and more effective monitoring, a task was set to only get a quantitative vulnerability assessment. To enable a comparative analysis of the sectors, the specific vulnerability indicators for each sector were brought to an assessment of the economic losses. A similar approach was used to assess climate risks that are inherently largely based on the vulnerability assessments.

According to the IPCC definition [3.3], a risk can be communicated as an occurrence probability of the emergencies multiplied by their impacts. An impact is usually understood as one of the vulnerability characteristics.

Bringing the vulnerability assessments to the losses economic assessment, in combination with the cost of the adaptation measures implementing, makes the measures prioritization possible. This is an important step for the action plans formulation. Only the quantitative assessment of the priorities will properly resolve the inevitable inter-departmental inconsistencies and undertake the actions very important for the country.

The main indicator of the priority adaptation measure is a ratio of implementation costs of a certain measure (group of measures) to the losses cost reduced by this measure (group of measures), i.e.:

$$K_{ij} = \frac{З_{ij}}{П_{ij}}$$

where,
j – sectorial index,
i – sectorial measure index.

Under this approach to identify the priorities, the different subsectors and sectors can be compared.

$$K_j = \frac{\sum_i З_{ji}}{\sum_i П_{ji}}$$

In the sectors analysis there are two study areas related to:

- assessing of the slow changes effect in the average values of climatic parameters, i.e. actual climate change;
- assessing the effects of changes in climate extremes repeatability (climate risk assessment), i.e. changes in climate variability.

Furthermore, the sectors analysis, where possible, studied the impact level, both on climate change and on its variability.

Different methodological approaches have been used for the vulnerability and risk assessment:

- physical models, reflecting the link between the vulnerability indicators and the climatic factors, in line with the known physical, chemical, etc. laws (more often used for modeling a state of glaciers and runoff with the water balance equation);

- well-known special models, such as the GLAM model [3.4] to estimate crop yields in the changing climatic conditions;
- statistical assessment of the relationship between the climatic factors and the vulnerability indicators, often used under a lack of other reasonable alternatives;
- statistical assessment of the vulnerability indicators, but instead of applying the climatic factors some of their generalizations are used (e.g., for agriculture it could be the drought and humidity indices);
- assessment based on the analysis of selecting and tracking the trends of the areas with optimal conditions of existence (for ecological systems and biodiversity).

The obtained vulnerability and risk assessments often have considerable uncertainty. This is due to the actual disadvantages of the models used and the uncertainty of the received input data and basics (e.g. climatic, demographic and macroeconomic scenarios) that require a regular updating of the models and input data.

This section does not address vulnerability and adaptation in the energy sector, although a change in surface runoff significantly impacts on the energy sector as hydro sets up the majority of power generation. Hydropower accounts for 80% of the generation capacity. For example, in 2011 the country's hydroelectric plants produced 93% of total electricity.

It is assumed that the energy sector vulnerability can be reduced mainly due to the energy sources diversification, i.e. the mitigation measures.

3.4.2. Water resources

Modeling was carried out for 11 hydrological basins in the Kyrgyz Republic:

- Issyk-Kul Lake;
- Chui River;
- Talas River;
- Syrdarya River, including:
- Rivers of the northern border of the Fergana Valley (Syrdarya River);
- Naryn River (Syrdarya River);
- Karadarya River (Syrdarya River);
- Rivers of southern border of FerganaValley (Syrdarya);
- Chatyr-Kul Lake;
- Amudarya River;
- Tarim River;
- Balkhash Lake.

The four climate scenarios (RCP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5) were used as initial data. Despite that in all these scenarios no significant changes are expected in precipitation, for broader coverage of the possible options, three additional options for changes in the precipitation level have been considered for each scenario:

1. Maintaining the precipitation level at the existing level;
2. Precipitation increase by 5%;
3. Precipitation decrease by 5%.

The flow potential evolution has been modeled based on a water balance equation adapted to the mountainous territory

$$W = P - E - Bg \pm \varepsilon$$

where,

W - total runoff;

P - annual precipitation;

E - annual evaporation;

Bg - complete mass balance of glaciers in water equivalent (fluid loss of glaciers);

ε - other components of the water balance, considered to be insignificant.

Due to actual absence of monitoring, a balance of the underground water reserves and a balance of water in the permafrost were not considered. It was assumed that the annual volume of infiltration into groundwater is approximately equal to the volume of its output to the surface, and an upper boundary of the permafrost changes is negligible.

Glacial water loss

The glaciation modeling was performed separately for each of 6771 glaciers of the Kyrgyz Republic (with an area of 0.1 km^2 and more) with a summation of the results on the selected hydrological basins. 1437 glaciers with an area below 0.1 km^2, for which there are no baseline data (only their total number and total area is known), have not been measured. These small glaciers, almost impossible to be modeled due to a lack of source data, make up 17.51% of the glaciers total number with total area of 0.84% and estimated amount of 0.26%. Their contribution to the river flow is small and, therefore, not considered in the model.

A mathematical modeling of glacial evolution under the warming climate, developed by PhD V.A. Kuzmichenok [3.7], helped assess the glacial runoff. It represents a value of the water volume received by the drain in addition to the difference between precipitation and evaporation. The calculations are performed for all 11 aforementioned hydrological basins. Summarized results of the modeling for the Republic are presented in Table 3.5.

Table 3.5 Modeled averages of glacial water flow in % of total runoff under the climatic scenarios

Scenario	RCP 2.6			RCP 6.0			RCP 8.5		
Precipitation	-5 %	0	5 %	-5 %	0	5 %	-5 %	0	5 %
2020	4,4	3,4	2,4	6,9	6,1	5,1	9,1	8,3	7,5
2030	4,7	3,4	1,9	7,9	6,8	5,7	10,2	9,3	8,4
2040	4,9	3,3	1,4	8,2	7,2	6	10	9,4	8,6
2050	5	3,2	1	8	7,1	6	9	8,6	8,1
2060	5	3,2	0,6	7,3	6,8	5,8	7,7	7,4	7,1
2070	5	3,1	0,4	6,6	6,1	5,5	6,1	6,1	6,1
2080	4,8	3	0,3	5,8	5,5	5	5,1	5	4,8
2090	4,7	2,9	0,2	4,9	4,8	4,5	4,6	4,2	4
2100	4,5	2,8	0,2	4,3	4,1	4,1	4	3,7	3,5

Surface runoff

The surface runoff modeling used the relief digital models and moisture conditions of the country land area (DMR and DMHum respectively) developed by V.A Kuzmichenok [3.8]. Each of these digital models describes the territory by a set of relevant characteristics in the nodes of a regular (square) grid with a 500 m pitch on the ground. These nodes coincide with a rectangular coordinates grid of a direct equivalent conical projection, the best for the country. Therefore, each node «represents» the equal territorial units, covering an area of 0.25 km^2, and the calculations do not require any additional account of geodetic latitude. The land area of the Republic is wholly covered by 770,418 units of these digital models.

The relief digital model contains the following values for each node of the regular grid: height, angle of slope, expositions, orientation index and mean curvature of topographic surface macro slope. The surface orientation indicator refers to the cosine of the angle between the normal to the surface vector and the direction of the sun at noon on the summer solstice. The average surface curvature is understood as the arithmetic average of the reciprocals of the principal radii of curvature. It is obvious that the surface with a positive curvature tends to accumulation (in the broadest sense of the word), and negative - to drift.

The digital model of moisture conditions on the land area provides for each node the following values: average annual temperature, annual amount of precipitation, annual layer of volatility, annual layer evaporation, runoff and moisture.

The estimation of possible changes in the surface runoff on the whole hydrological basin of the country based on the glaciers fluid loss is shown in Fig. 3.2.

These data indicate a significant reduction in the flow under all possible scenarios and options for precipitation changes. However, the reduction range is very wide. For the worst-case climate change scenario (RCP 8.5 scenario and the annual precipitation reduction by 5%) the runoff may reduce by approximately 40%.

Calculations of surface runoff for separate hydrological basins showed a little difference of the changes between the basins, determined by the specific conditions of the runoff formation zone.

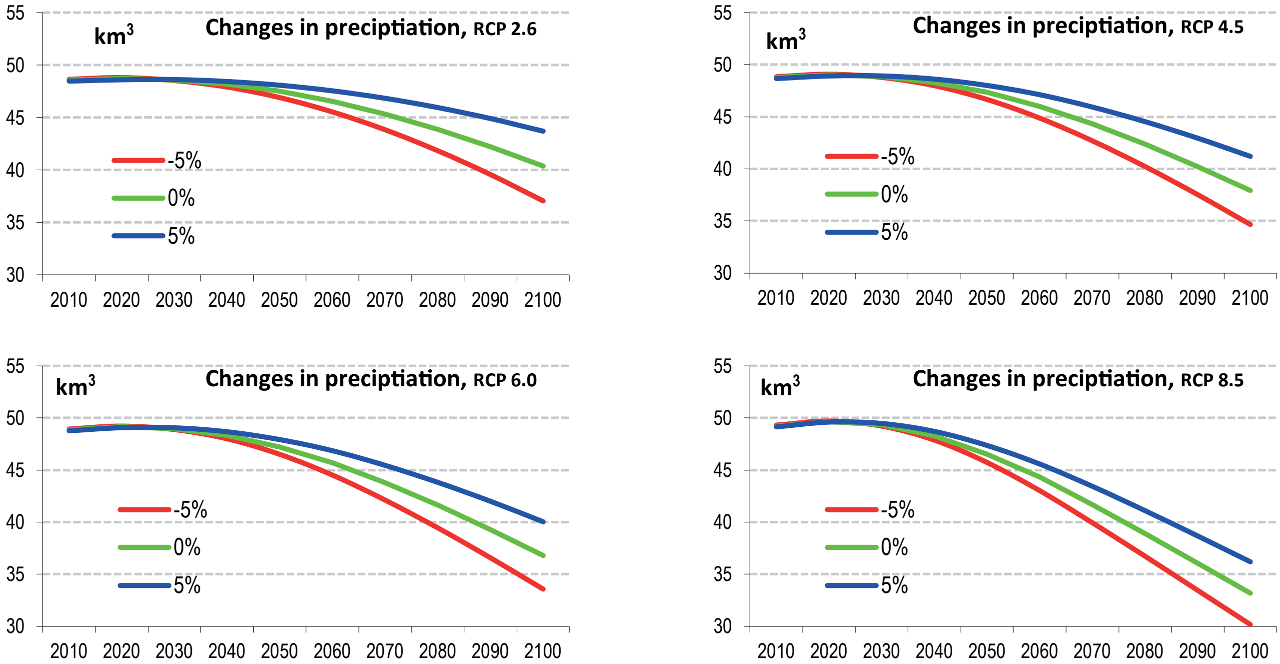


Fig. 3.2. Change in surface runoff in all basins under the climatic scenarios considering the glacial water flow

As seen in Fig. 3.2 and Table 3.5, the surface runoff is mainly determined by the atmosphere temperature and the precipitation, whereas the glaciers input to the total flow is lesser.

Runoff delivery

In addition to the surface runoff volume, its delivery was also modeled, which refers to a probability estimate of the minimum flows. The estimates used the statistical simulation method. The estimates of the probability of the climate factors (temperature and ground-level rainfall) distribution were obtained from the available observations. The statistical distribution of the climatic factors was assumed to be similar to the observed distribution, except for the mathematic expectations estimates. The estimates for the mathematic expectations for the climatic factors were used according to the climate scenarios. The modeling was performed separately to assess the glacial water loss and the runoff. Then the obtained results were combined to estimate the runoff accounting the glacial water loss.

The flow provision is required to assess an adequacy of the existing water resources and to determine the water reservoirs volume to ensure a continual water supply.

The estimation was made for all options from 0.01 to 0.99 for all water basins. Small values (e.g., 0.01) can be used to assess the floods. Fig. 3.3 shows the estimates for the whole country under two scenarios.

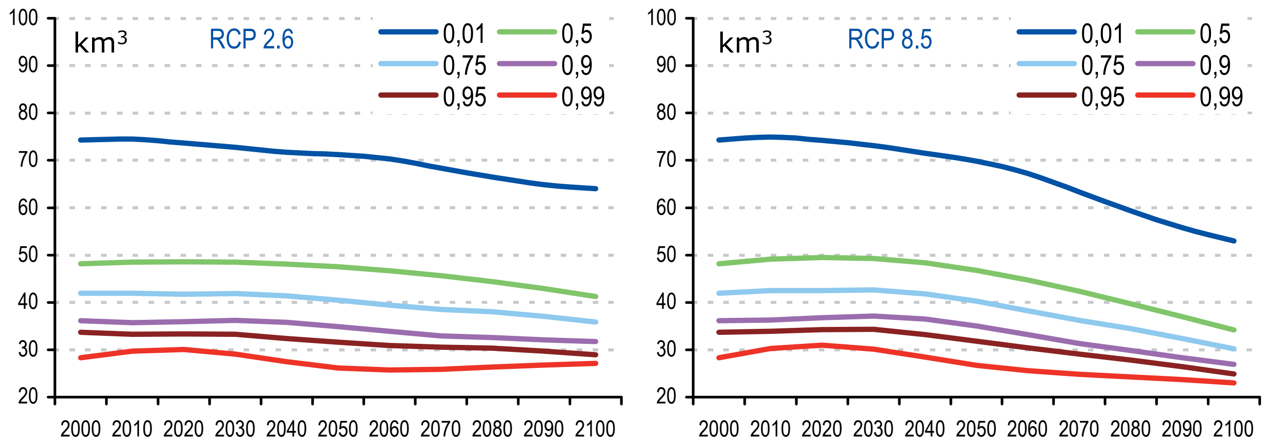


Fig. 3.3. Estimation of the surface runoff in the country, including the glacial water loss, under two climatic scenarios, RCP 2.6 (left) and RCP 8.5 (right)

As compared with the known assessments for other countries (e.g., [3.9]), the received provision ratio from 0.01 to 0.99 ranges about from 3 to 2.5, i.e. much lower.

Probably, the ratio is relatively small due to a compensatory effect of the glaciers, leveling the extreme values of the simulated runoff. So, in the extremely hot and dry years, when the runoff from rainfall decreases due to lower precipitation and increased evaporation, the glacial water loss increases. The opposite picture is observed in the cool and wet years. The obtained runoff estimates are actually an assessment of the climatic risks for the water resources.

Evolution of in-year distribution of surface runoff under climate change

In-year runoff distribution was determined based on the simulation method. The total runoff is divided into three components of the variables in the year of liquid precipitation, solid precipitation and glaciers ablation. The groundwater feed, with permissible error, is assumed to be constant throughout a year.

To ensure clarity and simplification of the decision, 4 typical hydrologic areas have been selected:

- Area A - the highest mountainous hydrological basin with a large area of glaciation (runoff from melting glaciers exceeds runoff from the seasonal snow cover melting). A proportion of the groundwater supply is about 2% of the maximum runoff rate (e.g., the basins of the Sarydzhaz and Big Naryn Rivers).
- Area B - alpine hydrological basin (the melting glaciers flow is approximately equal to the melting snow drain). A proportion of the groundwater supply is about 5% of the maximum flow rate (e.g., the Naryn River basin).
- Area C - midland hydrological basin with fewer glaciers and maximum precipitation in June (mainly in the eastern part of Kyrgyzstan). The proportion of the groundwater supply is up to 10% of maximum flow rate.
- Area D - midland hydrological basin with fewer glaciers and maximum precipitation in May (mainly the western part of country). A proportion of the groundwater supply is up to 10% of the maximum flow rate.

Climate change was taken into account for 5 possible change options from 1 (no change) to 5 (maximum change), which refers to the temperature in 2100 according to the RCP 8.5 scenario.

Simulation results for the highland areas showed a slight increase in the maximum discharge in the initial warming period, followed by a decrease in the maximum flow and shift to an earlier date by approximately 50 days (currently falling around the end of July).

For medium-altitude areas in the initial warming period, an increase in discharge does not take place. After the level stabilization, a steady decline in the maximum discharges is observed, which is less expressed as compared to the highlands. For C area a shift of the maximum runoff to the earlier terms makes up about 15 days, and for D area it is even lower.

Adaptation measures for the water resources

The key measures (more specific measures are given in the Ministry of Agriculture and Land Reclamation sectorial plan):

- Improving the water resources management and the economic incentives introduction for the water rational use;
- Rehabilitation of the existing infrastructure and the new water facility infrastructure construction;
- Preservation of the upper watershed of the rivers - restoration and forest planting, compliance with the water protection zones regimes and bands of water bodies;
- Giving the protected areas status to the key runoff formation zones;
- Restoration and maintenance of a monitoring system of climatic parameters;
- Awareness raising on of the qualitative and quantitative state of water resources;
- Strengthening the international cooperation on adaptation of the trans boundary water basins;
- Awareness raising on the socio-economic impacts of climate change, including a problem of increasing water deficit.

3.4.3. Agriculture

General information

The agriculture has traditionally been the leading sector of the economy, both by a size of the generated added value, and by a number of people employed in the industry. This sector produces about 1/5 of the GDP, providing the processing enterprises with raw materials and the population with food. The existence of the wide-ranging mountainous areas determined the development areas of agriculture, which employ above 60% of the population in the rural areas. However, only a small part of the territory (about 7%) can be used for the crops cultivation, and these are mostly the valley and foothill areas.

More than half of the land stock is agricultural land. Of this, 85% are pastures and 15% are arable land and hayfields. In Kyrgyzstan, the land has been transferred to private ownership. Currently, there are 382 million farmholds and 357 agricultural cooperatives in the country.

Agro-climatic conditions in the country are favorable for the cultivation of wheat, corn, barley, potatoes, cotton and some other crops. Recently there has been a tendency for lower provision of food security (Fig. 3.4.). The reason for this, among others, is the climate change impacts.

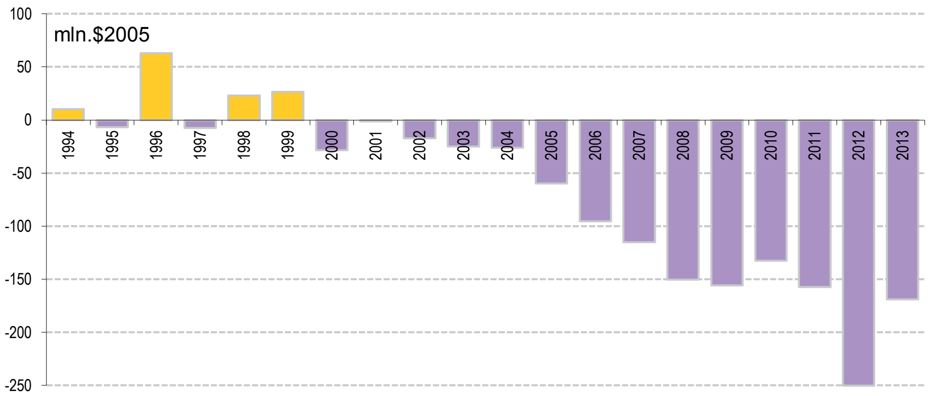


Fig. 3.4. Import and export balance of food products. Source: NSC

Unfavorable weather conditions (late spring and early autumn frosts, high temperature, etc.), pollution and uncomplimentary land reclamation conditions in some areas limit the comprehensive utilization of the agro-climatic and land resources.

Climate change will lead to the different effects on agriculture (quantitative impact assessment is taken from the report of the World Committee on Food Security [3.10]):

1. Changes of average temperatures with constant precipitation level.

In general, higher average temperatures can accelerate plant growth and development. However, the temperature rise in combination with a preserved precipitation level reduces stagnant moisture. Higher temperatures also identify higher concentrations of ground-level ozone. Ozone is harmful to all plants, but especially susceptible are soybean, wheat, oats, beans, peppers and some types of cotton.

The impact on livestock essentially depends on the climatic conditions of the region. The comfort zone for most cattle is 10-30 °C. At a higher temperature the animals feed intake is reduced by 3-5% per temperature degree rise. In addition to reducing the animals efficiency, the higher temperatures adversely affect fertility. Additionally, climate change affects the animal indirectly through the impact on the food base;

2. Changes of temperature extremes.

The temperature raising during the night can reduce the rice yield by 10% for each 1 °C increase in minimum temperature in the dry season. The increase in maximum temperatures can lead to a substantial reduction of yields and reproductive function of many cultures. For maize, e.g., every day with a temperature above 30 °C may reduce the yield by 1.7% in drought conditions.

3. Change of carbon dioxide concentration in the atmosphere.

Many studies show some increase of yield with increasing CO_2 concentrations in the atmosphere. However, this effect is not observed for all cultures. For such plants, as corn, sugar cane, and sorghum, the rising yields effect is limited. The impact of higher CO_2 concentrations on plant growth under typical field conditions also remains considerably uncertain. It is necessary to take into account a negative impact of increasing CO_2 concentrations to the nutrients composition in certain food crops. The studies have established that the wheat protein content is reduced at high CO_2 levels, and carbon dioxide also substantially reduces the minerals content, such as iron and zinc.

According to the data on the different climatic extremes, agriculture is severely affected by drought and water shortage (Table 3.6).

#	Culture	Damage from all emergencies, thous. $2005	Damage from drought and water deficit, thous. $2005	Share %
1	Wheat	6560,26	5826,35	88,81
2	Barley	934,68	728,46	77,94
3	Rice	237,82	182,96	76,93
4	Corn for grain	996,04	820,10	82,34
5	Pulses	28,16	26,68	94,74
6	Oats	2,68	2,07	77,24
7	Tobacco	251,66	202,54	80,48
8	Sugar beets	2216,86	2066,22	93,20
9	Oil seeds	202,36	165,50	81,78
10	Potato	249,57	143,40	57,46
11	Vegetables	2358,09	1817,60	77,08

Table 3.6. The average annual damage caused by climatic emergencies (including drought and water shortage) for the main agricultural crops in 1991-2011. Source: NSC

The damage economic cost (Table 3.6) was determined by accounting the different costs of the production unit and the different productivity of the crops. Therefore, with the same physical volumes of the crop losses (debited acreage), the damages are higher for the crops with higher a production unit cost.

Humidification assessment under climate change

As a quantitative assessment, the humidification factor was used, defined as a ratio of summed precipitation to evaporability. According to N.N Ivanov [3.2], correspondence between moistening areas and landscape features is as follows:

- Arid desert area - humidification 0 - 0.13;
- Semi-arid area of the semi-desert zone - 0.13 - 0.30;
- Steppes and dry savanna (zone of insufficient humidification) - 0.30 - 0.60;
- Moderate humidification zone (steppe, savannah) - 0.60 - 1.0;
- Sufficient humidification zone (forest) - 1.0 - 1.50

The humidity assessment was performed similarly to the water resources assessment based on the elevation advanced digital models DMR and the humidity features DMHum (Tables 3.7-3.9). The annual precipitation level is assumed to be unchanged re 2010. The areas maps of the moisture less than 0.13 (desert) and from 0.13 to 0.30 (semi-desert) under the different climate scenarios are presented in Appendix 4. These maps show the territory covered by the irrigated and rain-fed arable land. The estimates show that under the unfavorable climate scenarios actually the total arable land falls into desert and semi-desert areas.

Table 3.7. Average humidity of the oblasts under the climatic scenarios in 2100

#	Province	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
1	Chui	0,620	0,568	0,544	0,462
2	Issyk-Kul	0,797	0,713	0,674	0,544
3	Naryn	0,744	0,669	0,635	0,523
4	Osh	0,568	0,519	0,497	0,422
5	Talas	0,607	0,557	0,533	0,455
6	Djalal-Abad	0,633	0,583	0,560	0,483
7	Batken	0,465	0,428	0,410	0,351
8	Kyrgyz Republic	0,663	0,602	0,574	0,482

Table 3.8. Share (%) of humid (below 0.13) areas (desert) of the oblasts in 2000 and under the climatic scenarios in 2100

#	Province	Area, km^2	2000 г.	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
1	Chui	20025	0,00	0,000	0,000	0,001	0,016
2	Issyk-Kul	36823	2,51	3,557	4,240	4,579	5,838
3	Naryn	44958	0,01	0,000	0,000	0,000	0,466
4	Osh	29100	0,11	0,393	0,549	0,674	1,422
5	Talas	11441	0,00	0,000	0,000	0,000	0,131
6	Djalal-Abad	33273	0,00	0,030	0,070	0,149	0,792
7	Batken	16984	9,34	12,343	13,848	14,622	17,658
8	Kyrgyz Republic	192604	1,32	1,818	2,096	2,270	3,137

Table 3.9. Share of areas (%) with humidity ranging from 0.13 to 0.30 (semi-arid) in the oblasts in 2000 and under the climatic scenarios in 2100.

#	Oblasts	Area, km²	2000 г.	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
1	Chui	20025	15,48	27,91	30,64	32,01	37,19
2	Issyk-Kul	36823	8,86	12,19	13,68	14,47	17,78
3	Naryn	44958	8,29	13,31	16,41	18,05	24,82
4	Osh	29100	14,30	19,98	24,20	26,31	34,23
5	Talas	11441	23,94	29,51	32,53	34,03	39,56
6	Djalal-Abad	33273	14,07	18,99	21,50	22,80	27,85
7	Batken	16984	27,75	31,64	33,24	34,01	36,70
8	Kyrgyz Republic	192604	13,70	19,18	21,86	23,24	28,63

Assessment of the climate change direct impacts on crop yields

The assessment was based on the Standardized Precipitation Index (SPI). By means of the SPI index the potential climate change impact on crop yields was determined with applying a standardized classification of the drought intensity [3.13].

Table 3.10. Classification of the drought intensity based on SPI

Categories	SPI Value	Potential impact
D0, abnormal	−0,5; −0,7	Short-term drought – minor impact slowing down the vegetation
D1,mild	−0,8; −1,2	Insignificant damages for vegetation without significant crop loss
D2, significant	−1,3; −1,5	High probability of crop loss
D3, severe	−1,6; −1,9	Weighty crop loss
D4, extreme	-2.0 or less	Significant or total loss of crops

The estimates of the climate change direct impact on crop yields is based on the datum that the SPI index assesses drought, based on the rainfall data only. Hence, the correlation coefficient may be important only for the crops more dependent on rainfall rather than on the water resources availability for irrigation. The following crops yields were assessed:

- Grains (weight upon processing);
- Wheat (weight upon processing);
- Barley (weight upon processing);
- Corn for grain;
- Rice (weight upon processing);
- Sugar beet (factory);
- Tobacco (recorded weight);
- Oilseeds;
- Potatoes;
- Vegetables;
- Melon-plantation;
- Fruit and berry crops;
- Grapes.

The review time series cover 1991-2010 regarding the NSC official data on the yield. The SPI indices were calculated for the same period. The deadline for the index estimation (in months) and the accounting scope of moisture conditions (in months) have also been ranged. These parameters were changed to clarify the calculation methodology.

The studies key findings are as follows:

1. The SPI index provides the statistically valid estimates of the yield changes of four crops:
   - Grains (weight upon processing);
   - Wheat (weight upon processing);
   - Sugar beet (factory);
   - Barley (weight upon processing).
2. There is no statistically significant relationship between the SPI index and productivity for other crops tested. There may be such a connection to other crops, such as oats and buckwheat, for which the certified data on productivity lacks..
3. October is an optimal period to assess the index.
4. The highest relationship takes place under a use of the index calculation scope of 9-10 months.
5. The SPI index can serve as a baseline during the crop insurance system implementation for the above crops.
6. From a methodological point of view, it is more rational to use in the future the Standardized Precipitation Index and Evapotranspiration (SPEI) instead of SPI. It is based on a two-dimensional distribution and takes into account evapotranspiration, additionally to precipitation. This feature of the index may be valuable in the analysis of the aridity changes under the global warming. The assessment based on the available observations showed no significant difference between SPI and SPEI, possibly due to the small changes of the climatic factors in the current time interval.

Livestock

Agro-ecological conditions of the country to a large extent are determined by the land use for pastures, not for cropping. The livestock sector accounts for more than half of the total cost of the agricultural products, therefore, the efficiency of the livestock sector is very important for the national economy.

The climate change impacts on livestock are diverse, and some of them have already been given at the beginning of this Chapter. Unfortunately, the reliable local data is not available by all the aspects of the climate change impacts. Thus, the analysis of the already observed vulnerability assesses only the yield productivity. Data on the yields of dry edible green mass and hayfields mass, spring and autumn pastures, and summer and winter pastures is submitted by the Kyrgyz State Design Institute of Land Management «Kyrgyzgiprozem».

Detailed data on productivity was limited to the oblast and district level. Additionally to the yield productivity, the data on the climate observations (temperature and rainfall) and the animals number - cattle, sheep and goats, horses was used.

It should be noted that over the observation period (1950-2012), among all factors affecting the pastures productivity, the animals' number changed most significantly (Fig. 3.5).

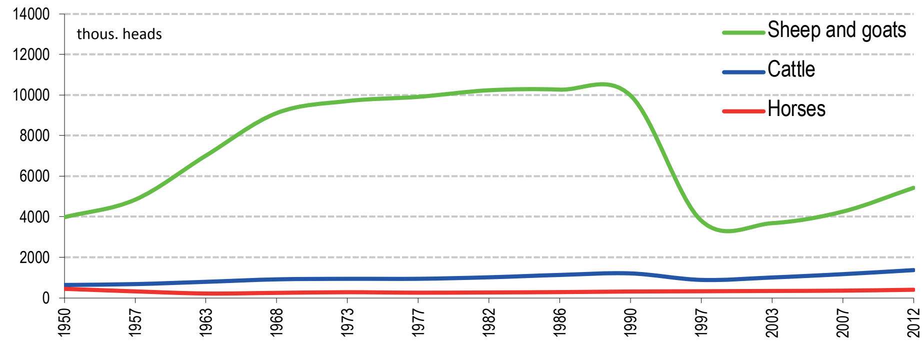


Fig. 3.5. Trends of a number of basic farm animals in the KR

In all oblasts and the whole country a similar growth trend of the basic farm animals is observed till the 80s (till 1990 for some areas), followed by a sharp decline in 2003, and then a rise again. Most vividly this tendency is expressed with sheep and goats. Further, under the pasture load estimation, the animals number was assessed with a transfer factor to a nominal head (one cattle head is equal to five sheep heads, and a horse head is equal to six nominal sheep heads).

The following conclusions were made out of the statistical analysis:

1. The hayfields and pastures yield is low on the whole in the Kyrgyz Republic. The average yield for the review period is shown in Table 3.11. The maximum yield of green mass was observed in the Djalal-Abad oblast - 25 c/ha for the summer pastures in 2012, which is well below the developed countries' yield. For example, in the Netherlands, the hay yield – on rangeland is 120 c/ha, in France - 45-50, in Germany – 60, Belgium – 80, and Denmark - 90 c/ha of dry matter. Naturally, this situation is largely determined by a difference in the climatic conditions, significantly less favorable in the Kyrgyz Republic. However, the effective pasture management organization in the developed countries significantly contributes to an increased yield.

2. Changes in the oblasts yields considerably differ (Table 3.11), but in the whole country there is a slight increase in the yield from hayfields and pastures of all kinds (0.007-0.4 c/ha per year). The highest growth is observed in the Batken and Chui oblasts, and the largest decrease in crop yields is in the Naryn oblast. The yield absolute value is not very high: the maximum increase of the yield is less than 0.1 c/ha per year (the Batken oblast), and the maximum reduction - less than 0.09 c/ha per year (the Naryn oblast).

Table 3.11. Changes of yields by pasture and hayfields types for different areas. Legend: + increase, - decrease

Province	Productivity of dry edible mass				Productivity of green mass		
	Hayfields	Spring-fall pasture	Summer pasture	Winter pasture	Hayfields	Spring-fall pasture	Summer pasture
Batken	+	+	+	+	+	+	+
Djalal-Abad	+	+	+	+	+	+	+
Issyk-Kul	-	-	-	-	-	-	-
Naryn	+	-	-	-	-	-	-
Osh	-	+	-	+	+	+	+

Province	Productivity of dry edible mass				Productivity of green mass		
	Hayfields	Spring-fall pasture	Summer pasture	Winter pasture	Hayfields	Spring-fall pasture	Summer pasture
Talas	+	+	+	+	-	+	+
Chui	+	+	+	+	+	+	+
Average in the republic	+	+	+	+	+	+	+
Average productivity, c/ha	14,40	3,15	5,32	2,36	9,18	18,32	3,43

3. A clear growth trend in a share of edible mass to green mass is observed for all types of pastures and all oblasts. Fig.3.6 shows this proportion trends for the Kyrgyz Republic. The possible reasons of such a trend are a decrease of the pastures load after the 1980s and the climatic changes.

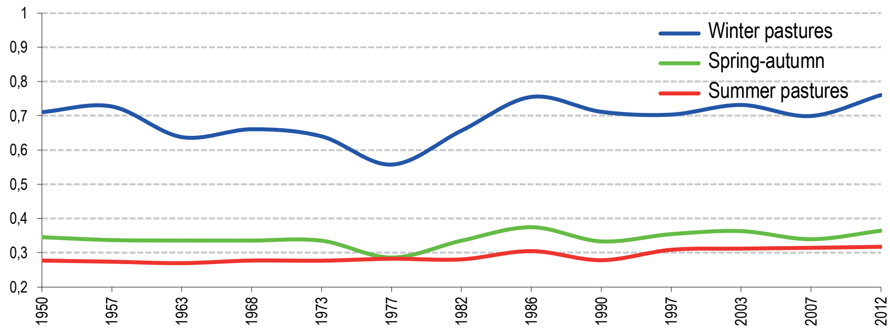


Fig. 3.6. Trends in the ratio of edible mass to green mass

4. Two factors negatively impact the yield - the pasture load, expressed in the nominal sheep head number, and temperature. Besides, the pasture load has a more significant impact compared to temperature. For winter pastures the temperature increase is not a negative impact for all regions.

5. If to assess the pastures load in more detail, then the greatest impact is made by the sheep number out of all livestock. This is an expected result, as while grazing sheep hooves crush the ground with a force of 5.4 kg/cm^2, while this figure for cattle is 5.1 kg/cm^2, and for horses - 2.6 kg/cm^2 [3.11].

Soils

The state of soil is of great importance to agriculture. Usually, in the climate change context, the soil role in the mitigation activities is stressed due to the carbon sink function. Unsustainable management of agricultural soil may result in the soil carbon emission to the atmosphere as carbon dioxide and become a factor affecting climate change. In its turn, the climate is one of the most important factors in soil formation and geographic distribution of soils.

Changes of temperature and precipitation can have a huge impact on the organic substance and the processes in soil, as well as on the plants and crops growing on it. The climate affects the soil formation both directly (by determining the soil energy level and hydrothermal regime), and indirectly through the vegetation, animal life and micro-organisms.

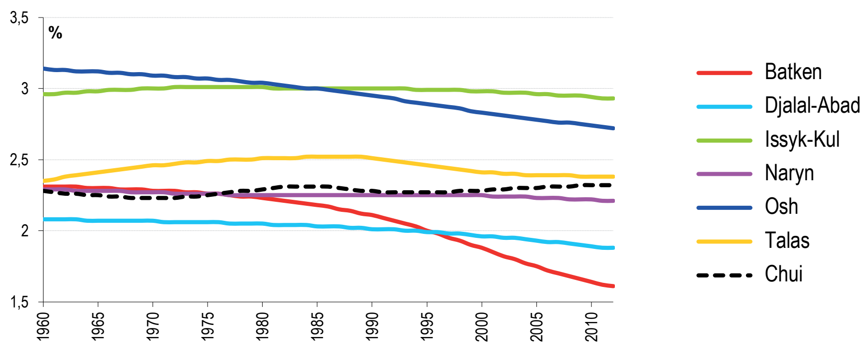


Fig. 3.7. Change trends of the soil humus by the oblasts

Analysis showed that, due to the observed climate change impact and the soil cultivation technologies, the soil humus content decreased in all oblasts except for the Chui (Fig. 3.7).

The observed situation is a serious challenge for food security. To solve it, the agricultural practices and land management should be profoundly changed. In this aspect, the advanced technologies in agricultural production and the soil resources management, such as agroecology, organic farming, conservation agriculture and agroforestry, provide numerous benefits to improve the organic carbon content in the soil. These methods provide soil fertility by increasing the organic substance content, contribute to the plant cover preservation on the soil surface, require less chemical fertilizers and promote crop rotation and biodiversity.

Adaptation measures in agriculture

According to the Priorities Directions [3.5], the key adaptation measures in the agricultural sector are as follows:

- Allocation optimization and agricultural production specialization;
- Selection work on the cultivation of drought-resistant and salt-tolerant crops;
- Phytomeliorative actions;
- Integrated pasture management and development of grazing industry, including adaptation to climate change;
- Improvement of the agricultural infrastructure to better adapt to the climate change impacts;
- Improvement of the monitoring of food security and establishment of a yield forecasting system.

More detailed information on the adaptation measures is listed in the sectoral plan of the Ministry of Agriculture and Land Reclamation of the Kyrgyz Republic.

3.4.4. Climatic emergencies

This section is prepared based on the Climate Change Adaptation Program for the Emergencies Sector for 2015-2017 [3.12]. As a mountainous country, the KR is particularly exposed to the numerous natural disasters. Of the 70 world dangerous natural processes and phenomena, causing significant damage to the population, economic activities and infrastructure, more than 20 take place in the country. The proactive adaptation measures in this sector can bring the significant economic benefits and minimize the threats to the ecosystems, human health, economic development, property and infrastructure.

Most of the emergencies in the country depend on the climate extremes, such as mudflows, floods, landslides, avalanches, torrential rain, strong wind, hail, snow.

Natural processes bear a seasonal character. For example, the avalanches prevail in winter and spring; the mudflows and floods begin in spring; the landslides activate closer to summer. Within a year, the occurrence of all emergencies is largely determined by the precipitation regime. Moreover, to a greater extent it is determined not by the average values shift, which changes relatively slowly, but by a changing number of the extreme values.

Mudflows and floods, due to their exceptional prevalence and frequency, as well as the total damage caused, are at the first place re the other natural hazards. Almost the whole republic is under the mudflows influence. In the Kyrgyz Republic there are 3,103 mudflow rivers. Of a total number of the known flood cases, about 80% are accounted for by rainstorms. Such mudflows occur annually in some areas. Snowmelt, especially when combined with the rains, is a significant factor in the mudslides formation. Their share is estimated to be 15% of the total. Recurrence of floods is estimated from one per 3-5 years up to one in 6-10 years. The share of floods from glaciers and seasonal snows melting in the glacial region reaches up to 13% of cases. Less than 1% of floods are accounted for by burst type lakes and intra-glacial cavity.

About 105 thousand km^2 are subject to avalanches, 53% of the whole territory. Within 779 avalanche areas, more than 30 thousand avalanche foci are allocated. The avalanche season lasts from 3-4 months (the Western Tien-Shan) to 11-12 months (the Central Tien-Shan). Most frequently, the avalanches in the Tien-Shan hit the roads in February and March (63% of the total registered number that have caused damage to highways). In January, 16% of the total number of avalanches occurs. In April, usually 13% of the total number of avalanches is registered. In December, it reduces to about 4%. In November and May, 1.5% and 2.5% of avalanches slide respectively. The maximum avalanches number, shifted by snow fall, takes place in March (52.6%). The majority of avalanches come from the northern and north-western slopes.

The landslides and mudslides occur mainly in the south of the country, where in some areas up to 30-40 landslides fall per 1 km^2. In total in the south there were 3,000 landslides registered, which damaged mainly the roads and the mining towns of Mailu-Suu, Sulukta and Min-Kush. In the whole country there are 5,000 landslide zones, of which 3,500 are in the southern region of the country.

Analysis of the observed weather extremes

Observations show a noticeable increase of the extreme weather events. Fig. 3.8-3.9 show the observation data at the meteorological station in Bishkek city.

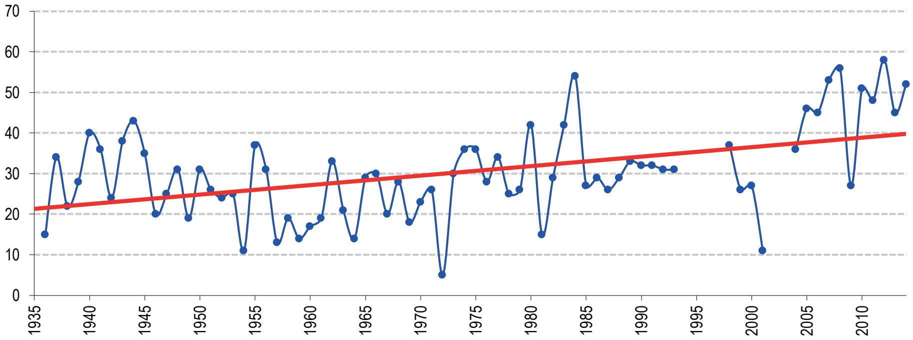


Fig. 3.8. Growth trend of a number of hot (t over 32.2 ^{0}C) days per year. Source: National Climatic Data Center (http://www1.ncdc.noaa.gov/)

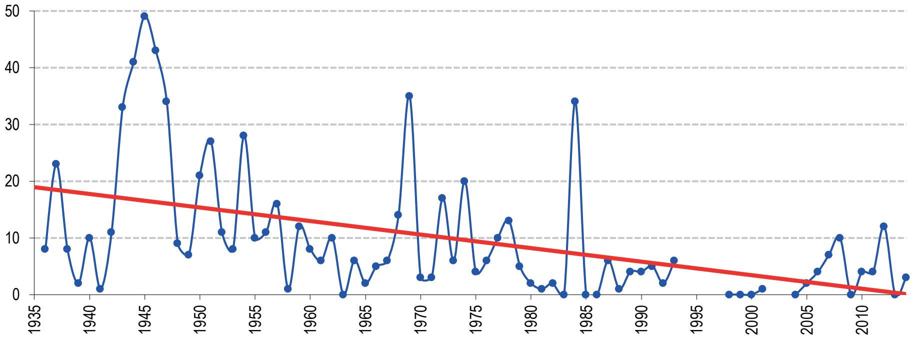
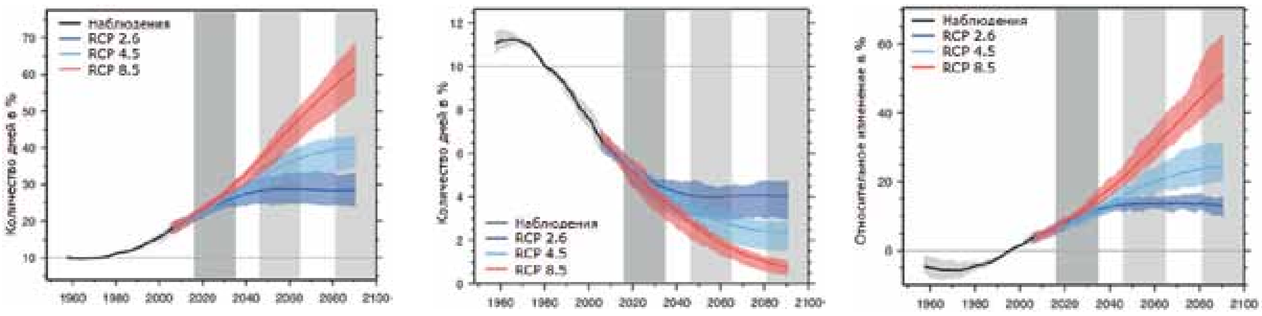


Fig. 3.9. Decline trend of a number of cold (below -17.8 °C) days per year. Source: National Center of Climatic Data (http://www1.ncdc.noaa.gov/)

By the Bishkek meteorological station data, a number of days with extreme precipitation are also growing. The growth speed of the different amount precipitation is:

- above 2.54 mm per day for 0.1357 day/year;
- above 12.7 mm per day for 0.0302 day/year;
- above 25.4 mm per day for 0.0018 day/year.

The observed growth of the weather extremes is determined by the climatic system changes as a whole. It is assumed that the expected future climate change will also lead to the continued growth of the weather extremes. The IPCC Assessment Report [3.1] presents the global assessment of changes in the weather extremes (Fig. 3.10).



Percentage of days with temperature exceeding 90% quantile by 1961-1990 data

Percentage of days with temperature below 10% quantile by 1951-1990 data

Percentage of days with temperature exceeding 95% quantile by 1986- 2005 data

Fig. 3.10. Global forecasts of a change of the weather extremes frequency. The solid lines show the median, and the shadowing identifies an area between 25 and 75 % of probability. Source: IPCCC [3.1]

Assessment of the emergencies frequency can be done by means of a mathematical tool based on their spread over time [3.14, 3.15 and 3.16]. The emergency situations are presented in a form of the accidental events' flow having the following properties:

- Ordinariness - no more than one emergency for quite small intervals;
- After-effect absence – after one emergency situation their frequency does not change. Although, the prevention and impact reduction measures are undertaken after each emergency situation.

However, this is a part of their implementation terms;

- Stationarity – frequency of emergency situations is regular at some interval (at least a year).

Under these conditions, the emergency flow is the simplest Poisson one, for which an accidental number of emergencies taking place during time Δt is distributed by the Poisson law:

$$P(k) = m^k e^{-m}/k!$$

where,

m – frequency (average number of emergency situations for single and rather small interval of time);
k – particular number of emergency situations.

Naturally, under the climate change the m value will depend on the time, i.e. m = f(t). The extrapolation assumes that the m value will be constant thru a year, and for the bigger intervals a linear closing of the time dependency has been used.

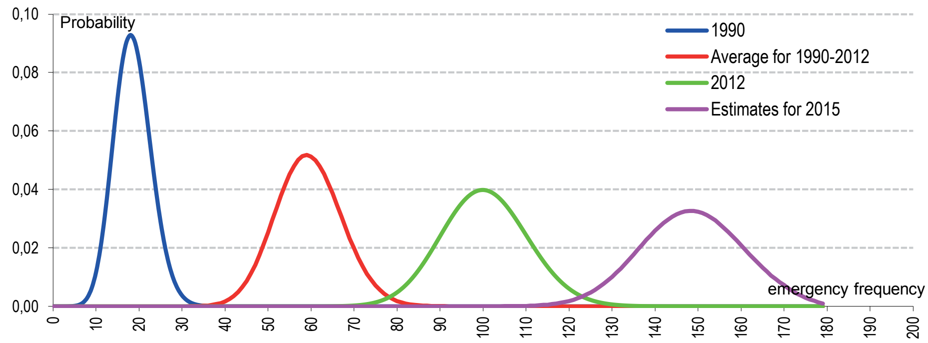


Fig. 3.11. Change of probability distribution of floods and mudflows

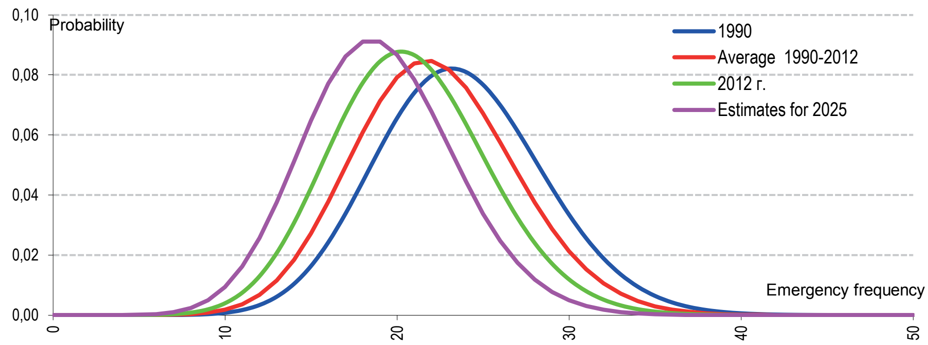


Fig. 3.12. Change of probability distribution of landslides

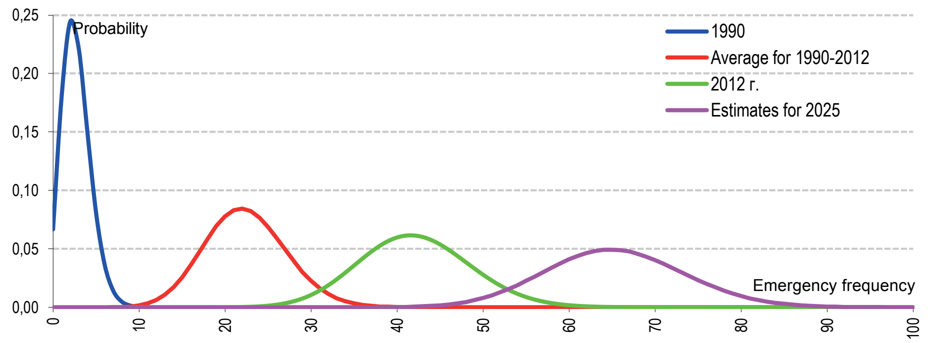


Fig. 3.13. Change of probability distribution of avalanches

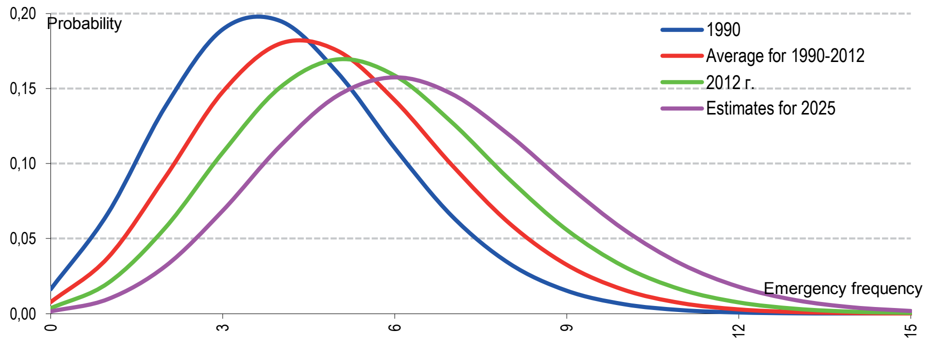


Fig. 3.14. Change of probability distribution of heavy rains

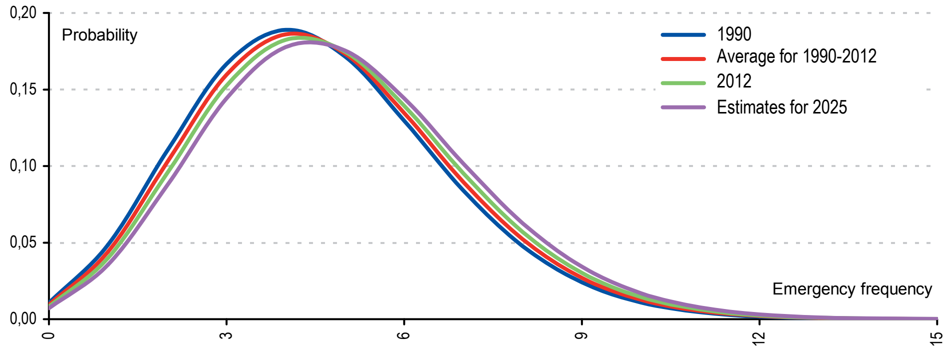


Fig. 3.15. Change of probability distribution of wind storms

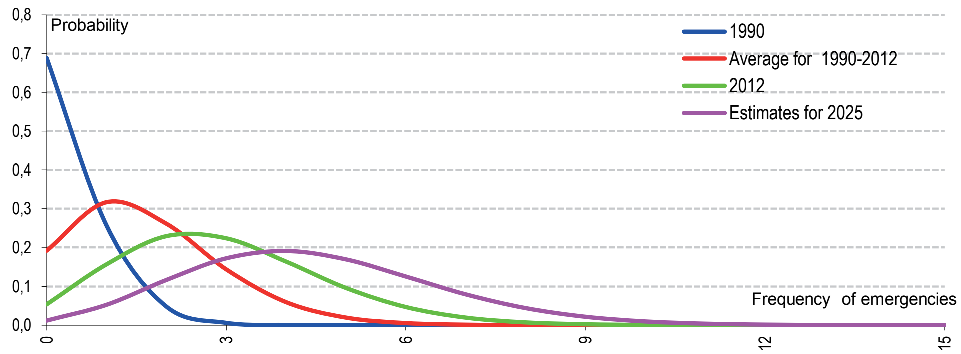


Fig. 3.16. Change of probability distribution of hail

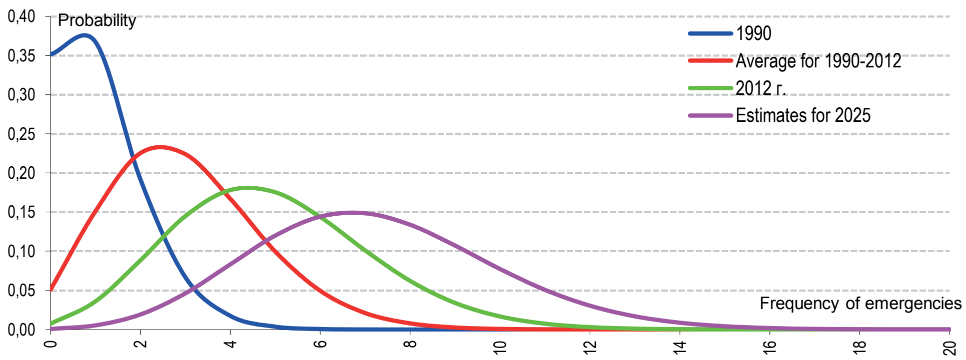


Fig. 3.17. Change of probability distribution of snow falls

The forecast results for major emergencies are given in Fig. 3.11- 3.17. The assessment shows that the distribution of wind storms remains practically unchanged, while landslides are projected to reduce in number. Other emergencies are expected to increase in occurrence frequency to the maximum probability. This growth is accompanied by a simultaneous increase in the spread between the maximum and minimum probability. The obtained dependences agree to the probability estimation of any number of emergencies per year, i.e., to assess the risk of its occurrence.

Using the available estimates for the economic damage by emergencies, a probability of the economic losses costs can also be estimated. The economic losses cost is now determined by the commission assessing the direct damage caused by a particular type of emergency, according to the Ministry of Emergency Situations (not including the NSC's estimates of damage to agriculture). According to the International Bank for Reconstruction and Development estimations, the full damage from climate emergencies may be higher several times. So, it is expected that the planned change in the damage assessing methodology will lead to a substantial increase in both the observed and expected damage caused by the emergency situations.

To estimate the expected changes in a number the climatic emergencies, in the Climate Profile [3.6] a frequency changes evaluation is presented in a form of a quantitative assessment of the changes attributable to 1 °C. Depending on the climate scenario we can estimate a number of the climatic emergencies for any particular period by this table. Definitely, such an idea, like any other using the statistical estimates, cannot be extended to the considerable periods in the future, since it does not account for changes in the physical nature of the conditions for the climatic emergencies formation under the significant changes in external conditions.

Table 3.12. Growth of climatic emergencies in % by the oblasts at temperature increase by 1°C. Source: Climate Profile of the Kyrgyz Republic [3.6]

Type	Chui	Osh	Djalal-Abad	Batken	Issyk-Kul	Naryn	Talas
Landslide	–4,31	1,28	5,23	0,90	0,41	3,12	n/a
Avalanche	7,14	12,96	21,57	n/a	12,58	5,67	n/a
Flood and mudflow	9,23	50,24	24,25	20,79	12,58	5,67	3,40
Flooding	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Heavy rainfall	–0,45	–2,72	–3,45	–1,24	–0,83	–0,58	0,91
Wind storm	4,91	5,60	–0,51	0,79	22,68	–0,92	2,48
Hail	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Snowfall	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total	10,42	66,72	44,68	21,24	49,07	13,76	7,84

n/a – lack of or not enough data for correct assessment

Adaptation measures in the emergency situations sector

In accordance with the Priorities Directions [3.5], the key adaptation measures in the emergency sector are the following:

- Improvement of the monitoring and forecasting system;
- Improvement of early warning systems for the population and organizations to prevent the human loss and minimize the economic damage;
- Improvement of building codes to ensure the infrastructure resilience to dangerous climatic events;
- Development of an insurance system for climatic risks;
- Development of preventive measures to prepare the public, health and social institutions to work in an emergency, and to assist populations impacted by floods, wildfires, severe frosts and heat waves, as well as by other climate change related emergencies.

More detailed information on the adaptation measures is listed in the sectoral plan of the Ministry of Emergency Situations.

3.4.5. Healthcare

The vulnerability of the sector was assessed based on the statistical models linking a change of mortality and disease incidence with the climatic factors. Such an approach cannot provide an accurate assessment for the longer periods, stipulating a necessity for the regular updates of the obtained assessments.

The observed health impacts of climate change are as follows:

- Increase in mortality and trauma – the deaths number in 2002-2007 averaged 61 cases per year. In 2008, 281 deaths were recorded. Most deaths were associated with the floods and mudflows.
- Years of potential life lost due to climate change - the years number of lost healthy life will increase due to the changes of temperature, precipitation and atmospheric pressure. Thus, the temperature dependence is considered as the most severe.
- Mortality among women of respiratory diseases due to atmospheric pressure was higher than that of men. Women aged 15-44 are more sensitive to the changes of atmospheric pressure, with this a direct correlation was found between an influence of the atmospheric pressure changes on mortality as of respiratory diseases.
- Vulnerable groups on health status - children, particularly with low weight and malnutrition, people with cardiovascular and respiratory diseases, as well as people with poor health and the elderly are most susceptible to *the heat waves impacts.*

- Infectious diseases and climate change - an increase of gastrointestinal infections, such as salmonellosis, due to the increase of temperature and water pollution as a result of flooding. The high prevalence of helminthiasis reduces the nutrients absorption, potentially increasing a risk of malnutrition among vulnerable children during poor harvests. Infections, such as malaria, are now less frequently recorded. However, warmer temperatures increase a risk of the recurrence and spread of malaria.

Forecasted climate change impacts on population health:
- Increase in cardiovascular diseases is expected: by 2100, compared to 2010, a number of cases of cardiovascular disease will increase by 10.5% related to temperature rises under the most unfavorable climatic scenario.
- Increase in the intestinal diseases rate: it is estimated that by 2100, compared to 2010, the infectious diseases incidence, particularly acute intestinal infections among children under a year, will rise by 18.2% (boys) and 17.8% (girls).
- Areas of high potential of malaria recurrence: with an average annual temperature increase, areas of high risk of malaria are identified in the country, especially in the south (the Osh, Djalal-Abad and Batken oblasts).
- The infections transmitted by ticks are forecasted to spread and increase: the expanded range and increased period of tick activity will significantly increase a risk of disease incidence transmitted by ticks, particularly encephalitis.
- The potential benefits to health from climate change: mortality and respiratory illnesses due to a rainfall decrease are expected to reduce in winter. However, climate change due to an increased variability of weather can reduce these potential benefits.

The assessment of the climate change impact on health established a quantitative dependency of the circulatory and respiratory systems, and cardiovascular diseases on the climatic-meteorological factors:
- Cardiovascular diseases: the elderly people are more sensitive to changes of temperature and precipitation. It was found that the incidence of circulatory system diseases (I00-I99) of men per 100 thousand people was higher by 1.4-2.1 times than of women. At the same time, the most vulnerable are people aged 64-75 years, followed by those over 75 years old, and finally those of 45-64 years. It is expected that by 2100 the cardiovascular diseases (I00-I99) incidence will grow by 1.6% -2.4%, depending on the climate scenarios, also vascular diseases of the arteries, arteriole and others are expected to increase by 10.5% (I70-I79) compared to 2010.
- Respiratory diseases: it was found that three age categories are most vulnerable to air temperature change - children (0-1 years), followed by those aged 75 and older, then those of 64-75 years (Fig.3.18-3.20). Men are more disposed to respiratory disease (J00-J99) under low temperatures. So, at the age of 75 years and older these indicators are expected to increase by 1.9 times, compared to those of women (917.7 cases vs. 459.9 cases per 100,000 people, respectively).

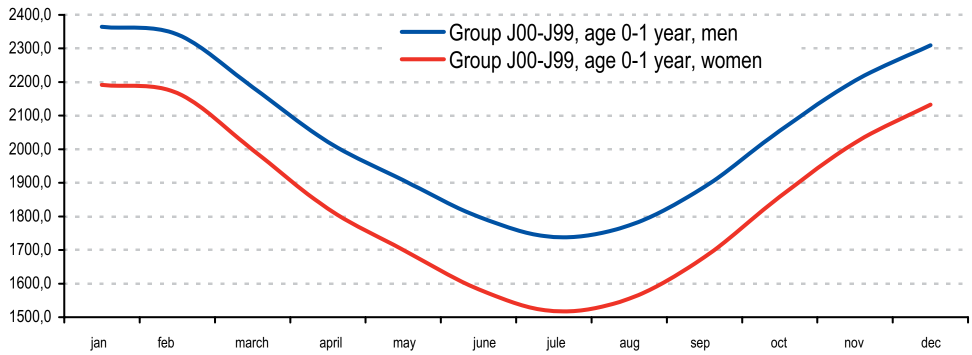


Fig. 3.18. Expected respiratory diseases (J00-J99) incidence in the age group 0-1 year under A2 Scenario.

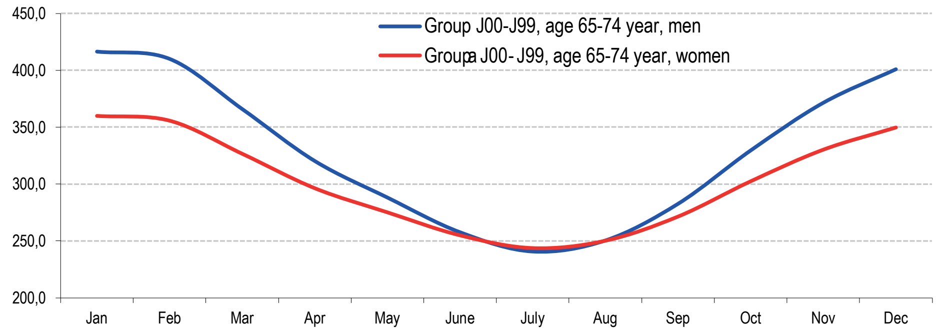


Fig. 3.19. Expected respiratory diseases (J00-J99) incidence in the age group 65-74 year under A2 Scenario.

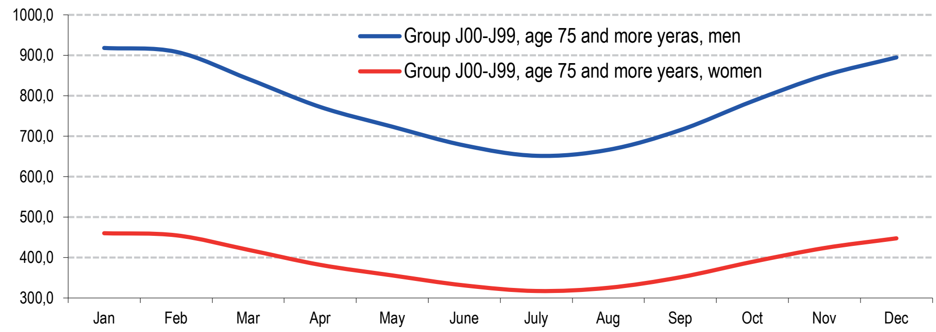


Fig. 3.20. Expected rate of respiratory diseases (J00-J99) in the age group of 75 and above under A2 Scenario.

- <u>Infectious diseases and climate change:</u> by 2100, the incidence of acute intestinal infections is expected to increase by 15.9% and 10.6% compared to the base year 2005, depending on the climate scenario.

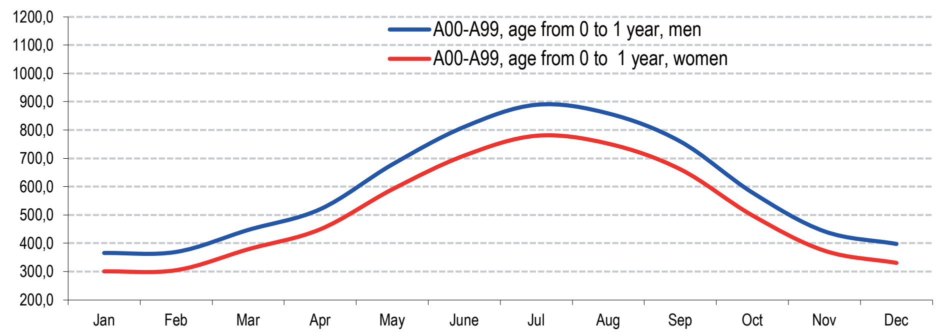


Fig. 3.21. Expected infectious morbidity of population by month in the age group 0 to 1 year under A2 Scenario.

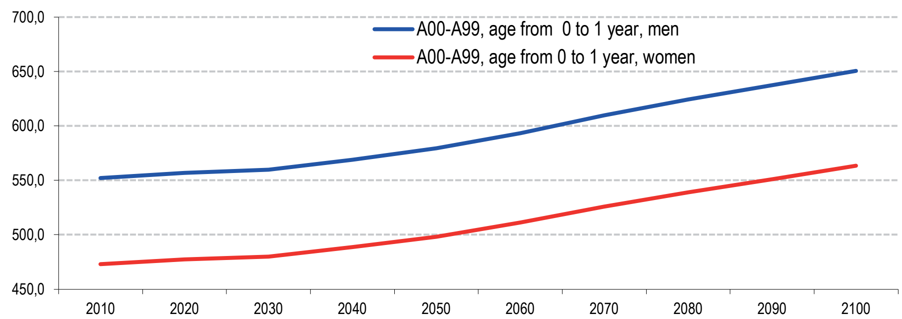


Fig. 3.22. Expected infectious morbidity of population by year in the age group 0 to 1 year under A2 Scenario.

The forecast data for infectious morbidity in Bishkek city indicates that a maximum number of calls to the ambulance stations will be in the age group of 1 year in summer (in July, 790-890 cases per 100,000 population) and a minimum in winter (in January, 300-370 cases per 100,000 population). Under the most unfavorable climatic scenario, by 2100 the incidence of acute intestinal infections of children under 1 year old is expected to increase, 18.2% - for boys and 17.8% - for girls, as compared to 2010 (Fig.3.21-3.22).

