Georgia’s Second National Communication to the UNFCCC

Tbilisi
2009

Ministry of Environment Protection and Natural Resources of Georgia and UNDP Country Office are greatly thankful to all national and international experts engaged in the project for their contribution in preparing of this document

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Acronyms

ALM – Adaptation Learning Mechanism
BAU – Business-As-Usual
BSEC – Organization of the Black Sea Economic Cooperation
CC – Climate Change
CDM – Clean Development Mechanism
CIDA – Canadian International Development Agency
COP – Conference of the Parties
DCP – Desertification Climate Potential
DNA – Designated National Authority
DOE – Designated Operational Entity
EBRD – European Bank for Reconstruction and Development
ESCO – Energy Service Company
FAO – Food and Agriculture Organization of the United Nations
FOD – First Order Decay
GAM – Global Average Method
GCM – Global Circulation Model
GCOS - Global Climate Observing System
GEF – Global Environment Facility
GEL – Georgian Lari
GFSIS – Georgian Foundation for Strategic and International Studies
GHG – Greenhouse Gas
GPG – Good Practice Guidance
GTZ – German Technical Cooperation
GWP – Global Warming Potential
HPP – Hydro Power Plant
HTC – Hydrothermal Coefficient
HWI – Heat Wave Index
ICAM – Integrated Coastal Area Management System
IDP – Internally Displaced Person
INC – Initial National Communication
INTAS – International Association for the promotion of co-operation with scientists from the New Independent States of the former Soviet Union
IPCC – Intergovernmental Panel on Climate Change
LPG – Liquefied Petroleum Gas
LULUCF – Land Use, Land-Use Change and Forestry
MOE – Ministry of Environment Protection and Natural Resources of Georgia
MoEdS – Ministry of Education and Science of Georgia
NCSP – National Communications Support Programme
NGO – Non-Governmental Organization
NMVOC – Non-Methane Volatile Organic Compound
OECD – Organization for Economic Co-operation and Development
PDD – Project Design Document
PPP – Public-Private Partnership
PIN – Project Idea Note
QA/QC – Quality Assurance / Quality Control
REC – Regional Environmental Centre for the Caucasus
SERI – Stockholm Environment Research Institute
SHPP – Small Hydro Power Plant
SIDA – Swedish International Development Agency
SNC – Second National Communication
SRES – Special Report on Emissions Scenarios
TACIS – Technical Assistance to the Commonwealth of Independent States

TED – Technology and Environmental Database
TRACECA – Transportation Corridor Europe-Caucasus-Asia
UNDP – United Nations Development Programme
UNEP – United Nations Environment Programme
UNFCCC – United Nations Framework Convention on Climate Change
USAID – United States Agency for International Development
USD – United States Dollar
WB – World Bank
WHO – World Health Organization
WMO – World Meteorological Organization

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Foreword

The United Nations Framework Convention on Climate Change (UNFCCC), adopted in 1992 at the Earth Summit in Rio de Janeiro, Brazil, has clearly provided some guiding principles, two of which ought to be mentioned here.

The first is the "precautionary principle", stating that the lack of full scientific certainty should not be used as a reason for postponing climate change mitigation measures, as there are threats of serious or irreversible damage. However, after the publication of the IPCC Fourth Assessment Report in 2007, it became clear that the scientific certainty is more than obvious, and the climate change processes have developed at a much faster rate than previously anticipated.

The second is the principle of "common but differentiated responsibilities". Countries should take appropriate actions in combating climate change and the adverse effects in accordance with their respective capabilities, and the developed countries should take the lead in taking these actions.

Georgia fully supports both of these principles as well as other principles as stated in the Convention.

Georgia acceded to the UNFCCC in 1994 as a non-Annex I Party, and since then it has been actively engaged in the fulfillment of its obligations under the Convention. Between 1997 and 1999, Georgia prepared its Initial National Communication to the UNFCCC. The present document is the Second National Communication, which presents new findings on climate change and its adverse impact as revealed in Georgia during the last 10 years since the preparation of the Initial National Communication. In the process of preparing this document, a number of vulnerable sectors and regions have been identified and assessed. For the most vulnerable of these, a portfolio of adaptation project proposals have been developed, and most of these proposals have been submitted to donors or investors for consideration for funding.

In this document, Georgia suggests that the adaptation of vulnerable sectors and regions to climate change systems and economy sectors is currently a priority to the country. Special attention in this process should be paid to the Black Sea coastal zone, regarded as the country's important economic and tourism development zone, as well as to the land degradation problem, as Georgia is historically an agrarian country. Agriculture is considered to be one of the leading sectors of its economy.

Georgia's national emission of GHGs is rather small, comprising less than 0.1% of total global emissions. In spite of this, recognizing the importance of each country's share in the reduction of emissions and consequent mitigation of climate change, Georgia is actively participating in the GHG mitigation process. Georgia supports the implementation of any projects and programmes that will lead to the reduction of GHG emissions, facilitate the drawing of additional environmentally sound investments and transfer the country to the sustainable development pathway.

Goga Khachidze

Minister of Environment Protection and Natural Resources

Executive Summary

National circumstances

Georgia's national and regional priorities are defined by its geopolitical location, historical relationships, social and cultural peculiarities, and the requirements of current momentum.

After the disintegration of the Soviet Union, Georgia became a member of European structures, and the process of entering NATO has been an active undertaking since. Georgia's national and regional priority is to be integrated into European structures. This has helped Georgia to establish and strengthen its democratic institutions and principles, maintain stable and mutually profitable relations with all states, protect common human rights, and provide favourable conditions for its own individual development. Regional priorities have included the development of mutually profitable economic relations, and a strengthening of the Black Sea Economic Cooperation.

Georgia is a Presidential republic. The executive power is represented by the Cabinet of Ministers headed by the Prime Minister, with the power Ministries being directly under the President's subordination. Legislative power is represented by the Parliament, and the judicial power by the Supreme, Constitutional, District, and Municipal courts.

As of July 2008, the population of Georgia was just above 4.6 million, and 53% of the population was living in urban areas.

Georgia is situated in the south-east of Europe, between the Black Sea and the Caspian Sea. Its total area is 69,700 km^2. Mountainous landscape determines the variety of Georgia's physical geography: there are humid subtropical lowlands and wetlands, plains, semi-deserts, highlands, mountains covered by forests and glaciers, some lakes and plenty of rivers. Mountains cover a significant part of the territory: 54% of it is located at an altitude of 1,000 m above sea level.

The Black Sea coastal zone has a humid subtropical climate. The average annual temperature there is 14-15^{0}C, with extremes ranging from -15^{0}C to +45^{0}C, and annual amounts of precipitation vary between 1,500 mm and 2,500 mm. The Black Sea influences the climate of West Georgia, resulting in mild winters, hot summers and abundant precipitation. Here in the mountainous and high mountainous areas, the annual air temperature ranges from 2-4^{0}C to 6-10^{0}C with an absolute minimum between -30^{0}C and -35^{0}C, and annual amounts of precipitation range between 1,200 mm and 2,000 mm.

The climate in the plains of East Georgia is dry: in the lowlands, it is dry and subtropical; and in mountainous areas, it is alpine. The average annual temperature is 11-13^{0}C in the plains, and 2-7^{0}C in the mountains. The absolute minima are -25^{0}C and -36^{0}C respectively. In the high mountains (the slopes of Mount Kazbegi), the absolute maximum reaches +42^{0}C, and the absolute minimum reaches -42^{0}C. The annual amounts of precipitation vary within the range of 400-600 mm in the plains, and 800-1,200 mm in the mountains.

Like other republics of the former USSR, Georgia has an economy in transition. Economic reforms aimed at transforming the country into a market economy began immediately after the disintegration of the Soviet Union, but have not succeeded so far. Under the Soviet Union, the leading branches of the economy were industry, agriculture, and services, comprising nearly equal shares in their GDPs. After the collapse of the Soviet Union, the industry underwent considerable decline, due to the disruption of economic relations between the former Soviet

Union republics and the boosting of energy prices as they were brought into line with international market prices. The problems in industry have led to a decline in other sectors as well. Conditions gradually began to improve after reforms launched in 1997 and improvement has intensified since 2003. According to the IMF an abundant flow of private capital investment into the country increased by 4.6 times between 2004 and 2007 amounting to USD 2.3 billion. This has made a considerable contribution to the region's economic revival.

In recent years, economic growth has followed an almost irreversible trend in nearly all sectors, and in 2008, a 9% GDP growth was expected. However, the military conflict in August 2008 changed the country's economic conditions: the country suffered heavy losses in all sectors of its economy, including those making major contributions to GDP, such as agriculture, manufacturing, trade, tourism, transportation, construction, and banking. The social costs of accommoding and assisting thousands of homeless Internally Displaced Persons (IDPs), as well as reduced purchasing power have imposed a heavy burden on the still weak economy.

Despite the possible further impact of this conflict on the structure and the dynamics of GDP, Georgia's development in the 21st century will conform to the SRES scenarios A1, A2 and B1. Of these, the most likely scenario judged by experts is A1.

National GHG inventory

The years 1987-1997 were considered and assessed in Georgia's first national inventory of greenhouse gases (GHGs) undertaken during the preparation of the Initial National Communication (INC). In the Second National Communication (SNC), the GHG inventory continued into the 1998-2006 period. Calculations were based on the IPCC 1996 Guidelines and were specified under the IPCC Good Practice Guidance (GPG) recommendations. For the first time the QA/QC procedures and uncertainty analysis for key sectors were implemented.

In the INC, the base year was 1990, while in the SNC, the base year is 2000.

Figure 1 presents the results of GHG emissions (Gg CO_2-eq) for CO_2, CH_4 and N_2O in Georgia for the years 1990 (A), 2000 (B) and 2006 (C), respectively.

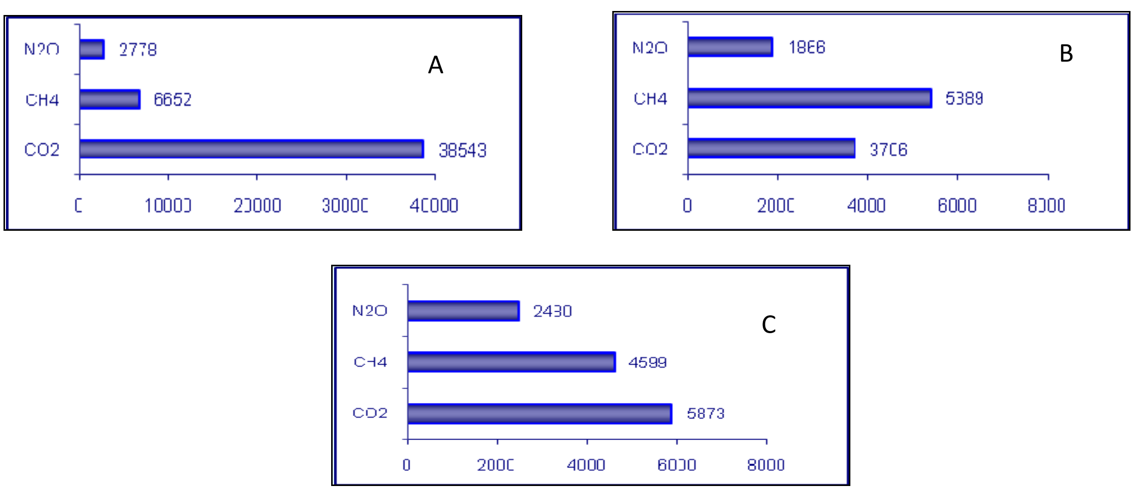

Figure 1. GHG emissions (Gg CO_2-eq) in Georgia in 1990 (A), 2000 (B) and 2006 (C)

As Figure 1 illustrates, the aggregated GHG emissions from the territory of Georgia underwent significant changes during the last two decades. First of all, CO_2 emissions fell drastically in the first decade (1990-2000) by more than ten times. CH_4 emissions have also declined, but only by 23%, and those of N_2O by 49%. In 2006, the emissions of CO_2 and N_2O increased by 58% and 33% respectively, while those of CH_4 decreased by 17% compared to 2000.

The sectoral distribution of emissions for the same years has indicated that the main reason for such a sharp decrease in CO_2 emissions is a fall in the energy and industry sectors, caused by the collapse of the Soviet Union's so-called "planned economy" and consequent disruption of existing economic ties between the former republics. The agriculture and waste sectors have been less responsive to these processes. From the end of 1990s, Georgia's economy began to revive, bringing about some increases in CO_2 emissions, mainly accounted for by the significant rise in transportation subsectors. The definite decrease in CH_4 emissions for the recent period of 2000-2006 is attributed to the marked decline in leakages from the natural gas transmission and distribution system, as a result of the improved maintenance of gas pipelines.

Based on the experience gained through compiling the second national GHG inventory, both short-term (2009-2012) and long-term GHG inventory strategies have been developed. Short-term objectives include annual updating of GHG inventory and the improvement of inventory quality control process, as well as the improvement of legislative measures. The objective of the long-term strategy, to be implemented from 2012, is to ensure a comprehensive and sustainable national inventory process and the implementation of regulations required under the EU legislation.

Steps planned to implement the Convention

As a first step towards implementing its obligations under the UNFCCC, Georgia prepared an Initial National Communication in 1997-1999. Since then a number of projects have been implemented in the country, aimed at studying various aspects of climate change and preparing for mitigation and adaptation proposals.

During 2006-2009, Georgia has prepared its SNC to the UNFCCC. In the process, the national GHG inventory has been undertaken; future climate change scenarios have been developed; and the vulnerability of different ecosystems and economic sectors to current and expected climate change has been assessed. The adaptation projects were prepared, along with the planning of GHG abatement measures, and a number of activities in raising public awareness were conducted.

Based on the assessments and results obtained in the SNC, as well as other past and ongoing projects in Georgia, short and long-term climate change strategies have been prepared. The strategies do not yet cover the whole territory of the country, but are focused on the priority regions selected during the stocktaking exercise.

The strategies aim to remove barriers in the following six areas: enhancing the local potential for the implementation of UNFCCC principles; ensuring the sustainability of the national GHG inventory; assessing the vulnerability to climate change and adaptation measures; mitigating GHG emissions and raising public awareness.

Key target groups considered in the Strategy are: the Cabinet of Ministers, the Ministries of Environment, Energy, Economic Development, Agriculture, Health, Education and Finance, the

Parliament of Georgia, the Department of Statistics, the private sector, non-governmental organizations (NGOs), research institutions, local administrations and municipalities, farmers and rural populace, teachers and lecturers, businessmen and mass-media representatives.

Measures to facilitate adequate adaptation to climate change

The vulnerability of three priority areas has been assessed based on the future climate change scenarios. These priority areas are the Black Sea coastal zone, Dedoplistskaro and Kvemo Svaneti regions.

Climate change scenarios. The current change in climate elements in Georgia, and in priority regions in particular, has been assessed based on actual observation data. Mean air temperature and temperature extremes, precipitation, relative humidity, wetting regimes and wind were investigated, as well as trends of extreme events (high winds, drought, landslides, floods, etc.), characteristic to each of the examined regions.

The trends of change in the mean annual air temperature, the mean annual precipitation, and the moistening regime, were estimated between the two time periods 1955–1970 and 1990-2005.

In all three priority regions, statistical analysis has revealed an increased tendency for both mean annual air temperature and annual precipitation from the first (1955-1970) to the second (1990-2005) period. The increment of temperature and precipitation in West Georgia appeared to vary in the range of 0.2–0.4^{0}C and 8-13% respectively, while in East Georgia the relevant values were found to be 0.6^{0}C and 6%. The changes in air temperature absolute minima and absolute maxima also demonstrated a warming tendency in both the warm and the cold periods of the year.

Two regional models have been used for the assessment of future climate scenarios: PRECIS and MAGICC/SCENGEN. The MAGICC/SCENGEN model was used for selecting the most suitable GCM for East and West Georgia, for each season and each climatic parameter. Two runs of the PRECIS model were used for the forecast of future localised changes. The results of these models in West Georgia show an increase by 3.5^{0}C in mean annual temperature to the end of this centuary, accompanied with a decrease in precipitation by about 6%, while in East Georgia the air temperature is expected to rise by 4.1^{0}C, and sums of precipitation could fall down to 14%. This process of reverse changes in temperature and precipitation is anticipated to be sharpened in summer when both tendencies are more distinct than in other seasons.

Black Sea coastal zone. Georgia's coastal zone is affected by a variety of geophysical processes (tectonic movements, rising sea levels, tidal waves, floods, underwater currents, river sedimentation, etc.), some of which are being intensified by current climate change. This zone is considered the most vulnerable to climate change. In the past century, the mean rate of sea-level rise (eustasy) at the eastern coast of the Black Sea was 2.6 mm/yr. In the years 1924-1996, the sea surface temperature decreased by 1.0^{0}C. However, in 1990-2006 it increased by 1.3^{0}C, resulting in the warming of the sea surface temperature by 0.2^{0}C. Owing to the increase in maximum wind velocities, the frequency of powerful storms (force 5 to 7) has increased by three times in Poti and Batumi during the past four decades.

A number of indicators have been identified (eustasy, storms, sedimentation and changes in sea surface water temperature) for assessing the vulnerability of various coastal zone areas to climate change (R. Rioni Delta, R. Chorokhi Delta, lower reaches of R. Rioni and the Sokhumi coastal area). This assessment has indicated that the most vulnerable part of the coastal zone is the R.

Rioni Delta surrounding the city of Poti. A number of adaptation projects have been developed for the most vulnerable areas to meet the challenges of climate change in this century.

Dedoplistskaro region. The Dedoplistskaro region (DTR), due to its territories under threat of desertification, has been selected as a second priority region for assessing the vulnerability to climate change, and adequate adaptation measures have been developed to mitigate this desertification process.

Extreme weather events such as drought and high winds are significantly affecting agriculture, the only developed economic sector in the region. Under the impact of climate change, the severity of these phenomena has increased markedly in the past 50 years: the annual duration of the drought period has extended from 54 to 72 days, and the frequency of its occurrence has risen two-fold. The frequency of high winds ($\geq$ 30 m/s) has increased by five times since the beginning of 1980s.

Analysis of meteorological records has indicated that for the past half-century, the mean annual temperature has increased by 0.6^0C, and the mean annual precipitation by 6%. The projected decrease in precipitation by 14% by the year 2100 could increase the aridity of local climate, transforming local semi-arid landscapes into arid semi-desert and desert landscapes.

With the threat of potential aridisation of the region's two rivers – the Alazani and Iori – in mind, the main water suppliers of the territory have been assessed through the hydrological model WEAP. The results have demonstrated the possibility of an 8% decrease in the annual runoff of R. Alazani in the period 2071-2100. However, the modelling of water deficit in the irrigation systems has shown that even in case of a 50% decrease in the river runoff, and the increase in water consumption by the same percentage, the demand will be met in all months except August. The same methodology applied to R. Iori has revealed an anticipated 11% decrease in river runoff and the impossibility of meeting a future water demand increase of even 10%.

The computer model CropWat has been applied to assess the influence of climate change on water deficit for some crops and pastures. The shortage of water for winter wheat, sunflower and pastures was revealed in the past (1960-2005) and assessed for the projected period 2021-2100.

Owing to the current minimum anthropogenic interference (arable land is not irrigated, wind belts are exterminated, part of the land is abandoned, etc.) the situation in the region is in the best position to reflect the impact of present climate conditions on the crops and their yield.

Kvemo Svaneti. Kvemo Svaneti (the mountainous region) has been identified as an ecosystem vulnerable to various disastrous weather events, significantly enhanced by global warming. As a result of the increased frequency and intensity of these phenomena (floods, landslides and mud torrents), land erosion has intensified and greatly damaged agriculture, forests, roads and communications.

As a result of the intensification of landslides and floods, the population of the Lentekhi region has decreased by 40% since 1986, and it is believed that this process will continue until decisive adaptation measures are taken to mitigate the adverse impact of climate change in the region.

The mean annual air temperature and level of precipitation in this region have increased by 0.4^0C and 106 mm (8%) respectively, for the past 50 years

Analysis of observation data on floods for the period of 1967–1989 has demonstrated that in the second half of the period the recurrence of floods grew by more than two-fold, and the maximum discharge has increased by 9%. At the same time, the duration of floods has decreased by 25%, which could explain the rise in intensity and severity of floods.

Since 1980, the number of landslides has increased by 43%, reaching a total of 117 at present. This especially steep rise in the number of landslides was provoked by the abundant snowfall in the winter of 1986-1987. The increase in heavy precipitation for the last two decades in Kvemo Svaneti has also caused an almost two-fold growth in the frequency of mud streams.

Despite sufficient provisions of precipitation in the Lentekhi region, its territory is affected by drought from time to time, the duration and recurrence of which have increased by 38% and 17% respectively since 1991, compared with the 1956-1972 period.

Forests represent one of the main natural riches of Kvemo Svaneti, covering about 60% of its territory. For the last 15-20 years, the growing spread of pests and diseases has been observed in the forests of the region.

Assessments of Central Caucasus glaciers, including in the Svaneti region, have indicated that up to the present time the total area of glaciers in Kvemo Svaneti may have decreased by 25%, and their total volume may have been reduced from 1.2 km^3 to 0.8 km^3. Projected rises in temperature by the year 2050 may result in the total disappearance of Kvemo Svaneti glaciers.

Health. This is the first time that the health sector has been studied in the SNC. The focus was on the priority regions considered above. This survey indicates that elderly people are the most sensitive category to changes in climate elements.

Malaria and leishmaniasis have been identified as the diseases posing most risk due to climate change. Analysis of the distribution of these vector borne diseases has indicated that they are spread predominantly in the far eastern part of Georgia – in the Kakheti region, which includes Dedoplistskaro, and in Tbilisi. From the total of 438 malaria cases detected in the period 1996-2005, 319 cases (73%) were attributed to the Kakheti region. The dynamic of leishmaniasis cases in Tbilisi for the same period of time shows an increase from 15 cases in 1995 to 160 cases in 2005. The current number of registered cases is not high enough to indicate that there is an epidemic of leishmaniasis, and moreover of malaria, in Georgia. Nevertheless, a growth in the mean annual temperature is expected to increase the frequency of these diseases.

Adaptation measures. Adaptation strategies have been developed for all three priority regions described above. Based on these strategies, a number of adaptation proposals have been elaborated upon, the main features of which are presented in Table 1.

Table 1. Adaptation proposals identified in Georgia's SNC

No.	Title of the project	Project objective	Project cost (USD)
The Black Sea coastal zone			
1	Management of climate change–driven risks in Rioni Delta	Establishment of flood warning and information dissemination system	100,000 (stocktaking exercise), 1 million (implementation phase)
2	Adaptation measures in Rioni Delta	Shoreline protection in Rioni Delta	100-130 million
3	Coast protection measures in Batumi-Adlia seashore zone	Shoreline protection in Batumi-Adlia segment	65–88 million
Dedoplistskaro Region			
4	Rehabilitation of wind belts in Dedoplistskaro region	Mitigation of climate change impact in the region that has been suffering from drought and land erosion processes	24.1 million
5	Plantation of 40 ha of energy forest in Dedoplistskaro region	Rehabilitation of eroded and degraded land, and supply of firewoods to local settlements	296,241
6	Irrigation of pastures from the Dali Reservoir	Rehabilitation of pastures for sustainable development of livestock husbandry in the region	205,000
7	Rehabilitation of Zilicha pumping station	Restoration of irrigation for 5,200 ha of arable land in Dedoplistskaro region	59,000
8	Watering 900 ha of Taribana arable land	Facilitation of sustainable harvest in the region	73,000
Kvemo Svaneti			
9	Planting of hazelnut in Lentekhi region	Combating land erosion at the landslide-prone slopes in the region	281,700
Other regions			
10	Mitigation of disastrous glacial phenomena in the Dariali Gorge	Elaboration of adaptation measures to reduce losses caused by melting glaciers	To be estimated after survey
11	Wind farm "Rustavi"	Substitution of fuel-based power by wind energy to reduce power deficiency	35.0 million
12	Wind farm "Skra"	Substitution of fuel-based power by wind energy to reduce power deficiency	35.5 million
13	Wind farm "Poti"	Substitution of fuel-based power by wind energy to reduce power deficiency	21.1 million
14	Wind farm "Batumi"	Substitution of fuel-based power by wind energy to reduce power deficiency	34.1 million

Policies and measures to mitigate climate change

The national GHG inventory for the years 2000-2006 has shown that the energy sector, including transportation, is the leading sector in emissions in Georgia. To estimate the future trends of GHG emissions under different mitigation policies, the software model LEAP has been applied. Three scenarios have been assumed for the evaluation of possible future trends of Georgia's energy sector: the baseline scenario (BAU), alternative scenario 1 (Split Public) and alternative scenario 2 (State Policy). The quantitative characteristics of energy sector evolution projected for 2025 are discussed for all three scenarios, covering residential, industry and service, agricultural and other subsectors, as well as the electricity generation features for the same period.

GHG emissions calculated for the entire energy sector appeared to be sufficiently sensitive to different scenarios. The results have clearly shown how different measures influence the GHG emissions. In particular, they demonstrate the role of Government policy (State Policy scenario) in reducing GHG emissions. The modelling results show that the energy efficiency measures and renewable energy savings are 6% under alternative scenario 1, and 12% under alternative scenario 2.

Calculations performed for the power generation sector have demonstrated the possibility of reducing emissions from this sector by increasing the share of renewable resources such as wind and hydro. For example, according to the State Policy scenario, the share of renewable resources in the power generation sector will be maximised in 2025, thus reducing the GHG emissions to zero by this year.
Conclusions and recommendations are supplemented by the National GHG Mitigation Strategy for the years 2010-2025, in which different measures are discussed, aimed at the abatement of GHG emissions, the creation of an enabling environment in the electricity generation sector, and fuel switching in energy demand, as well as in heat and energy consumption.

The CDM is regarded as an efficient tool for the practical implementation of the GHG Mitigation Strategy. In 2002, the Ministry of Environment Protection and Natural Resources was appointed as the Designated National Authority (DNA). Four CDM Project Idea Notes (PINs) have been prepared for submission to the DNA.

Other information

Climate change research and systematic observation, education and training, and capacity-building issues are discussed.

At present the systematic hydrometeorological observations in Georgia are being conducted at about 40 stations and posts. The Tbilisi meteorological station is included in the GCOS system.

A number of measures are being undertaken to optimize and rehabilitate the Georgian observation network. Under the assistance of WMO, USAID, and the Finnish and Canadian governments, a number of observation sites are being equipped with modern measuring devices. The Japanese government is considering assistance in the installation of two meteorological radars and a satellite imagery reception unit. The Georgian Government will also contribute to this process.

A number of theoretical studies have been carried out by Georgian research institutions and scientific organizations in the past 10 years since the preparation of the Initial National Communication. The research was mainly conducted at the Institutes of Hydrometeorology, Geography and Geophysics, the High Technology National Centre and I. Javakhishvili Tbilisi State University.

In addition, Georgia took part in implementing a number of regional projects, which included the following areas: (i) decreasing transboundary degradation in the Kura-Araks basin; (ii) improving water problems in South Caucasus and Moldova; (iii) improving the GHG inventory; (iv) developing environment networks and information systems; (v) monitoring floods; (vi) enhancing the energy efficiency in different sectors of economy; and (vii) promoting sustainable development in mountain regions.

In 2004-2006, two regional capacity-building projects were implemented: the EuropeAid CDM capacity-building project aimed at preparing the ground for the implementation of CDM projects in South Caucasus and Moldova; and UNDP/GEF project for improving the quality of the national GHG inventory.

Several activities have been carried out in the areas of education, training and awareness-raising. Among these activities are University students practised running various models (LEAP, WEAP, CropWat, CoFix, PRECIS, MAGICC/SCHENGEN, etc.); a painting exhibition organized for school pupils; and publishing calendars for 2008 and 2009 telling the stories of vulnerability in Dedoplistskaro and Kvemo Svaneti. Different guidelines have been translated from English to Georgian for national experts and annual bulletins have been published in 2007 and 2008.

Constraints and financial needs

The following main constraints have been identified in the process of preparing the SNC: Environment protection is not yet a priority for the country and therefore the integration of climate change issues in sectoral development programmes and concepts is almost impossible. There is also a lack of national experts on climate change; an absence of relevant scientific assessments and surveys; a lack of coordination and information-sharing between relevant projects and programmes being implemented in the country; and low awareness among decision-makers, private sector and the general public.

The main barriers to the implementation of the CDM process are the still weak market infrastructure, the inaccessibility of data to construct baseline scenarios, and the small potential of CDM projects.

The country's capacity-building needs include re-training of local experts in cross-cutting issues, encouraging young experts in their inolvement with international programmes, and improving the accessibility of national statistics.

The tentatively assessed financial needs of the country to cope with the adverse impact of climate change are considered in the relevant chapters. It is obvious that these needs can only be considered as preliminary to a broader assessment.

Chapter 1
National Circumstances

1.1 National and regional development priorities

Georgia's national and regional priorities are defined by its geopolitical location, historical relationships, social and cultural peculiarities, and the requirements of current momentum.

Georgia, one of the most ancient countries in the world, is situated in the South Caucasus, between the Black and the Caspian seas, to the south of the Great Caucasus mountain range. Because of its favourable geographic location, Georgia has been involved in the arena of its powerful neighbours' geopolitical interests, which have determined the particularities of its social, political, and commonwealth development.

After the disintegration of the Soviet Union, Georgia restored its independence and started to build a democratic society. Reforms in all areas have begun.

Georgia became a member of European structures, and the process of entering NATO has been an active undertaking since. Georgia's national and regional priorities have kept it closely integrated with European structures. This has helped Georgia to establish and strengthen its democratic institutions and principles, to maintain stable and mutually beneficial relations with all states, to protect common human rights and provide favourable conditions for its own individual development. Regional priorities have included the development of mutually beneficial economic relations, and a strengthening of the Black Sea Economic Cooperation. Georgia's national and regional interests include good neighbouring relations with Russia as well, but only under conditions of mutual respect for equality and territorial integrity for one another.

At present the utmost attention of the country's leaders in Georgia is devoted to protecting state security, and for this reason, to joining NATO. The same goals are underway in creating and establishing an energy corridor (Baku-Tbilisi- Ceyhan and Baku-Supsa oil pipelines and a Baku-Tbilisi-Erzerum gas pipeline) to provide fuel supplies to Europe which pass around Russia, thereby creating additional guarantees for the security of Georgia as well as the economic benefits.

1.2 Political profile

Georgia is a Presidential republic. The President of Georgia is Head of the Country. The executive power is represented in the Cabinet of Ministers headed by the Prime Minister, with the power Ministries being directly under the President's subordination. Legislative power is represented by the Parliament, and the judicial power by Supreme, Constitutional, District, and Municipal courts.

1.3 Geography and climate

Georgia is situated in the South-East of Europe. To the North, Georgia borders on the Russian Federation, to the south with Turkey, Azerbaijan and Armenia. Its total area comprises 69,700 km^2. A mountainous landscape determines the variety of Georgia's physical geography: there are mountains, valleys, plains, lowlands, glaciers, wetlands, arid lands, lakes, rivers and even geysers. Mountains cover a significant part of the territory: 54% of it is located at an altitude of 1,000 m above sea level. In addition to the Great Caucasus range, there are several other mountain ranges in Georgia. The most important is the Likhi Range, running from the North to the South and dividing the country into its Eastern and Western parts.

Almost every climatic zone is represented in Georgia except for savannas and tropical forests. To the North, the range of the Great Caucasus protects the country from the direct penetration of cold air. The circulation of these air masses has mainly determined the precipitation regime all over the territory of Georgia. The climatic picture totally differs in both parts of Georgia as divided by the Likhi Range.

The climate in Western Georgia is highly diverse, altering in certain areas very sharply from humid subtropical to permafrost. The climate is determined by the Black Sea coast to the West, and by the amphitheatre of three big mountain ranges (the Great Caucasus, the Likhi and the Meskheti), in addition to the surrounding Kolkheti lowland (wetland) in the very centre.

The Black Sea coastal zone has a humid subtropical climate. The average annual temperature there is 14-15^{0}C, with extremes ranging from +45^{0}C to -15^{0}C, and annual amounts of precipitation vary between 1,500 mm and 2,500 mm. The Black Sea influences the climate of West Georgia, resulting in mild winters, hot summers and abundant precipitation. Here in the mountainous and high mountainous areas, the annual air temperature ranges from 6-10^{0}C to 2-4^{0}C with an absolute minimum between -30^{0}C and -35^{0}C, and annual amounts of precipitation range between 1,200-1,600 mm and 2,000 mm.

In East Georgia the climate is also complex: the basin of the River Mtkvari (Kura) crosses the central plain. To the South of the river stretches the volcanic Javakheti Highland, with the Samsari Range (its highest peak at 3,301 m above sea level) at its centre. Kakheti makes up the extreme eastern region, which borders the southern branch of the Great Caucasus range from the North.

The climate in the plains of East Georgia is dry: in the lowlands, it is a dry subtropical climate, and in mountainous areas it is alpine. The average annual temperature is 11-13^{0}C in the plains, and 2-7^{0}C in the mountains. The absolute minima are -25^{0}C and -36^{0}C respectively. The absolute maximum reaches +42^{0}C, and the absolute minimum falls to -42^{0}C in the high mountains (the slopes of Mount Kazbegi). The annual amounts of precipitation vary in the range of 400-600 mm in the plains, and 800-1,200 mm in the mountains.

Georgia is rich in fresh water: rivers, lakes and springs. The rivers are not large enough to be navigated but they are fairly potent for the purposes of hydro energy and fishery, owing to their fast and sloping run. The largest river is the Mtkvari (Kura), which originates in Turkey and, crossing through almost all Georgia, flows into the Mingechaur Reservoir (in Azerbaijan). Two other rivers also flow here – the Alazani and the Iori, originating in the mountains of the Great Caucasus, and running down the Kakheti region. The other important rivers of Eastern Georgia are the Liakhvi, the Khrami, and the Aragvi.

Western Georgia is even richer in rivers than Eastern Georgia. Most of these have their origins in the mountains of the Great Caucasus. The rivers Rioni, Enguri, Tskhenistskali, Natanebi, and Supsa, all flow into the Black Sea.

In South Georgia, on the Javakheti Highland, at an altitude of 2,100 m, lies Georgia's largest lake, Paravani (37.5 km^2). Other lakes include Paliastomi (18.2 km^2), Tabatskuri (14.2 km^2), Jandari (10.6 km^2), and Bazaleti (12 km^2). There are also over 20 reservoirs of fresh water formed by different rivers.

Georgia is rich in various ecosystems. The Kolkheti lowland stretches over 600 km^2 of Western Georgia and is a vast wetland; in Eastern Georgia, the Kakheti region is the arid area of the Gareji semi-desert (70 km^2), and glaciers along the Great Caucasus occupy an area of about 500 km^2. Forests cover 43% of the total area of the country. Georgia's magnificent forests, abundant in rare species of wood, are the true wealth of the country.

The rich nature, diverse climate and large variety of healing geothermal and mineral waters in the country have resulted in a number of resorts being established, some of which are world-famous.

Georgia possesses certain reserves of various mineral resources, the most important of which are manganese, iron, copper, coal and marble.

Table 1.1. Georgia's Territory

Total area	**Agricultural area**	**Forest Area**		**Mountainous area (over 1,000 m)**	**Fresh waters (lakes, rivers, reservoirs)**	**Wetlands**	**Glaciers**	**Semi-deserts**
1,000 km^2	1,000 ha	1,000 ha	%	%	1,000 ha	km^2	km^2	km^2
69.7	3,025.8	2,456.2	43	54	835.1	600	511*	70

** Based on 1960 data; but latest estimate indicates that this area has been decreased to about 400 km^2 (in detail about glaciers (see below chapter. 4.1.4)*

1.4 Population and demographic profile

As of July 2008, the population of Georgia was about 4.63 million (estimation). Two thirds of the population (67.1%) were between 15 and 64 years old. An economically active population comprises 31% of the total. 52% live in towns, with this figure increasing annually by nearly 0.1%.

Georgia's population has been decreasing slightly (-0.32%), due to a high rate of migration (4.36 per 1000 capita) and not to the birth/mortality ratio (10.62 births and 9.51 deaths per 1,000 capita). The number of Internally Displaced Persons (IDPs) from the Abkhazia region, and South Ossetia, constitutes about 220-240 thousand inhabitants, according to a census in 2007. After the military conflict in August 2008, the number of IDPs increased by 120,000.

Ethnically the population of Georgia is heterogeneous (according to a census in 2002) consisting of 83.8% ethnic Georgians, 6.5% ethnic Armenians, 1.5% ethnic Russians, and 2.5% other ethnic groups. 71% speak Georgian as their first language; 9%, Russian; 7%, Armenian; and 6%, Azeri. Religious denominations are also presented in large variety: in traditionally and historically tolerant Georgia the 83.9% orthodox Christians peacefully co-exist with 9.9% Muslims, 3.9% Gregorian Christians, 0.8% Catholics and various other denominations.

Throughout the entire territory of Georgia the official language is Georgian.

Tbilisi, the Capital of Georgia, with nearly 1.5 million inhabitants, is situated in East Georgia on the banks of the River Mtkvari (Kura). Other important cities are Kutaisi, Rustavi, Gori, Zugdidi, Sokhumi, Batumi, and Poti. Large industrial enterprises are mainly concentrated in the urban areas.

Table 1.2. Population of Georgia

Number			**Rate of growth**	**Life Expectancy**			**Density**	**Share of inhabitants of cities**	**Social indicators**			**Level of education (over 10 years)**	
Total	**Without the population of Abkhazia and South Ossetia**	**Between the range Of 15-64 years**		**Total**	**Women**	**Men**			**Economically active population**	**Rate/level f unemployment**	**Below the level of poverty**	**Literacy level**	**Higher education**
(million person)	**(1,000)**	**(%)**	**(%)**	**Years**	**Years**	**Years**	**Men/ km^2**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**
4,630,841	4,382.1	67.1	-0.325	76.51	80.26	73.21	66	52.6	42.4	13.3	31(2006)	99.7	24.3

Source: Statistical Yearbook of Georgia 2008
CIA – The World Factbook – Georgia (2008)

1.5 Economy

Like other republics of the former USSR, Georgia has an economy in transition. Economic reforms aimed at transforming these countries into market economies began immediately after the disintegration of the Soviet Union, but have not yet succeeded. Up to this time, the economies of these countries have experienced a lot of quantitative as well as qualitative and structural changes. Under the Soviet Union, the leading branches of their economies were industry, agriculture, and services, comprising nearly equal shares in their GDPs. After the Soviet Union disintegrated, their industries underwent considerable decline, as a result of the disruption of economic relations between the former Soviet Union republics. This boosted prices for the energy owners. The problems in industry have led to a drop in other sectors as well. Conditions gradually began to improve after reforms launched in 1997, and in Georgia the improvement has intensified since the Rose Revolution succeeded in 2003. The Government has since identified priorities of economic development. Their first task was to provide a favourable milieu for investments, such as to remove barriers impeding economic development, and to ensure energy self-sufficiency and the construction of roads. Some energy security has been reached, opening up the way for further industry, agriculture, and other economic areas to revive. Current enterprises have been rehabilitated and renovated, new ones founded, and private entrepreneurship activity has intensified. Trade has been expanding; construction, financial intermediation (banking) and the service industries are still intensifying. According to the IMF, an abundant flow of private capital investment into the country increased by 4.6 times between 2004 and 2007, amounting to USD 2.3 billion, which has made a considerable contribution to the country's economic revival.

Table 1.3. Direct foreign investment in Georgia (in USD 1,000)

	2004	**2005**	**2006**	**2007**	**2008 1st Q**	**2008 2nd Q**	**2008 3rd Q**
Direct foreign investment (USD 1,000)	499.1	449.5	1 190.4	2 014.8	430.193	525.204	150.023

The counter-corruption policy led by a steadyhand has enhanced this economic resurrection. Unemployment has been decreasing slowly but steadily, and unfavourable social conditions have been ameliorated. Economic growth has become nearly irreversible, resulting in the dynamic growth of economic indicators. The income budget exceeded GEL 6 billion, and the annual growth of the GDP in 2005-2007 grew by about 10% on average. Based on the estimates of 2007, the GDP was approximately composed of agriculture (13.1%), industry (29.3%) and services (57.6%). In the same year, agriculture, industry, construction, trade and transport contributed 50.8% towards total GDP growth, relative to the previous year. Greater growth than these general GDP figures has been shown in the fields of construction, hotels and restaurants, transport, banking, real estate, renting and business activities, which have been demonstrating noticeable progress for last few years.

Table 1.4. Trend of GDP

	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008 1st Q**	**2008 2nd Q**	**2008 3rd Q**
Volume of total GDP (market prices; GEL million)									
Gross Domestic Product	7 456	8 564	9 824	11 621	13 790	16 999	4 182.5	4 995.2	4 793.2
Production of goods	3 130	3 716	3 986	4 477	4 539	5 116			
Service	3 903	4 404	5 079	5 937	7 615	9 664			
GDP per capita, GEL		1 972.1	2 276.7	2 689.1	3 133.1	3 866.9	954.5	1 139.9	1.093.8
Currency course USD/GEL		2.1459	1.9170	1.8127	1.7767	1.6707	1.5558	1.4460	1.4091
GDP by economic activities (% from the previous year)									
Agriculture, hunting and forestry; Fishing	98.6	110.3	92.1	112.0	88.3	103.3	106.8	103.7	98.1
Mining and quarrying	129.8	97.9	80.1	92.2	118.7	119.9	127.1	105.8	116.4
Manufacturing	120.8	109.5	111.6	114.1	122.3	111.5	100.5	107.3	93.8
Electricity, natural gas and water supply	89.8	109.2	96.0	105.1	113.4	106.8	113.1	106.6	88.2
Processing of products by household	100.9	104.7	98.4	112.4	103.0	128.1	103.3	97.3	96.8
Construction	143.1	146.6	135.9	114.1	108.5	114.6	112.4	101.4	68.3
Trade services, Repair services (wholesale and retail sale; repair of motor vehicles and household goods)	103.9	112.1	108.2	109.4	119..7	109.6	115.2	111.8	109.5
Restaurant and Hotel services	107.6	114.2	103.5	116.6	110.5	111.4	102.4	111.4	94.0
Transport and storage	109.7	104.4	103.7	103.9	116.8	111.9	99.9	104.9	78.2
Communications	102.5	138.5	116.9	128.7	113.4	108.7	112.5	121.2	121.7
Financial intermediation	122.9	88.8	112.8	152.8	136.9	115.3	115.8	140.4	81.6
Real estate, renting and business activities	118.1	142.2	128.1	110.6	117.4	123.1	113.1	101.5	102.1
Rent of own occupied dwellings	101.1	101.9	100.6	100.9	100.2	105.4	103.6	104.7	102.2
Public administration and defence	101.2	97.7	109.7	93.7	97.6	115.9	116.1	114.5	103.1
Education	101.5	101.5	101.8	113.7	112.1	109.5	103.7	113.6	128.7

Health care and social services	106.5	101.7	104.2	107.6	115.4	110.4	103.4	110.7	101.7
Other community, social and personal service activities	105.1	119.4	106.5	118.3	107.1	124.0	110.2	102.8	86.1
Private households with employed persons	85.9	96.1	120.5	81.2	108.5	107.5	117.5	102.1	102.8
Financial intermediary services	122.7	104.5	92.1	157.5	85.0	142.5	97.2	136.6	150.9
GDP (at market prices), % to the previous year	**105.5**	**111.1**	**105.9**	**109.6**	**109.4**	**112.3**	**109.1**	**108.3**	**96.1**
GDP deflator, % to the previous year	106.0	103.3	108.4	107.9	108.5	109.7	112.3	113.0	109.9

Due to the unequal development of different sectors, their shares in the Gross Domestic Product have been changing from year to year.

Table 1.5. Structure of the Gross Domestic Product, 2005-2007

Years	**2005**	**2006**	**2007**
Agriculture, hunting, forestry; Fishery	14.8	11.2	9.4
Industry	12.2	12.4	11.8
Processing of products by household	3.5	2.5	2.2
Construction	8.1	6.9	6.7
Trade services, Repair services (wholesale and retail sale; repair of motor vehicles and household goods)	12.0	13.6	13.1
Restaurant and Hotel services	2.8	2.3	2.2
Transport and storage	8.4	8.0	7.6
Communications	4.0	3.6	3.1
Financial intermediation	2.0	2.1	2.2
Real estate, renting and business activities	2.6	3.3	3.1
Public administration	6.5	8.5	12.8
Education	3.3	3.7	3.2
Health care and social services	3.5	4.3	4.2
Other sectors	4.9	5.0	4.4
Net indirect taxes	11.5	12.6	14.0
Gross Domestic Product	100	100	100

Industry. Industry in Georgia consists of machinery, mining (coal, oil, and gas), the chemical industry, ferroalloys, wood, wine, mineral waters and other kinds of production.

A major increase in the growth of the industry sector became possible as a result of solving the main problem of energy supplies for new enterprises. Owing to the privatization process, new investments were made, which enabled the rehabilitation and technical re-equipping of former industrial enterprises, and the formation of many others. Since then, industrial production has been increasing, available markets have been identified, and employment and exports have begun to increase. This stable growth of industry is reflected by the main economic indicators shown below.

Table 1.6. Main indicators of industry for 2003-2007

Year		Number of enterprises (unit)	Annual average number of employees (1000 persons)	Turnover (GEL million)	Output of industrial production at current prices (GEL million)	Main capital (GEL million)
2003		3,049	82.0	1,862.2	1,549.9	2,107.1
2004		3,439	85.4	2,119.7	1,754.2	2,164.8
2005		4,632	94.3	2,561.2	2,202.2	1,985.2
2006		4,149	90.3	3,228.7	2,757.3	2,124.4
2007		3,206	88.4	4,362.1	3,524.8	2,651.8
2008	1st Q	...	81.6	1,149.5	853.0	...
	2nd Q	...	85.3	1,151.7	1,019.8	...
	3rd Q	...	83.9	1,126.7	958.0	...

The growth in three branches of industry established in recent years (2003-2007) is shown in Table 1.7.

Table 1.7. Indices of industrial production by main economic activities[1)]for 2003-2007

	2003	2004	2005	2006	2007
		Percent to previous year			
Total Industry	114.8	108.6	116.4	110.6	114.5
Of which:					
Mining and quarrying	157.7	87.0	85.1	101.4	123.0
Manufacturing	117.6	114.9	124.9	112.2	114.4
Electricity, gas and water supply	103.3	102.7	106.3	110.9	108.3

1) 2002-2006 calculated on monthly data basis, from 2006 – on the basis of industrial Production Producers' Price index

Energy. Because of the exceptional importance of the energy sector from the point of view of the UNFCCC and, in particular for GHG emissions, this sector has been given special attention, especially while elaborating upon the Second National Communication. A comprehensive set of results from the research carried out during the SNC preparation process is presented in Chapter 5 of this document.

The energy sector has always been a priority for the economy of Georgia, but since 2003, assuring its independence has become the main goal in developing the total economic scenario. Since 2004, this sector has been reformed. Consistent policies in this sector and market economy principles in some components of the energy system have enhanced the energy security of the country, and enabled it to meet reasonable energy demands throughout all seasons of the year. Achieving this goal became possible through Baku-Tbilisi-Ceyhan, and Baku-Tbilisi-Erzerum oil and gas pipelines, constructed and launched across Georgia.

Georgia's energy resources include mineral, hydro and other renewable sources. Mineral resources consist of special reserves of coal, crude oil and natural gas. The economy of the country is based mainly on hydropower, which provides 72% of the overall demand of electricity. Georgia is also rich in other renewable energy resources, such as wind, solar, geothermal and biomass, though with the exception of biomass, they are scarcely used, and are still waiting to be developed. Wind energy has been estimated to potentially provide 5 billion kWh of electricity. There are some reserves of geothermal energy as well, but these are rarely used.

Forests are one of Georgia’s most important energy resources. They cover 43% of the area of the country. The practice of uncontrolled wood-cutting common in the 1990s is now rare, due to the increased availability of other energy sources. In addition, the forestry sector is undergoing reforms, aimed at optimising the protection, development, and use of the forests. A Forest Code is under consideration, and investments have been raised. However, reforms in forestry management have been slow. This slowness is incompatible with the great importance this sector has for the country, due to the overwhelming demands made on it from society.

Transport has become one of the fastest growing sectors of the economy, especially in road transport. The flow of cars has increased and been renewed, though mainly with second-hand vehicles. Fleets of municipal and intercity buses, as well as trucks, have been renovated; railway trains have been restored and partly renovated; the volume of railway transits has been increasing. Air transportation has also been expanding and intensifying. Water transport has been modernized, and thus cargo turnover has been increasing.

The communication sector has been showing the most significant rise in quantity and quality. The following areas exhibit the most improvement and increased usage: post, postal transfers, telephone networks (modernized and enlarged) and cell phones. Table 1.8 shows the main indicators of the transport and communication sectors, as well as noticeable changes in correlation between different sectors.

Table 1.8. Main indicators in transport and communications

	2000	2001	2002	2003	2004	2005	2006	2007
Goods turnover Total (million t-km):	30060.0	332441.3	37488.3	41081.4	41149.8	45971.5	49946.6	49830.4
Of which:								
Railway	11496.1	13209.6	14951.5	16558.7	15424.4	18986.7	22643.3	22230.2
Road	18500.0	20000.0	22500.0	24500.0	25700.0	26959.3	27261.3	27561.2
Maritime	62.6	30.5	35.5	21.4	23.9	23.9	40.4	37.9
Aerial	1.3	1.2	1.3	1.3	1.5	1.6	1.6	1.1
Passenger turnover by transport types								
Total (million. Pass.-km):	6002.0	6189.8	6413.1	6700.5	7069.9	7294.0	7302.1	7281.3
Of which								
Railway	452.9	400.9	400.6	387.4	614.9	719.7	808.9	773.9
Bus	4500.0	4764.3	4920.0	5150.0	5200.0	5252.0	5269.2	5416.7
Trolley bus	90.5	106.0	145.1	114.6	120.6	117.0	52.7	5.4
Underground	674.6	622.7	614.4	622.8	624.0	676.0	710.1	610.5
Tramway	46.2	55.4	35.7	25.4	21.1	18.5	8.3	-----
Aerial	237.8	240.5	297.3	400.3	489.3	510.8	452.9	474.8
Number of telephone users (x1000)	572.4	582.3	584.0	588.3	532.8	544.4	571.7	577.2
Number of cell telephone users (x1000)	185.5	284.0	412.8	560.8	840.6	1174.3	1703.9	2310.4

Traditionally, **agriculture** has been a leading sector in Georgia. The fertile soil of the country has provided favourable conditions for land cultivation, as well as animal husbandry. The agricultural area covers 43.4% of the territory. Traditional agriculture crops include grape vines, wheat, and maize, fruit of many kinds, citrus plants, and tea plantations. The traditional types of animal husbandry include cattle-breeding and sheep-breeding.

Owing to policy reforms in the 1990s, the agricultural sector has revived. Reforms aimed at privatising the land resulted in the ownership transfer of the land to the farmers. Recently there has been a progressive growth in the production of wine, poultry, fruit, vegetable, wheat, and fisheries. Animal husbandry consistently shows a tendency of growth in the animal headcount. This stable increase in agriculture also arises from successes in grape, citrus and other fruit production.

Table 1.9. Indices of agricultural production output (at constant prices, % to the previous year)

Years	Total	Agricultural Production Output	
		Plant Production	Animal husbandry Production
2000	88.0	79.0	100.2
2001	108.2	110.7	106.0
2002	98.9	93.6	104.4
2003	110.8	118.8	103.2
2004	94.1	88.0	100.8
2005	112.1	124.2	100.3
2006	80.1	65.5	96.4
2007	112.3	135.6	95.3

Construction. In recent years, construction has continued to be one of the fastest growing sectors in Georgia. This success has been encouraged by the intensified import of construction materials, and increased local production. Developments in the banking sector have also contributed. Stable growth in the construction sector (including roads) is expected to be maintained in the near future.

Table 1.10. The volume in construction work (at actual prices)

Years	Construction work Total (1,000 GEL)	Contribution to construction work (1,000 GEL)	
		Government	Private sector
2001	239,020	34,574	204,446
2002	322,229	44,308	277,921
2003	297,890	41,381	256,509
2004	377,092	30,407	346,685
2005	746,110	51,020	695,090
2006	1,184,909	35,578	1,149,331
2007	1,717,177	35,506	1,681,671

Health care. Due to the country's transition towards a market economy, this sector has experienced serious changes. The process of transition from free health care to an insurance-based system has begun. As a result of serious reforms carried out in this sector, idle ambulance services became re-activated, medical facilities were re-equipped, and insurance policy systems for the low-income population were set up. New hospitals, including those furnished with modern equipment, are continually being built, the quality of medical service has been improving, and the insurance system is gradually gathering force. Further development of the role of insurance system in medical services has been planned.

The Service sector is showing a noticeable development in Georgia. The strengthening of the banking sector and legal regulations encouraging individual initiatives have produced a favourable environment for growth in this sector. These dynamics are expected to be maintained in the future. Energy consumption by the service sector is increasing annually, making this sector one of the largest potential emitters of greenhouse gases; and consequently, its expected impact on new energy-efficiency measures is rather high. Without mitigating measures, energy consumption in this sector is projected to increase from 4% in 2006 to 5% in 2025, based on the Long-Term Energy Alternative Planning (LEAP) programmatic model.

In recent years, economic growth has followed an almost irreversible trend in nearly all sectors of the economy, and in 2008, 9% growth in GDP was expected. However, the military intervention of Russia in August 2008 changed the country's economic conditions: this conflict caused considerable losses in all sectors of Georgia's economy, including those making major contributions to the GDP, such as agriculture, manufacturing, trade, tourism, transportation, construction, and banking. The social costs of accommodating and assisting thousands of homeless IDPs, and a reduced purchasing power, have imposed heavy burdens on the still weak economy. According to expert judgment, the total economic loss in 2008 amounted to USD 804 million. These losses resulting from the conflict have been accompanied by worsening investment conditions, demonstrated by a lowered inflow of private capital, and heavily reflected in business activities. Investments decreased from USD 1.5 billion in the first half of 2008 to USD 0.5 billion in the second half of 2008. Conditions have influenced the GDP as well. According to expert estimates, the GDP is expected to fall to at least 3.5% instead of the 9% previously anticipated in early 2008, regardless of promised international assistance (USD 4.5 billion).

Evidently, the consequence of the conflict in August 2008 will affect the indicators and dynamics of the GDP in the next few years quite considerably. However, our long-term perspective for Georgia's development in the 21st century, according to experts, should conform to the SRES scenarios [1] A1, A2 and B1 from which the scenario A1 is the most liklyhood.

Table 1.11. Prognosis of the GDP (percentage growth to the year 1990) according to the SRES development scenarios A1, A2 and B1 for the REForm group* in the case of Georgia (GEL million)**

		1990**	2010	2020	2030	2040	2050	2100
A1 scenario could be regarded as the most probable option for the near future in Georgia, until the solution of territorial integrity restoration and NATO membership problems	%	0	27	90	218	363	536	2290
	million / GEL	14,965.00	19,005.55	28,433.5	47,588.7	69,257.95	95,177.40	35,7663.50
A2 scenario is less probable given the recent political and economic orientation of Georgia, as well as the scarcity of resources,	%	0	9	36	63	100	145	854
	million / GEL	14,965.00	16,311.85	20,352.40	24,392.95	29,930	36,664.25	142,766.10

though from the point of view of future development it can still be assumed and deserves consideration								
B1 scenario is expected to develop after some years when/if Georgia achieves its recently declared goals (NATO membership, restoration of territorial integrity)	%	0	27	81	172	272	381	1318
	million / GEL	14,965.00	19,005.50	27,086.65	40,704.80	55,669.80	71,981.65	212,203.70

* Nakicenovic, Nebojsa et al. 2000.Special Report on Emission Scenarios. Cambridge University Press, Cambridge
**Data for 1990 are taken from Statistical Yearbook of Georgia 1999. Other data are calculated from the data of 1990 as basic data by means of percentage prognostic growth.

1.6. Institutions related to the Convention implementation

Georgia is fully committed to supporting and implementing the principles of the UNFCCC, namely:

- To prepare and launch appropriate legislation;
- To incorporate climate change concerns into the country's development plans, including emission abatement as well as adaptations to climate change;
- To prepare and submit National Communications to the UNFCCC;
- To update the National GHG inventory periodically and submit it to the UNFCCC;
- To contribute to awareness-raising among the population and decision-makers;
- To plan and undertake the GHG emission abatement and climate change mitigation measures;
- To establish and implement measures of adaptation to climate change.

The most important of these commitments – the periodic preparation of National Communications and their submission to the UNFCCC - has already been undertaken with the financial support of the Global Environment Facility (GEF), as stipulated by the Convention.

The responsibility for implementating the UNFCCC lies fully with the Government of Georgia, i.e., in leading and coordinating all activities relating to climate change undertaken by various entities through the appropriate structures of the Ministry of Environment Protection and Natural Resources. These entities undertake data collection; process scientific research; analyse, prepare and implement practical measures; exchange information; and raise awareness relating to climate change. The institutions assigned to implement the Convention in Georgia involve those directly related to climate change; other governmental structures (Ministries, Departments); scientific organizations (institutes, research centres); technical and expert groups; municipalities; and other stakeholders and organizations.