Adaptation measures in the healthcare sector

The healthcare sector programme on adaptation to climate change for 2011-2015 provides for the following measures:

- Improving the legal framework to prevent the climate change negative impacts on public health, including the construction of buildings for medical diagnostic and prophylactic purposes;
- Monitoring on compliance with temperature standards in the medical institutions and typical buildings construction design;
- Revision of the medical universities and colleges curricula on medical climatology;
- Developing guidelines for seasonal and current secondary prophylaxis of coronary heart disease and stroke;
- Monitoring of seasonal infectious morbidity;
- Identification of vulnerable groups, accounting, medical examination, awareness raising on the climatic and meteorological impacts (early warning systems for mobile networks - SMS);
- Monitoring of drinking water and food safety;
- Developing an action plan for ensuring the medical institutions' preparedness to the prolonged heat and cold periods;
- Introduction of energy-efficient and energy-saving technologies in the health sector;
- Use of renewable energy for hot water and electricity in the health facilities;
- Educating local communities through the health centers.

3.4.6. Forest and biodiversity

The assessment of forest and biodiversity accounted for the adaptive capacity, which is to a significant extent determined by a speed of a possible shift towards optimal climatic conditions. It is natural that certain species in the ecosystems have a different maximum speed of movement in the landscape (Fig. 3.23).

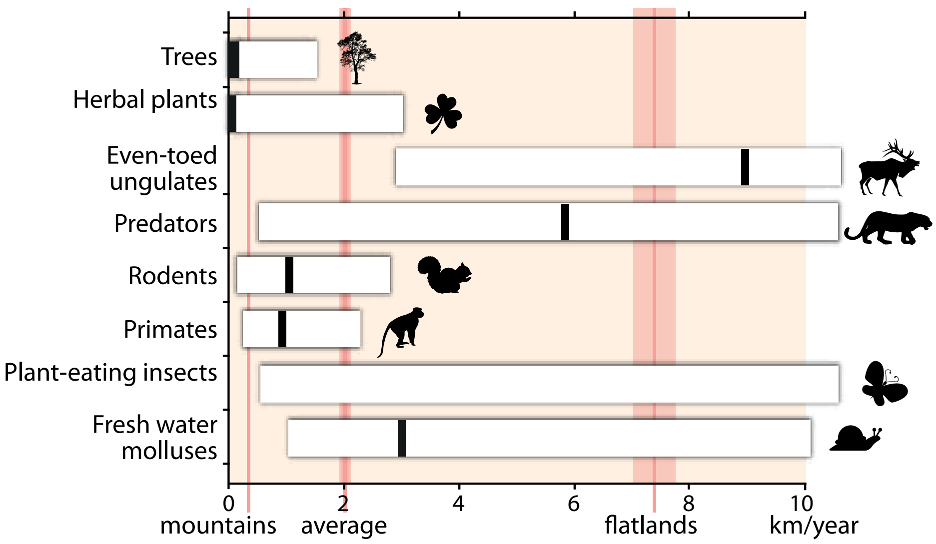


Fig. 3.23. Maximum movement speed of the species in the landscape, as compared to the temperature "movement" speed in the mountains, valleys and on the earth's surface according to RCP8.5 Scenario. Source: Climate change, 2014. Impacts, adaptation and vulnerability [3.3].

The data in Fig. 3.23 gives an impression that the mountain ecosystems are less vulnerable to climate change due to the slow «movement» of temperature horizontally. However, it should be noted that in the mountain ecosystems this movement also arises vertically, and naturally leads to a reduction of an area with the optimal climatic parameters for a particular ecosystem. Moreover, in some cases a possibility of an upward shift may simply be absent. Each type, species has the limiting borders of optimum, extending of which may cause its destruction.

Furthermore, it is obvious that, on overall, an ecosystem can move with a maximum speed of the slowest species. Typically, such a species is vegetation that stands at the bottom of the food chain of each ecosystem. Hence, an oppression of the vegetation inhibits the whole ecosystem.

The vulnerability assessment was based on the analysis of the ecosystems optimums' shift under the expected climate change. This study was executed as a part of the Priority Directions development. The analysis is done for the main forest tree species of the Kyrgyz Republic - Zeravshan juniper, hemispherical juniper, Turkestan juniper, spruce and fir, and walnut. The monitoring on these trees is quite satisfactory as compared to other types of vegetation.

At first, the allocation areas of the main forest tree species were selected by the average annual air temperature and the annual precipitation amount, and the isolated ranges of low, medium and high (climatic optimum) growth capability were defined. Additional studies have shown the need to also consider the terrain angle for walnut and the exposition for the spruce and fir.

Secondly, the climatic optimum zones under the changing climatic conditions have been identified. The modeling was carried out for the nodes covering 0.25 km^2.

The results showed the significant changes in the climatic optimum areas, depending on the climate scenario used. What is more, a significant shift was observed even under the most favorable climate scenario. Appendix 5 shows the assessment results of a possible evolution of the climatic optimum ranges of the main forest tree species under the climate scenarios (RCP 2.6, RCP 6.0 and RCP 8.5).

The obtained information is a basis for improving the actions effectiveness to preserve and expand the current areas covered by the main forest-forming species.

A similar approach can be used to assess the territorial evolution of the certain types of biodiversity and ecosystems for the expected climate change.

Adaptation measures in the forestry and biodiversity sector

In accordance with the Priority Directions [3.5], the key adaptation measures in the "Forestry and Biodiversity" sector are the following:

- Increasing the management efficiency of the protected nature areas;
- Preservation and restoration of wetlands as a habitat of natural biodiversity species and a vital component of the nature environment to play a decisive role in the adaptation to climate change;
- Accounting of the territories recreation capacity under the tourist activities design, etc.;
- Promotion of social forest cultivation and a cooperative forest management;
- Improving the forest management and reforestation, etc.

More detailed information on the adaptation is given in the sectoral plan of the State Agency on Environment Protection and Forestry under the Government of the Kyrgyz Republic.

3.5. Required resources and priority of the sectors

Based on the sectoral plans summary, the total costs required for the adaptation measures implementation in the Kyrgyz Republic have been calculated (Fig. 3.24). The costs identified are broken down into the internal resources (within the funding limits allocated to the public institutions for a relevant year), as well as the expected external resources.

Based on the accepted criterion of the adaptation measures priority (section 3.4.1), the funding efficiency for the selected sectors (excluding the energy sector) is assessed. The agricultural sector was further divided into two key subsectors - water and agriculture (crops and livestock). Founded on these estimates, the highest priority by efficiency is the agriculture sector (Fig.3.25).

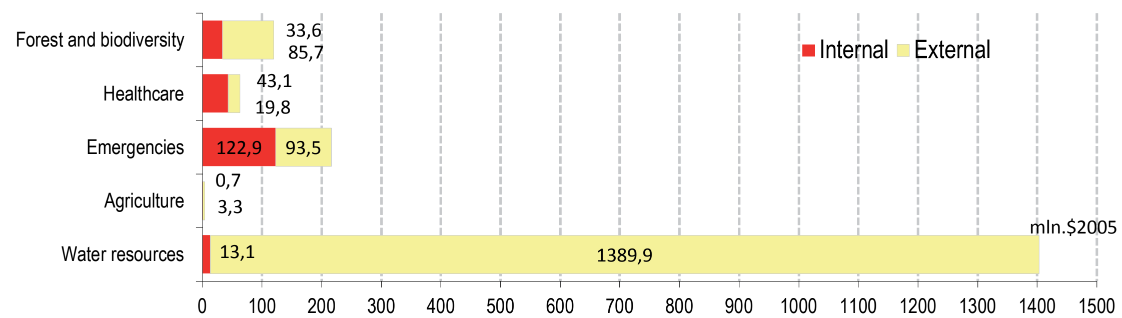


Fig. 3.24. Costs of the adaptation measures

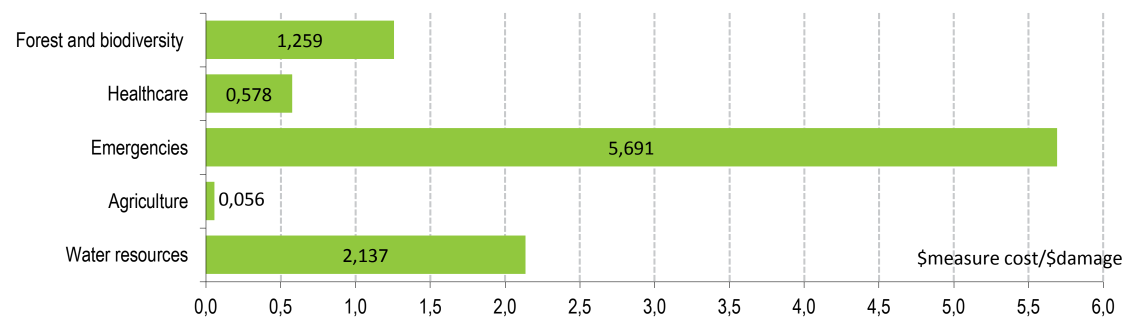


Fig. 3.25. Priorities of the sectors

4 Analysis of climate change mitigation

4.1. Methodology

This chapter is developed based on the guidelines for the preparation of the national communications from non-Annex I Parties adopted by Decision 17/CP 8.

As recommendations, the following materials were used:

- UNFCCC Resource Guide. Module 4: Measures to Mitigate Climate Change for Preparing the National Communications of Non-Annex I Parties.2008;
- Handbook for Conducting Technology Needs Assessment for Climate Change. UNDP. 2010;
- Preparing Low-Emission Climate-Resilient Development Strategies. A UNDP Guidebook — Version 1. UNDP. 2011;
- Training Handbook on Mitigation Assessment for Non-Annex I Parties. UNFCCC's Consultative Group of Experts on national communications from Parties not included in Annex I to the Convention. May 2006;
- IPCC Fifth Assessment Report: Climate Change 2013 (AR5). Working Group III "Mitigation of Climate Change";
- IPCC Special Report. Renewable Energy Sources and Climate Change Mitigation. 2011.

The analysis was based on the long-term demographic and macroeconomic scenario for the Kyrgyz Republic till 2100, developed under the current national communication process. The need for the long-term scenarios arises from the requirements to consider the rather long periods for an implementation of the major planned mitigation measures and even longer-term impacts; e.g., in the water resources management, particularly in the hydropower sector.

To obtain the energy and emission scenarios under the different development options, the analysis used the LEAP Program (Long-range Energy Alternatives Planning system), version 2014.0.1.9 and SHAKYR model developed in the KR.

4.2. Basic assumptions

4.2.1. Baseline information

The following documents provided the basic data for the analysis of the mitigation measures:

1) GHG inventory (Chapter 2);

2) National and local plans, programs, policies, etc., including GHG and precursor gases emissions reduction:

- National Sustainable Development Strategy of the Kyrgyz Republic for 2013-2017, approved by the Presidential Decree #11, as of January 21, 2013;
- Program for the Transition of the Kyrgyz Republic to Sustainable Development for 2013-2017, approved by the Parliament Decree #3694-V , as of December 18, 2013;
- Concept of Environmental Safety of the Kyrgyz Republic, approved by the Presidential Decree # 506, as of November 23, 2007 (till 2020);
- National Energy Program of the Kyrgyz Republic for 2008-2010 and Fuel and Energy Complex Development Strategy till 2025, approved by the Parliament Decision #346-IV , as of April 24, 2008.
- Small and Medium-Hydropower Development Program in the Kyrgyz Republic till 2012, approved by the Presidential Decree #365 , as of October 14, 2008;
- Mid-Term Strategy for the Electric Power Industry Development of the Kyrgyz Republic for 2012-2017, approved by the Government Decree #330, as of May 28, 2012;
- Auto Transport Development Strategy of the Kyrgyz Republic for 2012-2015, approved by the Government Decree #677, as of October 4, 2012;
- National Forest Program for 2005-2015, approved by the Government Decree #858, as of November 25, 2004;

- State Program for the Waste Management in Production and Consumption, approved by the Government Decree #389, as of August 19, 2005 (2005-2011);
- Health Sector Program of the Kyrgyz Republic on Adaptation to Climate Change for 2011-2015, approved by the Ministry of Health, Order #531 as of October 31, 2011;
- Long-Term Strategy for Heat Supply of the Kyrgyz Republic, approved by the Government Decree #300, as of April 27, 2004 (2004 - 2015);
- Concept of Housing and Communal Services and Life-Support Systems Development of Bishkek city for 2008-2010, approved by the Bishkek City Council Resolution #419 , as of February 18, 2008. Extended till 31 December 2012 in line with the Resolution #297, as of December 20, 2011;
- Concept of Municipal Program on Energy Efficiency in Buildings in Bishkek city for 2005-2016, approved by the Bishkek Mayor's Office Resolution #1063, as of November 23, 2005;
- Sustainable Development Concept of the Ecological and Economic System «Issyk-Kul» till 2020, approved by the Presidential Decree #98, as of February 10, 2009.

4.2.2. Setting goals

The Kyrgyz Republic aims to reduce GHG emissions in the short-term period as a part of its formally pledged voluntary commitments to UNFCCC [4.17]. In 2010, the contribution of the country to the global GHG emissions from fossil fuel combustion was 0.023%, while the population was 0.079% of the global population, i.e. GHG emissions per capita in the KR was three times lower than the global average [4.14]. Despite this, the KR considers it necessary to contribute to the solution of the global climate change problem and pledged to voluntarily reduce their GHG emissions by 20% by 2020 under a «business as usual» scenario with an adequate external support. It is obvious that the planned measures to reduce emissions should ensure the undertaken commitments fulfillment.

Recent estimates of climate change impacts under an increase in global temperatures over 2°C given in the IPCC Fifth Assessment Report and a report by the Potsdam Institute for Climate Impact Research [4.21] illustrate the disastrous significances of this increase. So, the ways to prevent the global temperature rise above 2°C have been considered for the longer-term prospects.

The UN Sustainable Development Network report [4.20] considers two possible scenarios. Given the assumption of a zero balance of CO_2 sources, other than energy and industry, the total amount of the cumulative emissions until 2100 will be 950 Gt, according to the IPCC RCP 2.6 scenario [4.12]. Based on this scenario's division of this amount for 2011-2050 and for 2051-2100 (825 and 125 Gt respectively), the goal for the emissions volume in 2050 can be determined. According to the estimates given in the report [4.13], emissions in 2050 must be below 11.7 Gt CO_2. This, accounting the projected global population, calculates the specific emissions in 2050 as 1.23 t CO_2 / person. This level of emissions ensures the global temperature rise below 2°C with a probability of over 66%.

The International Energy Agency reviewed the 2DS - 2°C scenario, which is softer in terms of CO_2 emissions reducing, and with a less probability level of "below 2 °C". The 2DS scenario identifies that global CO_2 emissions in 2050 need to be 15 Gt. Based on the estimated global population, the level of specific emissions can be determined as 1.58 t CO_2 / person. Under this scenario, the probability to achieve "below 2 °C" goal is 50%.

The specific emission estimates of 1.23 and 1.58 t CO_2 per capita multiplied by the projected population of the KR determines the desired target value of CO_2 emissions for 2050. These estimates should provide the national mitigation measures, as other GHG emissions for the key sources is easy to assess based on CO_2 emissions.

Given the current global level of CO_2 emission and its growth trend (Fig. 4.1), achieving the goals of 15 and above 11.7 Gt CO_2 is an extremely difficult task requiring the global sustained joint efforts.

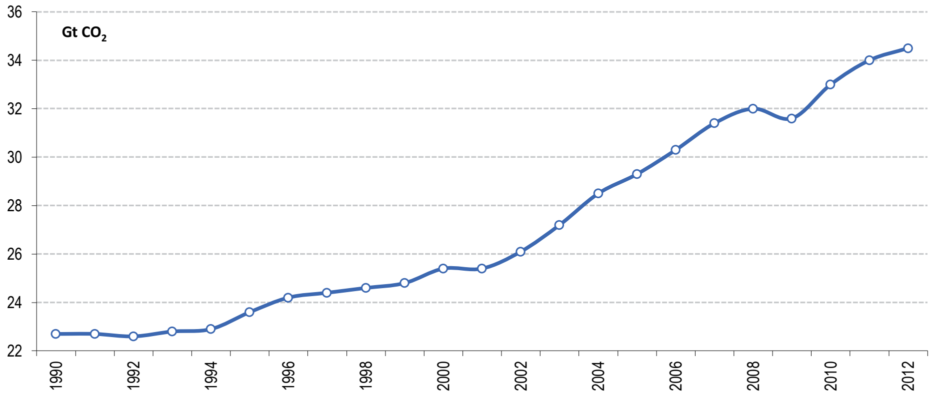


Fig. 4.1. Trends in global CO_2 emissions. Source: Report .Trends in Global CO_2 Emissions. [4.13]

4.2.3. Development scenarios

4.2.3.1. Demographic scenarios

Given a lack of the long-term national demographic research, the UN demographic scenarios served as a background. They are periodically developed for all countries and available in the World Population Prospects [4.28]. UN forecasts are made by reviewing the conventional cohort-component forecast method or the Leslie matrix method.

Key demographic characteristics for the KR with the UN scenarios are shown in the latest available assessment version (2012) in Fig. 4.2 - 4.4.

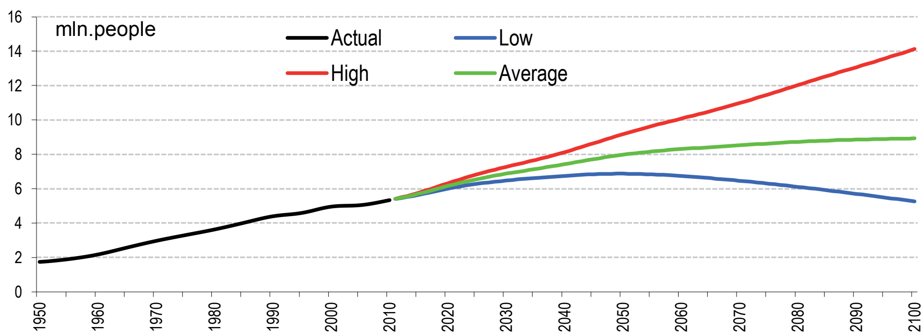


Fig. 4.2. The current and forecast population of the KR for three options of demographic development.

Actually, only the average option is assessed. The low and high variants are obtained from the average one with a change (+ / -) movement in time of the total birthrate by half of a child, i.e. by an empirical rule. As a result, the demographic projections cover a wide range of possible changes without probabilistic interpretation, the need for which has already been recognized by the developers. Therefore, further a focus should be placed on the medium option of the population as the most reasonable one. The low and high variants of the population forecast of the KR should be understood as a hypothetically possible, but less likely in the future.

Changes in the population age composition (Fig. 4.3) serve as the information source to determine the economically active population.

The UN forecast of the urban population is calculated only till 2050. As shown in Fig. 4.4, the process of independence attainment by the Central Asian countries has made significant changes in demographic processes. Formerly, growth in the urban population share almost coincided with the global trends. Then it slowed down, but a nature of changes makes it possible to easily carry out an extrapolation to 2100.

Apart from these basic demographic characteristics, the expected trends were also determined for changes in population density, life duration and expected migration. It is notable, that the migration scenarios look rather schematic and insufficiently substantiated, and, therefore, are not taken into account further.

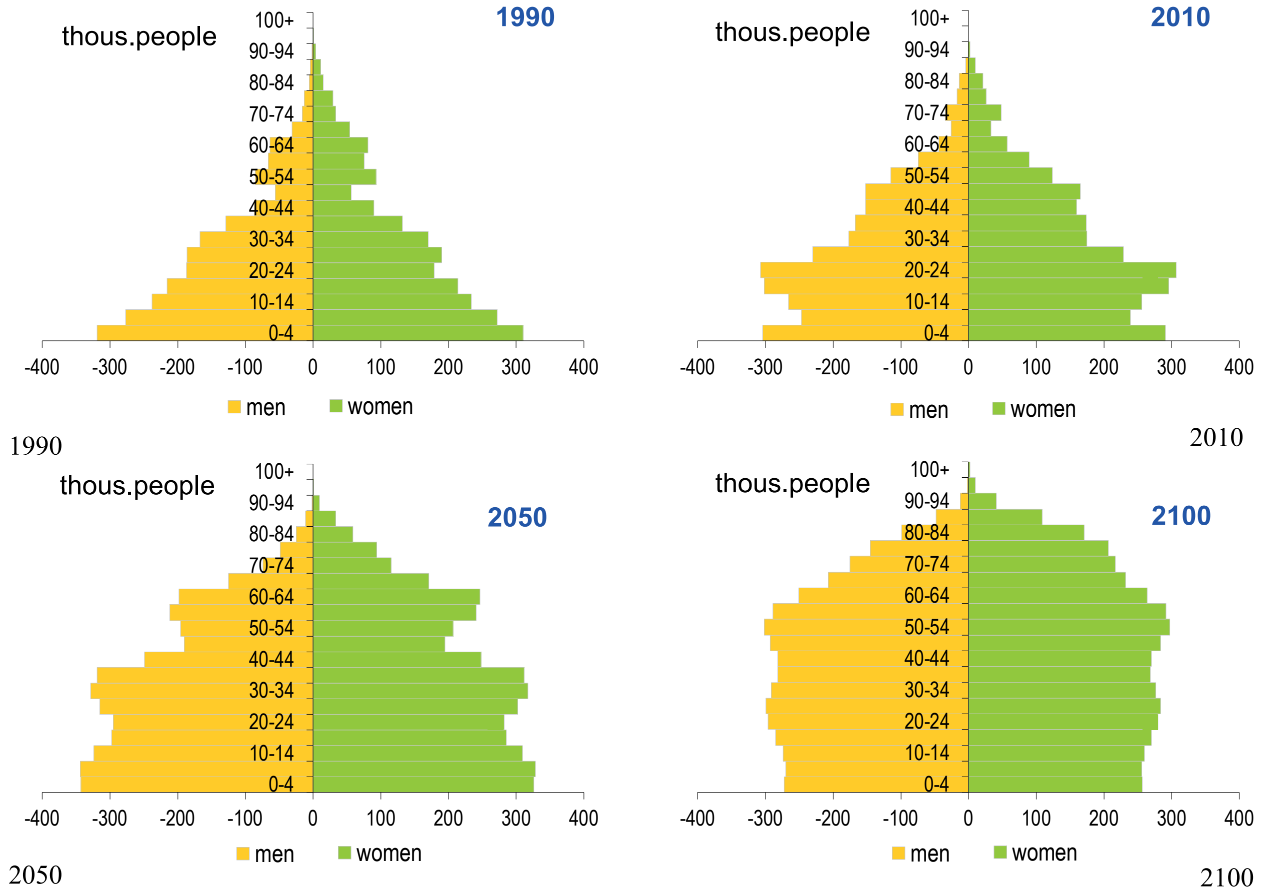


Fig. 4.3. Changes in an age composition in average population forecast variant.

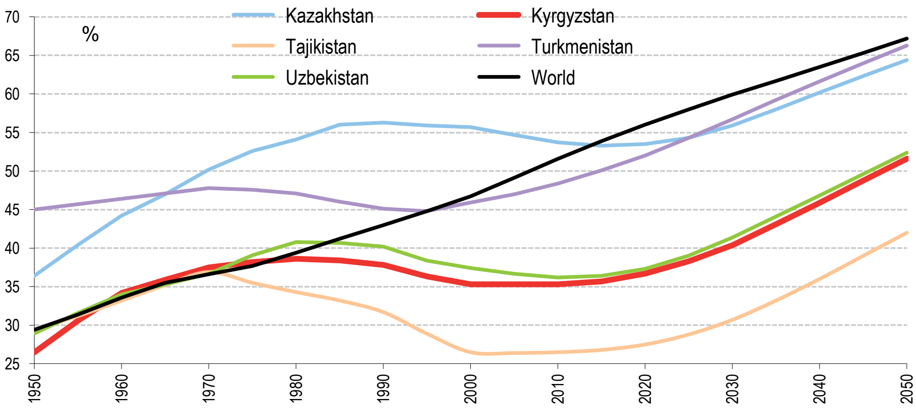


Fig. 4.4. Current and forecast share of urban population

4.2.3.2. Macroeconomic scenarios

Due to some reasons, Kyrgyzstan's economy is largely dependent on global trends of the countries development, its major trade partners, and thus develops under the influence of a number of risks and challenges, including the climate aspects. The global experience in assessing the long-term macroeconomic scenarios should be recognized as extremely limited, including the long-term forecast of world prices for raw materials and food markets. Furthermore, the forecast horizon for the different sources does not exceed 2050 level. It should be noted also that the forecast data of some sources often have the contradictory evaluations.

The economic growth trends by the macroeconomic scenarios are based on a GDP estimation model by the production approach accounting the retrospective estimates of the national economic development and the most important prerequisites and conditions for the sustainable development.

The long-term scenarios of the economic development were elaborated taking into account both the external and internal conditions and prerequisites.

Among the most important external factors impacting the national economy in the long term are the factors, such as:

- Long-term growth rate of the global economy;
- Global demographic forecasts;
- Long-term forecasts of global prices for oil, gas, precious metals and food products;
- Estimated rate of land degradation;
- Forecasted energy consumption;
- Global climate change.

Among the internal preconditions and conditions to elaborate the long-term economic development scenarios, the following were considered as the key decisions:

- Political course of the country's sustainable development till 2017;
- Demographic scenarios for the KR;
- Growth of national energy consumption;
- Constraints in diversifying the national economy;
- Deterioration level of fixed capitals;
- National plans, strategies and programs.

Based on forecast data for the GDP sectors, a service-agricultural model of the economic development is expected to remain in the long run. The total share of the service sector and agriculture is likely to be about two-thirds of the GDP. However, some structural changes in the economy under the different scenarios are inevitable, reflecting the public regulatory policy impact on the economy.

In case of the strengthened public control, a share of both the market and non-market services will significantly expand.

The structural changes (reduction of the services and construction sectors share) will lead to a larger share of the agricultural sector in the public regulation strengthening. Otherwise, the service and construction sectors' accelerated growth will change the GDP towards a decrease in the agriculture share.

To justify «angle» of the cumulative long-term trends, a factor analysis was made, as well as an evaluation of total score coefficients contribution of the key factors influencing the economic growth indicators in the long-term perspective until 2100.

The factor analysis was conducted to study a reliability of the cumulative long-term trends, based on the extrapolation to 2002 of the retrospective time series by the GDP production sectors in view of the major internal and external preconditions and conditions for the national economy development to 2100.

The key influencing factors were grouped according to the traditional macroeconomic criteria:

- supply / production factors;
- demand factors;
- other factors.

«Other factors» was used variably at the expert level to get the results satisfying the best options for authenticity.

Excluding other factors, the level of reliability of the long-term economic development trends ranged from 81 to 85%.

Below is the calculation formula for coefficients of each factor's contribution to cumulative GDP growth for each sector:

$$C = d_1 * r_1 + d_2 * r_2 + ... + d_n * r_n$$

where

C – rate of contribution;

$d_1, d_2 \ldots d_n$ – relative weight of factors influencing the GDP growth rate

$r_1, r_2 \ldots r_n$ – cumulative growth rates/ change of influencing factors in 2100.

A large majority of the global economy forecasts show that fluctuations in economic growth go in line with the demographic processes. So, the long-term macroeconomic scenarios were developed integrating the demographic component.

An analysis of the retrospective data and projections are, on the whole, consistent with the most common global practice of «measure saves». It recognizes that the population growth impact on the economic growth is mutual and comprehensive. Problems such as unemployment and malnutrition are caused by many aspects, and a focus only on the population growth reduction does not take into account other reasons of these phenomena leading to the incorrect marks.

On the other hand, the demographic factors serve as the social and economic development functions. Wealth can lead to children amount increase, but their labor can cover expenses for their maintenance and education. However, the wealthy people tend to have fewer children, while poverty is often accompanied not only by a high mortality rate, but by a high birthrate as well.

An analysis of the retrospective data and time series of the forecasted parameters for the national economy till 2100 gives a clear revelation of the explicit time intervals, alternating with some fluctuations in the economic growth. This allows making the specific assumptions and rationale at each of these cycles.

Cycle 1: 2010 - 2025 (15 years) - transition to sustainable development.

In January 2013, the President of the Kyrgyz Republic declared a policy of sustainable development in the framework of the National Strategy to 2017. During this period, an optimistic macroeconomic outlook was itemized to achieve a real economic growth rate of on average 7.5% per year.

Therefore, it is most likely that the cycle will be characterized by a slowdown in economic growth after 2017, if the economic growth will reach 6.5% - 7.5% on average per year during 2013-2017.

The forecast for rapid capitalization of the economy for this period via launching the planned major investment projects may trigger a risk of the economy «overheating». The average projected gross fixed capital formation during this period is 35% of GDP per year, or about 2 billion USD. The investment payback period can be expected in the next stage of the development cycle.

Therefore, the most likely assumption is that for 2017- 2025, there would be a slowdown in the economic growth. This might also be due to the influence of domestic political events, change of senior leadership, changes in the political platform and, as a consequence, possible change of the strategic development course.

In addition, the most likely reasons of economic slowdown in this period may be the limited opportunities for the national economy diversification. After 2020, the compensation capacity of the national economy may not be able to cover the losses associated with the gradual reduction of existing mining operations.

Cycle 2: 2025 - 2060 (35 years) - investment breakthrough.

The estimates of this national economic development cycle demonstrate the following periods of growth and decline, which are related to the following events and factors:

a) Increase in the positive economic trends during 2025 - 2040. Internal influencing factors:

- Environment oriented economy;
- Improved governance quality through reforms, including a lowering of corruption level in the country;
- Enabling activities for business development in the country;
- Obtaining socio-economic benefits from the investment projects launched afore 2025.
- Better economic opportunities based on the transport infrastructure improvement;
- Reduced power deficit through launching of additional generating capacity for power production;
- Introduction of energy-saving and energy-efficient technologies;
- Positive dynamics in agriculture due to the irrigation projects implementation and the expansion of organic farming.

b) Slow-down in economic growth expected in 2040-2060 will mostly be due to:

- Completion of the major investment projects implementation;
- Completion of the existing exploitation of the large deposits (gold, coal, oil, gas), given that the exploration of new fields is not actively conducted currently;
- Inertial development of agriculture and a growth of food security problems due to a gradual reduction in cultivated areas and pastures in a result of land degradation (the projected annual rate of land degradation will continue to grow in the average range of 4.5 - 12% per year). There is an urgent need for the land reclamation and technological modernization of the agricultural sector;
- Exhaustion of water resources (under the negative climate change trend in the rainfall stabilization or reduction).

Cycle 3: 2060-2090 (30 years) – technological progress.

During this period, the technological breakthrough and modernization of the economy is most expected with the widespread introduction of resource-saving technologies. This process could befall with a support from the international organizations and financial institutions provided that the strategic course to sustainable development is maintained.

High energy costs will push for the widespread introduction of energy-saving technologies and energy efficiency in all sectors, especially in the residential sector. It is expected that the energy savings would improve by an average of 60%, and, perhaps by 90% to 2100.

During this period, the active measures are expected on land reclamation and an introduction of resource-saving green technologies in the agricultural sector. Increasingly, greater resources will be spent for the implementation of scientific and technological progress in agriculture, which will lead to a more efficient use of resources, particularly the land and water resources. The introduction of energy-saving equipment and technology will reduce energy consumption per unit of production.

The mining industry will begin a new stage of developing mineral deposits by means of the new technologies and innovative techniques minimizing their negative impact on the environment.

The processing industry will receive a new impetus for development and significantly expand the scope of services through new services, including a formation of a modern market of IT services and technologies. The modernization process of the national economy will improve the competitiveness of the country as a whole. At this stage of the national economy, human resources can actually translate into human capital.

Cycle 4: 2090 - 2100 (10 years) - innovative model of the national economy.

Technological intensity expected in 2070-2080 (due to the national economy small size) will be replaced in 2090-2100 with a new cycle - a transition to an innovative model. The up-to-date industrial parks will lead for the development and introduction of innovations to the traditional and new sectors of the national economy.

The results of the macroeconomic scenarios assessment are presented in Fig. 4.5. Visible distortion of sequential growth come as a result of the above cyclic development of the national economy for different periods of growth.

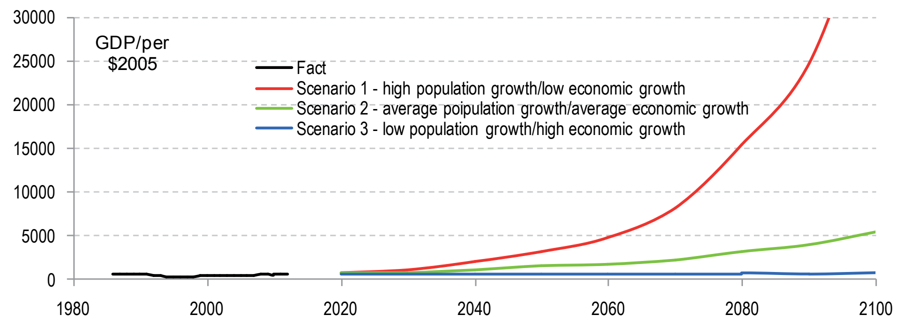


Fig. 4.5. Retrospective data and the long-term development options

4.2.3.3. Methodology of basic scenarios

The results of the basic demographic and macroeconomic indicators projection for different scenarios are shown in the summary Table 4.1. Other indicators used for the baseline scenarios design are derived from the above table.

Based on the identified trends, a low population growth level was accepted for the high economic growth. Although it is quite likely that practically there are other possible combinations of options for economic and demographic growth, the overuse of all the possible combinations leads to unnecessary complication. On the other hand, the adoption of extreme combinations provides a significant probability that the actual development is in between. The level of economic development is assumed proportionally to the volume of GDP per capita. It is normal to assume that the living standard is more precisely characterized not by the value of GDP per capita in constant dollars, as shown in Table 4.1, but by the value of GDP by purchasing power parity (PPP) in constant dollars.

However, there are significant complications in the GDP forecasting by purchasing power parity for the future. In addition, unfortunately no comprehensive and reliable sources of information were found about the GDP value in PPP terms for different countries and time periods in retrospect, required for further comparative analysis. For example, the World Bank database contains data constant only to the compliance rate of GDP and GDP by PPP for the whole time period (since 1961) without considering a significant change over time in the developing countries. While it is obvious that the compliance rate substantially and significantly depends on the GDP size (Fig. 4.6).

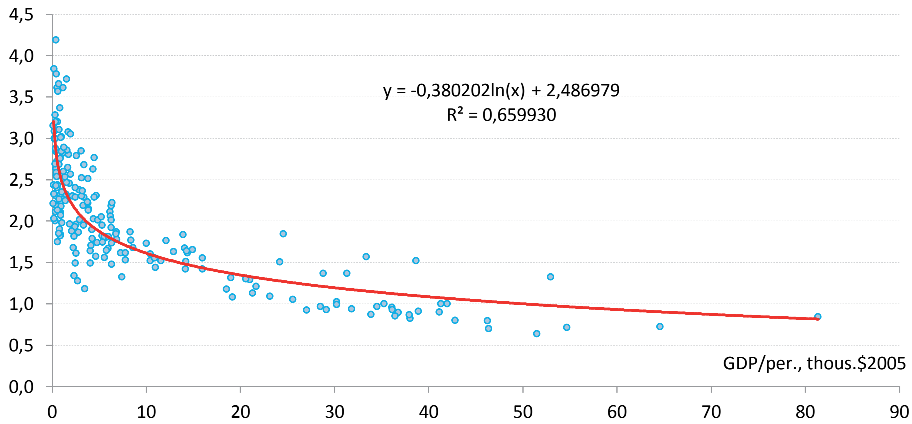


Fig. 4.6. Change of compliance ratio between GDP and GDP PPP depending on GDP per capita in $2005 re 2010 data

4.2.4. Specifics of the national accounting system

Incompatibility of the national energy performance accounting system with the sectors' structure under the GHG and precursor gases inventory creates certain difficulties in the estimation and inevitably introduces additional uncertainty in the final results. Development of the emission scenarios creates additional problems, since inside of certain sectors / sub-sectors or balance sheet items detailed division is required, due to the different sources influencing their trends in the future. The most typical example is the Energy Production sub-sector. As an example, Fig. 4.7 shows the necessary partition of 1A1 "Energy Production" subsector for the further analysis of changes. For other sub-sectors the similar structures were built separating different sources and different types of consumer.

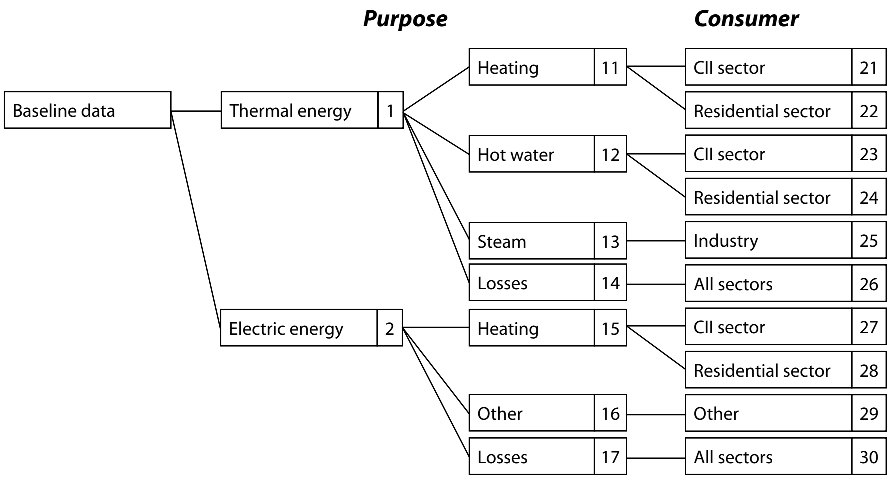


Fig. 4.7. Estimation for 1A1 "Power generation" subsector (CII –1A4a "Commercial/ Institutional" subsector, Residential –1A4b "Residential" sub-sector)

The estimation structure, shown in Fig. 4.7, is in some way universal, since it can use the emissions of separate GHG or precursor gases or the total GHG emissions in CO_2-eq. as input data, as well as the total power consumption or of certain types of energy resources. Breaking down the total baseline indicator into the individual components results from the serial multiplication of the conversion multiplicative coefficients, set in each box (Fig. 4.7), by the total baseline factor. The result is a separate emission of each gas or power resources consumption in accordance with the final list named as «consumer», or at any intermediate stage of consumption, indicated as «destination/purpose». A list of end users (Section 4.3) is shaped according to the requirements correctly to quantify the change trends in the future under the relevant scenarios.

The coefficients in boxes 1 and 2 are defined, based on the standards for power consumption for the heat and electricity production. The coefficients in boxes 11, 12 and 13 are defined by the actual heat distribution in recent years by the Thermal Power Plants "Bishkekteploenergo" and "Kyrgyzzhylcommunsoyuz" data. The coefficient in box 14 is defined according to the Fuel and Energy Balance data.

The electricity consumption for heating (box 15) is estimated by data on the power supply to the power network from 2009 to 2013 (Fig. 4.8). By selecting the months without heating (summer), it is easy to

Table 4.1. Main indicators of development scenarios

Indicator	Measurement unit	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
Scenario 1. Low population growth – high economic growth											
Population	thous. people	5418,3	6005,4	6475,2	6747,7	6872,5	6739,2	6460,6	6107,5	5699,5	5264,1
incl. urban	%	34,1	36,7	40,4	45,9	51,6	53,0	55,0	57,0	59,0	61,0
GDP/per capita	$2005	572,9	826,2	1175,8	2013,4	3203,9	4761,7	8284,1	15393,2	24850,3	45011,0
GDP share, %	Energy	2,9	2,41	3,39	2,83	2,34	2,13	1,84	1,16	0,99	0,69
	Industry	17,8	21,19	19,20	15,64	12,81	9,59	5,37	2,56	1,45	0,60
	Agriculture	17,5	20,94	22,19	19,78	21,65	24,85	27,23	27,73	28,34	33,74
	Construction	5,5	13,35	15,15	19,85	18,59	25,23	25,99	19,85	16,66	12,14
	Services	46,1	42,11	40,07	41,89	44,61	38,20	39,57	48,71	52,55	52,82
Scenario 2. Average population growth – average economic growth											
Population	thous. people	5418,3	6162,4	6871,1	7428,9	7975,9	8304,1	8523,0	8726,1	8855,7	8924,1
incl. urban	%	34,1	36,7	40,4	45,9	51,6	53,0	55,0	57,0	59,0	61,0
GDP/per capita	$2005	572,9	731,4	847,2	1193,1	1535,0	1731,0	2323,2	3285,2	3991,9	5434,8
GDP share, %	Energy	2,9	2,39	3,72	3,09	2,56	2,40	2,20	1,75	1,78	1,47
	Industry	17,8	21,75	20,74	18,17	15,69	12,49	7,34	3,60	1,99	0,78
	Agriculture	17,5	21,76	25,44	24,86	29,25	37,56	44,05	47,14	51,05	59,37
	Construction	5,5	12,52	12,53	14,69	11,96	14,88	13,32	8,64	6,20	3,56
	Services	46,1	41,58	37,56	39,19	40,55	32,67	33,10	38,87	38,98	34,82
Scenario 3. High population growth – low economic growth											
Population	thous. people	5418,3	6319,3	7267,3	8128,1	9170,6	10078,5	10978,4	12027,8	13068,6	14120,1
incl. urban	%	34,1	36,7	40,4	45,9	51,6	53,0	55,0	57,0	59,0	61,0
GDP/per capita	$2005	572,9	601,8	574,3	665,9	694,7	630,7	666,5	716,6	693,9	735,8
GDP share, %	Energy	2,9	2,68	4,39	4,17	3,71	3,76	3,35	2,18	1,91	1,17
	Industry	17,8	20,96	20,49	18,79	16,38	12,66	7,26	3,55	1,80	0,64
	Agriculture	17,5	26,51	33,36	34,76	42,14	55,27	64,67	70,29	76,06	83,24
	Construction	5,5	11,38	9,72	9,85	6,64	6,86	4,95	2,62	1,50	0,65
	Services	46,1	38,47	32,04	32,42	31,14	21,45	19,77	21,37	18,73	14,29

determine the share of electricity used for heating. In annual terms, this percentage over the past 5 years was 41.06% on average.

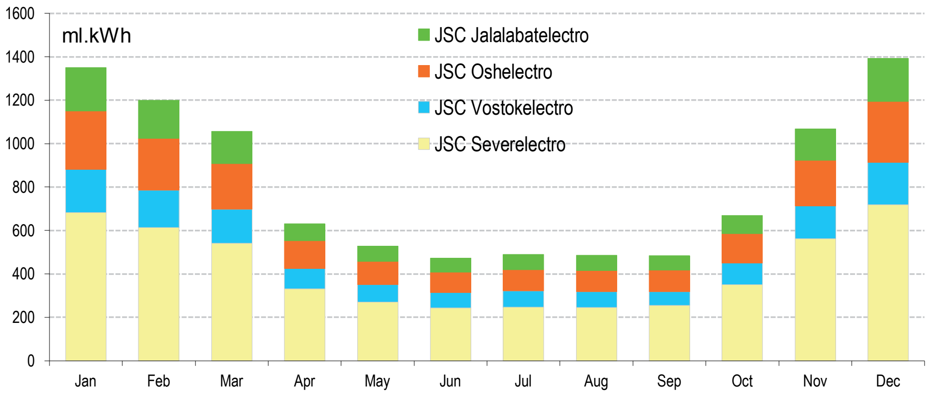


Fig. 4.8. Monthly supply of electric power by JSC Severelectro, JSC Vostokelectro, and JSC Jalalabatelectro, averaged for 2009-2013.

The share of energy losses (box 17) is defined by the Fuel and Energy Balance as a ratio of the losses to the total of electricity produced, and the share of the «Other» category as the remaining share:

$$B_{16} = 1 - B_{15} - B_{17}$$

The heat and power distribution (boxes 21-22, 23-24 and 27-28) between the Commercial / Institutional and Residential sub-sectors is assumed to be proportional to the area of these building categories.

The main structural characteristics of the economy, such as a structure of the used power resources, their use efficiency, etc., assumed for 2010 as the base year for the estimation.

4.3. Basic assumptions on the activity branches for the baseline emission scenarios

Based on the similar studies experience, e.g., conducted by the World Bank [4.11], the methodology for a change assessment of the different indicators is based on their relationship to quality of life. The calculations are based on the following main indicators:

- Specific living area;
- Number of cars per 1,000 people;
- Amount of produced municipal waste per person;
- Specific power and gas consumption.

The significant problems notably arise in the determining of different specific indicators, depending on the living standards (e.g., GDP per capita in constant US dollars) due to the informal sources of income changing the actual living standard compared to the official one. The baseline scenarios were developed without accounting unofficial income sources. This makes it difficult to identify the current situation and its change trends in the future. It is assumed that in the process of economic and social development, a difference between the official and unofficial assessment of the living standards will consistently decline. If in a transition from the base to the forecast year for some of the specific indexes, from the above listed, there is an abrupt change, the obtained predictive trends were smoothed, reflecting the gradual rapprochement process of the formal and informal assessments of the life level.

In order to make further analysis easier, the assessments for all scenarios were made by dividing them into the following categories:

- Thermal power. Heating. Commercial/Institutional sector;
- Thermal power. Heating. Residential sector;
- Thermal power. Hot water. Commercial / Institutional sector;
- Thermal power. Hot water. Residential sector;
- Thermal power. Steam;
- Thermal power. Losses;
- Electrical power. All consumers, except for the Commercial / Institutional and Residential sectors;
- Electric power. Losses;

- Heating. Commercial / Institutional sector (combustion);
- Heating. Commercial / Institutional sector (electricity usage);
- Hot water and others. Commercial / Institutional sector (combustion);
- Hot water and others. Commercial / Institutional sector (electricity usage);
- Heating. Residential sector (combustion);
- Heating. Residential sector (electricity usage);
- Hot water and others. Residential sector (combustion);
- Hot water and others. Residential sector (electricity usage);
- Transport;
- Industrial and Construction (combustion);
- Farm (combustion);
- Fugitive emissions from fuels;
- Industrial Processes (specific emission);
- Farm, except for 4A, 4C, 4D (specific emission);
- 4B Manure storage systems;
- 4F Agricultural residues incineration;
- 6A SDW;
- 6B2 Municipal wastewater management;
- 6B1 Industrial wastewater management.
- LULUCF.

The following set of indicators was established for each category assessed:

- CO_2 emission;
- CH_4 emission;
- N_2O emission;
- Summed GHG emission;
- NOx emission;
- CO emission;
- NMVOC emission;
- SO_2 emission;
- Power consumption (measurement unit – tce, toe and, where necessary, kWh).

Also, HFC-134a emissions were calculated for the Industrial Processes sector, and then added to the total GHG emissions. The results of the emissions calculations for all the above listed categories are given further. Estimations were made for all GHG, precursor gases and power indicators in tce, toe and kWh. The results are generally given only for the totals, as the rest, in most cases, are proportional to the total figures due to the basic assumption of a constant structure of the consumed power resources for basic options.

1A1 Power generation. Thermal power

The "Energy Generation" sub-sector actually involves as the consumers, population, businesses, institutions, etc., in accordance with the structure in Fig. 4.7. The change in thermal power consumption in the baseline scenario for the "Commercial / Institutional» and "Residential" subsectors heating was made proportionally to the specific area per capita. The projected specific living area for the period to 2100 was determined by interpolation in accordance with the recognized statistics on availability of living space per person, depending on the level of the economic standard of living given on the International Union of Tenants website (www.iut.nu).

The areas change for the Commercial / Institutional sub-sectors were expected to be similar to the retrospective trends of recent decades in the country (NSC data) and in Eastern Europe [4.10].

Under the step by step calculations from year to year, it has been assumed that a reduction in the existing areas (e.g., due to population reduction) would not happen.

The amount of thermal power for hot water in "Housing" subsector was accepted proportionally to the population, i.e. the existing specific consumption of hot water is expected to remain in the future. Additionally, the change in the volume of thermal power used as steam was assumed proportionally to the industrial sector development, in line with the macroeconomic scenarios including the share of industrial facilities utilizing steam.

The amount of heat energy losses is determined for each particular year and scenario by the following formula:

$$Q_{26} = \frac{k(Q_{21} + Q_{22} + Q_{23} + Q_{24} + Q_{25})}{(1-k)},$$

where

k – ratio of losses;

Q_{21}, Q_{22}, Q_{23}, Q_{24}и Q_{25} – –appropriate volumes of used indicators relating to heat energy by all the other categories of consumer.

The structure of power resources used is assumed to be constant throughout the forecasted interval and corresponding to 2100.

The volume dimensions depends on the dimension of the source data used (GHG, precursor gas emissions or the amount of power).

Fig. 9 shows the results of assessment of the change in the total GHG emissions in the production of thermal power for different consumers till 2100 and for different scenarios.

These calculations suggest the following:

1. GHG and precursor gas emissions and the consumption of heat power will grow under all country development scenarios;
2. The largest increase in consumption will be under Scenario 3, due to the largest population growth, since the future conditions are assumed to provide specific (per unit area) thermal power kept at the level of 2010 at least;
3. The smallest increase in consumption will be under Scenario 2;
4. Slowdown under Scenario 1, and, to a lesser extent, under Scenario 2 is due to lower than expected the population growth;
5. The main heat consumption category accounted for heating, much less is spent for hot water, than for steam;
6. Heat consumption by the Residential (R) sub-sector is much higher than the consumption of the Commercial / Institutional (CII) subsector;
7. Heat losses significantly exceed the average global indicators.

Trends in precursor gases emissions and heat consumption in power units coincide with the GHG emissions trends.

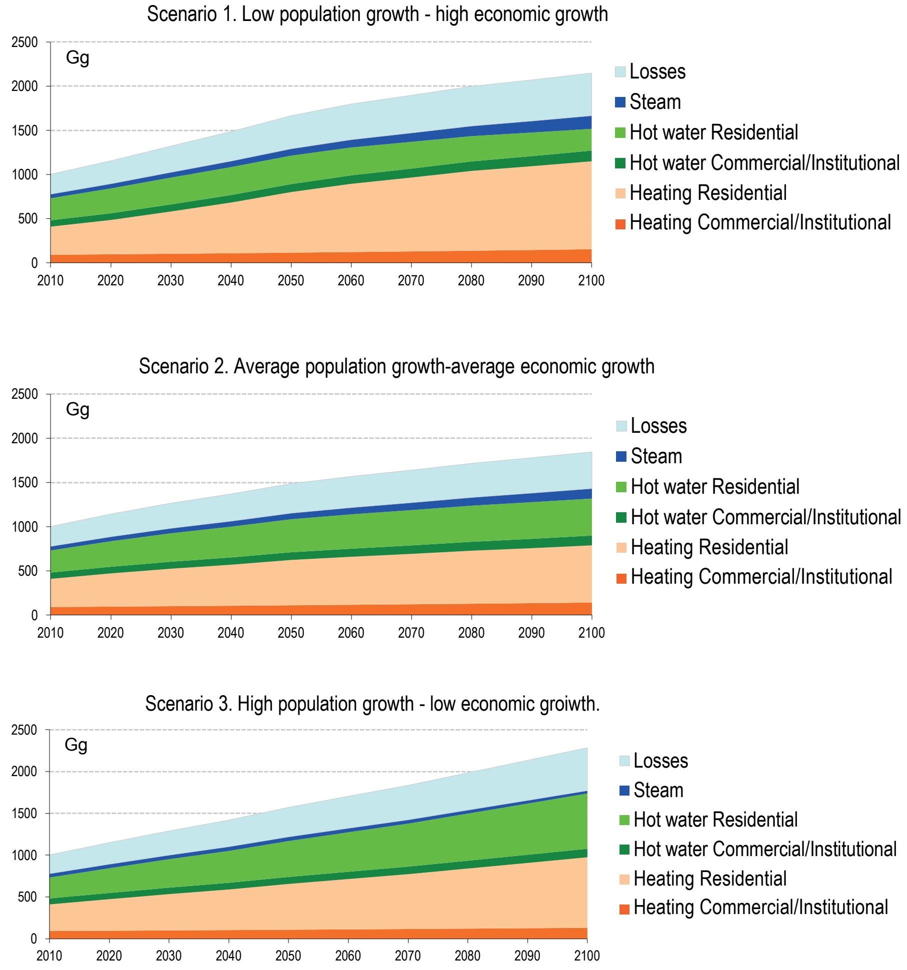


Fig. 4.9. Basic emission scenarios for 1A1 "Power generation: Thermal power" category

Fig. 4.10 shows the overall change of total energy consumption under different scenarios for the 1A1 "Power generation: Thermal power" category, which is given without a breakdown into separate consumers, as a breakdown fully coincides with the similar emission characteristics. The intense increase in consumption for Scenario 1 and a further reduction in consumption become smaller, as compared to Scenarios 2 and 3. As a result, the highest consumption of power resources is expected for Scenario 3, as population growth for this scenario outweighs the increase in the consumption share for the other scenarios.

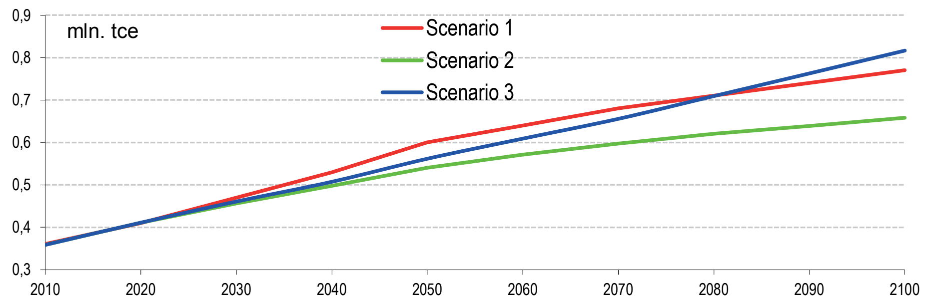


Fig. 4.10. Change of total power consumption under different scenarios for the 1A1 "Power generation: Thermal power" category.

1A1 Power generation. Electric power

In general, the electric power consumption was determined in accordance with the known global trends binding a dependence of electric power consumption on the living standards. Fig. 4.11 shows the electric power consumption for different countries according to available retrospective data by the World Bank.

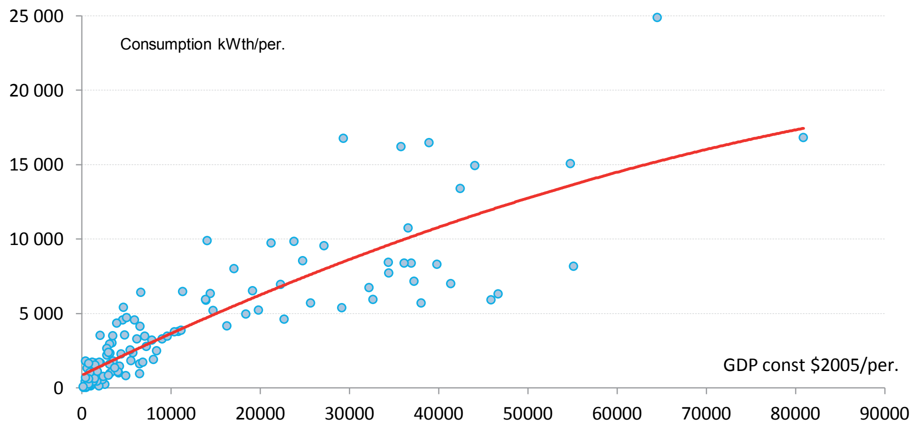


Fig. 4.11. Dependence of electrical power consumption on the living standard

Based on the dependence, the electric power consumption in the country was determined for the recognized living standards values under the development scenarios. The consumption of electric power for heating and hot water supply, as well as other needs in the "Commercial / Institutional" and "Residential" subsectors was defined similarly to the assessment of thermal power consumption, i.e., depending on the living area and population number for the "Residential" subsector and depending on the expected living standards in the "Commercial / Institutional" subsector.

Other electric power consumption in the country was determined by subtracting from the total consumption, consumption in two subsectors and losses. This has taken into account that the level of expected consumption in the "Commercial / Institutional" and "Residential" subsectors cannot be below the achieved level.

Loss of electric power is defined by the following formula:

$$E_L = k \frac{\sum E_i}{1 - k}$$

k – loss ratio;

ΣE_i – amount of consumed electric power by all sectors.

GHG and precursor gases emissions are estimated for electricity, as well as for thermal power. However, for electric power it is considered, that one part is generated by hydro, and the other part - by the thermal power stations, utilizing fossil fuels. The generation ratio between them varies somewhat from year to year, affecting the environmental indicators. The average power generation indicators in the country for recent years are shown in Table 4.2.

Table 4.2. Environmental characteristics of electric power generation, average in recent years

#	Indicator	Dimension	Value
1	CO_2	g CO_2/kWh	59,26
2	CH_4	g CH_4/ kWh	0,00077
3	N_2O	g N_2O/ kWh	0,00074
4	GHG	g GHG/ kWh	59,51
5	NOx	g NOx/ kWh	0,1796
6	CO	g CO/ kWh	0,0135
7	NMVOC	g NMVOC/kWh	0,00343
8	SO_2	g SO_2/ kWh	0,4441
9	Fossil fuel consumption	g oil eq./ kWh	27,39

Based on the electric power consumption and living standards statistics (Source: World Bank), dependencies of changes in the power consumption in the country as a whole (Fig. 4.12) were developed. The electricity consumption in the country is expected to grow under all the scenarios, but most rapidly under Scenario 1.

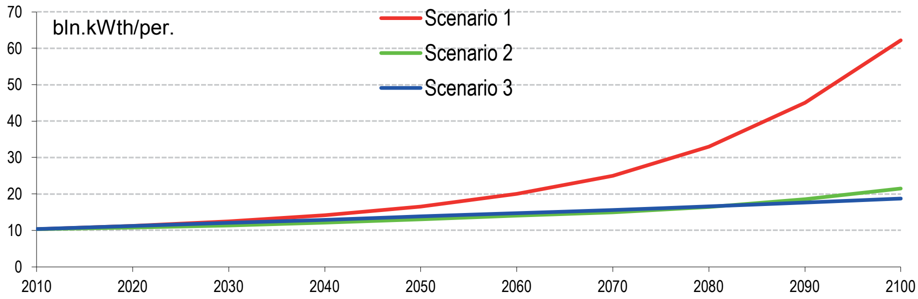
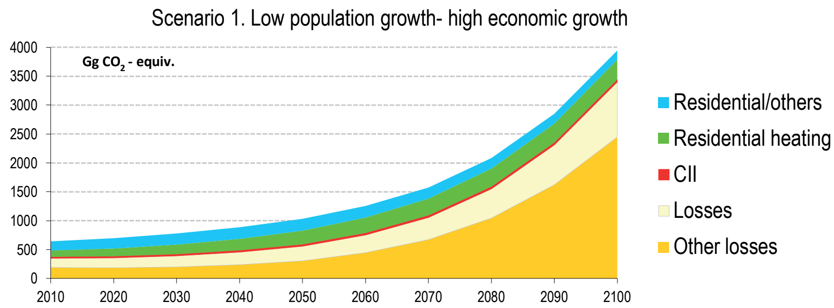
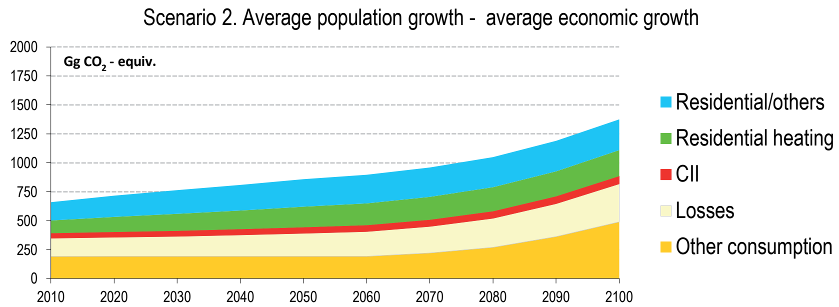


Fig. 4.12. Trends in the electric power consumption for different scenarios





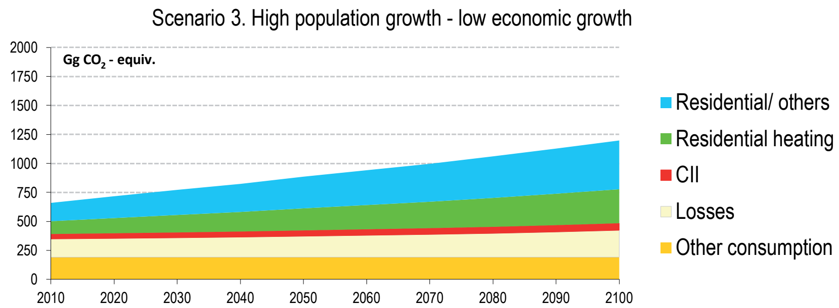


Fig. 4.13 shows GHG emission trends for the different scenarios and different consumers.

For convenience of the further analysis the main areas of the of electric power distribution have been defined:

- Heating - Commercial / Institutional subsector;
- Hot water and other consumption - Commercial / Institutional subsector;
- Heating - Residential subsector;
- Hot water and other consumption - Residential sub-sector;
- Other consumers, except the above listed (industry and construction, transport, agriculture, etc.);
- Losses.

Obviously, the economic development will increase the power consumption, which at certain time will exceed the existing generation capacity. In this case, the missing volume is supposed to be generated preserving the fossil fuel use structure, and hence the emissions structure. The balance will be maintained by means of the parallel commissioning of the renewable energy sources, e.g. the planned construction of hydropower plants and power sources on fossil fuels (Bishkek TPS-2 with a planned capacity of 400 MW by natural gas and Kara-Keche thermal power plant with a planned capacity of 1200 MW at the Kara-Keche coal field).

These calculations suggest the following:

- GHG and precursor gases emissions and electric power consumption will rise under all the country development scenarios;
- The strongest growth is typical for Scenario 1, due to the increase of electricity share for other consumption, providing the planned growth of the economy;
- Electricity losses are significantly higher than the global average;
- Precursor gases emission trends and the electric power consumption match with the GHG emissions trends.

1A2 Industry and Construction

The structure of consumed fossil fuels for the entire projected period for the 1A2 "Industry and Construction" subsector is assumed to be constant. Throughout the baseline scenario period, changes in emissions and energy consumption are assumed to be proportional to the absolute amount of an industry and construction contribution to the total national GDP. The assessment takes into account the progressive reduction of emissions and energy consumption per unit of production as follows:

$$Q(x) = \frac{\left(\frac{(d_i(x) + d_c(x)) * GDP(x) * GDP(x-1)}{d_i(x-1) + d_c(x-1)} - 1 \right)}{k_{ic}} + 1 \ ,$$

where

$d_i(x)$, $d_c(x)$ – share of the Industry and Construction sectors' contribution into the national GDP in the year x;

$GDP(x)$ – gross domestic product in the year x;

k_{ic} – reduction rate of emissions and power consumption in "1A2 Manufacturing industry and Construction" subsector for GDP growth;

x – current year.

The results of GHG emissions estimate for different scenarios are shown in Fig. 4.14. They were not divided into the separate categories as emissions in this category are small as a whole.

1A3 Transport

The "Transport" subsector is characterized by an absolute predominance of GHG emissions in the "Road transport" category. In accordance with the results of the GHG inventory given in Chapter 2, the share of GHG emissions in 2010 under the "Road transport" category is over 99%, while a share of the "Civil aviation" category is 0.87%, and a contribution from the "Railways and Water transport" categories is even less - 0.079 and 0.012%, respectively. Therefore, under the emission scenarios analysis only the "Road transport" category has been assessed, as the observed trends show that it is difficult to expect a significant increase of the other categories contribution in the future.

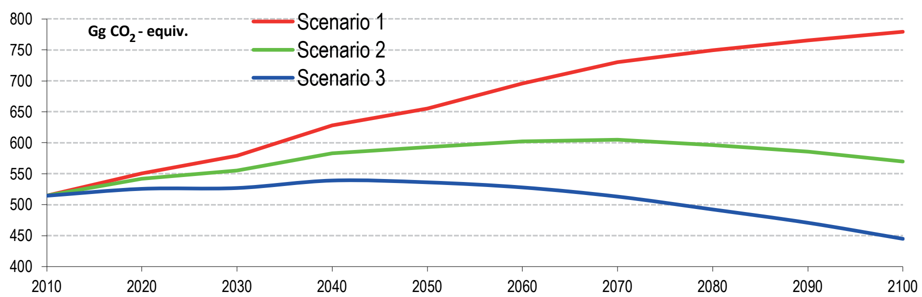


Fig. 4.14. Trends in total emissions in 1A2 "Manufacturing and Construction" subsector

The baseline scenario did not use a traditional approach to the initial data source, based on the possible changes in a number of vehicles, but an information on the volume of fuel consumed. Firstly, data on the road vehicles number is not accessible. Secondly, the transition from fuel volume to emissions is greatly simplified and reduces the uncertainties.

To estimate the baseline scenario, a dependence of specific consumption of motor fuel for the countries with different living standards was used as an analogue (Fig. 4.15).

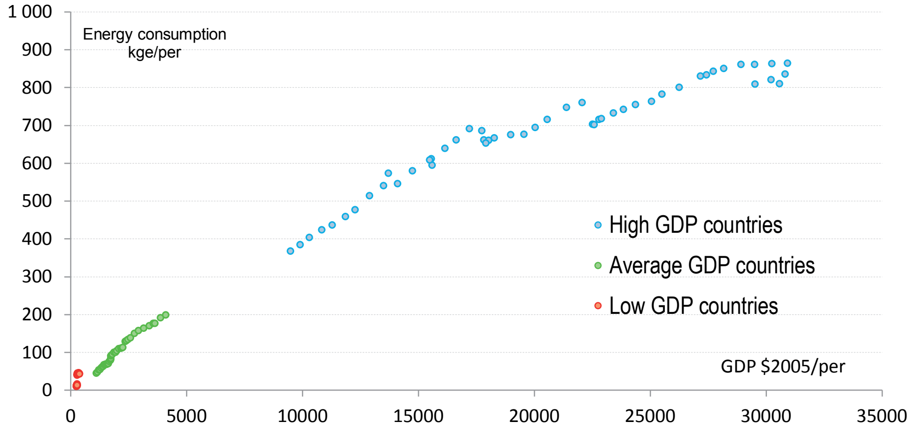


Fig. 4.15. Dependence of road transport fuel consumption on the living standards. Source: the World Bank

It is notable, that the dependence of power consumption by road transport on the living standards is clearly non-linear and decreases with the living standards growing. Characteristically, like by many other indicators, evidently depending on the living standard, the existing power consumption by road transport in the country, according to official data, is much higher than the global figure with a similar standard of living. This required making appropriate corrections to the assessment of the estimated scenarios for power consumption.