Table 1.12. Institutions related to the UNFCCC implementation and their functions

Institutional Structures		Functions
Institutional structures directly related to climate change	- Climate Change Administration at the Ministry of Environment Protection and Natural Resources -National Environmental Agency at the Ministry of Environment Protection and Natural Resources - Department of Forestry at the Ministry of Environment Protection and Natural Resources	-Coordination, direction and monitoring of the policy and measures implemented; -Preparation of legislative basis and proposals and their submission to the appropriate Committee of the Parliament; -Monitoring of the planned measures; -Monitoring of the documentation to be submitted to the UNFCCC
Other governmental structures	- Ministry of Economic Development and, particularly, its departments: - Department of Statistics; - Department of Transport - Ministry of Energy; - Ministry of Agriculture - Ministry of Health Care - Ministry of Finance - Ministry of Foreign Affairs - Ministry of Culture, Protection of Cultural Monuments and Sports -Department of Tourism - Ministry of Education and Science	- Exchange of data and proposals; - Consideration of the climate change problem in sectoral development plans; - Awareness raising
Legislative structures of Georgia	Committees of the Parliament of Georgia: - Environment Protection and Natural Resources; - Economic branches and economic policy; - Agriculture; - Education, science and culture; - Health care and Social Services; - Regional policy, local municipal and highlands administrations	- Support in setting up legal basis for implementation of the UNFCCC and Clean Development Mechanism of the Kyoto Protocol; - Incorporation of climate change concerns in the sectoral and regional development plans
Scientific organizations	National Academy of Sciences of Georgia: - Scientific Research Institute of Hydrometeorology; - Institute of Geography; - Institute of Geophysics - Institute of Botany; -I. Javakhishvili Tbilisi State University	- Data exchange, processing, scientific research and analysis
Local municipal and regional structures	Municipalities (Local Administrations; other regional structures)	- Exchange of data and proposals - Cooperation in projects implementation - Awareness raising
Other participants	- Non-Governmental Organizations - Industrial enterprises - Mass Media - National experts	- Data collection, exchange and processing; - Expert analysis materials, preparation of documentation; - Preparation of proposals for mitigation of, and adaptation to, climate change; - Information outreach

To enhance data reliability, **data collection** has been based on the official documents of the Department of Statistics (Yearbooks) and the National Environmental Agency, as well as certain Ministries and enterprises. To the fullest extent possible, data obtained from different sources have been compared and expertly analysed.

Data processing, scientific research and analysis were mainly carried out by scientific organizations and their staff, as well as experts from different fields.

The Second National Communication to be submitted to the UNFCCC has been prepared by the Government of Georgia with the financial support of the GEF and technical support of UNDP. Within the framework of this project, four working groups have been formed: the GHG Inventory; Vulnerability and Adaptation; GHG Abatement; and Awareness Raising. Each group is composed of selected national experts from different entities, who are also in close cooperation with relevant institutional and sectoral experts. To the fullest extent possible, the groups prepared their reports according to relevant UNFCCC and IPCC references and guidelines.

References

1. Nakicenovic, N. *et. al*. Special Reporto n Emission Scenarios. IPCCC, Cambridge, 2000.
2. Statistical Yearbooks of Georgia (2000-2008);
3. Official site of the Ministry of Economic Development (Department of Statistics) of Georgia (www.statistics.ge);
4. Georgia's Initial National Communication under the United Nations Framework Convention on Climate Change, Tbilisi, 1999.

Chapter 2
National GHG Inventory

Introduction

On 9 May 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted and signed at the 1992 Earth Summit by the majority of countries in the world. Its ultimate objective is to achieve the "*stabilization of greenhouse gas concentrations in the atmosphere, at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner*."

The ability of the international community to attain the above objective greatly depends upon a full knowledge of the trends of greenhouse gas emissions. According to paragraph 1(a) of Article 4 and paragraph 1(a) of Article 12 of the UNFCCC, each Party is obliged to provide the governing body of the Convention – the Conference of the Parties (COP) - with information on national GHG emissions and sinks. For the non-Annex I countries, the main mechanism of reporting was defined to be the National Communication, while the Annex I Parties have been obliged to present annually an independent national report on the inventory of GHGs.

In 1996, the COP at its second session (COP 2), under the decision 10/CP.2, adopted Guidelines to prepare initial national communications for the non-Annex I Parties, according to which the non-Annex I countries were to undertake an initial national GHG inventory for 1994, or as an alternative, for 1990. In 2002, COP 8 adopted new Guidelines for National Communications from non-Annex I Parties (decision 10/CP.8). In the Second National Communication the national GHG inventory was to be carried out for the year 2000.

According to decision 17/CP.8, the non-Annex I Parties, while conducting a national inventory, were to use the IPCC Guidelines worked out in 1995, and revised in 1996 [1], which will be henceforth referred to as "IPCC 1996" (including its relevant software).

The national GHG inventory includes 6 sectors:

1. Energy
2. Industrial processes
3. Solvents and other products use
4. Agriculture
5. Land Use Change and Forestry
6. Waste

The UNFCCC requires information on the following greenhouse gases, which are controlled by the Kyoto Protocol:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)

- Sulphur hexafluoride (SF_6)

These gases are often called the "six GHGs", although HFCs and PFCs are virtually groups of gases. Each gas plays its individual part in the "greenhouse effect". The share in global warming by these mixtures of gases depends on their proportional presence in the mixture. The most powerful greenhouse gases are SF_6, HFCs and PFCs, known in general as the "F-gases". Methane is 21 times more effective in trapping heat than CO_2, and N_2O is 310 times more effective. To control GHG emissions, the concept of Global Warming Potential (GWP) was developed, which expresses the emissions of all greenhouse gases in CO_2 equivalents (CO_2-eq). The exact definition of this notion is a matter for discussion, as the GWP could be expressed as a summary warming effect for a certain time horizon, for instance 2,100 or 500 years. The Parties to the Convention agreed [2] and the Kyoto Protocol has adopted the GWP time horizon of 100 years. These values of GWP for different GHGs are given in the Table 2.1 below.

Table 2.1. Atmospheric lifetime and the GWP (time horizon 100 years)
for various greenhouse gases

Gas	**Lifetime (years)**	**GWP (Time horizon 100 years)**
CO_2	variable (50-200)	1
CH_4	12±3	21
N_2O	120	310
HFCs		
HFC-23	264	11700
HFC-32	5,6	650
HFC-125	32,6	2800
HFC-134	10,6	1300
HFC-143	48,3	3800
HFC-152	1,5	140
HFC-227	36,5	2900
HFC-236	209	6300
HFC-245	6,6	560
PFCs		
CF_4	50000	6500
C_2F_6	10000	9200
C_3F_8	2600	7000
C_4F_{10}	2600	7000
C_6F_{14}	3200	7400
SF_6	3200	23900

GHG emissions in 1987-2006

In Georgia's Initial National Communication (INC) [3], an inventory of GHGs was undertaken for the years 1987-1997. Within the framework of the Second National Communication (SNC), the inventory was continued for the following years, 1998-2006. Calculations were based on IPCC 1996 Guidelines and the IPCC GPG recommendations [4] were followed. For the first time, QA/QC procedures and uncertainty analyses for key sectors were implemented. Table 2.2 shows GHG emissions from 1987 to 2006. Due to the unreliability of the data, methane emissions from industrial wastewater are not included for the years 1987-1989 and 1991-1994.

It can be seen from this table that total GHG emissions began to sharply decrease after 1990. In 2006 emissions were about 2.5 thousand Gg, or about 25% higher than the the 1998 level. Emissions from different sectors were estimated as follows: energy sector, an increase of 1.5

thousand Gg (29%); industrial processes sector, an increase of 0.3 thousand Gg (40%); and agricultural sector, an increase of 1.3 thousand Gg (45%). Emissions have changed insignificantly in the solid waste subsector.

Table 2.2. GHG emissions (Gg CO_2-eq) in 1987-1996

Sectors	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Energy	36.689	36.329	35.207	36,592	28,810	19,391	11,250	7,437	4,792	7,581
Industrial processes	6.684	6.113	6.098	5,383	4,083	2,245	1,069	544	521	707
Agriculture	5.090	4.752	4.457	3,983	3,530	3,246	2,699	2,394	2,462	2,958
Waste	1.410	1.434	1.457	2,017	1,482	1,505	1,476	1,382	1,352	1,311
Total	**49.874**	**48.628**	**47.220**	**47,975**	**37,905**	**26,387**	**16,493**	**11,756**	**9,126**	**12,557**

Table 2.2. (continued) GHG emissions (Gg CO_2-eq) in 1997-2006

Sectors	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Energy	9,020	5,052	5,187	5,927	5,467	5,007	5,451	6,147	5,785	5,964
Industrial processes	784	716	1,002	1,024	669	972	1,109	1,334	1,672	1,002
Agriculture	3.122	2.795	2,991	2,802	3,024	3,212	3,327	3,115	3,460	3,544
Waste	1.279	1.257	1,249	1,236	1,228	1,233	1,224	1,220	1,224	1,240
Total	**14,205**	**9,820**	**10,429**	**10,989**	**10,388**	**10,424**	**11,112**	**11,817**	**12,141**	**11,75**

The data from table 2.2 are illustrated in Figure 2.1. The level of emissions from the energy sector and for total national emissions is given at the left axis, while the level of emissions from industrial processes, agricultural, and waste sectors is given on the right axis due to different scales. As is evident from this figure, a sharp fall in emissions has continued since 1991, which is exceptionally noticeable in the energy and industrial processes sectors. Emissions from the waste sector have reduced insignificantly, relating to a decrease in population.

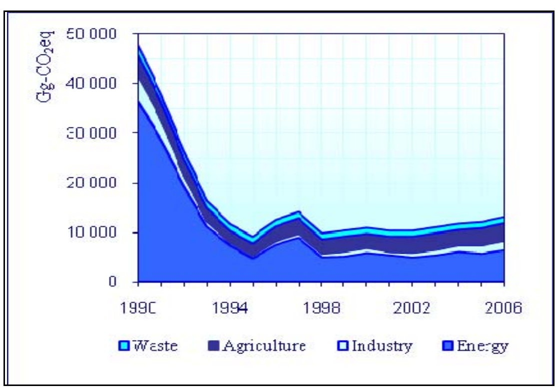

Figure 2.1. GHG emissions (Gg CO_2-eq) in 1990-2006

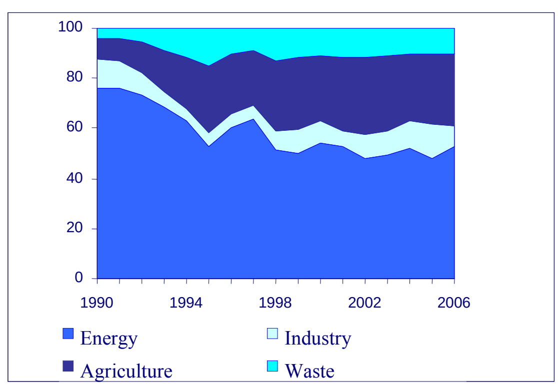

Figure 2.2. Share of sectoral emissions in total national emissions in 1990-2006.

Figure 2.2 shows the percentage share of sectoral emissions in total national emissions. The contribution of the energy sector is presented on the left axis, and those of other sectors, on the right axis. This figure shows that since 1991, the share of the energy sector in total emissions has been decreasing almost continuously. In 2006, its share comprised 45.6%, while in 1990, it comprised 76.3%. The share of emissions from industrial processes in 2006 was approximately the same as in 1987, though the actual emissions decreased by about four times. The share of emissions from the agriculture and waste sectors significantly increased in those years, mainly due to emission decreases in other sectors.

In Table 2.3, the key emission sources are presented (with relevant values are given in bold). To reveal the key sources, emissions are ranked in ascending order for the year 2000. According to definition, the key sources are those whose total share of whole emissions equal or exceed 95%. Other sources are relatively insignificant, and comparatively simplified QA/QC procedures have been applied to estimate their emission figues.

Table 2.3. Key emission sources in 1990, 2000 and 2006

Sector	Source-category	Gas	National emissions		
			2000	1990	2006
Energy: Fugitives	Oil and gas activities	CH_4	**21.65**	**4.98**	**9.75**
Agriculture	Enteric fermentation	CH_4	**11.72**	**3.53**	**11.91**
Energy: Fuel combustion	Transport	CO_2	**10.12**	**7.91**	**10.38**
Energy: Fuel combustion	Energy industries	CO_2	**8.87**	**25.36**	**12.51**
Waste	Solid waste disposal	CH_4	**8.39**	**2.30**	**7.48**
Industrial processes	Nitric acid production	N_2O	**4.32**	**1.04**	0.00
Energy: Fuel combustion	Residential/commercial/institutional sectors	CO_2	**4.25**	**9.95**	**7.33**
Energy: Fuel combustion	Manufacturing industries and construction	CO_2	**3.76**	**21.85**	**5.42**
Agriculture	Leaching, erosion and runoff	N_2O	**3.41**	**1.17**	**4.71**
Energy: Fuel combustion	Residential/commercial/institutional sectors	CH_4	**2.66**	0.01	**3.74**
Industrial processes	Cement production	CO_2	**2.51**	**2.28**	**5.27**
Agriculture	N_2O emissions from animal production	N_2O	**2.45**	**0.94**	**2.52**
Agriculture	Manure management	CH_4	**2.37**	0.64	**2.43**
Agriculture	Synthetic nitrogen fertilizers	N_2O	**2.37**	**0.69**	**4.28**
Waste	Domestic and commercial wastewater treatment	CH_4	**1.96**	0.58	**1.75**
Industrial processes	Ammonia production	CO_2	**1.86**	**0.68**	0.01
Energy: Fuel combustion	Agriculture/Forestry/Fishing	CO_2	**1.54**	**4.80**	**2.22**
Agriculture	Animal manure applied to soils	N_2O	**0.91**	0.36	**0.91**
Waste	Domestic and commercial wastewater treatment	N_2O	**0.79**	0.21	0.72
Agriculture	Crop residue decomposition	N_2O	**0.79**	0.23	0.44
Agriculture	Volatilization and re-deposition of nitrogen	N_2O	0.71	0.25	0.88
Agriculture	Manure management	N_2O	0.65	0.34	0.66
Energy: Fuel combustion	Residential/commercial/institutional sectors	N_2O	0.52	0.03	0.74
Industrial processes	Ferroalloy production	CO_2	0.41	0.41	**1.68**
Energy: Fuel combustion	Others	CO_2	0.38	0.54	0.62
Industrial processes	Industrial gases	*HFC*	0.19	0	**0.95**
Waste	Industrial wastewater treatment	CH_4	0.12	**1.12**	0.14
Energy: Fuel combustion	Transport	CH_4	0.05	0.03	0.05
Energy: Fuel combustion	Agriculture/Forestry/Fishing	CH_4	0.05	0.01	0.07
Agriculture	Agricultural field burning of agriculture residues	CH_4	0.05	0.02	0.03
Agriculture	Nitrogen-fixing crops	N_2O	0.04	0.01	0.04
Energy: Fuel combustion	Transport	N_2O	0.03	0.05	0.02
Agriculture	Agricultural field burning of agriculture residues	N_2O	0.03	0.01	0.03
Energy: Fugitives	Coal mining and handling	CH_4	0.02	0.56	0.02
Industrial processes	Lime production	CO_2	0.02	0.09	0.22
Energy: Fuel combustion	Manufacturing industries and construction	CH_4	0.01	0.03	0.01

Energy: Fuel combustion	Energy industries	N_2O	0.01	0.03	0.01
Energy: Fuel combustion	Manufacturing industries and construction	N_2O	0.01	0.07	0.01
Energy: Fuel combustion	Agriculture/Forestry/Fishing	N_2O	0.01	0.02	0.02
Agriculture	Cultivation of organic soils (histosols)	N_2O	0.01	0.12	0.01
Energy: Fuel combustion	Energy industries	CH_4	0	0.01	0
Energy: Fuel combustion	Others	CH_4	0	0.04	0
Energy: Fuel combustion	Others	N_2O	0	0.01	0
Industrial processes	Iron and steel production	CO_2	0	**6.47**	0.01
Industrial processes	Chemical manufacturing process of coke	CH_4	0	0.01	0
Industrial processes	Caprolactam production	N_2O	0	0.23	0

As can be seen from Table 2.3, key sources in 2000 and 2006 were insignificantly modified compared to 1990. However, the relative importance of sources has changed. In 1990, the CO_2 emissions from electricity and heat production, and the manufacturing industries, were dominant. By 2000, these subsectors had moved to the 4th and 8th places respectively, and to 6th and 7th places in 2006. The largest source in 2000 was methane emissions from natural gas transmission, when the losses were high. In 2006, the CO_2 emission share from the transport subsector, and the methane emissions share from enteric fermentation and oil and gas activities, did not exceed 10% separately.

Georgia's national GHG inventory for 2000

In 2000, anthropogenic GHG emissions in Georgia were estimated as follows: 3.705.7 Gg of carbon dioxide (CO_2), 256.62 Gg of methane (CH_4), and 6.02 Gg of nitrous oxide (N_2O). Emissions expressed in carbon dioxide equivalents (CO_2-eq) amounted to 10.960 Gg CO_2-eq, and emissions per capita amounted to 2.35 tonne CO_2-eq.

Figure 2.3 shows the main GHG emissions in CO_2-eq, and the contribution of each gas to national emissions. Figure 2.4 shows emissions (CO_2-eq) from various sectors, and their share in national emissions.

Figures 2.5 and 2.6 show the 1990 data. It is evident that the GHG emissions in 2000 significantly decreased compared to the 1990 levels, especially for CO_2 from the energy sector.

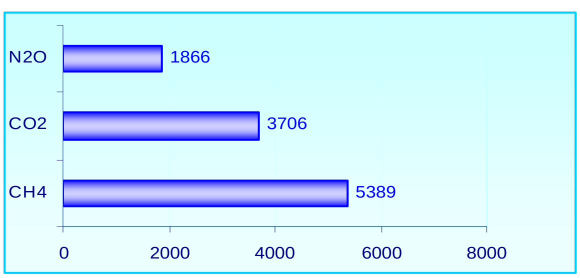

Figure 2.3 GHG emissions (Gg CO2-eq) in Georgia in 2000.

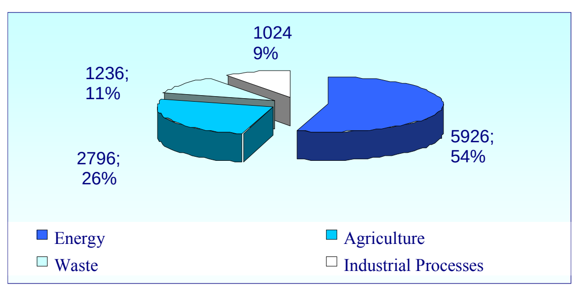

Figure 2.4 Sectoral GHG emissions (Gg CO_2-eq) and share in national emissions in 2000.

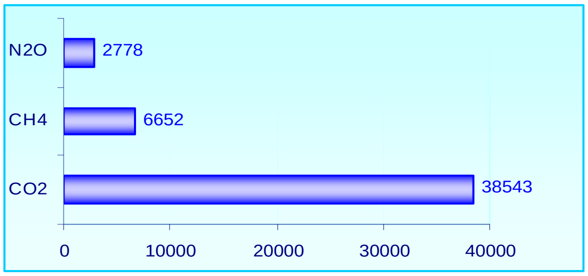

Figure 2.5 GHG emissions (Gg CO_2-eq) in Georgia in 1990.

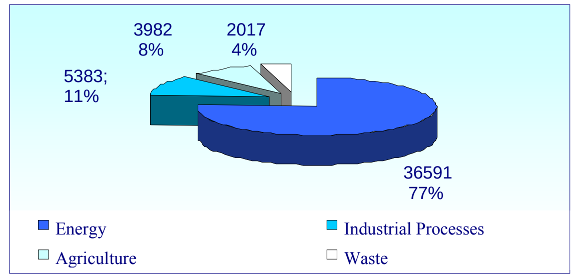

Figure 2.6 Sectoral GHG emissions (Gg CO_2-eq) and share in national emissions in 1990.

According to aggregated data on anthropogenic emissions by sources, and removals by sinks, the emissions in 2000 from the energy sector amounted to 5,926.9 Gg CO_2-eq, which was about 54% of national emissions. The share of each GHG in sectoral emissions is presented in Figure 2.7. A major source of CO_2 emissions in the sector is the combustion of fossil fuels, in which the contributions of natural gas and liquid fuel (mainly gasoline and diesel fuel) were approximately equal, and comprised 51.7% and 46.1% respectively. The main source of CH_4 emissions was fugitive emissions caused by activities related to natural gas. The emissions of N_2O from the energy sector were insignificant.

Emissions from energy subsectors and their share in sectoral emissions in 2000 are given in Figure 2.8.

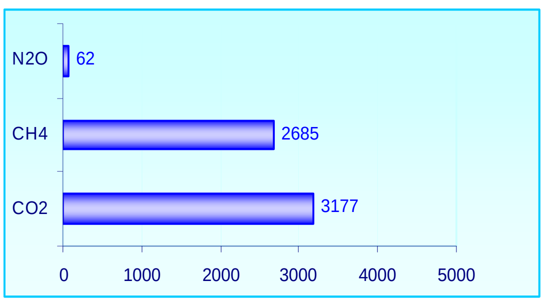

Figure 2.7 GHG emissions (Gg CO_2-eq) from the energy sector in 2000.

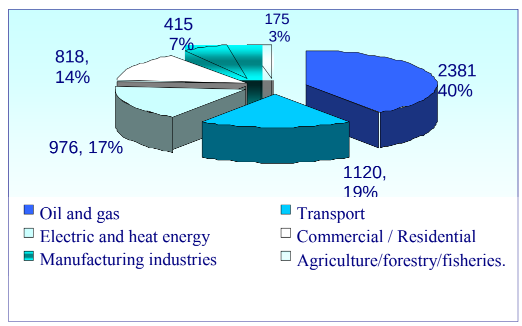

Figure 2.8 GHG emissions from the energy subsectors and their share in sectoral emissions in 2000.

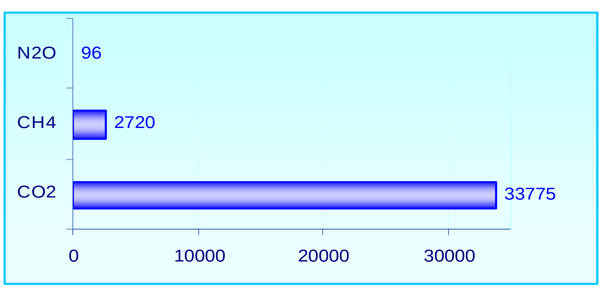

Figure 2.9 GHG emissions (Gg CO_2-eq) from the energy sector in 1990.

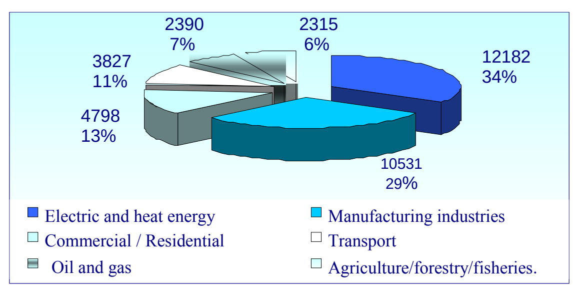

Figure 2.10. GHG emissions from the energy subsectors and their share in sectoral emissions in 1990.

Figures 2.9 and 2.10 show the 1990 data. It is evident that the emissions from the energy sector significantly decreased in 2000 compared to the 1990 levels, mainly caused by a drop in CO_2 emissions.

In 2000, 1,002.6 Gg CO_2-eq or 9.1% of national GHG emissions came from the industrial processes sector. This percentage contained CO_2 emissions from metal (ferroalloys) production, mineral products (cement and lime production) and N_2O emissions from chemical industry (ammonia and nitric acid production). The GHG emissions from the industrial processes sector in 2000 is shown in Figure 2.11. The emissions from industrial processes subsectors and their share in sectoral emissions in 2000 is shown in Figure 2.12.

By comparing Figures 2.11 and 2.12 (based on 2000 data) with Figures 2.13 and 2.14 (based on 1990 data), it can be seen that emissions significantly declined in 2000 compared to the 1990 levels, mainly as a result of a fall in CO_2 emissions from metal production.

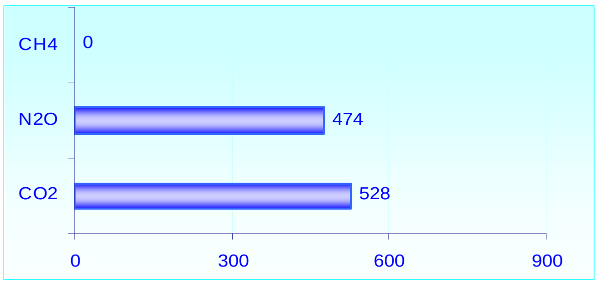

Figure 2.11. GHG emissions (Gg CO_2-eq) from industrial processes in 2000.

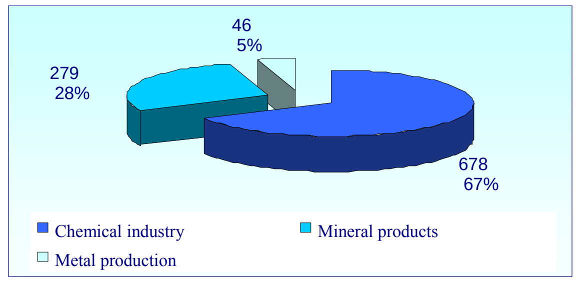

Figure 2.12. GHG emissions from industrial processes and their share in sectoral emission in 2000.

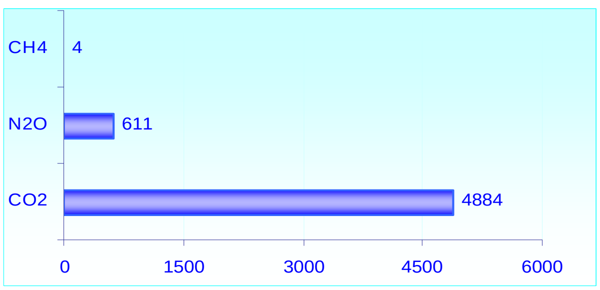

Figure 2.13. GHG emissions (Gg CO2-eq) from industrial processes in 1990.

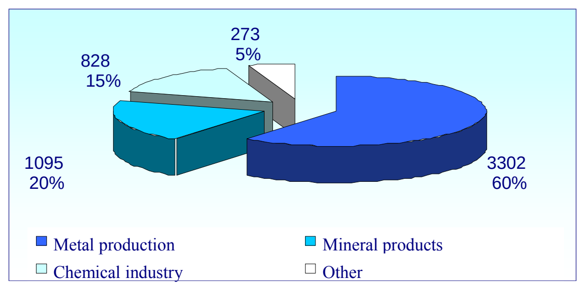

Figure 2.14. GHG emissions from industrial processes and their share in sectoral emission in 1990.

In 2000, GHG emissions from the agriculture sector amounted to 2,795.8 Gg CO_2-eq, comprising 25.5% of national emissions. Emissions from the agriculture sector consisted of CH_4 and N_2O. However, CO_2 emissions produced in the agricultural sector by energy consumption are regarded as part of emissions from the energy sector. Sources of emissions from the agriculture sector are animal enteric fermentation, manure management, agricultural soils, and the field burning of agricultural residues. Figure 2.15 shows emissions of CH_4 and N_2O from the agricultural sector in 2000, and Figure 2.16 shows the emissions of the same GHGs from the agricultural subsectors, and their share in sectoral emissions. Most CH_4 emissions are related to enteric fermentation, and most N_2O emissions to agricultural soils.

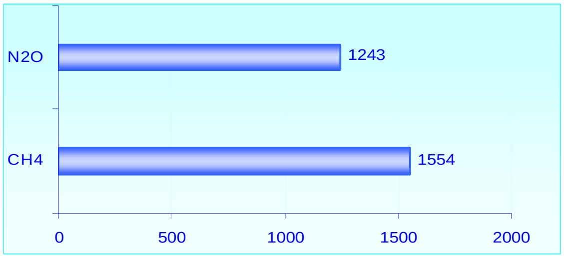

Figure 2.15. GHG emissions (Gg CO2-eq) from the agricultural sector in 2000.

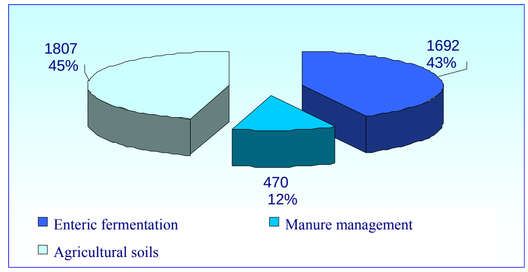

Figure 2.16. GHG emissions from the agricultural subsectors and their share in sectoral emissions in 2000.

Figures 2.17 and 2.18 show the 1990 data. The distribution of emissions among agricultural subsectors in 2000 did not change significantly compared to the 1990 data, though a decrease in emissions took place.

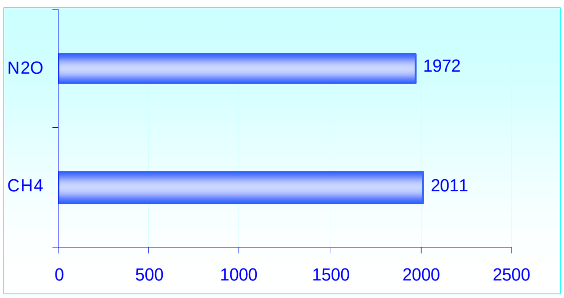

Figure 2.17. GHG emissions (Gg CO2-eq) from the agricultural sector in 1990.

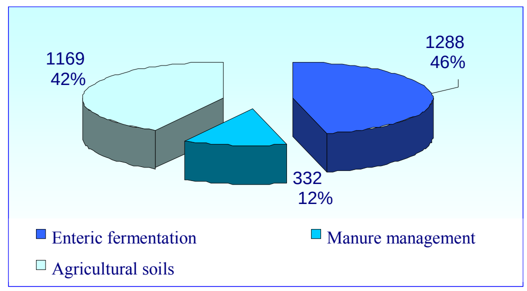

Figure 2.18. GHG emissions from the agriculture subsectors and their share in sectoral emissions in 1990.

GHG emissions from the Land Use, Land Use Change and the Forestry (LULUCF) sector contain total emissions produced by changes in forests, and other woody biomass stocks, emissions from forest and pasture change activities and the abandonment of managed lands, as well as emissions from soils. Net emissions from this sector in 2000 accounted for -1673.4 Gg CO_2-eq, due to the difference between CO_2 emissions (412.1 Gg CO_2), and removals (2 085.5 Gg-CO_2eq).

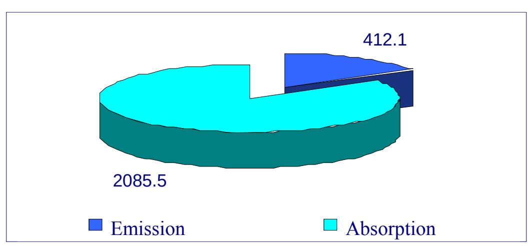

Figure 2.19. CO2 –eq emissions and removals (Gg) from the LULUCF sector in 2000.

In 2000, GHG emissions from the waste sector amounted to 1,236.3 Gg CO_2-eq, which accounted for 11.2% of national GHG emissions. The main source was solid waste disposal on land (74.6%). Figure 2.20 shows the GHG emissions (Gg CO_2-eq) from the waste sector in 2000, and Figure 2.21 shows the emissions from solid waste and wastewater and their share in sectoral emissions in 2000.

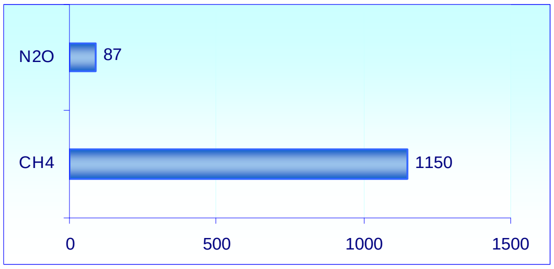

Figure 2.20. GHG emissions (Gg CO_2-eq) from the waste sector in 2000.

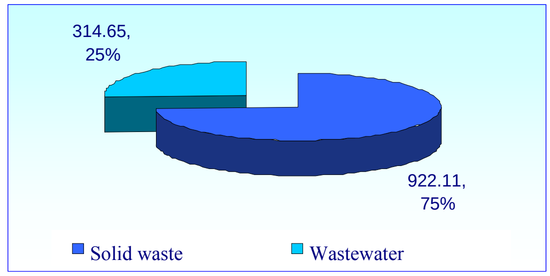

Figure 2.21. GHG emissions from the waste subsectors and their share in sectoral emission in 2000.

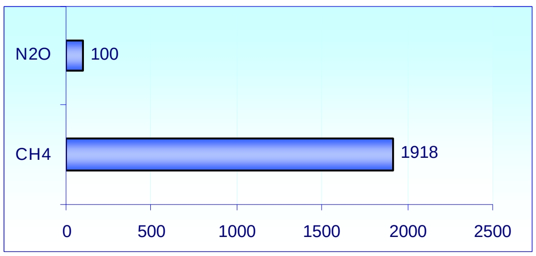

Figure 2.22. GHG emissions (Gg CO2-eq) from the waste sector in 1990.

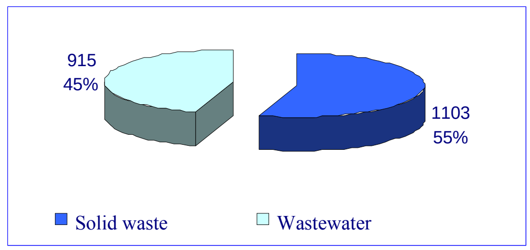

Figure 2.23. GHG emissions from the waste subsectors and their share in sectoral emission in 1990.

The disposal and handling of solid and liquid waste produces GHG emissions. In the waste sector, emission sources include disposal sites of municipal solid waste, and the treatment of domestic and industrial wastewaters. In Georgia's large cities, solid waste is being collected and transported to disposal sites. In towns and settlements, waste is being decomposed in aerated conditions, and thus methane is not produced.

Figures 2.22 and 2.23 show the 1990 data. It is evident that in 2000, the emissions of CH_4 declined significantly, resulting from a decrease in the amount of industrial wastewater.

After a general review of emissions and trends, individual GHG emissions from different sectors are discussed below.

2.1. GHG Emissions

This section discusses the contribution of each GHG (CO_2, CH_4 and industrial gases) to the total emissions based on the inventory from the energy, industrial processes, agriculture and waste sectors.

2.1.1. Carbon dioxide (CO_2)

In 2000, 3,705.7 Gg CO_2 were emitted into the atmosphere, accouting for 33.7% of total GHG emissions. The major emitter of CO_2 was the "Fuel Combustion" subsector of the energy sector, though the following subsectors of industrial processes, "Chemical Industry", "Mineral Products" and "Metal Production", were also significant sources of CO_2. In 2000, the relative share of the energy and industrial process sectors comprised 85.7% and 14.3%, respectively, in the total national emissions of CO_2. Compared to the emission level (38,542.7 Gg CO_2) in 1990, the CO_2 emissions in 2000 were reduced by 90.4%. This was due mainly to a sharp decline of fuel consumption in the energy sector.

Figure 2.25 shows the CO_2 emissions from different subsectors in 2000, while Figure 2.24 shows the 1990 data. It can be seen that the emissions from all subsectors were significantly reduced in 2000. In 2006, CO_2 emissions increased especially in the fuel combustion subsector, where emissions have increased by almost 49% (Figure 2.26).

Figure 2.27 shows the CO_2 emissions in 1990-2006 according to sector.

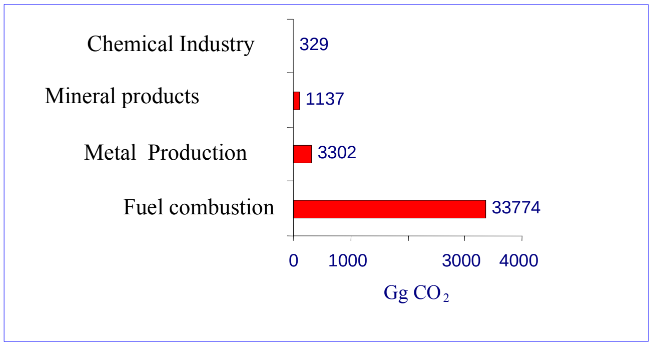

Figure 2.24. CO_2 emissions (Gg CO_2) from different subsectors in 1990.

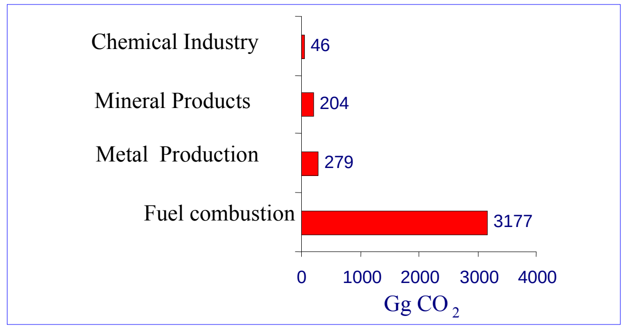

Figure 2.25. CO_2 emissions (Gg CO_2) from different subsectors in 2000.

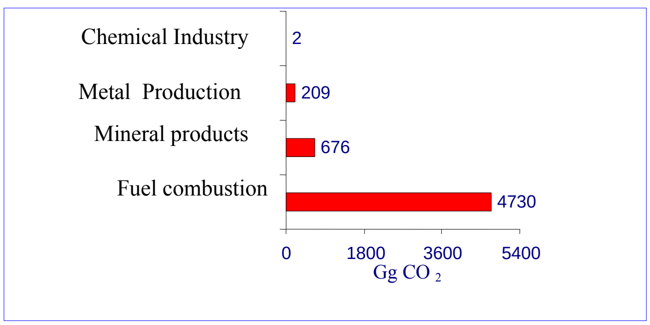

Figure 2.26. CO2 emissions (Gg CO2) from different subsectors in 2006.

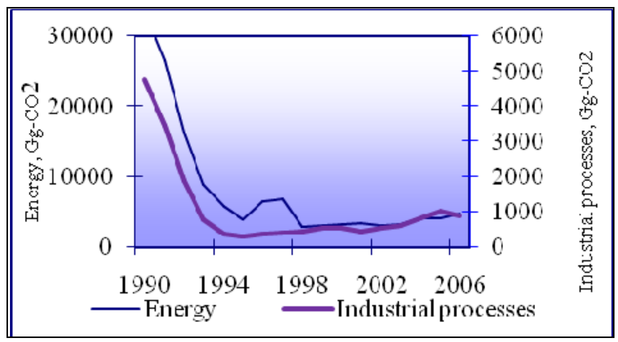

Figure 2.27. CO2 emissions from energy and industrial processes in 1990-2006.

2.1.1.1. Energy

In the national inventory, CO_2 emissions from the subsector "Fuel Combustion" were estimated. Four source categories have been identified: electric energy and heat production; manufacturing industries and construction; transport; and the residential and public sector.

❖ ***Fuel Combustion***

During fuel combustion, the carbon in the fuel is almost entirely emitted in the form of CO_2. The amount of carbon per unit of energy capacity in fuel varies significantly according to the fuel type. For example, coal contains much more carbon than oil or natural gas per unit of energy produced.

In the energy sector, 3,177.4 Gg of CO_2 were emitted from fuel combustion in 2000. Fossil fuels provided 42% of total energy consumed in Georgia, while hydro and biomass (fuelwood) provided provided 18% and 40%, respectively. Fossil fuel combustion contributed 86% of total CO_2 emissions. In the energy sector, natural gas and liquid fuel (mainly gasoline and diesel fuel) contributed 56% and 44% of CO_2 emissions, respectively.

Methodology: The simple Tier 1 method was used for the calculation of CO_2 emissions from all combustion sources, which were estimated by multiplying the amount of fuel consumed by the averaged emission factors.

Emission factors*:* Default values from the IPCC 1996 were used for carbon emission factors (carbon emission per unit of energy) and conversion co-efficients (specific heat or calorific value of fuel). However, an exception was made for natural gas, for which the CO_2 emission factor was calculated according to the contents of natural gas consumed in Georgia.

Activity data: Statistical Yearbooks from the State Department of Statistics, surveys by the USAID [6], and information from different facilities on the amount of consumed fuel were used as data sources. Some data were obtained from the Ministry of Energy and organizations owning thermal power plants.

The data on the consumption of fuel in the country in 2000-2006 are given in Annex II.

CO_2 emissions produced from the combustion of fuel in different sectors of the economy are discussed below.

- ***Electric Energy and Heat Production***

In 2000, 974.7 Gg CO_2 were emitted into the atmosphere from electric energy and heat production in Georgia, comprising 30.7% of CO_2 emissions from the energy sector, 26.3% of total CO_2 emissions, and 8.9% of total national GHG emissions. CO_2 emissions were mainly caused by the generation of electric energy at thermal power plants. Some enterprises and parts of the population were using diesel-generators to produce electric energy.

In 2000, CO_2 emissions from this source accounted for only 8.0% of the 1990 level (12,165.3 Gg CO_2). Such a drastic discrepancy between 1990 and 2000 emissions is due to the fact that until 1991, Georgia's large cities used centralized heating systems with natural gas and black oil as fuel. These systems have virtually disappeared, resulting in a drop in GHG emissions from this subsector to almost zero. At present, the major part of the population uses firewood for heating, and in large cities where natural gas is supplied, gas stoves are used. In separate organizations in large cities, such as ministries, departments and hospitals, etc.), autonomous heating systems are installed.

The CO_2 emissions for the period of 1990-2006) from electric energy and heat production are given in Figure 2.28. This figure shows that in the period 2002-2006, a steady growth of CO_2 emissions took place, with an average increment of 170 Gg CO_2 per annum.

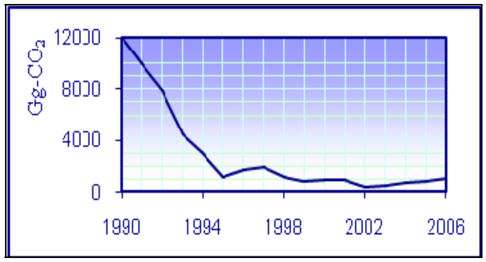

Figure. 2.28 CO_2 emissions in 1990-2006 from the electric energy and heat production.

❖ ***Manufacturing Industries and Construction***

In 2000, 413.4 Gg CO_2 were emitted into the atmosphere from the manufacturing and construction industries in Georgia, accounting for 13.0% of CO_2 emissions from the energy sector, 11.2% of total CO_2 emissions, and 3.8% of total national GHG emissions.

The CO_2 emissions above accounted for just 3.9% of the 1990 level (10,481.3 Gg CO_2). This sharp decrease in emissions was mainly caused by the industrial crises of that era. CO_2 emissions from the manufacturing and construction industries resulted from fuel combustion in the production of iron and steel, non-ferrous metals, chemicals, paper, food and other products, as well as fuel combustion in construction-related activities. The CO_2 emissions from manufacturing and construction industries for the period 1990-2006 are shown in Figure 2.29.

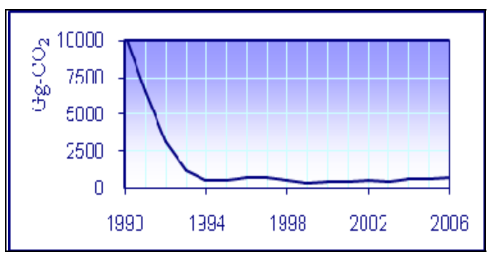

Figure 2.29. CO_2 emissions for the priod 1990-2006 (Gg CO_2) from the manufacturing and construction industries.

❖ ***Transport***

In 2000, CO_2 emissions from the transport subsector amounted to 1,111.9 Gg, accounting for 35.0% of CO_2 emissions from the energy sector, 30% of total CO_2 emissions, and 10.1% of national GHG emissions. The major source of CO_2 emissions in this subsector was road transport, which emitted 1,052.9 Gg CO_2, accounting for 94.7% of CO_2 emissions from the transport subsector in 2000. In the same year, the total emissions from aviation and railways amounted to 47.9 Gg CO_2, accounting for only 0.4% of national GHG emissions.

The transport subsector is one of the most significant GHG emitters in Georgia. In the national GHG inventory, aviation, road transport, railway transport, and were examined in this subsector.

The motor vehicles in Georgia include passenger cars, light and heavy duty trucks, mini-buses and buses, and motorcycles. Road transport predominantly uses gasoline and diesel fuel and, in smaller quantity, natural gas. In the aviation sector, the calculation of emissions is based on the statistics of consumed aviation fuel in the country. As railway transport in Georgia runs almost completely on electricity, its share of emissions is insignificant.

Methodology: The CO_2 emissions from the transport subsector were assessed based on the statistics of fuel consumption, applying the Tier 1 (top-down) approach. This methodology was used to conduct the national GHG inventory.

Emission factors: The IPCC 1996 default values were used as emission factors.

Activity data: The inventory of CO_2 emissions from the transport subsector was based on the initial information provided by the State Department of Statistics, Traffic Police and the Customs Department. The 1990 and 2001 energy balances and a USAID survey were also used [5, 6].

Compared with the 1990 level (3,793.4 Gg CO_2), CO_2 emissions from the transport subsector decreased by 70.7% in 2000. There was a decrease of 66% from road transport emissions. The fall in aviation CO_2 emissions from 595.6 Gg CO_2 to 24.9 Gg CO_2, or by 96.4%, is especially remarkable.

The trend of CO_2 emissions from road transport is shown in Figure 2.30, while the CO_2 emissions from aviation and railway are shown in Figure 2.31.

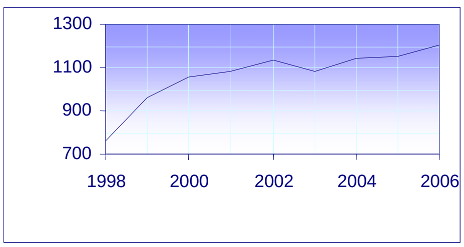

Figure 2.30. CO_2 emissions in 1998-2006 (Gg CO_2) from road transport.

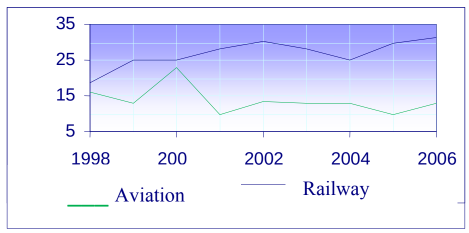

Figure 2.31. CO_2 emissions (Gg CO_2) from aviation and railway in 1998-2006

To verify GHG emissions from road transport, the emissions were calculated according to the Tier 3 approach using COPERT IV (Computer Programme to Calculate Emissions from Road Transport) established by the European Environment Agency, and widely used in Europe. The results can be found on the following web-page: **www.climatechange.telenet.ge**

The inventory results were compared to the results of calculations using COPERT. The differences in CO_2 emissions appeared to be insignificant, with a deviation in the range of 2-3%.

- ***Residential, commercial and public subsectors***

In 2000, 467.4 Gg CO_2 were emitted into the atmosphere from the residential and public subsectors of Georgia, comprising 14.7% of CO_2 emissions from the energy sector, 12.6% of total CO_2 emissions, and 4.3% of total national GHG emissions.

The residential and public sectors are characterized by fuel consumption mainly for cooking, lighting and heating. The main source of CO_2 emissions in these subsectors is natural gas; though small quantities of coal, kerosene and liquid gas were also consumed. However, the CO_2 emissions from biomass combustion (mainly firewood) were excluded because biomass is regarded as carbon-neutral fuel.

In 2000, the CO_2 emissions from the source above accounted for just 9.8% of the 1990 level (4775.2 Gg CO_2). Figure 2.32 shows the CO_2 emission dynamic in the residential and public subsectors during the period 1990-2006. The sharp decline in emissions began in 1990, and continued until 1994. Moderate to stable growth tendencies have been observed since 2000, mainly due to the rehabilitation of natural gas systems.

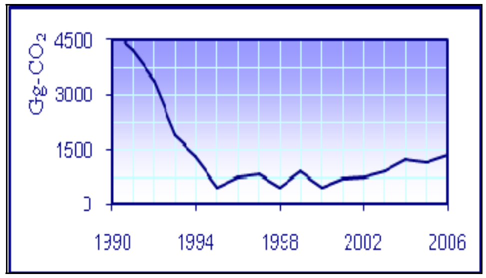

Figure 2.32. CO_2 emissions for the period 1990-2006 (Gg CO_2) from the residential and public subsectors.

❖ ***Agriculture, Fishery and Forestry***

In 2000, CO_2 emissions from agriculture, fishery and forestry amounted to 168.7 Gg CO_2 , comprising only 5.3% of CO_2 emissions from the energy sector, 4.6% of total CO_2 emissions, and 1.5% of national GHG emissions. CO_2 emissions from these sources were mainly produced by fuel combustion in agricultural machinery (combines, tractors, etc.) and in mobile construction equipment. The equipment of this category belongs to off-road vehicles, and was not examined in the transport subsector.

In 2000, CO_2 emissions from these sources accounted for only 7.3% of the 1990 level (2,302.2 Gg CO_2). Figure 2.33 shows the CO_2 emissions from agriculture, fishery and forestry during the period 1990-2006. It shows that a sharp decrease in emissions began in 1990 and continued until 1996. An insignificant increase has taken place since 2000.

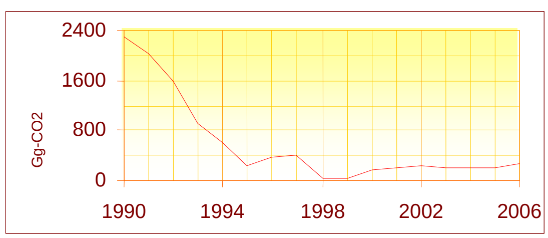

Figure 2.33. CO_2 emissions for the period 1990-2006 from agriculture, fishery and forestry.

2.1.1.2 Industrial Processes

In 2000, CO_2 emissions from industrial processes in Georgia accounted for 528.3 Gg CO_2, accounting for 14.3% of the total CO_2 emissions, and 4.8% of national GHG emissions. The major sources were cement, lime, ammonia and ferroalloys production. However, iron and steel production was virtually at a standstill in 2000.

The industrial processes sector only accounted for GHG emissions produced as a direct consequence of industrial activity. The CO_2 emissions generated from the fuel combustion required for industrial processes are attributed to the energy sector.

Methodology: The IPCC Tier 1 approach was applied to calculate the emissions from the industrial processes.

Emission factors*:* The IPCC 1996 default emissions factors were used to estimate the emissions.

Activity data*:* Statistical Yearbooks from the State Department of Statistics, and information obtained from the industrial facilities (including the Rustavi Nitric Acid Plant of JSC "Azot" that produces ammonia and nitric acid; the Kaspi and Rustavi Cement Plants; the Rustavi Metallurgical Plant; and the Zestaphoni Plant of Ferroalloys) were used as data sources.

In 2000, CO_2 emissions sharply reduced in comparison to the 1990 level (4,768.2 Gg CO_2), taking into account all industrial processes. Emissions from cement production reduced by 74.8%, from ammonia production by 37.9%, from ferroalloys production by 77%, and from lime production by 93.8%.

Figure 2.34 shows CO_2 emissions from different industrial subsectors during the period 1990-2006.

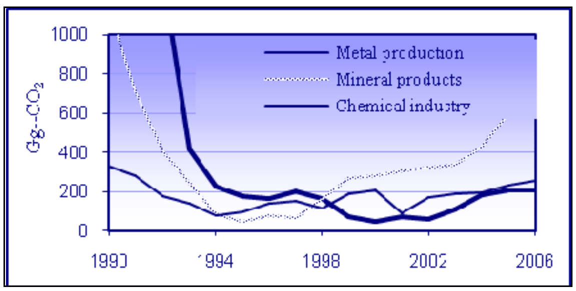

Figure 2.34. CO_2 emissions (Gg CO_2) from different industrial subsectors in 1990-2006

- ***Cement Production***

In 2000, CO_2 emissions from cement production in Georgia amounted to 275.9 Gg CO_2 (173.5 Gg CO_2 from basic cement production, and 102.4 Gg CO_2 from 'clinker' production), accounting for 52.2% of sectoral CO_2 emissions, 7.4% of total CO_2 emissions, and 2.5% of national GHG emissions.

In cement plants, clinker (products containing $CaCO_3$, such as limestone, chalk, or other materials rich in calcium) - is heated in a high-temperature kiln to produce lime (CaO) and CO_2 in the process of calcination. In Georgia, part of the clinker produced is used locally to produce cement and part of it is exported. The production of cement in 2000, relative to the 1990 level, fell from 1290 thousand tonnes to 348,000 tonnes, and the production of clinker fell from 892,000 tonnes to 302,000 tonnes. Since 2003, production has been rapidly increasing.

Figure 2.35 shows the CO_2 emissions from cement and clinker production in the period 1990-2006.

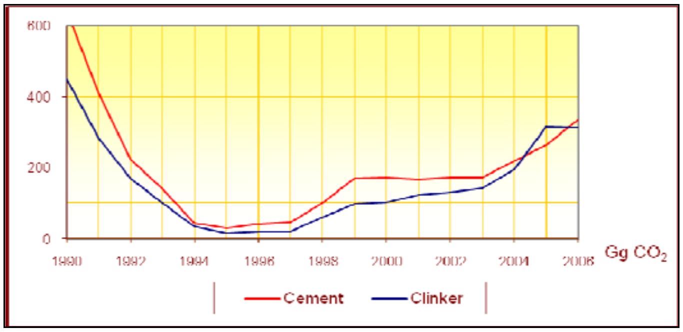

Figure 2.35. CO_2 emissions in 1990-2006 (Gg CO_2) from cement production.

❖ *Lime Production*

In 2000, CO_2 emissions from lime production amounted to 2.6 Gg CO_2, accounting for only 0.5% of CO_2 emissions from the industrial processes sector.

CO_2 emissions generated during the high-temperature heating of $CaCO_3$ were estimated by multiplying the IPCC default emission factor by the amount of lime produced.

❖ *Ammonia Production*

In 2000, CO_2 emissions from ammonia production in Georgia amounted to 204.0 Gg CO_2, accounting for 38.6% of sectoral CO_2 emissions, 5.5% of total CO_2 emissions, and 1.9% of national GHG emissions.

For the most part, ammonia in Georgia is produced under the Haber-Bosch process in which nitrogen and hydrogen react with one another; hydrogen is generated as a result of the natural gas transformation.

In 2000, CO_2 emissions from ammonia production accounted for 62.1% of the 1990 level (328.5 Gg CO_2). CO_2 emissions depend on the amount and quality of natural gas used in the process. It is assumed that the entire amount of carbon contained in the NG is fully emitted into the atmosphere. The emissions were calculated by multiplying the amount of ammonia produced by the emission factor.

Figure 2.36 shows CO_2 emissions from ammonia production in the period 1990-2006. In 2006 the plant only produced 1,100 tonnes of ammonia.

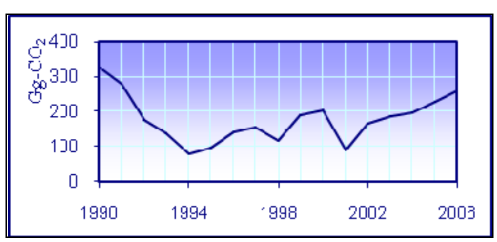

Figure 2.36. CO_2 emissions in 1990-2006 from ammonia production.

❖ *Iron and Steel Production*

In 2000, iron and steel production had virtually ceased in Georgia.

Iron is produced through iron ore recovery by metallurgical coke, which is oxidized in the blast furnace. The CO_2 produced is emitted into the atmosphere. Part of the carbon remains in the pig iron, though, as a rule it is emitted into the atmosphere during the process of steel production. Since the main purpose of coke oxidation is the production of pig iron, these emissions are considered to be industrial.

In Georgia, this industry was previously well-developed. However, after the disintegration of the Soviet Union, production declined, particularly rapidly during 1990-1993. In 2000, the production of iron and steel had virtually come to a standstill.

Figure 2.37 shows CO_2 emissions from iron and steel production in the period 1990-2000.

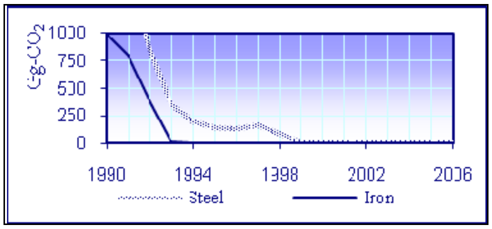

Figure 2.37. CO_2 emissions in 1990-2000 (Gg CO_2) from iron and steel production.

- ***Ferroalloys Production***

In 2000, CO_2 emissions from ferroalloys amounted to 45.6 Gg CO_2, of which 10.7 Gg CO_2 were from ferromanganese production, and 34.9 Gg CO_2 were from silicomanganese production. During ferroalloys production, the materials that produce non-concentrated ore, coke and slag are melted together at high-temperatures. During this process the recovery reaction occurs: carbon catches oxygen from metal oxides producing CO, and ore is recovered in the form of melted metal. Further component metals combine in the mixture. In the closed electric furnace, direct emissions are composed entirely of CO. However, after some days all CO is transformed into CO_2.

Compared to 1990 levels (198.4 Gg CO_2), CO_2 emissions from ferroalloys production fell by almost 20 times in 2000. Since 1994, the emissions have varied in the range of 6.5-22.2 Gg CO_2. Until 1992, silicomanganese was not produced at all. Since 2003, CO_2 emissions have begun to increase sharply. In 2006, emissions had increased approximately five times relative to those in 2000.

Figure 2.38 shows CO_2 emissions from ferroalloys production in 1990-2006.

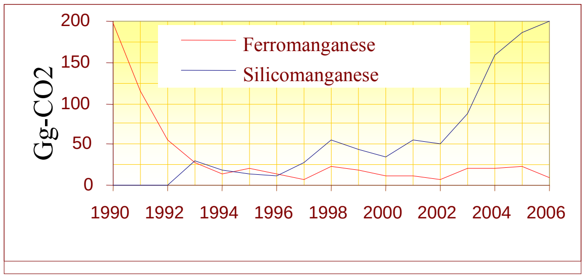

Figure 2.38. CO_2 emissions from ferroalloys production in 1990-2006.