The structure of the motor fuels consumption for all scenarios accepted the same, as for 2010, data. The expected emissions for the "Road transport" category are shown in Fig.4.16.

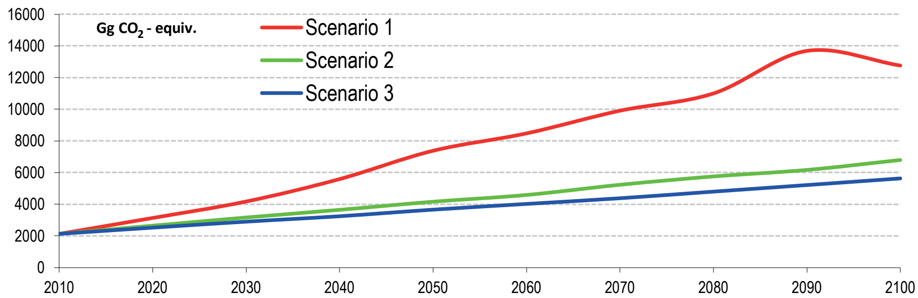


Fig. 4.16. Trends in total emissions in 1A3b "Road transport" subsector

The GHG emissions reduction for Scenario 3 at the end of the century reflects the current trend of reducing the specific consumption of motor fuel at a high living standard of the developed countries.

1A4a Commercial/Institutional

The methodology for the emission scenarios for this subsector is similar to those in 1A1 "Power generation: Thermal power" and 1A1 "Power generation" subsectors. Emission scenarios are estimated only for the fossil fuels combustion, as the emissions from the electric power use are already taken into account in the analysis of 1A1 "Power generation" subsector.

GHG emissions estimate is shown in Fig. 4.17. The emissions are divided into two consumption categories - heating and other consumption (hot water, cooking, etc.).

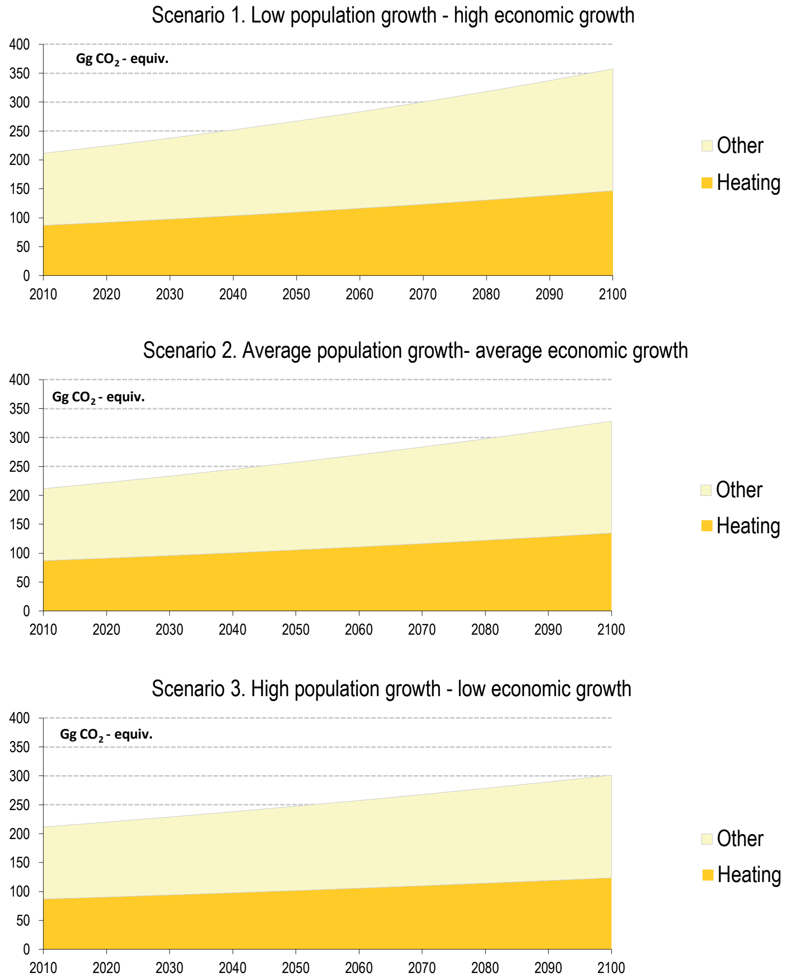


Fig. 4.17. Trends of GHG emissions under different scenarios in 1A4a "Commercial/ Institutional" subsector

1A4b Residential

The methodology for the emissions scenarios development and the results presentation (Fig. 4.18) for this subsector is identical to that of the 1A4a "Commercial / Institutional" subsector.

1A4c Agriculture

The consumption structure of fossil fuels is assumed to remain constant for the whole forecast period in the 1A4c "Agriculture" subsector. Throughout the baseline scenario period, the changes in emissions and power consumption are presumed proportional to the absolute volume of the agriculture contribution to the total GDP. The forecast calculation accounts for the progressive reduction of emissions and power consumption per unit of production:

$$Q(x) = \frac{\left(\dfrac{d_a(x) * GDP\ (x) * GDP\ (x-1)}{d_a(x-1)} - 1\right)}{k_a} + 1 ,$$

where

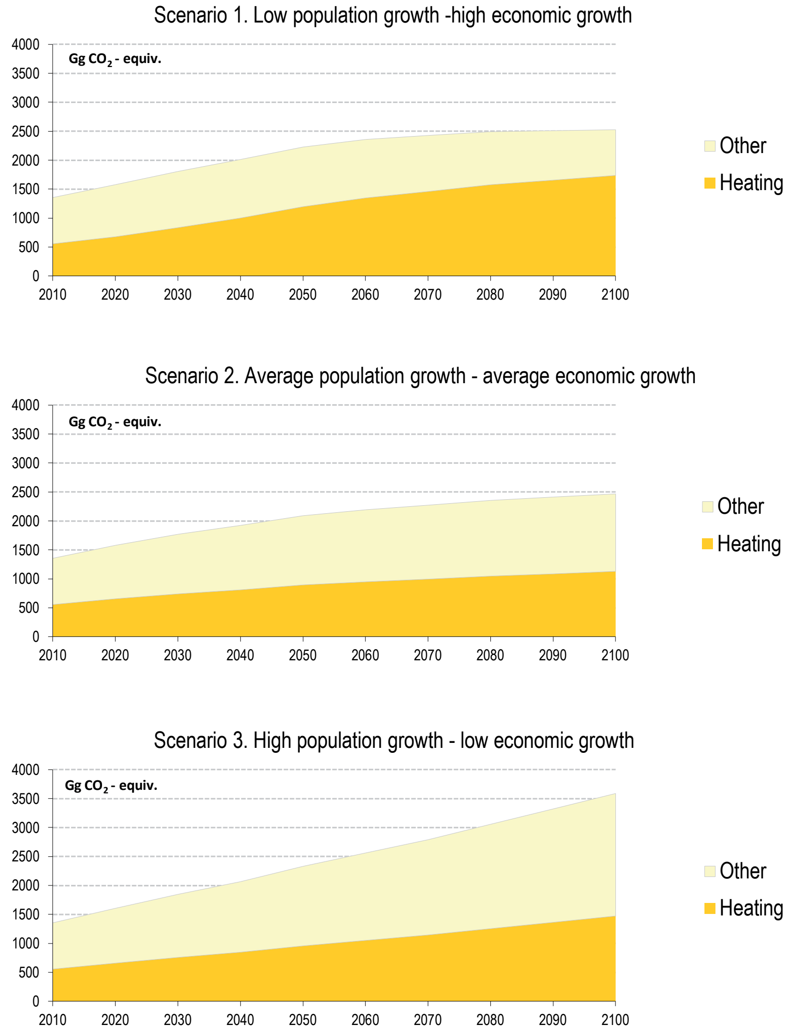
da (x) - share of the agricultural sector contribution into the national GDP in the year x;

GDP (x) - gross domestic product in the year x;

k_a - reduction rate of emissions and power consumption for the 1A4c "Agriculture" subsector against GDP growth;

x - current year.

Fig. 4.18. Trends of GHG emissions under different scenarios in 1A4b "Residential" subsector



The GHG emissions estimation without division into separate categories is shown in Fig. 4.19.

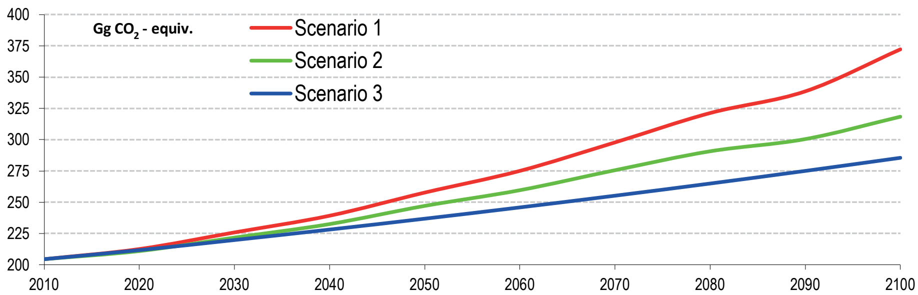


Fig. 4.19. Trends of GHG emissions under different scenarios in 1A4c "Agriculture" subsector

1B Fuel fugitive emissions

The GHG inventory showed that the key contribution to this subsector emissions is made by the in 1V2b "Natural gas" source category (94.65%), followed by 1B1 "Solid fuel" (3.16%) and 1B2a "Oil" (2.18%). The emissions in 1V2b "Natural Gas" category changed sharply during 1990-2010, while emissions in other categories have dully decreased. Under the emissions scenarios development, it is assumed that this situation will continue in the future, i.e. relatively small emissions from solid fuels and oil (at 2010 level) with simultaneous significant changes in volatile emissions of natural gas.

Accordingly, the emissions scenarios reflect changes only of volatile gas emissions. Emissions from solid fuel and oil are taken at the level of 2010. To assess changes in natural gas volatile emissions, the potential consumption volumes were identified. Given the fact that natural gas is consumed in many sectors of the economy, the potential consumption of natural gas is assessed for the country as a whole. Similar to the power consumption by road transport, the dependence of natural gas consumption on the living standards was developed based on the World Bank statistics, with an exception of the list of the countries - major manufacturers of natural gas with abnormally high consumption level.

Based on this interpolated dependence, the total volume of natural gas consumption was determined, and by means of the loss factor, the amount of volatile emissions for two basic scenarios (Fig.4.20) were estimated. Since the current gas consumption (2010) for the third scenario exceeds the corresponding average global consumption even by 2100, the subsector emissions are accepted at the 2010 level.

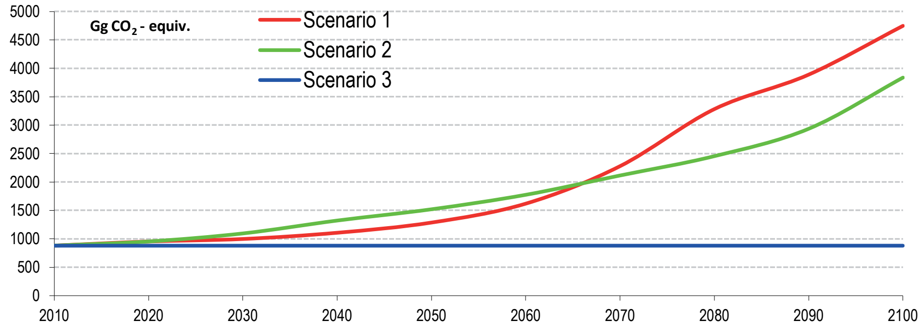


Fig. 4.20. Trends of GHG emissions under different scenarios in 1B "Fuel fugitive emissions" subsector

2 Industrial Processes

This sector accounts the industry's specific emissions, different to 1A2 "Industry and Construction" subsector. Accurate estimates require the in-sector changes assessment, which is quite a challenge when developing a long-term forecast. Thus, to simplify the process it was assumed that the total sector emission trends would be the same for both fossil fuels and for its specific emissions. Based on this assumption, for building the emission scenarios a methodology similar to that for calculating the fossil fuels combustion emissions in industry was used. The emissions shown in Fig. 2.21 are presented for all GHG. Emissions variations reflect the cyclical nature of the economy, as described in Section 4.2.2.2.

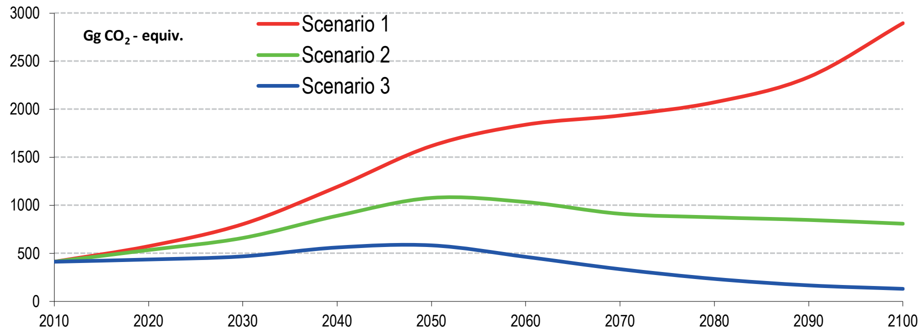


Fig. 4.21. Trends of GHG emissions under different scenarios in "2 Industrial Processes" sector

3 Solvent use

The results of the inventory established that there are no GHG emissions in this sector. However, since the task has been set to calculate all gases emissions, accounted in the inventory, the NMVOCs estimation for the "3 Solvent use" sector was made. It utilized the same calculation methodology as accepted for the "2 Industrial Processes" sector. Emissions reduction for Scenarios 2 and 3 reflects the expected downward trend of the industrial sector contribution. Fig. 4.22. shows the GHG emission trends undr different scenarios in the "2 Industrial processes" sector.

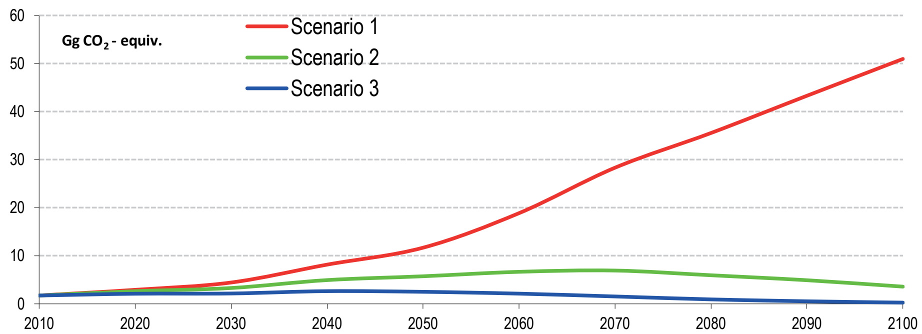


Fig. 4.22. NMVOC emission trends under different scenarios in "3 Solvent use" sector

4 Agriculture

In this sector, we measured only the sector's specific emissions - 4 "Agriculture: Emissions from fossil fuel combustion" accounted for in the 1A4c "Agriculture" subsector. The methodology for developing the emissions scenarios is in line with that used in the A4c "Agriculture" subsector, except that different emissions reduction factors are used. The calculation is made using the following formula:

$$Q(x) = \frac{\left(\frac{d_a(x) * GDP\ (x) * GDP\ (x-1)}{d_a(x-1)} - 1\right)}{k_{as}} + 1,$$

where

d_a *(x)* - share of the agricultural sector contribution to the national GDP in the year *x*;

GDP (x) - gross domestic product in the year *x*;

k_{as} – the sector's rate of emissions reduction against the GDP growth, based on the FAO emissions forecast;

x - current year.

For the convenience of further accounting, the emission changes under implementing different measures, the sector total emissions are divided into three components:

- 4A "Enteric fermentation", 4C "Rice cultivation" and 4D "Agricultural soils";
- 24B "Manure storage systems";
- 4F "Agricultural residues incineration".

The calculated results of the total GHG emissions are presented in Fig. 4.23.

Absolute volumes of emissions vary slightly for different scenarios. Under a reduction of the total GDP for Scenarios 2 and 3, the agriculture share increases for them.

5 Land use, land use change and forestry

In line with the GHG inventory for 1990-2010, no clear tendency for a change of emissions and sinks has been observed for this sector.

A slight increase in sinks was observed in 5A "Wood biomass stocks" subsector for the unmanaged forests, and a similar reduction observed for the managed forests, which compensates each other. As a result, the total stock remains practically unchanged.

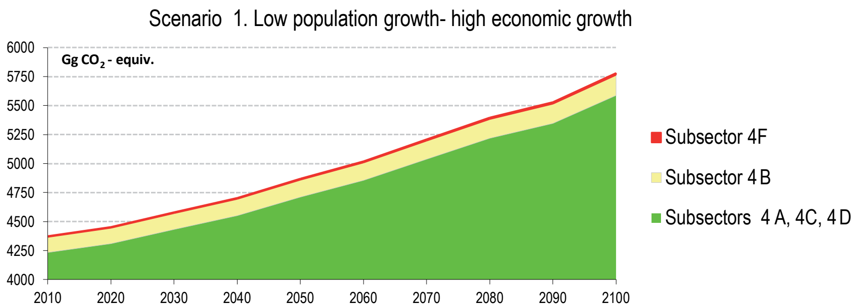
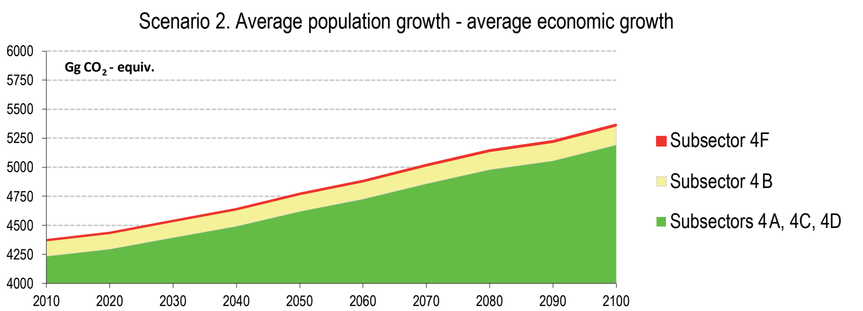
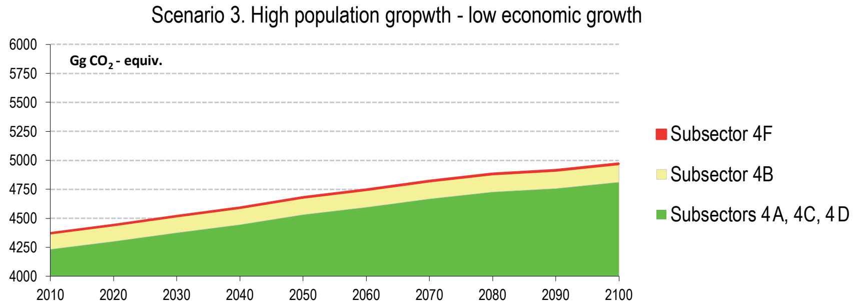


Fig. 4.23. GHG emission trends under different scenarios in 4 "Agriculture" sector.





An unchanging emission is observed in the 5B "Soil emissions and sinks" subsector with a slight decrease caused with the arable land withdrawal. This emission is quite regular due to the plowing practice [4.15]. Taking into account this and the significant uncertainty in the sources identification leading to significant changes in the sector state in the future, emissions from 5 "LULUCF" sector are assumed to be constant at 2010 levels for the whole forecast period.

- -802.02 for 5A "Woody biomass stocks" subsector;
- 558.30 for 5B "Soil emissions and sink" subsector;
- -243.72 Gg for the whole sector.

6 Waste

Emissions from the "Waste" sector are divided into three components for forecasting and the mitigation measures development:

- 6A SDW disposal;
- 6B1 Industrial wastewater management;
- 6B2 Municipal and commercial wastewater management.

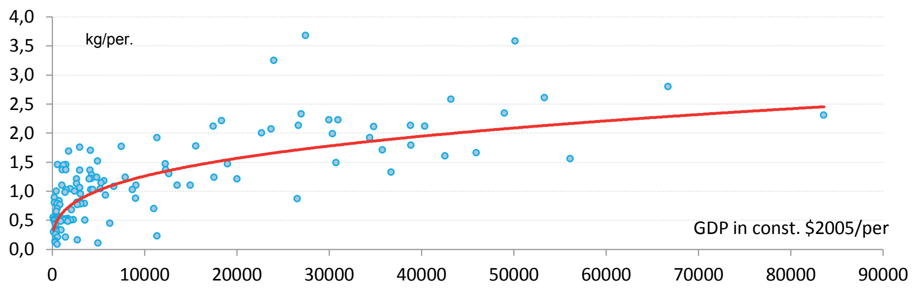


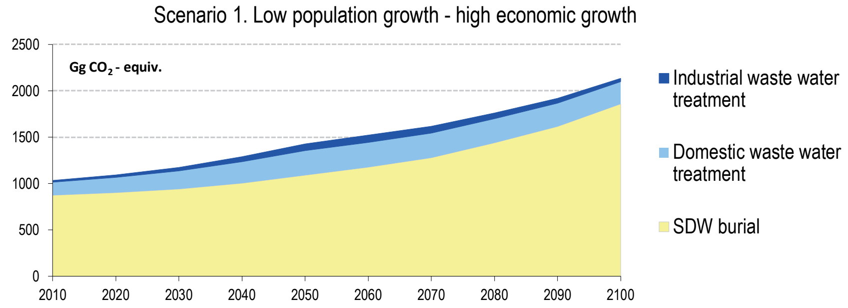
Fig. 4.24. Dependence of the SDW specific amount on the living standard

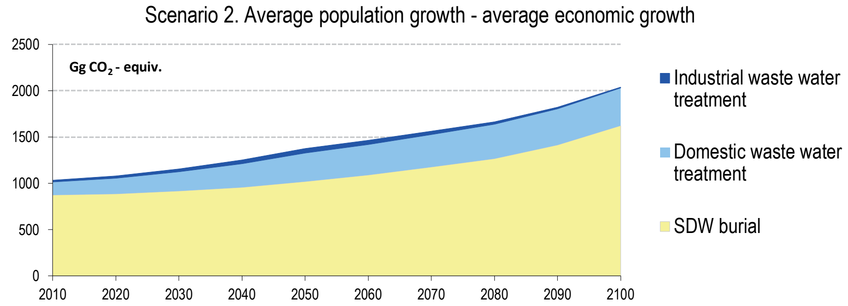
The 6A "Solid waste disposal" subsector used the same approach as that to assess the power and motor fuel consumption, based on a dependence on the living standard. A similar approach is described in the World Bank publication [4.11]. By using data on the volume of SDW formation in different countries, a dependence of the solid waste amount, by an urban resident per day, on the specific GDP was defined (Fig. 4.24). The data on the countries with a developed tourism industry have not been used, as the excessive SDW volumes characterize them. In addition to the actual SDW volumes, their collectability plays an important role. The results of the World Bank studies defined that a collection rate also depends on the life quality. However, this relationship is not as great as for SDW volume. Regarding the World Bank data, collection efficiency varies from 43% for the least developed countries to 97% for the countries with a high income. However, in Eastern Europe and Central Asia the collection efficiency is quite high and is about 80%. Therefore, for the KR, with an effective waste collection system till 1990, only some fluctuations in its efficiency and not significant monotonic changes can be communicated.

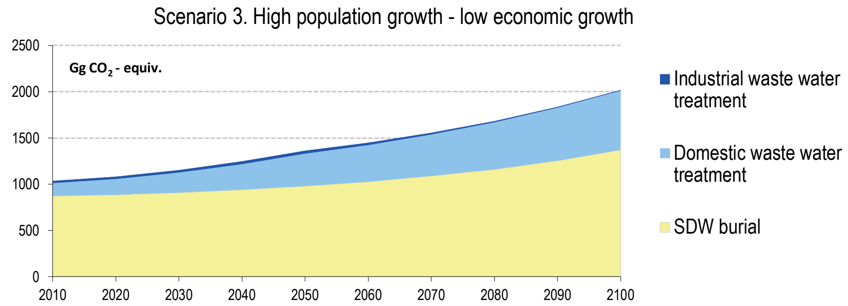
Based on the obtained dependencies, the SDW specific amount was determined for different scenarios followed by the GHG assessment. For the 6B1 "Industrial wastewater refining" subsector, the emissions are expected proportional to the value of the industrial sector contribution to the GDP. For 6B2 "Municipal and commercial wastewater refining", the emissions were forecasted assumed proportional to the urban population.

Estimate of the total GHG emissions is presented in Fig. 4.25.

Fig. 4.25. GHG emission trends under different scenarios in 6 "Waste" subsector.







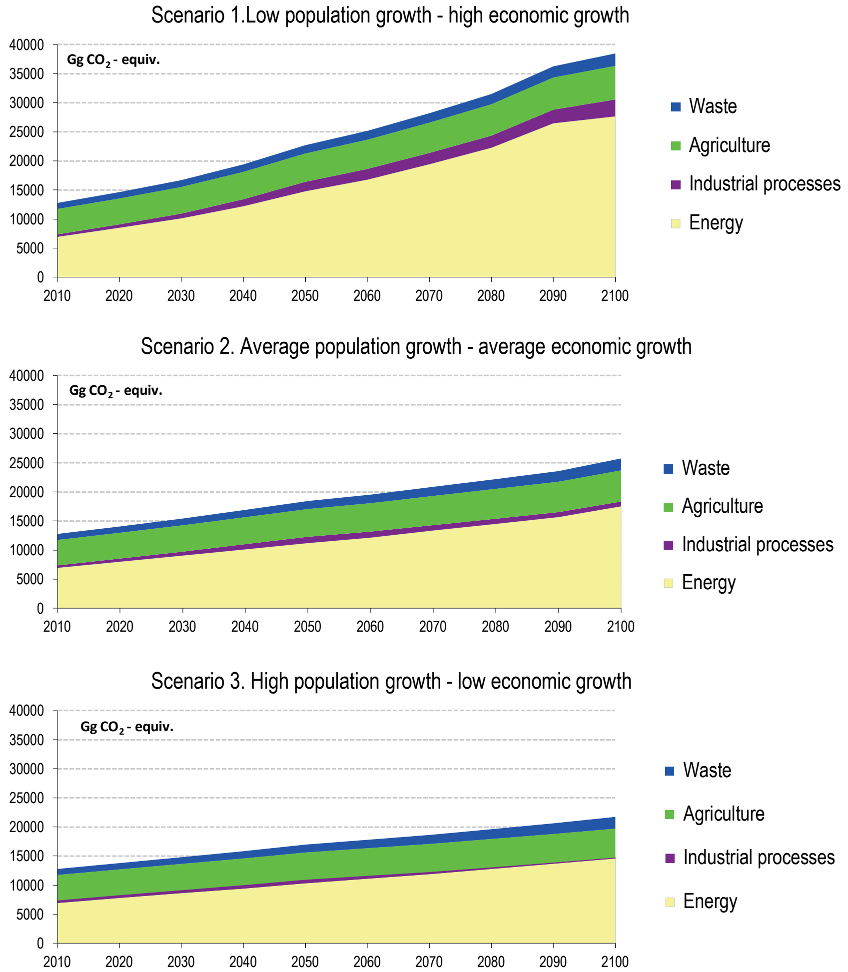
The emissions for different scenarios differ only slightly, since there are two key factors determining divergent factors - the living standard and the population number. Only a slight reduction of emissions may be noted for the 6B1 "Industrial wastewater management" subsector in Scenarios 2 and 3, associated with a significant reduction of the industrial sector share.

4.4. The baseline scenarios (without measures scenarios)

A summation of the separate calculation categories gives an evaluation of the expected emissions for GHG and precursor gases, as well as for power indicators.

Fig. 4.26 shows GHG emissions by sectors, except for the "Solvent use" sector with no GHG emissions, as well as the LULUCF sector, for which the emission/sink net is assumed constant. For all scenarios, the largest emission is observed in the "Energy" sector, but its share decreases for the scenarios with lower levels of the economic growth.

Fig. 4.26. Trends of summed GHG emissions under the baseline scenarios



In fact, the baseline scenarios shown in Fig. 4.26 are not fully the «without measures scenarios». The actions to preserve the existing balance between the power generation by hydro and fossil fuels are already the mitigation actions. Understanding these scenarios as a baseline is grounded on the current energy sector development plans, not containing the measures on the additional facilities introduction for the electricity generation on fossil fuels, with the exception of the Bishkek Thermal Power Station-2 and Kara-Keche Thermal Power Plant.

For all scenarios, the "Energy" sector contribution to the total emission distribution by sectors is growing relative to the share in 2010, and to the highest extent for the scenarios with a high level of economic growth (Fig.4.27). The "Agriculture" sector contribution reduced relative to 2010 for all scenarios, but in inverse dependence on the economic growth level. The "Industrial Processes" sector share grows only for Scenario 1. It almost unchanged for Scenario 2, and for Scenario 3 reduced comparative to the sector input in 2010. The "Waste" sector input changed less significantly.

It is notable that the national distribution of GHG emissions by sector is significantly different from the current global distribution. This is primarily due to the low share of the "Industrial processes" sector, which globally is about 20 % on average. In 2010, it was 3.2% in Kyrgyzstan, and the highest value by 2100 is expected to be about 7.5% for Scenario1.

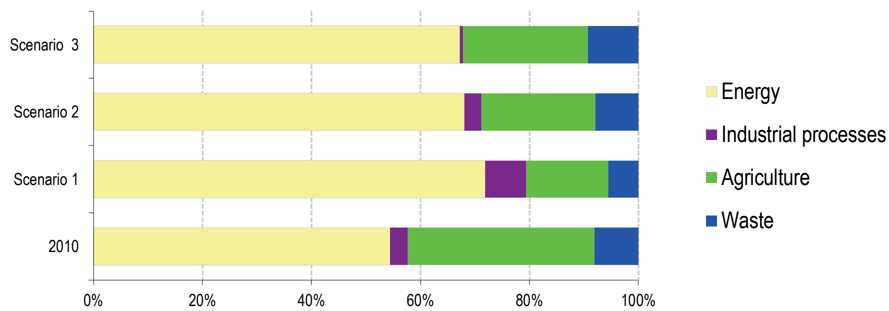


Fig. 4.27. Distribution of GHG emissions by sector under different scenarios in 2010 and 2100

The GHG emissions trends in the subsectors consuming fossil fuel combustion are shown in Fig. 4.28.

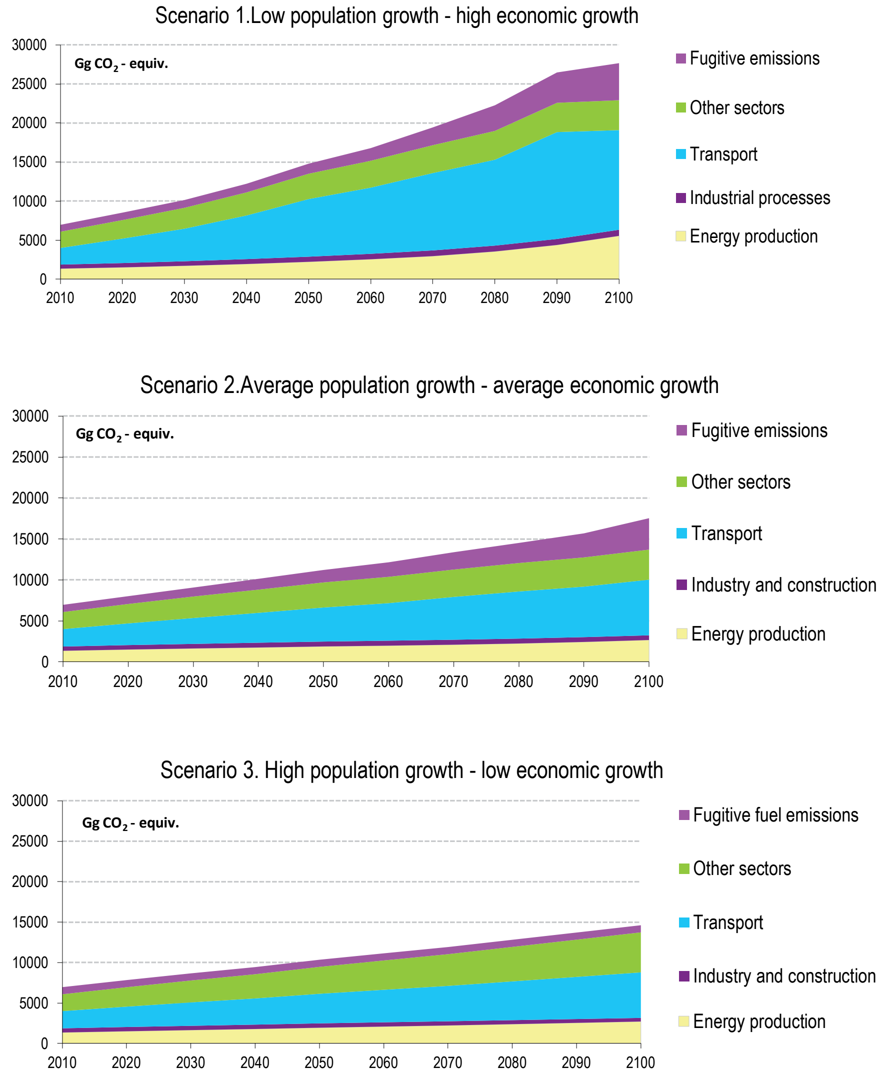


Fig. 4.28. GHG emission trends under the baseline scenario in the "Energy" subsector

The trends for separate GHG and precursor gases are mainly proportional to the total GHG trends.

The biggest emission for Scenario 1 happen in the "Power Generation" and "Transport" categories. Emissions for Scenario 3 are characterized by the constant emission of the "Fuel Fugitive Emissions" category, explained by the continuous consumption (Section 4.3) and a slight increase in emissions of the "Other Sectors" category, caused by a significant population growth and related power consumption for heating and other purposes.

Fig. 4.29 shows the emissions distribution in the "Energy" sector. Under all scenarios, only the "Transport" category input increases. Gas emissions would have to be the greatest for Scenario 1, but the losses reduction is supposed to reach a value corresponding to the economic development level, i.e. to the developed countries losses. Emission of the "Other Sectors" category is almost proportional to the population. Emissions of the "Industry and Construction" do not increase because of selecting the agrarian and service-based economic development of the country.

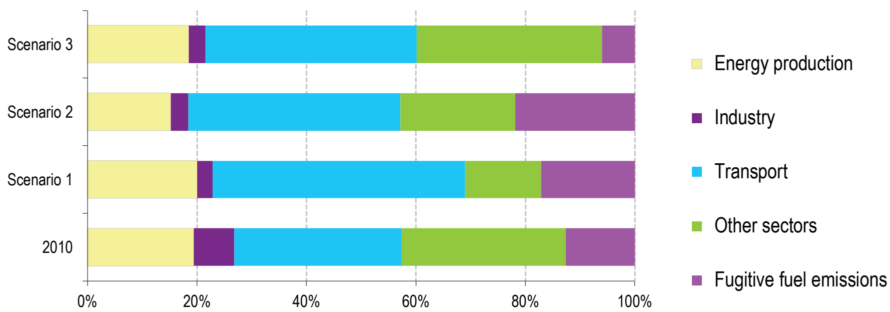
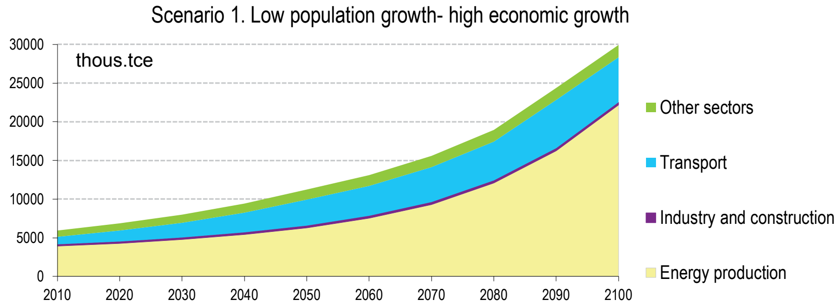
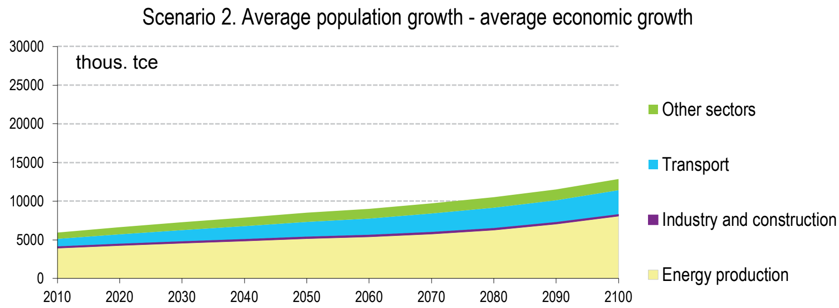


Fig. 4.29. GHG emissions distribution by sector under different scenarios in 2010 and 2100

For an assessment of the required power resources, Fig. 4.30 shows the trends in the overall consumption of primary energy resources, including electric power of HPP.





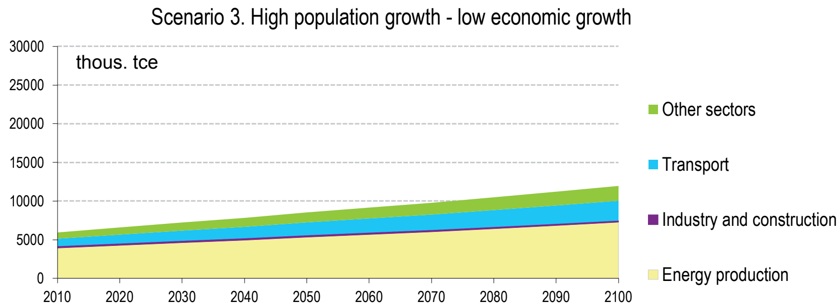


Fig. 4.30. Trends in power resources consumption under basic scenarios in 1A "Fuel combustion" subsector

The fastest increase in power consumption is observed under Scenario 1, and to a lesser extent under Scenario 2. While for Scenario 3, the consumption growth is almost linear over time. The increase is mainly because of the consumption for power generation. Under Scenario 3 the share of consumption of all the main consumers (power generation, transport and other sectors) is almost identical. For Scenario 3 the consumption of energy resources by 2100 in the "Other sectors" subsector is even greater, than under Scenarios 1 and 2 due to a greater population growth.

Fig. 4.31 displays a change in the power consumption distribution for different scenarios in 2100, as compared with the distribution in 2010. The connection is visible between a consumption in the "Other Sectors" subsector with the population number and the preservation of the minor input in the "Industry and Construction" subsector due to the service-agrarian structure of the economic development.

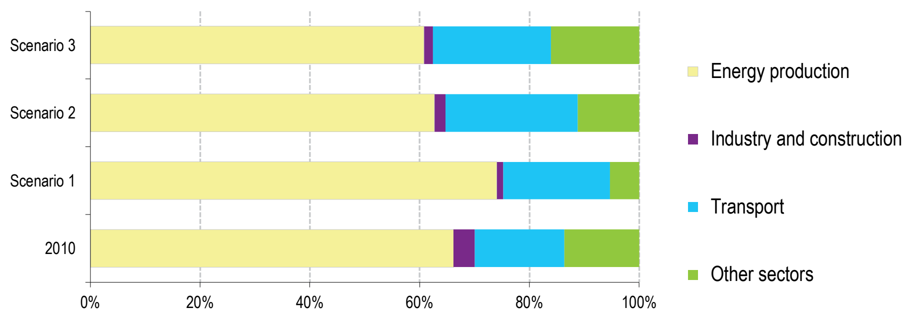


Fig. 4.31. Distribution of power consumption in "Energy" sector under different scenarios for 2010 and 2100

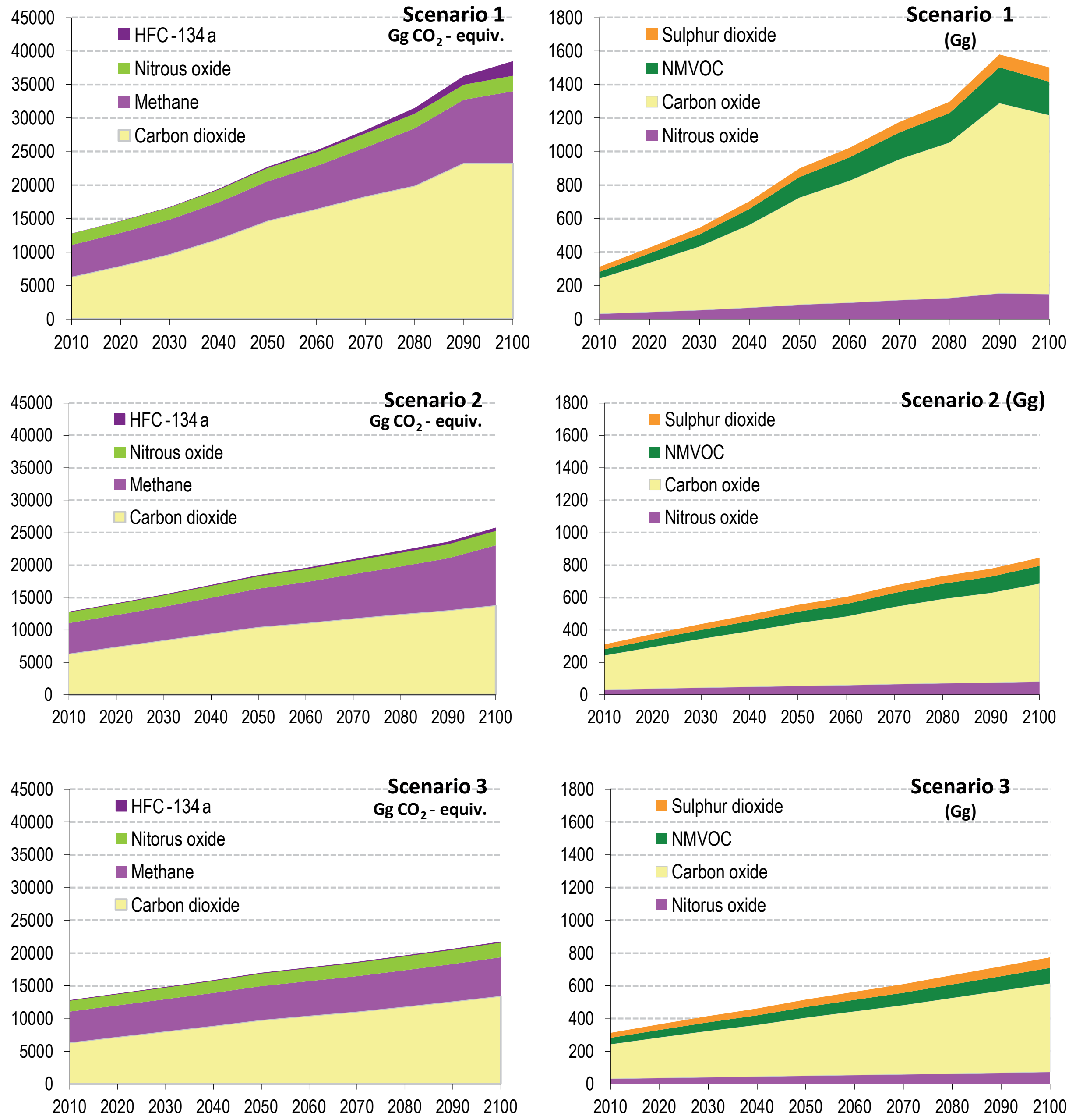


Fig. 4.32. GHG and precursor gas emissions under different scenarios

Fig. 4.32 shows the trends in GHG and precursor gases emissions by selected gases under different baseline scenarios. The slower the economic growth, the smaller is HFC-134a input to the total emissions, and the greater is the nitrous oxide contribution. For other GHG, the trends do not precisely relate to the economic growth.

For precursor gases, the lower the economic growth rate, the lower is the NMVOC emissions contribution and the higher sulfur dioxide contribution.

The estimates show that under all "without measures scenarios", especially those with high economic growth, the precursor gases (i.e. pollutants) emissions will significantly increase. This will meaningfully impact the environmental, since geographically the key sources of emissions are located in the areas of high population density.

Fig. 4.33 shows trends in the specific emissions of CO_2 and GHG.

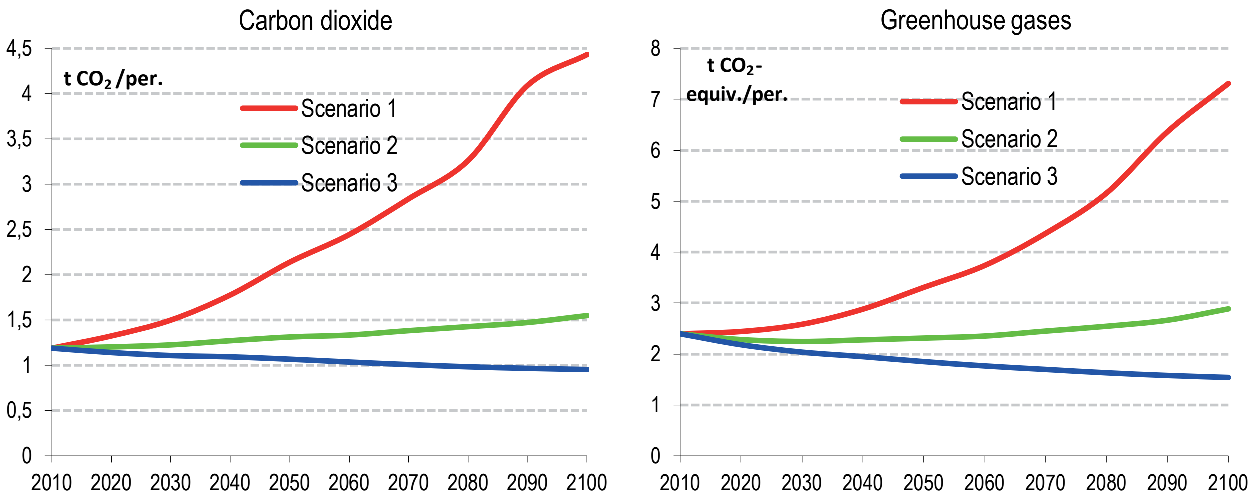


Fig. 4.33. Emission factors of a) carbon dioxide; and b) GHG

The assessment shows that, if CO_2 emission level ensuring the "below 2ºC" goal achievement with 66% of probability is taken as a mid-term objective, then only baseline Scenario 3, assuming actual economic stagnation, is within the acceptable limits (1.23 t CO_2 per capita) by 2050.

4.5. Scenarios with measures

4.5.1. Analysis of potential emissions reduction

The analysis on the mitigation capacities was carried out by the key sectors in accordance with the IPCC Inventory Guidelines and recommendations [4.18], and based on the categories given in Section 4.3, as well.

To make things easier, the similar measures were assessed for all economic and demographic development scenarios, but CO_2 and GHG reduction measures were estimated separately.

4.5.1.1. Thermal power

The GHG emissionscan be reduced during the production and use of thermal power in two core ways [4.10, 4.16]:

- Increasing efficiency in generation and distribution, including renewable energy sources;
- Reducing specific consumption.

Increasing efficiency in generation and distribution

One of the efficiency indicators in the thermal power sector is the losses level. As shown in Fig. 4.34. the losses have increased significantly over recent years. If Kazakhstan saw some decrease in losses since 2000, a situation in the KR is still worsening.

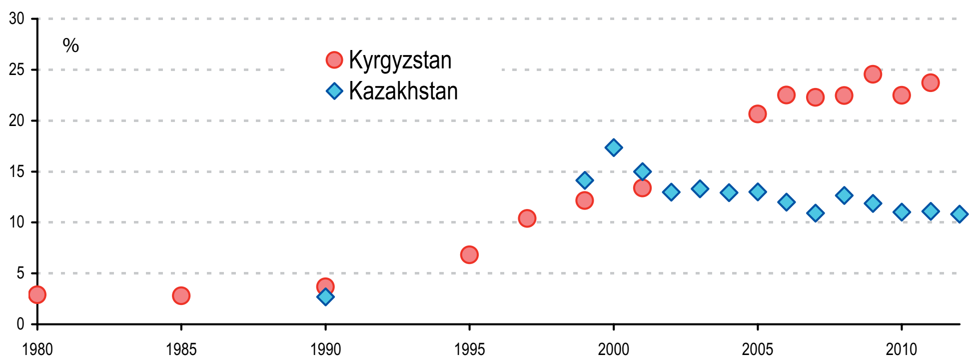


Fig. 4.34. Dynamics of power losses in Kyrgyzstan and Kazakhstan. Sources: NSC and Statistics Agency of Kazakhstan.

Based on the national data and the CIS and Eastern Europe countries statistics, a reduction of power losses is expected to17% by 2020 and to 11% by 2050 (Fig. 4.35). These could be achieved with the consistent measures on the activities improvement and timely updating of the technical base for the thermal power sector generation and distribution (installation of meters, heating systems upgrade, boilers replacement, etc.). The measures total cost amounts to 242 million in $2005.

The results of reduced GHG emission by cutting heat losses for the indicator year are shown in Table 4.3. Reduced emissions of separate GHGs, precursor gases and the primary fuels cost are almost proportional to the reduction in the total GHG emissions. The emissions reduction by reducing losses is lowest for Scenario 1 and highest for Scenario 3, due to the population trends change, the key consumer of thermal power (about 80% in 2010).

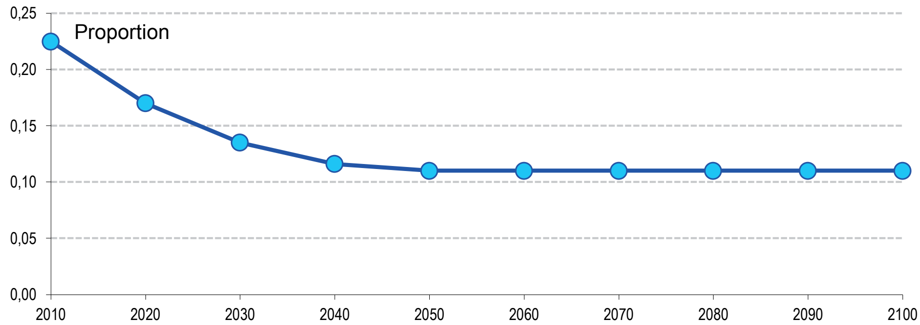


Fig. 4.35. Schedule of the planned thermal power losses reduction in shares 0f the total consumption volume

Table 4.3. CO_2 and GHG emissions reduction by cutting thermal power losses

Years	2020	2050	2100
Carbon dioxide, Gg			
Scenario 1. Low population growth – high economic growth	82,04	250,18	338,68
Scenario 2. Average population growth – average economic growth	80,22	215,90	274,76
Scenario 3. High population growth – low economic growth	80,69	229,12	346,71
Total GHG emission, Gg CO_2-eq.			
Scenario 1. Low population growth – high economic growth	82,37	251,17	340,02
Scenario 2. Average population growth – average economic growth	80,54	216,76	275,85
Scenario 3. High population growth – low economic growth	81,01	230,03	348,09

Improving of the generation and distribution efficiency is realized through the measures of the Long-term Heat Supply Strategy of the Kyrgyz Republic. Potential reduction of GHG emissions in the thermal power generation via renewable energy sources use will be given further in Section 4.5.1.5.

Reduction in specific heat consumption

The GHG emissions reduction was determined based on the reduced specific consumption of thermal power consumed for heating per area unit. In line with the Program for Transition to Sustainable Development of the Kyrgyz Republic for 2013-2017 (para. 8.6. Construction Industry Development), it is planned to reduce the power consumption in new buildings by 30- 40% compared to the current state. This will be achieved by meeting the new requirements for power efficiency in buildings re SCNR 23-01: 2009, T Construction Thermal Engineering (heat protection in buildings) and SCNR 23-101: 2009, Thermal Protection of Buildings Design.

Reducing of the thermal power consumption can be determined through two action ways:

- energy efficiency of new buildings re the newly introduced SCNR mandatory requirements;
- improve energy efficiency in existing buildings to meet the SNIP required levels.

The emissions reduction by improving energy efficiency in buildings in line with the newly introduced SCNR mandatory requirements is shown in Table 4.4. The emissions for Scenarios 1 and 2, upon SCNR implementation, are significantly reduced in the second half of the century, while for Scenario 3 the emissions increase remains constant, determined by the population trends.

Table 4.4. Reducing CO_2 and total GHG emissions under mandatory SCNR performance of power efficiency measure

Years	2020	2050	2100
Carbon dioxide, Gg			
Scenario 1. Low population growth – high economic growth	87,38	532,43	1101,22
Scenario 2. Average population growth – average economic growth	71,26	270,74	505,23
Scenario 3. High population growth – low economic growth	73,00	318,86	820,88
Total GHG emission, Gg CO_2-eq.			
Scenario 1. Low population growth – high economic growth	90,91	554,25	1145,73
Scenario 2. Average population growth – average economic growth	74,16	281,65	525,07
Scenario 3. High population growth – low economic growth	75,99	331,90	854,41

In addition to total GHG emissions reduction under a mandatory implementation of SCNR on energy efficiency, it is necessary to assess the measures aimed to improve the energy efficiency of existing buildings. These measures require a considerable funding (about $3.5 billion as stated by the assessment under the GEF/UNDP PIMS 3910 Project "Improving Energy Efficiency in Buildings"). However, this estimate is probably too high, since part of the buildings, due to the operating deadlines at the moment, will be replaced by the new ones, and some reconstructed. Given that the reconstruction been made will meet the energy efficiency requirements, the necessary costs will be minimal, and also apply to monitoring of the process (about 50 thousand. $2005 of internal funds).

The emissions reductions results accounting the actions for improvement of the energy efficiency in existing buildings are given in Table 4.5. The table includes emission cuts by both the mandatory implementation of SCNR and by the reducing losses, as losses naturally vary with the consumption volumes. The estimates assume that energy efficiency will increase in all existing buildings up to 2050.

Table 4.5. CO_2 and total GHG emissions reduction under the SCNR mandatory implementation and the implemented measures on energy efficiency in the existing buildings, as well as measures on thermal power losses reduction

Years	2020	2050	2100
Carbon dioxide, Gg			
Scenario 1. Low population growth – high economic growth	288,60	1178,04	1660,38
Scenario 2. Average population growth – average economic growth	271,01	941,02	1193,24
Scenario 3. High population growth – low economic growth	272,87	987,16	1477,42
Total GHG emission, Gg CO_2-eq.			
Scenario 1. Low population growth – high economic growth	296,51	1214,21	1712,64
Scenario 2. Average population growth – average economic growth	278,27	968,34	1227,74
Scenario 3. High population growth – low economic growth	280,23	1016,26	1522,01

4.5.1.2. Electric power

Currently, the energy sector of the Kyrgyz Republic consumes electric power as a primary energy resource in large volumes, as compared to other countries. If the global average share of fossil fuels in power consumption in 2010 amounted to 80.9% (the other 19.1% includes all power sources that do not emit GHG, including nuclear energy), the Kyrgyz Republic accounts for half of it (Fig. 4.36). Moreover, regarding assessment on the national economic development for Scenarios 1 and 2, after a fall by mid-century, a share of electricity is expected to increase later.

The second essential feature of the energy sector is a proactive use of hydro as a source of electric power, a positive factor in view of climate change. However, further development of the sector must take into account the limited nature of the hydro resources and their dependence on climate change.

According to macroeconomic forecasts, electricity consumption in the country is expected to grow under all scenarios, but most rapidly under Scenario 1 (Fig. 4.12) followed by a proportional GHG emission growth. This growth, in view of the sector development directions, is not as significant as in the case of a primary use of fossil fuels. However, the natural limits of hydropower resources lead to develop the efficiency improvement measures in the energy sector. Measures known in the electric power sector are the following:

- maintaining and increasing the electric power share in the total primary energy resources consumed by means of hydropower and other renewable energy sources;
- efficiency increase in energy generation and distribution;
- energy efficiency improvement under consumption.

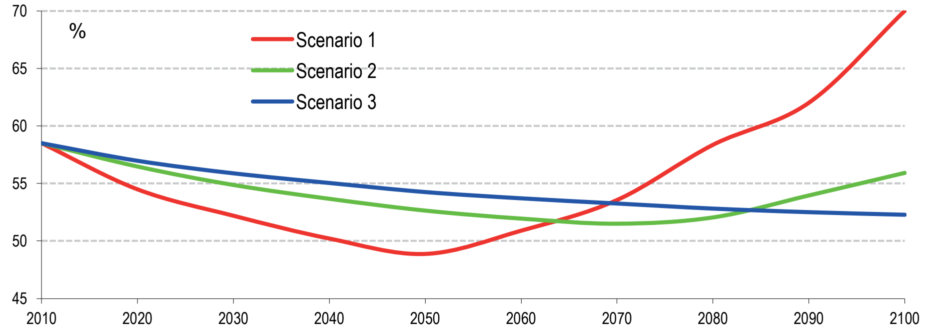


Fig. 4.36. Share of HPP electric power in total of primary energy resources consumed

Preserving and increasing the electric power share in hydro and other renewable energy sources in the total primary energy resources

As noted in Section 4.4, the baseline scenarios are not a pure base, i.e. without measures scenarios. In fact, the baseline scenario already includes mitigation measures, due to the assumed preserving of the structure of primary power sources consumption and the electricity generation sources, i.e. a conservation of specific GHG and precursor gases emissions by 1 kWh. These measures lead to an increase of the electric power share in the total balance of primary energy resources (Fig. 4.36).

The capacities for further potential ways for hydropower development are given in Section 4.5.1.5.5.

Potential reduction of GHG emissions by introducing renewable energy sources is shown in Section 4.5.1.5.

Increased efficiency in generation and distribution

The most obvious and vital measure in this sphere is the losses reduction. Analysis of the losses statistics in different countries shows that power losses depend more on the maintenance level of the energy sector than on its technical state. Losses are steadily declining in high-income countries, while in the countries with a low, lower-middle and upper-middle-income there are significant variations, including the losses growth. Fig. 4.37 shows the levels of electric power losses in Central Asian countries for 2010. It is notable, that a significant difference in the losses levels depends on the losses accounting methodology.

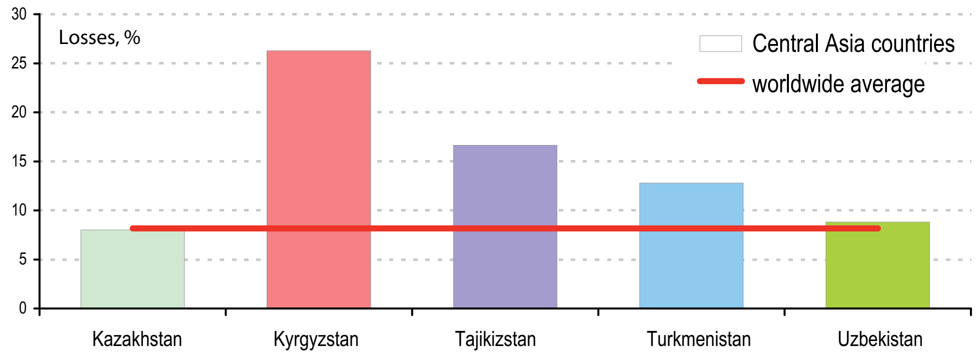


Fig. 4.37. Comparative level of electric power losses. Source: World Bank

Taking into account that the largest part of electric power is generated by HPP (about 93% for recent years), and only a small part - at thermal power stations on fossil fuel, the losses reduction will not result in a significant cut of GHG emissions. But this task is important from the point of ensuring the national energy and economic security.

The structure of energy sector is subdivided into generation, transmission and distribution.

Generation

According to the expert assessment of the Design and Research Centre "Energy", based on losses assessment by the methodology of average monthly planned loading of transformers with a "the highest losses method", the recommended loss normative is 0,4 %. So, taking into account the minor loss values, to achieve the significant reduction of losses in the generation sector is unfeasible. Only the measures aimed at modernization of the current generation equipment should be considered, not covered under the TNC preparation.

Transmission

Further reduction is possible in the transmission sector. According to the presented justification, it requires implementation of 12 measures, resulted with losses reduction by 230 mln. Kwh, i.e. to 4,5 %. Capital investments for implementation of the action plan, by rough estimates, make up 0,946 bln. som in 2014 prices.

Distribution

In the distribution sector it is quite possible to further reduce the losses. This requires a comprehensive implementation of the Action Plan measures on reducing power energy losses in grids of energy concession companies. According to the plan, the activities should be implemented at all companies, resulting in losses annual reduction to 10%.

Capital investments required for plan implementation, by rough estimation, is 27,45 bln. som in prices of 2014.

The planned measures are supposed to be implemented in the coming decade. However, considering a lack of internal resources, the exact time is determined depending on the terms of the external resources allocation.

Table 4.6. CO_2 and total GHG emissions reduction by reducing electric power losses

Years	2020	2050	2100
Carbon dioxide, Gg			
Scenario 1. Low population growth – high economic growth	113,49	198,71	748,36
Scenario 2. Average population growth – average economic growth	109,43	156,56	258,90
Scenario 3. High population growth – low economic growth	103,53	135,58	170,89
Total GHG emission, Gg CO_2-eq.			
Scenario 1. Low population growth – high economic growth	113,98	199,58	751,64
Scenario 2. Average population growth – average economic growth	109,91	157,25	260,04
Scenario 3. High population growth – low economic growth	103,98	136,17	171,64

Improving energy efficiency in consumption

There are a number of known methods, of logistic and technical nature, to increase energy efficiency under consumption, as well as involving the economic incentives. Application of these methods may significantly reduce power consumption. However, simultaneously going processes on a broader usage of a various equipment, especially in small business and in household due to rising living standards, naturally lead to increased consumption. Therefore, despite a need to implement the energy saving programs, it is difficult to assess the specific quantitative indicators, and expected changes to the consumption structure in the future. By expert estimates, the unexploited potential for energy savings in the country is 0.5-1 mln. toe [4.7] by the level of 2006. However, these estimates are not accompanied by a description of the methodology. So it is not clear what directions have been included. They might be already accounted for in other sections of this communication, such as the measures on electricity losses reduction or the renewable energy sources use.

Given these barriers, as well as that the implied energy efficiency is already accounted in the specific consumption; the forecast assumes no emissions reductions by improving energy efficiency under consumption. Energy consumption efficiency is already included in the expected per capita consumption, since projected electricity consumption is based on the global trends. From this, great values of specific electricity consumption come, that naturally match the developed countries and already include some reduction due to energy efficiency measures implemented to date.

4.5.1.3. Use of natural gas

The recognizable measure for GHG emissions reduction is the leakage reduction. The comparison with other countries has shown the capacity to significantly improve the situation, mainly by the logistic measures. Based on the other countries indicators, as well as the national losses level till 2000, it is assumed that there are no obstacles in taking the losses down.

According to the "Gazprom of Kyrgyzstan" Ltd, to reduce natural gas leakage in the gas distribution networks and supply facilities, a number of activities is planned to bring the losses down to 7%.

The estimate of emission reduction based on the above assumption is shown in Table 4.7. For evident reasons, the reduction of CO_2 emissions does not take place. The emissions, on the contrary, are expected to grow a little.

Table 4.7. Methane emissions reduction by losses cut

Years	2020	2050	2100
Methane emission, Gg CO_2-eq.			
Scenario 1. Low population growth – high economic growth	860,06	1195,01	4228,89
Scenario 2. Average population growth – average economic growth	860,06	1434,98	3692,24
Scenario 3. High population growth – low economic growth	791,53	812,70	812,70

4.5.1.4. Transport

Transport GHG emissions in 2010 were the most significant among all source categories. There is a substantial potential for energy savings in this source category, since the primary power resources are used very ineffectively currently, particularly in our country.

According to the IPCC Fifth Assessment Report, 67.7% of energy resources consumed in transport sector is not converted into mechanical energy, i.e. is lost. Emissions in this category are growing most rapidly, as compared with the other categories, similar to the global trends [4.19]. During 1995-2010 against a slight increase of GHG emissions in the KR as a whole, the transport emissions more than doubled. So, transport has the priority need to implement the mitigation measures. As noted in Section 4.3, over 99% of total sector emissions are accounted for by "Road transport" category. Hence, this section will define the mitigation measures for this source category only.

The mitigation measures can be divided into several key areas:

- legal and economic measures;
- public transport development;
- traffic management and road infrastructure planning;
- bicycle infrastructure development;
- pedestrian areas development;
- environment-friendly driving programs implementation.

Legal and economic measures

The evident measures to be taken are the measures encouraging import of the new low carbon vehicles. For all vehicle categories there is a clear trend for the fuel consumption reduction and, consequently, GHG emissions. The similar trends are estimated to stay further. For example, according to the IPCC Fifth Assessment Report estimates, by 2030 the GHG emissions by passenger petrol cars is expected to be reduced by almost two times, as compared to 2010. Given the requirements constriction for vehicle emissions in the main producer countries, Kyrgyzstan should preferably focus on limiting the environmentally inefficient vehicles import and on stimulating the import of more energy efficient ones. This can be done by:

- limiting the auto vehicles import that do not comply with firm requirements;
- changing tariffs at the customs vehicles clearance towards establishing larger tariff rates for older vehicles;
- changing tax rates on vehicles towards establishing higher rates for older vehicles;
- establishing a favorable environment for the import and taxation of hybrid and electric vehicles.

These measures can help achieve fuel savings up to 20-30% in the short-term period (Source: Japan Automobile Research Institute data). The implementation of legal measures in the Kyrgyz Republic by 2020 is expected to reduce emissions by 20%. However, in the subsequent years emissions reduction by legal measures is not expected.

Tire characteristics control system

About 20% of vehicle fuel is used to overcome the rolling resistance of tires. Measures aimed at improving this indicator should account that it is not sufficient to control the car tire efficiency only. The consumers tend to replace the worn out tires with the cheaper, but less efficient tires. As a result, the fuel economy effect is lost in the long run.

For example, in 2009 the US Transportation Department presented the "Tire Efficiency Consumer Information Program", which proposed a labeling scheme for tires accounting fuel consumption efficiency. The EU has also taken the significant steps in this direction. The "CO_2 Emission Reduction in Road Transport Strategy" 2009 includes the requirements for tire pressure, rolling resistance and other factors. In Japan, since January 2010, a system of the voluntary tires labeling is in place to inform vehicle owners on fuel consumption and reliability of adhesion to asphalt.Thus, the three main motor vehicles manufacturer regions launched the tires monitoring systems directly affecting the volume of fuel consumption. The effect of reduced emissions by improving the tires efficiency can be achieved by the appropriate incentives or restrictive customs regulations.

By ensuring the use of efficient tires, the fuel consumption can be reduced by 4 - 5% in the short-term period. (Source: Japan Automobile Research Institute data). For the Kyrgyz Republic it is quite possible to achieve the fuel consumption reduction by 2020, and thus emissions to 2.25%. Further significant reduction is not expected.

Development of public transport

In terms of the urban transport, this means the priority development of public transport, providing a change in the turnover balance of private and public passenger transport. When traveling by bus/trolley bus the energy consumption per passenger is about 5-20 times less than by car (depending on the load). Moreover, a passenger in public transport requires 10-20 times smaller area of the carriage way. Thus, reorientation for passenger traffic requires:

- increase in a number and frequency of rolling stock for public transport;
- increase in a number of routes for full coverage of the main movement directions;
- travel comfort improving;
- speed rise (e.g., by a provision of separate lanes for public transport);
- tariff policy enhancing the public transport practice and energy efficient suburban and long-distance transport;
- raising awareness on the problems associated with transport and the ways to solve them.

According to the International Energy Agency, as a result of these measures, each 10% of passengers transfer from cars to buses (without changing the load factor), saves up to 5% of the power consumed by vehicles. Emissions reduction is estimated based on the assumption that by 2020 passenger traffic will be translated to public transport by 10%, and by 2100 - 20%, which will reduce GHG emissions by 5% by 2020 and 10% by 2100.

Planning of road infrastructure

Measures on the road infrastructure planning are aimed at increasing the vehicles average speed, lying within 50 - 90 km/h, as this helps to achieve a significant reduction in fuel consumption (Fig. 4.38). For different vehicles, the dependence of consumption on speed is slightly different, but in general they have a similar nature.

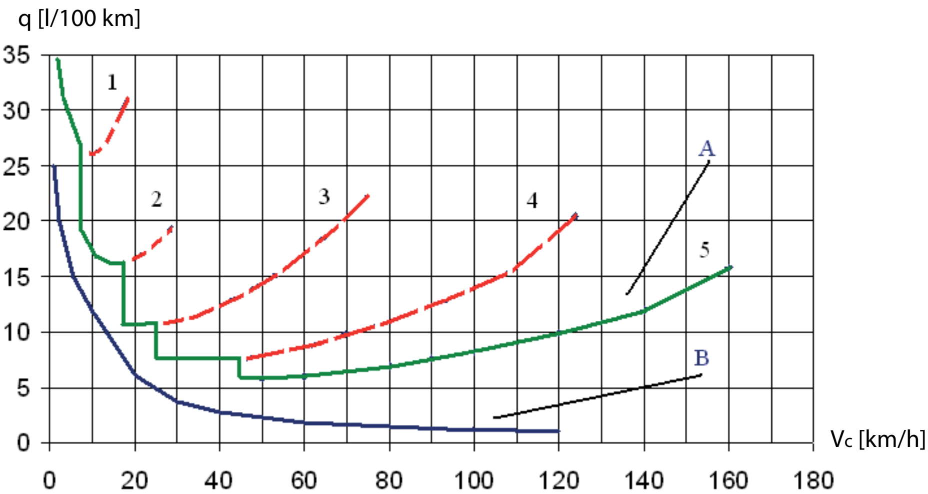


Fig. 4.38. Example of a relation between average speed and fuel consumption. (1-5 – transmissions number). Source: Research by M.A.Osipov and O.V. Mayboroda [4.8]

The key mitigation measures:

- - setting of traffic lights optimal work (“green wave”) and automated traffic light management system;
- development of different level road intersections on the main highways;
- entry restricting into city centers (except for public transport and bicycles);
- restricting for heavy vehicles movement on the cities highways in the daytime;
- expanding and improving the state of existing secondary roads (backup roads) and bypass roads;
- banning the new buildings construction without parking areas and green territories;
- construction of intercepting parking areas;
- introduction of fees for entry into the city center;
- organization of paid parking in the city centers;
- limiting and partial banning of parking in city centers;
- evacuation of improperly parked transport.

Considering an expensiveness of the most measures for the road infrastructure planning, it is expected that by implementing some less costly measures by 2020, emissions can be reduced by 10%. Full implementation of all measures is expected by 2100, which is to ensure emissions cut by 20%.

Bicycle infrastructure

The key measures:

- building of bicycle lanes;
- installation of special road signs and traffic lights;
- arranging bicycle parking areas;
- specially allocated places for the bicycles transportation in the public transport.

According to expert estimates, currently bikes are used by about 1% of the population. Increasing a share of the population regularly using bicycles in 2020 to 10 - 15% will provide a cut in emissions of about 5%. Subsequently, by 2100, a share of people using bicycles is expected to reach 30% , which would reduce emissions by about 10%.

Eco-driving

Eco-driving is a set of rules by which every driver can reduce the fuel consumption by the vehicle. In general, by using eco-driving, GHG emission cuts could reach 5- 20% in the short term and an additional 5 - 10% in the long term perspective (Source: Japan Automobile Research Institute data). For the Kyrgyz Republic it is quite realistic to reduce emissions by 5% in 2020.

The total cost of implementing all of the above measures in the road transport sector, according to preliminary estimates, will account more than $1 million. The most expensive measure is the road infrastructure planning, followed by the public transport development.

The results of emission reduction based on the foregoing assumptions are given in Table 4.8.

Table 4.8. Reducing CO_2 and total GHG emissions under the measures implementation in the road transport sector

Years	2020	2050	2100
Carbon dioxide, Gg			
Scenario 1. Low population growth – high economic growth	1640,44	3315,48	4150,17
Scenario 2. Average population growth – average economic growth	1386,26	1868,93	2209,65
Scenario 3. High population growth – low economic growth	1320,03	1643,27	1831,22
Total GHG emission, Gg CO_2-eq.			
Scenario 1. Low population growth – high economic growth	1651,77	3338,38	4178,83
Scenario 2. Average population growth – average economic growth	1395,83	1881,83	2224,91
Scenario 3. High population growth – low economic growth	1329,15	1654,62	1843,87

4.5.1.5. Renewable energy sources

The installed capacity and power generation by RES types is currently insignificant in the country. This is natural in the context of rather cheap HPP electricity, comparatively low living standards and insufficient level of internal and external support.

The consuming capacity for certain RES types in the republic was not determined. There are only expert assessments, which differ as a result of the different approaches used for an assessment. The task to assess the renewable energy sources capacity for the Kyrgyz Republic was identified as the highest priority in the mid-term perspective.

According to the IPCC and IEA [4.9, 4.12, 4.22 – 27] capacity building and the GHG emissions possible reduction were estimated for the following renewable energy sources in the country:

- biomass;
- solar power;
- wind power;
- geothermal power;
- hydro power.

The capacity assessment methodology for renewable energy sources is based on the Guidelines methodology [4.1] and the TASIS project outcomes [4.6].

The process of RES application is expected to implement by the end-users stimulation scheme. Hence, the necessary costs are half of the required funding. Accordingly, half of the received GHG emissions reduction will be got by the domestic resources.

4.5.1.5.1. Bioenergy resources

Any utilization of biomass as power resource, even direct combustion, does not lead to an increase in CO_2 emissions as it is absorbed by plants in the process of photosynthesis.

The main barriers in using biomass are higher costs and low conversion efficiency, as compared to fossil fuel, underdeveloped supply logistics and risks associated with an intensification of agriculture. Biomass capacity to reduce waste GHG emission will be assessed further:

- agriculture (livestock and plant management);
- food industry;
- solid domestic waste.

The forestry waste, wastewater treatment systems, wood processing and the paper industry were not considered due to their insignificant amount.

The capacity assessment for 2010 was made on the NSC data and on the zoo technical norms of animal husbandry and wastes heat properties according to Reference data [4.1].

Gross potential for animal waste was defined by all livestock (cattle, sheep and goats, horses, pigs and poultry). The technical potential is defined excluding a share of livestock grazing on pastures, according to the estimates given in Section 3. The economic potential is defined only for part of the livestock in the large farms. Under the large farms those were understood, where animal waste could provide all the needs for energy resources of the average household.

The gross potential for crop residues was defined for the total volume of agricultural residues (grain-legumes, cotton, potatoes and vegetables). The technical potential is defined by a share of residues at the large farms, which refers to the entities, with more than 1 ha of land occupied by a particular culture. Economic potential was determined based on the technical capacity, including the actual volume of collectable crop residues.

The gross potential for the food industry waste was defined on the total volume of generated waste (milling industry, sugar and ethanol, meat processing industry). The technical potential is assumed to be equal to gross, since all the above are assumed to be major production units. Economic potential was determined based on the technical capacity with the actual volume of collected food waste.

The gross capacity for municipal solid waste was determined using the total volume of collectable organic fraction for urban residents. The technical potential is assumed equal to the gross one. The economic potential is determined from the technical considering the incomplete separation of the organic fraction out of total waste mass.

The productiion potential in all cases was determined based on the economic capacity, taking into account the actual conversion factor into useful power.

Table 4.9. Capacity assessment of bioenergy resources for 2010

Source of biomass	Capacity, toe			
	gross	technical	economic	productive
Livestock management*				
Cattle	406380,18	162552,07	28400,28	10224,10
Sheep and goats	609996,28	157665,56	30111,79	10840,24
Horses	157881,09	63152,43	5616,96	2022,11
Pigs	3738,89	3738,89	626,00	225,36
Poultry	19827,08	19827,08	3176,52	1143,55
Plant management				
legume	237300,00	118650,00	106783,42	38442,03
cotton	44400,00	34639,36	17319,68	6235,08
potato	44646,67	19548,22	9774,11	3518,68
vegetables	27070,00	14455,55	7227,77	2602,00
Food industry				
flour and cereals	65732,57	65732,57	32866,28	11831,86
sugar	1948,80	1948,80	974,40	350,78
alcohol	1397,15	1397,15	698,58	251,49
meat processing	111,30	111,30	55,65	20,03
Solid domestic waste	161188,21	161188,21	80594,11	29013,88
Total	**1781618,22**	**824607,19**	**324225,55**	**116721,19**

The economic and productive capacity of biomass from livestock, plant management and the food industry significantly relies on the accepted productivity of processing equipment and the farms distribution by volumes. For example, an assessment of the minimum potential for cattle is:

- economic – 8402.01 tce;

- productive – 3042.72 tce,

which is significantly lower than accepted values while the maximum potential is almost half as much:

- economic – 56701.99 tce;
- productive – 20412.72 tce.

The farms distribution by their size was based on the latest available statistical data and is not expected to change in future. This assumption possibly undervalues capacity assessment in the future based on the observed tendencies for aggregation.

Based on the assessment of bioenergy resources (Table 4.9) for 2010 and development scenarios, the changes of capacity values were determined for the overall period under review.

Regarding the other countries experience, it is expected that the whole bioenergy productive capacity of livestock, plant management and food industry will be implemented no earlier than 2050, and solid domestic waste - in 2040.

The GHG emissions results are given in Table 4.10, considering the assumptions that bioenergy resources are to replace the fossil fuel used for heating and other purposes. This takes into account that the CO_2 reduction is somewhat relative. Actually, these emissions will remain anyway. However, they are not considered in country's emissions but are transferred to Section 7 "For information". Only SO_2 emissions per value of replaced fossil fuel are fully reduced. The calculations used the option of minimal emissions reduction – biomass combustion. For other utilization options, e.g., decomposition of organic fraction without access to oxygen, the indicators will naturally be higher. Of significant interest is the biotechnological processing of organic waste with the extraction of biogas, especially in rural areas, allowing to address the power, economic, ecological, epidemiological and socio-economic issues which are important for healthcare.

Table 4.10. Potential for CO_2 and total GHG emissions in the biomass utilization

Years	2020	2050	2100
Carbon dioxide, Gg			
Scenario 1. Low population growth – high economic growth	52,14	213,09	290,25
Scenario 2. Average population growth – average economic growth	51,68	205,66	262,84
Scenario 3. High population growth – low economic growth	51,67	114,46	128,98
Total GHG emission, Gg CO_2-eq.			
Scenario 1. Low population growth – high economic growth	352,69	1302,90	2148,07
Scenario 2. Average population growth – average economic growth	347,00	1224,91	1885,75
Scenario 3. High population growth – low economic growth	357,70	1135,91	1614,05

4.5.1.5.2. Solar energy

The Kyrgyz Republic has objective preconditions (climatic and technical) for the broader development of solar power. Climatic conditions are present in the rather high specific characteristics of solar equipment in power and thermal generation (annual specific power generation by photoelectrical equipment up to 300 kWh/m^2; annual specific productivity of solar hot water supply up to 750 kWh (heat)/m^2). In general, the country's geographic position and climatic conditions are quite favorable for the solar energy use which is evident from the solar radiation maps. Technical presumptions are an availability of increasingly cheaper photoelectrical converters, modules and flat solar collectors, as well as the existing scientific-technical capacity in the given area.

This chapter considers the use of solar energy, based on its direct use. There are different technologies to obtain thermal or electrical power, either by passive or active methods [4.12]. Currently, solar power is often used for the generation of low-grade solar heat by simple flat solar collectors as the lowest cost option. However, the country needs to develop other areas, such as the use of solar cells to generate electricity. This direction is widely developed in many countries: - «100,000 solar roofs» in all EU member countries, «70,000 solar roofs» in Japan, «One million solar roofs» in the US, and even in the developing country Mongolia - «100,000 solar yurts».

The total solar energy potential for the Kyrgyz Republic is huge, but the technical, economic and industrial potential is usually identified based on empirical methods that lead to results, depending on the preferences of a particular study (e.g., Reference [4.1]). Hence, below is used an approach based on an already well-known experience.

To generate the thermal power in the Kyrgyz Republic, an implementation of a similar program involving the use of photovoltaic roofs 100,000 by 2030, the same amount in addition by the 2060 and 400,000 roofs by 2100 is expected. The estimation of emission reductions are presented in Table 4.11. The program is expected to be implemented under all scenarios. Emissions reduction is somewhat arbitrarily attributed to the use of electrical power in the "Heat: Residential" sector (electricity use), as the key category for measure implementation.

Table 4.11. Potential of CO_2 and total GHG emissions reduction under use of photo elements to generate electric power

Years	2020	2050	2100
Carbon dioxide, Gg	12,90	50,64	113,55
Total GHG emissions, Gg CO_2-eq.	12,95	50,85	114,02

For thermal power generation it is supposed that the implementation of a program similar to the program for electricity, i.e. 10% coverage of households by 2030, an additional 10% in 2060 and around 35% coverage by 2100. The coverage volume is generally consistent with global growth trends of this type of renewable energy, according to [4.13]. The results of the emission reductions are presented in Table 4.12. Reductions refer to the following:

- Heating. Commercial/institutional sector (fuel combustion);
- Hot water and etc. Commercial/institutional (fuel combustion);
- Heating. Residential sector (fuel combustion);
- Hot water etc. Residential sector (fuel combustion).

A smaller reduction of emissions is also possible in others sectors, connected with the power consumption for heating and hot water needs, but it is quite low and, therefore, was not considered.

Table 4.12. Potential of CO_2 and total GHG emissions reduction under use of solar energy to generate thermal power

Years	2020	2050	2100
Carbon dioxide, Gg			
Scenario 1. Low population growth – high economic growth	73,09	264,68	598,89
Scenario 2. Average population growth – average economic growth	73,49	261,87	657,80
Scenario 3. High population growth – low economic growth	74,53	308,11	1019,59
Total GHG emission, Gg CO_2-eq.			
Scenario 1. Low population growth – high economic growth	78,02	284,46	643,85
Scenario 2. Average population growth – average economic growth	78,44	281,46	707,14
Scenario 3. High population growth – low economic growth	79,06	323,48	1052,95

4.5.1.5.3. Geothermal energy

The advantages of geothermal power are its inexhaustibility, regardless of external conditions, daytime and year, and a possibility of the complex use of thermal waters for heating and medical needs. The disadvantages are related to the high mineralization of the thermal water at most of the deposits and the presence of toxic compounds and metals, which eliminates most of the thermal water discharge into natural water bodies, as well as the lack of studies on the geothermal energy potential assessment in the country.

In the Kyrgyz Republic there are more than 30 geothermal sources, but only some of them are used in sanatoriums and resorts (e.g., Issyk-Ata, Teplye klyuchi) exclusively for the needs of these institutions, due to their low capacity.

One of the methods to use geothermal power is a beneficial use of scattered low-temperature (5 ÷ 10 °C) of the natural heat or the industrial waste heat for heat supply through heat pumps.

In their turn, heat pumps being free from most of the centralized heating system disadvantages are already widely used in many countries.

Heating from an additional heat source other than the pump is required when the ambient temperature falls below freezing, and the heat losses of buildings exceed the thermal capacity of the pump. To improve the cost effectiveness of the system, adding a sub-heater, in this case the electric one, is recommended only when the heat pump cannot cover the full load.

The mass production of heat pumps is well developed in almost all the developed countries. According to forecasts, by 2020, a share of heating and hot water in the developed countries using a heat pump will be 75%.

It should be noted that in the Kyrgyz Republic heat pumps are not widely used due to a number of different objective and subjective reasons:

- relatively low electricity tariffs;
- lack of consumers knowledge on the advantages and disadvantages of modern heat supply technologies for residential customers;

- lack of preferential loans for the geothermal heat supply system installation;
- lack of specialized installation companies;
- lack of service, maintenance and repair centers;
- lack of investors due to political instability.

Given the barriers listed, it can be assumed that a share of heat pumps used for heating and hot water supply in Kyrgyzstan will reach 75% only by 2100. Based on this assumption, the emission reductions volumes were estimated and presented in Table 4.13.

The main reduction in emissions is expected for the following categories:

- Heating. Residential sector (combustion);
- Heating. Residential sector (electricity usage);
- Hot water and others. Residential sector (combustion);
- Hot water and others. Residential sector (electricity usage).

Also, a smaller reduction of emissions is possible in the commercial/institutional sector, but this decrease is expected to be much smaller compared to theresidential sector.

Table 4.13. Potential of CO_2 and total GHG emissions reduction under geothermal power consuming

Years	2020	2050	2100
Carbon dioxide, Gg			
Scenario 1. Low population growth – high economic growth	128,01	492,35	868,04
Scenario 2. Average population growth – average economic growth	128,98	489,24	992,12
Scenario 3. High population growth – low economic growth	131,28	585,07	1650,26
Total GHG emission, Gg CO_2-eq.			
Scenario 1. Low population growth – high economic growth	136,20	526,51	930,49
Scenario 2. Average population growth – average economic growth	137,22	523,10	1060,87
Scenario 3. High population growth – low economic growth	138,81	611,72	1697,45

4.5.1.5.4. Wind energy

Currently, the wind power installments have reached a level of commercial ripeness and in places with favorable wind speeds can compete with the traditional energy sources [4.12].

Under strong wind, from 10 to 12m/s, the wind turbines generate electricity sufficient to be transmitted to a centralized system of power supply. Difficulties arise in periods of prolonged calm or light wind. Consequently, the areas with an average wind speed of 5 m/s are considered unsuitable for the wind turbines installation, and favorable at a rate of 8 m/s, i.e. a construction of a wind power plant is feasible only in the areas with the average annual wind speed high enough. In mountainous terrain, which is characteristic for the Kyrgyz Republic, the winds of constant direction and of sufficient strength can only be found in the remote and sparsely populated areas.

The analysis of the instrumental observations at the meteorological stations shows the actual average annual wind speed much lower 5 m/s (according to only one weather station, it is in excess for two months a year only). Moreover, in practically all meteorological stations there is a steady downward trend of the average wind speed. Hence, it can be concluded that the potential for wind energy in the country within the main populated residential area is small. Probably, in the Kyrgyz Republic conditions the wind energy use is economically viable only in certain areas, which are less fit for the wind turbines construction in view of the difficult accessibility and remoteness from the major customers.

Based on the above, the country does not intend to use wind energy in large volumes and therefore the possible emissions reduction was not estimated.

4.5.1.5.5. Hydropower

Hydro is one of the priority areas for the economic development. Hydropower stations actually form a basis of the power system, namely, the HPP generate more than 90% of electricity (Table 4.13). This aspect is positive from the point of the climatic impact of the Kyrgyz Republic. The main difficulty is related to the preservation of the existing situation because the renewable energy resources, particularly hydropower, are largely dependent on climate change.

The division into small hydropower plants (Table 4.14) and further is conditional since the country does not have a classification system officially established. It is notable that there are a small number of small hydroelectric power stations at present. Earlier, a substantial number of small hydroelectric power stations operated in the KR, although some of them can even be attributed to micro hydro power plant (see Fig. 4.39).

There were 161 small hydropower plants operating with a total installed capacity of 44 MW. After the large hydro and thermal power plants having commissioned, most of the small hydropower plants were taken out, and then dismantled and destroyed. In recent years, the subject of the reconstruction and construction of new small hydropower plants has gained greater urgency in connection with the emerging power shortages and the rising costs of fossil fuels.

Table 4.14. Characteristics of current power stations. Source: Ministry of Energy and Industry of the KR

#	Title	Installed capacity, MW	Annual output, mln. kWh
ГЭС			
1.1	Toktogulskaya	1200	4100
1.2	Kurpsaiskaya	800	2630
1.3	Tash-Kumyrskaya	450	1555
1.4	Shamaldysaiskaya	240	902
1.5	Uch-Kurganskaya	180	820
1.6	At-Bashinskaya	40	150
1.7	Kambarata -2	120	383
Total by HPP		**3030**	**10540**
TPS			
1.8	Bishkek*	666	1400,58
1.9	Osh *	50	68,17
1.10	Kainda	10	-
1.11	Kara-Balta**	10	128,61
Total by TPS		**736**	**1597,36**
Small HPP			
1.12	Alamedinskaya HPP N1	2,2	18
1.13	Alamedinskaya HPP N 2	2,5	20
1.14	Alamedinskaya HPP N 3	2,14	20
1.15	Alamedinskaya HPP N 4	2,14	17
1.16	Alamedinskaya HPP N 5	6,42	23
1.17	Alamedinskaya HPP N 6	6,42	23
1.18	SmallAlamedinskaya HPP	0,41	2,0
1.19	Bystrovskaya HPP	8,7	46,4
1.20	Lebedinovskaya HPP	7,6	65
1.21	Kalininskaya HPP	1,48	6
Total by small HPP		**42,11**	**240,4**
Total		**3808,11**	**12377,76**

*According to data of 1990 – 2012
**According to data of 2005 – 2012 .

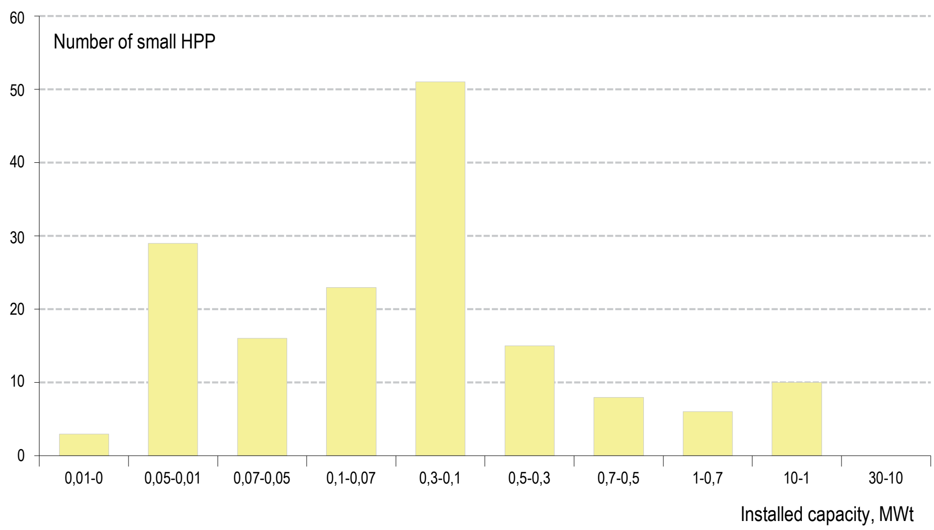


Fig. 4.39. Distribution of formerly operating small HPP by capacity. Source: Small HPP Inventory, approved by the Government Decision #62 of 11 February, 2002

Table 4.15. Characteristics of the scheduled power stations (number of small HPP given in brackets). Source: Ministry of Energy and Industry of the KR

#	Name	Installed capacity, MW	Annual output, mln. kWh	Capital investment, mln. USD
	HPP			
1.1	Kambarata-1	1900/1600	5164/3400	2900/1600
1.2	Kambarat-2*	240	766	280
1.3	Naryn 1	39	207,7	83,345
1.4	Naryn 2	38	227,5	82,964
1.5	Naryn 3	47	259,5	124,627
1.6	Akbulunskaya	67	361,2	220
1.7	Sary-Djaz	1200	5400	1200
1.8	Kara-Kolskaya	33	95	~
1.9	Kokomerenskaya 1	360	958	-
1.10	Kokomerenskaya 2	912	2375	-
Total HPP		**4836**	**15813,9**	**4972,936**
	On fossil fuel			
1.11	Bishkek TPS 1**	125	500	380
1.12	Bishkek TPS 2	360	1500	137,9
1.13	Kara-Keche TPS	1200	9500	1150
Total		**1685**	**11500**	**1667,9**
	Small HPP			
1.12	Restored (39)	23,08	106,16	16,62
1.13	Newly built (62)	180,77	930,29	210,35
1.14	On the waterworks (7)	72,2	204,5	86,2
Total by small HPP		**276,05**	**1240,95**	**313,17**
Total		**6797,05**	**28554,85**	**6954,006**

*Increasing installed capacity by commissioning of new units
**Increasing installed capacity by reconstruction

As shown in Table 4.15, the energy development plans are expected to increase generation volumes by all types of source, but the key focus will be on hydro. The table does not include the entry dates of different generating facilities, as the construction start and completion depends on the funding opportunities. For further analysis, it is assumed that by 2100, all electricity generation facilities will be employed.

The expected power consumption is shown in Fig. 4.40, based on the forecast in the baseline case with subtraction of the reduction value under an implementation of the previously considered measures.

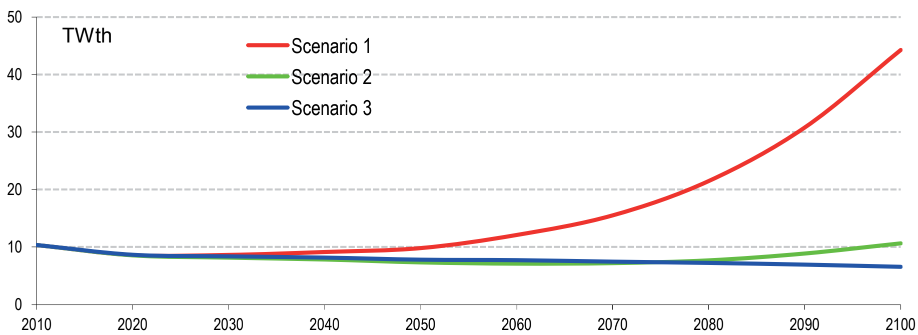


Fig. 4.40. Assessment of expected power consumption considering the earlier reviewed reduction measures

The hydropower potential has been identified based on the approach developed by the Water Problems and Hydropower Institute of the NAN, under the Adaptation Priorities preparation. The assessment of the potential for 2010 is shown in Table 4.15.

The gross hydropower potential refers to the power equivalent of hydraulic energy reserves, concentrated in the surface runoff, without losses. Technical hydropower potential is a part of the gross one. This is a part of the gross one that can technically be used accounting the inevitable losses associated with the electricity generation. It also includes an inability to make full use of runoff. This is caused by the insufficient capacity of the reservoirs and limited HPP power, due to the limited use of upstream and downstream rivers sections with low potential, losses by evaporation from the reservoirs surface and filtration, and pressure and power losses in the flow path and hydroelectric power equipment, etc. The technical potential is constant and can only depend on significant changes in the modes of electricity generation at HPP. The technical hydropower potential estimated re the Institute assessments [4.4] in percentage of gross hydropower potential is: the Naryn River Basin - 62%; the Chu River - 40%; the Ak-Sai river- 40%; the Sary Jaz river - 70%; the river basin of Issyk-Kul Lake - 55%. For the other river basins of the Kyrgyz Republic an average value equal to 54% was accepted.

The economic hydropower potential is a part of the technical hydropower potential, which use is cost-effective. So, the economic potential may vary over time and depend on the power and economic conditions of a HPP construction site. According to the estimates [4.5], the economic hydropower potential is below 25% of the gross hydropower potential. The productive capacity in this estimation is assumed to be equal to the economic one. But at the HPP design stage it can be reduced taking into account the limitations associated with some areas exclusion out of the planned HPP site. For example, these are the protected areas and areas unfit for the HPP construction in terms of engineering-geological conditions. As well, the surface runoff accounting can determine a slight decrease in the capacity.

Table 4.16. Estimates of the annual hydropower potential for 2010

Basin	Capacity, TWh			
	Gross	Technical	Economic	Productive
Issyk-Kul	17,29	9,51	3,99	3,99
Chu	21,11	8,44	3,55	3,55
Talas	11,98	6,47	2,72	2,72
Chatyr-Kul	0,14	0,07	0,03	0,03
Kyzylsu	8,67	4,68	1,97	1,97
Tarim	45,29	31,70	13,32	13,32
Balkhash	0,28	0,15	0,06	0,06
Naryn	73,18	45,37	19,06	19,06
Fergana- north	15,20	8,21	3,45	3,45
Fergana –south	19,65	10,61	4,46	4,46
Karadarya	32,74	17,68	7,43	7,43
Total	245,52	142,90	60,02	60,02

According to the estimates in the Table 4.16, the current hydropower potential of the country already being used is18% (for large HPP - 19.5%, for small ones - 4%). During the construction of planned hydropower plants in accordance with Table 4.14, the use of the capacity increases to 46.0% (for large hydropower plants to 48.8%, while for small to 21.3%).

If the hydropower potential is considered constant, a comparison of the country's hydropower potential (Table 4.15), with the expected consumption estimate (Fig. 4.40) shows that the implementation of the mitigation measures listed above, provides a significant reduction in electric power consumption. Thus, for Scenarios 2 "average population growth - average economic growth" and 3 "high population growth - low economic growth" the electricity needs are fully covered by the existing energy sources. For Scenario 1 "low population growth - high economic growth", the commissioning of all the planned hydropower sources (Table 4.14) does not provide the national needs by 2100. There are two solutions to this problem:

- construction of new HPP for full use of the whole hydropower potential (Table 4.15);
- construction of projected fossil fuel sources (TPS2 Bishkek and Kara-Keche TPS).

From the viewpoint of climate change mitigation the first option is obviously more preferable. The solution to the problem of providing electric power is realistic and based on existing capacity and the planned national measures.

The situation is less favorable under estimation of the climate change impact on surface water resources. Fig. 4.41 and 4.42 represent an estimation of the hydropower potential under two climate scenarios:

- RCP2.6 - the most environment-friendly scenario based on the agreed joint mitigation actions by the whole global community;
- RCP8.5 - the most unfavorable scenario assuming a temperature increase above 5 °C, based on the current trends' continuation.

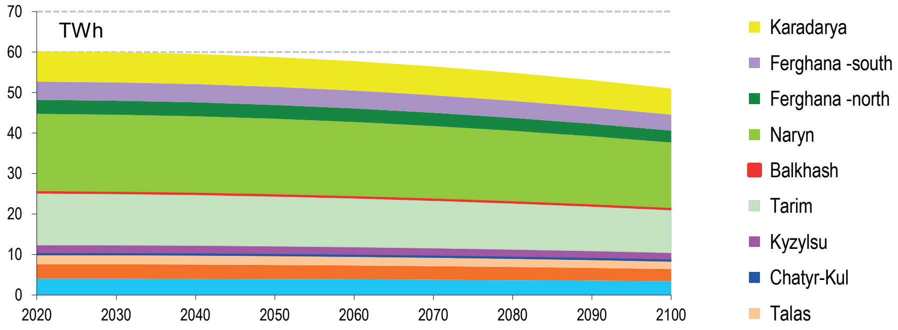


Fig 4.41. Estimates of the annual productive hydropower potential of the KR till 2100 under RCP 2.6 climatic scenario, Twh

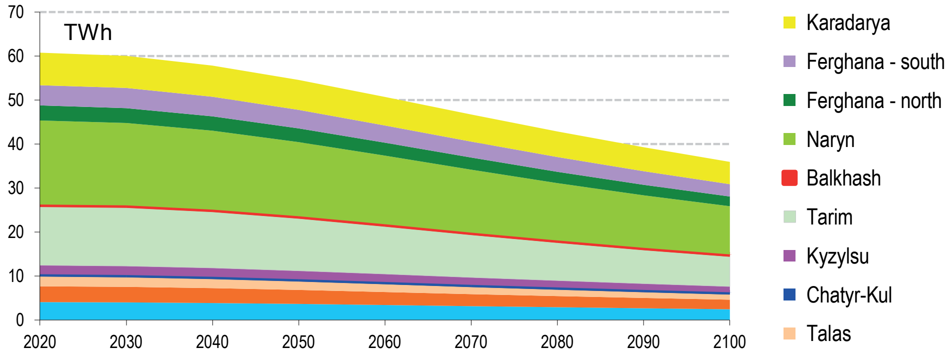


Fig.4.42. Estimates of the annual productive hydropower potential of the KR till 2100 under RCP8.5 climatic scenario, TWh

A comparison of the hydropower potential under climate scenario RCP2.6 (Fig. 4.41) with the expected consumption estimate (Fig. 4.40) shows the situation generally similar to the described above in a case of zero climate change impacts, i.e. constant hydropower potential. In this case, the potential is reduced from 60.02 TWh to 50.94 TWh by 2100. But it is still sufficient to meet the power needs of the country till 2100. For Scenarios 2 and 3 the electricity needs are fully covered by the existing power sources by the planned measures implementation. Scenario 1 is similar to the above case and the two possible solutions are feasible to provide the country with the electric power.

The most unfavorable case is the possible implementation of RCP8.5 climate scenario (Fig 4.42), leading to a significant reduction of the hydropower potential from 60.02 TWh to 35.87 TWh. For Scenarios 2 and 3, there is no problem due to the expected small electricity consumption. For Scenario 1 "low population growth - high economic growth", the electric power providing until 2100 is only possible via the new HPPs construction to take full advantage of the total hydropower potential and the simultaneous construction of the TPS 2 Bishkek and Kara-Keche TPS.

There is an option for additional mitigation measures (excluding the above), and, thus, for energy consumption reduction.

Given the uncertainty in the timing of the planned measures implementation for the new energy sources introduction and the limited mitigation goals by 2050 (Section 4.2.2), to estimate the measures scenarios it is assumed that by 2050 out of all the planned HPPs (Table 4.14), only two – the Kambarata-1 and the Kambarata-2 will be commissioned. Also, the reduction assessment is entirely based on the Kambarata-2 operation.

In fact, under the new HPPs commissioning, the power for internal use for the expected consumption (Fig. 4.40) will be sufficient until the mid of the century, even with the complete exclusion of fossil fuel sources generation. But fossil fuel sources generation are accounted to safeguard the possible electricity import.

Given this assumption, the expected emissions reduction was estimated relating to the category "Electric power. All consumers, except for the Commercial/institutional and "Residential" sector. The reduction is achieved by a ratio change of electric power generation sources by fossil fuel and by hydro, which leads to a reduction in the specific emissions of CO_2 and GHG by 1 kWh.

The reduction in carbon dioxide emissions is 48.8 Gg.

The reduction of total GHG emissions is 49 Gg CO_2-eq.

Based on the assumptions, the similar reduction is expected under all scenarios by 2020 and by 2050. It is challenging to provide an assessment for 2100. It assumed to double.

4.5.2. Scenarios with measures

4.5.2.1. Assessments

The reductions aggregation for certain source categories help estimate the reductions by all of the above planned measures. Fig. 4.43 shows the total GHG emissions by all the sectors except for the "Solvent use" sector with no GHG emissions, as well as the "LULUCF" sector, for which the emission/sink net is assumed constant.

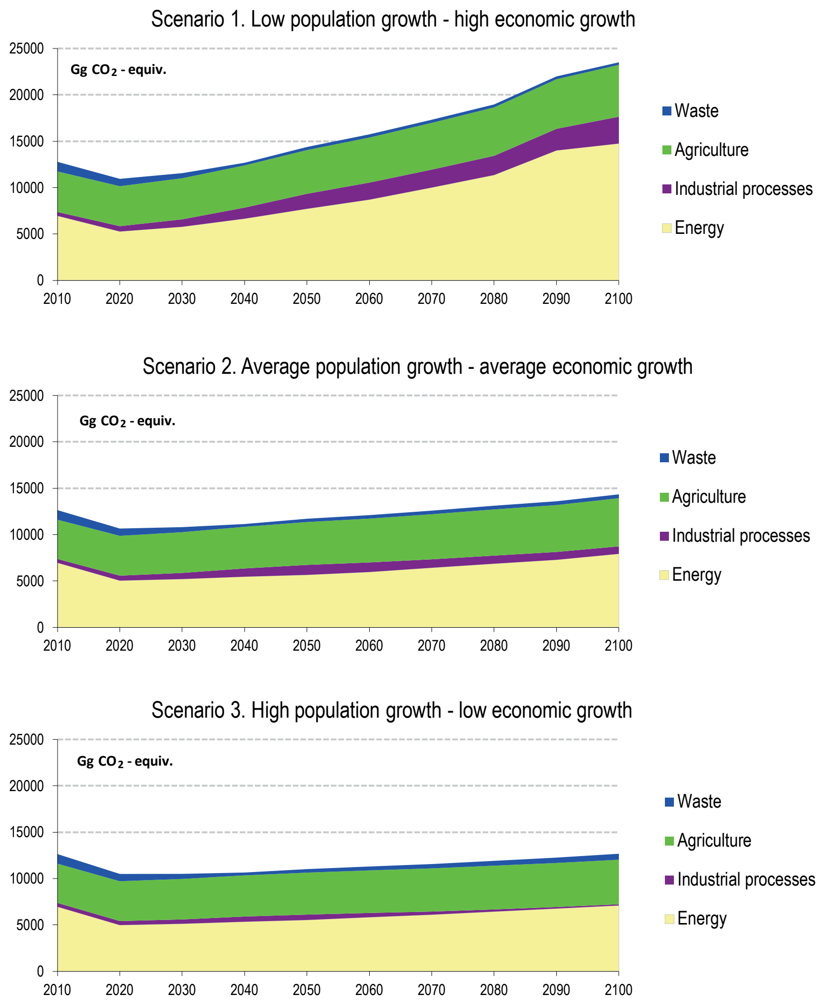


Fig. 4.43. Total GHG emissions trends under scenarios with the planned measures

The emissions significantly depend on the economic growth rates. For Scenario 3, even by 2100 the emissions level is expected not to exceed the level of 2010. And for Scenario 2 the emissions level in 2100 will exceed the level of 2010 by 12%, while for Scenario 1 the emissions will almost double.

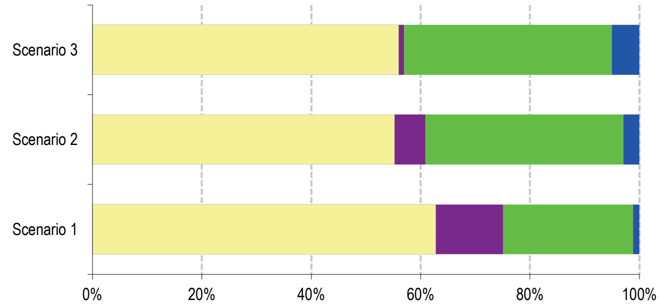
The sharp emissions decline in 2020 by the measures under all the development scenarios, is explained by the fact that the initial operations period (2015-2020) is the first for the country to launch the mitigation actions, as the previous mitigation measures has not been set and addressed as a such task in the KR. Naturally, during this period, a reduction will be achieved by clear and easily implemented measures with the greatest effect. The subsequent implementation of measures will provide a less visual effect and be achieved through greater efforts.

A characteristic feature of the scenarios (Fig. 4.43) is a nearly constant absolute input of the "Agriculture" sector, at a level of 4000-5000 Gg. The emissions increase in the "Industrial processes" sector is observed only under Scenario 1. In the «Energy» sector the emissions growth is observed under all scenarios, but the most significant under Scenario 1. The relative contributions of the sectors are shown in Fig. 4.44.

The estimation of the scenarios with measures (Table 4.17) shows that the target on the GHG emission reduction for the short-term period of the Kyrgyz Republic (GHG emissions reduction by 20% by 2020 under the «business as usual» scenario under the appropriate external support), could be achieved by means of the planned measures under all scenarios.

Table 4.17. Implementation capacity of the voluntary commitments on GHG emission reduction by 2020

Development scenarios	GHG emissions in Gg			Reduction, %
	Baseline scenarios	Scenarios with measures	Absolute reduction	
Scenario 1	14641,25	11089,11	3552,14	24,26118
Scenario 2	14065,54	10795,81	3269,73	23,24639
Scenario 3	13783,34	10641,25	3142,09	22,79629



4.44. GHG emissions distribution by sector in 2100 for different scenarios under the planned measures implementation

Fig. 4.45 shows GHG emission trends for source categories with fossil fuel combustion.

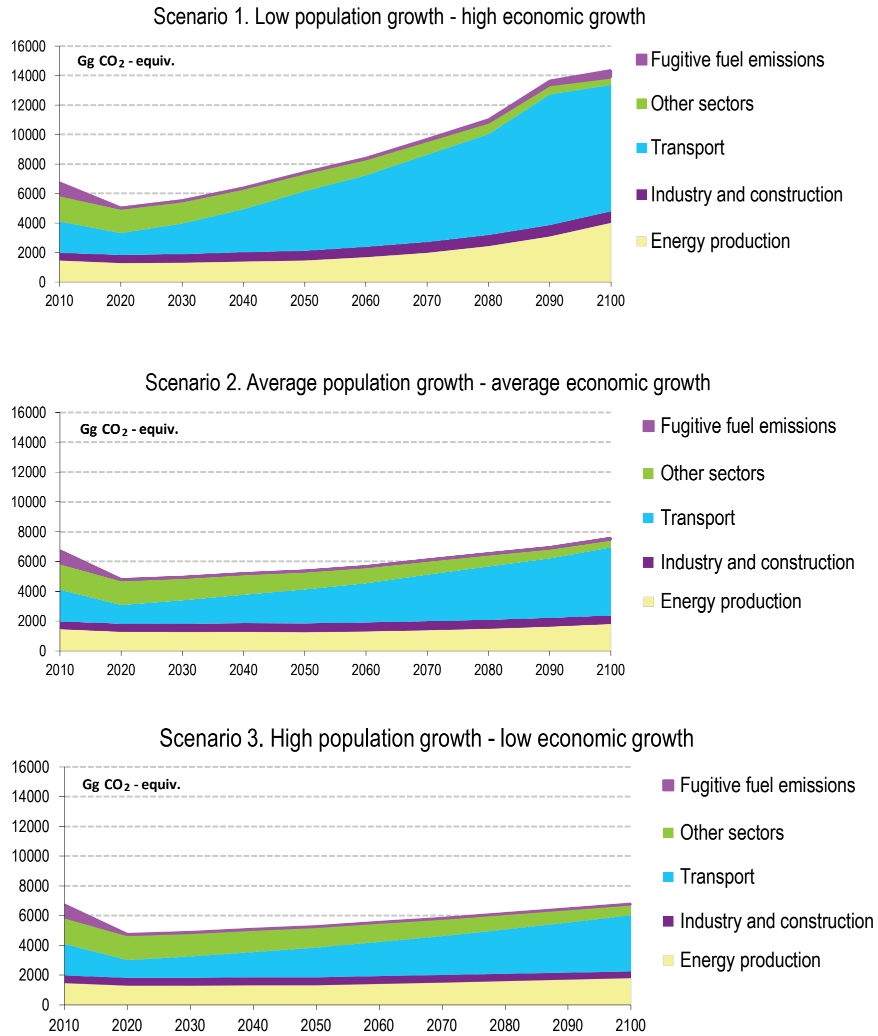


Fig. 4.45. GHG emissions trends for scenarios with measures in the "Energy" sector

The GHG emissions trends analysis in the "Energy" sector shows the effectiveness of the planned measures in many source categories. The steady emissions growth is sustained only in the "Transport" category. A less significant increase, heavily dependent on the scenario (the higher an economic growth, the greater emissions increase), is also kept in the "Power generation" category. And so, it can be concluded that the additional measures should be considered mainly for the "Transport" and "Power generation" categories. The planned measures are quite effective for other categories of the "Energy" sector.

Fig. 4.46 shows the emissions distribution in the "Energy" sector. Under all scenarios, a major source of GHG emissions is the "Transport"category, followed by the "Power generation" category. The other categories contribution does not exceed 20% in total.

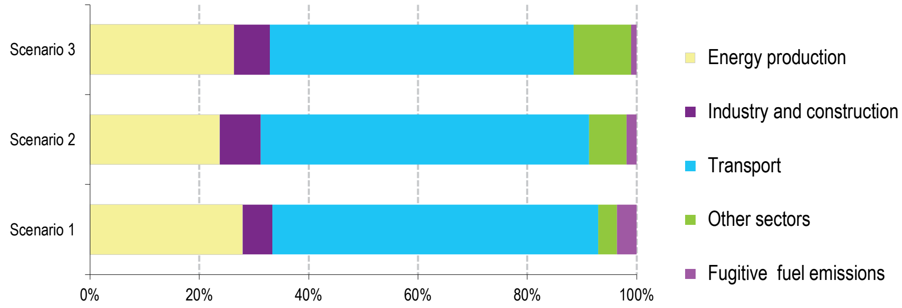


Fig. 4.46. GHG emissions distribution by source categories in the "Energy" sector in 2100 under the scenarios with the planned measures implemented.

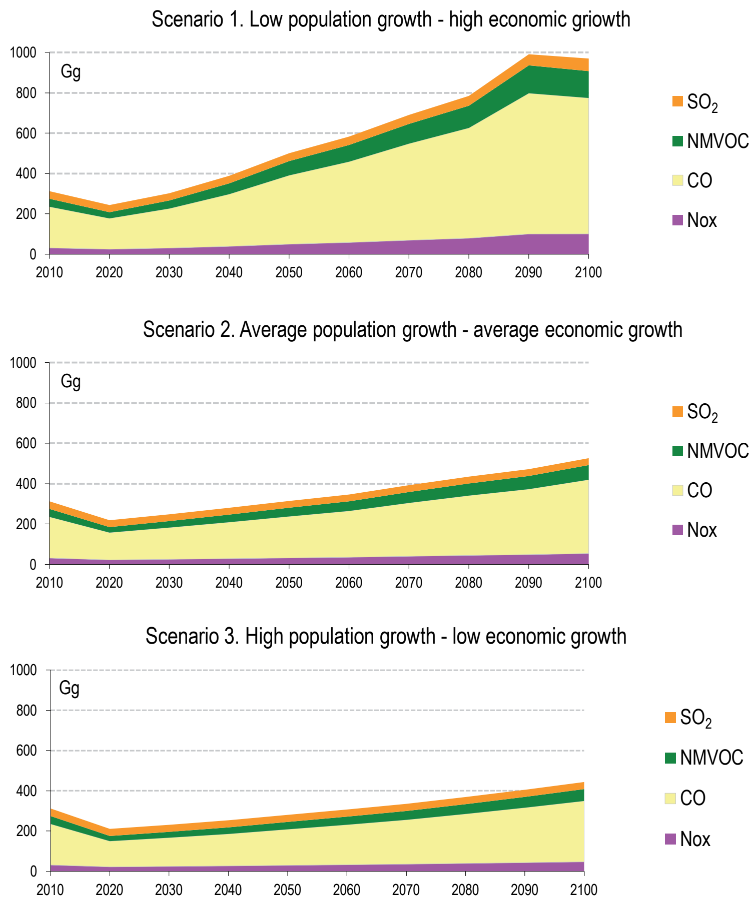


Fig. 4.47. Trends in precursor gases emissions under the scenarios with measures

Fig. 4.47 shows trends in precursor gas emissions broken down by the gases. A reduction of fossil fuel consumption mainly determines the volumes of reduced precursor gases emissions.

Emissions of precursor gases under the scenarios with measures significantly reduced relative to the baseline scenarios:

- Scenario 1 - from 1502.0 to 970.0 Gg;
- Scenario 2 - from 845.5 to 526.5 Gg;
- Scenario 3 - from 773.9 to 443.9 Gg.

However, an increase of the precursor gases total emissions is observed under all scenarios. This may harmfully affect the environment and calls for mitigation measures. Interestingly, the relative contributions of the separate gases retain. Except for SO_2, which almost halves due to the fossil fuels replacement with biomass. For Scenarios 2 and 3 even the absolute values of SO_2 emissions reduce relative to the baseline scenarios.

Fig. 4.48 shows the distribution of power consumption by the main categories in the "Energy" sector with the mitigation measures implementation. Only the "Energy" sector is assessed, as in other sectors there is no energy resources consumption. Fig. 4.48 does not include the "Fuels fugitive emissions" category, as power consumption in this category does not actually happen.

Separately shown is a distribution of the power and fossil fuel consumption share in the total power consumption. It largely determines the remaining potential of GHG emissions reduction.

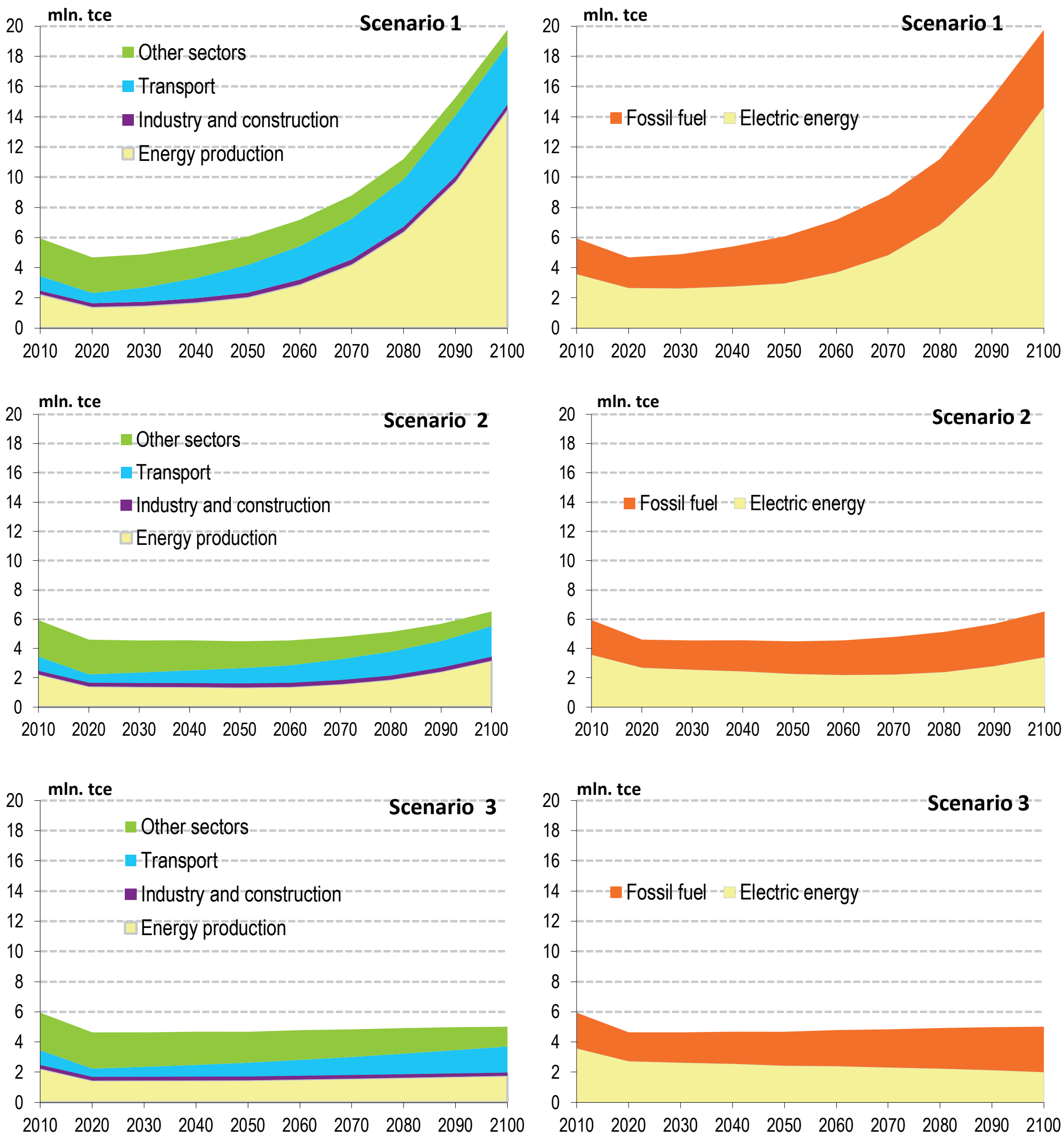


Fig. 4.48. Trends in power consumption scenarios with measures in "Energy" sector (left column) and the consumption distribution between electricity and fossil fuels (right column)

For Scenarios 2 and 3, the growth in consumption in the "Power generation" category is actually absent. In this category a sharp increase in power consumption is characteristic for Scenario 1. However, if compared with the energy consumption growth, it becomes clear that this growth should not lead to a similar increase in GHG emissions.

Unfortunately, the lack of accurate data on the timing of the generating capacity introduction actually leads to some overestimation of GHG emissions and fossil fuel consumption. Basically, it refers to Scenario 1, as it is with the greatest increase in primary power consumption. The impossibility to re-estimate the specific consumption of fossil fuels and specific GHG emissions per 1 kWh, forced the initial assumption of preserving the specific indicators at the level of 2010.

The key category for which power consumption is growing under all scenarios is the "Transport" category. It is this category that builds an increase in fossil fuel consumption, and here the key capacity to implement additional mitigation measures is. This assessment is based on the projected preserving of the existing transport structures. Possible changes related to the extensive use of eco transport (e.g., electric) will facilitate a task of GHG emissions reduction.

The key emissions sources in the "Other sectors" category are subcategories consuming power for the population needs and commercial/institutional entities for heating, hot water, etc. It is for them the intended measures are assessed more comprehensively. In "Other sectors" category there is a steady reduction of power consumption under all scenarios, especially sharp under Scenarios 1 and 2 (2.5 times), and nearly halved under Scenario 3. This reduction characterizes the measures efficiency in this category, despite the fact that in agriculture (also included in the "Other sectors" category) the mitigation measures were not considered in this assessment due to their insignificance. In the further, the mitigation measures on the power consumption should be assssed for the "Agriculture" subcategory.

To assess the long-term goals, Fig. 4.49 shows the trends in CO_2 and GHG specific emissions scenarios with measures. These trends show that, when as the target "below 2 ⁰C" level of CO_2 emissions with above 50% of probability is considered, the emissions under all scenarios will be within acceptable limits (1.58 t CO_2 /pers.). If the target "below 2 ⁰C" level of CO_2 emissions with 66% of probability is considered, then by 2050 only the basic Scenarios 2 and 3 are within the acceptable limits (1.23 t CO_2 / pers.), while under Scenario 1 the specific CO_2 emission is slightly higher of the required level (1.300 t CO_2 / pers.). The subsequent increase in the specific emissions under Scenario 1 surely includes the additional measures implementation to receive the reduction.

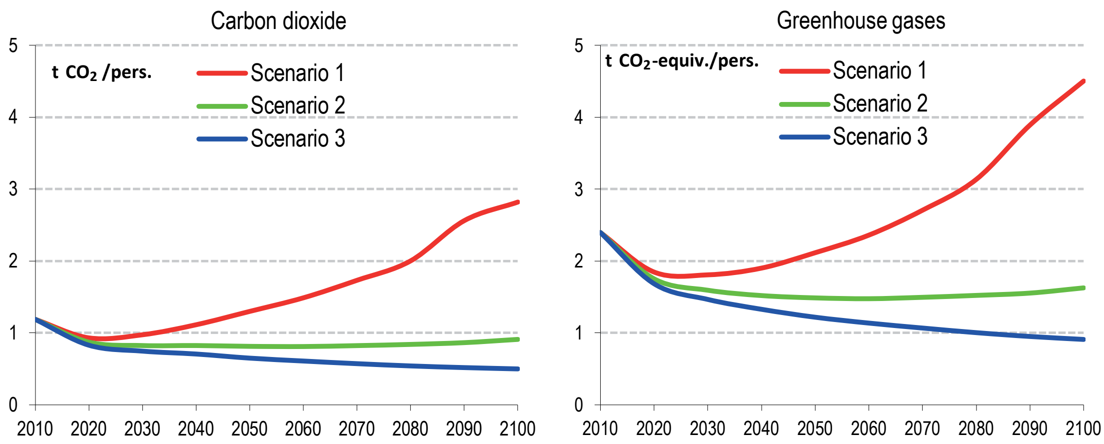


Fig. 4.49. Specific emission scenarios with measures: a) - carbon dioxide; b) - GHG

4.5.2.2. Comparison with baseline scenario by specific characteristics

To enable a detailed analysis of the planned measures effectiveness, the basic specific characteristics, used by the International Energy Agency, are considered below.

Fig. 4.50 shows the trends in total power consumption (fossil fuels and electricity) per capita. The planned measures implementation under all scenarios provides the power consumption reduction by almost 1.5 times, but under Scenario 1 the consumption increase continues, characterizing a need in the additional measures.

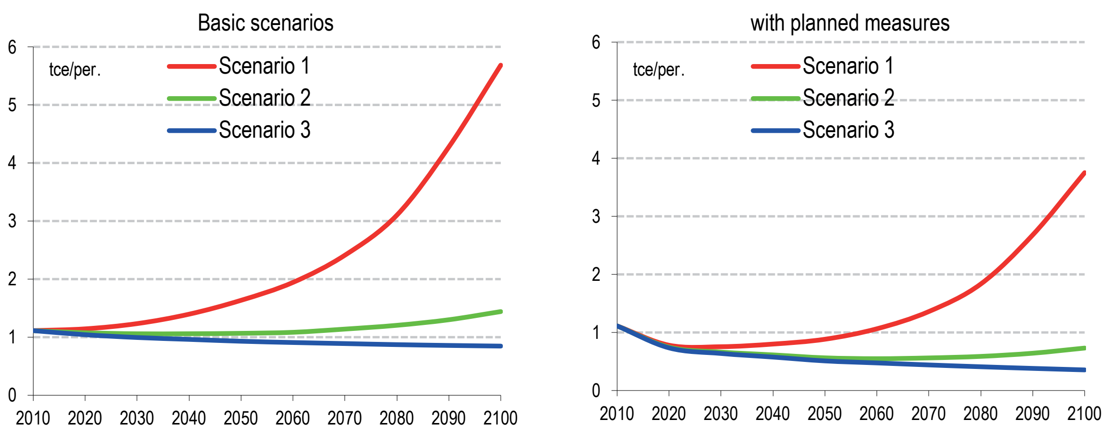


Fig. 4.50. Trends in power consumption per capita under baseline scenarios and scenarios with measures

Fig. 4.51 illustrates the trends in the total of power consumption (fossil fuels and electricity) for GDP in $1,000. The aim is to get the indicator achieved in the economically developed countries. In 2010, the average figure for OECD countries was 0.2 tce/$1,000, the lowest figure is 0.1 tce/$1,000, while the global average was 0.357 tce/$1,000 (source: International Energy Agency). The planned measures implementation allow for Scenarios 1 and 2 to reach the goal (0.083 and 0.134 tce/$1,000, respectively). For Scenario 3, connected with the expected slower economic growth rate for 2100, it is much higher - 0.482 tce/$1,000. These figures are significantly lower as compared to the baseline scenarios (0.126, 0.265 and 1.150 tce/$1,000 for Scenarios 1, 2, 3, respectively).

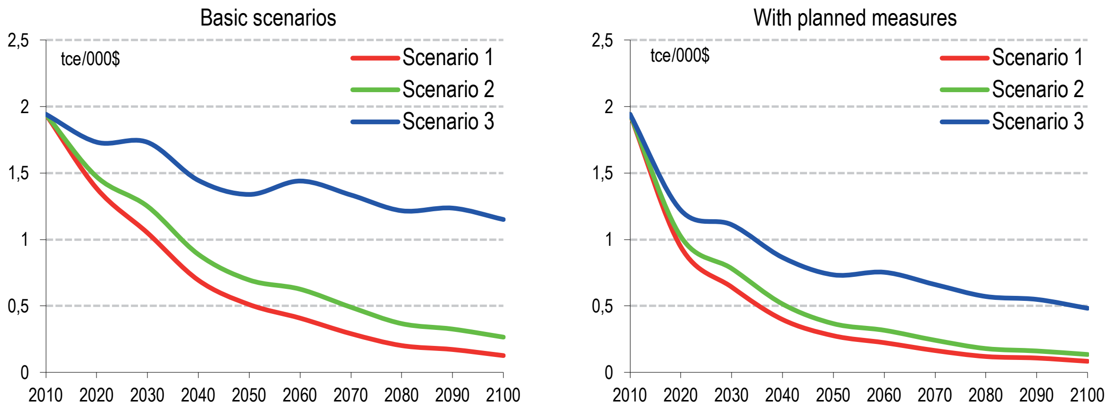


Fig. 4.51. Trends in power consumption by 1000 to $2005 for baseline scenarios and scenarios with measures

Fig. 4.52 shows the trends in aggregate GHG emissions from fossil fuel combustion in the GDP in USD. In 2010, for the OECD countries the average was 0.33 kg CO_2-eq./$. The lowest rate was 0.11 kg CO_2-eq./$, and the global average was 0.60 kg CO_2-eq./$ (source: International Energy Agency). The planned measures implementation by 2100 lets to reach 0.062, 0.163 and 0.683 kg CO_2-eq./$, for Scenarios 1, 2 and 3 respectively. For the baseline Scenarios 1, 2 and 3, these figures are significantly higher than 0.117, 0.362 and 1.406 kg CO_2-eq./$, respectively. Initially low values are explained by the significant share of HPP use for power generation in the KR.

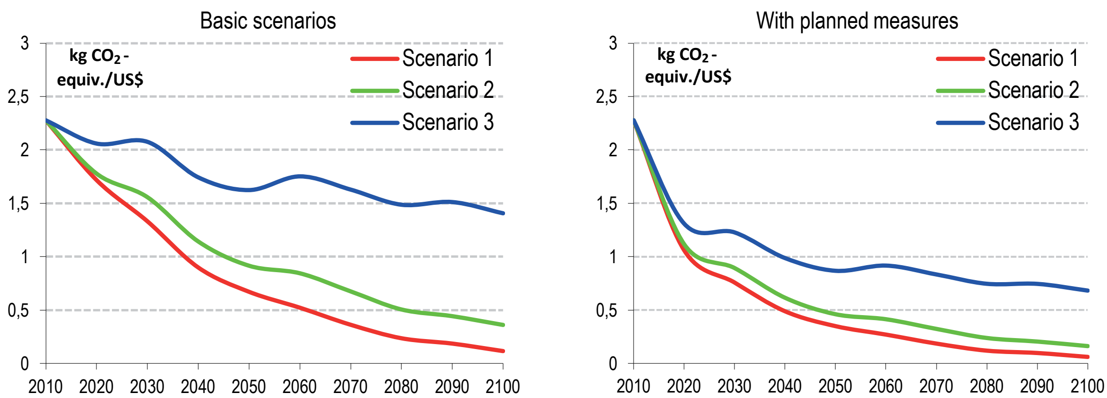


Fig. 4.52. Trends in power consumption per capita for the baseline scenarios and scenarios with measures

4.5.2.3. Overall assessment of the scenarios with measures

The list of planned measures and a total assessment of GHG emission reductions under the different scenarios are summarized in Table 4.18.

The national economic situation does not provide a possibility for the planned mitigation measures implementation by its own resources. According to preliminary estimates, from the internal resources the country can reduce the GHG emissions by 46.5-48.2% out of total reduction, depending on the demographic and economic development scenarios.

The GHG emissions growth by the end of the century under Scenario 1 demonstrates a need for the regular review and updating of the low-carbon strategy, depending on the new data availability.

The required costs identification caused some complications and will be done after specifying of the actions in this direction. Approximate costs for the separate measures can be assessed based on the data given in the IPCC Special Report (see Fig. 4.53).