2.1.2. Methane (CH_4)

Atmospheric methane (CH_4) is an integral component of the greenhouse effect, second only to CO_2 as a contributor to anthropogenic greenhouse gas emissions.

In 2000, methane was emitted from the energy sector (subsectors: fuel combustion and fugitive emissions), agricultural sector (subsectors: enteric fermentation, manure management and agricultural residue burning) and waste sector (subsectors: solid waste disposal and wastewater treatment).

In 2000, total CH_4 emissions from the territory of Georgia amounted to 256.62 Gg CH_4, or 5,889 Gg CO_2-eq. The energy sector's contribution to methane emissions accounted for 49.8% of the total. The agricultural and waste sectors contributed 28.8% and 21.4% respectively. In comparison with the 1990 level (316.8 Gg CH_4), methane emissions decreased by 19.0%. Within this decrease, CH_4 emissions from the energy sector were reduced only by 1.3%, while the emissions from the agricultural and waste sectors were reduced by 27.7% and 40.0% respectively.

In 2000, the major source of CH_4 emissions within the energy sector was the transmission and distribution of natural gas (88.7% of sectoral CH_4 emissions). Within the agricultural sector, the major source was enteric fermentation (83% of sectoral emissions); and within the waste sector, solid waste disposal (80% of total emissions from this sector).

Methane emissions from different subsectors in 1990, 2000 and 2006 are given in Figures 2.39, 2.40 and 2.41 respectively. Methane emissions more or less decreased across all subsectors in 2000.

Methane emissions in the period 1990-2006 in different subsectors are shown in Figure 2.42, while the total methane emission in 1990-2006 is given in Figure 2.43.

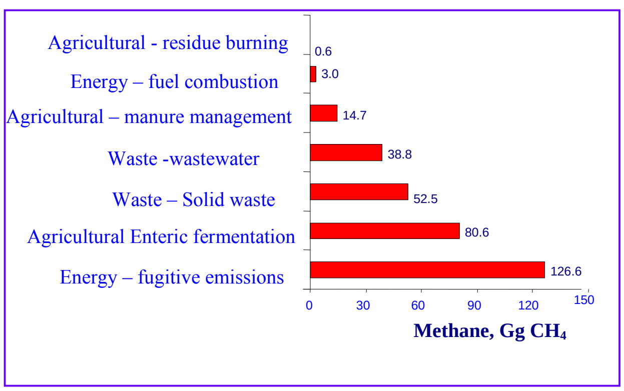

Figure 2.39. Methane emissions (Gg CH_4) from different subsectors in 1990.

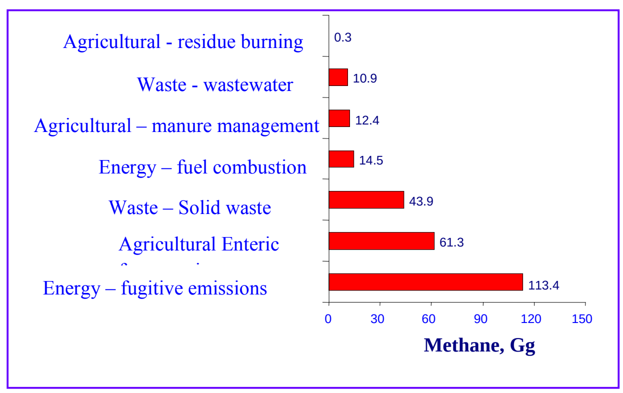

Figure 2.40. Methane emissions (Gg-CH_4) from different subsectors in 2000.

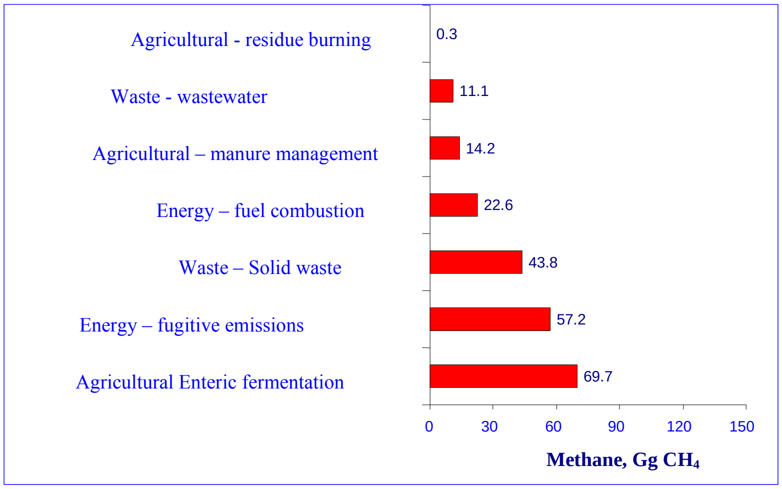

Figure 2.41. Methane emissions (Gg CH_4) from different subsectors in 2006.

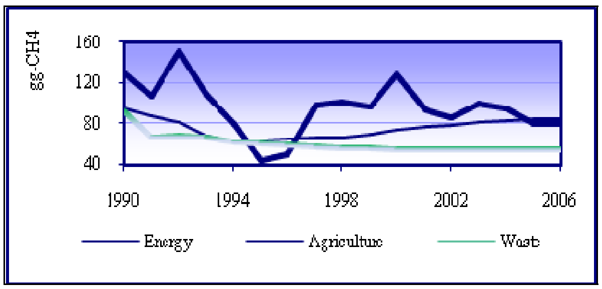

Figure 2.42. Sectoral methane emissions (Gg CH_4) in 1990-2006.

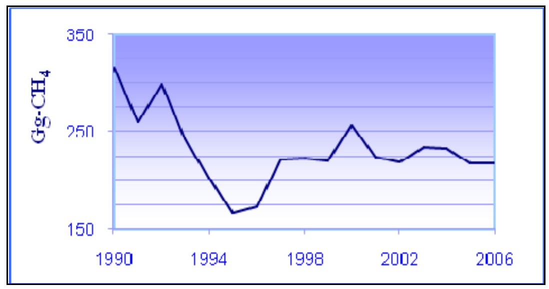

Figure 2.43. Total methane emissions (Gg CH_4) in 1990-2006.

A sharp annual variation in methane emissions from the energy sector was mainly caused by a variation in the amount of transported natural gas. The variations since 2001 were attributed to a reduction of losses due to the gradual abatement of leakages. In the agricultural and waste sectors, the variations of emissions were smaller.

2.1.2.1. Energy

In 2000, methane emissions from the energy sector amounted to 127.88 Gg CH_4, accounting for 49.8% of total methane emissions, and 25.4% of total GHG emissions. Methane emissions in the energy sector came from two subsectors: fuel combustion and fugitive emissions.

- ***Fuel combustion***

In 2000, fuel combustion in the energy sector resulted in 14.5 Gg of CH_4 emissions, accounting for 11.3% of CH_4 emissions from the energy sector, 5.6% of the total CH_4 emissions, and 2.8% of total GHG emissions.

In this source category, methane is produced by the incomplete burning of fuel in stationary and mobile sources. The amount of methane emissions depends on the type of fuel, combustion technology and other factors.

Methodology: Calculations were based on IPCC Tier 1 methodology.

Emission factors: IPCC 1996 default values of emission factors were used.

Activity data: Data on the amount of consumed fuel are the same as the data used for the calculation of CO_2 emissions from fuel combustion (see Annex II).

Methane emissions from fuel combustion during 2000-2006 are given in Figure 2.44.

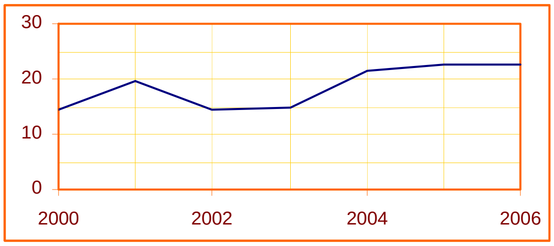

Figure 2.44. Methane emissions from fuel combustion (Gg-CH_4) in 2000-2006.

❖ ***Fugitive Emissions***

In the national GHG inventory, fugitive emissions from the energy sector include the source categories "Methane emissions from coal mining and post-mining activities" and "Methane emissions from oil and natural gas activities".

In this subsector, the major sources of CH_4 emissions were natural gas transmission and distribution. Emissions from oil activities are very insignificant, and accounted for only 0.1 Gg CH_4 in 2000.

❖ ***Coal mining***

In 2000, CH_4 emissions from coal mining amounted to just 0.09 Gg CH_4, accounting for 0.03% of CH_4 emissions from the energy sector.

Coal extraction from underground mines in Georgia has been well-developed in the past. Since 1992, coal mining has sharply declined, and after 1996 it virtually stopped. The main reason for this was the inefficiency of mining activities and the impossibility of the state subsidising the sector due to the economic crisis.

Methodology: The IPCC Tier 1 approach based on the Global Average Method (GAM) was used for calculations.

Emission factors*:* IPCC 1996 default values of emission factors were applied.

Activity data*:* The data source is the State Department of Statistics (see Annex II).

In 2000, methane emissions from coal mining accounted for only 0.7% of the 1990 level (12.78 Gg CH_4).

Figure 2.45 shows CH_4 emissions from coal mining and treatment in 1990-2006.

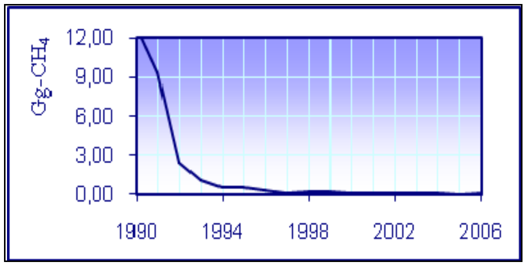

Figure 2.45. Methane emissions (Gg CH4) from coal mining and treatment in 1990-2006

- ***Natural Gas Production***

In 2000, CH_4 emissions from natural gas production amounted to 1.05 Gg CH_4, accounting for 0.08% of CH_4 emissions from the energy sector, 0.4% of total CH_4 emissions, and 0.2% of national GHG emissions.

Until 1980, a certain amount of natural gas was produced in Georgia. After this, production has drastically declined due to the exhaustion of deposits, and in 1997-1999 it stopped completely. Production resumed in 2000, but in subsequent years it dropped again.

Methodology*:* To calculate the methane emissions from this source, the Tier 1 approach was used, based on the aggregated emission factors relevant to production and data on the amounts of gas produced.

Emission Factors*:* The emission factors recommended by the IPCC 1996 for the countries of the former Soviet Union were used.

Activity Data*:* The data source is the State Department of Statistics. In 2000, methane emissions from this source exceeded the 1990 level by 36.4% (0.77 Gg CH_4). Figure 2.46 shows the methane emissions from natural gas production in 1990-2006.

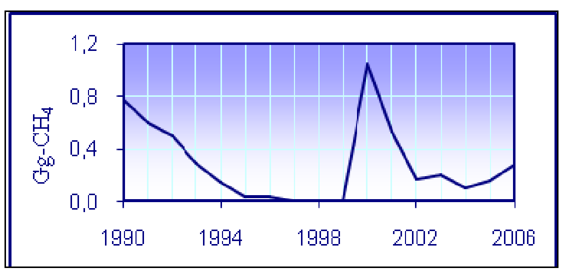

Figure 2.46: Methane emissions (Gg CH_4) from the natural gas production in 1990-2006.

- ***Transmission and Distribution of Natural Gas***

In 2000, 112.25 Gg CH_4 were emitted from the transmission and distribution of natural gas, accounting for 87.8% of CH_4 emissions from the energy sector, 43.7% of total CH_4 emissions, and 21.5% of national GHG emissions.

Georgia was supplied with natural gas imported from Russia through its main gas pipelines. Until the collapse of the Soviet Union, the price of gas was much lower than the world market price, and the economic losses were huge. This situation has changed drastically since Georgia's declaration of independence. Gas providers have brought prices nearer to world market values. In view of the deep economic crisis of that time, Georgia was not able to pay the costs entirely and on time, which resulted in an abrupt reduction of supplied gas. The improvement of the economic situation has resulted in increased gas deliveries, and thus a decreased commercial losses.

Due to the lack of means required for the rehabilitation of depreciated main gas pipelines and gas distribution networks, the losses of gas were immensely high.

Methane emissions from natural gas systems occur during both normal functioning regimes and maintenance and repair work. In Georgia, emissions are high due to the faultiness and frequent damage of transportation and distribution pipelines.

Methodology: To estimate methane emissions from this source category, the Tier 1 methodology was applied, based on data on transmitted and distributed gas quantities and default emission factors.

Emission factors*:* To calculate the emissions in 1990-1996, an emission factor recommended by the IPCC 1996 for countries of the former Soviet Union was used, and during 1997-2006, emission factors were assessed according to information on gas leakages obtained from the Georgian Gas Transmission International Company (GGTIC).

Activity data*:* The data sources on transmitted and delivered consumer gas are the GGTIC and the Statistical Yearbooks of the State Department of Statistics.

In 2000, methane emissions from the transmission and distribution of natural gas were approximately the same as the 1990 level (112.94 Gg CH_4).

Figure 2.47 shows the methane emissions from natural gas transmission and distribution in 1990-2006. The reduction in emissions since 2000 has been mainly due to a decrease in leakages, as a result of gas pipeline rehabilitation, and variations in the amount of transmitted gas. In 2000, natural gas losses accounted for 6.78%. After the rehabilitation of pipelines, and improvements in accounting, losses decreased to 3.44% in 2006.

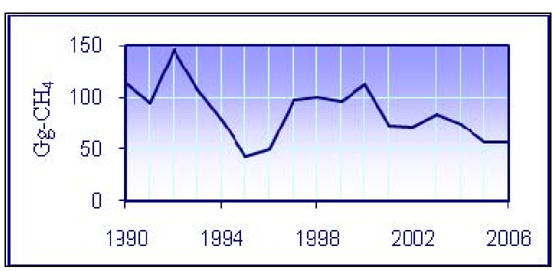

Figure 2.47. Methane emissions (Gg CH_4) from natural gas transmission and distribution in 1990-2006

2.1.2.2. Agriculture

In 2000, methane emissions from the agricultural sector amounted to 73.98 Gg CH_4, accounting for 28.8% of total CH_4 emissions, and 14.1% of total GHG emissions. In the agricultural sector, methane emissions came from the subsectors of enteric fermentation, manure management and the field burning of agricultural residues.

❖ ***Enteric fermentation***

The subsector “enteric fermentation” in the national inventory is comprised of cattle, buffalo, sheep, goats, horses and swine. The cattle are divided into two groups: dairy and non-dairy (calf, bull calf, and bull). Methane emissions from enteric fermentation were calculated using two methodological approaches: IPCC Tier 1 and IPCC Tier 2.

Tier 1 approach

In 2000, methane emissions from enteric fermentation amounted to 61.33 Gg CH_4, accounting for 82.9% of CH_4 emissions from the agricultural sector, 23.9% of total CH_4 emissions and 11.7% of national GHG emissions. The major source of CH_4 emissions in these subsectors was cattle (55.22 Gg CH_4), which contributed to 90% and 21.5% of total methane emissions in this subsector.

Methodology: The IPCC Tier 1 simplified approach was used based on the IPCC default values of emission factors. In accordance with Tier 1, the amount of methane produced by the animal population was calculated as an emission per animal, and multiplied by the number of animals.

Emission factors: Emission factors for dairy and non-dairy cattle are taken as the default values for the Asian region, as the animal parameters and habitat conditions in Asia best match Georgia’s conditions (i.e., cattle graze predominantly in pastures and more rarely, in confined areas, mainly in winter; and the animals are of a relatively small size and have multifunctional purposes). For other animals, emission factors were taken as the default values attributed to developing countries with temperate climates.

Activity data: The source of information is the State Statistics Yearbooks.

Georgia’s livestock headcount in 1990-2006 are shown in Figure 2.48.

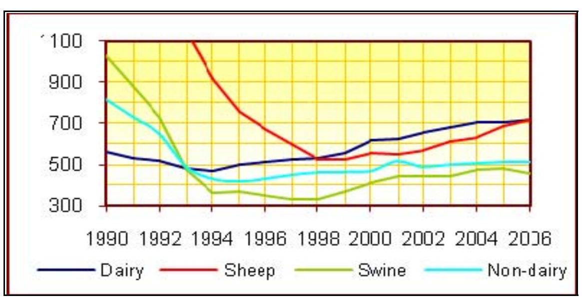

Figure 2.48 Livestock headcount (1000 hands) in Georgia in 1990-2006

Figure 2.48 shows that since 1990, the number of dairy cattle has significantly decreased. This can be explained by the elimination of large state farms. However, since 1994, the process has been reversed, mainly as a result of increased demand in the population for dairy products.

The number of non-dairy cattle decreased until 1994, due to the rising demand for locally produced beef under restrictions on the importing of this product. After 1994, the situation stabilized.

The decrease in the number of sheep continued until 1998. The main reasons for this decrease were a fall in the demand for wool, as well as the impossibility of driving sheep into winter pastures in neighbouring Daghestan.
In 2000, methane emissions from enteric fermentation accounted for 76.1% of the 1990 level (80.59 Gg CH_4). Figure 2.49 shows the total CH_4 emissions during the period 1990-2006. It also shows emissions from cattle as the major source in this subsector. The main reason for the CH_4 emissions decline in 1991-1994 was the decrease in the number of animals, caused by the economic collapse and the abolition of state farms.

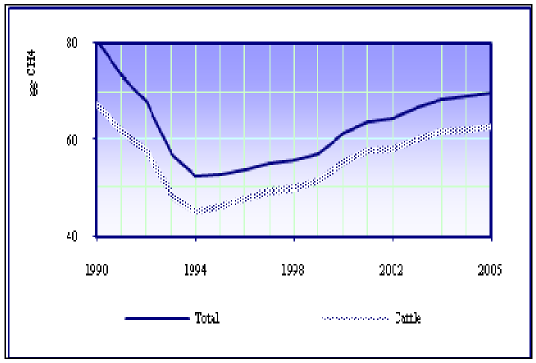

Figure 2.49 Methane emissions (Gg CH_4) in 1990-2006 from enteric fermentation subsectors and the cattle.

Tier 2 approach

Methodology: In the case where enteric fermentation represents a key source of emissions, the "IPCC GPG and Uncertainty Management in National GHG Inventories" [4] recommends using the Tier 2 approach for the category of animals, which makes up a major input in methane emissions from enteric fermentation. In 1990-2006, the contribution of methane emissions from cattle to total emissions from enteric fermentation, varied in the range of 84-90%. Accordingly, for this source category, the "Tier 2" methodological approach was applied.

Tier 2 represents a more complex approach, which demands detailed information on animal food, forms of taking food, and, most importantly, on the features of the livestock (kind, weight, yield of milk, birth rate, etc.) in the country.

Emission factors: Emission factors were calculated for each age category of animals using data on livestock weight, growth norms, yields of milk, and other parameters of major kinds of cattle, required by the IPCC methodology. Methane emissions from enteric fermentation were calculated multiplying the number of cattle groups (according to kind and age) by the relevant emission factors, and by a summing up of obtained emissions.

Activity data*:* Based on the above mentioned statistical information, the distribution in 1990-2006 of cattle in Georgia was estimated according to the main wide-spread kinds. To establish the distribution of cattle by age groups, a model was constructed, founded upon the characteristic features of the main kinds (birth rate, age of first lactation and of maturity, etc.). Model parameters were selected in maximum proximity to the actual status. This model provided the balance of heads of livestock from year to year.

In 2000, methane emissions from enteric fermentation, calculated using Tier 2 methodology (54.09 Gg CH_4) appeared to be about 12% less than the value obtained under the Tier 1 approach (61.33 Gg CH_4).

Figure 2.50 compares methane emissions calculated for 1990-2006, under both Tier 1 and Tier 2 methodologies. It can be seen that calculations under the Tier 2 approach result in lower emissions. This difference is caused by a variation in the age structure of the livestock. Since 1992, the difference between emissions calculated by both approaches varies in the range of 10-13%.

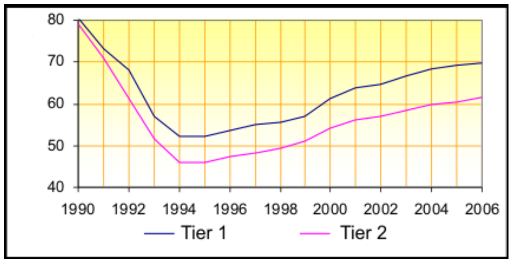

Figure 2.50. Methane emissions (Gg CH_4) in 1990-2006 from enteric fermentation calculated under Tier 1 and Tier 2 approaches.

❖ ***Manure management***

In 2000, the methane emissions from the manure management subsector accounted for 12.4 Gg CH_4, accounting for 16.8% of CH_4 emissions from the agricultural sector, 4.8% of total CH_4 emissions, and 2.4% of national GHG emissions.

During the storage and treatment of manure, CH_4 and N_2O are produced. The emission of these gases depends on the kind and amount of manure and its management system. In badly aerated systems, the production of methane is usually higher, and that of nitrous oxide is lower. Under good aeration, however, less CH_4 and more N_2O are produced.

After extraction, manure quickly starts to decompose. Under conditions of limited mixing with oxygen, decomposition is predominantly anaerobic, causing the production of methane. The amount of methane depends on the quantity of manure, the type of waste management system and the level of aeration.

Methodology: Methane emissions from manure management were calculated under the IPCC Tier 1 methodology, based on the simplified approach using default values of emission factors. In accordance with IPCC 1996, the Tier 1 methodology in most countries provides fully acceptable accuracy for many types of livestock.

Emission factors*:* For cattle (dairy and non-dairy), buffalo, swine and poultry, emission factors typical for Asian regions with a temperate climate were used. For other types of animals, default values for developing countries with a temperate climate were used.

Activity data*:* Data on the livestock are the same as those used in the enteric fermentation subsector.

In 2000, methane emissions amounted to 12.5 Gg $CH_{4,}$ accounting for 85% of the 1990 level (14.71 Gg CH_4). Figure 2.51 shows the methane emissions from this subsector in 1990-2006.

A fall in emissions compared to the 1990 level was caused by a decrease in heads of livestock, especially manifest in 1991-1994. In the following years, emissions grew at an approximately steady rate.

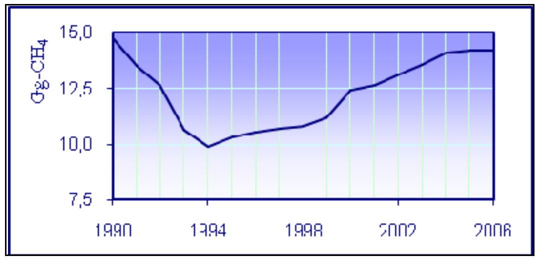

Figure 2.51: Methane emissions (Gg CH_4) from the manure management subsector, 1990-2006

- ***Field burning of agricultural residues***

Burning of agricultural residues is not a source of CO_2, as the carbon emitted into the atmosphere in the process of burning is again absorbed by the vegetation in the following vegetation period. During the burning of harvest residues CH_4 and N_2O are being released. Emissions of these two gases accompanying the burning of agricultural residues are insignificant and do not represent key sources for Georgia.

In 2000, methane emissions from this subsector were equal to 0.25 Gg CH_4, making up only 0.3% of methane total emissions from the Agriculture sector. In other years the picture is the same. For example in 1990, methane emissions comprised 0.45 Gg CH_4, accounting for 0.5% of sectoral emissions.

2.1.2.3. Waste

In this sector, methane emissions from two subsectors are examined: solid waste disposal on land and wastewater handling.

- ***Solid waste disposal***

In 2000, methane emissions from solid waste disposal sites amounted to 43.91 Gg CH_4, making up 80.2% of the 1990 level, 17.1% of CH_4 total emissions, and 8.4% of GHGs national emissions.

Its share in the total CH_4 emissions from the country varies from year to year, in the range of 2-11%.

In Georgian cities, municipal waste is collected and transported to landfills. Unfortunately, there is no precise information on the amount and composition of solid waste. In rural settlements the collection and dumping of waste is not practiced. As the waste is scattered, there are no conditions for anaerobic decomposition and therefore methane is not actually generated.

At present there are about 80 registered landfills. Of them, 2 landfills of Georgia's capital Tbilisi can be regarded as managed solid waste disposal sites. The third municipal landfill of Tbilisi was closed in 2003. In other large and medium-sized cities of the country, waste disposal sites are unmanaged.

In view of the fact that it appeared practically impossible to establish accurately when and in what quantity the population of Tbilisi took away solid waste before the opening of the above mentioned landfills, it is assumed that since 1961 waste has been taken away to the hypothetical disposal site #1.

Due to the absence of information about landfills in small towns and settlements, it has been assumed that since 1980 wastes were taken away to the hypothetic disposal site #2.

Methane emissions from the solid waste disposal subsector have been calculated using two methodological approaches: IPCC Tier 1 and IPCC Tier 2.

Default method (Tier 1 approach)

Methodology: To determine methane emissions from Georgian landfills initially, the "Default method" (Tier 1 methodological approach) was used, based on the assumption that the entire amount of decomposable organic carbon existing in the waste was entirely decayed (or the potential methane was totally emitted) within the year of taking away the waste to the disposal site.

Emission factors: Values of parameters required for the calculation of emission factors were selected according to IPCC GPG [4] recommendations.

Activity data: Initial information on the amount of solid waste is based upon the relevant data for Tbilisi (including hypothetical disposal site # 1), other big cities (Kutaisi, Batumi, Zugdidi, Rustavi, Poti, and Gori) and small towns (hypothetical disposal site # 2). Population data for cities were taken from Department of Statistics yearbooks. Methane emissions trends in 1990-2006 from solid waste disposal sites in Georgia, calculated under the Tier 1 approach (red curve) are given in Figure 2.52. In 2000, methane emissions from this subsector made up about 84% of the 1990 level (52.51 Gg CH_4). Emissions trends virtually duplicate population trends, as shown in Figure 2.53.

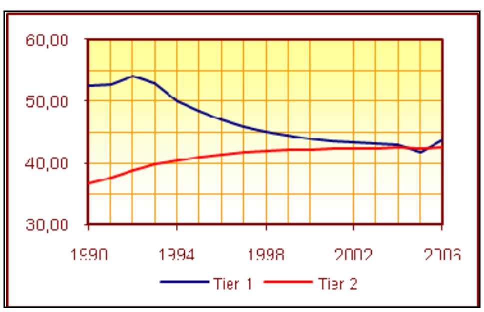

Figure 2.52. Methane emissions (Gg CH_4) from solid waste disposal sites, 1990-2006

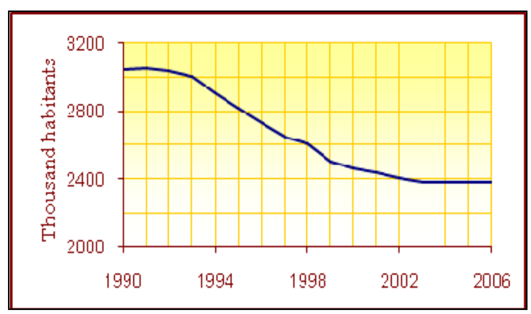

Figure 2.53. Population (thousands) sending waste to landfills, 1990-2006

First order decay method (Tier 2 approach)

The default method provides for the reliable estimation of existing annual emissions, if the amount of taken-away waste, and its composition, is constant or slowly changing over a period of some decades. If the waste disposal period is less than 3-4 decades, the IPCC default method does not provide the CH_4 emissions values with adequate accuracy. For this reason, calculations have been conducted for 1990-2006 applying the first order decay (FOD) method. The same activity data were used as for the Tier 1 case. Results are given in Figure 2.52 (blue curve).

- ***Wastewater handling***

In 2000, methane emissions from wastewater handling comprised 10.85 Gg CH_4, making up 19.8% of CH_4 emissions from the Waste sector, 4.2% of total CH_4 emissions and 2.1% of national GHG emissions.

Wastewater is generated by a variety of sources. Domestic and commercial wastewater contains sewage water from kitchens, bathrooms, etc. The sources of industrial wastewater are different branches of industry, such as the food processing industry, paper and pulp production, etc.

Methodology: To assess methane emissions from the wastewater handling subsector, the default IPCC methodology has been used, and the default values of parameters have been applied for both residential and industrial wastewater.

Emission factors: Default values recommended by the IPCC GPG for different branches of industry were used.

The parameters required for calculating the methane emissions from domestic wastewater were determined according to default values, recommended by the IPCC 1996 and IPCC GPG for the republics of the former Soviet Union.

Activity data*:* Data on the volume of production from local facilities were used in performing the calculations. Our sources of information were statistical yearbooks of the Department of Statistics and data obtained from different local enterprises.

In 2000, methane emissions from residential wastewater equalled 10.24 Gg CH_4, and from industrial wastewater – 0.61 Gg CH_4. In 1990, the corresponding values amounted to 13.30 Gg CH_4, and 25.50 Gg CH_4. The sharp reduction in methane emissions from industrial wastewater in 2000, compared to the 1990 level, can be explained by the fall in industrial production. Figure 2.54 demonstrates methane emissions from wastewater handling in 1998-2006.