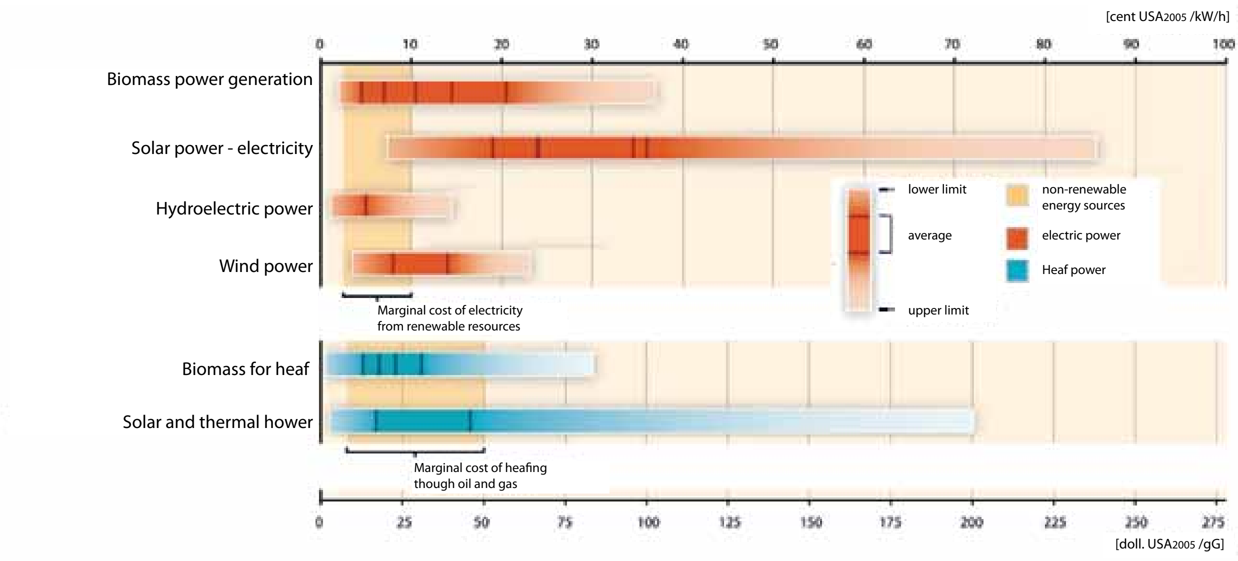


Fig. 4.53. Costs estimates for the renewable energy sources use. Source: IPCCC

Table 4.18. Reduction of GHG emissions by planned measures under different scenarios, Gg CO_2-eq.

#	Planned measure	Scenario 1			Scenario 2			Scenario 3		
		2020	2050	2100	2020	2050	2100	2020	2050	2100
1	Reduction of thermal power losses	82,0	251,2	340,0	80,5	216,8	275,9	81,0	230,0	348,1
2	Execution of SCNR on energy efficiency of buildings	90,9	554,3	1145,7	74,2	281,7	525,1	76,0	331,9	854,4
3	Increasing energy efficiency of existing buildings	123,2	408,8	226,9	123,6	469,9	426,8	123,2	454,3	319,5
4	Reduction of electric power losses	114,0	199,6	751,6	109,9	157,3	260,0	104,0	136,2	171,6
5	Reduction of gas leakage	860,1	1195,0	4228,9	860,1	1435,0	3692,2	791,5	812,7	812,7
6	Transport	1651,8	3338,4	4178,8	1395,8	1881,8	2224,9	1329,2	1654,6	1843,9
7	Biomass	352,7	1302,9	2148,1	347,0	1224,9	1885,8	357,7	1135,9	1614,0
8	Solar power - electricity	13,0	50,8	114,0	13,0	50,8	114,0	13,0	50,8	114,0
9	Solar power - heat	78,0	284,5	643,9	78,4	281,5	707,1	79,1	323,5	1053,0
10	Geothermal power	136,2	526,5	930,5	137,2	523,1	1060,9	138,8	611,7	1697,5
11	Hydropower	49,0	49,0	98,0	49,0	49,0	98,0	49,0	49,0	49,0
	Total	3550,9	8161,0	14806,4	3268,7	6571,8	11270,7	3142,5	5790,6	8926,7

5 Other information relevant to achievement of the Convention goals

5.1. Integration of climate change issues into sustainable development programs

The Kyrgyz Republic signed and ratified 13 international environmental conventions. The country is a member of the UN Sustainable Development Commission and its regional institutions. The country's activity under the UNFCCC is considered an integral part of the implementation of the main UN strategies, in particular, the Millennium Development Goals (MDG). It is linked to the goals and objectives of this strategy through making a contribution to the eradication of poverty, ensuring environmental sustainability and promoting global partnership for development.

The activity under the UNFCCC focused on reducing greenhouse gases, the introduction of energy saving technologies, fuel and energy saving, the use of environmentally clean energy sources is implemented as part of the national, regional and sectoral strategies and socio-economic development programs.

Since the preparation and submission of the Second National Communication, considerable positive developments have taken place in the state policy development and implementation arrangement in climate change areas. A number of strategic decisions were adopted at presidential, governmental and ministerial and agency level of the country:

- **Forestry Sector Development Concept** (The KR Government Resolution #256, 14.04.2004), which is based on institutional and legal reforms, the development of forest science and education, as well as increasing public awareness.
- **National Forestry Program for 2005-2015** (The KR Government Resolution #858, 25.11.2004), aimed at ensuring sustainable forest development through engaging the population and local communities in joint forestry management and defining the government's role in the forestry sector within the new context.
- **Concept of the Municipal Programme on Energy Efficiency in Buildings in Bishkek.** (Resolution #1063 of the Bishkek Mayor's Office, 23.11.2005).
- **Concept of the Environmental Safety of the Kyrgyz Republic** (Decree #506 of the President of the Kyrgyz Republic, 23.11.2007) defines the main areas of state environment and nature management policy in a sustainable development context for the short-term (until 2020).
- **National Energy Program of the Kyrgyz Republic for 2008-2010 and Fuel and Energy Complex Development Strategy until 2025** (Resolution #346-IV of the Jogorku Kenesh (KR parliament) of the Kyrgyz Republic, 24.04.2008). Among the most important principles of ensuring energy safety is the integration of requirements for environmental safety, environment protection and the use of alternative energy sources;
- **Sustainable Development Concept of the Issyk-Kul Ecological and Economic system for the period until 2020** (Decree #98 of the President of the Kyrgyz Republic, 10.02.2009). As the largest mountain lake in Asia, Issyk-Kul due to its volume (1738 km3) and surface area (6236 km2), is a powerful climate-forming factor for the whole lake basin, creating a relatively stable and mild climatic situation favorable for agriculture and the development of tourism. The priority task for the near future is to ensure the energy safety of the Issyk-Kul oblast.
- **Mid-term Development Strategy of the Kyrgyz Republic for 2012-2017** (The KR Government Resolution #330, 28.05.2012) is aimed at pursuing the energy saving policy.
- **Comprehensive Safety Strategy of Populations and Territories of the Kyrgyz Republic in Emergency and Crisis Situations until 2020** (The KR Government Resolution #357, 2.06.2012).
- **Concept of the Kyrgyz Republic's National Security** (Decree #120 of the President of the Kyrgyz Republic, 12.06.2012,). The Concept addresses the main areas for the prevention and neutralization of external and internal threats, which will be implemented further as a set of practical measures of internal and external policy, namely in the environment and nature management areas.
- **Auto Transport Development Strategy of the Kyrgyz Republic for 2012-2015** (The KR Government Resolution #677, 4.10.2012).
- **National Strategy on the Sustainable Development of the Kyrgyz Republic for 2013-2017** (Decree #11 of the President of the Kyrgyz Republic, 21.01.2013). In this document the President of the Kyrgyz Republic outlined the policy directions of a new sustainable development model, the main priorities and took the initiative to launch 78 major investment projects for this period. The issues of environment protection for ensuring sustainable development are included in Chapter 5 of this Strategy.

- **Programme for the Transition of the Kyrgyz Republic to Sustainable Development for 2013-2017** (The KR Government Resolution #218, 30.04.2013) adopted in the implementation of the National Strategy for the next 5 years. The Programme provides for the integration of environmental sustainability and climate change aspects in sectoral and regional development programs taking the country's international obligations into account.
- In accordance with the Copenhagen Agreements in 2013, the **Kyrgyz Republic has undertaken voluntary commitments to reduce greenhouse gas emissions by 20% by 2020**, contingent on international support.
- The Mayors of Osh and Talas cities signed **the agreement on joining the international initiative of the world's city mayors for the reduction of greenhouse gases by 20% by 2020**.
- **Programme on Adaptation to Climate Change of Healthcare Sector of the Kyrgyz Republic for 2011-2015** (Decree #531 of the Minister of Health of the Kyrgyz Republic, 31.10.2011,).
- **The Priority Directions for Adaptation to Climate Change in the Kyrgyz Republic until 2017** (The KR Government Resolution #549, 02.10.2013) covers the most vulnerable to climate change sectors.
- **Programme and Action Plan for Adaptation to Climate Change of the Forestry and Biodiversity Sector for 2015-2017** (Order # 01-9/110 of the Director, 17.04.2015).
- **Programme and Action Plan on Adaptation to Climate Change of the Emergency Situations Sector for 2015-2017** (Minister Order #692, 07.07.2015).
- **Programme on Adaptation to Climate Change of the Agricultural and Water Resources Sector for 2016-2020** (Minister Order of 31.07.2015, #228).
- **The Kyrgyz Republic Government Programme on Energy Saving and Planning Energy Saving Policy in the Kyrgyz Republic for 2015-2017** (The KR Government Resolution #601, 25.08.2015).
- **The intended nationally determined contribution to the 2015 Agreement submitted to the UNFCCC on 29th September 2015** (approved by the CCCC Protocol Decision #19-87, 22.09.2015). The contribution was prepared in the context of national priorities, circumstances and opportunities. This document identifies the country's activity on adaptation and the reduction of GHG emissions, as well as on funding of these activities.

Funding is considered in two aspects – determining the required funding both by the Kyrgyz Republic's internal resources and by external resources.

It is notable that the work has been started on an integration of climate change issues into the methodology of strategic country development planning, initiated by the State Agency on Environment Protection and Forestry jointly with the Ministry of Economy of the Kyrgyz Republic in 2015.

The aforementioned strategic decisions cover almost all activity areas in climate change. However, the adopted decisions do not always develop positive dynamics and sustainability. In particular, there is no clearly defined scheme for the organizational, financial and legal and regulatory support of this activity, nor a vertically integrated evaluation system of the results of undertaken efforts. The by-laws identifying the implementation mechanisms of climate actions are not fully developed. The financial and other resources are insufficiently allocated, especially at the ministerial and agency level.

5.2. Gender equality

The Kyrgyz government, civil society and international institutions have undertaken the implementation of a whole range of tasks - from reducing extreme poverty to environmental sustainability and universal education, reducing child mortality and promoting gender equality.

Climate change most severely affects the poorest group of the population, and about 70 percent of the world's poor are women. Therefore, the involvement of women on an equal basis with men in all decision-making processes against climate change is an important factor in achieving the long-term goals of the UN FCCC.

The importance of gender mainstreaming in the process of analysis and decision making in sustainable development, green growth and climate change areas is related to the fact that men and women respond differently to changes in the environment and could be affected by the consequences of climate change in different ways.

In response to a variety of effects, they prefer different solutions. The differences are based on the fact that men and women in most societies have different gender roles and responsibilities, as well as unequal access to resources and decision-making. This can be seen from the gender-disaggregated statistics.

Women are mainly responsible for the production of food, household water supply and energy for heating and cooking. With the rise of climate change, these problems become more complex. However, women have their own strategies for the use of knowledge and overcoming the difficulties which help them make practical use of innovation and skills to adapt to changing realities and to make their own contribution to solving the problems.

However, these strategies for climate variability are still a largely under-utilized resource. In addition, women often face difficulties when it comes to public access to financial resources, capacity-building activities and technology transfer.

This is often an obstacle to the empowerment of women in general and their role in climate change adaptation and mitigation in particular. Very often, women are underrepresented in decision-making on climate change at all levels. This severely limits their ability to contribute to the implementation of the decisions and apply their knowledge.

However, existing statistics and studies do not fully reveal the gender dimension in all areas. It is necessary to take into account the role of women in the development of policies not only as policy objects, but also as important agents of development and implementation. At institutional level for achieving gender equality, including gender analysis and gender specific development, measures were carried out in the framework of the movement towards sustainable development. The analysis revealed the following problems and constraints:

- The indicators of the effectiveness of government policies are gender and environmentally insufficient and, ultimately, lead to asymmetry in the concentration of wealth and greater inequality, including gender inequality;
- There is a gap in living conditions between urban and rural areas, and persistent trends in the dilapidation of infrastructure in the regions. The increase in social inequality as a result of these problems will lead to the inequitable distribution of the risks associated with climate change, and increase the burden on the most vulnerable populations, including women.
- Women are often a key part of communities, families and the local economy. As a result, it is women who primarily feel the devastating effects of environmental changes, and to a large extent on the ability of communities to adapt to them;
- Women play a crucial role in biodiversity conservation and the management of water, land and other natural resources at local level. While environmental degradation has severe consequences for everyone, it primarily affects the most vulnerable, who are mostly women and children;
- At local government level, the exclusion of women from decision-making on access to natural resources, such as water, land, etc. is observed;
- Institutional arrangements for the transfer of knowledge and security in local communities (medical obstetric stations, hospitals, schools, etc.) are financed by a leftover principle and not ready for the challenges of climate change;
- The lack of gender analysis of the consequences of climate change and other aspects of environmental crisis leads to the absence of a clear picture of the risk distribution for different social groups;
- Lack of constructive mechanisms for equitable access to natural and social resources in the context of the challenges of climate change will lead to a sharp increase in social conflicts. According to the research in the national communications, the peak of reducing water availability in the region is predicted for the period from 2050 to 2100. Thus, we already need to see women as important participants in the resource allocation system and reduce conflicts to mitigate the dramatic effects of climate change.

Therefore, on the path to sustainable development and «green growth», the long-term development programs should be developed on the basis of inter-agency cooperation, taking a minimization of environmental risks, the natural ecosystems conservation and the gender component into account.

5.3. Development and transfer of environmentally sound technologies

The concept of the environmental safety of the Kyrgyz Republic defines the need for special attention to the introduction of alternative, environmentally sound technologies (ESTs) promoting non-hydrocarbon dependence.

The main participants in the process of technology transfer include vendors and the developers of technology, including research and design institutes, private innovators, non-governmental organizations and the users of technology, such as state enterprises and individual consumers, private companies, local communities and other organizations.

At national level, action is being taken to ensure the transfer and implementation of ESTs. As a result, the Ministry of Agriculture and Land Reclamation established the centre for the implementation of modern progressive resource-saving technologies in agriculture (drip irrigation, greenhouses, etc.).

Among the priorities of the Energy Saving Program of the Kyrgyz Republic till 2015 on the establishment of an economic and institutional environment to improve science, technology and innovation in the field of energy efficiency provides the following:

- Establishing in the country of centers of technology transfer and intellectual property management in the field of energy efficiency;
- Developing parks and innovation & technology centers on the basis of the country's leading technical universities, allowing the realization of the most efficient development of innovative and investment activities in the region by attracting investors;
- Establishing an assessment system and an innovation support database, the organization of competitions, the establishment of special awards and grants, scientific-technical and innovation exhibitions and conferences in the field of energy efficiency;
- Promoting cooperation between domestic scientists and inventors with foreign partners;
- To develop projects on a continuous and multi-level education system in the field of energy efficiency.

However, due to the economic problems, the public financing is inadequate. Over the past decade, the potential of research and design institutes in the republic has fallen significantly and remains, with few exceptions, on the old framework and the opportunities provided by donor projects.

As a result, skills and expertise in the field of ESTs is mostly complemented trainings and courses in the framework of international programs and projects. Additionally, the adaptation and testing of small and non-capital intensive technologies are mainly led by non-governmental organizations, particularly in the areas of agriculture, energy, forestry and emergencies.

At the same time, there are a number of examples demonstrating the implementation of approaches using environmentally sound technologies. For example, the experience of growing organic cotton in the south of the country initiated by the Helvetas project with the support of Switzerland, shows that organic farming on the basis of ESTs has great potential for development.

In 2008, the WHO Regional Office for Europe with the BMU support launched a protecting health from climate change project. Raising public awareness, strengthening the expert capacity and the renewable energy sources use were among the objectives of the project.

One of the best solutions in the energy sector is a support of micro-crediting for the introduction of energy saving technologies at a local level in rural areas. The technologies themselves are developed, adapted and distributed locally by a number of NGOs, including the active ones such as: CAMP Ala-Too, PF UNISON, Environmental Movement Biom and others.

The technologies are concerned with alternative energy issues, including solar panels, biogas plants, methods for the thermal insulation of buildings, and the construction of energy-saving stoves. For the distribution of such technologies, local craftsmen united in associations are trained and performance monitoring is carried out.

A collaborative forestry management approach which is being implemented in Kyrgyzstan and Switzerland, combines various technologies, is now under the new terms of the GIZ program.

The Regional Conservation of Biodiversity and Poverty Reduction Through the Community-Based Management of Walnut Forests and Pastures Program helps the community to engage in forest management, expansion of forest areas with new adapted varieties and the introduction of innovative methods giving greater importance to biodiversity and the improvement of resource management efficiency. Actively working in this sector now is the Association of Forest and Land Users in Kyrgyzstan.

In 2015 the Climate Investment Fund approved the application of the Kyrgyz Republic to participate in the PPCR. As a pilot country the KR started to prepare the national strategic programme on improvement of climate resilience. At the second phase the implementation of programme projects will be implemented.

Kyrgyzstan has active business entities that are members of the International Business Council. Companies, such as CIC (Kyrgyzstan), Grundfos (Denmark), Itron (France) and others, provide advice and supply modern equipment in the field of water supply and heating, as well as in the introduction of new technologies and renewable energy sources.

Active in the sector of energy-saving technologies is the European Bank for Reconstruction and Development through its sustainable energy funding program in Kyrgyzstan (KyrSEFF) in collaboration with four Kyrgyz financial institutions. The program additionally provided technical assistance and incentive grants to the amount of 6.8 million euros through the EU Investment Fund.

However, the country needs the widespread introduction of public-private initiatives for the implementation of the climate commitments through attracting investment from businesses in the industrialized countries on the basis of bilateral agreements. There is a need for the implementation of i energy efficiency programs with the participation of the leading companies in developed countries.

The three main elements making the technology transfer more effective are capacity building, creation of an enabling environment and technology transfer mechanisms. The transfer of many types of ESTs demands a wide range of technical, business, managerial and legal skills.

The availability of these skills on the ground can increase the flow of international investment contributing to the transfer of technology. The country needs to strengthen capacity building for the preparation and dissemination of technology. The wider spread of adapted and tested technologies require even more active partnership by all parties - the advisory sector, businesses and governments.

5.4. Systematic observation and investigation

The Kyrgyz Republic has been a member of the World Meteorological Organization (WMO) since August 19, 1994. The working body of the Kyrgyz Republic in charge for cooperation with the WMO is the Agency for Hydro-meteorology (Kyrgyzhydromet) under the Ministry of Emergency Situations of the Kyrgyz Republic.

Kyrgyzhydromet undertakes activities in the field of hydrometeorology and observations of the polluting of the natural environment in order to protect the population from natural hydro-meteorological phenomena, and prevent or reduce the damage that can be caused by them; meet the needs of the population of the executive power of hydro-meteorological information and information on environmental pollution.

The systematic observations in the country are based on:

- Carrying out systematic meteorological observations and environmental monitoring;
- Warning of potential extreme weather events;
- Implementation of meteorological support to energy, agriculture and other economic sectors;
- Meet the needs of government agencies, industries and the public for information about the pollution and the causes of these changes.

The whole of the country's hydro-meteorological system and its main observation network, as well as the basic operating principles were developed before the mid-1970s.

The first meteorological station in Kyrgyzstan was opened in 1856 in the village of Ak-Suu on the shores of Lake Issyk-Kul. Observations were conducted of precipitation, air temperature and atmospheric phenomena. The beginning of systematic instrumental climate observations can be considered as starting in1883, when the weather station was opened in Karakol.

Systematic hydrological observations started in the country in 1911 with the hydrological stations «Alamedin» and «Sokh» functioned during 1911-1915. From 1925, monitoring began to develop more intensively.

The guides published during the Soviet era provide the measurements of meteorological characteristics at 427 hydrological stations. In the 1960s the monitoring network consisted of 470 hydrological stations, and in the 70s there were 155 hydroposts in the basins of the Chui, Talas, and Tarim rivers and Lake Issyk-Kul, and 151in the Syr Darya River basin (within Kyrgyzstan), i.e. 306 hydrological posts. In 1985, 149 hydrological stations worked at the same time. The dynamics of further changes in the number of hydrological stations is shown in Fig. 5.1.

The peak of the monitoring system in the Kyrgyz Republic took place in the 1970sand the beginning of the 1980s. As part of Kyrgyzhydromet,77 meteorological and 7 snow avalanche stations, 3 upper-air stations and 149 hydrological and agrometeorological posts were in operation. Due to the lack of funding by the early 21st century, the meteorological observation network decreased by 42%. While the avalanche network decreased by 57%. The upper-air stations located in Bishkek closed down due to the lack of radiosonde.

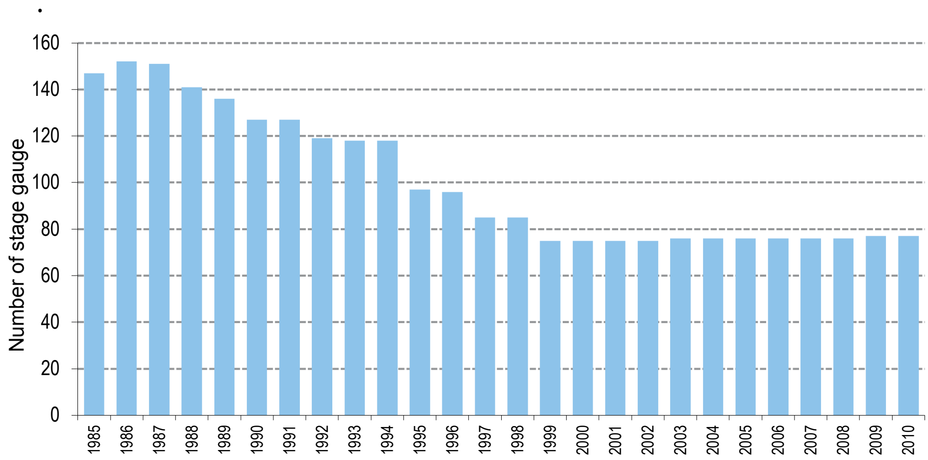


Fig. 5.1. The dynamics of the hydrological network observations decrease

Currently the observation network of Kyrgyzhydromet includes:

- 33 meteorological stations, 4 of which are automated, 3 snow avalanche stations and the lake observatory at Cholpon-Ata from which scientific-research vessels (15 of which are baseline; that is designed for obtaining the homogeneous continuous observation data needed for the establishment of long-term climate change trends);
- 77 hydrological stations, 5 Lakes and 22 hydro-chemical stations on rivers, lakes and reservoirs;
- 31 agro-meteorological observation posts;
- 20 weather stations monitoring the radiation situation;
- 14 monitoring stations for air pollution.

The Kyrgyz Republic is part of the Global Climate Observing System Program established by WMO, UNESCO, UNEP and others. The main objective of the program is to organize a long-term climate observation system, based on existing atmospheric, oceanic and terrestrial systems. The global network of climate observation consists of two meteorological stations.

Table 5.1. Weather stations of the Kyrgyz Republic included in the global network of climate observations

Index	Name	Latitude	Longitude	High, m
36974	Naryn	41 26N	76 00E	2,041
38353	Bishkek	42 51N	74 32E	760

Information from 7 weather stations in the Kyrgyz Republic (Tokmok, Naryn, Tien Shan (Kumtor), Talas, Bishkek, Djalal-Abad, Kara-Suu) is transmitted to WMO and Roshydromet.

At the same time, for the production of various forecast products across the country, Kyrgyzhydromet has the right to use the information and the products of hydro-meteorological services of the neighboring Central Asian countries, CIS countries and other countries of the world, predictive models data of atmospheric circulation of the European Centre for Medium Forecasts, and the National Meteorological Center of the United States, and data from weather satellites.

International co-operation is needed for the monitoring of cross-border air pollution, allowing information from the global data centers of the trajectories of pollutant transport to be acquired in a short time.

The Kyrgyz Republic is a part of the global monitoring of atmospheric composition (Global Atmosphere Watch, GAW). This system includes the Issyk-Kul station (latitude 42 62N, longitude 76 98E, high 1640 m).

Insufficient coverage of the alpine zone by meteorological observations is the biggest gap. In the Naryn region, which is the most mountainous, there are no alpine weather stations, nor in the south of Talas and Batken oblasts. In the Issyk-Kul and Jalal-Abad regions there are two of them, one in the Osh region, and three in the Chui region (Fig. 5.2).

The lack of information about precipitation in mountainous areas significantly affects the quality of forecasts, water availability and water flow in the reservoir during the vegetation period at national and regional levels, as well as the quality of weather forecasts. The most vulnerable in this situation are the agriculture, water management, and energy sectors. Agrometeorological observations are barely conducted on the high mountain pastures. Snow avalanche monitoring is carried out in Kyrgyzstan by 3 snow avalanche stations (SAS), covering no more than 10% of the avalanche-risk sites:

1. SAS Too-Ashu conducts monitoring from the 120km through to the 138km stretch of the Bishkek-Osh road;

2. SAS Chon-Ashu conducts surveillance of the 45km to 90 km stretch of Karakol-Sarydzhaz;

3. SAS It-Agar carries out observations of the 198kmto 265 km stretch of the Bishkek-Osh highway.

Generally the hydrological network is mostly located in such a way as to cover the natural water flow in the zone of its formation – at the outlet of mountain valleys, on the border with the region of its distribution and water withdrawal for agriculture needs (mainly agricultural irrigation). After 1980, the hydrological network developed to study the channel balance of the Chui and Talas Rivers, to determine the inflow and the water balance of the Toktogul and Kirov reservoirs and the Issyk Kul Lake.

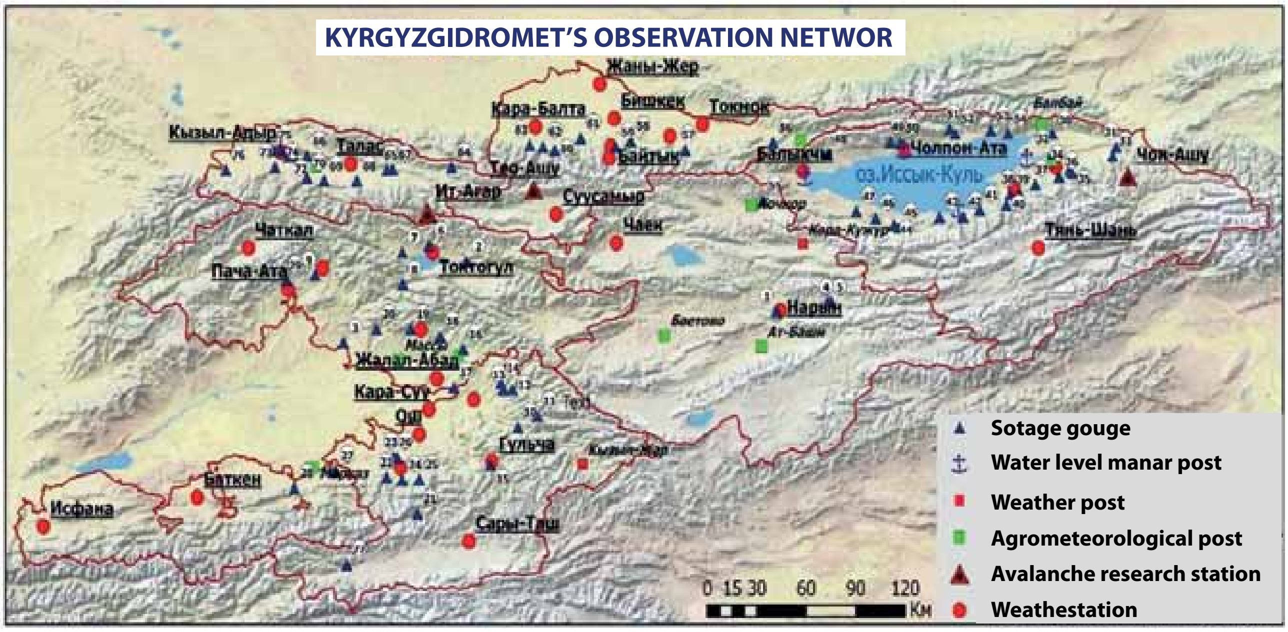


Fig. 5.2 Location of the main facilities of the observation network

The national studies in the field of climate change are conducted in the research institutions, but they should be significantly extended. One of the most valuable practical researches to be noted is an assessment of climate change impact on runoff, carried out by the Institute of Water Problems and Hydropower of the National Academy of Science.

The planned research work on climate change impact on human health involved the specialists of a Scientific-Production Association «Preventive Medicine» of the Ministry of Healthcare and the National Research Center of Cardiology and Therapy named after the acad. M. Mirrahimov, as well as specialists of the Kyrgyz State Medical Academy and other higher education institutions. The Institute of Mountain Medicine of the National Academy of Sciences conducts studies on the country's bioclimatic zoning.

5.5. Capacity building

The national communications process has become a catalyst for the country's efforts to build technical and institutional capacity, and implement research findings in the national and sectoral development plans and programs. The process helped deepen public understanding of climate change, strengthen the exchange of information and cooperation among all stakeholders, including the government, NGOs, academia, the public and the private sector.

Institutional Capacity

To strengthen the institutional capacity of the Kyrgyz Republic a Coordination Commission on Climate Change - CCCC was established by Resolution No783 of the Government of the Kyrgyz Republic on, November 21, 2012. The commission was established to provide leadership and coordination in the implementation of the commitments of the Kyrgyz Republic under the UNFCCC.

Basic functions of the CCCC:

- Guide the development, periodic update and submission of required reports to the executive bodies of the UNFCCC;
- Coordinate and assist ministries and departments in the organization of the development and implementation of national and regional programs to mitigate climate change, as well as the organization of publications and regular update reports on their implementation progress;
- Coordinate and assist ministries and departments in the organization of the development and implementation of national and regional programs on adapting to climate change, as well as the organization of publications and the regular update reports on the progress of their implementation;
- Promote the development and transfer of technologies, practices and processes to reduce or eliminate greenhouse gas emissions, adaptation to climate change and improve the country's capacity in this area;
- Coordinate the activities of ministries and departments to ensure the incorporation of climate change issues in pursuing national, social, economic and environmental policies;
- facilitate the organization of scientific, technological, technical, socio-economic and other research; systematic observation and development of data archives related to climate change;
- ensure coordination of the full, transparent and immediate exchange of scientific, technological, technical, socio-economic and legal information related to climate change;
- facilitate the organization of activities in education, staff training and public awareness of climate change and support a wide stakeholder involvement in the process, including NGOs;
- coordinate the preparation and implementation of projects on the adaptation and mitigation of climate change, including nationally appropriate plans to reduce greenhouse gas emissions; interaction with potential investors on strategic issues;
- coordinate and assist in the development of normative legal and methodical instructions and documentation in the field of climate change.

The CCCC structure:

- Chairman - First Vice Prime Minister of the Kyrgyz Republic;
- Deputy Chairman - head of the authorized environmental protection public body;
- The members are the heads of key ministries and departments, representatives of business, science, education and non-governmental organizations;
- The working body a regular basis is the State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic, whose tasks include the organizational, technical, informational and analytical support of the Commission and monitoring the implementation of the commission's decisions;
- Executive Secretary is the head of the Climate Change Center.

The Commission decisions, in accordance with its competence, are obligatory for performance by all bodies of executive power, as well as enterprises, institutions and organizations operating in their jurisdiction. By its first decision the Commission bound the key ministries and departments to assign staff responsible for implementation of the adaptation and mitigation related activities.

Since its establishment, the CCCC coordinates just about all activities in the country relating climate change. The experience showed a marked increase in the efficiency and coordination of national activities at all levels. Under the leadership of the Commission "The Priority Directions for Adaptation to Climate Change in the Kyrgyz Republic till 2017" were developed and adopted, as well as sectoral adaptation strategies and action plans in all key ministries and agencies.

Legal Aspects

To improve national legislation on climate change issues, amendments were introduced to the laws of the Kyrgyz Republic on transport, environmental protection, air protection, public health, and the forest and water codes of the Kyrgyz Republic.

Staff capacity

An increase of the national staff capacity previously used to be carried out mainly due to the involvement of the specialists in the projects. Workshops and expert meetings on relevant topics to some extent also contribute to an achievement of this goal. The main drawback of the existing approaches to capacity building is their irregularity and thematic coverage of needs.

According to the decision of the Coordination Commission on Climate Change in February 2013, the ministries and departments formed working groups of decision makers on the issues related to adaptation and mitigation of climate change. Currently, the capacity of these professionals is increasing on a regular basis. The members of these working groups were the key developers of the sectoral programs and action plans on adaptation to climate change.

5.6. Education, information and networks

Upon having ratified the UNFCCC, the Kyrgyz Republic moved to practical actions, including the implementation of Article 4 of the Convention, which calls on all Parties to actively participate in education, training and public awareness to help people understand the problem, and to participate fully in the decision-making of governments, general public and NGOs. Correspondingly, Article 6 of the Convention, which more widely covers these issues, calls upon all parties to promote this activity at the national, regional and sub-regional levels.

The education system of Kyrgyzstan covers about 1.5 million people, but indirect beneficiaries are the entire population of the country. Policy development, education management and state control over its availability and quality is conducted by the Ministry of Education and Science. In addition to the formal education sector, the country also has numerous institutions and organizations that provide supplementary education and carry out training and retraining to meet the needs of the labor market.

The country's education system has a developed infrastructure, trained teaching staff (80% with higher education), and a significant tradition of the education and upbringing of children. Educational issues are regulated by the Constitution, laws and policy documents such as the Education Development Strategy for 2012-2020 (EDS 2020), and the Action Plan for the implementation of the EDS 2020 to 2012-2014. To ensure the quality of education, in the mid-1990s the process of standardization in education was started at all levels. The implementation of state educational standards is mandatory for all educational institutions regardless of their forms of education.

In March 2005, Kyrgyzstan officially committed to implement the UNECE Strategy for Education for Sustainable Development (ESD) and the Global UN Decade of ESD. Priorities of education for sustainable development are reflected in official documents such as the National Framework Standard 1 (curriculum) of general school education, the Concept of Environmental Security, and the Concept of Education for Sustainable Development. The transition to the new standards is to ensure a gradual transition to the integration of sustainable development, energy efficiency and climate change in the education content.

National guides were developed to integrate sustainable development, «green economy» and climate change issues into the policies and programs of schools and universities. A public network and the ESD Association were created, which involve schools, universities and pre-school institutions, helping them to develop the ideas of sustainable development, biodiversity, environment and others.

In all schools, climate change issues are considered separately in the course of geography. The geography program was developed by the Kyrgyz Academy of Education in 2014, and climate change issues are taught in the following topics: the characteristics of global climate change on the continents, global patterns of the Earth's development, and the geographical view of the problems of environmental protection.

Topics about atmospheric precipitation, energy efficiency, greenhouse gas emissions, biodiversity and other relevant topics are covered in other natural science courses: physics, chemistry, and biology. More widely, this work is advanced within the framework of specialized ecological schools.

In medical schools a sufficient number of hours for the of climate change topics are allocated within the discipline the fundamentals of ecology, there is a separate lesson on the greenhouse effects and global warming & the protection of the natural ozone layer in the atmosphere.

Climate change is introduced in the curriculum of the general education discipline of ecology in the global environmental problems section for all specialties. The curricula of the construction universities (Kyrgyz State University of Construction, Technology and Architecture, the Kyrgyz-Russian Slavic University and the Bishkek Construction College) since 2013 have introduced a training course on energy efficiency in buildings for specialties such as: industrial and civil construction, urban construction and management, and heat and ventilation. A manual on Improving the Energy Efficiency of Buildings was published for this discipline.

The country has a number of sources regularly providing the official news and analytical information on climate change in the country. The SAEPF website (www.nature.gov.kg) has a climate change page, with official information available. In addition, on the official website of the National State of the Environment Report of the Kyrgyz Republic there is also a climate change section (www.nd.nature.gov.kg). The national report is based on environmental performance, and is designed for a wide range of people - representatives of government agencies and the general public - for objective and reliable information on the state of the environment, including the impact of climate change.

Regularly updated information is available on the website of Kyrgyzhydromet (www.meteo.kg), which presents current information on weather, water and air, radiation and environment. The website also has the regulations for the hydro-meteorological activities. In 2015, Kyrgyzhydromet released the first Annual Bulletin of the Current State of Climate Change in Kyrgyzstan in 2014. The bulletin presents the results of the climate monitoring in Kyrgyzstan for 2014. It provides data on the observed anomalies in 2014, air temperature and precipitation, synoptic conditions of the formation of weather conditions, and extreme weather events, as well as the current climate change in the Kyrgyz Republic. The report is an official publication by Kyrgyzhydromet.

There are a number of Internet resources by NGOs on this subject in Kyrgyzstan.

Extra information about climate change can be also found on the website of the Climate Change Centre in the Kyrgyz Republic (www.climatechange.kg). The centre was established in 2005 to support the public authority – the State Agency on Environment Protection and Forestry under the Government of the Kyrgyz Republic in charge for an implementation of the national commitments and actions under the UNFCCC. The centre provides the expert and information support in the preparation of regular reporting, the improvement of climate policy and legal capacity building and strengthening the synergy of joint action by all stakeholders. The website of Climate Center has a news line and a section called "Kyrgyzstan and Climate Change", which provides information on the activities of the Coordination Committee on Climate Change; updated information on the cross-sectoral partnership and international cooperation; a large section on the legislation of the Kyrgyz Republic in the field of climate change, as well as information on the geography and climate of the Kyrgyz Republic.

In addition, the First and Second National Communications on climate change of the Kyrgyz Republic, as well as publications section are available online, where the texts on the National Profile on Climate Change, the Priority Directions for Adaptation in the Kyrgyz Republic till 2017, and other relevant publications in this area can be downloaded.

Since 2009, the online newsletters of Climate Network of Kyrgyzstan - INFOIC (www.infoik.net.kg) are sent out regularly. The newsletters includes information on the most pressing issues in the climate policy of Kyrgyzstan, the Central Asian region, and international politics, as well as practical issues on adaptation and mitigation.

The eldest resource, the environmental information service EKOIS- Bishkek (www.ekois.net) provides a thematic section on climate change, which has news and analytical information. The email newsletter is available for subscription.

Information about climate change in Kyrgyzstan and in the region can be found on the website of the Ecological Movement BIOM (www.biom.kg) – a public nonprofit organization established in 1993. The organization brings together, on a voluntary basis, young specialists, scientists and leaders involved in the environmental issues of the Kyrgyz Republic and Central Asia. The site publishes a selection of materials - news information, presentations, and video. The publications Climate Change, Energy Efficiency and Conservation, Gender, Environment and Climate Change, Climate Change and Health and information about the organization can be downloaded here.

A large selection of climate change related materials is available in the regional information network CARNet (www.caresd.net). In addition to the latest news, it presents analysis, publications and interviews. The site exists since 2004 and during this period became a big archive, illustrating all activities on climate change held in the Kyrgyz Republic and Central Asia.

It is worth noting that most of the information on the specifics of public outreach on climate change issues in the Kyrgyz Republic is available from official sources (websites of government bodies) and of non-governmental environmental organizations. At the same time, the issue is not actively or systematically covered by the media. The topic is addressed only in cases of newsworthy information such as an event, a dispute of interest, emergency etc.

To improve the journalists' capacity, a module on climate change has been included in the training program of environmental journalism, organized by the UNDP in Kyrgyzstan (2011). Climate related nomination was presented in the competition on environmental journalism (2012). Regular topics of climate change, such as «The glaciers melting and climate change», «Climate Risk Management» and others, are brought to the agenda of meetings of the Club of Environmental Journalism.

With the support of OSCE, two Aarhus centers operate in Kyrgyzstan - in Bishkek city (launched in April 2015) and Osh city (2004). The scope of the centers' activity includes ensuring access to information and public participation in addressing environmental issues, including climate change adaptation.

As practice has shown, the problem of efficient information is solved jointly and there are already examples of such cooperation: today, in Kyrgyzstan, there are networks bringing together participants whose activities are related to climate change.

The first forum of environmental NGOs was held in November 1997, which was attended by representatives of 78 organizations. The forum was aimed to attract new initiative groups at local community level to nature conservation activities. The Second Forum of Environmental NGOs of the Kyrgyz Republic took place in the run-up to the global conference in Rio de Janeiro in June 2012. The forum was attended by more than 90 NGOs from all regions of Kyrgyzstan. The main objective of the Second Forum of Environmental NGOs was the development of civil society position for Rio + 20. The forum was an initiative on a wide range of issues, among which were particularly highlighted the access to clean water, sustainable land practices, implementation of environmentally sound technologies, climate change mitigation, and adaptation of local communities and economic sectors to climate change.

Since 2003, the international educational program SPARE has been operating in Kyrgyzstan, focusing on secondary school teachers and students. The project is aimed at attracting young people to the practical implementation of sustainable energy. The SPARE Network is a school project for the conservation of resources and energy - the world's largest international educational project on climate change, energy and the environment for students. SPARE involves more than 6,000 schools and 300,000 students from 17 countries in Europe, the Caucasus and Central Asia. The project involves all the regions of Kyrgyzstan, and today there are more than 200 schools actively involved in the project.

In 2009 the Climate Network of the Kyrgyz Republic launched in the country - a voluntary, self-governing, non-profit network of social organizations, created to protect the environment and combat climate change. The objectives of the network are: to support and promote the development of national policies on climate change and joint initiatives and improvement recommendations; representation of public interest in climate change sphere; support of communication between experts and exchange of experiences on climate change. It is also planned to prepare analytical materials on climate change.

On an initiative of the CCCC working body, the SAEPF, the Climate Dialogue Platform of Kyrgyzstan was created in 2014 (CDP-kg) (www. nature.gov.kg; www.climatechange.kg). What makes this platform unique is that the underlying mechanisms allow for regular multidisciplinary and comprehensive exchange of information, knowledge and experience at a national level. CDP-KR operates on the basis of a cross-sectoral and cross-level approach and brings together a group of participants who are interested in reducing the risk of climate change and mitigating its effects. The dialogue participants are the government and its institutions, on the one hand, while the public is represented by a wide range of civil society organizations, representatives of scientific and educational communities, the private sector, on the other hand. The third parties are the development partners active in the Kyrgyz Republic, represented by the international organizations and projects.

Since 2014, the regional countries have formed the Climate Coalition of Civil Society Organizations in Central Asia. This is an informal, voluntary association of non-governmental organizations and civil society activists, created for the free exchange of information, dialogue and debate on issues of environmental and climate policy and adaptation to climate change, energy conservation and energy efficiency, and the development of alternative energy sources. At present, the network consists of more than 10 organizations from all Central Asian countries, including Kyrgyzstan.

6 Constraints, gaps and related needs

The national communications process and other climate change related activities identified a number of constraints and gaps, which weaken the efficiency of the results.

Table 6.1. Climate change related barriers and gaps and related needs

No	Constraints and gaps	Comment	Measures
1	***GHG Inventory***		
1.1	Lack of institutional mechanisms for the inventory execution on a regular basis.	Currently, GHG inventory is carried out only under the national communication processes. There is a need for a more regularity accounting the requirements for periodicity. Moreover, the climatic indicators should be included into various development programs and plans.	Preparation of the normative acts to the Law "On State Regulation and Policy on Greenhouse Gas Emission and Removal", defining its implementation mechanism. Calculation of GHG emissions by the basic approach with a support of statistical bodies and the results inclusion into the official statistical reporting.
1.2	Inconsistency of official statistical records with the inventory requirements.	The inconsistency complicates the inventory process and introduces additional uncertainty in the outcomes.	Work on improving the Fuel and Energy Balance has already started but requires time for finalization.
1.3	Part of the required data is not collected by statistical bodies and is solely owned by the organizations.	The inventory requires specific data.	Cooperation between the different sectors should be strengthened.
1.4	Part of the data is missing or has a large uncertainty.	It refers, first of all, to a morphological composition of wastes, biomass growth rates, humus content in the soil.	Additional studies should be carried out, and in some cases at a regular basis.
2	***Vulnerability and adaptation***		
2.1	Insufficient level of regional cooperation on adaptation to climate change.	Many problems of vulnerability and adaptation of natural resources, such as water resources or biodiversity have a trans boundary character. Solution of such problems should also take into account the trans boundary aspects.	Regional cooperation should be strengthened.
	Water resources		
2.2	Huge losses under a distribution and use of the water resources.	Tariff system does not ensure sufficiently the water resources saving.	Justified change of tariff system is needed.
2.3	Lack of incentives for introducing water saving technologies.	Introduction of water saving technologies in many cases are not economically justified in the short-term perspective.	Further improvement of legal framework is needed.
	Agriculture		
2.4	Modern models such as "climate-yield" are not used"	Models like "climate-yield" are widely used in many countries to assess the yield of major crops in changing climate conditions.	To acquire the models and maintain training for the specialists is necessary.
2.5	Insufficiency of studies assessing the climate change impacts on agricultural crops and pasture productivity.	Studies on climate impacts in the national conditions.	Studies should be conducted regularly.
2.6	Climate change issues are insufficiently integrated into the strategic documents on ensuring the food security.	Climate change significantly impacts agriculture and food security.	Updating process of the strategic documents should include an obligatory additional analysis of the impact level of the climatic changes and relevant measures.
2.7	National insurance system of agricultural activity is lacking.	A lack of an insurance system increases the climatic risks for the agricultural manufacturers.	Feasibility of introducing agricultural insurance system should be analyzed.

No	Constraints and gaps	Comment	Measures
	Forest and biodiversity		
2.8	No studies conducted on a shift of optimal habitat for the focal ecological systems under climate change.	Assessments of optimal habitat shifts for the main ecological systems provide the basic information for the forest and biodiversity conservation activities.	Assessments need to be conducted on a shift of optimal habitat of the main ecological systems.
2.9	Insufficient use of environment-friendly pest control methods for forest ecosystems.	Currently used the pest control methods are mainly chemical ones, causing considerable damage to the ecological systems.	Biological methods need to be used to control pest of the forest ecosystems.
2.10	Conservation activities of soil fertility are not sufficiently implemented.	Humus content in agricultural soils is sustainably decreasing, leading to lower yields.	Modern soil cultivation technologies should be introduced.
2.11	Lack of evidence-based recom-mendations on conservation and expanding of specially protected nature areas in the context of climate change.	Climate change has large impacts on specially protected areas, both on the current and planned ones. The activities on conservation and their expansion should consider the climatic aspects.	It is necessary to introduce the climate impact concerns into SPN management practice.
2.12	Assessment methods of the climate impacts related economic damage for forest and biodiversity are underdeveloped.	Adaptation measures should be preceded by the economic cost assessments.	More studies need to be conducted to develop the assessment methods of the damage economic cost.
	Public health		
2.13	Climate change impacts on public health and their economic costs are insufficiently studied.	Insufficient studies of climate impacts on public health.	It is necessary: a. To study the impacts of climate change and extreme temperature waves on public health (by example of vulnerable categories). b. Develop assessment methodologies of climate impacts on public health and the economic consequences.
2.14	Application of modern technologies in diagnostics, treatment and prophylaxes are insufficiently studied and assessed.	Insufficient studies.	Organization of studies (incl. nanotechnologies).
3	***Mitigation***		
3.1	Insufficient capacity in emissions forecasting.	Long-term forecast, including macroeconomic, demographic and other projections, is required as a basic data, while in practice the government normally practices the short-term forecasts.	The capacity of the government bodies engaged in the long-term forecasting should be strengthened.
3.2	Lack of a national strategy on GHG emissions reduction.	A lack of the strategy complicates monitoring of the emissions reduction process and reduces the opportunities to mobilize the external support for mitigation actions.	National strategy should be developed based on the nationally determined contributions of the Kyrgyz Republic.
3.3	Insufficient legal framework for stimulating the clean technologies introduction.	Introduction of clean technologies in many cases is not cost effective in a short-term period. On the other hand, it is clear that activities on introduction should be preventive. The country has adopted a number of stimulating measures but they are not sufficient.	Legal framework should be further improved.

No	Constraints and gaps	Comment	Measures
3.4	Insufficient capacity on using of forecasting models linking the emissions with baseline data (alike Marcal program) or on development of the national models.	Emissions forecasting for a long-term period requires utilization of models, correct and clear for users.	Training sessions for groups of specialists to support a regular forecasting process.

In general, the main problems in all thematic areas are lack of the financial resources and availability and reliability of the information. The main reasons for the information lacking are the insufficient monitoring, incomplete conversion of the departmental archives to digital media and the limited access to information.

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7 Annexes

Annex 1. GHG inventory in metric Gg

1990

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**21368,610**	**798,096**	**255,1676**	**8,0774**	**0,00000**	**78,6670**	**386,6109**	**79,4813**	**92,6496**
1 Energy	**19825,363**		**55,7395**	**0,2002**		**77,9213**	**377,3260**	**69,0797**	**90,6239**
1A Fuel combustion	19825,363		10,6148	0,2002		77,9213	377,3260	69,0797	90,6239
1A1 Energy Industries	8136,733		0,1770	0,0672		22,8441	2,0520	0,5543	32,0225
1A2 Manufacturing Industries and Construction	1712,750		0,1320	0,0116		4,7583	1,2157	7,9377	5,5801
1A3 Transport	3154,945		0,6445	0,0265		29,0595	244,6727	46,0737	1,4797
1A3a Civil Aviation	46,805		0,0003	0,0013		0,1986	0,0662	0,0331	0,0148
1A3b Road Transportation	2918,790		0,6314	0,0237		25,7672	242,0500	45,5159	1,4521
1A3c Railways	182,931		0,0123	0,0015		2,9638	2,4698	0,5073	0,0123
1A3d Navigation	6,419		0,0004	0,0001		0,1300	0,0867	0,0173	0,0004
1A4 Other Sectors	6820,935		9,6613	0,0949		21,2594	129,3856	14,5140	51,5417
1A4a Commercial/ Institutional	2626,079		0,3524	0,0358		2,8503	46,2750	4,6675	22,4002
1A4b Residential	3042,753		8,6179	0,0486		3,3123	66,5168	6,9488	25,6523
1A4c Agriculture	1152,103		0,6911	0,0104		15,0969	16,5938	2,8978	3,4892
1B Fugitive Emissions from Fuels			45,1246						
1B1 Solid Fuel			12,8052						
1B2 Oil and Natural Gas			32,3194						
1B2a Oil			1,2357						
1B2b Natural Gas			31,0837						
2 Industrial Processes	**706,207**		**0,0000**	**0,0000**	**0,00000**	**0,4556**	**2,0053**	**7,6976**	**2,0256**
2A Mineral Products	694,329					0,0000	0,0000	5,1916	0,4162
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0200	0,0000
2C Metal Production	4,832		0,0000	0,0000		0,4556	0,3852	0,0000	1,6094
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	2,4860	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,00000				
2G Shot-firing	7,046						1,6201		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**2,7040**	
4 Agriculture			**146,0705**	**7,5807**		**0,2833**	**6,9341**		
4A Enteric Fermentation			139,2560						
4B Manure Management			6,0523	0,0000					
4C Rice Cultivation			0,4980						
4D Agricultural Soils			0,0000	7,5729					
4F Field Burning of Agricultural Residues			0,2642	0,0078		0,2833	6,9341		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**837,040**	**798,096**	**0,0691**	**0,0004**		**0,0070**	**0,3455**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	798,096	0,0691	0,0004		0,0070	0,3455		
5B Forest and Grassland Conversion	837,040	0,000							
6 Wastes			**53,2886**	**0,2960**					
6A Solid Waste Disposal on Land			43,8874						
6B Wastewater Handling			9,4012	0,2960					
6B1 Industrial Wastewater			6,5311	0,0000					
6B2 Domestic and Commercial Wastewater			2,8701	0,2960					
7 Other	**548,641**		**0,0025**	**0,0101**		**1,5099**	**0,5033**	**0,2517**	**0,0050**
7A International aviation	359,863		0,0025	0,0101		1,5099	0,5033	0,2517	0,0050
7B CO_2 emission from biomass	188,779								

1991

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**18434,492**	**803,823**	**254,1445**	**8,4225**	**0,0000**	**67,7619**	**329,0620**	**70,9343**	**84,7100**
1 Energy	**16930,476**		**50,2162**	**0,1705**		**66,8840**	**320,6220**	**58,9277**	**82,8050**
1A Fuel combustion	16930,476		8,8353	0,1705		66,8840	320,6220	58,9277	82,8050
1A1 Energy Industries	7068,163		0,1508	0,0594		19,9098	1,7793	0,4792	34,8606
1A2 Manufacturing Industries and Construction	1449,300		0,1119	0,0097		4,0234	1,0248	6,6935	4,6725
1A3 Transport	2706,403		0,5552	0,0228		24,9362	210,8986	39,7125	1,2696
1A3a Civil Aviation	41,881		0,0003	0,0012		0,1777	0,0592	0,0296	0,0133
1A3b Road Transportation	2504,200		0,5442	0,0204		22,1455	208,6807	39,2399	1,2456
1A3c Railways	154,304		0,0104	0,0013		2,5000	2,0833	0,4279	0,0104
1A3d Navigation	6,019		0,0004	0,0000		0,1131	0,0754	0,0151	0,0004
1A4 Other Sectors	5706,610		8,0174	0,0785		18,0146	106,9192	12,0426	42,0023
1A4a Commercial/ Institutional	2126,305		0,2878	0,0288		2,3081	37,1886	3,7523	18,0190
1A4b Residential	2594,580		7,1250	0,0407		2,8221	55,4734	5,8080	20,9800
1A4c Agriculture	985,724		0,6046	0,0090		12,8844	14,2572	2,4823	3,0033
1B Fugitive Emissions from Fuels			41,3808						
1B1 Solid Fuel			12,3045						
1B2 Oil and Natural Gas			29,0763						
1B2a Oil			1,1895						
1B2b Natural Gas			27,8868						
2 Industrial Processes	**668,516**		**0,0000**	**0,0000**	**0,00000**	**0,5931**	**1,3280**	**9,9566**	**1,9049**
2A Mineral Products	659,698					0,0000	0,0000	5,1916	0,3961
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0180	0,0000
2C Metal Production	4,485		0,0000	0,0000		0,5931	0,3320	0,0000	1,5088
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	4,7470	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,00000				
2G Shot-firing	4,333						0,9960		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**2,0500**	
4 Agriculture			**143,7240**	**7,9832**		**0,2784**	**6,7919**		
4A Enteric Fermentation			136,7260						
4B Manure Management			6,0379	0,0000					
4C Rice Cultivation			0,7012						
4D Agricultural Soils			0,0000	7,9755					
4F Field Burning of Agricultural Residues			0,2587	0,0077		0,2784	6,7919		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**835,500**	**803,823**	**0,0640**	**0,0004**		**0,0065**	**0,3201**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	803,823	0,0640	0,0004		0,0065	0,3201		
5B Forest and Grassland Conversion	835,500	0,000							
6 Wastes			**60,1403**	**0,2685**					
6A Solid Waste Disposal on Land			51,6406						
6B Wastewater Handling			8,4997	0,2685					
6B1 Industrial Wastewater			5,6210	0,0000					
6B2 Domestic and Commercial Wastewater			2,8787	0,2685					
7 Other	**263,680**		**0,0008**	**0,0031**		**0,4611**	**0,1537**	**0,0768**	**0,0015**
7A International aviation	109,893		0,0008	0,0031		0,4611	0,1537	0,0768	0,0015
7B CO_2 emission from biomass	153,788								

1992

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**15412,569**	**798,788**	**232,2034**	**8,4579**	**0,0000**	**56,4866**	**273,6252**	**59,4516**	**69,2121**
1 Energy	**14035,340**		**42,3671**	**0,1412**		**55,8521**	**264,4089**	**48,8347**	**67,6215**
1A Fuel combustion	14035,340		7,0853	0,1412		55,8521	264,4089	48,8347	67,6215
1A1 Energy Industries	5999,364		0,1246	0,0516		16,9704	1,5067	0,4041	30,3341
1A2 Manufacturing Industries and Construction	1185,840		0,0919	0,0078		3,2885	0,8339	5,4492	3,7649
1A3 Transport	2257,852		0,4659	0,0192		20,8130	177,1246	33,3513	1,0596
1A3a Civil Aviation	36,956		0,0003	0,0010		0,1568	0,0523	0,0261	0,0117
1A3b Road Transportation	2089,600		0,4569	0,0171		18,5238	175,3114	32,9638	1,0390
1A3c Railways	125,677		0,0085	0,0010		2,0362	1,6968	0,3485	0,0085
1A3d Navigation	5,619		0,0003	0,0000		0,0962	0,0641	0,0128	0,0003
1A4 Other Sectors	4592,284		6,4028	0,0626		14,7803	84,9438	9,6300	32,4629
1A4a Commercial/Institutional	1626,532		0,2232	0,0219		1,7659	28,1023	2,8370	13,6377
1A4b Residential	2146,408		5,6615	0,0332		2,3425	44,9209	4,7261	16,3077
1A4c Agriculture	819,345		0,5181	0,0075		10,6719	11,9206	2,0669	2,5175
1B Fugitive Emissions from Fuels			35,2818						
1B1 Solid Fuel			8,2687						
1B2 Oil and Natural Gas			27,0131						
1B2a Oil			1,0823						
1B2b Natural Gas			25,9308						
2 Industrial Processes	**565,949**		**0,0000**	**0,0000**	**0,00000**	**0,3115**	**0,8941**	**9,9359**	**1,5906**
2A Mineral Products	558,935					0,0000	0,0000	5,1916	0,3287
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0093	0,0000
2C Metal Production	3,421		0,0000	0,0000		0,3115	0,0681	0,0000	1,2619
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	4,7350	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,00000				
2G Shot-firing	3,592						0,8260		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**0,6810**	
4 Agriculture			**135,3520**	**8,0475**		**0,3158**	**7,9675**		
4A Enteric Fermentation			128,5540						
4B Manure Management			5,7434	0,0000					
4C Rice Cultivation			0,7508						
4D Agricultural Soils			0,0000	8,0388					
4F Field Burning of Agricultural Residues			0,3035	0,0087		0,3158	7,9675		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**811,280**	**798,788**	**0,0709**	**0,0004**		**0,0072**	**0,3546**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	798,788	0,0709	0,0004		0,0072	0,3546		
5B Forest and Grassland Conversion	811,280	0,000							
6 Wastes			**54,4133**	**0,2687**					
6A Solid Waste Disposal on Land			47,4280						
6B Wastewater Handling			6,9853	0,2687					
6B1 Industrial Wastewater			4,0994	0,0000					
6B2 Domestic and Commercial Wastewater			2,8859	0,2687					
7 Other	**308,375**		**0,0012**	**0,0049**		**0,7388**	**0,2463**	**0,1231**	**0,0025**
7A International aviation	176,085		0,0012	0,0049		0,7388	0,2463	0,1231	0,0025
7B CO_2 emission from biomass	132,290								

1993

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**12493,529**	**797,073**	**202,1240**	**5,4868**	**0,0000**	**45,1896**	**217,6477**	**43,9551**	**55,1513**
1 Energy	**11093,043**		**36,3722**	**0,1114**		**44,6477**	**208,7726**	**38,8092**	**52,6102**
1A Fuel combustion	11093,043		5,3700	0,1114		44,6477	208,7726	38,8092	52,6102
1A1 Energy Industries	4883,382		0,0979	0,0429		13,8469	1,2219	0,3259	25,9799
1A2 Manufacturing Industries and Construction	922,392		0,0718	0,0059		2,5537	0,6429	4,2050	2,8573
1A3 Transport	1809,310		0,3766	0,0155		16,6897	143,3505	26,9902	0,8495
1A3a Civil Aviation	32,032		0,0002	0,0009		0,1359	0,0453	0,0226	0,0102
1A3b Road Transportation	1675,010		0,3696	0,0137		14,9021	141,9420	26,6878	0,8325
1A3c Railways	97,050		0,0066	0,0008		1,5724	1,3103	0,2691	0,0066
1A3d Navigation	5,219		0,0003	0,0000		0,0793	0,0529	0,0106	0,0003
1A4 Other Sectors	3477,958		4,8237	0,0472		11,5574	63,5573	7,2882	22,9235
1A4a Commercial/Institutional	1126,758		0,1586	0,0149		1,2237	19,0159	1,9218	9,2564
1A4b Residential	1698,235		4,2334	0,0262		1,8743	34,9574	3,7149	11,6354
1A4c Agriculture	652,965		0,4317	0,0060		8,4594	9,5840	1,6515	2,0316
1B Fugitive Emissions from Fuels			31,0022						
1B1 Solid Fuel			6,4282						
1B2 Oil and Natural Gas			24,5740						
1B2a Oil			0,6040						
1B2b Natural Gas			23,9700						
2 Industrial Processes	**626,216**		**0,0000**	**0,0000**	**0,00000**	**0,2332**	**0,5640**	**4,8808**	**2,5412**
2A Mineral Products	611,159					0,0000	0,0000	0,5147	0,3633
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0071	0,0000
2C Metal Production	13,086		0,0000	0,0000		0,2332	0,1110	0,0000	2,1779
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	4,3590	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,00000				
2G Shot-firing	1,971						0,4530		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**0,2650**	
4 Agriculture			**124,7710**	**5,1081**		**0,3007**	**7,9160**		
4A Enteric Fermentation			118,0310						
4B Manure Management			5,4586	0,0000					
4C Rice Cultivation			0,9800						
4D Agricultural Soils			0,0000	5,0998					
4F Field Burning of Agricultural Residues			0,3016	0,0083		0,3007	7,9160		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**774,270**	**797,073**	**0,0790**	**0,0005**		**0,0080**	**0,3951**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	797,073	0,0790	0,0005		0,0080	0,3951		
5B Forest and Grassland Conversion	774,270	0,000							
6 Wastes			**40,9018**	**0,2668**					
6A Solid Waste Disposal on Land			35,9301						
6B Wastewater Handling			4,9717	0,2668					
6B1 Industrial Wastewater			2,1212	0,0000					
6B2 Domestic and Commercial Wastewater			2,8505	0,2668					
7 Other	**165,516**		**0,0003**	**0,0012**		**0,1786**	**0,0595**	**0,0298**	**0,0006**
7A International aviation	42,565		0,0003	0,0012		0,1786	0,0595	0,0298	0,0006
7B CO_2 emission from biomass	122,951								

1994

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**9401,836**	**845,476**	**158,5543**	**4,2856**	**0,0000**	**34,2732**	**159,6275**	**32,1975**	**39,1859**
1 Energy	**8254,185**		**29,1331**	**0,0840**		**33,8578**	**153,7295**	**28,8585**	**37,2213**
1A Fuel combustion	8254,185		3,6900	0,0840		33,8578	153,7295	28,8585	37,2213
1A1 Energy Industries	3870,813		0,0724	0,0361		11,1268	0,9639	0,2544	21,2481
1A2 Manufacturing Industries and Construction	658,941		0,0518	0,0040		1,8188	0,4520	2,9608	1,9497
1A3 Transport	1360,769		0,2873	0,0118		12,5664	109,5764	20,6290	0,6394
1A3a Civil Aviation	27,107		0,0002	0,0008		0,1150	0,0383	0,0192	0,0086
1A3b Road Transportation	1260,420		0,2823	0,0104		11,2805	108,5727	20,4118	0,6260
1A3c Railways	68,422		0,0046	0,0006		1,1086	0,9238	0,1897	0,0046
1A3d Navigation	4,820		0,0002	0,0000		0,0624	0,0416	0,0083	0,0002
1A4 Other Sectors	2363,662		3,2785	0,0321		8,3458	42,7372	5,0143	13,3841
1A4a Commercial/Institutional	627,014		0,0940	0,0080		0,6815	9,9295	1,0066	4,8751
1A4b Residential	1250,062		2,8392	0,0196		1,4175	25,5603	2,7717	6,9631
1A4c Agriculture	486,586		0,3452	0,0046		6,2469	7,2474	1,2360	1,5458
1B Fugitive Emissions from Fuels			25,4431						
1B1 Solid Fuel			2,6951						
1B2 Oil and Natural Gas			22,7480						
1B2a Oil			0,9980						
1B2b Natural Gas			21,7500						
2 Industrial Processes	**414,641**		**0,0000**	**0,0000**	**0,00000**	**0,2149**	**0,5090**	**3,2420**	**1,9646**
2A Mineral Products	403,301					0,0000	0,0000	1,1433	0,2449
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0017	0,0000
2C Metal Production	9,306		0,0000	0,0000		0,2149	0,0410	0,0000	1,7197
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	2,0970	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,00000				
2G Shot-firing	2,034						0,4680		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**0,0970**	
4 Agriculture			**103,6930**	**3,9637**		**0,1965**	**5,1945**		
4A Enteric Fermentation			97,4525						
4B Manure Management			4,8293	0,0000					
4C Rice Cultivation			1,2136						
4D Agricultural Soils			0,0000	3,9583					
4F Field Burning of Agricultural Residues			0,1979	0,0054		0,1965	5,1945		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**733,010**	**845,476**	**0,0389**	**0,0002**		**0,0039**	**0,1945**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	845,476	0,0389	0,0002		0,0039	0,1945		
5B Forest and Grassland Conversion	733,010	0,000							
6 Wastes			**25,6893**	**0,2376**					
6A Solid Waste Disposal on Land			22,0180						
6B Wastewater Handling			3,6713	0,2376					
6B1 Industrial Wastewater			0,8712	0,0000					
6B2 Domestic and Commercial Wastewater			2,8001	0,2376					
7 Other	**143,107**		**0,0002**	**0,0009**		**0,1380**	**0,0460**	**0,0230**	**0,0005**
7A International aviation	32,894		0,0002	0,0009		0,1380	0,0460	0,0230	0,0005
7B CO_2 emission from biomass	110,213								

1995

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**6250,083**	**841,700**	**148,3138**	**3,7742**	**0,0028**	**22,7472**	**105,6377**	**20,7536**	**24,1307**
1 Energy	**5239,945**		**24,5395**	**0,0544**		**22,4052**	**99,9094**	**19,0486**	**22,4982**
1A Fuel combustion	5239,945		2,0840	0,0544		22,4052	99,9094	19,0486	22,4982
1A1 Energy Industries	2682,900		0,0448	0,0261		7,7185	0,6601	0,1716	17,1820
1A2 Manufacturing Industries and Construction	395,489		0,0317	0,0021		1,0839	0,2610	1,7166	1,0422
1A3 Transport	912,220		0,1980	0,0081		8,4431	75,8024	14,2678	0,4294
1A3a Civil Aviation	22,182		0,0002	0,0006		0,0941	0,0314	0,0157	0,0070
1A3b Road Transportation	845,822		0,1950	0,0071		7,6588	75,2034	14,1357	0,4195
1A3c Railways	39,795		0,0027	0,0003		0,6448	0,5373	0,1104	0,0027
1A3d Navigation	4,420		0,0002	0,0000		0,0455	0,0303	0,0061	0,0002
1A4 Other Sectors	1249,337		1,8094	0,0182		5,1596	23,1858	2,8926	3,8447
1A4a Commercial/Institutional	127,241		0,0295	0,0010		0,1393	0,8432	0,0914	0,4939
1A4b Residential	801,890		1,5212	0,0140		0,9860	17,4319	1,9807	2,2909
1A4c Agriculture	320,207		0,2587	0,0031		4,0343	4,9108	0,8206	1,0599
1B Fugitive Emissions from Fuels			22,4555						
1B1 Solid Fuel			1,5575						
1B2 Oil and Natural Gas			20,8980						
1B2a Oil			0,8300						
1B2b Natural Gas			20,0680						
2 Industrial Processes	**316,818**		**0,0000**	**0,0000**	**0,00280**	**0,1560**	**0,5000**	**1,6480**	**1,6325**
2A Mineral Products	306,400					0,0000	0,0000	0,2026	0,1836
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0014	0,0000
2C Metal Production	8,319		0,0000	0,0000		0,1560	0,0170	0,0000	1,4489
2D Other Production (food and drinks)	0,000		0,0000			0,0000	0,0000	1,4440	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,00280				
2G Shot-firing	2,099						0,4830		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**0,0570**	
4 Agriculture			**96,5784**	**3,4617**		**0,1782**	**4,8451**		
4A Enteric Fermentation			89,9706						
4B Manure Management			4,6340	0,0000					
4C Rice Cultivation			1,7892						
4D Agricultural Soils			0,0000	3,4568					
4F Field Burning of Agricultural Residues			0,1846	0,0049		0,1782	4,8451		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**693,320**	**841,700**	**0,0767**	**0,0004**		**0,0077**	**0,3833**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	841,700	0,0767	0,0004		0,0077	0,3833		
5B Forest and Grassland Conversion	693,320	0,000							
6 Wastes			**27,1193**	**0,2576**					
6A Solid Waste Disposal on Land			23,7321						
6B Wastewater Handling			3,3872	0,2576					
6B1 Industrial Wastewater			0,6018	0,0000					
6B2 Domestic and Commercial Wastewater			2,7853	0,2576					
7 Other	**317,539**		**0,0012**	**0,0048**		**0,7169**	**0,2390**	**0,1195**	**0,0024**
7A International aviation	170,868		0,0012	0,0048		0,7169	0,2390	0,1195	0,0024
7B CO_2 emission from biomass	146,671								

1996

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**6397,237**	**828,167**	**137,5045**	**3,7557**	**0,0031**	**23,8364**	**122,1120**	**25,2100**	**22,1685**
1 Energy	**5417,723**		**19,5344**	**0,0543**		**23,4367**	**114,1601**	**21,8549**	**20,0106**
1A Fuel combustion	5417,723		2,0749	0,0543		23,4367	114,1601	21,8549	20,0106
1A1 Energy Industries	2783,301		0,0476	0,0251		8,0307	0,7223	0,1870	14,4579
1A2 Manufacturing Industries and Construction	432,234		0,0328	0,0025		1,1835	0,2737	1,7999	1,2701
1A3 Transport	1078,152		0,2385	0,0095		9,9929	91,4267	17,2028	0,5178
1A3a Civil Aviation	18,479		0,0001	0,0005		0,0784	0,0261	0,0131	0,0059
1A3b Road Transportation	1022,000		0,2359	0,0086		9,3172	90,9066	17,0884	0,5094
1A3c Railways	35,463		0,0024	0,0003		0,5746	0,4788	0,0983	0,0024
1A3d Navigation	2,210		0,0001	0,0000		0,0227	0,0152	0,0030	0,0001
1A4 Other Sectors	1124,036		1,7560	0,0172		4,2296	21,7374	2,6652	3,7648
1A4a Commercial/Institutional	113,801		0,0277	0,0009		0,1219	0,8338	0,0899	0,3935
1A4b Residential	687,601		1,4349	0,0132		0,8703	16,4788	1,8738	2,1100
1A4c Agriculture	322,634		0,2933	0,0031		3,2374	4,4248	0,7015	1,2613
1B Fugitive Emissions from Fuels			17,4595						
1B1 Solid Fuel			1,0765						
1B2 Oil and Natural Gas			16,3830						
1B2a Oil			0,8310						
1B2b Natural Gas			15,5520						
2 Industrial Processes	**321,164**		**0,0000**	**0,0000**	**0,00315**	**0,1333**	**0,4260**	**3,2691**	**2,1579**
2A Mineral Products	307,234					0,0000	0,0000	1,0126	0,3120
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0015	0,0000
2C Metal Production	12,158		0,0000	0,0000		0,1333	0,0190	0,0000	1,8459
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	2,2550	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,00315				
2G Shot-firing	1,772						0,4070		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**0,0860**	
4 Agriculture			**92,2602**	**3,4493**		**0,2568**	**7,0467**		
4A Enteric Fermentation			85,3798						
4B Manure Management			4,4656	0,0000					
4C Rice Cultivation			2,1464						
4D Agricultural Soils			0,0000	3,4422					
4F Field Burning of Agricultural Residues			0,2685	0,0071		0,2568	7,0467		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**658,350**	**828,167**	**0,0958**	**0,0006**		**0,0097**	**0,4792**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	828,167	0,0958	0,0006		0,0097	0,4792		
5B Forest and Grassland Conversion	658,350	0,000							
6 Wastes			**25,6140**	**0,2516**					
6A Solid Waste Disposal on Land			22,0384						
6B Wastewater Handling			3,5757	0,2516					
6B1 Industrial Wastewater			0,7062	0,0000					
6B2 Domestic and Commercial Wastewater			2,8695	0,2516					
7 Other	**356,206**		**0,0014**	**0,0058**		**0,8644**	**0,2881**	**0,1441**	**0,0029**
7A International aviation	206,027		0,0014	0,0058		0,8644	0,2881	0,1441	0,0029
7B CO_2 emission from biomass	150,179								

1997

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**7172,305**	**764,051**	**137,2018**	**4,4151**	**0,0036**	**25,6863**	**137,6741**	**27,8412**	**24,7803**
1 Energy	**5901,914**		**14,9409**	**0,0573**		**25,2612**	**127,7788**	**24,5924**	**22,6492**
1A Fuel combustion	5901,914		2,0272	0,0573		25,2612	127,7788	24,5924	22,6492
1A1 Energy Industries	3190,093		0,0531	0,0278		9,1498	0,8384	0,2158	16,8601
1A2 Manufacturing Industries and Construction	468,980		0,0338	0,0029		1,2831	0,2863	1,8833	1,4981
1A3 Transport	1244,096		0,2791	0,0108		11,5426	107,0510	20,1378	0,6061
1A3a Civil Aviation	14,776		0,0001	0,0004		0,0627	0,0209	0,0104	0,0047
1A3b Road Transportation	1198,190		0,2769	0,0102		10,9755	106,6098	20,0410	0,5994
1A3c Railways	31,130		0,0021	0,0003		0,5044	0,4203	0,0863	0,0021
1A3d Navigation	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
1A4 Other Sectors	998,745		1,6612	0,0158		3,2858	19,6031	2,3555	3,6849
1A4a Commercial/Institutional	100,371		0,0260	0,0008		0,1045	0,8243	0,0884	0,2932
1A4b Residential	573,313		1,3073	0,0118		0,7408	14,8399	1,6846	1,9291
1A4c Agriculture	325,061		0,3280	0,0032		2,4404	3,9389	0,5824	1,4626
1B Fugitive Emissions from Fuels			12,9136						
1B1 Solid Fuel			0,9466						
1B2 Oil and Natural Gas			11,9670						
1B2a Oil			0,8930						
1B2b Natural Gas			11,0740						
2 Industrial Processes	**641,081**		**0,0000**	**0,0000**	**0,00363**	**0,0988**	**0,5480**	**3,2058**	**2,1310**
2A Mineral Products	626,528					0,0000	0,0000	1,7288	0,3719
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0010	0,0000
2C Metal Production	12,270		0,0000	0,0000		0,0988	0,0230	0,0000	1,7591
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	1,4760	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,00363				
2G Shot-firing	2,283						0,5250		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**0,0430**	
4 Agriculture			**95,2168**	**4,1231**		**0,3151**	**8,7919**		
4A Enteric Fermentation			87,8451						
4B Manure Management			4,5987	0,0000					
4C Rice Cultivation			2,4380						
4D Agricultural Soils			0,0000	4,1144					
4F Field Burning of Agricultural Residues			0,3349	0,0087		0,3151	8,7919		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**629,310**	**764,051**	**0,1111**	**0,0006**		**0,0112**	**0,5554**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	764,051	0,1111	0,0006		0,0112	0,5554		
5B Forest and Grassland Conversion	629,310	0,000							
6 Wastes			**26,9331**	**0,2340**					
6A Solid Waste Disposal on Land			24,2142						
6B Wastewater Handling			2,7189	0,2340					
6B1 Industrial Wastewater			0,4931	0,0000					
6B2 Domestic and Commercial Wastewater			2,2258	0,2340					
7 Other	**252,180**		**0,0008**	**0,0032**		**0,4759**	**0,1586**	**0,0793**	**0,0016**
7A International aviation	113,433		0,0008	0,0032		0,4759	0,1586	0,0793	0,0016
7B CO_2 emission from biomass	138,747								

1998

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**6125,879**	**793,783**	**131,7242**	**4,3843**	**0,0042**	**23,2075**	**131,3063**	**27,1538**	**21,3755**
1 Energy	**5144,456**		**11,8639**	**0,0535**		**22,8583**	**121,3212**	**22,8582**	**19,6275**
1A Fuel combustion	5144,456		2,4973	0,0535		22,8583	121,3212	22,8582	19,6275
1A1 Energy Industries	2373,275		0,0413	0,0208		6,8230	0,6208	0,1609	11,9574
1A2 Manufacturing Industries and Construction	468,151		0,0321	0,0029		1,2779	0,2654	1,7929	1,3885
1A3 Transport	1144,913		0,2489	0,0100		10,6643	94,9003	17,8605	0,6445
1A3a Civil Aviation	14,923		0,0001	0,0004		0,0633	0,0211	0,0106	0,0047
1A3b Road Transportation	1102,230		0,2469	0,0093		10,1512	94,5044	17,7730	0,6379
1A3c Railways	27,761		0,0019	0,0002		0,4498	0,3748	0,0770	0,0019
1A3d Navigation	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
1A4 Other Sectors	1158,117		2,1749	0,0198		4,0932	25,5347	3,0439	5,6371
1A4a Commercial/Institutional	123,751		0,0285	0,0013		0,1293	1,5445	0,1604	0,6688
1A4b Residential	654,969		1,6646	0,0146		0,8620	18,4756	2,0900	2,9438
1A4c Agriculture	379,397		0,4819	0,0040		3,1019	5,5147	0,7936	2,0246
1B Fugitive Emissions from Fuels			9,3666						
1B1 Solid Fuel			0,5946						
1B2 Oil and Natural Gas			8,7720						
1B2a Oil			0,8920						
1B2b Natural Gas			7,8800						
2 Industrial Processes	**375,094**		**0,0000**	**0,0000**	**0,00424**	**0,0300**	**0,9810**	**4,2766**	**1,7480**
2A Mineral Products	358,876					0,0000	0,0000	3,3046	0,2128
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0010	0,0000
2C Metal Production	11,996		0,0000	0,0000		0,0300	0,0100	0,0000	1,5352
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	0,9710	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,00424				
2G Shot-firing	4,222						0,9710		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**0,0190**	
4 Agriculture			**97,0809**	**4,0853**		**0,3100**	**8,5498**		
4A Enteric Fermentation			89,7835						
4B Manure Management			4,7837	0,0000					
4C Rice Cultivation			2,1880						
4D Agricultural Soils			0,0000	4,0767					
4F Field Burning of Agricultural Residues			0,3257	0,0086		0,3100	8,5498		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**606,330**	**793,783**	**0,0909**	**0,0005**		**0,0092**	**0,4543**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	793,783	0,0909	0,0005		0,0092	0,4543		
5B Forest and Grassland Conversion	606,330	0,000							
6 Wastes			**22,6886**	**0,2450**					
6A Solid Waste Disposal on Land			19,6295						
6B Wastewater Handling			3,0591	0,2450					
6B1 Industrial Wastewater			0,2164	0,0000					
6B2 Domestic and Commercial Wastewater			2,8427	0,2450					
7 Other	**312,986**		**0,0011**	**0,0044**		**0,6593**	**0,2198**	**0,1099**	**0,0022**
7A International aviation	157,133		0,0011	0,0044		0,6593	0,2198	0,1099	0,0022
7B CO_2 emission from biomass	155,852								

1999

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**5641,263**	**827,822**	**133,3288**	**4,4307**	**0,0050**	**22,1371**	**124,2375**	**24,9646**	**23,0796**
1 Energy	**4837,568**		**9,2791**	**0,0555**		**21,7936**	**114,4781**	**21,0899**	**21,4101**
1A Fuel combustion	4837,568		2,9440	0,0555		21,7936	114,4781	21,0899	21,4101
1A1 Energy Industries	2007,018		0,0347	0,0200		5,8437	0,4936	0,1289	11,8590
1A2 Manufacturing Industries and Construction	467,322		0,0305	0,0029		1,2727	0,2445	1,7024	1,2790
1A3 Transport	1045,740		0,2188	0,0091		9,7859	82,7496	15,5832	0,6828
1A3a Civil Aviation	15,069		0,0001	0,0004		0,0639	0,0213	0,0107	0,0048
1A3b Road Transportation	1006,280		0,2170	0,0085		9,3268	82,3989	15,5049	0,6764
1A3c Railways	24,391		0,0016	0,0002		0,3952	0,3293	0,0676	0,0016
1A3d Navigation	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
1A4 Other Sectors	1317,488		2,6601	0,0234		4,8913	30,9906	3,6753	7,5892
1A4a Commercial/Institutional	147,131		0,0309	0,0018		0,1540	2,2646	0,2323	1,0443
1A4b Residential	736,624		1,9934	0,0169		0,9739	21,6355	2,4382	3,9584
1A4c Agriculture	433,734		0,6358	0,0047		3,7634	7,0905	1,0048	2,5866
1B Fugitive Emissions from Fuels			6,3352						
1B1 Solid Fuel			0,5412						
1B2 Oil and Natural Gas			5,7940						
1B2a Oil			0,9080						
1B2b Natural Gas			4,8860						
2 Industrial Processes	**214,655**		**0,0000**	**0,0000**	**0,00498**	**0,0300**	**1,0990**	**3,8637**	**1,6695**
2A Mineral Products	197,775					0,0000	0,0000	2,0652	0,1159
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0005	0,0000
2C Metal Production	12,149		0,0000	0,0000		0,0300	0,0110	0,0000	1,5536
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	1,7980	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,00498				
2G Shot-firing	4,731						1,0880		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**0,0110**	
4 Agriculture			**99,3264**	**4,1229**		**0,3059**	**8,2849**		
4A Enteric Fermentation			91,6450						
4B Manure Management			4,9369	0,0000					
4C Rice Cultivation			2,4288						
4D Agricultural Soils			0,0000	4,1144					
4F Field Burning of Agricultural Residues			0,3156	0,0085		0,3059	8,2849		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**589,040**	**827,822**	**0,0751**	**0,0004**		**0,0076**	**0,3755**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	827,822	0,0751	0,0004		0,0076	0,3755		
5B Forest and Grassland Conversion	589,040	0,000							
6 Wastes			**24,6481**	**0,2519**					
6A Solid Waste Disposal on Land			21,7244						
6B Wastewater Handling			2,9237	0,2519					
6B1 Industrial Wastewater			0,0711	0,0000					
6B2 Domestic and Commercial Wastewater			2,8526	0,2519					
7 Other	**275,770**		**0,0008**	**0,0031**		**0,4656**	**0,1552**	**0,0776**	**0,0016**
7A International aviation	110,979		0,0008	0,0031		0,4656	0,1552	0,0776	0,0016
7B CO_2 emission from biomass	164,791								

2000

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**5534,042**	**808,808**	**140,8255**	**4,4113**	**0,0058**	**20,8201**	**117,7244**	**26,7958**	**22,5349**
1 Energy	**4710,341**		**15,6455**	**0,0545**		**20,4846**	**107,8486**	**19,8592**	**21,0319**
1A Fuel combustion	4710,341		2,8117	0,0545		20,4846	107,8486	19,8592	21,0319
1A1 Energy Industries	2144,894		0,0353	0,0205		6,2427	0,5459	0,1409	11,9813
1A2 Manufacturing Industries and Construction	460,976		0,0302	0,0029		1,2559	0,2406	1,6932	1,2154
1A3 Transport	949,520		0,2025	0,0083		8,8749	76,9046	14,4779	0,5659
1A3a Civil Aviation	12,737		0,0001	0,0004		0,0540	0,0180	0,0090	0,0040
1A3b Road Transportation	912,713		0,2008	0,0077		8,4302	76,5616	14,4022	0,5602
1A3c Railways	23,909		0,0016	0,0002		0,3874	0,3228	0,0663	0,0016
1A3d Navigation	0,160		0,0000	0,0000		0,0033	0,0022	0,0004	0,0000
1A4 Other Sectors	1154,951		2,5438	0,0229		4,1112	30,1576	3,5471	7,2693
1A4a Commercial/Institutional	148,455		0,0324	0,0019		0,1560	2,4526	0,2516	1,1883
1A4b Residential	703,237		2,1427	0,0178		0,9584	22,9408	2,5798	4,5047
1A4c Agriculture	303,259		0,3686	0,0032		2,9969	4,7643	0,7157	1,5763
1B Fugitive Emissions from Fuels			12,8338						
1B1 Solid Fuel			0,9888						
1B2 Oil and Natural Gas			11,8450						
1B2a Oil			0,9200						
1B2b Natural Gas			10,9250						
2 Industrial Processes	**246,801**		**0,0000**	**0,0000**	**0,00585**	**0,0343**	**1,4990**	**6,9326**	**1,5030**
2A Mineral Products	229,818					0,0000	0,0000	5,3256	0,1359
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
2C Metal Production	10,508		0,0000	0,0000		0,0343	0,0100	0,0000	1,3671
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	1,6070	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,00585				
2G Shot-firing	6,475						1,4890		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**0,0040**	
4 Agriculture			**100,7510**	**4,1129**		**0,2893**	**7,7906**		
4A Enteric Fermentation			92,8576						
4B Manure Management			5,0291	0,0000					
4C Rice Cultivation			2,5676						
4D Agricultural Soils			0,0000	4,1049					
4F Field Burning of Agricultural Residues			0,2968	0,0080		0,2893	7,7906		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**576,900**	**808,808**	**0,1172**	**0,0007**		**0,0118**	**0,5861**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	808,808	0,1172	0,0007		0,0118	0,5861		
5B Forest and Grassland Conversion	576,900	0,000							
6 Wastes			**24,3118**	**0,2432**					
6A Solid Waste Disposal on Land			20,8818						
6B Wastewater Handling			3,4300	0,2432					
6B1 Industrial Wastewater			0,3132	0,0000					
6B2 Domestic and Commercial Wastewater			3,1168	0,2432					
7 Other	**290,954**	**0,000**	**0,0008**	**0,0031**		**0,4656**	**0,1552**	**0,0776**	**0,0016**
7A International aviation	110,979		0,0008	0,0031		0,4656	0,1552	0,0776	0,0016
7B CO_2 emission from biomass	179,975								

2001

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**5298,153**	**813,996**	**147,7814**	**4,5524**	**0,0068**	**19,1453**	**112,7209**	**26,3379**	**22,7720**
1 Energy	**4471,014**		**21,7094**	**0,0520**		**18,7492**	**101,8918**	**18,7055**	**21,0985**
1A Fuel combustion	4471,014		2,7202	0,0520		18,7492	101,8918	18,7055	21,0985
1A1 Energy Industries	2170,808		0,0345	0,0190		6,2010	0,5689	0,1456	12,5484
1A2 Manufacturing Industries and Construction	454,630		0,0298	0,0028		1,2391	0,2366	1,6841	1,1519
1A3 Transport	853,302		0,1862	0,0074		7,9638	71,0596	13,3727	0,4490
1A3a Civil Aviation	10,405		0,0001	0,0003		0,0441	0,0147	0,0074	0,0033
1A3b Road Transportation	819,148		0,1845	0,0069		7,5336	70,7242	13,2995	0,4441
1A3c Railways	23,428		0,0016	0,0002		0,3796	0,3163	0,0650	0,0016
1A3d Navigation	0,321		0,0000	0,0000		0,0065	0,0043	0,0009	0,0000
1A4 Other Sectors	992,274		2,4696	0,0228		3,3453	30,0267	3,5031	6,9493
1A4a Commercial/Institutional	149,789		0,0339	0,0020		0,1579	2,6406	0,2708	1,3324
1A4b Residential	669,851		2,3343	0,0193		0,9571	24,9481	2,8056	5,0509
1A4c Agriculture	172,635		0,1015	0,0016		2,2303	2,4381	0,4267	0,5660
1B Fugitive Emissions from Fuels			18,9892						
1B1 Solid Fuel			1,0542						
1B2 Oil and Natural Gas			17,9350						
1B2a Oil			1,1180						
1B2b Natural Gas			16,8170						
2 Industrial Processes	**257,789**		**0,0000**	**0,0000**	**0,00684**	**0,0557**	**1,4660**	**7,6324**	**1,6735**
2A Mineral Products	240,071					0,0000	0,0000	6,3674	0,1410
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
2C Metal Production	11,424		0,0000	0,0000		0,0557	0,0190	0,0000	1,5325
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	1,2650	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,00684				
2G Shot-firing	6,294						1,4470		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**0,0000**	
4 Agriculture			**101,8430**	**4,2526**		**0,3300**	**8,8525**		
4A Enteric Fermentation			94,1466						
4B Manure Management			5,1098	0,0000					
4C Rice Cultivation			2,2496						
4D Agricultural Soils			0,0000	4,2435					
4F Field Burning of Agricultural Residues			0,3372	0,0091		0,3300	8,8525		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**569,350**	**813,996**	**0,1021**	**0,0006**		**0,0103**	**0,5106**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	813,996	0,1021	0,0006		0,0103	0,5106		
5B Forest and Grassland Conversion	569,350	0,000							
6 Wastes			**24,1268**	**0,2471**					
6A Solid Waste Disposal on Land			20,8320						
6B Wastewater Handling			3,2948	0,2471					
6B1 Industrial Wastewater			0,2831	0,0000					
6B2 Domestic and Commercial Wastewater			3,0118	0,2471					
7 Other	**303,330**		**0,0008**	**0,0031**		**0,4676**	**0,1559**	**0,0779**	**0,0016**
7A International aviation	111,454		0,0008	0,0031		0,4676	0,1559	0,0779	0,0016
7B CO_2 emission from biomass	191,876								

2002

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**5510,236**	**822,758**	**164,1507**	**4,6441**	**0,0080**	**20,1100**	**120,8954**	**23,2934**	**22,4456**
1 Energy	**4642,274**		**36,0047**	**0,0559**		**19,7443**	**110,0339**	**20,3780**	**20,9173**
1A Fuel combustion	4642,274		2,8273	0,0559		19,7443	110,0339	20,3780	20,9173
1A1 Energy Industries	2217,832		0,0336	0,0214		6,4907	0,5724	0,1459	12,3651
1A2 Manufacturing Industries and Construction	493,231		0,0352	0,0029		1,3477	0,2808	1,9129	1,2115
1A3 Transport	926,550		0,2045	0,0081		8,6174	78,1906	14,7122	0,4989
1A3a Civil Aviation	10,924		0,0001	0,0003		0,0463	0,0154	0,0077	0,0035
1A3b Road Transportation	892,291		0,2029	0,0076		8,1918	77,8601	14,6398	0,4938
1A3c Railways	23,044		0,0016	0,0002		0,3733	0,3111	0,0639	0,0016
1A3d Navigation	0,292		0,0000	0,0000		0,0059	0,0039	0,0008	0,0000
1A4 Other Sectors	1004,660		2,5540	0,0236		3,2885	30,9901	3,6071	6,8418
1A4a Commercial/Institutional	143,351		0,0291	0,0019		0,1501	2,5748	0,2628	1,3212
1A4b Residential	693,585		2,4166	0,0201		0,9992	26,0046	2,9280	4,9445
1A4c Agriculture	167,724		0,1083	0,0016		2,1392	2,4108	0,4162	0,5761
1B Fugitive Emissions from Fuels			33,1774						
1B1 Solid Fuel			1,1604						
1B2 Oil and Natural Gas			32,0170						
1B2a Oil			0,9190						
1B2b Natural Gas			31,0980						
2 Industrial Processes	**302,242**		**0,0000**	**0,0000**	**0,00797**	**0,0353**	**1,6900**	**2,0854**	**1,5283**
2A Mineral Products	284,460					0,0000	0,0000	0,1424	0,1625
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
2C Metal Production	10,508		0,0000	0,0000		0,0353	0,0170	0,0000	1,3658
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	1,9430	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,00797				
2G Shot-firing	7,274						1,6730		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**0,8300**	
4 Agriculture			**104,0270**	**4,3250**		**0,3193**	**8,6178**		
4A Enteric Fermentation			95,7711						
4B Manure Management			5,2132	0,0000					
4C Rice Cultivation			2,7144						
4D Agricultural Soils			0,0000	4,3162					
4F Field Burning of Agricultural Residues			0,3283	0,0088		0,3193	8,6178		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**565,720**	**822,758**	**0,1107**	**0,0006**		**0,0112**	**0,5537**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	822,758	0,1107	0,0006		0,0112	0,5537		
5B Forest and Grassland Conversion	565,720	0,000							
6 Wastes			**24,0083**	**0,2626**					
6A Solid Waste Disposal on Land			20,7927						
6B Wastewater Handling			3,2157	0,2626					
6B1 Industrial Wastewater			0,2082	0,0000					
6B2 Domestic and Commercial Wastewater			3,0075	0,2626					
7 Other	**593,477**		**0,0027**	**0,0109**		**1,6333**	**0,5444**	**0,2722**	**0,0054**
7A International aviation	389,269		0,0027	0,0109		1,6333	0,5444	0,2722	0,0054
7B CO_2 emission from biomass	204,208								

2003

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**5659,880**	**821,911**	**177,2349**	**4,6938**	**0,0092**	**20,5254**	**128,8619**	**26,0284**	**22,0265**
1 Energy	**4670,135**		**50,4154**	**0,0566**		**20,1799**	**117,4831**	**21,9632**	**20,8593**
1A Fuel combustion	4670,135		2,8939	0,0566		20,1799	117,4831	21,9632	20,8593
1A1 Energy Industries	2121,457		0,0317	0,0211		6,2341	0,5399	0,1376	12,3050
1A2 Manufacturing Industries and Construction	531,833		0,0405	0,0029		1,4564	0,3250	2,1417	1,2710
1A3 Transport	999,798		0,2228	0,0087		9,2710	85,3216	16,0517	0,5489
1A3a Civil Aviation	11,443		0,0001	0,0003		0,0485	0,0162	0,0081	0,0037
1A3b Road Transportation	965,434		0,2212	0,0082		8,8500	84,9959	15,9801	0,5436
1A3c Railways	22,659		0,0015	0,0002		0,3671	0,3059	0,0628	0,0015
1A3d Navigation	0,262		0,0000	0,0000		0,0053	0,0035	0,0007	0,0000
1A4 Other Sectors	1017,046		2,5989	0,0238		3,2185	31,2966	3,6322	6,7344
1A4a Commercial/Institutional	136,914		0,0243	0,0019		0,1423	2,5091	0,2548	1,3100
1A4b Residential	717,319		2,4594	0,0204		1,0281	26,4041	2,9716	4,8382
1A4c Agriculture	162,814		0,1152	0,0015		2,0480	2,3835	0,4058	0,5862
1B Fugitive Emissions from Fuels			47,5215						
1B1 Solid Fuel			0,9985						
1B2 Oil and Natural Gas			46,5230						
1B2a Oil			0,9180						
1B2b Natural Gas			45,6050						
2 Industrial Processes	**424,495**		**0,0000**	**0,0000**	**0,00923**	**0,0313**	**2,7626**	**3,0763**	**1,1672**
2A Mineral Products	405,456					0,0000	0,0000	0,8423	0,2272
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
2C Metal Production	7,100		0,0000	0,0000		0,0313	0,0176	0,0000	0,9400
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	2,2340	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,00923				
2G Shot-firing	11,939						2,7450		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**0,9890**	
4 Agriculture			**103,5510**	**4,3675**		**0,3021**	**8,0191**		
4A Enteric Fermentation			95,6302						
4B Manure Management			5,1235	0,0000					
4C Rice Cultivation			2,4916						
4D Agricultural Soils			0,0000	4,3591					
4F Field Burning of Agricultural Residues			0,3055	0,0084		0,3021	8,0191		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**565,250**	**821,911**	**0,1194**	**0,0007**		**0,0120**	**0,5971**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	821,911	0,1194	0,0007		0,0120	0,5971		
5B Forest and Grassland Conversion	565,250	0,000							
6 Wastes			**23,1491**	**0,2691**					
6A Solid Waste Disposal on Land			20,1616						
6B Wastewater Handling			2,9875	0,2691					
6B1 Industrial Wastewater			0,3874	0,0000					
6B2 Domestic and Commercial Wastewater			2,6001	0,2691					
7 Other	**716,547**		**0,0036**	**0,0144**		**2,1530**	**0,7177**	**0,3588**	**0,0072**
7A International aviation	513,139		0,0036	0,0144		2,1530	0,7177	0,3588	0,0072
7B CO_2 emission from biomass	203,408								

2004

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**5886,323**	**838,879**	**200,9573**	**4,6867**	**0,0105**	**21,3682**	**137,3926**	**27,6591**	**23,2666**
1 Energy	**4826,880**		**65,2868**	**0,0599**		**21,0314**	**126,1899**	**23,7032**	**21,8924**
1A Fuel combustion	4826,880		3,0366	0,0599		21,0314	126,1899	23,7032	21,8924
1A1 Energy Industries	2153,974		0,0319	0,0226		6,3687	0,5342	0,1364	13,3360
1A2 Manufacturing Industries and Construction	570,434		0,0458	0,0030		1,5650	0,3691	2,3705	1,3306
1A3 Transport	1073,050		0,2411	0,0093		9,9246	92,4525	17,3912	0,5988
1A3a Civil Aviation	11,962		0,0001	0,0003		0,0507	0,0169	0,0085	0,0039
1A3b Road Transportation	1038,580		0,2395	0,0088		9,5082	92,1317	17,3203	0,5934
1A3c Railways	22,275		0,0015	0,0002		0,3609	0,3007	0,0618	0,0015
1A3d Navigation	0,233		0,0000	0,0000		0,0047	0,0031	0,0006	0,0000
1A4 Other Sectors	1029,423		2,7177	0,0250		3,1731	32,8340	3,8050	6,6269
1A4a Commercial/Institutional	130,466		0,0196	0,0018		0,1346	2,4433	0,2467	1,2989
1A4b Residential	741,052		2,5762	0,0217		1,0816	28,0345	3,1629	4,7318
1A4c Agriculture	157,904		0,1220	0,0015		1,9569	2,3562	0,3954	0,5963
1B Fugitive Emissions from Fuels			62,2503						
1B1 Solid Fuel			1,1493						
1B2 Oil and Natural Gas			61,1010						
1B2a Oil			0,9160						
1B2b Natural Gas			60,1850						
2 Industrial Processes	**492,493**		**0,0000**	**0,0000**	**0,01051**	**0,0134**	**2,4820**	**2,6680**	**1,3742**
2A Mineral Products	472,755					0,0000	0,0000	0,3380	0,2609
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
2C Metal Production	9,046		0,0000	0,0000		0,0134	0,0240	0,0000	1,1133
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	2,3300	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,01051				
2G Shot-firing	10,692						2,4580		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**1,2880**	
4 Agriculture			**106,3650**	**4,3520**		**0,3136**	**8,2324**		
4A Enteric Fermentation			98,3188						
4B Manure Management			5,2634	0,0000					
4C Rice Cultivation			2,4688						
4D Agricultural Soils			0,0000	4,3433					
4F Field Burning of Agricultural Residues			0,3136	0,0087		0,3136	8,2324		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**566,950**	**838,879**	**0,0977**	**0,0006**		**0,0098**	**0,4884**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	838,879	0,0977	0,0006		0,0098	0,4884		
5B Forest and Grassland Conversion	566,950	0,000							
6 Wastes			**29,2078**	**0,2742**					
6A Solid Waste Disposal on Land			26,4065						
6B Wastewater Handling			2,8013	0,2742					
6B1 Industrial Wastewater			0,2406	0,0000					
6B2 Domestic and Commercial Wastewater			2,5607	0,2742					
7 Other	**800,877**		**0,0041**	**0,0163**		**2,4459**	**0,8153**	**0,4076**	**0,0082**
7A International aviation	582,929		0,0041	0,0163		2,4459	0,8153	0,4076	0,0082
7B CO_2 emission from biomass	217,948								

2005

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**5961,846**	**840,367**	**213,3589**	**4,8355**	**0,0121**	**21,7588**	**143,6739**	**28,9163**	**23,1295**
1 Energy	**4851,768**		**79,3807**	**0,0605**		**21,4475**	**133,4032**	**25,2593**	**22,1600**
1A Fuel combustion	4851,768		3,0882	0,0605		21,4475	133,4032	25,2593	22,1600
1A1 Energy Industries	2054,630		0,0290	0,0224		6,0973	0,5000	0,1272	13,6015
1A2 Manufacturing Industries and Construction	609,035		0,0511	0,0030		1,6737	0,4133	2,5993	1,3902
1A3 Transport	1146,295		0,2593	0,0100		10,5781	99,5835	18,7307	0,6488
1A3a Civil Aviation	12,480		0,0001	0,0004		0,0529	0,0176	0,0088	0,0042
1A3b Road Transportation	1111,720		0,2578	0,0095		10,1664	99,2676	18,6606	0,6431
1A3c Railways	21,891		0,0015	0,0002		0,3547	0,2956	0,0607	0,0015
1A3d Navigation	0,204		0,0000	0,0000		0,0041	0,0028	0,0006	0,0000
1A4 Other Sectors	1041,809		2,7487	0,0250		3,0984	32,9064	3,8020	6,5195
1A4a Commercial/Institutional	124,029		0,0148	0,0017		0,1268	2,3776	0,2387	1,2877
1A4b Residential	764,786		2,6051	0,0219		1,1059	28,2000	3,1784	4,6254
1A4c Agriculture	152,994		0,1289	0,0015		1,8657	2,3289	0,3850	0,6064
1B Fugitive Emissions from Fuels			76,2925						
1B1 Solid Fuel			1,0575						
1B2 Oil and Natural Gas			75,2350						
1B2a Oil			0,9170						
1B2b Natural Gas			74,3180						
2 Industrial Processes	**540,388**		**0,0000**	**0,0000**	**0,01212**	**0,0058**	**2,0470**	**2,2050**	**0,9696**
2A Mineral Products	525,991					0,0000	0,0000	0,3300	0,2918
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
2C Metal Production	5,602		0,0000	0,0000		0,0058	0,0250	0,0000	0,6778
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	1,8750	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,01212				
2G Shot-firing	8,795						2,0220		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**1,4520**	
4 Agriculture			**109,6030**	**4,4903**		**0,2968**	**7,7909**		
4A Enteric Fermentation			101,5530						
4B Manure Management			5,4054	0,0000					
4C Rice Cultivation			2,3472						
4D Agricultural Soils			0,0000	4,4821					
4F Field Burning of Agricultural Residues			0,2968	0,0082		0,2968	7,7909		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**569,690**	**840,367**	**0,0866**	**0,0005**		**0,0087**	**0,4328**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	840,367	0,0866	0,0005		0,0087	0,4328		
5B Forest and Grassland Conversion	569,690	0,000							
6 Wastes			**24,2886**	**0,2842**					
6A Solid Waste Disposal on Land			21,7098						
6B Wastewater Handling			2,5788	0,2842					
6B1 Industrial Wastewater			0,2086	0,0000					
6B2 Domestic and Commercial Wastewater			2,3702	0,2842					
7 Other	**599,867**		**0,0028**	**0,0110**		**1,6509**	**0,5503**	**0,2751**	**0,0055**
7A International aviation	393,458		0,0028	0,0110		1,6509	0,5503	0,2751	0,0055
7B CO_2 emission from biomass	206,409								

2006

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**6099,765**	**804,864**	**209,4650**	**4,8766**	**0,0138**	**23,2647**	**155,1059**	**31,2625**	**22,8259**
1 Energy	**4961,463**		**72,6951**	**0,0681**		**22,9712**	**147,3896**	**27,2779**	**22,1169**
1A Fuel combustion	4961,463		3,3375	0,0681		22,9712	147,3896	27,2779	22,1169
1A1 Energy Industries	1938,508		0,0268	0,0216		5,7746	0,4686	0,1190	13,0220
1A2 Manufacturing Industries and Construction	735,532		0,0618	0,0033		2,5986	0,4787	2,9813	1,5090
1A3 Transport	1199,439		0,2679	0,0104		11,1324	102,5714	19,2964	0,6699
1A3a Civil Aviation	12,564		0,0001	0,0004		0,0533	0,0178	0,0089	0,0054
1A3b Road Transportation	1164,560		0,2663	0,0099		10,7176	102,2524	19,2256	0,6630
1A3c Railways	22,316		0,0015	0,0002		0,3615	0,3013	0,0619	0,0015
1A3d Navigation	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
1A4 Other Sectors	1087,983		2,9810	0,0327		3,4656	43,8708	4,8811	6,9160
1A4a Commercial/Institutional	120,456		0,0643	0,0087		0,6205	12,3166	1,2326	1,2908
1A4b Residential	861,407		2,9029	0,0232		1,2090	30,1501	3,3721	5,4451
1A4c Agriculture	106,120		0,0137	0,0009		1,6362	1,4041	0,2764	0,1802
1B Fugitive Emissions from Fuels			69,3576						
1B1 Solid Fuel			1,1436						
1B2 Oil and Natural Gas			68,2140						
1B2a Oil			0,9160						
1B2b Natural Gas			67,2980						
2 Industrial Processes	**566,092**		**0,0000**	**0,0000**	**0,01377**	**0,0087**	**0,0230**	**2,4416**	**0,7090**
2A Mineral Products	562,917					0,0000	0,0000	0,5456	0,3153
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
2C Metal Production	3,175		0,0000	0,0000		0,0087	0,0230	0,0000	0,3937
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	1,8960	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,01377				
2G Shot-firing	0,000						0,0000		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**1,5430**	
4 Agriculture			**113,8840**	**4,5227**		**0,2728**	**7,0965**		
4A Enteric Fermentation			105,4790						
4B Manure Management			5,5960	0,0000					
4C Rice Cultivation			2,5388						
4D Agricultural Soils			0,0000	4,5151					
4F Field Burning of Agricultural Residues			0,2703	0,0076		0,2728	7,0965		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**572,210**	**804,864**	**0,1194**	**0,0007**		**0,0120**	**0,5969**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	804,864	0,1194	0,0007		0,0120	0,5969		
5B Forest and Grassland Conversion	572,210	0,000							
6 Wastes			**22,7665**	**0,2852**					
6A Solid Waste Disposal on Land			19,6023						
6B Wastewater Handling			3,1642	0,2852					
6B1 Industrial Wastewater			0,6682	0,0000					
6B2 Domestic and Commercial Wastewater			2,4959	0,2852					
7 Other	**1057,032**		**0,0059**	**0,0235**		**3,5292**	**1,1764**	**0,5882**	**0,0118**
7A International aviation	841,133		0,0059	0,0235		3,5292	1,1764	0,5882	0,0118
7B CO_2 emission from biomass	215,899								

2007

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**7077,821**	**804,167**	**210,7755**	**5,0007**	**0,0155**	**31,9537**	**205,6680**	**43,2292**	**24,7550**
1 Energy	**5840,425**		**72,0952**	**0,0743**		**31,6447**	**198,5823**	**37,4123**	**23,4941**
1A Fuel combustion	5840,425		3,4295	0,0743		31,6447	198,5823	37,4123	23,4941
1A1 Energy Industries	1915,799		0,0263	0,0214		5,7103	0,4622	0,1173	12,9830
1A2 Manufacturing Industries and Construction	775,336		0,0668	0,0038		2,5628	0,5457	3,4725	1,8469
1A3 Transport	1800,369		0,3977	0,0155		16,7596	151,8032	28,5611	1,0464
1A3a Civil Aviation	13,302		0,0002	0,0004		0,0563	0,0188	0,0094	0,0111
1A3b Road Transportation	1760,030		0,3957	0,0150		16,2646	151,4194	28,4768	1,0334
1A3c Railways	26,861		0,0018	0,0002		0,4352	0,3627	0,0745	0,0018
1A3d Navigation	0,177		0,0000	0,0000		0,0036	0,0024	0,0005	0,0000
1A4 Other Sectors	1348,921		2,9388	0,0335		6,6119	45,7713	5,2614	7,6179
1A4a Commercial/Institutional	151,683		0,0803	0,0100		0,7239	14,1557	1,4184	1,4150
1A4b Residential	876,731		2,7913	0,0209		1,1577	27,3755	3,0272	5,6088
1A4c Agriculture	320,507		0,0672	0,0026		4,7303	4,2401	0,8158	0,5940
1B Fugitive Emissions from Fuels			68,6657						
1B1 Solid Fuel			1,0157						
1B2 Oil and Natural Gas			67,6500						
1B2a Oil			0,9170						
1B2b Natural Gas			66,7330						
2 Industrial Processes	**664,116**		**0,0000**	**0,0000**	**0,01554**	**0,0437**	**0,0350**	**4,0038**	**1,2609**
2A Mineral Products	657,586					0,0000	0,0000	2,2498	0,3689
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
2C Metal Production	6,530		0,0000	0,0000		0,0437	0,0350	0,0000	0,8920
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	1,7540	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,01554				
2G Shot-firing	0,000						0,0000		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**1,8130**	
4 Agriculture			**118,6570**	**4,6470**		**0,2538**	**6,4792**		
4A Enteric Fermentation			110,1340						
4B Manure Management			5,8093	0,0000					
4C Rice Cultivation			2,4668						
4D Agricultural Soils			0,0000	4,6400					
4F Field Burning of Agricultural Residues			0,2468	0,0070		0,2538	6,4792		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**573,280**	**804,167**	**0,1143**	**0,0007**		**0,0115**	**0,5715**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	804,167	0,1143	0,0007		0,0115	0,5715		
5B Forest and Grassland Conversion	573,280	0,000							
6 Wastes			**19,9091**	**0,2788**					
6A Solid Waste Disposal on Land			16,5706						
6B Wastewater Handling			3,3384	0,2788					
6B1 Industrial Wastewater			0,7338	0,0000					
6B2 Domestic and Commercial Wastewater			2,6046	0,2788					
7 Other	**919,114**		**0,0052**	**0,0206**		**3,0938**	**1,0313**	**0,5156**	**0,0103**
7A International aviation	737,347		0,0052	0,0206		3,0938	1,0313	0,5156	0,0103
7B CO_2 emission from biomass	181,768								

2008

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**7929,445**	**804,080**	**229,6137**	**5,0618**	**0,0174**	**33,8355**	**220,8305**	**43,2202**	**31,5068**
1 Energy	**6675,641**		**79,1471**	**0,0788**		**33,5573**	**213,6622**	**39,7777**	**30,5020**
1A Fuel combustion	6675,641		4,5641	0,0788		33,5573	213,6622	39,7777	30,5020
1A1 Energy Industries	2286,267		0,0299	0,0271		6,8842	0,5377	0,1361	16,3367
1A2 Manufacturing Industries and Construction	697,610		0,0591	0,0030		2,1250	0,4462	2,7357	1,2064
1A3 Transport	2036,646		0,4471	0,0175		18,9755	170,4393	32,0696	1,2322
1A3a Civil Aviation	12,673		0,0001	0,0004		0,0537	0,0179	0,0089	0,0075
1A3b Road Transportation	1996,640		0,4452	0,0170		18,4785	170,0536	31,9851	1,2228
1A3c Railways	26,800		0,0018	0,0002		0,4328	0,3606	0,0741	0,0018
1A3d Navigation	0,534		0,0000	0,0000		0,0106	0,0072	0,0014	0,0000
1A4 Other Sectors	1655,118		4,0280	0,0312		5,5726	42,2390	4,8364	11,7267
1A4a Commercial/Institutional	215,506		0,0290	0,0028		0,2234	3,6697	0,3702	2,0430
1A4b Residential	1195,987		3,9697	0,0265		1,5381	35,3022	3,8223	9,2772
1A4c Agriculture	243,625		0,0292	0,0020		3,8112	3,2671	0,6438	0,4066
1B Fugitive Emissions from Fuels			74,5831						
1B1 Solid Fuel			1,2291						
1B2 Oil and Natural Gas			73,3540						
1B2a Oil			0,9170						
1B2b Natural Gas			72,4370						
2 Industrial Processes	**682,013**		**0,0000**	**0,0000**	**0,01744**	**0,0095**	**0,0190**	**1,8175**	**1,0048**
2A Mineral Products	676,983					0,0000	0,0000	0,3855	0,3828
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
2C Metal Production	5,030		0,0000	0,0000		0,0095	0,0190	0,0000	0,6220
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	1,4320	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,01744				
2G Shot-firing	0,000						0,0000		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**1,6250**	
4 Agriculture			**124,1880**	**4,6916**		**0,2581**	**6,6217**		
4A Enteric Fermentation			115,4670						
4B Manure Management			6,0589	0,0000					
4C Rice Cultivation			2,4104						
4D Agricultural Soils			0,0000	4,6845					
4F Field Burning of Agricultural Residues			0,2523	0,0071		0,2581	6,6217		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**571,790**	**804,080**	**0,1055**	**0,0006**		**0,0106**	**0,5276**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	804,080	0,1055	0,0006		0,0106	0,5276		
5B Forest and Grassland Conversion	571,790	0,000							
6 Wastes			**26,1731**	**0,2907**					
6A Solid Waste Disposal on Land			22,9545						
6B Wastewater Handling			3,2186	0,2907					
6B1 Industrial Wastewater			0,6461	0,0000					
6B2 Domestic and Commercial Wastewater			2,5725	0,2907					
7 Other	**1047,969**		**0,0061**	**0,0243**		**3,6397**	**1,2132**	**0,6066**	**0,0121**
7A International aviation	867,467		0,0061	0,0243		3,6397	1,2132	0,6066	0,0121
7B CO_2 emission from biomass	180,503								

2009

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**7501,451**	**803,662**	**239,2284**	**5,4206**	**0,0195**	**35,8588**	**238,0823**	**46,6373**	**32,9691**
1 Energy	**6612,306**		**53,5732**	**0,0763**		**35,4754**	**228,6057**	**42,5351**	**32,3816**
1A Fuel combustion	6612,306		4,2167	0,0763		35,4754	228,6057	42,5351	32,3816
1A1 Energy Industries	2126,409		0,0339	0,0264		6,3508	0,4592	0,1209	16,4950
1A2 Manufacturing Industries and Construction	395,020		0,0257	0,0035		1,3531	0,2762	2,1769	2,1446
1A3 Transport	2427,504		0,5109	0,0209		23,0117	192,8700	36,3159	1,5678
1A3a Civil Aviation	14,149		0,0002	0,0004		0,0597	0,0199	0,0100	0,0183
1A3b Road Transportation	2358,330		0,5070	0,0200		22,0800	192,1245	36,1570	1,5459
1A3c Railways	54,670		0,0036	0,0004		0,8649	0,7208	0,1480	0,0036
1A3d Navigation	0,356		0,0000	0,0000		0,0071	0,0048	0,0010	0,0000
1A4 Other Sectors	1663,373		3,6462	0,0255		4,7599	35,0003	3,9214	12,1743
1A4a Commercial/Institutional	231,056		0,0325	0,0028		0,2368	3,6192	0,3659	2,0112
1A4b Residential	1235,317		3,5884	0,0211		1,3907	28,6871	3,0253	9,8216
1A4c Agriculture	196,999		0,0253	0,0016		3,1324	2,6939	0,5303	0,3415
1B Fugitive Emissions from Fuels			49,3565						
1B1 Solid Fuel			1,1095						
1B2 Oil and Natural Gas			48,2470						
1B2a Oil			0,9160						
1B2b Natural Gas			47,3310						
2 Industrial Processes	**322,205**		**0,0000**	**0,0000**	**0,01948**	**0,0318**	**0,0610**	**2,8001**	**0,5875**
2A Mineral Products	319,317					0,0000	0,0000	1,4401	0,1914
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
2C Metal Production	2,888		0,0000	0,0000		0,0318	0,0610	0,0000	0,3961
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	1,3600	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,01948				
2G Shot-firing	0,000						0,0000		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**1,3020**	
4 Agriculture			**130,1940**	**5,0401**		**0,3421**	**8,9473**		
4A Enteric Fermentation			121,0110						
4B Manure Management			6,3287	0,0000					
4C Rice Cultivation			2,5136						
4D Agricultural Soils			0,0000	5,0306					
4F Field Burning of Agricultural Residues			0,3409	0,0095		0,3421	8,9473		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**566,940**	**803,662**	**0,0937**	**0,0005**		**0,0094**	**0,4684**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	803,662	0,0937	0,0005		0,0094	0,4684		
5B Forest and Grassland Conversion	566,940	0,000							
6 Wastes			**55,3676**	**0,3038**					
6A Solid Waste Disposal on Land			51,9526						
6B Wastewater Handling			3,4150	0,3038					
6B1 Industrial Wastewater			0,7396	0,0000					
6B2 Domestic and Commercial Wastewater			2,6754	0,3038					
7 Other	**1119,651**		**0,0071**	**0,0283**		**4,2377**	**1,4126**	**0,7063**	**0,0141**
7A International aviation	1009,979		0,0071	0,0283		4,2377	1,4126	0,7063	0,0141
7B CO_2 emission from biomass	109,672								

2010

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	NO_x	CO	NMVOCs	SO_2
National emissions and sinks	**6921,677**	**804,097**	**224,4363**	**5,4821**	**0,0216**	**31,6654**	**211,6888**	**40,9147**	**30,5638**
1 Energy	**5980,268**		**46,5708**	**0,0727**		**31,3567**	**204,0951**	**37,7878**	**30,0396**
1A Fuel combustion	5980,268		4,6194	0,0727		31,3567	204,0951	37,7878	30,0396
1A1 Energy Industries	1659,081		0,0242	0,0205		4,9695	0,3669	0,0949	12,9341
1A2 Manufacturing Industries and Construction	512,467		0,0293	0,0044		1,5462	0,2964	2,4586	2,7192
1A3 Transport	2132,909		0,4335	0,0183		19,8473	162,7841	30,6620	1,5373
1A3a Civil Aviation	18,641		0,0003	0,0005		0,0786	0,0262	0,0131	0,0260
1A3b Road Transportation	2112,330		0,4331	0,0177		19,7364	162,7317	30,6435	1,5112
1A3c Railways	1,690		0,0001	0,0000		0,0274	0,0228	0,0047	0,0001
1A3d Navigation	0,248		0,0000	0,0000		0,0050	0,0033	0,0007	0,0000
1A4 Other Sectors	1675,811		4,1323	0,0296		4,9936	40,6479	4,5722	12,8490
1A4a Commercial/Institutional	210,211		0,0286	0,0026		0,2088	3,6336	0,3661	1,9333
1A4b Residential	1262,056		4,0853	0,0253		1,5142	34,2544	3,6577	10,5871
1A4c Agriculture	203,544		0,0185	0,0017		3,2706	2,7599	0,5485	0,3286
1B Fugitive Emissions from Fuels			41,9514						
1B1 Solid Fuel			1,3264						
1B2 Oil and Natural Gas			40,6250						
1B2a Oil			0,9170						
1B2b Natural Gas			39,7080						
2 Industrial Processes	**383,109**		**0,0000**	**0,0000**	**0,02164**	**0,0252**	**0,0390**	**1,4210**	**0,5242**
2A Mineral Products	381,042					0,0000	0,0000	0,0130	0,2279
2B Chemical Industry	0,000		0,0000	0,0000		0,0000	0,0000	0,0000	0,0000
2C Metal Production	2,067		0,0000	0,0000		0,0252	0,0390	0,0000	0,2963
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,0000	0,0000	1,4080	0,0000
2F Consumption of Halocarbons and Sulphur Hexafluoride					0,02164				
2G Shot-firing	0,000						0,0000		
3 Solvent and Other Product Use	**0,000**			**0,0000**				**1,7060**	
4 Agriculture			**133,0260**	**5,1041**		**0,2743**	**7,0993**		
4A Enteric Fermentation			123,7240						
4B Manure Management			6,3981	0,0000					
4C Rice Cultivation			2,6344						
4D Agricultural Soils			0,0000	5,0965					
4F Field Burning of Agricultural Residues			0,2705	0,0076		0,2743	7,0993		
5 Land Use, Land-Use Change and Forestry (LULUCF)	**558,300**	**804,097**	**0,0911**	**0,0005**		**0,0092**	**0,4554**		
5A Changes in Forest and Other Woody Biomass Stocks	0,000	804,097	0,0911	0,0005		0,0092	0,4554		
5B Forest and Grassland Conversion	558,300	0,000							
6 Wastes			**44,7485**	**0,3047**					
6A Solid Waste Disposal on Land			41,6059						
6B Wastewater Handling			3,1426	0,3047					
6B1 Industrial Wastewater			0,9439	0,0000					
6B2 Domestic and Commercial Wastewater			2,1986	0,3047					
7 Other	**914,869**		**0,0054**	**0,0215**		**3,2238**	**1,0746**	**0,5373**	**0,0107**
7A International aviation	768,328		0,0054	0,0215		3,2238	1,0746	0,5373	0,0107
7B CO_2 emission from biomass	146,542								

Annex 2. GHG inventory in Gg of CO_2-eq.

1990

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**21368,610**	**-798,096**	**5358,5194**	**2503,9858**	**0,0000**	**28433,019**
1 Energy	**19825,363**		**1170,5286**	**62,0581**		**21057,950**
1A Fuel combustion	19825,363		222,9114	62,0581		20110,332
1A1 Energy Industries	8136,733		3,7162	20,8168		8161,266
1A2 Manufacturing Industries and Construction	1712,750		2,7719	3,6072		1719,129
1A3 Transport	3154,945		13,5355	8,2265		3176,707
1A3a Civil Aviation	46,805		0,0070	0,4104		47,223
1A3b Road Transportation	2918,790		13,2601	7,3405		2939,391
1A3c Railways	182,931		0,2593	0,4594		183,649
1A3d Navigation	6,419		0,0091	0,0161		6,444
1A4 Other Sectors	6820,935		202,8879	29,4077		7053,231
1A4a Commercial/Institutional	2626,079		7,3996	11,1002		2644,579
1A4b Residential	3042,753		180,9751	15,0779		3238,806
1A4c Agriculture	1152,103		14,5132	3,2296		1169,846
1B Fugitive Emissions from Fuels			947,6172			947,617
1B1 Solid Fuel			268,9098			268,910
1B2 Oil and Natural Gas			678,7074			678,707
1B2a Oil			25,9497			25,950
1B2b Natural Gas			652,7577			652,758
2 Industrial Processes	**706,207**		**0,0000**	**0,0000**	**0,0000**	**706,207**
2A Mineral Products	694,329					694,329
2B Chemical Industry	0,000		0,0000	0,0000		0,000
2C Metal Production	4,832		0,0000	0,0000		4,832
2D Other Production (food and drinks)	0,000		0,0000	0,0000		0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000				0,0000	0,000
2G Shot-firing	7,046					7,046
3 Solvent and Other Product Use	**0,000**		**0,0000**	**0,0000**		**0,000**
4 Agriculture			**3067,4795**	**2350,0310**		**5417,510**
4A Enteric Fermentation			2924,3760			2924,376
4B Manure Management			127,0983	0,0000		127,098
4C Rice Cultivation			10,4580			10,458
4D Agricultural Soils			0,0000	2347,6006		2347,601
4F Field Burning of Agricultural Residues			5,5472	2,4304		7,978
5 Land Use, Land-Use Change and Forestry (LULUCF)	**837,040**	**-798,096**	**1,4513**	**0,1249**		**40,520**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-798,096	1,4513	0,1249		-796,520
5B Forest and Grassland Conversion	837,040	0,000				837,040
6 Wastes			**1119,0600**	**91,7718**		**1210,832**
6A Solid Waste Disposal on Land			921,6353	0,0000		921,635
6B Wastewater Handling			197,4248	91,7718		289,197
6B1 Industrial Wastewater			137,1526	0,0000		137,153
6B2 Domestic and Commercial Wastewater			60,2722	91,7718		152,044

1991

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**18434,492**	**-803,823**	**5337,0343**	**2610,9718**	**0,0000**	**25578,675**
1 Energy	**16930,476**	**0,000**	**1054,5398**	**52,8564**	**0,0000**	**18037,872**
1A Fuel combustion	16930,476	0,000	185,5422	52,8564	0,0000	17168,874
1A1 Energy Industries	7068,163	0,000	3,1667	18,4081	0,0000	7089,738
1A2 Manufacturing Industries and Construction	1449,300	0,000	2,3508	3,0179	0,0000	1454,669
1A3 Transport	2706,403	0,000	11,6601	7,0823	0,0000	2725,146
1A3a Civil Aviation	41,881	0,000	0,0062	0,3674	0,0000	42,254
1A3b Road Transportation	2504,200	0,000	11,4272	6,3135	0,0000	2521,941
1A3c Railways	154,304	0,000	0,2188	0,3875	0,0000	154,910
1A3d Navigation	6,019	0,000	0,0079	0,0140	0,0000	6,041
1A4 Other Sectors	5706,610	0,000	168,3646	24,3481	0,0000	5899,322
1A4a Commercial/Institutional	2126,305	0,000	6,0434	8,9432	0,0000	2141,292
1A4b Residential	2594,580	0,000	149,6240	12,6282	0,0000	2756,833
1A4c Agriculture	985,724	0,000	12,6971	2,7767	0,0000	1001,198
1B Fugitive Emissions from Fuels	0,000	0,000	868,9976	0,0000	0,0000	868,998
1B1 Solid Fuel	0,000	0,000	258,3953	0,0000	0,0000	258,395
1B2 Oil and Natural Gas	0,000	0,000	610,6023	0,0000	0,0000	610,602
1B2a Oil	0,000	0,000	24,9795	0,0000	0,0000	24,980
1B2b Natural Gas	0,000	0,000	585,6228	0,0000	0,0000	585,623
2 Industrial Processes	**668,516**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**668,516**
2A Mineral Products	659,698	0,000	0,0000	0,0000	0,0000	659,698
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	4,485	0,000	0,0000	0,0000	0,0000	4,485
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	0,0000	0,000
2G Shot-firing	4,333	0,000	0,0000	0,0000	0,0000	4,333
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**3018,2040**	**2474,7780**	**0,0000**	**5492,982**
4A Enteric Fermentation	0,000	0,000	2871,2460	0,0000	0,0000	2871,246
4B Manure Management	0,000	0,000	126,7951	0,0000	0,0000	126,795
4C Rice Cultivation	0,000	0,000	14,7252	0,0000	0,0000	14,725
4D Agricultural Soils	0,000	0,000	0,0000	2472,3910	0,0000	2472,391
4F Field Burning of Agricultural Residues	0,000	0,000	5,4335	2,3870	0,0000	7,821
5 Land Use, Land-Use Change and Forestry (LULUCF)	**835,500**	**-803,823**	**1,3443**	**0,1156**	**0,0000**	**33,137**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-803,823	1,3443	0,1156	0,0000	-802,363
5B Forest and Grassland Conversion	835,500	0,000	0,0000	0,0000	0,0000	835,500
6 Wastes	**0,000**	**0,000**	**1262,9462**	**83,2218**	**0,0000**	**1346,168**
6A Solid Waste Disposal on Land	0,000	0,000	1084,4519	0,0000	0,0000	1084,452
6B Wastewater Handling	0,000	0,000	178,4943	83,2218	0,0000	261,716
6B1 Industrial Wastewater	0,000	0,000	118,0408	0,0000	0,0000	118,041
6B2 Domestic and Commercial Wastewater	0,000	0,000	60,4535	83,2218	0,0000	143,675

1992

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**15412,569**	**-798,788**	**4876,2712**	**2621,9358**	**0,0000**	**22111,987**
1 Energy	**14035,340**	**0,000**	**889,7099**	**43,7593**	**0,0000**	**14968,809**
1A Fuel combustion	14035,340	0,000	148,7915	43,7593	0,0000	14227,891
1A1 Energy Industries	5999,364	0,000	2,6174	15,9836	0,0000	6017,965
1A2 Manufacturing Industries and Construction	1185,840	0,000	1,9297	2,4282	0,0000	1190,198
1A3 Transport	2257,852	0,000	9,7847	5,9379	0,0000	2273,574
1A3a Civil Aviation	36,956	0,000	0,0055	0,3240	0,0000	37,286
1A3b Road Transportation	2089,600	0,000	9,5943	5,2864	0,0000	2104,481
1A3c Railways	125,677	0,000	0,1782	0,3156	0,0000	126,170
1A3d Navigation	5,619	0,000	0,0067	0,0119	0,0000	5,638
1A4 Other Sectors	4592,284	0,000	134,4598	19,4096	0,0000	4746,153
1A4a Commercial/Institutional	1626,532	0,000	4,6873	6,7859	0,0000	1638,005
1A4b Residential	2146,408	0,000	118,8914	10,3003	0,0000	2275,599
1A4c Agriculture	819,345	0,000	10,8810	2,3235	0,0000	832,549
1B Fugitive Emissions from Fuels	0,000	0,000	740,9183	0,0000	0,0000	740,918
1B1 Solid Fuel	0,000	0,000	173,6432	0,0000	0,0000	173,643
1B2 Oil and Natural Gas	0,000	0,000	567,2751	0,0000	0,0000	567,275
1B2a Oil	0,000	0,000	22,7283	0,0000	0,0000	22,728
1B2b Natural Gas	0,000	0,000	544,5468	0,0000	0,0000	544,547
2 Industrial Processes	**565,949**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**565,949**
2A Mineral Products	558,935	0,000	0,0000	0,0000	0,0000	558,935
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	3,421	0,000	0,0000	0,0000	0,0000	3,421
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	0,0000	0,000
2G Shot-firing	3,592	0,000	0,0000	0,0000	0,0000	3,592
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2842,3920**	**2494,7374**	**0,0000**	**5337,129**
4A Enteric Fermentation	0,000	0,000	2699,6340	0,0000	0,0000	2699,634
4B Manure Management	0,000	0,000	120,6104	0,0000	0,0000	120,610
4C Rice Cultivation	0,000	0,000	15,7668	0,0000	0,0000	15,767
4D Agricultural Soils	0,000	0,000	0,0000	2492,0280	0,0000	2492,028
4F Field Burning of Agricultural Residues	0,000	0,000	6,3741	2,7094	0,0000	9,084
5 Land Use, Land-Use Change and Forestry (LULUCF)	**811,280**	**-798,788**	**1,4894**	**0,1283**	**0,0000**	**14,110**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-798,788	1,4894	0,1283	0,0000	-797,170
5B Forest and Grassland Conversion	811,280	0,000	0,0000	0,0000	0,0000	811,280
6 Wastes	**0,000**	**0,000**	**1142,6799**	**83,3108**	**0,0000**	**1225,991**
6A Solid Waste Disposal on Land	0,000	0,000	995,9890	0,0000	0,0000	995,989
6B Wastewater Handling	0,000	0,000	146,6909	83,3108	0,0000	230,002
6B1 Industrial Wastewater	0,000	0,000	86,0876	0,0000	0,0000	86,088
6B2 Domestic and Commercial Wastewater	0,000	0,000	60,6033	83,3108	0,0000	143,914