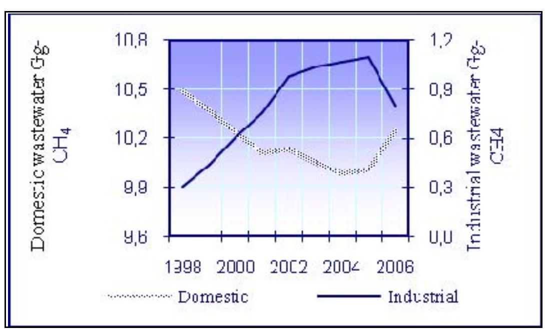

Figure 2.54. Methane emissions from wastewater handling, 1998-2006

2.1.3. Nitrous oxide (N_2O)

Nitrous oxide (N_2O) is a greenhouse gas generated as a result of both natural processes and anthropogenic activity in the Energy, Agriculture, Industrial processes, and Waste sectors.

In 2000, emissions of N_2O in Georgia made up 6.04 Gg N_2O, comprising 17% of GHGs national emissions.

In 2000, N_2O was emitted from the Energy sector (fuel combustion subsector), the Industrial processes sector ("Chemical Production" subsector, source category Production of Nitric Acid), the Agriculture sector (subsectors: manure management, field burning of agricultural residues and emission from agricultural soils subsector source categories: direct and indirect emissions from soils and animal production), and from the Waste sector (subsector "wastewater", source category human sewage water).

In 2000, the main share of N_2O emissions was made by the Agriculture (66.7%) and Industrial processes (25.2%) sectors. The share of emissions coming from the Energy and Waste sectors were relatively insignificant – correspondingly 3.4% and 4.6%. In Figures 2.55-2.58, emissions of N_2O are shown from different sources in 1990, 2000, and 2006. In 2000, emissions of N_2O were equal to 67.3% of the 1990 level, and emissions were reduced from all sources. In Figure 2.57, N_2O emissions trends from different sectors in 1990-2006 are given. This figure shows that N_2O emissions fell drastically in 1990-1995, and that since 2000 they have begun to increase smoothly. An exception is in the Agriculture sector in 2004 and in Industrial processes in 2006.

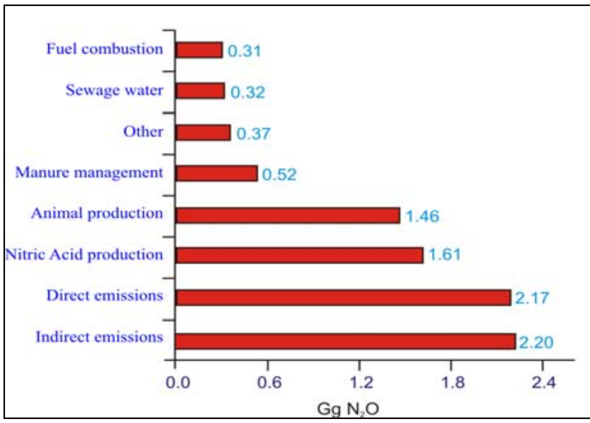

Figure 2.55. Emissions of nitrous oxide (Gg N_2O) from different sources, 1990

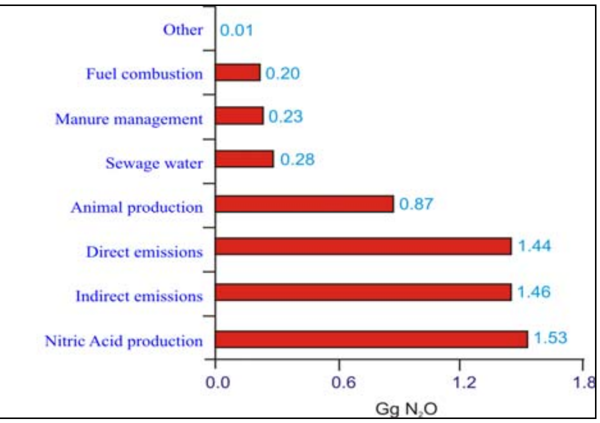

Figure 2.56. Emissions of nitrous oxide (Gg N_2O) from different sources, 2000

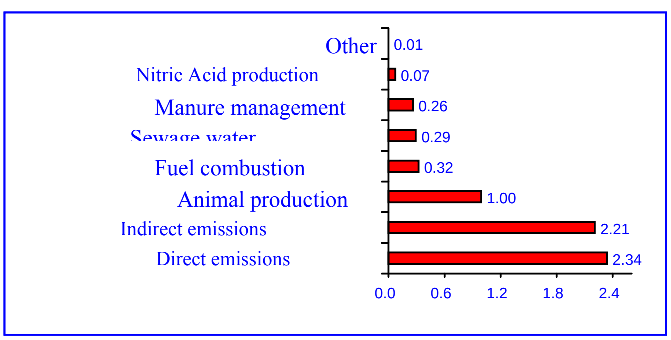

Figure 2.57. Emissions of nitrous oxide (Gg N_2O) from different sources, 2006

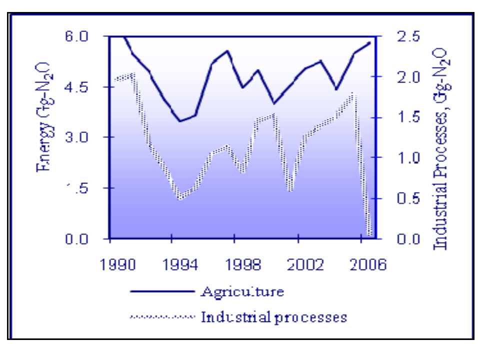

Figure 2.58. Trends of nitrous oxide emissions from different sectors, 1990-2006

2.1.3.1 **Energy**

Emissions of N_2O from the Energy sector took place in the "Fuel Combustion" subsector. N_2O is produced as a result of the reaction between nitrogen and oxygen during the combustion of fuel in stationary and mobile sources. Stationary sources of N_2O emissions are from the production of electric and heat energy, the manufacturing industries, construction, and others. Mobile sources of N_2O emissions include road transport, civil aviation, and railway transport. The amount of N_2O emissions from all sources depends on fuel type, combustion technology, and other factors.

Methodology: Calculations were based upon the IPCC Tier 1 approach.

Emission factors*:* The IPCC 1996 default emissions factors were used.

Activity data: Data on the amount of consumed fuel are the same as the data used to calculate CO_2 emissions from the fuel combustion.

In 2000, an insignificant amount of N_2O (0.21 Gg N_2O) was emitted from fuel combustion in the Energy sector, making up 3.4% of N_2O total emissions, and only 0.6% of the total national emissions.

2.1.3.2. **Industrial processes**

In 2000, emissions of N_2O from the production of nitric acid in Georgia amounted to 1.53 Gg N_2O, equalling 25.3% of N_2O total emissions, and 4.3% of national GHG emissions.

In 2000, according to the National GHG Inventory, the only source of N_2O emissions from the Industrial processes was the production of nitric acid (HNO_3). This acid is an organic compound, mainly used to produce synthetic fertilizers. HNO_3 is produced as a result of the catalytic oxidation of ammonia at high temperatures during which N_2O is generated as a byproduct. The amount of N_2O produced is proportional to the amount of ammonia used. The concentration of N_2O in emitted cases depends upon the production technology and the emission control level.

Methodology*:* As there is no data on N_2O concentration measurements in Georgia, the calculation of emissions in the country were carried out on the basis of nitric acid production data, and the IPCC 1996 emission coefficient relevant to the existing technology.

Emission factor*:* The JSC "Azot" in Rustavi applies so called low-pressure technology to produce nitric acid. Hence, the IPCC 1996 default value of emission factors relevant to this kind of technology was used in the calculations.

Activity data*:* The sources for activity data are the Department of Statistics, and JSC "Azot".

In 2000, emissions of N_2O from nitric acid production was slightly lower compared to the 1990 level (1.61 Gg N_2O). Figure 2.59 shows the trend of N_2O emissions in 1990-2006. A sharp variation in annual emissions was caused by the unsteadiness of nitric acid production. Up until 1996, the JSC "Azot" had produced Caprolactam as well.

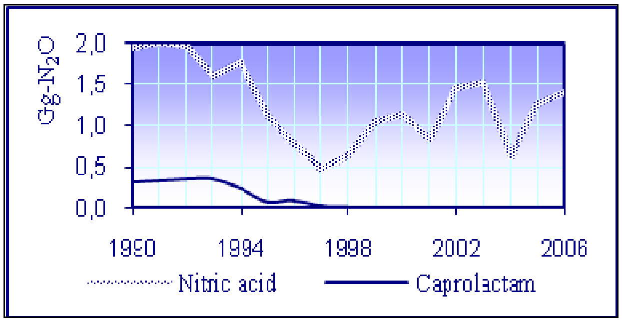

Figure 2.59. N_2O emissions (Gg CO_2-eq) from the production of nitric acid and Caprolactam, 1990-2006

2.1.3.3 Agriculture

In 2000, emissions of N_2O from the Agriculture sector amounted to 4.03 Gg N_2O equalling 66.7% of the N_2O total emissions, and 11.4% of national GHG emissions.

N_2O emissions from the Agriculture sector include emissions from agricultural soils (source categories: direct and indirect emissions from soils, and emissions from animal production), as well as emissions from manure management and the field burning of agricultural residues.

Emissions from manure management make up 0.23 Gg N_2O (5.7% of sectoral emissions), direct emissions from soils 1.46 Gg N_2O (36.2%), indirect emissions from soils 1.46 Gg N_2O (36.2%), from animal production 0.87 Gg N_2O (21.6%), and from burning of residues only 0.01 Gg N_2O (0.2%).

In 2000, emissions of N_2O from Agriculture decreased by 36.6%, relative to the 1990 level (6.36 Gg N_2O). Figure 2.60 shows the trends during 1990-2006 of N_2O emissions. Since 2000, emissions of N_2O have been increasing, with the exception of 2004, when the level of synthetic nitrous fertilizer consumption was low compared to other years.

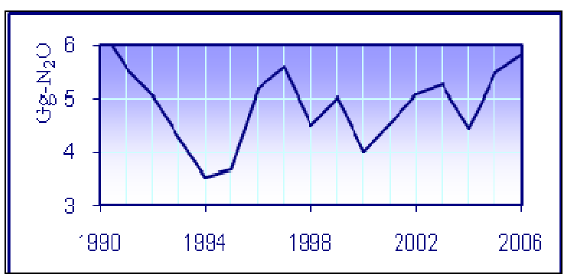

Figure 2.60 Trend of N_2O emissions from the Agriculture sector, 1990-2006

- ***Manure management***

In 2000, emissions of N_2O from manure management made up 0.23 Gg N_2O, comprising 5.7% of N_2O emissions from the Agriculture sector, 3.8% of total N_2O emissions, and 0.6% of national GHG emissions.

During the process of manure storing and management, a part of the contained nitrogen is transformed into nitrous oxide as a result of nitrification and denitrification. Manure management systems are important regulation factors for N_2O emissions. In this subsector, the emission of N_2O is examined for a number of management systems (anaerobic lagoons, liquid systems, solid storage and dry lot, and stalls and other systems), for manure introduction into agricultural soils (e.g. daily dispersion), and is regarded as the source of N_2O direct emissions from agricultural soils.

Methodology: Emissions of N_2O from manure management were estimated according to the 1996 IPCC Tier 1 approach. Emissions from each category of animals were calculated by multiplying the number of animals by the average level of nitrogen emission for each animal category, and their share of "Digestible Nitrogen" relevant to types of manure management systems used.

Emission factors: The IPCC default values were taken for emission factors and other parameters.

In 2000, N_2O emissions from manure management made up about 44% of the 1990 level (0.52 Gg N_2O). Figure 2.61 shows emissions of N_2O from the manure management subsector in 1990-2006. Since 2000, emissions have not been increasing significantly.

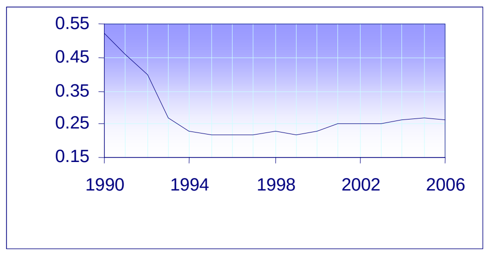

Figure 2.61. Trend of N_2O emissions from the manure management subsector, 1990-2006

- ***Emissions from soils***

This source category is the largest among N_2O emission sources from agriculture soils. In 2000, emissions of N_2O from soils amounted to 3.79 Gg N_2O, making up 94% of N_2O emissions from the Agriculture sector, about 63% of total N_2O emissions and 10.7% of national GHG emissions.

Agricultural soils represent both direct and indirect sources of N_2O. Direct source means the emission of N_2O takes place directly from the soil. These emissions are produced by the introduction into the soil of nitrous-containing synthetic fertilizers and manure, the biological fixing of nitrogen, and the production of nitrogen as a result of harvest residues mineralisation, and the mineralisation of nitrogen during the cultivation of organic peat-containing soils. Emissions of N_2O from indirect sources are produced by the volatilisation of nitrogen contained in synthetic fertilizers and manure and leaching, as well as resulting from erosion and washing off.

- ***Direct emissions from soils***

In 2000, direct emission from soils made up 1.46 Gg N_2O, comprising 36.2% of N_2O emissions from the Agriculture sector, 24.1% of N_2O total emissions, and 4.1% of national GHG emissions. The dominant sources of direct emissions of N_2O from soils were N_2O emissions from the introduction of synthetic nitrous fertilizers, their share of which in 2000 was 57.5%.

During the application of synthetic fertilizers, huge amounts of nitrogen are introduced into the soil. This additional nitrogen is nitrified and denitrified, as a result of which N_2O is released. The amount of N_2O emissions depends on the quantity of applied nitrous fertilizers and their type, the kind of vegetation and soil, and on the climate and other factors.

Introducing nitrogen to the soil as a result of the application of manure could increase the level of nitrification/denitrification and enhance the N_2O emissions from agricultural soils.

Nitrogen absorbed from the atmosphere by nitrogen-fixing crops can undergo nitrification and denitrification in a similar way to nitrogen brought into the soil from synthetic fertilizers. After harvesting, part of the yield decomposes in the field. The remaining mass of vegetation represents a source of nitrogen for further processes of nitrification and denitrification, and therefore produces N_2O.

The cultivation of peat-containing organic soils usually includes draining to lower the level of underground waters, and to increase aeration, thus accelerating the decay of organic matter. In the process, nitrification and denitrification also takes place, resulting in N_2O emissions.

Methodology: The IPCC Tier 1 methodological approach was applied to estimate the N_2O direct emissions from the soil.

Emission factors: IPCC default values of emission factors and other parameters were used to perform these calculations.

Activity data: Statistical yearbooks of the Department of Statistics were used as a data source.

In 2000, direct emissions of N_2O from soils were 67.3% of the 1990 level (2.17 Gg N_2O). Figure 2.62 shows the trend of N_2O direct emissions from the soil in 1990-2006, by major source (other sources are insignificant).

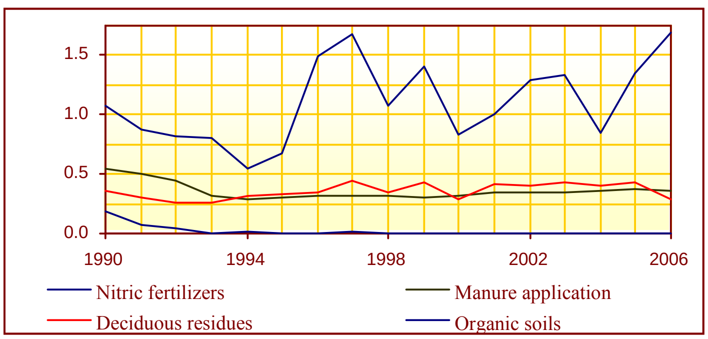

Figure 2.62. Trend of direct emissions of N_2O (Gg N_2O) from soil, 1990-2006

- ***Indirect emissions from soil***

In 2000, indirect emissions from soil accounted for 1.46 Gg N_2O, making up 36.2% of N_2O emissions from the Agriculture sector, and about 24% of total N_2O emissions, and 4.1% of national GHG emissions.

After the introduction of synthetic fertilizers and manure into arable land, part of the nitrogen is lost as a result of volatilisation in the form of ammonia (NH_3) and nitrogen oxides (NO_x). The volatilised nitrogen can sediment again in other places and undergo transformation, resulting in the production of N_2O. The quantity of volatilised nitrogen depends on the type of fertilizer, the level of fertilizer application, the method and time, as well as on soil structure, precipitation and other factors.

When the nitrogen contained in synthetic fertilizer or manure is applied to ploughed soil, part of the nitrogen is lost as a result of leaching, erosion and washing off. Losses of nitrogen depend on the methodology, time and rate of nitrogen application, kind of vegetation, soil structure, run-off, landscape, etc. This lost nitrogen can subsequently undergo transformation and hence produce N_2O away from the place of application.

Methodology: The IPCC 1996 Tier 1 approach was used to calculate N_2O indirect emissions, both through volatilisation and repeated sedimentation from synthetic fertilizers and manure applied to the soil, and as a result of leaching, erosion and washing off.

Emission factors: The IPCC 1996 default values were used as emission factors. It was assumed that the amount of volatilised nitrogen is equal to 10% of the applied nitric fertilizer, and 20% of the applied manure, and that 30% of nitrogen used a fertilizer was lost as a result of leaching, erosion and runoff.

In 2000, indirect emissions of N_2O from soils made up 66.4% of the 1990 level (2.20 Gg N_2O). Figure 2.63 shows the trend of indirect emissions of N_2O from soils in 1990-2006.

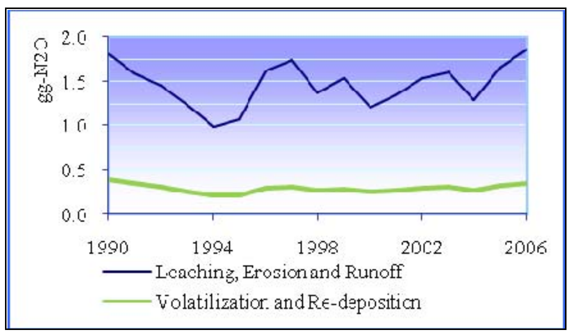

Figure 2.63. Indirect emissions of N_2O (Gg) from soils, 1990-2006

- ***Emissions from animal production***

In 2000, emissions from annual production accounted for 0.87 Gg N_2O, making up 21.6% of N_2O emissions from the Agriculture sector, about 14.4% of total N_2O emissions, and 2.5% of national GHG emissions.

In this subsector, N_2O emissions were examined from manure excreted on the soil by grazing animals (pastures and paddock).

When manure is excreted from grazing animals on pasture and paddock, nitrogen in the manure undergoes ammonification, nitrification and denitrification. During these transformation processes N_2O is produced.

Methodology: The emissions manure excreted by grazing animals was calculated using the IPCC 1996 Tier 1 approach. Emissions were calculated for each animal category by multiplying the animal population by the appropriate nitrogen excretion rate, and by the fraction of manure nitrogen available for conversion to N_2O.

Emission factors*:* The IPCC default values were used for emission factors and other parameters.

Activity data*:* Statistics yearbooks of the Department of Statistics were used as a data source.

In 2000, emissions of N_2O from animal production amounted to 59.6% of the 1990 emissions level (1.46 Gg N_2O). Figure 2.64 demonstrates trends of N_2O emissions from animal production in 1990-2006.

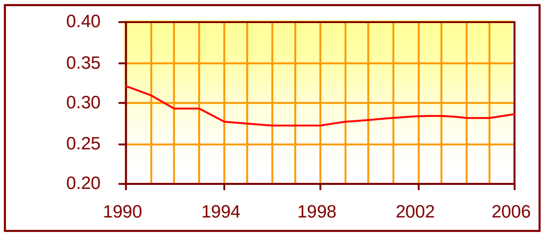

Figure 2.64. Trend of N_2O emissions (Gg) from animal production, 1990-2006

Field burning of agricultural production in 1990-2006

The share of N_2O emissions from field burning of crop residues is very insignificant. In 2000 these emissions made up only 0.01 Gg N_2O, or 3.1 Gg CO_2 eq.

2.1.3.4. Waste

The only source of N_2O emissions from the Waste sector was nitrification and denitrification of nitrogen contained in sewage wastewater. Emissions of N_2O from sewage wastewater were calculated according to FAO data on per-capita consumption of protein and population data.

In 2000, emissions of N_2O from this source were equal to 0.28 Gg N_2O, making up 87.5% of the 1990 level (0.32 Gg N_2O). The fall in emissions was caused by a decrease in the population. Emissions of N_2O from sewage water made up 4.6% of total N_2O emissions, and 0.8% of total national emissions. Figure 2.65 shows trends of N_2O emissions from sewage wastewater in 1990-2006.

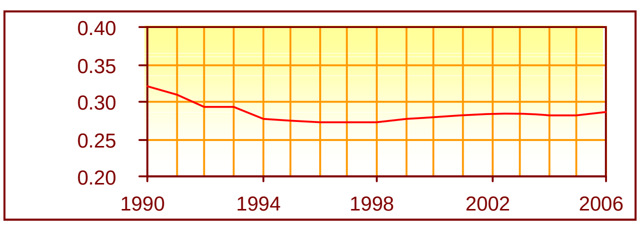

Figure 2.65. Dynamics of N_2O emissions (Gg) from sewage wastewater, 1990-2006.

2.1.4. Industrial Gases

In 2000, industrial gases (hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF6)) were not produced in Georgia, and are not produced currently. Only some of them (in the role of cooling agents) are imported into the country to substitute for ozone-depleting substances in refrigerators.

The imported cooling agents are tetrafluoroethane (HFC-134a) and mixes of industrial gases:

HFC-404a = 44% pentafluoroethane (HFC-125) + 52% triflouroethane (HFC-143a) + 4% tetrafluoroethane (HFC-134a);

HFC-407c = 23% difluoromethane (HFC-32) + 25% pentafluoroethane (HFC-125) + 52% tetrafluoroethane (HFC-134a).
Industrial gases are loaded into imported refrigerators, air conditioning devices and other equipment, and through their leakages, emissions into the atmosphere are taking place.

Table 2.3 demonstrates the Global Warming Potential (GWP) of industrial gases applied in the country. For R-404a and R-407c the GWP is calculated according to their contents.

Table 2.3. Global Warming Potential of industrial gases used in Georgia

Gas	Name	Formula	GGWP
HFC-32	Difluoroethane	CH_2F_2	650
HFC-125	Pentafluoroethane	C_2HF_5	2,800
HFC-134a	Tetrafluoroethane	$C_2H_2F_4$	1,300
HFC-143a	Triflouroethane	$C_2H_3F_3$	3,800
R-404a	Mix	HFC-125 (44%) HFC-143a (52%) HFC-134a (4%)	3,260
R-407c	Mix	HFC-32 (23%) HFC-125 (25%) HFC-134a (52%)	1,525

The 2000 inventory in Georgia comprises emissions of HFCs in the industrial gases subsector, from domestic, commercial and industrial refrigerators. Information required to determine emissions from other sources does not exist. Data on agents loaded into the imported air conditioners imported to the country have existed only since 2000.

Methodology: The IPCC Tier 2 approach was used in calculations. The values of losses resulting from leakages are taken into account according to IPCC recommendations.

Emission factors: The IPCC 1996 default values were used as emission factors.

Activity data*:* Information on cooling agents imported into the country, as well as on cooling agents contained in appliances, by type and amount, were used.

In the case of domestic refrigerators it was assumed that 1% of the initially loaded cooling agent was emitted annually into the atmosphere, as a result of leakage. The import of HFC-134a cooling agents contained in refrigerators began in Georgia in 1998, and has been growing. In 2000, only 5 tonnes of CO_2-eq were emitted into the atmosphere, and in 2006 141 tonnes CO_2-eq were emitted.

The import of other types of refrigeration devices (commercial and industrial) has been taking place since 1995, first of refrigerators using HFC-404a as a cooling agent and then, since 2005, refrigerators containing HFC-134a. It was assumed during the calculations that the average annual losses resulting from leakages made up 2% of the loaded cooling agents. In 2000, the emissions equalled 21.0 Gg CO2-eq, or virtually 100% of industrial gases emissions from this source.

Figure 2.66 shows the trend of industrial gases emissions (Gg CO2-eq) in 2000-2006.

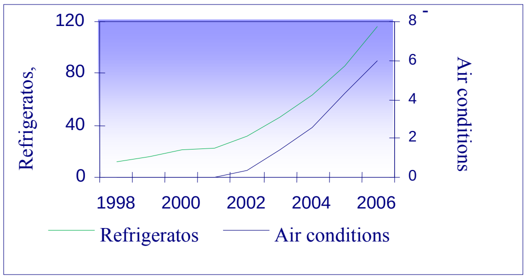

Figure 2.66. Trend of industrial gases emissions (Gg CO2-eq), 2000-2006

2.1.5. Other GHGs and SO_2

In 2000, emissions of indirect GHGs in Georgia made up 24.2 Gg of nitrous oxides (NO_x), 338.3 Gg of carbon monoxide (CO), and 47.0 Gg of non-methane volatile organic compounds (NMVOCs). In 2000, a small amount of sulphur-containing fuel was consumed in Georgia; 15 thousand tonnes of black oil, and 27 thousand tonnes of coal. Correspondingly, emissions of sulphur dioxide (SO_2) were small and amounted to only 1.2 Gg SO_2.

Methodology: The IPCC Tier 1 methodological approach was applied, which calculates emissions by multiplying the amount of consumed fuel or generated product by the relevant emission factor.

Emission factors*:* Default values from the IPCC 1996 were used as emission factors.

Activity data*:* Activity data are the same as that used for the calculation of direct GHG emissions.

As compared to the 1990 level, emissions of NO_x decreased by 48.2%, of SO_2 by 35.8% and of NMVOCs by 63.7%.

Figure 2.67 shows the trend of indirect GHG emissions in 2000-2006.

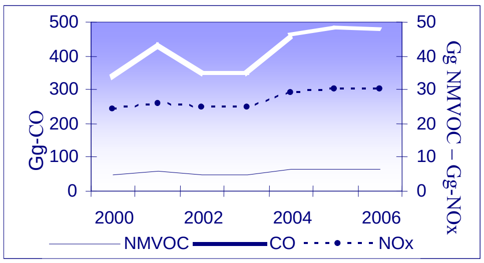

Figure 2.67. Trend of indirect GHG emissions, 2000-2006

2.2. Sectoral emissions of GHGs

In 2000, GHG emissions by sector in Georgia were distributed as follows:

2.2.1. Energy

In 2000, emissions of GHGs from the Energy sector in Georgia accounted for 5,926.9 Gg CO_2 making up 53.9% of the total national emissions of GHGs. The dominant gases in the sector were CO_2 and CH_4, the emissions of N_2O from the sector equalling less than 1% of national GHG emissions.

Figure 2.69 shows emissions of specific GHGs and their share in total sectoral emissions in 2000. Figure 2.68, constructed on the basis of the 1990 data, shows that the amount of CH_4 and N_2O emissions in Gg in 2000 were about at the 1990 level, while CO_2 emissions fell approximately 10-fold resulting in changes of share of these gases in total emission. Figure 2.70 gives emissions of GHGs from the Energy sector in 2006. Compared to 2000, emissions of CH_4 in 2006 were lower, while emissions of CO_2 had grown. As a whole, emissions in 2006 rose by about 10%, relative to the 2000 level.

Figure 2.71 demonstrates trends of CO_2 and CH_4 emissions from the Energy sector in 2000-2006. Since 2003, the CO_2 emissions trend has been closely related to the increased consumption of liquid fuel in the country. The decrease in CH_4 emissions in the same period was caused by a reduction in natural gas leakages from transmission and distribution.

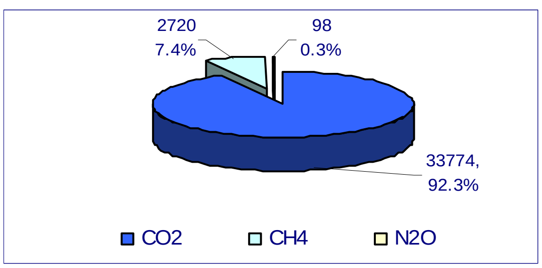

Figure 2.68. Emissions of GHGs (Gg CO_2-eq) from the Energy sector and their share in sectoral emissions, 1990

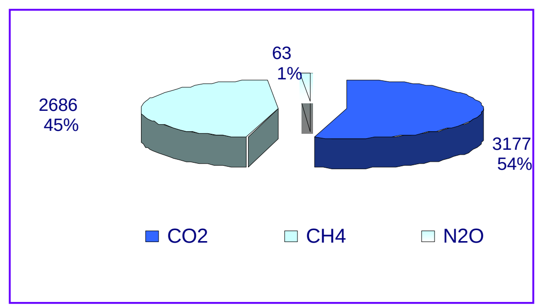

Figure 2.69. Emissions of GHGs (Gg CO_2-eq) from the Energy sector and their share in sectoral emissions, 2000

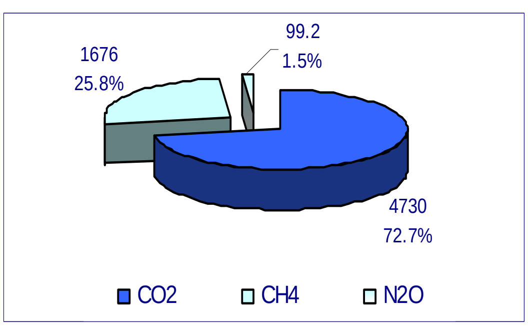

Figure 2.70. Emissions of GHGs (Gg CO_2-eq) from the Energy sector and their share in sectoral emissions, 2006

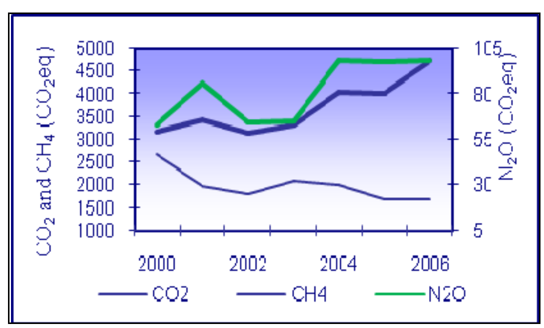

Figure 2.71. Trend of CO_2, CH_4 and N_2O emissions (Gg CO_2-eq) from the Energy sector, 2000-2006

2.2.2. Industrial Processes

In 2000, emissions of CO_2 and N_2O took place from within the Industrial processes sector.

Aggregated emissions of CO_2 and N_2O from Industrial processes totalled 1,023.6 Gg CO_2-eq, making up 9.3% of the total national GHG emissions. In 1990-2000, a minor source of methane emissions came from the chemical production of coke. In 2000, emissions of CH_4 from this source were practically zero.

Figure 2.73 shows emissions of GHGs from Industrial processes and their share in sectoral emissions in 2000. Figure 2.72 constructed on the basis of 1990 data shows that emissions from the sector significantly decreased, especially the CO_2 emissions. Figure 2.74 gives the GHG emissions in 2006, suggesting that the share of NO_2 emissions was insignificant in that year.

Figure 2.75 demonstrates trends of CO_2 and N_2O emissions from Industrial processes in 2000-2006. According to this figure, since 2000 emissions of both CO_2 and N_2O have been growing, though in 2006 this trend was broken in the case of N_2O.

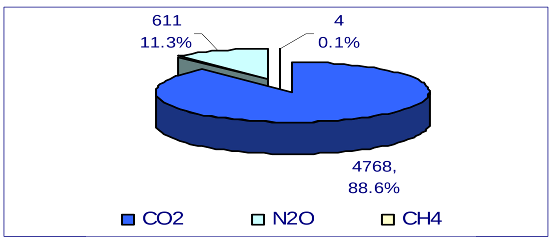

Figure 2.72. Emissions of GHGs (Gg CO_2-eq) from the Industrial processes and their share in sectoral emissions, 1990

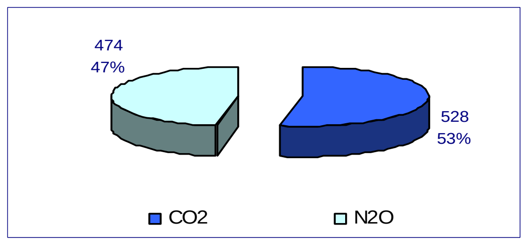

Figure 2.73. Emissions of GHGs (Gg CO_2-eq) from the Industrial processes and their share in sectoral emissions, 2000

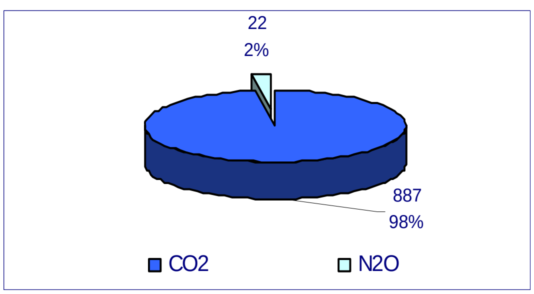

Figure 2.74. Emissions of GHGs (Gg CO_2-eq) from the Industrial processes and their share in sectoral emissions, 2006

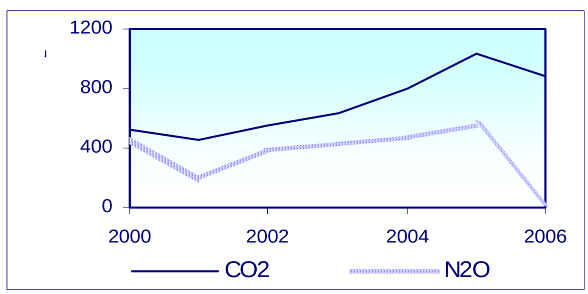

Figure 2.75 Trend of CO_2 and N_2O emissions (Gg CO_2-eq) from the Industrial processes, 2000-2006

2.2.3. Solvent and other product use

Emissions of NMOCs and N_2O from this source category, owing to the absence of direct measurements, were calculated according to population, using annual default values of per-capita emissions recommended by the EMEP/CORINAIR Guidelines (EEA, 2005). Calculations were performed for 1990-2006 in the following sub-sectors:

- Emissions of NMVOCs: (3.A) – Paint application, (3.B) – Degreasing and dry cleaning et al., (3.C) – Polygraphy, glue and lacquer application, domestic use of solvents et al.

- Emissions of N_2O: application for anaesthetic in medicine.

Annual emissions have been averaged for the above-mentioned time period. The results above indicate that annual emissions from the territory of Georgia due to solvent and other product use are equal to 51.76 Gg for NMVOCs and 0.0169 Gg for N_2O.

2.2.4. Agriculture

In 2000, aggregated emissions of CH_4 and CO_2 in the Agriculture sector accounted for 2,802.5 Gg CO_2-eq, making up 25.5% of the total national GHG emissions. Emissions of CO_2 from the Agriculture sector were negligible and they have not been accounted for. Figure 2.77 shows emissions of CH_4 and NO_2 from the Agriculture sector in 2000, and their share in sectoral emissions. The same Figure 2.76 constructed on the basis of 1990 data shows that compared to 1990, emissions in 2000 were significantly lower, by 1,180.2 Gg CO_2-eq, or 29.6%, in total. Figure 2.78 gives the GHG emissions for 2006.

Figure 2.79 shows the trends of CH_4 and N_2O emissions from the Agriculture sector in 2000-2006. Since 2000, emissions of both gases have been constantly growing with the exception of 2004, when synthetic fertilizers were applied to the soil in relatively small quantity, and which entailed accordingly low emissions of N_2O.

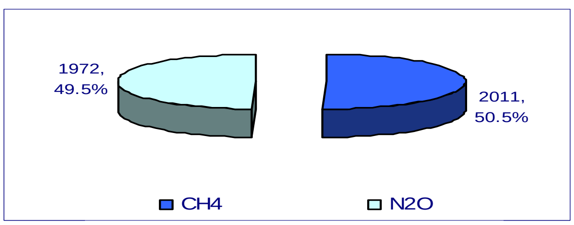

Figure 2.76. Emissions of GHGs (Gg CO_2-eq) from the Agriculture sector and their share in sectoral emissions, 1990

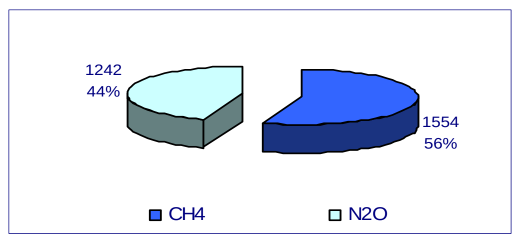

Figure 2.77. Emissions of GHGs (Gg CO_2-eq) from the Agriculture sector and their share in sectoral emissions, 2000

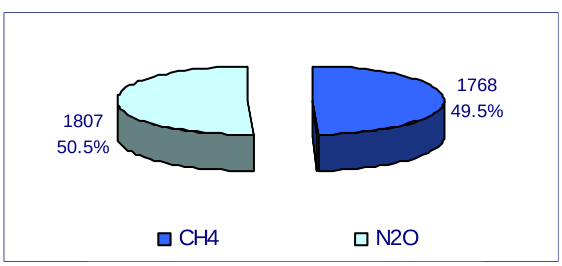

Figure 2.78. Emissions of GHGs (Gg CO_2-eq) from the Agriculture sector and their share in sectoral emissions, 2006

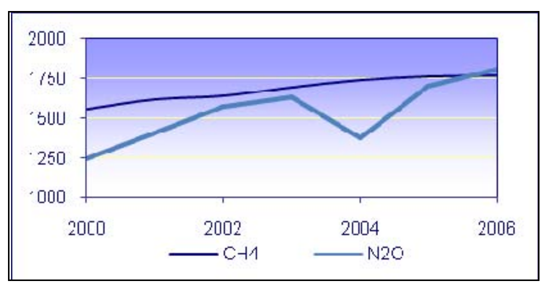

Figure 2.79. Trend of CH_4 and N_2O emissions (Gg CO_2-eq) from the Agriculture sector, 2000-2006

2.2.5. Land Use, Land Use Change and Forestry (LULUCF)

In 2000 in Georgia 2,085.5 Gg C were removed by sinks from land use, land-use change and the forestry sector, making up 412.1 Gg C and amounting to a net absorption equal to 1,673.4 Gg C. The carbon absorption from forests amounted to 1,392.6 Gg C (66%), from other woody biomass 573.7 (27.5%), and by soils 119.2 Gg C (5.7%). The forests emitted 294.7 Gg C (31.5%), other woody biomass 49.2 Gg C (11.9%), and soils 68.2 Gg C (16.5%). Accordingly, the net uptake by forests made up 1,097.9 Gg C (65.6%), other woody biomass 524.5 Gg C (31.3%), and by soils 51.0 Gg C (3%).

The inventory of land use, land-use change and the forestry sector, were based upon the idea that the flow of CO_2 from (or to) the atmosphere was equal to changes in carbon stocks existing in biomass or soils, and that the changes in carbon stocks could be assessed on the basis of land-use change and activities, causing these changes (burning, complete cutting down, selected cuttings, etc.).

In the IPCC approach, the emissions assessment examined changes in carbon stocks caused by: (1) changes in forest and other woody biomass stocks; (2) forest and grassland conversion to agricultural or other types of land; (3) carbon uptake by the abandoned (managed) lands, and (4) emissions and removals from soil.

In Figure 2.80 the amount of absorbed and emitted carbon Gg C from this sector is given for 2000, and in Figure 2.81 the trend of net uptake Gg C is shown for 1990-2006.

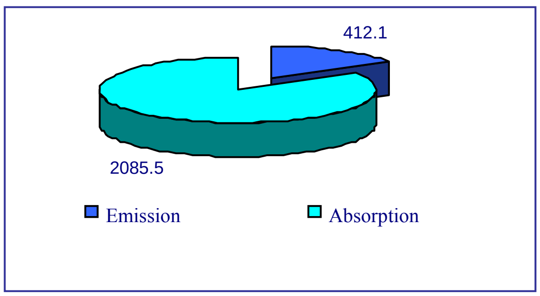

Figure 2.80. Carbon emissions and uptake Gg C, 2000

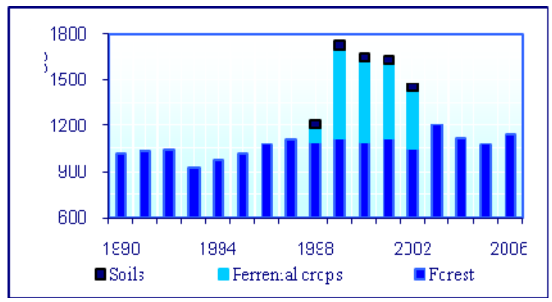

Figure 2.81. Trend of net carbon uptake Gg C from the LULUCF sector

2.2.5.1. Changes in forestry and other woody biomass stocks

In forests the continuous process of CO_2 absorption from the atmosphere, and its emission in turn, takes place subject to natural and anthropogenic impacts.

Emissions of CO_2 from changes in forests and other woody biomass stocks are caused by changes in carbon stocks as a result of an increase or decrease in biomass (commercial storage of timber and traditional consumption of firewood).

According to the IPCC classification, Georgia is situated in a temperate climate zone in which seasonal changes in climate are well pronounced.

The territory of Georgia's forest fund equals 2.9 million ha, of which 2.7 million ha is covered by forests making up 40% of Georgia's total territory (6.97 million ha). The state economic forest fund occupies 2.4 million ha, of which 2.3 million ha is covered by forests. The annual increment of timber amounts to 4.6-4.8 million $m^{3,}$ and the annual average increment of timber per hectare equals 1.8 m^3. Total wood reserves amount to 451.7 million m^3.

The distribution of forests, which are massive over the territory of Georgia, is complex and full of contrast. More than 90% of forests are situated on mountain slopes (the greater and smaller Caucasus Mountains). A significant part (40%) of them occupy slopes with great steepness

(>35%) as a result of which the economic use of forests is very limited. Georgia is characterised by a variety of environmental conditions that promote the spread of different kinds of trees.

Detailed data on the distribution of forests by kind of trees (vegetation) doesn't exist. Hence, they are classified only as coniferous and deciduous.

The total absorption of CO_2 by forests was assessed by multiplying the areas occupied by coniferous and deciduous forests, by the IPCC 1996 default values of mean annual increment of biomass, and summarising the results obtained.

Calculations for 1998-2002 were made by applying the IPCC Tier 1 methodological approach, using default coefficients relevant to specific climatic zones in Georgia. For other years, the information was not available.

Calculations were performed for the areas occupied by forests having economic function. Therefore the data on areas covered by coniferous and deciduous forests were taken from Georgia's forest fund statistical yearbooks, compiled on the basis of inventories carried out in different years by the forestry department.

As for stored timber and forest fires data, these were taken from the balance reports compiled at the end of each year for the forestry department.

In 2000, the annual increment of biomass in Georgia's forests amounted to 1,392.6 Gg C, while as a result of commercial extraction and traditional consumption of firewood, 294.7 Gg C had been released (see Figure 2.82). Hence in 2000, the net absorption of carbon in Georgia's forests equalled 1,097.9 Gg C, or 4,025.5 Gg CO_2. Compared to the same value in 1990, (3,738.8 Gg CO_2) in 2000, the net absorption of CO_2 had increased by 286.7 Gg CO_2. Figure 2.83 demonstrates the trend of carbon net absorption change in Georgia's forests in 1990-2006.

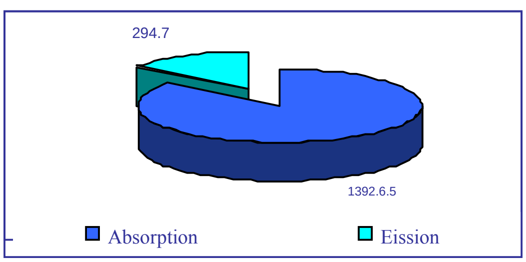

Figure 2.82. Carbon emission and absorption (Gg C) from Georgia's forests, 2000

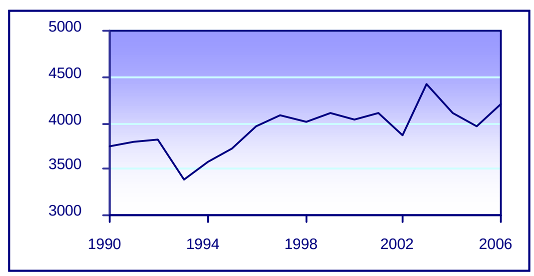

Figure 2.83. Trend of net carbon uptake by forests, 1990-2006.

Among other stocks of woody biomass, the areas covered by perennial crops (fruit orchards, tea plantation, etc.) were considered, for which the annual changes in carbon stock contained in green biomass were calculated.

In 2000, the net change in carbon stock contained in perennial green biomass crops amounted to -524.544 Gg CS, or 1,923.328 Gg CO_2 had been absorbed. Figure 2.84 shows amounts of carbon absorbed and emitted by the perennial crops.

In 2000, the net change in carbon stock in forests and other woody biomass in Georgia made up 1,640.4 Gg C, i.e. 6,014.9 Gg CO_2 had been absorbed from the atmosphere. Figure 2.85 shows the amount of absorbed and emitted carbon from Georgia's forests and other woody biomass stock.

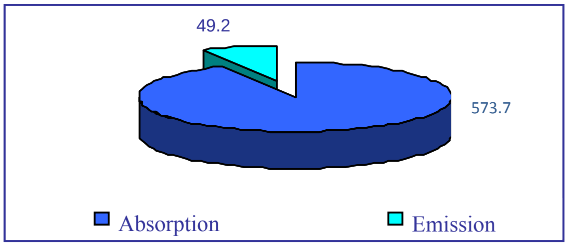

Figure 2.84. Carbon absorption and emission (Gg C) from perennial crops, 2000

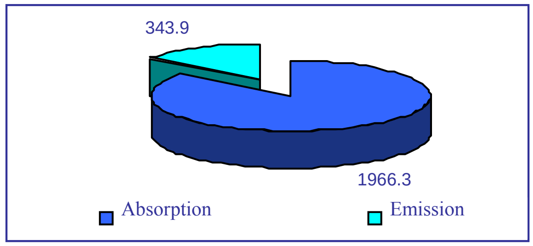

Figure 2.85. Carbon absorption and emission (Gg C) from forest and other woody biomass stocks, 2000

2.2.5.2. Forest and grassland conversion

The estimation of annual losses of biomass in Georgia in 2000 resulting from forest and grassland conversion to arable land proved to be impossible, due to the absence of relevant data. Meanwhile, as a result of a survey among experts in the Ministries of Environmental Protection and Natural Resources and Agriculture, as well as the Department of Statistics, it was revealed that there were no large-scale conversions of different categories of land into arable land during the examined period.

2.2.5.3. Abandonment of managed lands

The assessment of changes in carbon stocks resulting from the abandonment of cultivated arable land proved to be impossible, due to the absence of necessary data.

According to expert judgement, this change was not significant, as arable lands are mainly situated in plains, and as a rule at sufficient distance from forests. As a result, forest assault is not observed. Correspondingly, there was no sharp increase in biomass quantity. In separate cases, the abandoned lands had completely degraded and turned into barren land, without any above ground biomass growth.

2.2.5.4. CO_2 emissions and removals from soils

The emission and removal of CO_2 from the soil is connected with changes in the amount of organic carbon stockpiled into the soil. CO_2 is emitted by inorganic sources as well as by natural carbonate minerals or lime applied to the soil. Therefore, in this source category, changes in carbon stocks contained in mineral soils were examined, caused by changes in land use or changes in land cultivation. This process also incorporates CO_2 emissions from cultivated organic soils (e.g. from peaty soils) and CO_2 emissions as a result of soil liming.

In the National GHG Inventory, changes in carbon stocks in arable land, pastures and hayfields, and mineral soils, were examined for 1998-2002. For other years the information was not available.

The IPCC Tier 1 approach was used in the calculations.

The IPCC 1996 default values were used. Statistical yearbooks of the Department of Statistics were used as a source of information.

In 2000, carbon removal by pastures and hayfield soils amounted to 119.2 Gg C, while the emission from croplands made up 68.2 Gg C.

The conversion of organic lands (peaty soils) to agricultural soils was performed through artificial drying, cultivation and liming that resulted in the rapid oxidation of organic matter, and increased emissions of carbon into the atmosphere. For the last 10-12 years, data on the drying of organic soils in Georgia has not existed. According to experts' judgement, conversion of organic soils did not take place in this period of time.

The humid subtropical soils typical for Western Georgia are characterised by high acidity. Their liming has began in the 1960s. The last liming was undertaken in 1997 on an area of 300 ha. Data on the liming of soils for the subsequent period does not exist.

Hence the net uptake of carbon from mineral soils made up 51 Gg C. In Figure 2.86, the emission and removal of carbon from mineral soils (Gg C) is shown and in Figure 2.87 the trend of net carbon uptake from mineral soils is demonstrated for 1998-2002.

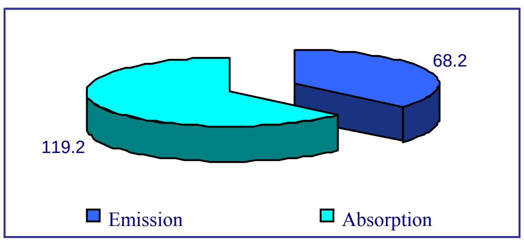

Figure 2.86. Emissions and removal of carbon (Gg C) from mineral soils, 2000

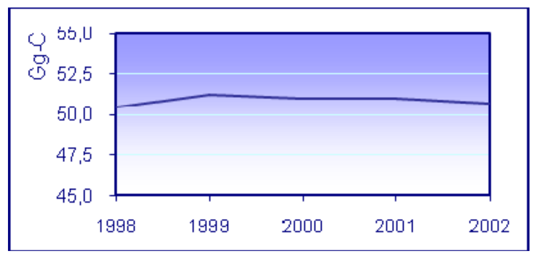

Figure 2.87. Trend of net carbon uptake from mineral soils, 1998-2002

2.2.6. Waste

In 2000, emissions of methane and nitrous oxide in Georgia amounted to 1,236.3 Gg CO_2-eq, making up 11.3% of total national emissions. The dominant gas in this sector was CH_4, the share of which in sectoral GHG emissions equalled 93%. Figure 2.89 gives the emissions of these two gases from the Waste sector, and their shares in sectoral emissions. From Figure 2.88, constructed on the basis of 1990 data, it can be seen that in 2000 emissions of CH_4 significantly decreased, relevant to 1990, which was caused by a reduction in the amount of industrial wastewater.

Figure 2.91 demonstrates trends of CH_4 and N_2O emissions from the Waste sector in 2000-2006. Emissions during this period did not vary significantly. Figure 2.90 shows the emissions of GHGs in 2006, almost repeating the 2000 picture.

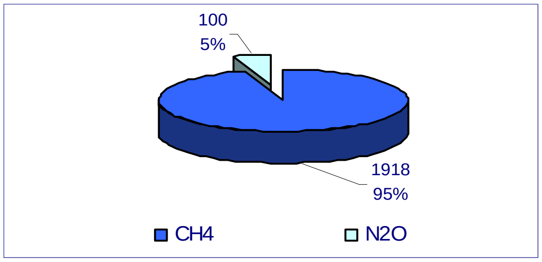

Figure 2.88. Emissions of GHGs (Gg CO_2-eq) from the Waste sector and their share in sectoral emissions, 1990

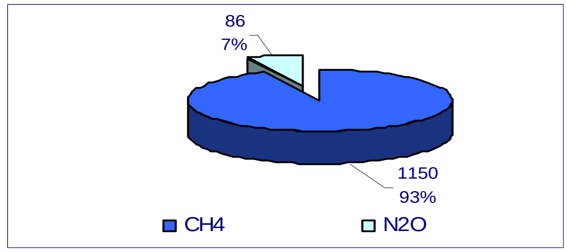

Figure 2.89. Emissions of GHGs (Gg CO_2-eq) from the Waste sector and their share in sectoral emissions, 2000

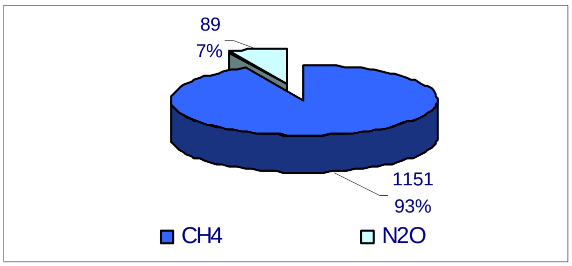

Figure 2.90. Emissions of GHGs (Gg CO_2-eq) from the Waste sector and their share in sectoral emissions, 2006

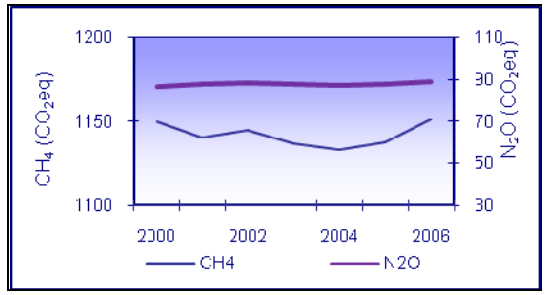

Figure 2.91. Trend of CH_4 and N_2O emissions (Gg CO_2-eq) from the Waste sector, 2000-2006

2.3 Uncertainty analysis

Uncertainty assessment of Georgia's GHG inventory relied on the quantitative Tier 1 method, and an uncertainty analysis recommended by the IPCC (GPG). GHG emissions uncertainties by source category, and aggregated uncertainties, were calculated based on uncertainties of the input variables (AD and EFs), and by using the error propagation rules for sums and products. Country-specific input uncertainties were determined via expert judgement, on the basis of the standard (IPCC guidance) uncertainty limits for the AD and EFs, or for parameters/variables in the formulae for them, with the further use of error propagation rules to calculate the uncertainty of the final variables. The uncertainties of GHG emissions at all levels of the Inventory (by source category/gas and the aggregated uncertainties) were reported in the recommended (Table 6.1 GPG) format of Tier 1 of the Uncertainty Calculation and Reporting Table (see Annex III).

The uncertainty assessment for each sector and source category was given in greater detail in the Georgia I National GHG Inventory Report (published only in Georgian).

2.4. National GHG Inventory strategy

An important element of Georgia's integration into the EU is the provision of GHG inventory system continuity. Aligning this goal with the preparation of a relevant legal basis, it became necessary to assemble and improve the national system of GHG inventory, which implies improvements in data compilation, processing and reporting. Different elements of the national inventory can be improved and strengthened within various national and international programmes. To provide sustainability and continuity of a national inventory process, a national inventory strategy needs to be worked out which must be approved by the government. This draft of the National GHG Inventory Strategy was prepared in the framework of Georgia's SNC.

The results of a regional project (RER/01/GE31), implemented earlier with UNDP and GEF support, are considered and accounted for in it.

2.4.1 Inventory process in Georgia

Georgia acceded to the UNFCCC in 1994, and got status as a non-Annex I Party with the economy in transition. Unlike Annex I countries to the Convention, Georgia as a non-Annex I Country is not committed to carry out and submit to the CoP an annual inventory of GHGs, and its inventory process is still fully related to the preparation of National Communications or implementation of other international programmes. The country has not yet adopted a national strategy on National GHG Inventory, and this second draft could be regarded as the next attempt in this direction. Three main projects considering the sustainability of National GHG Inventory, and improvement of its elements, have already been financially supported by the UNDP/GEF: Georgia's INC, under the UNFCCC (1997-1999), "Regional Project (12 countries) on Capacity Building for Improving the Quality of GHG Inventory", and Georgia's SNC to the UNFCCC (2006-2008). Apart from the above-mentioned projects, a more detailed inventory of GHG emissions has been conducted for some source-categories (cement and ammonia production, energy generation and distribution, etc.) under the preparation of CDM proposals.

The first inventory of GHG emissions in Georgia was carried out in 1997-1999, while preparing the INC, which was presented at COP 5 in 1999. The years 1980 to 1997 and all the main greenhouse gases (CO_2, CH_4, N_2O), were covered by this initial inventory.

The second national inventory in Georgia was conducted in 2006-2008, in the framework of Georgia's SNC. The 1990-2006 years, and all six GHGs (including industrial gases) were covered by the SNC. The main focus was on the years 2000-2006, and 2000 was selected as the base year.

2.4.2 Georgia's Second National Inventory

In the framework of Georgia's SNC, a second attempt was made to undertake a relatively more valuable inventory. Under the tender, an inventory Team Leader was selected and a responsible person appointed for the QA/QC procedures. For each sector (energy, transport, agriculture, industry, waste, forest and land use change, industrial gases) a responsible expert was appointed as well. A responsible person was selected to compile databases and to create the inventory archive. All in all, ten experts were engaged in the process, and USD 70,000 was spent on this 2000-2006 inventory.

As Georgia has not yet committed to carrying out annual inventories, which is a substantial undertaking, they are currently conducted by and large only on a periodic basis. Carrying out such an inventory depends predominantly on the preparation of a national communication to the UNFCCC, or on other projects which are supported financially from outside the country. For the efficient management of the GHG inventory process, the periodicity of its conduct and reporting should be determined by the law, and the entity responsible for carrying out the inventory should be clearly defined, along with its duties and its relationships with all parties participating in the inventory. At the same time, the maximum engagement of the state or non-governmental structures, which are responsible for statistics in the country, should be provided in this process of inventory. As to the third inventory, which should be carried out no later than 2010, its management process in the meantime should remain the same. The objective of this task is to obtain valuable information on the GHG status up to 2012, i.e. to the end of the Kyoto first commitment period.

In the SNC preparation process a basis has been created at the Ministry of Environment Protection and Natural Resources (Hydrometeorology and Climate Change Administration) to ensure carrying out of the GHG inventory with a certain periodicity using our country's own capabilities. Despite the fact that the results of these activities can not be perfect, they can provide a continuity of the inventory process.

2.4.3 Georgia's Second National Inventory Report

In Georgia's SNC, the 1990-2006 period was assessed. Computer databases created under the IPCC and UNFCCC were compiled and an archive of data sources set up. To avoid errors and improve the precision of the final results, the QA/QC procedure and certainty analyses have been conducted for all sectors. The first independent document on GHG inventory in Georgia has already been printed, in which the double checked and revised results prepared for the SNC were included.