1993

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**12493,529**	**-797,073**	**4244,6047**	**1700,9014**	**0,0000**	**17641,962**
1 Energy	**11093,043**	**0,000**	**763,8162**	**34,5436**	**0,0000**	**11891,402**
1A Fuel combustion	11093,043	0,000	112,7702	34,5436	0,0000	11240,356
1A1 Energy Industries	4883,382	0,000	2,0552	13,2931	0,0000	4898,730
1A2 Manufacturing Industries and Construction	922,392	0,000	1,5087	1,8386	0,0000	925,739
1A3 Transport	1809,310	0,000	7,9092	4,7937	0,0000	1822,013
1A3a Civil Aviation	32,032	0,000	0,0047	0,2809	0,0000	32,317
1A3b Road Transportation	1675,010	0,000	7,7614	4,2594	0,0000	1687,031
1A3c Railways	97,050	0,000	0,1376	0,2437	0,0000	97,431
1A3d Navigation	5,219	0,000	0,0055	0,0098	0,0000	5,235
1A4 Other Sectors	3477,958	0,000	101,2971	14,6181	0,0000	3593,873
1A4a Commercial/Institutional	1126,758	0,000	3,3311	4,6289	0,0000	1134,718
1A4b Residential	1698,235	0,000	88,9010	8,1187	0,0000	1795,255
1A4c Agriculture	652,965	0,000	9,0650	1,8705	0,0000	663,901
1B Fugitive Emissions from Fuels	0,000	0,000	651,0461	0,0000	0,0000	651,046
1B1 Solid Fuel	0,000	0,000	134,9921	0,0000	0,0000	134,992
1B2 Oil and Natural Gas	0,000	0,000	516,0540	0,0000	0,0000	516,054
1B2a Oil	0,000	0,000	12,6840	0,0000	0,0000	12,684
1B2b Natural Gas	0,000	0,000	503,3700	0,0000	0,0000	503,370
2 Industrial Processes	**626,216**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**626,216**
2A Mineral Products	611,159	0,000	0,0000	0,0000	0,0000	611,159
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	13,086	0,000	0,0000	0,0000	0,0000	13,086
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	0,0000	0,000
2G Shot-firing	1,971	0,000	0,0000	0,0000	0,0000	1,971
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2620,1910**	**1583,5172**	**0,0000**	**4203,708**
4A Enteric Fermentation	0,000	0,000	2478,6510	0,0000	0,0000	2478,651
4B Manure Management	0,000	0,000	114,6310	0,0000	0,0000	114,631
4C Rice Cultivation	0,000	0,000	20,5800	0,0000	0,0000	20,580
4D Agricultural Soils	0,000	0,000	0,0000	1580,9380	0,0000	1580,938
4F Field Burning of Agricultural Residues	0,000	0,000	6,3328	2,5792	0,0000	8,912
5 Land Use, Land-Use Change and Forestry (LULUCF)	**774,270**	**-797,073**	**1,6596**	**0,1429**	**0,0000**	**-21,001**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-797,073	1,6596	0,1429	0,0000	-795,271
5B Forest and Grassland Conversion	774,270	0,000	0,0000	0,0000	0,0000	774,270
6 Wastes	**0,000**	**0,000**	**858,9379**	**82,6977**	**0,0000**	**941,636**
6A Solid Waste Disposal on Land	0,000	0,000	754,5319	0,0000	0,0000	754,532
6B Wastewater Handling	0,000	0,000	104,4060	82,6977	0,0000	187,104
6B1 Industrial Wastewater	0,000	0,000	44,5453	0,0000	0,0000	44,545
6B2 Domestic and Commercial Wastewater	0,000	0,000	59,8607	82,6977	0,0000	142,558

1994

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**9401,836**	**-845,476**	**3329,6405**	**1328,5502**	**0,0000**	**13214,551**
1 Energy	**8254,185**	**0,000**	**611,7955**	**26,0512**	**0,0000**	**8892,032**
1A Fuel combustion	8254,185	0,000	77,4907	26,0512	0,0000	8357,727
1A1 Energy Industries	3870,813	0,000	1,5212	11,1860	0,0000	3883,520
1A2 Manufacturing Industries and Construction	658,941	0,000	1,0876	1,2493	0,0000	661,278
1A3 Transport	1360,769	0,000	6,0338	3,6496	0,0000	1370,452
1A3a Civil Aviation	27,107	0,000	0,0040	0,2378	0,0000	27,349
1A3b Road Transportation	1260,420	0,000	5,9284	3,2324	0,0000	1269,581
1A3c Railways	68,422	0,000	0,0970	0,1717	0,0000	68,691
1A3d Navigation	4,820	0,000	0,0044	0,0078	0,0000	4,832
1A4 Other Sectors	2363,662	0,000	68,8481	9,9662	0,0000	2442,477
1A4a Commercial/Institutional	627,014	0,000	1,9750	2,4716	0,0000	631,461
1A4b Residential	1250,062	0,000	59,6242	6,0772	0,0000	1315,764
1A4c Agriculture	486,586	0,000	7,2489	1,4173	0,0000	495,252
1B Fugitive Emissions from Fuels	0,000	0,000	534,3048	0,0000	0,0000	534,305
1B1 Solid Fuel	0,000	0,000	56,5968	0,0000	0,0000	56,597
1B2 Oil and Natural Gas	0,000	0,000	477,7080	0,0000	0,0000	477,708
1B2a Oil	0,000	0,000	20,9580	0,0000	0,0000	20,958
1B2b Natural Gas	0,000	0,000	456,7500	0,0000	0,0000	456,750
2 Industrial Processes	**414,641**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**414,641**
2A Mineral Products	403,301	0,000	0,0000	0,0000	0,0000	403,301
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	9,306	0,000	0,0000	0,0000	0,0000	9,306
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	0,0000	0,000
2G Shot-firing	2,034	0,000	0,0000	0,0000	0,0000	2,034
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2177,5530**	**1228,7594**	**0,0000**	**3406,312**
4A Enteric Fermentation	0,000	0,000	2046,5025	0,0000	0,0000	2046,503
4B Manure Management	0,000	0,000	101,4145	0,0000	0,0000	101,414
4C Rice Cultivation	0,000	0,000	25,4856	0,0000	0,0000	25,486
4D Agricultural Soils	0,000	0,000	0,0000	1227,0730	0,0000	1227,073
4F Field Burning of Agricultural Residues	0,000	0,000	4,1557	1,6864	0,0000	5,842
5 Land Use, Land-Use Change and Forestry (LULUCF)	**733,010**	**-845,476**	**0,8169**	**0,0704**	**0,0000**	**-111,578**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-845,476	0,8169	0,0704	0,0000	-844,588
5B Forest and Grassland Conversion	733,010	0,000	0,0000	0,0000	0,0000	733,010
6 Wastes	**0,000**	**0,000**	**539,4751**	**73,6692**	**0,0000**	**613,144**
6A Solid Waste Disposal on Land	0,000	0,000	462,3782	0,0000	0,0000	462,378
6B Wastewater Handling	0,000	0,000	77,0969	73,6692	0,0000	150,766
6B1 Industrial Wastewater	0,000	0,000	18,2946	0,0000	0,0000	18,295
6B2 Domestic and Commercial Wastewater	0,000	0,000	58,8023	73,6692	0,0000	132,472

1995

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**6250,083**	**-841,700**	**3114,5893**	**1169,9966**	**3,6370**	**9696,606**
1 Energy	**5239,945**	**0,000**	**515,3287**	**16,8724**	**0,0000**	**5772,146**
1A Fuel combustion	5239,945	0,000	43,7640	16,8724	0,0000	5300,582
1A1 Energy Industries	2682,900	0,000	0,9415	8,0783	0,0000	2691,920
1A2 Manufacturing Industries and Construction	395,489	0,000	0,6665	0,6597	0,0000	396,815
1A3 Transport	912,220	0,000	4,1584	2,5052	0,0000	918,883
1A3a Civil Aviation	22,182	0,000	0,0033	0,1944	0,0000	22,380
1A3b Road Transportation	845,822	0,000	4,0955	2,2053	0,0000	852,123
1A3c Railways	39,795	0,000	0,0564	0,0998	0,0000	39,952
1A3d Navigation	4,420	0,000	0,0032	0,0056	0,0000	4,429
1A4 Other Sectors	1249,337	0,000	37,9975	5,6293	0,0000	1292,964
1A4a Commercial/Institutional	127,241	0,000	0,6189	0,3143	0,0000	128,174
1A4b Residential	801,890	0,000	31,9459	4,3505	0,0000	838,186
1A4c Agriculture	320,207	0,000	5,4328	0,9644	0,0000	326,604
1B Fugitive Emissions from Fuels	0,000	0,000	471,5647	0,0000	0,0000	471,565
1B1 Solid Fuel	0,000	0,000	32,7067	0,0000	0,0000	32,707
1B2 Oil and Natural Gas	0,000	0,000	438,8580	0,0000	0,0000	438,858
1B2a Oil	0,000	0,000	17,4300	0,0000	0,0000	17,430
1B2b Natural Gas	0,000	0,000	421,4280	0,0000	0,0000	421,428
2 Industrial Processes	**316,818**	**0,000**	**0,0000**	**0,0000**	**3,6370**	**320,455**
2A Mineral Products	306,400	0,000	0,0000	0,0000	0,0000	306,400
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	8,319	0,000	0,0000	0,0000	0,0000	8,319
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	3,6370	3,637
2G Shot-firing	2,099	0,000	0,0000	0,0000	0,0000	2,099
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2028,1464**	**1073,1363**	**0,0000**	**3101,283**
4A Enteric Fermentation	0,000	0,000	1889,3826	0,0000	0,0000	1889,383
4B Manure Management	0,000	0,000	97,3134	0,0000	0,0000	97,313
4C Rice Cultivation	0,000	0,000	37,5732	0,0000	0,0000	37,573
4D Agricultural Soils	0,000	0,000	0,0000	1071,6080	0,0000	1071,608
4F Field Burning of Agricultural Residues	0,000	0,000	3,8762	1,5283	0,0000	5,404
5 Land Use, Land-Use Change and Forestry (LULUCF)	**693,320**	**-841,700**	**1,6097**	**0,1386**	**0,0000**	**-146,632**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-841,700	1,6097	0,1386	0,0000	-839,952
5B Forest and Grassland Conversion	693,320	0,000	0,0000	0,0000	0,0000	693,320
6 Wastes	**0,000**	**0,000**	**569,5045**	**79,8493**	**0,0000**	**649,354**
6A Solid Waste Disposal on Land	0,000	0,000	498,3740	0,0000	0,0000	498,374
6B Wastewater Handling	0,000	0,000	71,1305	79,8493	0,0000	150,980
6B1 Industrial Wastewater	0,000	0,000	12,6382	0,0000	0,0000	12,638
6B2 Domestic and Commercial Wastewater	0,000	0,000	58,4923	79,8493	0,0000	138,342

1996

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**6397,237**	**-828,167**	**2887,5943**	**1164,2682**	**4,0932**	**9625,025**
1 Energy	**5417,723**	**0,000**	**410,2225**	**16,8280**	**0,0000**	**5844,773**
1A Fuel combustion	5417,723	0,000	43,5724	16,8280	0,0000	5478,123
1A1 Energy Industries	2783,301	0,000	0,9992	7,7717	0,0000	2792,072
1A2 Manufacturing Industries and Construction	432,234	0,000	0,6883	0,7815	0,0000	433,704
1A3 Transport	1078,152	0,000	5,0093	2,9319	0,0000	1086,093
1A3a Civil Aviation	18,479	0,000	0,0027	0,1620	0,0000	18,644
1A3b Road Transportation	1022,000	0,000	4,9547	2,6781	0,0000	1029,633
1A3c Railways	35,463	0,000	0,0503	0,0890	0,0000	35,602
1A3d Navigation	2,210	0,000	0,0016	0,0028	0,0000	2,214
1A4 Other Sectors	1124,036	0,000	36,8755	5,3429	0,0000	1166,254
1A4a Commercial/Institutional	113,801	0,000	0,5823	0,2796	0,0000	114,662
1A4b Residential	687,601	0,000	30,1333	4,0895	0,0000	721,824
1A4c Agriculture	322,634	0,000	6,1599	0,9737	0,0000	329,768
1B Fugitive Emissions from Fuels	0,000	0,000	366,6501	0,0000	0,0000	366,650
1B1 Solid Fuel	0,000	0,000	22,6071	0,0000	0,0000	22,607
1B2 Oil and Natural Gas	0,000	0,000	344,0430	0,0000	0,0000	344,043
1B2a Oil	0,000	0,000	17,4510	0,0000	0,0000	17,451
1B2b Natural Gas	0,000	0,000	326,5920	0,0000	0,0000	326,592
2 Industrial Processes	**321,164**	**0,000**	**0,0000**	**0,0000**	**4,0932**	**325,257**
2A Mineral Products	307,234	0,000	0,0000	0,0000	0,0000	307,234
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	12,158	0,000	0,0000	0,0000	0,0000	12,158
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	4,0932	4,093
2G Shot-firing	1,772	0,000	0,0000	0,0000	0,0000	1,772
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**1937,4642**	**1069,2830**	**0,0000**	**3006,747**
4A Enteric Fermentation	0,000	0,000	1792,9758	0,0000	0,0000	1792,976
4B Manure Management	0,000	0,000	93,7768	0,0000	0,0000	93,777
4C Rice Cultivation	0,000	0,000	45,0744	0,0000	0,0000	45,074
4D Agricultural Soils	0,000	0,000	0,0000	1067,0820	0,0000	1067,082
4F Field Burning of Agricultural Residues	0,000	0,000	5,6375	2,2010	0,0000	7,838
5 Land Use, Land-Use Change and Forestry (LULUCF)	**658,350**	**-828,167**	**2,0128**	**0,1733**	**0,0000**	**-167,631**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-828,167	2,0128	0,1733	0,0000	-825,981
5B Forest and Grassland Conversion	658,350	0,000	0,0000	0,0000	0,0000	658,350
6 Wastes	**0,000**	**0,000**	**537,8948**	**77,9840**	**0,0000**	**615,879**
6A Solid Waste Disposal on Land	0,000	0,000	462,8054	0,0000	0,0000	462,805
6B Wastewater Handling	0,000	0,000	75,0894	77,9840	0,0000	153,073
6B1 Industrial Wastewater	0,000	0,000	14,8300	0,0000	0,0000	14,830
6B2 Domestic and Commercial Wastewater	0,000	0,000	60,2594	77,9840	0,0000	138,243

1997

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**7172,305**	**-764,051**	**2881,2381**	**1368,6937**	**4,7175**	**10662,904**
1 Energy	**5901,914**	**0,000**	**313,7580**	**17,7763**	**0,0000**	**6233,449**
1A Fuel combustion	5901,914	0,000	42,5715	17,7763	0,0000	5962,262
1A1 Energy Industries	3190,093	0,000	1,1159	8,6273	0,0000	3199,836
1A2 Manufacturing Industries and Construction	468,980	0,000	0,7101	0,9033	0,0000	470,593
1A3 Transport	1244,096	0,000	5,8603	3,3588	0,0000	1253,315
1A3a Civil Aviation	14,776	0,000	0,0022	0,1296	0,0000	14,908
1A3b Road Transportation	1198,190	0,000	5,8140	3,1512	0,0000	1207,155
1A3c Railways	31,130	0,000	0,0441	0,0781	0,0000	31,253
1A3d Navigation	0,000	0,000	0,0000	0,0000	0,0000	0,000
1A4 Other Sectors	998,745	0,000	34,8852	4,8868	0,0000	1038,517
1A4a Commercial/Institutional	100,371	0,000	0,5458	0,2449	0,0000	101,161
1A4b Residential	573,313	0,000	27,4523	3,6586	0,0000	604,424
1A4c Agriculture	325,061	0,000	6,8871	0,9833	0,0000	332,932
1B Fugitive Emissions from Fuels	0,000	0,000	271,1865	0,0000	0,0000	271,187
1B1 Solid Fuel	0,000	0,000	19,8795	0,0000	0,0000	19,880
1B2 Oil and Natural Gas	0,000	0,000	251,3070	0,0000	0,0000	251,307
1B2a Oil	0,000	0,000	18,7530	0,0000	0,0000	18,753
1B2b Natural Gas	0,000	0,000	232,5540	0,0000	0,0000	232,554
2 Industrial Processes	**641,081**	**0,000**	**0,0000**	**0,0000**	**4,7175**	**645,798**
2A Mineral Products	626,528	0,000	0,0000	0,0000	0,0000	626,528
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	12,270	0,000	0,0000	0,0000	0,0000	12,270
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	4,7175	4,718
2G Shot-firing	2,283	0,000	0,0000	0,0000	0,0000	2,283
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**1999,5528**	**1278,1672**	**0,0000**	**3277,720**
4A Enteric Fermentation	0,000	0,000	1844,7471	0,0000	0,0000	1844,747
4B Manure Management	0,000	0,000	96,5727	0,0000	0,0000	96,573
4C Rice Cultivation	0,000	0,000	51,1980	0,0000	0,0000	51,198
4D Agricultural Soils	0,000	0,000	0,0000	1275,4640	0,0000	1275,464
4F Field Burning of Agricultural Residues	0,000	0,000	7,0335	2,7032	0,0000	9,737
5 Land Use, Land-Use Change and Forestry (LULUCF)	**629,310**	**-764,051**	**2,3327**	**0,2009**	**0,0000**	**-132,207**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-764,051	2,3327	0,2009	0,0000	-761,517
5B Forest and Grassland Conversion	629,310	0,000	0,0000	0,0000	0,0000	629,310
6 Wastes	**0,000**	**0,000**	**565,5946**	**72,5493**	**0,0000**	**638,144**
6A Solid Waste Disposal on Land	0,000	0,000	508,4981	0,0000	0,0000	508,498
6B Wastewater Handling	0,000	0,000	57,0965	72,5493	0,0000	129,646
6B1 Industrial Wastewater	0,000	0,000	10,3542	0,0000	0,0000	10,354
6B2 Domestic and Commercial Wastewater	0,000	0,000	46,7424	72,5493	0,0000	119,292

1998

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**6125,879**	**-793,783**	**2766,2086**	**1359,1276**	**5,5099**	**9462,942**
1 Energy	**5144,456**	**0,000**	**249,1417**	**16,5869**	**0,0000**	**5410,184**
1A Fuel combustion	5144,456	0,000	52,4424	16,5869	0,0000	5213,485
1A1 Energy Industries	2373,275	0,000	0,8673	6,4539	0,0000	2380,596
1A2 Manufacturing Industries and Construction	468,151	0,000	0,6750	0,9064	0,0000	469,732
1A3 Transport	1144,913	0,000	5,2273	3,0932	0,0000	1153,234
1A3a Civil Aviation	14,923	0,000	0,0022	0,1308	0,0000	15,056
1A3b Road Transportation	1102,230	0,000	5,1857	2,8926	0,0000	1110,308
1A3c Railways	27,761	0,000	0,0394	0,0698	0,0000	27,870
1A3d Navigation	0,000	0,000	0,0000	0,0000	0,0000	0,000
1A4 Other Sectors	1158,117	0,000	45,6728	6,1334	0,0000	1209,923
1A4a Commercial/Institutional	123,751	0,000	0,5977	0,3946	0,0000	124,743
1A4b Residential	654,969	0,000	34,9561	4,5130	0,0000	694,438
1A4c Agriculture	379,397	0,000	10,1190	1,2257	0,0000	390,742
1B Fugitive Emissions from Fuels	0,000	0,000	196,6993	0,0000	0,0000	196,699
1B1 Solid Fuel	0,000	0,000	12,4873	0,0000	0,0000	12,487
1B2 Oil and Natural Gas	0,000	0,000	184,2120	0,0000	0,0000	184,212
1B2a Oil	0,000	0,000	18,7320	0,0000	0,0000	18,732
1B2b Natural Gas	0,000	0,000	165,4800	0,0000	0,0000	165,480
2 Industrial Processes	**375,094**	**0,000**	**0,0000**	**0,0000**	**5,5099**	**380,604**
2A Mineral Products	358,876	0,000	0,0000	0,0000	0,0000	358,876
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	11,996	0,000	0,0000	0,0000	0,0000	11,996
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	5,5099	5,510
2G Shot-firing	4,222	0,000	0,0000	0,0000	0,0000	4,222
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2038,6989**	**1266,4368**	**0,0000**	**3305,136**
4A Enteric Fermentation	0,000	0,000	1885,4535	0,0000	0,0000	1885,454
4B Manure Management	0,000	0,000	100,4583	0,0000	0,0000	100,458
4C Rice Cultivation	0,000	0,000	45,9480	0,0000	0,0000	45,948
4D Agricultural Soils	0,000	0,000	0,0000	1263,7770	0,0000	1263,777
4F Field Burning of Agricultural Residues	0,000	0,000	6,8399	2,6598	0,0000	9,500
5 Land Use, Land-Use Change and Forestry (LULUCF)	**606,330**	**-793,783**	**1,9082**	**0,1643**	**0,0000**	**-185,381**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-793,783	1,9082	0,1643	0,0000	-791,711
5B Forest and Grassland Conversion	606,330	0,000	0,0000	0,0000	0,0000	606,330
6 Wastes	**0,000**	**0,000**	**476,4598**	**75,9396**	**0,0000**	**552,399**
6A Solid Waste Disposal on Land	0,000	0,000	412,2191	0,0000	0,0000	412,219
6B Wastewater Handling	0,000	0,000	64,2407	75,9396	0,0000	140,180
6B1 Industrial Wastewater	0,000	0,000	4,5436	0,0000	0,0000	4,544
6B2 Domestic and Commercial Wastewater	0,000	0,000	59,6972	75,9396	0,0000	135,637

1999

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**5641,263**	**-827,822**	**2799,9041**	**1373,5237**	**6,4703**	**8993,339**
1 Energy	**4837,568**	**0,000**	**194,8619**	**17,1970**	**0,0000**	**5049,627**
1A Fuel combustion	4837,568	0,000	61,8230	17,1970	0,0000	4916,588
1A1 Energy Industries	2007,018	0,000	0,7277	6,1991	0,0000	2013,945
1A2 Manufacturing Industries and Construction	467,322	0,000	0,6399	0,9092	0,0000	468,871
1A3 Transport	1045,740	0,000	4,5943	2,8273	0,0000	1053,162
1A3a Civil Aviation	15,069	0,000	0,0022	0,1321	0,0000	15,204
1A3b Road Transportation	1006,280	0,000	4,5575	2,6338	0,0000	1013,471
1A3c Railways	24,391	0,000	0,0346	0,0614	0,0000	24,487
1A3d Navigation	0,000	0,000	0,0000	0,0000	0,0000	0,000
1A4 Other Sectors	1317,488	0,000	55,8611	7,2614	0,0000	1380,610
1A4a Commercial/Institutional	147,131	0,000	0,6497	0,5441	0,0000	148,324
1A4b Residential	736,624	0,000	41,8605	5,2495	0,0000	783,734
1A4c Agriculture	433,734	0,000	13,3508	1,4679	0,0000	448,552
1B Fugitive Emissions from Fuels	0,000	0,000	133,0389	0,0000	0,0000	133,039
1B1 Solid Fuel	0,000	0,000	11,3649	0,0000	0,0000	11,365
1B2 Oil and Natural Gas	0,000	0,000	121,6740	0,0000	0,0000	121,674
1B2a Oil	0,000	0,000	19,0680	0,0000	0,0000	19,068
1B2b Natural Gas	0,000	0,000	102,6060	0,0000	0,0000	102,606
2 Industrial Processes	**214,655**	**0,000**	**0,0000**	**0,0000**	**6,4703**	**221,125**
2A Mineral Products	197,775	0,000	0,0000	0,0000	0,0000	197,775
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	12,149	0,000	0,0000	0,0000	0,0000	12,149
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	6,4703	6,470
2G Shot-firing	4,731	0,000	0,0000	0,0000	0,0000	4,731
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2085,8544**	**1278,0866**	**0,0000**	**3363,941**
4A Enteric Fermentation	0,000	0,000	1924,5450	0,0000	0,0000	1924,545
4B Manure Management	0,000	0,000	103,6751	0,0000	0,0000	103,675
4C Rice Cultivation	0,000	0,000	51,0048	0,0000	0,0000	51,005
4D Agricultural Soils	0,000	0,000	0,0000	1275,4640	0,0000	1275,464
4F Field Burning of Agricultural Residues	0,000	0,000	6,6278	2,6226	0,0000	9,250
5 Land Use, Land-Use Change and Forestry (LULUCF)	**589,040**	**-827,822**	**1,5770**	**0,1358**	**0,0000**	**-237,069**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-827,822	1,5770	0,1358	0,0000	-826,109
5B Forest and Grassland Conversion	589,040	0,000	0,0000	0,0000	0,0000	589,040
6 Wastes	**0,000**	**0,000**	**517,6108**	**78,1043**	**0,0000**	**595,715**
6A Solid Waste Disposal on Land	0,000	0,000	456,2133	0,0000	0,0000	456,213
6B Wastewater Handling	0,000	0,000	61,3975	78,1043	0,0000	139,502
6B1 Industrial Wastewater	0,000	0,000	1,4924	0,0000	0,0000	1,492
6B2 Domestic and Commercial Wastewater	0,000	0,000	59,9051	78,1043	0,0000	138,009

2000

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**5534,042**	**-808,808**	**2957,3356**	**1367,4926**	**7,5988**	**9057,660**
1 Energy	**4710,341**	**0,000**	**328,5553**	**16,8998**	**0,0000**	**5055,796**
1A Fuel combustion	4710,341	0,000	59,0455	16,8998	0,0000	4786,286
1A1 Energy Industries	2144,894	0,000	0,7403	6,3624	0,0000	2151,997
1A2 Manufacturing Industries and Construction	460,976	0,000	0,6333	0,8897	0,0000	462,499
1A3 Transport	949,520	0,000	4,2525	2,5629	0,0000	956,336
1A3a Civil Aviation	12,737	0,000	0,0019	0,1117	0,0000	12,851
1A3b Road Transportation	912,713	0,000	4,2165	2,3907	0,0000	919,320
1A3c Railways	23,909	0,000	0,0339	0,0601	0,0000	24,003
1A3d Navigation	0,160	0,000	0,0002	0,0004	0,0000	0,161
1A4 Other Sectors	1154,951	0,000	53,4195	7,0847	0,0000	1215,455
1A4a Commercial/Institutional	148,455	0,000	0,6810	0,5828	0,0000	149,718
1A4b Residential	703,237	0,000	44,9977	5,5227	0,0000	753,758
1A4c Agriculture	303,259	0,000	7,7407	0,9793	0,0000	311,979
1B Fugitive Emissions from Fuels	0,000	0,000	269,5098	0,0000	0,0000	269,510
1B1 Solid Fuel	0,000	0,000	20,7648	0,0000	0,0000	20,765
1B2 Oil and Natural Gas	0,000	0,000	248,7450	0,0000	0,0000	248,745
1B2a Oil	0,000	0,000	19,3200	0,0000	0,0000	19,320
1B2b Natural Gas	0,000	0,000	229,4250	0,0000	0,0000	229,425
2 Industrial Processes	**246,801**	**0,000**	**0,0000**	**0,0000**	**7,5988**	**254,399**
2A Mineral Products	229,818	0,000	0,0000	0,0000	0,0000	229,818
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	10,508	0,000	0,0000	0,0000	0,0000	10,508
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	7,5988	7,599
2G Shot-firing	6,475	0,000	0,0000	0,0000	0,0000	6,475
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2115,7710**	**1274,9990**	**0,0000**	**3390,770**
4A Enteric Fermentation	0,000	0,000	1950,0096	0,0000	0,0000	1950,010
4B Manure Management	0,000	0,000	105,6103	0,0000	0,0000	105,610
4C Rice Cultivation	0,000	0,000	53,9196	0,0000	0,0000	53,920
4D Agricultural Soils	0,000	0,000	0,0000	1272,5190	0,0000	1272,519
4F Field Burning of Agricultural Residues	0,000	0,000	6,2326	2,4800	0,0000	8,713
5 Land Use, Land-Use Change and Forestry (LULUCF)	**576,900**	**-808,808**	**2,4617**	**0,2120**	**0,0000**	**-229,235**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-808,808	2,4617	0,2120	0,0000	-806,135
5B Forest and Grassland Conversion	576,900	0,000	0,0000	0,0000	0,0000	576,900
6 Wastes	**0,000**	**0,000**	**510,5477**	**75,3817**	**0,0000**	**585,929**
6A Solid Waste Disposal on Land	0,000	0,000	438,5168	0,0000	0,0000	438,517
6B Wastewater Handling	0,000	0,000	72,0309	75,3817	0,0000	147,413
6B1 Industrial Wastewater	0,000	0,000	6,5777	0,0000	0,0000	6,578
6B2 Domestic and Commercial Wastewater	0,000	0,000	65,4532	75,3817	0,0000	140,835

2001

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**5298,153**	**-813,996**	**3103,4090**	**1411,2471**	**8,8953**	**9007,709**
1 Energy	**4471,014**	**0,000**	**455,8980**	**16,1352**	**0,0000**	**4943,048**
1A Fuel combustion	4471,014	0,000	57,1240	16,1352	0,0000	4544,274
1A1 Energy Industries	2170,808	0,000	0,7244	5,8835	0,0000	2177,416
1A2 Manufacturing Industries and Construction	454,630	0,000	0,6266	0,8702	0,0000	456,127
1A3 Transport	853,302	0,000	3,9107	2,2989	0,0000	859,512
1A3a Civil Aviation	10,405	0,000	0,0015	0,0912	0,0000	10,498
1A3b Road Transportation	819,148	0,000	3,8755	2,1480	0,0000	825,171
1A3c Railways	23,428	0,000	0,0332	0,0589	0,0000	23,520
1A3d Navigation	0,321	0,000	0,0005	0,0008	0,0000	0,322
1A4 Other Sectors	992,274	0,000	51,8624	7,0826	0,0000	1051,219
1A4a Commercial/Institutional	149,789	0,000	0,7123	0,6219	0,0000	151,123
1A4b Residential	669,851	0,000	49,0194	5,9703	0,0000	724,840
1A4c Agriculture	172,635	0,000	2,1307	0,4904	0,0000	175,256
1B Fugitive Emissions from Fuels	0,000	0,000	398,7740	0,0000	0,0000	398,774
1B1 Solid Fuel	0,000	0,000	22,1390	0,0000	0,0000	22,139
1B2 Oil and Natural Gas	0,000	0,000	376,6350	0,0000	0,0000	376,635
1B2a Oil	0,000	0,000	23,4780	0,0000	0,0000	23,478
1B2b Natural Gas	0,000	0,000	353,1570	0,0000	0,0000	353,157
2 Industrial Processes	**257,789**	**0,000**	**0,0000**	**0,0000**	**8,8953**	**266,684**
2A Mineral Products	240,071	0,000	0,0000	0,0000	0,0000	240,071
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	11,424	0,000	0,0000	0,0000	0,0000	11,424
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	8,8953	8,895
2G Shot-firing	6,294	0,000	0,0000	0,0000	0,0000	6,294
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2138,7030**	**1318,3153**	**0,0000**	**3457,018**
4A Enteric Fermentation	0,000	0,000	1977,0786	0,0000	0,0000	1977,079
4B Manure Management	0,000	0,000	107,3062	0,0000	0,0000	107,306
4C Rice Cultivation	0,000	0,000	47,2416	0,0000	0,0000	47,242
4D Agricultural Soils	0,000	0,000	0,0000	1315,4850	0,0000	1315,485
4F Field Burning of Agricultural Residues	0,000	0,000	7,0820	2,8303	0,0000	9,912
5 Land Use, Land-Use Change and Forestry (LULUCF)	**569,350**	**-813,996**	**2,1445**	**0,1848**	**0,0000**	**-242,317**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-813,996	2,1445	0,1848	0,0000	-811,667
5B Forest and Grassland Conversion	569,350	0,000	0,0000	0,0000	0,0000	569,350
6 Wastes	**0,000**	**0,000**	**506,6634**	**76,6119**	**0,0000**	**583,275**
6A Solid Waste Disposal on Land	0,000	0,000	437,4721	0,0000	0,0000	437,472
6B Wastewater Handling	0,000	0,000	69,1913	76,6119	0,0000	145,803
6B1 Industrial Wastewater	0,000	0,000	5,9442	0,0000	0,0000	5,944
6B2 Domestic and Commercial Wastewater	0,000	0,000	63,2472	76,6119	0,0000	139,859

2002

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**5510,236**	**-822,758**	**3447,1654**	**1439,6843**	**10,3600**	**9584,688**
1 Energy	**4642,274**	**0,000**	**756,0980**	**17,3294**	**0,0000**	**5415,701**
1A Fuel combustion	4642,274	0,000	59,3736	17,3294	0,0000	4718,977
1A1 Energy Industries	2217,832	0,000	0,7066	6,6303	0,0000	2225,169
1A2 Manufacturing Industries and Construction	493,231	0,000	0,7384	0,8872	0,0000	494,857
1A3 Transport	926,550	0,000	4,2946	2,4984	0,0000	933,343
1A3a Civil Aviation	10,924	0,000	0,0016	0,0958	0,0000	11,022
1A3b Road Transportation	892,291	0,000	4,2599	2,3439	0,0000	898,895
1A3c Railways	23,044	0,000	0,0327	0,0580	0,0000	23,134
1A3d Navigation	0,292	0,000	0,0004	0,0007	0,0000	0,293
1A4 Other Sectors	1004,660	0,000	53,6340	7,3135	0,0000	1065,608
1A4a Commercial/Institutional	143,351	0,000	0,6118	0,5992	0,0000	144,562
1A4b Residential	693,585	0,000	50,7476	6,2316	0,0000	750,564
1A4c Agriculture	167,724	0,000	2,2746	0,4827	0,0000	170,482
1B Fugitive Emissions from Fuels	0,000	0,000	696,7244	0,0000	0,0000	696,724
1B1 Solid Fuel	0,000	0,000	24,3674	0,0000	0,0000	24,367
1B2 Oil and Natural Gas	0,000	0,000	672,3570	0,0000	0,0000	672,357
1B2a Oil	0,000	0,000	19,2990	0,0000	0,0000	19,299
1B2b Natural Gas	0,000	0,000	653,0580	0,0000	0,0000	653,058
2 Industrial Processes	**302,242**	**0,000**	**0,0000**	**0,0000**	**10,3600**	**312,602**
2A Mineral Products	284,460	0,000	0,0000	0,0000	0,0000	284,460
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	10,508	0,000	0,0000	0,0000	0,0000	10,508
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	10,3600	10,360
2G Shot-firing	7,274	0,000	0,0000	0,0000	0,0000	7,274
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2184,5670**	**1340,7593**	**0,0000**	**3525,326**
4A Enteric Fermentation	0,000	0,000	2011,1931	0,0000	0,0000	2011,193
4B Manure Management	0,000	0,000	109,4774	0,0000	0,0000	109,477
4C Rice Cultivation	0,000	0,000	57,0024	0,0000	0,0000	57,002
4D Agricultural Soils	0,000	0,000	0,0000	1338,0220	0,0000	1338,022
4F Field Burning of Agricultural Residues	0,000	0,000	6,8943	2,7373	0,0000	9,632
5 Land Use, Land-Use Change and Forestry (LULUCF)	**565,720**	**-822,758**	**2,3255**	**0,2003**	**0,0000**	**-254,512**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-822,758	2,3255	0,2003	0,0000	-820,232
5B Forest and Grassland Conversion	565,720	0,000	0,0000	0,0000	0,0000	565,720
6 Wastes	**0,000**	**0,000**	**504,1749**	**81,3953**	**0,0000**	**585,570**
6A Solid Waste Disposal on Land	0,000	0,000	436,6459	0,0000	0,0000	436,646
6B Wastewater Handling	0,000	0,000	67,5290	81,3953	0,0000	148,924
6B1 Industrial Wastewater	0,000	0,000	4,3712	0,0000	0,0000	4,371
6B2 Domestic and Commercial Wastewater	0,000	0,000	63,1579	81,3953	0,0000	144,553

2003

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**5659,880**	**-821,911**	**3721,9331**	**1455,0934**	**11,9927**	**10026,988**
1 Energy	**4670,135**	**0,000**	**1058,7235**	**17,5394**	**0,0000**	**5746,398**
1A Fuel combustion	4670,135	0,000	60,7720	17,5394	0,0000	4748,446
1A1 Energy Industries	2121,457	0,000	0,6655	6,5556	0,0000	2128,678
1A2 Manufacturing Industries and Construction	531,833	0,000	0,8502	0,9043	0,0000	533,587
1A3 Transport	999,798	0,000	4,6784	2,6982	0,0000	1007,175
1A3a Civil Aviation	11,443	0,000	0,0017	0,1003	0,0000	11,545
1A3b Road Transportation	965,434	0,000	4,6442	2,5401	0,0000	972,618
1A3c Railways	22,659	0,000	0,0321	0,0570	0,0000	22,749
1A3d Navigation	0,262	0,000	0,0004	0,0007	0,0000	0,263
1A4 Other Sectors	1017,046	0,000	54,5779	7,3814	0,0000	1079,006
1A4a Commercial/Institutional	136,914	0,000	0,5113	0,5766	0,0000	138,002
1A4b Residential	717,319	0,000	51,6479	6,3299	0,0000	775,296
1A4c Agriculture	162,814	0,000	2,4186	0,4749	0,0000	165,708
1B Fugitive Emissions from Fuels	0,000	0,000	997,9515	0,0000	0,0000	997,952
1B1 Solid Fuel	0,000	0,000	20,9685	0,0000	0,0000	20,969
1B2 Oil and Natural Gas	0,000	0,000	976,9830	0,0000	0,0000	976,983
1B2a Oil	0,000	0,000	19,2780	0,0000	0,0000	19,278
1B2b Natural Gas	0,000	0,000	957,7050	0,0000	0,0000	957,705
2 Industrial Processes	**424,495**	**0,000**	**0,0000**	**0,0000**	**11,9927**	**436,488**
2A Mineral Products	405,456	0,000	0,0000	0,0000	0,0000	405,456
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	7,100	0,000	0,0000	0,0000	0,0000	7,100
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	11,9927	11,993
2G Shot-firing	11,939	0,000	0,0000	0,0000	0,0000	11,939
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2174,5710**	**1353,9126**	**0,0000**	**3528,484**
4A Enteric Fermentation	0,000	0,000	2008,2342	0,0000	0,0000	2008,234
4B Manure Management	0,000	0,000	107,5939	0,0000	0,0000	107,594
4C Rice Cultivation	0,000	0,000	52,3236	0,0000	0,0000	52,324
4D Agricultural Soils	0,000	0,000	0,0000	1351,3210	0,0000	1351,321
4F Field Burning of Agricultural Residues	0,000	0,000	6,4153	2,5916	0,0000	9,007
5 Land Use, Land-Use Change and Forestry (LULUCF)	**565,250**	**-821,911**	**2,5080**	**0,2161**	**0,0000**	**-253,937**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-821,911	2,5080	0,2161	0,0000	-819,187
5B Forest and Grassland Conversion	565,250	0,000	0,0000	0,0000	0,0000	565,250
6 Wastes	**0,000**	**0,000**	**486,1306**	**83,4253**	**0,0000**	**569,556**
6A Solid Waste Disposal on Land	0,000	0,000	423,3934	0,0000	0,0000	423,393
6B Wastewater Handling	0,000	0,000	62,7372	83,4253	0,0000	146,163
6B1 Industrial Wastewater	0,000	0,000	8,1345	0,0000	0,0000	8,135
6B2 Domestic and Commercial Wastewater	0,000	0,000	54,6027	83,4253	0,0000	138,028

2004

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**5886,323**	**-838,879**	**4220,1038**	**1452,8886**	**13,6634**	**10734,100**
1 Energy	**4826,880**	**0,000**	**1371,0234**	**18,5811**	**0,0000**	**6216,485**
1A Fuel combustion	4826,880	0,000	63,7677	18,5811	0,0000	4909,229
1A1 Energy Industries	2153,974	0,000	0,6707	7,0069	0,0000	2161,652
1A2 Manufacturing Industries and Construction	570,434	0,000	0,9619	0,9216	0,0000	572,318
1A3 Transport	1073,050	0,000	5,0623	2,8976	0,0000	1081,010
1A3a Civil Aviation	11,962	0,000	0,0018	0,1049	0,0000	12,068
1A3b Road Transportation	1038,580	0,000	5,0286	2,7364	0,0000	1046,345
1A3c Railways	22,275	0,000	0,0316	0,0558	0,0000	22,362
1A3d Navigation	0,233	0,000	0,0003	0,0006	0,0000	0,234
1A4 Other Sectors	1029,423	0,000	57,0727	7,7550	0,0000	1094,250
1A4a Commercial/Institutional	130,466	0,000	0,4108	0,5540	0,0000	131,431
1A4b Residential	741,052	0,000	54,0992	6,7335	0,0000	801,885
1A4c Agriculture	157,904	0,000	2,5626	0,4675	0,0000	160,934
1B Fugitive Emissions from Fuels	0,000	0,000	1307,2557	0,0000	0,0000	1307,256
1B1 Solid Fuel	0,000	0,000	24,1347	0,0000	0,0000	24,135
1B2 Oil and Natural Gas	0,000	0,000	1283,1210	0,0000	0,0000	1283,121
1B2a Oil	0,000	0,000	19,2360	0,0000	0,0000	19,236
1B2b Natural Gas	0,000	0,000	1263,8850	0,0000	0,0000	1263,885
2 Industrial Processes	**492,493**	**0,000**	**0,0000**	**0,0000**	**13,6634**	**506,156**
2A Mineral Products	472,755	0,000	0,0000	0,0000	0,0000	472,755
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	9,046	0,000	0,0000	0,0000	0,0000	9,046
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	13,6634	13,663
2G Shot-firing	10,692	0,000	0,0000	0,0000	0,0000	10,692
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2233,6650**	**1349,1138**	**0,0000**	**3582,779**
4A Enteric Fermentation	0,000	0,000	2064,6948	0,0000	0,0000	2064,695
4B Manure Management	0,000	0,000	110,5306	0,0000	0,0000	110,531
4C Rice Cultivation	0,000	0,000	51,8448	0,0000	0,0000	51,845
4D Agricultural Soils	0,000	0,000	0,0000	1346,4230	0,0000	1346,423
4F Field Burning of Agricultural Residues	0,000	0,000	6,5858	2,6908	0,0000	9,277
5 Land Use, Land-Use Change and Forestry (LULUCF)	**566,950**	**-838,879**	**2,0511**	**0,1767**	**0,0000**	**-269,701**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-838,879	2,0511	0,1767	0,0000	-836,651
5B Forest and Grassland Conversion	566,950	0,000	0,0000	0,0000	0,0000	566,950
6 Wastes	**0,000**	**0,000**	**613,3644**	**85,0169**	**0,0000**	**698,381**
6A Solid Waste Disposal on Land	0,000	0,000	554,5364	0,0000	0,0000	554,536
6B Wastewater Handling	0,000	0,000	58,8280	85,0169	0,0000	143,845
6B1 Industrial Wastewater	0,000	0,000	5,0527	0,0000	0,0000	5,053
6B2 Domestic and Commercial Wastewater	0,000	0,000	53,7753	85,0169	0,0000	138,792

2005

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**5961,846**	**-840,367**	**4480,5362**	**1499,0185**	**15,7622**	**11116,796**
1 Energy	**4851,768**	**0,000**	**1666,9949**	**18,7549**	**0,0000**	**6537,518**
1A Fuel combustion	4851,768	0,000	64,8518	18,7549	0,0000	4935,375
1A1 Energy Industries	2054,630	0,000	0,6082	6,9539	0,0000	2062,192
1A2 Manufacturing Industries and Construction	609,035	0,000	1,0738	0,9387	0,0000	611,047
1A3 Transport	1146,295	0,000	5,4462	3,0971	0,0000	1154,838
1A3a Civil Aviation	12,480	0,000	0,0019	0,1094	0,0000	12,592
1A3b Road Transportation	1111,720	0,000	5,4130	2,9323	0,0000	1120,065
1A3c Railways	21,891	0,000	0,0310	0,0549	0,0000	21,977
1A3d Navigation	0,204	0,000	0,0003	0,0005	0,0000	0,205
1A4 Other Sectors	1041,809	0,000	57,7236	7,7652	0,0000	1107,298
1A4a Commercial/Institutional	124,029	0,000	0,3104	0,5313	0,0000	124,870
1A4b Residential	764,786	0,000	54,7067	6,7741	0,0000	826,267
1A4c Agriculture	152,994	0,000	2,7066	0,4597	0,0000	156,160
1B Fugitive Emissions from Fuels	0,000	0,000	1602,1431	0,0000	0,0000	1602,143
1B1 Solid Fuel	0,000	0,000	22,2081	0,0000	0,0000	22,208
1B2 Oil and Natural Gas	0,000	0,000	1579,9350	0,0000	0,0000	1579,935
1B2a Oil	0,000	0,000	19,2570	0,0000	0,0000	19,257
1B2b Natural Gas	0,000	0,000	1560,6780	0,0000	0,0000	1560,678
2 Industrial Processes	**540,388**	**0,000**	**0,0000**	**0,0000**	**15,7622**	**556,150**
2A Mineral Products	525,991	0,000	0,0000	0,0000	0,0000	525,991
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	5,602	0,000	0,0000	0,0000	0,0000	5,602
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	15,7622	15,762
2G Shot-firing	8,795	0,000	0,0000	0,0000	0,0000	8,795
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2301,6630**	**1391,9961**	**0,0000**	**3693,659**
4A Enteric Fermentation	0,000	0,000	2132,6130	0,0000	0,0000	2132,613
4B Manure Management	0,000	0,000	113,5134	0,0000	0,0000	113,513
4C Rice Cultivation	0,000	0,000	49,2912	0,0000	0,0000	49,291
4D Agricultural Soils	0,000	0,000	0,0000	1389,4510	0,0000	1389,451
4F Field Burning of Agricultural Residues	0,000	0,000	6,2328	2,5451	0,0000	8,778
5 Land Use, Land-Use Change and Forestry (LULUCF)	**569,690**	**-840,367**	**1,8176**	**0,1566**	**0,0000**	**-268,703**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-840,367	1,8176	0,1566	0,0000	-838,393
5B Forest and Grassland Conversion	569,690	0,000	0,0000	0,0000	0,0000	569,690
6 Wastes	**0,000**	**0,000**	**510,0607**	**88,1109**	**0,0000**	**598,172**
6A Solid Waste Disposal on Land	0,000	0,000	455,9055	0,0000	0,0000	455,906
6B Wastewater Handling	0,000	0,000	54,1552	88,1109	0,0000	142,266
6B1 Industrial Wastewater	0,000	0,000	4,3806	0,0000	0,0000	4,381
6B2 Domestic and Commercial Wastewater	0,000	0,000	49,7746	88,1109	0,0000	137,886

2006

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**6099,765**	**-804,864**	**4398,7653**	**1511,7548**	**17,8991**	**11223,321**
1 Energy	**4961,463**	**0,000**	**1526,5980**	**21,1024**	**0,0000**	**6509,163**
1A Fuel combustion	4961,463	0,000	70,0875	21,1024	0,0000	5052,653
1A1 Energy Industries	1938,508	0,000	0,5628	6,6898	0,0000	1945,761
1A2 Manufacturing Industries and Construction	735,532	0,000	1,2984	1,0280	0,0000	737,858
1A3 Transport	1199,439	0,000	5,6259	3,2377	0,0000	1208,303
1A3a Civil Aviation	12,564	0,000	0,0021	0,1101	0,0000	12,676
1A3b Road Transportation	1164,560	0,000	5,5922	3,0715	0,0000	1173,224
1A3c Railways	22,316	0,000	0,0316	0,0561	0,0000	22,403
1A3d Navigation	0,000	0,000	0,0000	0,0000	0,0000	0,000
1A4 Other Sectors	1087,983	0,000	62,6003	10,1469	0,0000	1160,731
1A4a Commercial/Institutional	120,456	0,000	1,3504	2,6821	0,0000	124,489
1A4b Residential	861,407	0,000	60,9619	7,1970	0,0000	929,566
1A4c Agriculture	106,120	0,000	0,2880	0,2678	0,0000	106,676
1B Fugitive Emissions from Fuels	0,000	0,000	1456,5105	0,0000	0,0000	1456,511
1B1 Solid Fuel	0,000	0,000	24,0165	0,0000	0,0000	24,017
1B2 Oil and Natural Gas	0,000	0,000	1432,4940	0,0000	0,0000	1432,494
1B2a Oil	0,000	0,000	19,2360	0,0000	0,0000	19,236
1B2b Natural Gas	0,000	0,000	1413,2580	0,0000	0,0000	1413,258
2 Industrial Processes	**566,092**	**0,000**	**0,0000**	**0,0000**	**17,8991**	**583,992**
2A Mineral Products	562,917	0,000	0,0000	0,0000	0,0000	562,917
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	3,175	0,000	0,0000	0,0000	0,0000	3,175
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	17,8991	17,899
2G Shot-firing	0,000	0,000	0,0000	0,0000	0,0000	0,000
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2391,5640**	**1402,0215**	**0,0000**	**3793,586**
4A Enteric Fermentation	0,000	0,000	2215,0590	0,0000	0,0000	2215,059
4B Manure Management	0,000	0,000	117,5154	0,0000	0,0000	117,515
4C Rice Cultivation	0,000	0,000	53,3148	0,0000	0,0000	53,315
4D Agricultural Soils	0,000	0,000	0,0000	1399,6810	0,0000	1399,681
4F Field Burning of Agricultural Residues	0,000	0,000	5,6771	2,3405	0,0000	8,018
5 Land Use, Land-Use Change and Forestry (LULUCF)	**572,210**	**-804,864**	**2,5071**	**0,2158**	**0,0000**	**-229,931**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-804,864	2,5071	0,2158	0,0000	-802,141
5B Forest and Grassland Conversion	572,210	0,000	0,0000	0,0000	0,0000	572,210
6 Wastes	**0,000**	**0,000**	**478,0963**	**88,4152**	**0,0000**	**566,511**
6A Solid Waste Disposal on Land	0,000	0,000	411,6488	0,0000	0,0000	411,649
6B Wastewater Handling	0,000	0,000	66,4475	88,4152	0,0000	154,863
6B1 Industrial Wastewater	0,000	0,000	14,0328	0,0000	0,0000	14,033
6B2 Domestic and Commercial Wastewater	0,000	0,000	52,4147	88,4152	0,0000	140,830

2007

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**7077,821**	**-804,167**	**4426,2861**	**1550,2310**	**20,2041**	**12270,375**
1 Energy	**5840,425**	**0,000**	**1513,9987**	**23,0236**	**0,0000**	**7377,447**
1A Fuel combustion	5840,425	0,000	72,0197	23,0236	0,0000	5935,468
1A1 Energy Industries	1915,799	0,000	0,5515	6,6433	0,0000	1922,994
1A2 Manufacturing Industries and Construction	775,336	0,000	1,4019	1,1811	0,0000	777,919
1A3 Transport	1800,369	0,000	8,3509	4,8201	0,0000	1813,540
1A3a Civil Aviation	13,302	0,000	0,0033	0,1163	0,0000	13,422
1A3b Road Transportation	1760,030	0,000	8,3092	4,6357	0,0000	1772,975
1A3c Railways	26,861	0,000	0,0381	0,0676	0,0000	26,966
1A3d Navigation	0,177	0,000	0,0002	0,0004	0,0000	0,178
1A4 Other Sectors	1348,921	0,000	61,7153	10,3791	0,0000	1421,015
1A4a Commercial/Institutional	151,683	0,000	1,6867	3,0895	0,0000	156,459
1A4b Residential	876,731	0,000	58,6173	6,4843	0,0000	941,833
1A4c Agriculture	320,507	0,000	1,4114	0,8054	0,0000	322,724
1B Fugitive Emissions from Fuels	0,000	0,000	1441,9790	0,0000	0,0000	1441,979
1B1 Solid Fuel	0,000	0,000	21,3290	0,0000	0,0000	21,329
1B2 Oil and Natural Gas	0,000	0,000	1420,6500	0,0000	0,0000	1420,650
1B2a Oil	0,000	0,000	19,2570	0,0000	0,0000	19,257
1B2b Natural Gas	0,000	0,000	1401,3930	0,0000	0,0000	1401,393
2 Industrial Processes	**664,116**	**0,000**	**0,0000**	**0,0000**	**20,2041**	**684,320**
2A Mineral Products	657,586	0,000	0,0000	0,0000	0,0000	657,586
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	6,530	0,000	0,0000	0,0000	0,0000	6,530
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	20,2041	20,204
2G Shot-firing	0,000	0,000	0,0000	0,0000	0,0000	0,000
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2491,7970**	**1440,5762**	**0,0000**	**3932,373**
4A Enteric Fermentation	0,000	0,000	2312,8140	0,0000	0,0000	2312,814
4B Manure Management	0,000	0,000	121,9951	0,0000	0,0000	121,995
4C Rice Cultivation	0,000	0,000	51,8028	0,0000	0,0000	51,803
4D Agricultural Soils	0,000	0,000	0,0000	1438,4000	0,0000	1438,400
4F Field Burning of Agricultural Residues	0,000	0,000	5,1834	2,1762	0,0000	7,360
5 Land Use, Land-Use Change and Forestry (LULUCF)	**573,280**	**-804,167**	**2,4001**	**0,2068**	**0,0000**	**-228,280**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-804,167	2,4001	0,2068	0,0000	-801,560
5B Forest and Grassland Conversion	573,280	0,000	0,0000	0,0000	0,0000	573,280
6 Wastes	**0,000**	**0,000**	**418,0903**	**86,4244**	**0,0000**	**504,515**
6A Solid Waste Disposal on Land	0,000	0,000	347,9829	0,0000	0,0000	347,983
6B Wastewater Handling	0,000	0,000	70,1074	86,4244	0,0000	156,532
6B1 Industrial Wastewater	0,000	0,000	15,4101	0,0000	0,0000	15,410
6B2 Domestic and Commercial Wastewater	0,000	0,000	54,6973	86,4244	0,0000	141,122

2008

Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**7929,445**	**-804,080**	**4821,8887**	**1569,1471**	**22,6771**	**13539,077**
1 Energy	**6675,641**	**0,000**	**1662,0900**	**24,4290**	**0,0000**	**8362,160**
1A Fuel combustion	6675,641	0,000	95,8452	24,4290	0,0000	6795,915
1A1 Energy Industries	2286,267	0,000	0,6270	8,3982	0,0000	2295,292
1A2 Manufacturing Industries and Construction	697,610	0,000	1,2411	0,9170	0,0000	699,768
1A3 Transport	2036,646	0,000	9,3894	5,4362	0,0000	2051,472
1A3a Civil Aviation	12,673	0,000	0,0026	0,1109	0,0000	12,786
1A3b Road Transportation	1996,640	0,000	9,3482	5,2570	0,0000	2011,245
1A3c Railways	26,800	0,000	0,0379	0,0670	0,0000	26,905
1A3d Navigation	0,534	0,000	0,0008	0,0013	0,0000	0,536
1A4 Other Sectors	1655,118	0,000	84,5878	9,6776	0,0000	1749,383
1A4a Commercial/Institutional	215,506	0,000	0,6097	0,8609	0,0000	216,976
1A4b Residential	1195,987	0,000	83,3646	8,2029	0,0000	1287,555
1A4c Agriculture	243,625	0,000	0,6135	0,6138	0,0000	244,852
1B Fugitive Emissions from Fuels	0,000	0,000	1566,2449	0,0000	0,0000	1566,245
1B1 Solid Fuel	0,000	0,000	25,8109	0,0000	0,0000	25,811
1B2 Oil and Natural Gas	0,000	0,000	1540,4340	0,0000	0,0000	1540,434
1B2a Oil	0,000	0,000	19,2570	0,0000	0,0000	19,257
1B2b Natural Gas	0,000	0,000	1521,1770	0,0000	0,0000	1521,177
2 Industrial Processes	**682,013**	**0,000**	**0,0000**	**0,0000**	**22,6771**	**704,691**
2A Mineral Products	676,983	0,000	0,0000	0,0000	0,0000	676,983
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	5,030	0,000	0,0000	0,0000	0,0000	5,030
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	22,6771	22,677
2G Shot-firing	0,000	0,000	0,0000	0,0000	0,0000	0,000
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2607,9480**	**1454,4084**	**0,0000**	**4062,356**
4A Enteric Fermentation	0,000	0,000	2424,8070	0,0000	0,0000	2424,807
4B Manure Management	0,000	0,000	127,2377	0,0000	0,0000	127,238
4C Rice Cultivation	0,000	0,000	50,6184	0,0000	0,0000	50,618
4D Agricultural Soils	0,000	0,000	0,0000	1452,1950	0,0000	1452,195
4F Field Burning of Agricultural Residues	0,000	0,000	5,2975	2,2134	0,0000	7,511
5 Land Use, Land-Use Change and Forestry (LULUCF)	**571,790**	**-804,080**	**2,2157**	**0,1907**	**0,0000**	**-229,884**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-804,080	2,2157	0,1907	0,0000	-801,674
5B Forest and Grassland Conversion	571,790	0,000	0,0000	0,0000	0,0000	571,790
6 Wastes	**0,000**	**0,000**	**549,6349**	**90,1190**	**0,0000**	**639,754**
6A Solid Waste Disposal on Land	0,000	0,000	482,0452	0,0000	0,0000	482,045
6B Wastewater Handling	0,000	0,000	67,5897	90,1190	0,0000	157,709
6B1 Industrial Wastewater	0,000	0,000	13,5680	0,0000	0,0000	13,568
6B2 Domestic and Commercial Wastewater	0,000	0,000	54,0217	90,1190	0,0000	144,141

2009

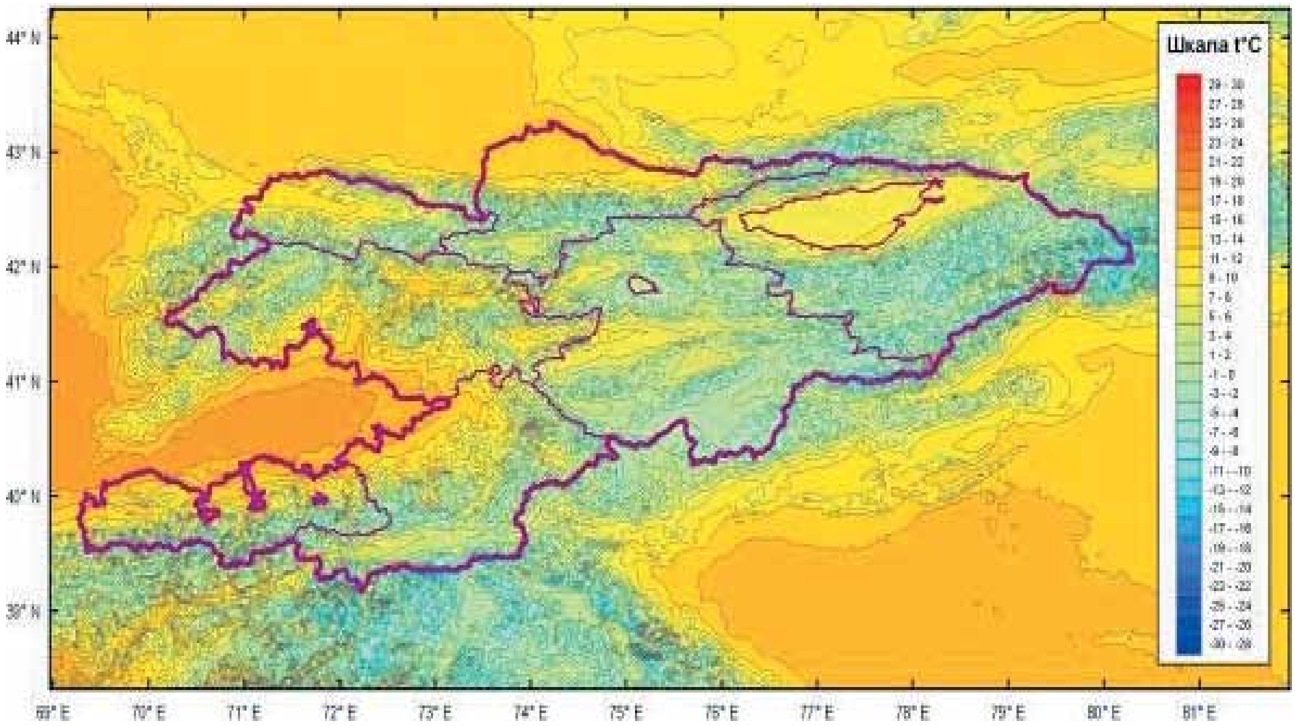
Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**7501,451**	**-803,662**	**5023,7974**	**1680,3978**	**25,3182**	**13427,302**
1 Energy	**6612,306**	**0,000**	**1125,0372**	**23,6378**	**0,0000**	**7760,981**
1A Fuel combustion	6612,306	0,000	88,5497	23,6378	0,0000	6724,494
1A1 Energy Industries	2126,409	0,000	0,7120	8,1694	0,0000	2135,290
1A2 Manufacturing Industries and Construction	395,020	0,000	0,5392	1,0928	0,0000	396,652
1A3 Transport	2427,504	0,000	10,7287	6,4647	0,0000	2444,698
1A3a Civil Aviation	14,149	0,000	0,0048	0,1234	0,0000	14,277
1A3b Road Transportation	2358,330	0,000	10,6477	6,2065	0,0000	2375,184
1A3c Railways	54,670	0,000	0,0757	0,1339	0,0000	54,879
1A3d Navigation	0,356	0,000	0,0005	0,0009	0,0000	0,357
1A4 Other Sectors	1663,373	0,000	76,5699	7,9109	0,0000	1747,853
1A4a Commercial/Institutional	231,056	0,000	0,6828	0,8575	0,0000	232,597
1A4b Residential	1235,317	0,000	75,3567	6,5488	0,0000	1317,223
1A4c Agriculture	196,999	0,000	0,5304	0,5047	0,0000	198,034
1B Fugitive Emissions from Fuels	0,000	0,000	1036,4875	0,0000	0,0000	1036,487
1B1 Solid Fuel	0,000	0,000	23,3005	0,0000	0,0000	23,300
1B2 Oil and Natural Gas	0,000	0,000	1013,1870	0,0000	0,0000	1013,187
1B2a Oil	0,000	0,000	19,2360	0,0000	0,0000	19,236
1B2b Natural Gas	0,000	0,000	993,9510	0,0000	0,0000	993,951
2 Industrial Processes	**322,205**	**0,000**	**0,0000**	**0,0000**	**25,3182**	**347,523**
2A Mineral Products	319,317	0,000	0,0000	0,0000	0,0000	319,317
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	2,888	0,000	0,0000	0,0000	0,0000	2,888
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	25,3182	25,318
2G Shot-firing	0,000	0,000	0,0000	0,0000	0,0000	0,000
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2734,0740**	**1562,4217**	**0,0000**	**4296,496**
4A Enteric Fermentation	0,000	0,000	2541,2310	0,0000	0,0000	2541,231
4B Manure Management	0,000	0,000	132,9019	0,0000	0,0000	132,902
4C Rice Cultivation	0,000	0,000	52,7856	0,0000	0,0000	52,786
4D Agricultural Soils	0,000	0,000	0,0000	1559,4860	0,0000	1559,486
4F Field Burning of Agricultural Residues	0,000	0,000	7,1579	2,9357	0,0000	10,094
5 Land Use, Land-Use Change and Forestry (LULUCF)	**566,940**	**-803,662**	**1,9671**	**0,1693**	**0,0000**	**-234,586**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-803,662	1,9671	0,1693	0,0000	-801,526
5B Forest and Grassland Conversion	566,940	0,000	0,0000	0,0000	0,0000	566,940
6 Wastes	**0,000**	**0,000**	**1162,7190**	**94,1691**	**0,0000**	**1256,888**
6A Solid Waste Disposal on Land	0,000	0,000	1091,0037	0,0000	0,0000	1091,004
6B Wastewater Handling	0,000	0,000	71,7153	94,1691	0,0000	165,884
6B1 Industrial Wastewater	0,000	0,000	15,5309	0,0000	0,0000	15,531
6B2 Domestic and Commercial Wastewater	0,000	0,000	56,1844	94,1691	0,0000	150,353

2010

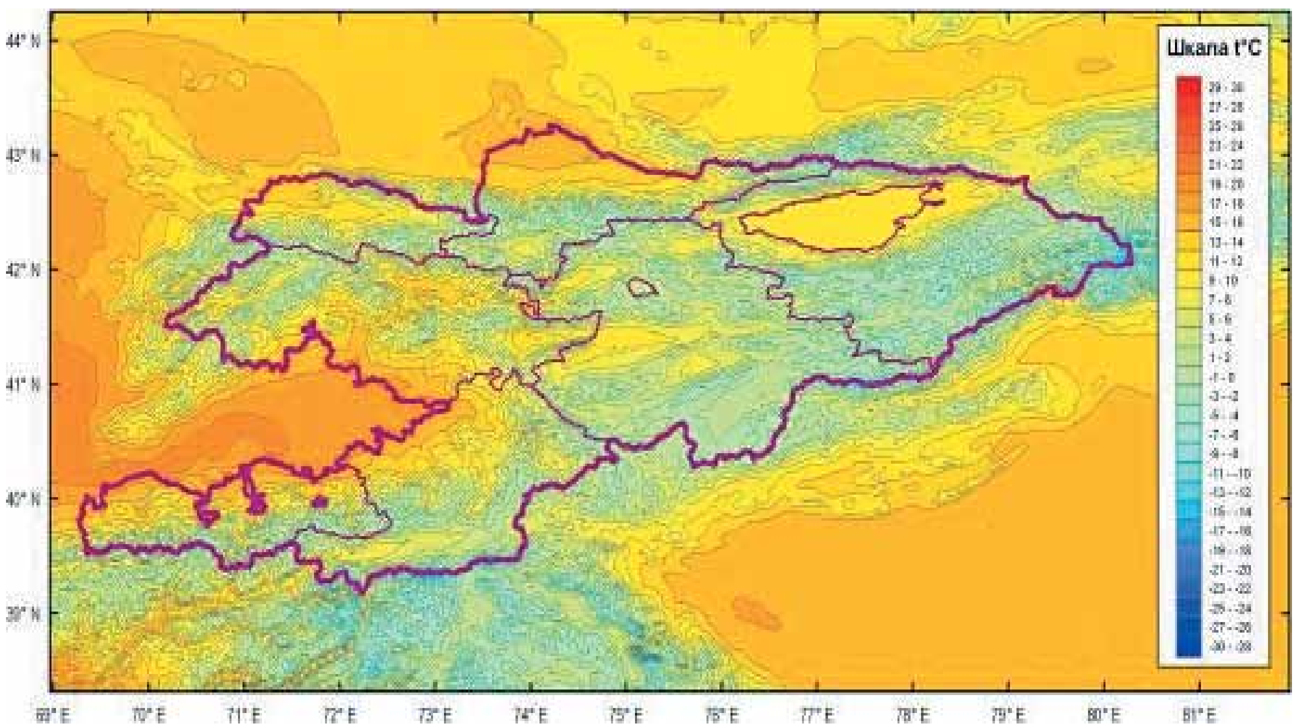
Source Categories \ Greenhouse Gases	CO_2 emissions	CO_2 sinks	CH_4	N_2O	HFC_s	Total
National emissions and sinks	**6921,677**	**-804,097**	**4713,1629**	**1699,4463**	**28,1273**	**12558,316**
1 Energy	**5980,268**	**0,000**	**977,9863**	**22,5413**	**0,0000**	**6980,795**
1A Fuel combustion	5980,268	0,000	97,0072	22,5413	0,0000	6099,816
1A1 Energy Industries	1659,081	0,000	0,5073	6,3407	0,0000	1665,929
1A2 Manufacturing Industries and Construction	512,467	0,000	0,6162	1,3578	0,0000	514,441
1A3 Transport	2132,909	0,000	9,1045	5,6605	0,0000	2147,674
1A3a Civil Aviation	18,641	0,000	0,0068	0,1625	0,0000	18,810
1A3b Road Transportation	2112,330	0,000	9,0950	5,4932	0,0000	2126,918
1A3c Railways	1,690	0,000	0,0024	0,0042	0,0000	1,696
1A3d Navigation	0,248	0,000	0,0004	0,0006	0,0000	0,249
1A4 Other Sectors	1675,811	0,000	86,7792	9,1822	0,0000	1771,772
1A4a Commercial/Institutional	210,211	0,000	0,6000	0,8091	0,0000	211,620
1A4b Residential	1262,056	0,000	85,7910	7,8570	0,0000	1355,704
1A4c Agriculture	203,544	0,000	0,3882	0,5162	0,0000	204,448
1B Fugitive Emissions from Fuels	0,000	0,000	880,9791	0,0000	0,0000	880,979
1B1 Solid Fuel	0,000	0,000	27,8541	0,0000	0,0000	27,854
1B2 Oil and Natural Gas	0,000	0,000	853,1250	0,0000	0,0000	853,125
1B2a Oil	0,000	0,000	19,2570	0,0000	0,0000	19,257
1B2b Natural Gas	0,000	0,000	833,8680	0,0000	0,0000	833,868
2 Industrial Processes	**383,109**	**0,000**	**0,0000**	**0,0000**	**28,1273**	**411,237**
2A Mineral Products	381,042	0,000	0,0000	0,0000	0,0000	381,042
2B Chemical Industry	0,000	0,000	0,0000	0,0000	0,0000	0,000
2C Metal Production	2,067	0,000	0,0000	0,0000	0,0000	2,067
2D Other Production (food and drinks)	0,000	0,000	0,0000	0,0000	0,0000	0,000
2F Consumption of Halocarbons and Sulphur Hexafluoride	0,000	0,000	0,0000	0,0000	28,1273	28,127
2G Shot-firing	0,000	0,000	0,0000	0,0000	0,0000	0,000
3 Solvent and Other Product Use	**0,000**	**0,000**	**0,0000**	**0,0000**	**0,0000**	**0,000**
4 Agriculture	**0,000**	**0,000**	**2793,5460**	**1582,2679**	**0,0000**	**4375,814**
4A Enteric Fermentation	0,000	0,000	2598,2040	0,0000	0,0000	2598,204
4B Manure Management	0,000	0,000	134,3599	0,0000	0,0000	134,360
4C Rice Cultivation	0,000	0,000	55,3224	0,0000	0,0000	55,322
4D Agricultural Soils	0,000	0,000	0,0000	1579,9150	0,0000	1579,915
4F Field Burning of Agricultural Residues	0,000	0,000	5,6795	2,3529	0,0000	8,032
5 Land Use, Land-Use Change and Forestry (LULUCF)	**558,300**	**-804,097**	**1,9126**	**0,1646**	**0,0000**	**-243,720**
5A Changes in Forest and Other Woody Biomass Stocks	0,000	-804,097	1,9126	0,1646	0,0000	-802,020
5B Forest and Grassland Conversion	558,300	0,000	0,0000	0,0000	0,0000	558,300
6 Wastes	**0,000**	**0,000**	**939,7181**	**94,4725**	**0,0000**	**1034,191**
6A Solid Waste Disposal on Land	0,000	0,000	873,7240	0,0000	0,0000	873,724
6B Wastewater Handling	0,000	0,000	65,9941	94,4725	0,0000	160,467
6B1 Industrial Wastewater	0,000	0,000	19,8228	0,0000	0,0000	19,823
6B2 Domestic and Commercial Wastewater	0,000	0,000	46,1713	94,4725	0,0000	140,644

Annex 3. Distribution of ground temperature (°C) and annual precipitation (mm) in the Kyrgyz Republic

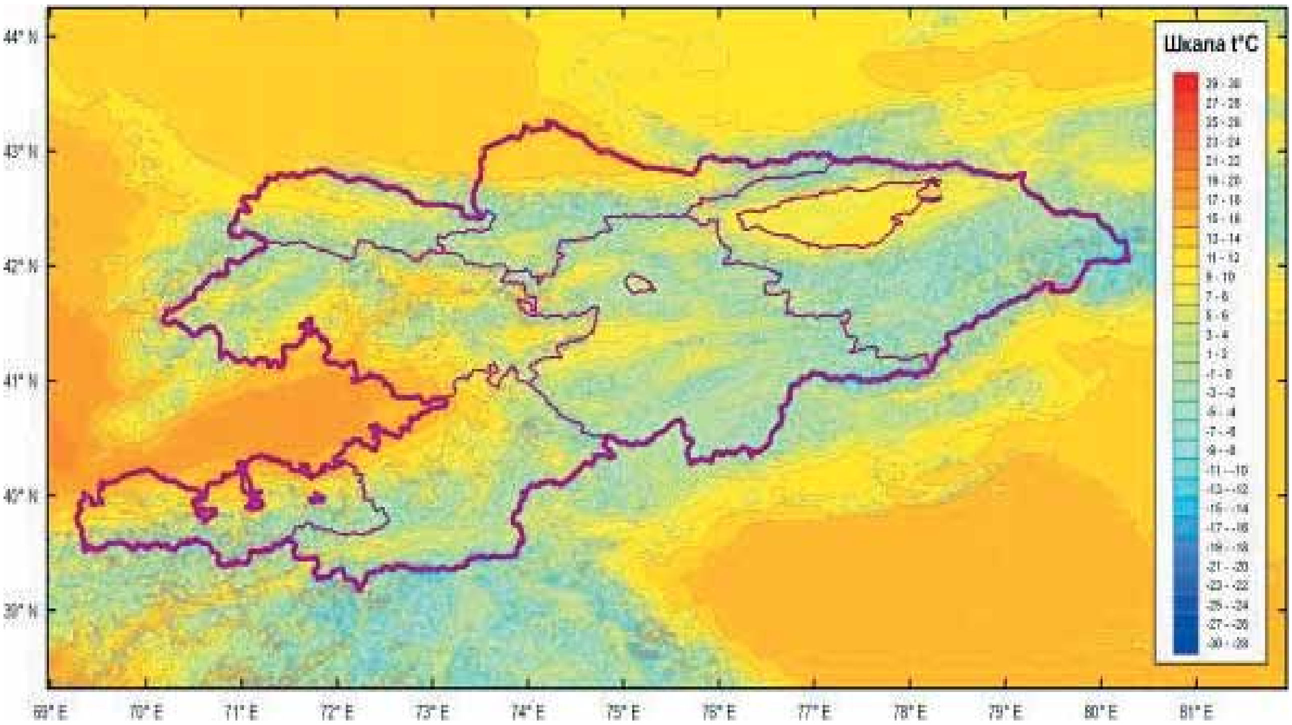
Appendix 3.1. Distribution of ground temperature under RCP4.5 Scenario by ensemble of 17 climatic models in 2030



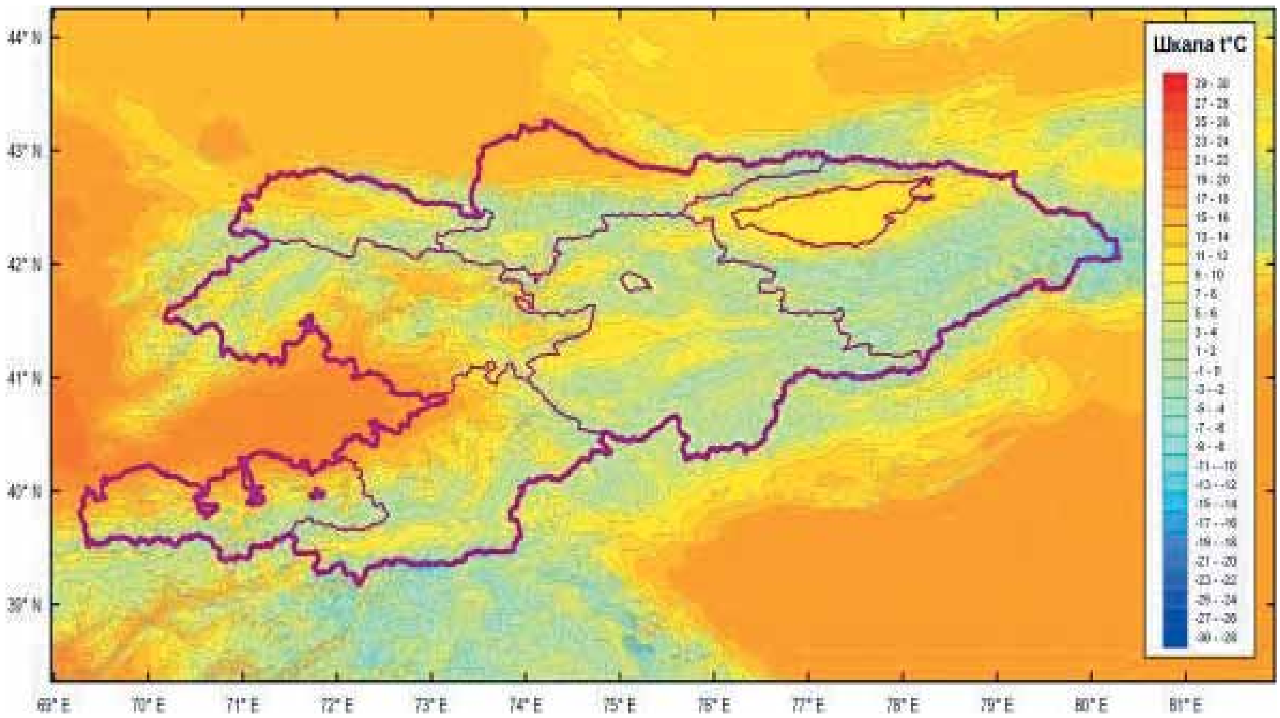
Appendix 3.2. Distribution of ground temperature under RCP4.5 Scenario by ensemble of 19 climatic models in 2070



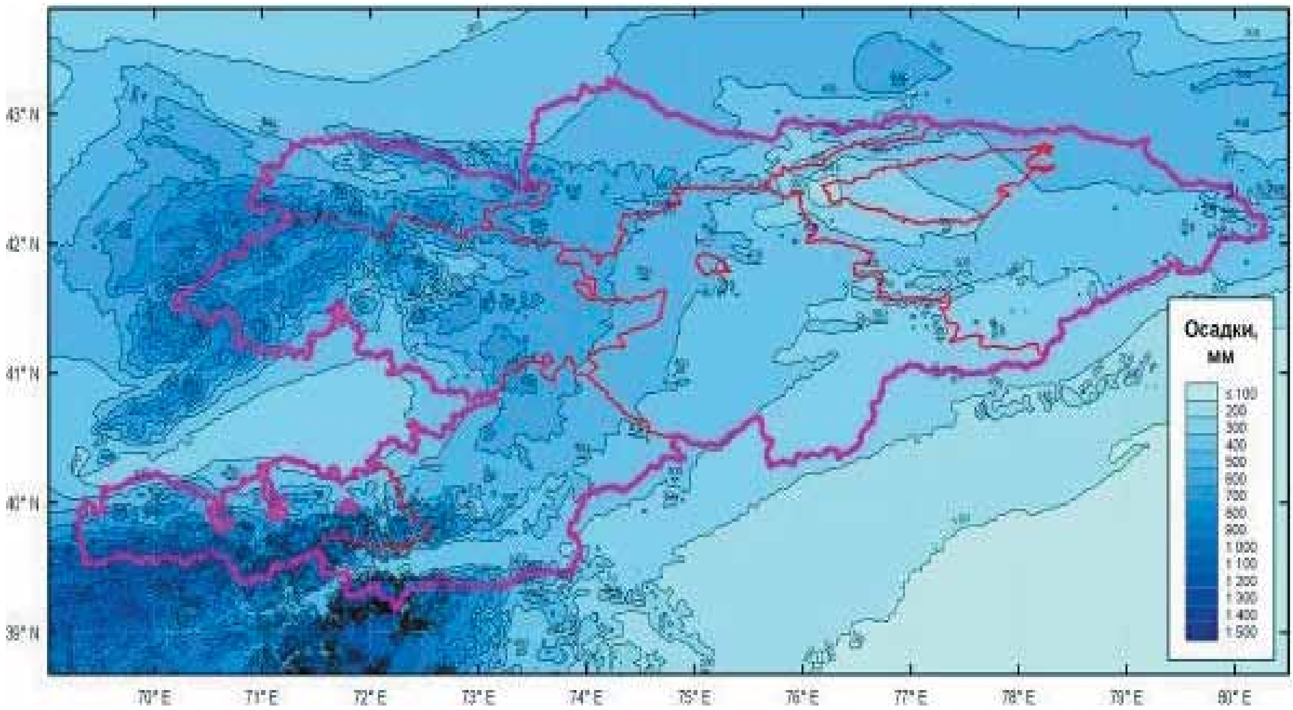
Appendix 3.3. Distribution of ground temperature under RCP8.5 Scenario by ensemble of 17 climatic models in 2030



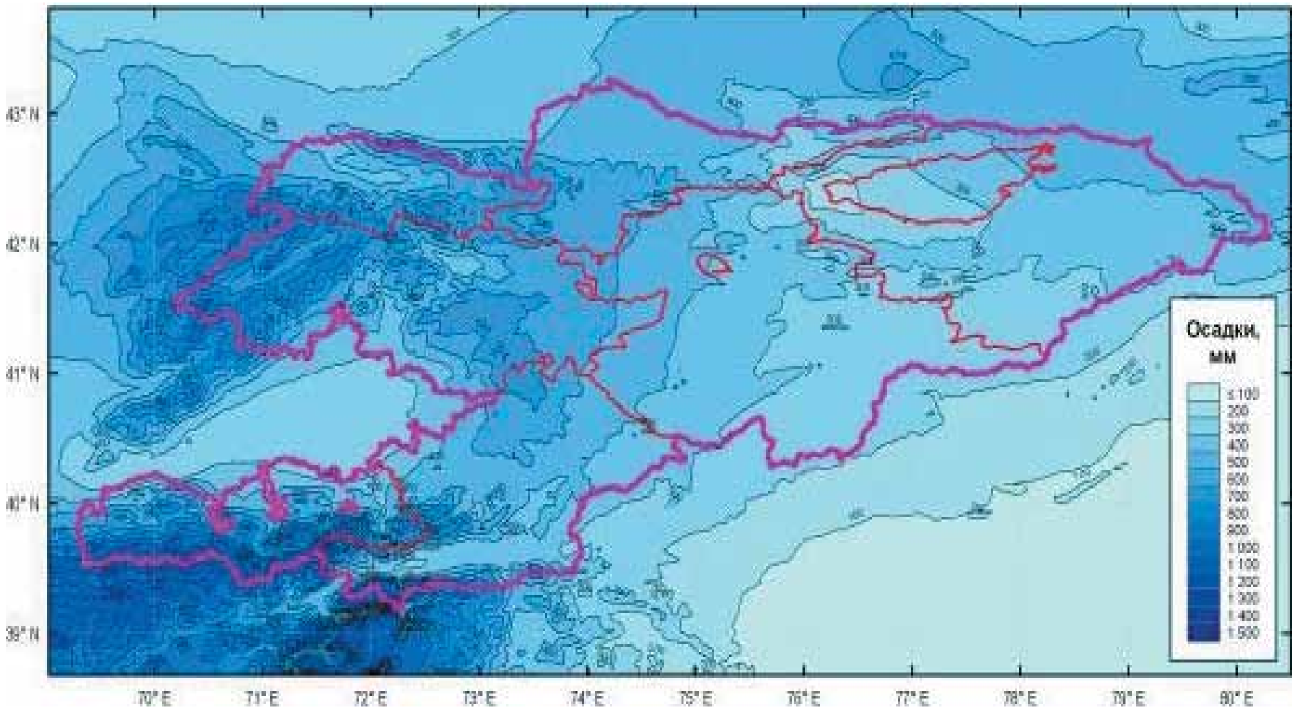
Appendix 3.4. Distribution of ground temperature under RCP8.5 Scenario by ensemble of 17 climatic models in 2070



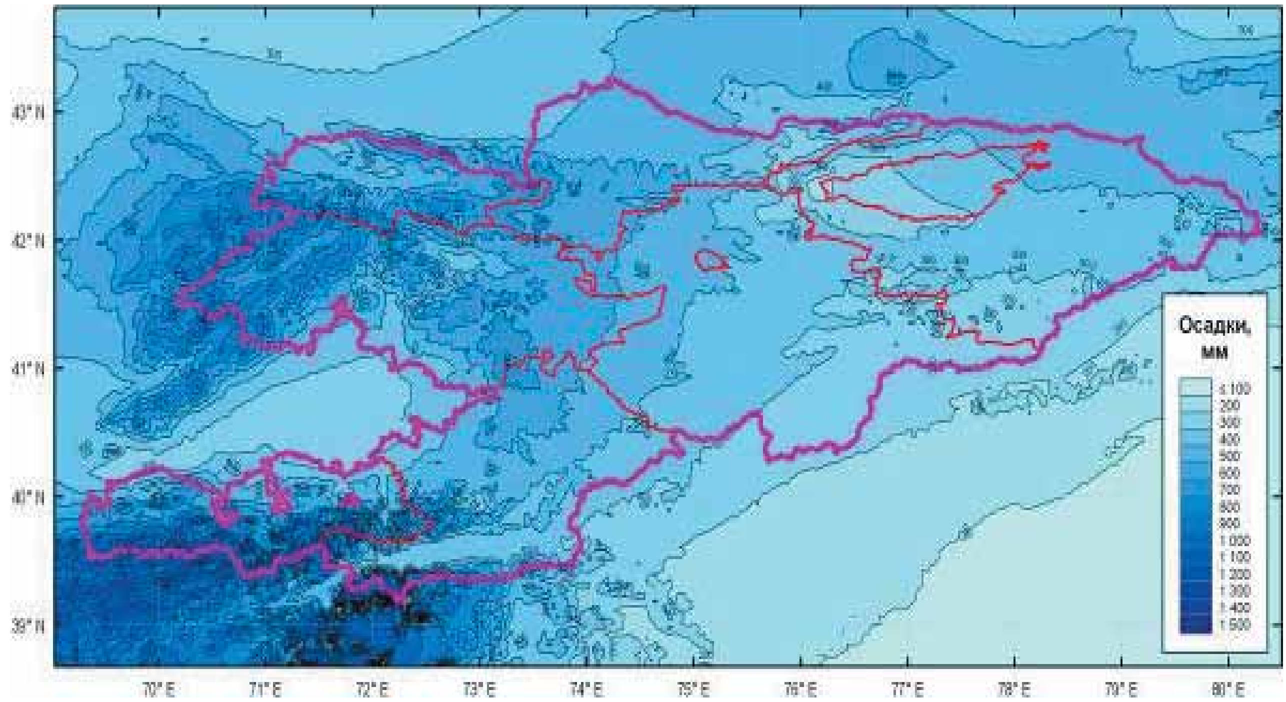
Appendix 3.5. Distribution of ground temperature under RCP4.5 Scenario by ensemble of 17 climatic models in 2030



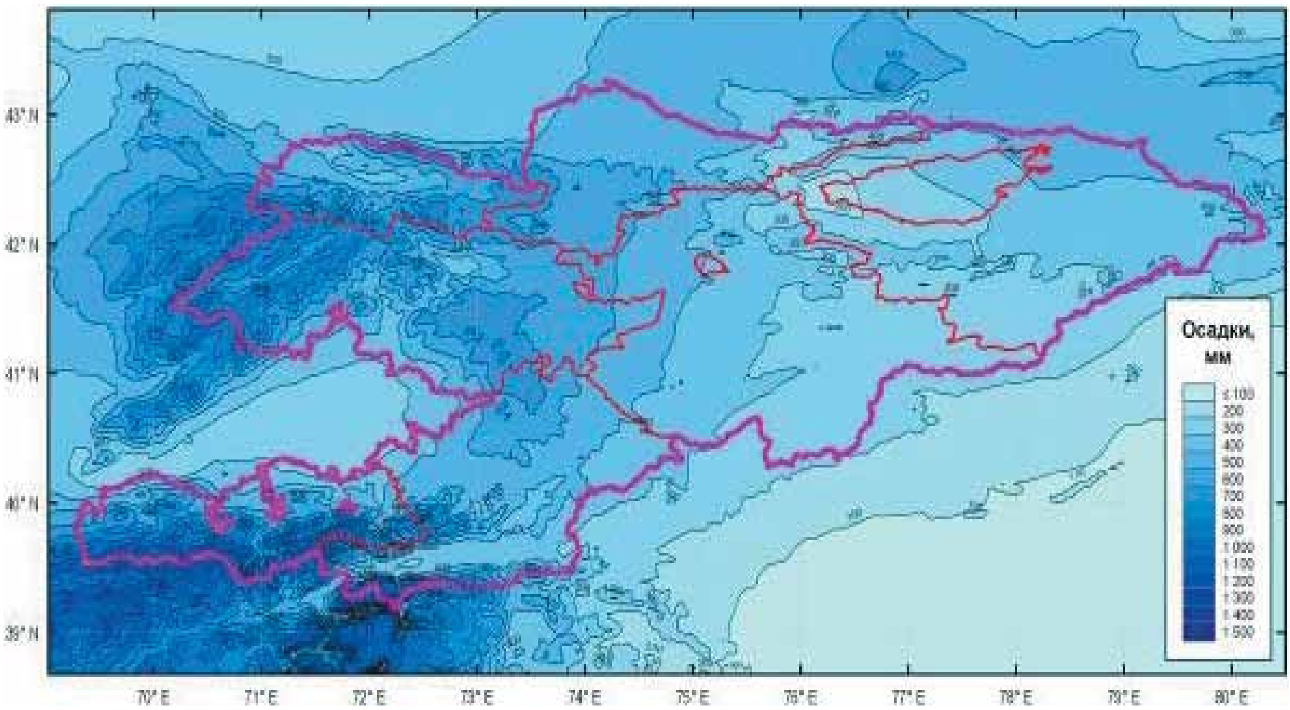
Appendix 3.6. Distribution of ground temperature under RCP4.5 Scenario by ensemble of 19 climatic models in 2070



Appendix 3.7. Distribution of ground temperature under RCP8.5 Scenario by ensemble of 17 climatic models in 2030

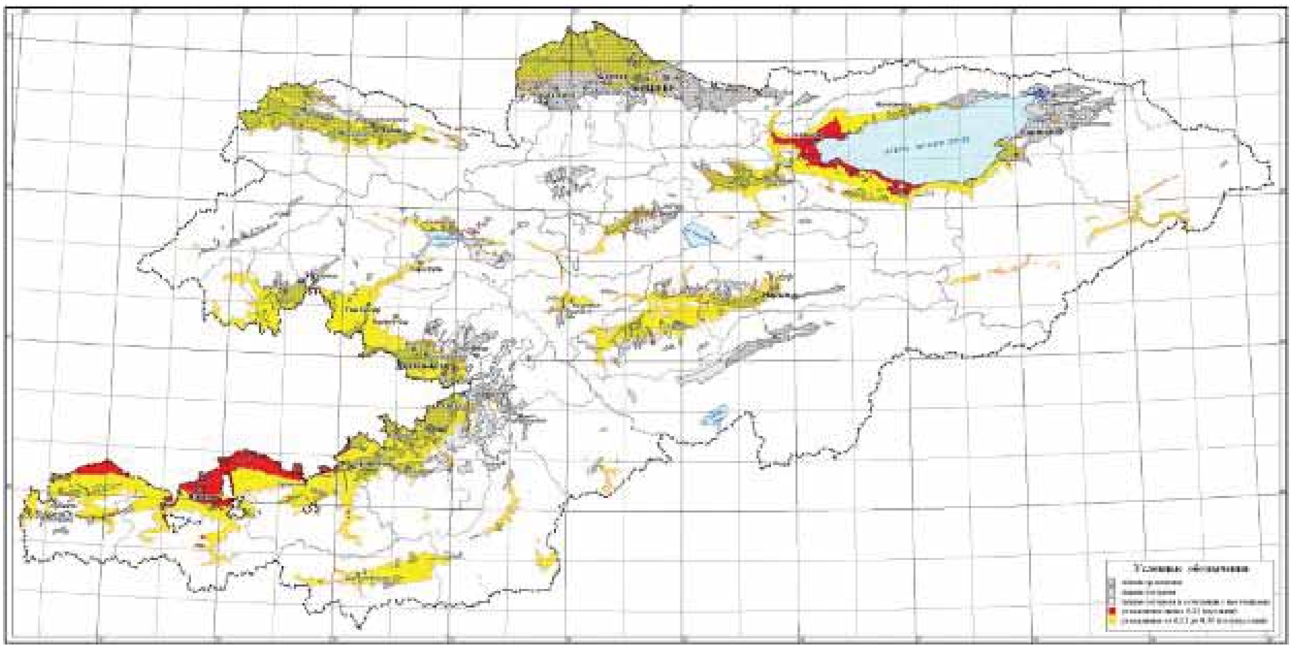


Appendix 3.8. Distribution of ground temperature under RCP8.5 Scenario by ensemble of 17 climatic models in 2070

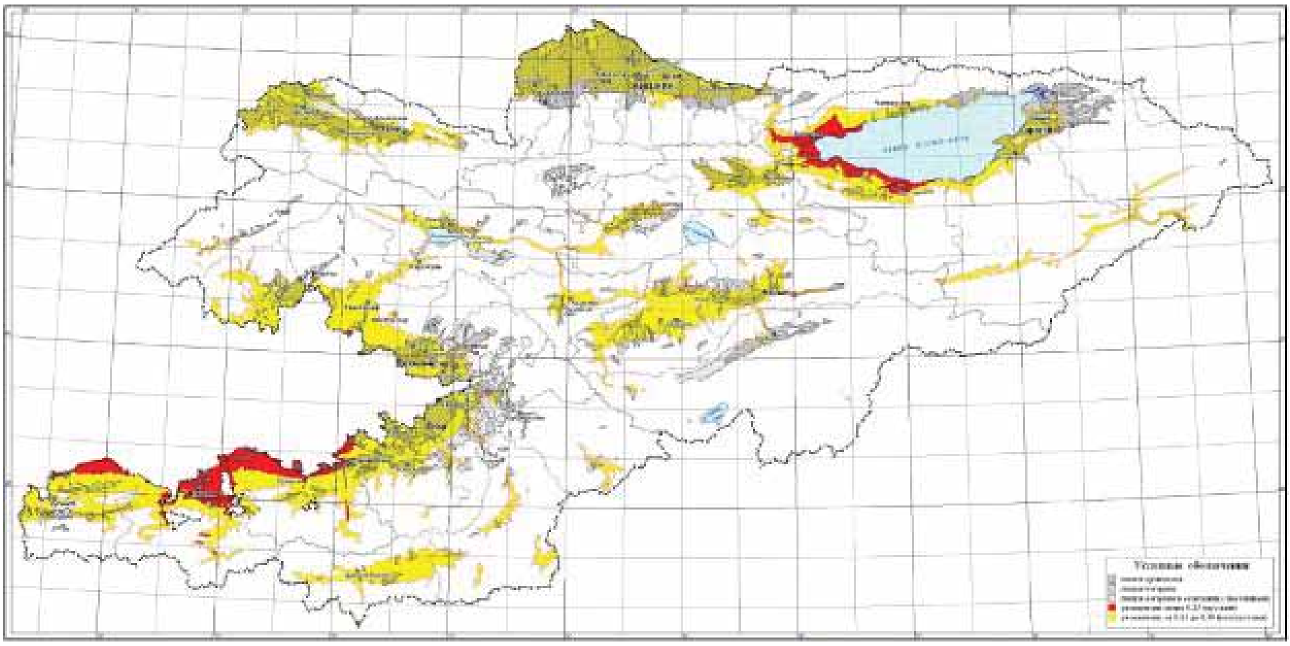


Annex 4. Areas of different humidity level under the climate change in the Kyrgyz Republic

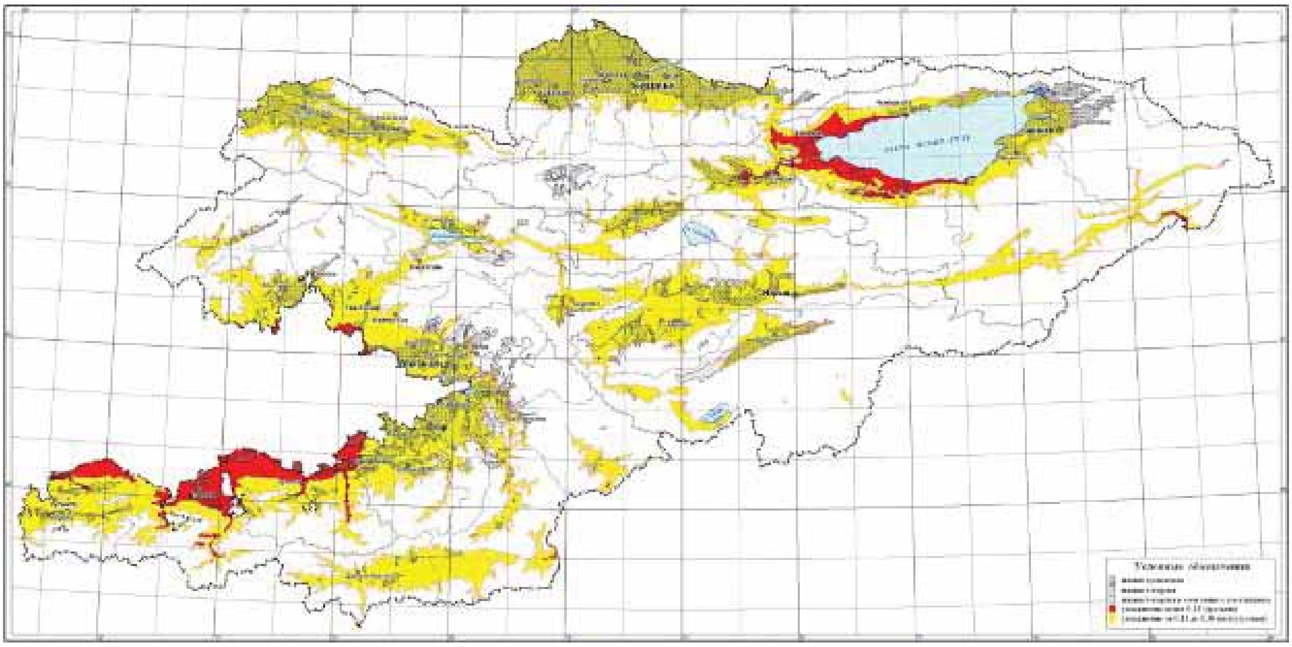
Appendix 4.1. Areas with different humidity level in 2000



Appendix 4.2. Areas of different humidity level at temperature increase by 1,5°C and stabilized precipitation re 1961-1990

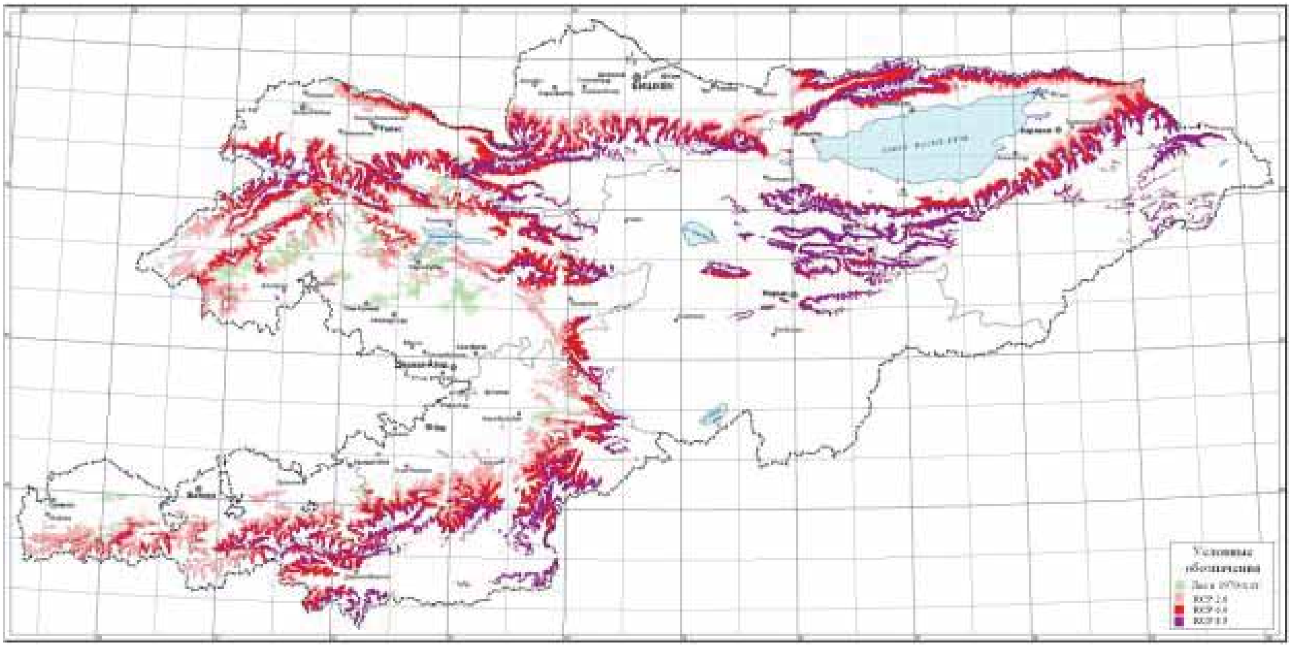


Appendix 4.3. Areas of different humidity level with temperature increase by 4 °C and stabilized precipitation re 1961-1990

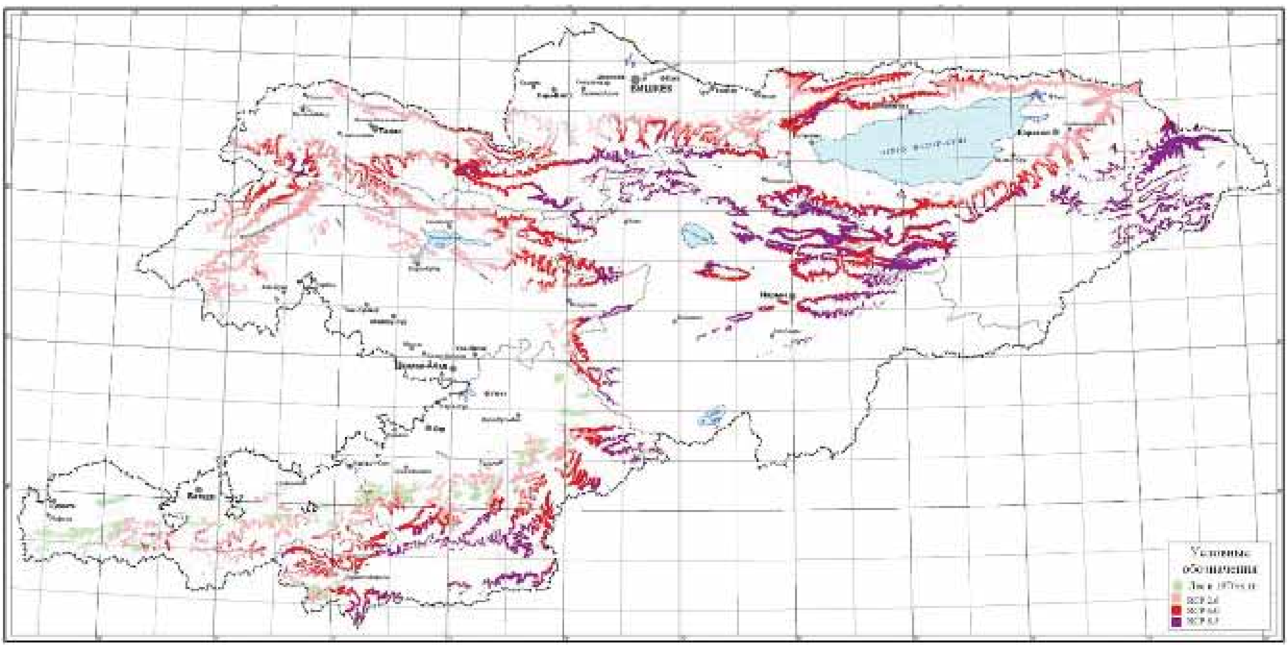


Annex 5. Potential evolution of the climatic optimums of the focal forest forming tree species in the Kyrgyz Republic

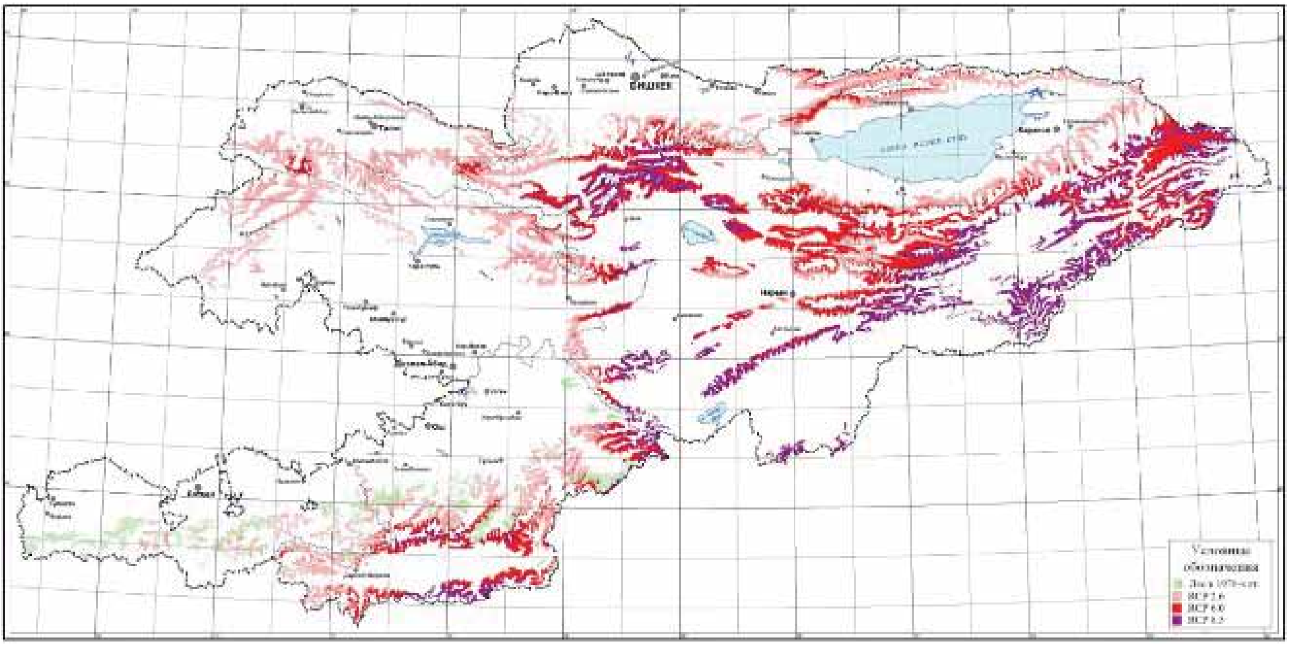
Appendix 5.1. Zeravshan juniper tree areal



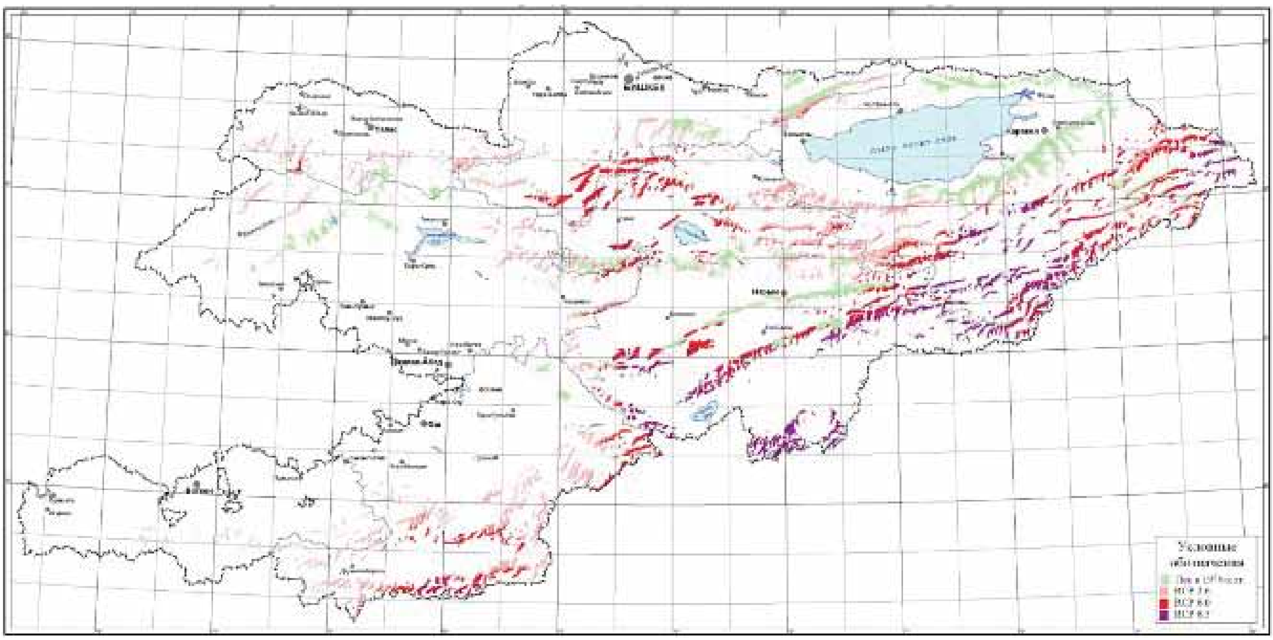
Appendix 5.2. Semispherical juniper tree areal



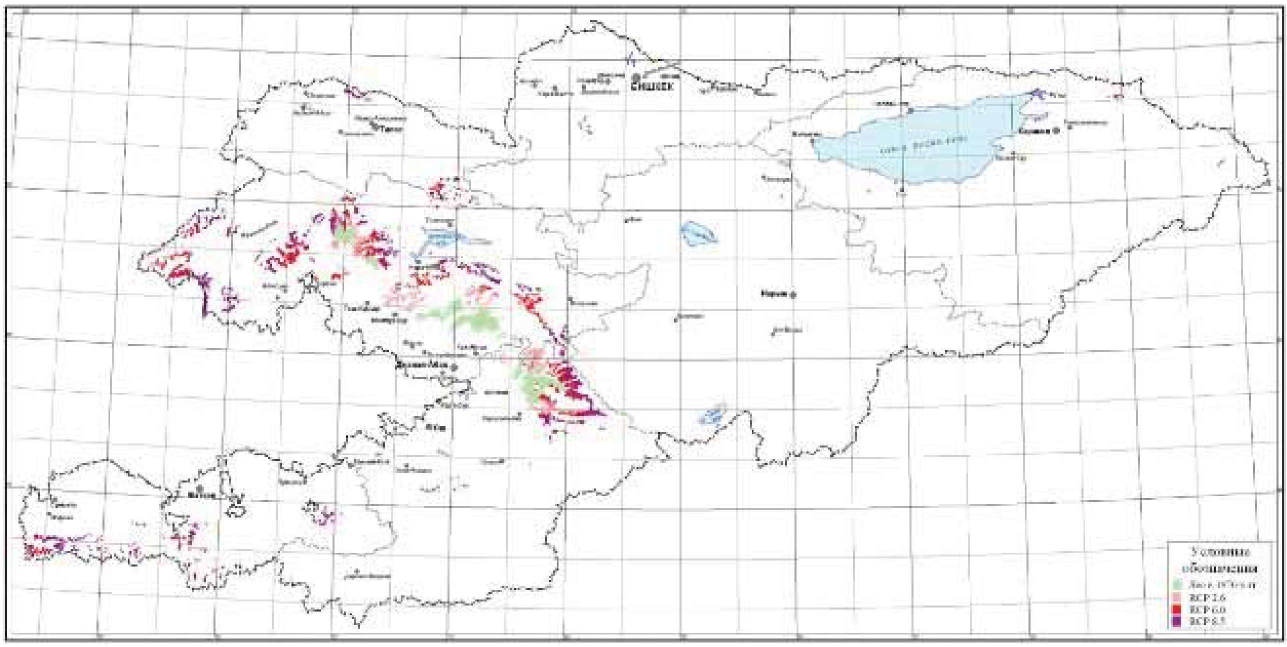
Appendix 5.3. Turkestan juniper tree areal



Appendix 5.4. Pine tree areal



Appendix 5.5. Walnut areal



Annex 6: External Support of the Climate Changes Activities in the Kyrgyz Republic

#	Activities: strategies, programs, plans, projects, etc.	Deadlines	Budget and Finance Sources	*Activity Lines* *adaptation, mitigation, monitoring, capacity building, raising public awareness, etc.*
				UN Development Program (UNDP)
1	Sustainable Development Environmental Program	2011-2016	$1,096,790 UN Deve-lop-ment Program	***Capacity building*** Supporting formation of political and coordination frameworks on adaptation to the climate changes and reduction of GHG emissions Increase of potential of the individuals making decisions on adaptation to the climate changes and reduction of GHG emissions. ***Raising public awareness on*** the issues of adaptation to the climate changes and reduction of GHG emissions. ***3 components:*** - promotion of the ***environmental development principles*** by reduction of carbon emissions acting as the sustainable development vector; - transition to the economy resistant to the climatic changes by development of the ***strategies on adaptation*** to the climate changes; - sustainable ***management of natural resources*** to improve the environment and the standard of living.
2	Development of Small Hydropower Plants	July 2010 –December 2015	$950,000 - GEF $100,000 - UN Development Project	***Mitigation*** ***Capacity building*** Reduction of GHG emissions by development of small hydropower plants in Kyrgyzstan. 1. Formation of rational and integrated market-oriented ***policy in the power-engineering sphere and the regulatory and legal framework for development of small hydropower plants.*** 2. Development of the potential for efficient solution of institutional issues and assessment of the economic and finance viability of small hydropower plants projects. 3. Enhancing the potential on assessment of hydrological resources, designing, assessment and projects implementation and main-tenance. 4. Drawing up of the Preliminary Feasibility Study and ***technical projects for 3 small hydropower plants.*** 5. Documentation/distribution of the obtained project experience / advanced know-how / results to be implemented all over the country.
3	Climatic Risks Management (CRM) in Kyrgyzstan	2010-2014	$600,000 BCPR UNDP	***Adaptation*** ***Capacity building*** 1. Create the relevant conditions to implement the CRM principles at the system, institutional and individual levels 2. Demonstrate a climatically adapted management of pasturelands in ***Suussamyr Valley*** 3. Management of knowledge and the MCR learned lessons

#	Activities: strategies, programs, plans, projects, etc.	Deadlines	Budget and Finance Sources	*Activity Lines adaptation, mitigation, monitoring, capacity building, raising public awareness, etc.*
4	Conservation of Globally Important Biodiversity and Association Land and Forest Resources of Western Tian Shan Forest Mountain Ecosystemsand Sup-port to Sustainable Livelihoods	2016-2020	$ 4 500 000 UNDP / GEF	***GHG Reduction*** ***Capacity Building*** Increase the stability of the system of protected areas of Kyrgyzstan with a focus on globally important ecosystems of Western Tien Shan and its global biodiversity is under threat
5	Strengthening of Institutional and Legal Possibilities to develop National Monitoring and Environmental Information Management System	2016-2018	$ 950 000 UNDP / GEF	***Capacity Building*** Expected outcomes of the project: 1. Improvement of legislation and policy instruments for the effective monitoring and decision-making. 2. Strengthening institutional capacity. 3. Increasing awareness of the global environmental values
				UN Environment Programme (UNEP)
1	Enabling Activities for the Preparation of Third National Communication under the United Nations Framework Convention on Climate Change Project	2012-2015	$ 500 000 GEF	***Technical assistance:*** Key components of the project: • GHG national inventory for 2006-2010 developed. Time series for 1990-2005 re-estimated; • Updating the analysis of potential measures to reduce increasing GHG emissions in Kyrgyzstan; • Assessment of the potential climate change impacts in selected areas of Kyrgyzstan and adaptation measures; • Preparation of the Third National Communication and submit officially it to the CoP of the UNFCCC; • Strengthening technical and institutional potential of the country; • Raising awareness, strengthening the information sharing and collaboration among stakeholders.
2	Preparation of intended nationally determined contribution (INDC) to the 2015 Agreement under the United Nations Framework Convention on Climate Change Project	2015	$ 138 000 GEF	***Technical assistance:*** Key components of the project • Institutional arrangement for the preparation of INDC to the 2015 UNFCCC agreement; • Preparation, compilation, production of INDCs; • Provision of technical assistance to national teams for INDC preparation.
				UN Food and Agricultural Organization (UN FAO)
1	Sustainable Management of Highland Forestry and Land Resources in the Kyrgyz Republic Subject to the Climatic Changes Project	2014-2018	$ 24 454 695 $ 5 454 545 GEF, $ 2 400 000 FAO, $ 1 700 000 GIZ, $ 5 000 000 IFAD, $ 500 000 WFP, $ 1 716 850 Mountain Partnership	***Mitigation*** ***Adaptation*** ***Capacity building*** *Component 2: Increase of carbon reserves in the arid forestry within the innovation management and rehabilitation practices* *Component 3: Promotion and demonstration of agriculture subject to the climate changes including pastures as part of the sustainable land and water management in the arid areas.*
2	National Forest Monitoring and Information System of Deforestation and Forest Degradation program (REDD +) Global project	2013-2016	Government of Germany $ 5 235 598 for 18 countries	***Adaptation*** ***Capacity building*** Exchange of experiences, knowledge transfer and capacity-building at the national level to meet the requirements of REDD +. Building capacity in 18 developing countries for monitoring of forest resources under the REDD + program (deforestation, forest degradation, carbon storage in forests, sustainable forests management and increase carbon storage in forests). Support to countries in the development of remote sensing and geographic information systems (GIS) as a component of the state forest monitoring system

#	Activities: strategies, programs, plans, projects, etc.	Deadlines	Budget and Finance Sources	*Activity Lines adaptation, mitigation, monitoring, capacity building, raising public awareness, etc.*
		UN World Food Programme (UNWFP)		
3	Analysis of Climatic Risks and Food Safety (Pilot Analysis)	2014	UN WFP	***Adaptation*** ***Capacity building*** Investigation. (Material to be used for preparation of the agricultural adaptation program.)
4	Mapping of Food Safety and Vulnerability Project	2014	$293,927 Department for International Development of Great Britain (DFID)	**Raising Public Awareness** Develop and distribute the National Atlas on the food safety and vulnerability at the national and sub-national level to increase understanding of the food safety purposes, gaps, problems, and resources.
5	Analysis of the UN WFP adaptation projects and partners to document the best adaptation practices Project	2014	$80,000 Swedish Agency (SIDA)	***Adaptation*** ***Capacity building*** To identify the best adaptation practices to be replicated in other projects.
6	Analysis of the climatic risks impact on the food safety at the regional household level Project	2014	No budget approval as yet Swedish Agency	***Adaptation*** ***Capacity building*** Identify and understand a link of climate changes with the food safety at the level of regions and draw up recommendations.
7	Building sustainability in the communities by creation of the infrastructure resources Project	2014-2017	Under development	***Adaptation*** ***Capacity building***
		International Fund for Agriculture Development (IFAD)		
1	Livestock Sector and Market-2 Development Project	2014-2018	Total budget – $32 mln: including $21 mln – grant $11 mln – loan International Fund for Agricultural Development	***Adaptation*** ***Capacity building*** ***Raising Public Awareness*** Adaptation measures in the sphere of ***pastures and livestock management***
		German Society for International Cooperation (GIZ)		
1	Regional Program for Sustainable Use of the Natural Resources	April 2013 - October 2015	€11,400,000 countries of the Central Asia BMZ / EC Program – FL-ERMONECA	***Capacity building*** Building the potential of the state and non-state stakeholders in the sphere of adaptation to the climatic changes, reduction of GHG emissions by promoting the sustainable land management approaches KR Components: 1. support of the forestry piloting reforms 2. support of the pasturelands reform 3. support of the wildlife management reform 4. support in development of the integrated land planning system 5. support in the adaptation and introduction of the EbA (Ecosystem-based Adaptation) approach 6. 6. building the potential of the state and non-state structures responsible for coordination of the country policy in the field of the climate changes

#	Activities: strategies, programs, plans, projects, etc.	Deadlines	Budget and Finance Sources	*Activity Lines adaptation, mitigation, monitoring, capacity building, raising public awareness, etc.*
2	Conservation of the Biodiversity and Poverty Reduction Through Management of the Local Community's Nut and Fruit Forestry and Pasturelands Regional Program	Jan.14, 2014 – Aug. 31, 2018	€ 5 000 000 South of Kyrgyzstan BMZ	**Capacity building** **Adaptation** 1. drawing up and implementation of the management plans involving communities for sustainable management of forestry and pasturelands 2. expansion of the existing forestry areas by planting new forests and mixed nut and fruit plants adapted to the climate changes; 3. adoption of the innovation techniques to enhance significance of the biodiversity and increase efficiency on using the resources
3	Public Health in the Central Asia Regional Program	2009-2018 1. Phase 1 2009-2011 Phase 2 2012-2015	$28,000,000 Kyrgyzstan, Tajikistan, Uzbekistan €13,000,00	**Mitigation,** **Adaptation** Supply maternity wards with warm water using solar energy through installation of the SVWHU (solar vacuum water-heating units). - Management of water saving activities among the medical staff and patients. - Adoption of the green policy in the maternity units.
4	Transboundary Management of Water Resources in the Central Asia Program	2009-2017	€ 21 000 000 (Countries of Central Asia) Above € 4 000 000 German Federal Foreign Office	***Capacity building*** ***Adaptation*** Components: • Promoting regional institutional cooperation. • Improving the management of transboundary river basins
5	Civil Society Support Fund Project	2013 -2014 2014 –2015	3 211884 KGS - GIZ 149 300 KGS – CEEBA 6 949 879 KGS - GIZ 10% - CEEBA	***Improvement of Education and Public Awareness*** Building an experts association and their further institutional development through training sessions, as well as assistance in the expansion and distribution of the energy-efficient construction services in Issyk-Kul region. Promotion and use of energy-efficient technologies and building through the development of the Expert Association
6	Facebook profile created by the partners and the seminar and workshop participants on the various CS (Civil Society) development subjects including the environmental and climate change problems	2013-present	€ 3 660	***Increase of the Civil Society Capacity and Public Awareness*** Information on the various resources allowing to increase both the civil society potential and the fund-raising resources (mobilization of resources)
7	E-mail Distribution to NGO resources in Central Asia including the environmental and climate change issues	2014 – present	Central Asia countries	***Capacity Building of the Civil Society and Public Awareness*** Information on the various resources allowing to increase both the civil society potential and the fund-raising resources
8	Concept development for smoothing conflicts on natural resources through the initiation of a regional council for sustainable natural resource management, integrated into existing administrative structures at the level of separating ridge in Naryn oblast	2014 -2015	€ 81 400 10% - Camp Alatoo	***Capacity Building of the Civil Society and Public Awareness*** Developed an approach to facilitate the work of the regional council on sustainable natural resources management at the level of separating ridge. Established the «Tabiygat Bashkaruu» Board to resolve conflicts at the level of administrative structures

#	Activities: strategies, programs, plans, projects, etc.	Deadlines	Budget and Finance Sources	*Activity Lines adaptation, mitigation, monitoring, capacity building, raising public awareness, etc.*
9	The social mechanisms' development for the local community to ensure transparency of local governments - Ail Demilgesi.	2014-2015	€ 429 191 10% co-finance of Ail Demilgesi	***Capacity Building and Public Awareness*** Use of energy-efficient constructions and technologies. Conducting training sessions on sustainability projects for the public, local governments Coverage: the villages of the Issyk-Kul, Naryn, Osh oblasts
10	Vocational Training and Employment Promotion Ministry of Labour, Youth and Migration of the KR Vocational Training and Employment Promotion Ministry of Education and Science of the KR	2014-2016	€ 7 750 000 BMZ	***Improvement of Education and Public Awareness*** Training of qualified staff to perform thermal insulation jobs Training of energy-efficient construction and finishing teachers and foremen for the specialized construction lyceums Introduction of the energy-efficiency and energy-saving subjects in the educational content of the construction colleges
11	Improvement of living standards in Kyrgyzstan and Tajikistan via adaptation to the climate change	2014-2018	€ 6 000 000 BMZ	***Capacity building*** ***Adaptation*** Improve the living standards and reduce vulnerability of the local population in the selected communities via the measures allowing to adapt to the climate changes. KR Components: 1. Adaptation to the climate changes in the ***agricultural sector.*** 2. Adaptation to the climate changes to ***reduce natural disasters.***
12	NAMA Development in Pasture and Livestock Sectors in the Kyrgyz Republic	2015	€ 20 000 BMUB	***GHG reduction*** ***Capacity building*** Development and bringing to NAMA financing
13	Regional Program on Adaptation to the Climate Changes in the Central Asia Highlands Based on the Ecosystem Services	2015-2019	€ 4 000 000 Tajikistan Kyrgyzstan Kazakhstan BMZ	***Capacity building*** Building the potential for the state and non-state stakeholders in the sphere of adaptation to the climate changes, reduction of GHG emissions by advancing the sustainable **lands** management approaches ***KR Components:*** • Piloting the EbA approach in one water basin • Building the potential for introduction in the national strategies on adaptation to the climate changes • Communicating with funds on adaptation to the climate changes to fund projects on sustainable management of the KR land resources
14	Capacity Building and Implementation of intended nationally determined contribution (INDC) in Land-Use Sector Programme	Under confirmation process 2015	€ 100 000 Tajikistan Kyrgyzstan BMUB	***Capacity building*** Capacity Building in Adaptation. • Workshops on capacity building on international discussions of the INDC and requirements for national planning. • Review INDC policy commitments and the existing implementing activities in Kyrgyzstan, as well as an overview of the countries of CACAM / MLDC group. • Side event at the COP21 in Paris to present INDC plans and implementation in CACAM / MLDC region, with a focus on the Kyrgyz Republic.
	Regional Environmental Center of the Central Asia (RECCA)			
1	An integrated approach to the development of Climate-friendly Economies of Central Asia (NAMA).	01.2012 – 05.2014	€ 982 000 To CA countries Germany BMU	***GHG reduction*** ***Capacity building*** ***Kyrgyzstan:*** Developed the program of modernization of small coal-fired boilers of the Kyrgyz Republic

#	Activities: strategies, programs, plans, projects, etc.	Deadlines	Budget and Finance Sources	*Activity Lines adaptation, mitigation, monitoring, capacity building, raising public awareness, etc.*
European Bank of Reconstruction and Development (EBRD)				
1	Promotion of Increasing the Water Supply Sustainability in Kyrgyzstan to the Climate Changes Project	2014-2017	$ 5 000 000	**Adaptation** **Capacity building** • Increase of the KR water supply system sustainability to the climate changes. • Development of potential in the field of water management. • Increase of the water supply reliability and long-term sustainability of potable water sources.
2	Financing the Sustainable energy in the Kyrgyz Republic - KyrSEFF Program	2013-2016	$ 20 000 000 EBRD Credit line for partner banks & MFOs € 6 800 000 EU IFCA Finance to the Technical Assistance Component and grant payment to loan debtor	**Adaptation** **GHG reduction** **Monitoring, Capacity Building, Raising Awareness** KyrSEFF is a financing programme intended for residential and commercial sectors, provided a set of free technical assistance measures. The programme includes specialized credit products and investment grants for customers in the residential and industrial sectors. KyrSEFF provides funding for equipment suppliers for business expansion
World Bank (WB)				
1	CAHMP – Central Asia Hydrometeorology Moder-nization Project	2016 - 2021	$6 000 000 $5 100 000 credit $ 900 000 grant	• strengthening of interaction between the NHMSs for information and knowledge exchange • reconstruction of infrastructure • capacity building. The project is directed at hazard risk reduction, management of effects of climate changes and assistance to economic development of agriculture and water sectors, as well as energy and transport sectors within Central Asia. in Kyrgyz Republic the project aimed: • Strengthen the institutional capacity of Kyrgyzhydromet, including improvement of its human resources and its financial sustainability model; 2. Improve the hydrometeorological observation networks to provide more timely extreme and hazardous weather warnings and a more efficient national water resources management system; 3. Enhance the service delivery system of Kyrgyzhydromet
2	Integrated Forest Ecosys-tems Management Project	2016-2021	$ 15 000 000 WB $ 4 110 000 GEF	**Adaptation** **Capacity Building** **Raising Awareness** **GHG reduction** • The area of land where sustainable land management practices adapted by the project. • Forest are included in the management plans. • The area of land restored or forested. • Trained forest users. • Government agencies are supported capacity building. • Supported reforms in forest policy, legislation and the regulatory sphere

#	Activities: strategies, programs, plans, projects, etc.	Deadlines	Budget and Finance Sources	*Activity Lines* *adaptation, mitigation, monitoring, capacity building, raising public awareness, etc.*
European Union (EC)				
1	Regional Environmental Program for Central Asia (EURECA)	2012-2015	€9,200,000 EC	***Capacity building*** ***Raising Public Awareness*** Expansion of regional cooperation and partnership with Europe in the field of the integrated management of water resources, forestry and biodiversity including environmental monitoring and education subject to the support of the strengthened environmental coordination mechanism provided via the EC-Central Asia Environmental and Water Protection Cooperation Platform
	Component 1: Regional coordination and support to stimulate the regional environmental and water protection cooperation between the European Union and the Central Asia (WECOOP)	2012-2014	€ 1 496 000 EC	***Capacity building*** ***Raising Public Awareness*** Component 1: EC-CA Environmental and Water Protection Cooperation Platform Component 2: Strengthening of the institutional structure and potential of regional organizations Component 3: Distribution of information and publicity
	Component 2: Forestry and Biodiversity Management Including Environmental Monitoring: FLERMONECA	2013–2015	€ 4 800 000 Kazakhstan Kyrgyzstan Tajikistan Turkmenistan Uzbekistan	***Capacity building*** ***Raising Public Awareness*** Strengthening of regional cooperation and partnership with Europe on the issues of sustainable use of natural resources, management of forestry and biodiversity including the environmental monitoring. ***Component 1:*** Enforcement of the CA Forestry Legislation and Forestry Management ***(FLEG Central Asia)***: GIZ together with the German Forestry Agency – Landesbetrieb Hessen Forst. ***Component 2: Environmental rehabilitation and conservation of biodiversity in the CA (ERCA)***: GIZ will promote the active dialogue between the EC and the Central Asia. ***Component 3: Environmental Monitoring in the CA (MONECA)***: GIZ together with the Austrian Federal Environmental Ministry (UBA) and the Regional Environmental Center of the Central Asia (RECCA) will improve environmental monitoring, reporting and data exchange in the Central Asia and generally in the region, as well as it will strengthen the ties and partner relations between the relevant institutions of the Central Asia and the EC.
	Component 3: Partnership in Management of the Water Resources and Basin Organizations in the Central Asia: WMBOCA	2012-2014	€2,500,000 EC Kazakhstan Kyrgyzstan Tajikistan Turkmenistan Uzbekistan GIZ Program: Transboundary Management of Water Resources in the CA in partnership with RECCA	***Capacity building*** ***Raising Public Awareness*** Support of the water management and basin organizations in the CA (WMBOCA) is composed of two interrelated projects: 1. Support in management of the water resources and strengthening potential of the transboundary basin water-management organizations in the Central Asia. 2. Building potential of water management organizations and the joint basin institutes in the basin planning area.

#	Activities: strategies, programs, plans, projects, etc.	Deadlines	Budget and Finance Sources	*Activity Lines adaptation, mitigation, monitoring, capacity building, raising public awareness, etc.*
	Component 4: Raising Public Environmental Awareness: AWARE	2012-2014	€ 900 000 EC Kazakhstan Kyrgyzstan Tajikistan Turkmenistan Uzbekistan	***Raising Public Awareness*** The Project is realized over three lines: • Raising awareness on use of return water and recycled/ repeated water supply • Raising awareness on the most applicable practices, such as the Shared Environmental Information System (SEIS), etc. • Provision of the private sector involvement in the Sustain-able Consumption And Production Processes (SCPP) by raising awareness and increase of Energy Efficiency (EE), as critical components for the State-Private Partnership (SPP).
2	Central Asian Sustainable Power Industry Regional Program	2014-2016	€6,000,000 - technical assistance €2,000,000 pilot projects and awareness-raising activities EC, GIZ	***Capacity building*** Creation of required legal and institutional mechanisms pro-moting implementation of the ***renewable energy sources***, as well as ***increase of energy efficiency*** at the national level.