In Georgia's second national inventory, all direct (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6) and indirect (CO, NO_x, NMVOC, SO_2) GHGs were considered, defined by the Convention (Decision 17/CP.7). These inventory results in the recommended established format are presented in Annex I to this document.

In Table 1, presented below, the amounts of direct GHG emissions in 2000 are presented. (In Georgia the share of industrial gases in total emissions is insignificant, and hence they are not included in this Table. For industrial gases see Annex I.

Table 2.4. Georgia's GHG emissions (Gg), 2000.

Module	CO_2	CH_4	N_2O	Total sectoral CO_2 eq	Share of modul in total emission (%)
1. Energy	3,177	128	0.21	5,930.1	54.1
2. Industrial procesess	528	0	1.53	1,002.3	9.1
4. Agriculture	0	74	4.03	2,803.3	25.5
6. Waste	0	55	0.28	1,241.8	11.3
Total	3,705	257	6.05		
GWP	1	21	310		
Total CO_2-eq direct GHG emission	3,705	5,397	1,875.5	**10,977.5**	
Share of GHG (%) in total emission	34	49	17		**100**
5. Forests	-4,025.5	0.066	0.0004	4,025.57	

Methodology. The IPCC 1996 revised guideline and the GPG (2003) were used as the principle guidelines in the process of the SNC inventory. For the Transport sector, the computer programme COPERT was applied in addition. For the Agriculture and solid Waste sector, a Tier

1 methodology was used within a framework in which national factors were estimated. However, 90% of the emissions factors used in the national inventory were still the IPCC default values adjusted to national conditions.

On the basis of the initial inventory results analysis using the key source categories selection method given in the GPG, key source categories were identified for which a number of new elements were required for the continuity and sustainability of the inventory process, all of which have been implemented. They are: The IPCC and UNFCCC software application, a documentation of the inventory process, the creation of an archive for initial data and applied methodologies, the compilation of national inventory guidelines (a provision of the inventory process sustainability), the implementation of QA/QC procedures (improvement of the management process), an uncertainty analysis, and an elaboration of the GHG inventory national strategy, on the basis of GPG.

In the first strategic document created for the inventory sector in Georgia, a short-term strategy was envisaged for the four year period 2006-2009. During the creation of the strategy, the financial and technological assistance potential existing at that time, or expected in the near future, was taken into account. In particular, three major sources of technical and financial assistance were considered: Regional projects aimed at the improvement of national inventories (2003-2006), Georgia's SNC to the UNFCCC (2006-2008) and preparation of project proposals in the framework of the CDM (2005-2012). In the process of SNC preparation, elements of existing short-term strategies were taken into account, and most if not almost all of them were implemented, except the provision of a relevant legislative basis. The improvement of an inventory management system should be considered a main success. To achieve this goal at the initial stage, the perfection of its separate elements in the framework of regional projects was undertaken. These elements were: elaboration of a national inventory strategy, the carrying out of QA/QC procedures, the preparation of a national guideline for the conduct of inventory, and the documentation of the inventory process. In the framework of regional projects, these strategic elements were implemented only for some major source categories. In the second national inventory all the above listed elements were adopted in all sectors.

2.4.4 Short-term strategy (2009-2012)

To improve the GHG inventory process, three main elements were considered in the strategy: the **provision of sustainability/continuity of the process,** which includes permanent updating of the guidelines, documenting of information/permanent updating of the archive and databases; **proper management**, implying constant renewal of appointments of responsible experts, the creation of a final report structure, the adoption of advanced methodologies, the promotion and the creation of a necessary legislative basis, the elaboration of short- and long-term strategic documents and **quality assurance** containing the QA/QC and uncertainty assessments, and the improvement of activity data and emission factors.

For the implementation of a national inventory short-term (2009-20012) strategy in Georgia, the following activities are planned:

- Regulation of national inventories frequency;
- Perfection of legislative basis: Determination of an inventory process sequence, the appointment of responsible entities, the improvement of data collection systems;
- Improvement of management;
- Constant renewal of a national expert base and training of experts;

- Rechecking of the second National GHG Inventory process by national experts and documentation of errors;
- In-depth reviews of the inventory process results at the regional and international levels;
- Specification of activity data and emission factors in the frame of concrete CDM projects;
- Making relevant corrections to the archive and databases.

The short-term strategy has been limited to 2009-2012 because in 2009, if a new agreement is adopted in Copenhagen (Denmark), countries could get new commitments which should be considered at the next stage.

2.4.5 Long-term strategy

The objective of the National GHG Inventory long-term strategy is the provision of national inventory process sustainability, and quality, as well as the implementation of legislation and procedures required by EU regulations. The time period for the implementation of a long-term strategy is approximately 10 years (2012-2025) or more, while the approximate period for the implementation of a short-term strategy is considered to be 2009-2012.

In the long-term strategy, a step-by-step perfection of the inventory process should be undertaken, the final goal of which is to carry out such a valuable inventory on an annual basis. To achieve this goal it is necessary to:

- Create of a valuable legislative basis;
- Perfect of a national system of data collection and improve statistics;
- Create a sustainable/ongoing system of national inventory to carry out an inventory on an annual basis (a permanent group, inventory database, distribution of obligations, financial support);
- Conduct a complete inventory for all sectors and source categories;
- Determination of national emission factors, or improvement of their accuracy;
- Application of possibly high-level methodologies for the key source categories;
- Annual publication of GHG inventory reports.

Georgia's National GHG Inventory Strategy

Key strategic objectives	Key target groups	Activity	Potential lead agencies	Output	Potential donors
Short-term objectives			• Ministry of Environment Protection and Natural Resources; Hydrometeorology and Climate Change Administration	The objective of the short-term strategy is the perfection of different elements and stages of the National GHG Inventory, removal of barriers to implementing the long-range strategy, elaboration of measures to provide the National GHG Inventory long-term sustainability. The short-term strategy is planed for a 4-year period (2009-2012) and implies the carrying out of a draft national inventory with local financial support (state budget).	Government of Georgia, Georgia's National Communication, CDM projects
1. Ongoing renewal and filling of experts (national and international) register	• Inventory experts; • Hydrometeorology and Climate Change Administration (MoE).	• Ongoing training of experts included in the national register; • Enabling the process of national experts training at the regional and international levels; • Preparation of new experts (minimum one expert in each sector) at relevant faculties of appropriate universities (Chemistry, Soil Science, Forestry, Energy). Introduction of academic courses on the inventory items; • Ongoing renewal of international and regional experts staff.	• Ministry of Environment Protection and Natural Resources, Hydrometeorology and Climate Change Administration.	• Staff of national experts is permanently available, renewed and expanded.	Government of Georgia, Third National Communication, CDM, UNFCCC Secretariat
2. Analyses and assessment of trends for key GHG sources (according to GPG)	• Inventory experts • Hydrometeorology and Climate Change Administration (MoE)	• The trend for each sector examined in the last inventory should be assessed according to the GPG and key	• National GHG Inventory Team Leader (Ministry of Environment Protection and Natural Resources).	• Key sources of GHG emissions in Georgia are identified and assessed.	Government of Georgia, Third National Communication,

		sectors are to be determined			
3.Improvement of the overall management of the inventory process	• Inventory experts; • Hydrometeorology and Climate Change Administration (MoE).	• Working out of the detailed plan (2009-2012) for carrying out the inventory; • Sharing of responsibilities, appointment of responsible persons and working out of annual individual work-plans; • Permanent updating of GHGs inventory manual (Georgian version); • Appointment of QA/QC responsible person and provision of this process implementation (minimum one sector annually) ; • Permanent updating of inventory work plan.	• Inventory Team Leader (Ministry of Environment Protection and Natural Resources); • Third National Communication Coordinator.	• The list of activities to be implemented annually in the framework of national inventory is assigned; • Responsible persons are appointed; • Duties of each inventory expert are formulated.	National Communication, Climate Change National Programme
4. Peer and expert review / revision	• National inventory team.	• The results of national inventory are sent to all stockholders for .comments and remarks; • The inventory results before publishing are sent to relevant international structures (e.g. NCSP) for comments; • All comments are rechecked correspondingly assessed and taken into account in the document.	• National inventory team; • Department of Statistics.	• Georgia’s national inventory is reviewed by stakeholders; • Final document of national communication is improved.	

5. Rechecking of Georgia's second national inventory and documenting of remarks (QA/QC)	• National inventory team.	• Appointment of responsible person for each sector; • Documenting of incoming and locally identified mistakes; • Insertion of relevant corrections in main document.	• Inventory Team Leader (Ministry of Environment Protection and Natural Resources); • Department of Statistics; • Initial data provider ministries.	• Rechecking of 2000-2006 inventory results and data in the framework of QA/QC procedure. The main source categories rechecked, are those which were not rechecked in the process of second national inventory.	Government of Georgia
6. Improvement of activity data and emissions factors for the priority sectors	• National inventory team.	• Identification of activity data and emissions factors the improvement of which is possible in the relevant time period; • Responsible person for the inventory process is to follow the IPCC guidelines and inform relevant experts; • Provision of maximum participation of private sector in the perfection of activity data; • Raising of public awareness in the science sector aiming at the improvement of emission factors.	• Inventory team; • Private sector engaged in CDM; • Relevant research institution.	• Activity data for key source categories are improved; • Emission factors for key source categories are improved .	Government of Georgia, Third National Communication, CDM
7. Improvement of data archiving and presentation system and permanent update of the archive	• National inventory team.	• Permanent update and improvement of archive according to the requirements of the latest developments; • Provision of electronic copies relevant to the addition of new information (in case of information update).	• Inventory Team Leader.	• The archive is permanently updated; • Back-up copies of electronic archive should be ensured; • Responsible person for the archive should be appointed with clear responsibilities identified in ToR. (within the SNC such person was Mr. R. Batonisashvili who at the same time has created the archive).	Government of Georgia, Third National Communication
8. Updating of the GHG inventory national manual	• National inventory team.	• Updating of the manual and addition of non-key sectors; • Publication of the manual.	• Inventory team.	• New sectors are included in the manual (industrial gases, solvents); • The Manual is systematically updated; • The Manual is published (only in case if special budget for publishing is received) .	Third National Communication

9. Implementation of the QA/QC procedure for the key sectors	• National inventory team.	• This procedure could be performed annually for the key sectors; • Under the State budget support only one sector could be controlled on quality annually.		• In the process of second national inventory a manual (section) and experts (4) were prepared to carry out QA/QC procedure.	
10. Improvement of legislation	• Ministry of Environment Protection and Natural Resources.	• Determination of the periodicity to carry out the inventory; • Identification of legislative gaps in the data collection system.	• Ministry of Environment Protection and Natural Resources, Hydrometeorology and Climate Change Administration; • Parliament of Georgia; • Different structures engaged in the inventory.	• Legislative gaps in data collection system are eradicated or lessened.	Ministry of Environment Protection and Natural Resources, Parliament of Georgia
11. National Inventory Report	• UNFCCC; • Government of Georgia ; • Ministry of Environment Protection and Natural Resources.	• Preparation of the Report; • Ensuring the stakeholder commenting process; • Publication of the Report.	• Ministry of Environment Protection and Natural Resources, Hydrometeorology and Climate Change Administration.	• The document of the annual national inventory is prepared; • The national inventory Report is published in the framework of national communications (or using other budget allocated to this purpose).	National Communications or other target programme
12. Elaboration of long-term strategy and its permanent updating	• Ministry of Environment Protection and Natural Resources.	• Identification of main elements for long-term strategy; • Preparation of long-term strategy.	• Ministry of Environment Protection and Natural Resources.	• GHG national inventory long-term strategy is updated.	Government of Georgia
Long-term strategy			• Ministry of Environment Protection and Natural Resources, Hydrometeorology and Climate Change Administration	The objective of the National GHG Inventory long-term strategy is the provision of the sustainability of the national inventory process and the implementation of regulations required under EU legislation. Time period for the implementation of long-term strategy is 10 years (2012-2025) and more	State budget, National Communications, other programme

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Chapter 3

Steps planned to implement the Convention

3.1. Strategy for climate-change related actions

Climate change was identified as a serious problem at the first world climate conference held in 1979. At this scientific forum the possible impacts of human activity on climate change were analysed. A declaration was adopted urging world governments to consider and avoid climate change.

The UNFCCC was signed along with other conventions in 1992 in Rio de Janeiro, Brazil, at the world summit on sustainable development. The primary objective of this convention is to achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

The Convention formulated some distinct guiding principles: the "Precautionary Principle" declares that lack of full scientific certainty should not be used as a reason for postponing such measures, as there is a risk of serous and irreversible damage. However, at present, after the publication of the IPCC Fourth Assessment Report it has become obvious that there is plenty of certainty and that processes are going at a much faster rate than was anticipated earlier. The "principle of common but differentiated responsibility" puts the leadership onus in tackling the consequences of climate change on developed countries, although it is implied that all countries to should contribute to this effort to the extent possible. Other principles concern specific needs of developing countries and their sustainable development.

The Convention entered into force on 24 March 1994. Georgia joined the Convention in 1994 as a non-Annex country. Since then Georgia has been actively involved in the process of implementing basic principles and obligations to the UNFCCC. In 1996 under the Presidential Decree the National Climate Change Programme was adopted. In the same year the National Climate Research Centre was established, on the basis of which the National Agency on Climate Change was later organised. At present the Climate Change Administration functions at the Ministry of Environment Protection and Natural Resources, co-ordinating the policy and processes taking place in this direction in the country.

In 1997-1999, under the financial support of the GEF, Georgia prepared its INC. Since 1999 a number of projects have been implemented in Georgia, in the framework of which various aspects of climate change were examined and various project proposals elaborated.

In 2006-2009, Georgia prepared its SNC to the UNFCCC. In the process of this activity the National GHG Inventory was undertaken, anticipated climate change scenarios were developed and the vulnerability of the different ecosystems and sectors of the economy to current and expected changes in climate was assessed. Adaptation projects were prepared, along with the planning of GHG abatement measures, and a number of activities in the field of public awareness were carried out.

This strategy on climate change is prepared on the basis of assessments and results obtained in the framework of the SNC and other projects going on or already being implemented in Georgia. It does not yet cover the whole territory of the country and is oriented predominantly towards the estimation of climate change impacts on the most vulnerable systems and extreme events (eroded soils, floods and landslides) and on the preparation of adaptation measures, as well as on the implementation of already prepared adaptation steps.

Chapter 7 of this document analyses barriers that are hampering the implementation of Convention principles in general, as well as the transfer of specific environmentally-friendly technologies, the integration of climate change issues into the plans and concepts of sectoral development, the preparation and implementation of adaptation measures for vulnerable sectors and systems, the development of renewable energy and energy-saving policy, and the development of local potential in general, etc. The climate change strategy presented below aims at the removal of these barriers.

Key strategic objective	Key target groups	Activities	Potential lead entity	Output	Potential donor parties
Short-term objectives • Consideration of the climate change risks in development plans and concepts; • Preparation and implementation of complete adaptation strategy.	• Government of Georgia; • Parliament of Georgia.		• Ministry of Environment Protection and Natural Resources.		Government of Georgia, International donors
Enhancement of local potential for the implementation of UNFCCC principles					
1. Recognition of climate change problem as one of the priorities by the government of Georgia	• Cabinet of Ministers; • MoE; • Ministry of Energy; • Ministry of Economic Development ; • Ministry of Agriculture; • Ministry of Health, Labour and Social Protection; • Ministry of Education and Science; • Ministry of Finance; • Ministry of Foreign Affairs; • Parliament of Georgia.	• Systematic assessment of climate change impact on Georgia's economy and separate ecosystems, preparation of reports for the government ; • Arrangement of information and consultation meetings with the participation of EU experts; • Ensure the representation of all relevant ministries in Georgian delegations participating in climate change international meetings; • Initiation and promotion of debates in the country on climate change issues.	• Cabinet of Ministers.	• Dealing with Climate Change problem is recognised by the Government of Georgia as one of its priorities; • Possible impact of climate change is considered in plans and concepts of sectoral development.	Government of Georgia MoE EU UNEP
2. Enhancement of capabilities and authorities of nationally responsible entity on the climate change activities	• MoE (Hydrometeorology and Climate Change Administration and the Department of Integrated Environmental Management).	• Participation in international meetings and workshops; • Invitation of international experts to discuss different items on climate change; • In situ training of staff members in the process of strategic planning and elaboration of conceptns.	• MoE (Hydrometeorolog y and Climate Change Administration).	• Capabilities and authorities of nationally designated operational entity to the UNFCCC and national focal points are enhanced; • Georgian delegation is fully engaged in negotiation process.	Government of Georgia UNFCCC International donors (UNDP, UNEP, WB) Different EU programmes (EuropeAid)
3. Local capacity-building in Georgia for the efficient implementation of UNFCCC principles and participation in global processes	• MoE ; • Ministry of Energy • Ministry of Economic Development ; • Ministry of Agriculture;	• Facilitation of the establishment of local potential in all climate-change related ministries; • Appointment of climate-change related responsible contact person having	• MoE (Hydrometeorolog y and Climate Change Administration).	•	Government of Georgia International donors (UNDP, UNEP, WB)

	• Ministry of Health, Labour and Social Protection; • Ministry of Education and Science.	clearly defined obligations in all relevant ministries; • Constantly informing responsible persons in relevant ministries on possible adverse impacts of climate change and providing recommendations to consider these items in the planning process.			Different EU programmes (EuropeAid) Bilateral donors
4. Improvement of legislative basis for the implementation of UNFCCC major obligations (GHG inventory, GHG mitigation, carrying out of adaptation measures) and the Kyoto Protocol mechanisms and its adjustment to EU legislative basis	• Parliament of Georgia; • MoE.	Preparation of recommendations to introduce amendments at the legislative basis necessary for : • Provision of annual inventory of GHGs; • Implementation of adaptation climate change measures; • Promotion to the adoption and use of renewable sources of energy; • Carrying out of energy saving policy; • Efficient introduction of CDM.	• Parliament of Georgia; • MoE.	Legislative basis existing in the country provides: • Annual undertaking of GHG inventory. • Preparation of adaptation measures and their implementation; • Mitigation of GHG emissions; • Efficient implementation of CDM. • Introduction of clean and adaptation technologies.	MoE (Europe Aid) Bilateral donors (Netherlands)
National GHG Inventory					
5. Periodic conduct of National GHG Inventory with local capacity (including financing). (Details see In Inventory strategy, Chapter 2)	• MoE ; • Department of Statistics • Ministry of Energy; • Private sector involved in CDM.	• Permanent renewal and extension of roster of experts (national and international); • Analyses and assessment of trends for key GHG sources; • Improvement of the overall management of the inventory process ; • Rechecking of Georgia's SNC national inventory report and documenting of findings (QA/QC); • Improvement of data archiving and presentation system and permanent updating of the archive; • Permanent updating of the GHG inventory strategy.	• MoE .	• GHG inventory is undertaken in the country on the periodic (annual) basis.	Government of Georgia
6. Development and improvement of separate elements of GHG inventory (QA/QC, uncertainty analysis, data collection system, national emission factors, etc) In the framework	• MoE ; • Department of Statistics • Ministry of Energy; • Private sector involved in CDM;	• Improvement of activity data and emissions factors for the priority sectors; • Updating of the GHG inventory national manual; • Implementation of the QA/QC procedure for the key sectors;	• MoE.	• Inventory annual reports are published; • Process is sustainable and reliability of inventory results increases from year to year.	Government of Georgia GEF/UNDP IPCC UNFCCC Europe Aid

of different target projects (see. Inventory strategy, Chapter 2)		• Preparation of national inventory report.			
Assessment of vulnerability to climate change and adaptation					
7.Creation of permanent monitoring system on climate change and its impact in protected territories of Dedoplistskaro region, on glaciers feeding large rivers (Tzanner, Koruldashi, Dollra, Kirtisho), in the Black Sea coastal zone (advisable the Sokhumi segment), in the Lentekhi region and in upper reaches of large rivers where the run-off is initially formed)	• National Environmental Agency.	• Introduction of permanent (or periodic) monitoring systems on the impact of climate change (glaciers, high mountain regions, arid zones, Black Sea coastal zone on the Rioni River); • Preparation of reports on current trends and anticipated hazards; • Assessment of climate related risks; • Preparation of recommendations on adaptation measures in order to avoid anticipated risks and hazards; • Providing relevant ministries with the required information.	• National Environmental Agency; • MoE; • Ministry of Energy • Ministry of Economic Development; • Ministry of Agriculture; • Ministry of Health, Labour and Social Protection; • Ministry of Culture, Monument Protection and Sport.	• Permanent monitoring of natural ecosystems is carried on; • Reports are systematically prepared on the revealed impact of climate change on different ecosystems; • Anticipated risks are assessed and recommendations are prepared to avoid the hazards; • Government of Georgia is informed on current process.	WMO UNEP Government of Georgia
8.Enabling adaptation to climate change activity in the country (creation of relevant responsible entity, legislative basis, project proposals and investment environment)	• Government of Georgia; • Local administrations of vulnerable regions; • Farmers; • Local population and business representatives.	• Creation of responsible on adaptation to climate change entity; • Preparation of legislative basis facilitating the implementation of adaptation measures; • Enabling the permanent updating of climate change adaptation strategy.	• Government of Georgia; • MoE.	• National entity responsible for carrying out of adaptation measures is set up; • Legislative basis facilitating the implementation of adaptation measures is created; • Adaptation strategy is systematically reviewed and updated.	GEF/UNDP Government of Georgia EU
9.Assessment of possible impact of climate change on Georgia's water resources (Mtkvari, Rioni, Enguri, Aragvi and other large rivers, lakes and glaciers)	• MoE (Water Resources Management Administration); • MoE (Hydrometeorology and Climate Change); • National Environmental Agency; • Institutes of Hydrometeorology and Geography.	• Assessment of anticipated impact of climate change on the water resources using WEAP model; • Preparation of recommendations for the proper management of particularly vulnerable rivers (floods, water deficit).	• MoE (Water Resources Management Administration).	• The impact of climate change on Georgia's water resources is assessed; • Adaptation measures are prepared for the most vulnerable rivers (proper management, avoiding flood risks and water deficit).	Georgia's Third National Communication Transboundary rivers programmes; Regional project on climate change; Water Convention
10.Assessment of possible impact of climate change and	• Ministry of Health, Labour and Social Protection;	• Assessment of heat wave trend in Georgia's large cities and tourist	• Ministry of Health, Labour and Social	• The trend of heat wave recurrence is assessed for large	UNEP WHO

in particular heat waves on the Health and Tourism sectors	• MoE; • Department of Tourism.	regions; • Assessment of needs and technical capabilities for the creation of Early Warning System; • preparation of portfolio of recommendations to protect especially vulnerable categories of population (elderly, young children); • Continuation of observations on epidemiological diseases (malaria, leishmaniasis); • Preparation of recommendations in case of rising trend of epidemiological diseases.	Protection; • MoE.	cities and tourist regions; • In case of rising trend in heat wave recurrence recommendations are prepared for the most vulnerable categories of population; • In case of rising trend in epidemiological diseases (malaria, leishmaniasis) relevant recommendations are prepared; • Recommendations are systematically communicated to population.	Government of Georgia
11. Drawing of investments and facilitating the implementation of adaptation measures in Dedoplistskaro region. Financing of adaptation projects is already initiated (see climate change adaptation strategy in Dedoplistskaro region)	• Local administration; • Government of Georgia; • Farmers; • Protected territories local. Administration	• Permanent monitoring of adverse; impacts of climate change; • Rehabilitation of wind-breakers; • Establishing of energy forests; • Rehabilitation of eroded soil; • Mobilisation of farmers associations; • Facilitation of proper management of pastures ; • Creation of efficient scheme of irrigation systems and their rehabilitation.	• Local administration; • Population.	• Wind breaker are rehabilitated; • Pilot energy groves are planned; • Package of measures to rehabilitate the degraded lands is prepared; • Farmers associations are created and mobilised; • Proper management of pastures is introduced; • Irrigation systems are rehabilitated primarily at the high risk sections.	Government of Georgia GTZ, Government of Germany Government of Italy; Local administration Farmers
12. Assessment of possible impact of climate change on arid regions that was not included in the SNC and preparation of recommendations on adaptation measures (Kvemo Kartli, Gare Kakheti).	• MoE; • Relevant NGOs; • Research Institutes; • Local administrations; • Farmers; • Population.	• Assessment of arid regions which could be particularly vulnerable to climate change; • Preparation of adaptation measures portfolio and concrete project proposals; • Preparation of adaptation strategy for vulnerable regions and ecosystems; • Attraction of local and international donors to implement adaptation measures; • Creation of local potential to plan and implement adaptation measures.	• Local administrations; • Farmers; • Government of Georgia.	• Vulnerability of all arid regions in Georgia affected by climate change is assessed; • For the most vulnerable regions adaptation measures portfolio and strategy are prepared; • *In situ* the potential is created to implement the adaptation measures.	Georgia's Third National Communication GEF GTZ
13.Attraction of investments and promotion of the implementation of adaptation measures in Lentekhi region (see Adaptation to climate change strategy in the	• Government of Georgia; • Local administrations (Municipality); • Population; • NGOs.	• Creation in the region of landslide Monitoring and Early Warning System; • Creation of river floods Monitoring and Early Warning System; • Establishment of population	• Local administrations; • Population; • NGOs.	• Landslides monitoring service is established locally; • Population in landslide endangered areas are constantly informed on potential risks and	CDM adaptation fund Local administrations

Lentekhi region)		(households) awareness raising (informing) system and trainings on prevention measures; • Implementation of pilot projects to avoid landslides (e.g. arrangement of small hazelnut plantations); • Rehabilitation and proper management of most damaged forest areas; • Restoration of landslides protection function of forest in places not affected earlier by landslides and planning of new plots; • Accurate inventory of climate induced landslides and preparation of recommendation measures.		measures, that could be taken by themselves to avoid the danger; • Pilot projects on planting hazelnut, as a soil fixing plant, are implemented; • Rehabilitation/restoration of most damaged forest plots is systematically carried out;	
14.Assessment of possible impact of climate change on Georgia's high mountain regions that was not included in the SNC and preparation of recommendations on adaptation measures (Zemo Svaneti, Adjara mountains)	• MoE. • Relevant NGOs. • Research Institute. • Local administration. • Population.	• Assessment of climate change risk in high mountain regions; • Preparation of adaptation measures portfolio and concrete project proposals; • Preparation of vulnerable region or ecosystem adaptation strategy; • Attraction of local and international donors to implement adaptation measures; • Creation of local potential to plan and implement adaptation measures.	• Local administration; • Government of Georgia.	• Risks related to climate change are revealed in high mountain zone; • Adaptation strategy is developed for each vulnerable region; • Local potential is created to plan and implement the adaptation measures.	Georgia's Third National Communication GEF Government of Georgia
15. Promoting the implementation of adaptation strategy for the Black Sea coastal zone (see Adaptation to climate change strategy for Georgia's Black Sea coastal zone, Chapter 4.2.1.)	• National Environmental Agency; • Coastal protection service; • Local administrations of Poti and Batumi; • Kolkheti protected area Administration.	• Systematically informing local administration on ongoing processes and their economic outcomes; • Creation of monitoring and early warning system in the Rioni Delta (Black Sea level rise and storm intensity increase); • Setting up of permanent Steering Committee for planning and implementation of adaptation to climate change measures; • Implementing sea coast protection measures in the Rioni Delta; • Implementing sea coast protection measures at the Adlia-Batumi section to protect the Batumi coastal zone; • Preparation and implementation of adaptation measures for the Paliastomi	• Coastal protection service; • Kolkheti protected area administration.	• Local administration is permanently informed of climate change processes and their possible impacts; • The sea level rise and storm intensity monitoring system is created, including an early warning system to inform the population and relevant bodies in case of disastrous events; • Systematic coast protection measures are carried out in Rioni Delta; • A portfolio of adaptation measures is prepared for the Lake Paliastomi; • The possible impact of anticipated climate change is	GEF Government of Georgia Government of Netherlands CDM Adaptation funds

		Lake; • Assessment of climate change impact on tourism development (heat waves, water temperature, beach degradation) and preparation of adaptation measures; • Consideration for anticipated climate change impact in the local infrastructure development process.		considered in the infrastructure planning and development in Rioni Delta.	
Mitigation of GHG emissions					
16.Promoting maximum activation of CDM in Georgia (see Energy sector development strategy, Chapter 5.2)	• MoE; • Ministry of Energy; • Ministry of Finance; • Private sector.	• Selection of sectors providing maximum efficiency in programmatic and sectoral approach (wind, biomass, solar energy, energy efficiency in residential sector, waste, forests); • Promoting private sector activation (especially banking sector) in CDM; • Improvement of CDM promoting legislative basis.	• MoE (DNA).	• Projects prepared in the framework of CDM are implemented; • New projects are prepared.	Netherlands, Austria, German, Italy, Japan, Belgium, Denmark, UNDP, EBRD
17. Identification of renewable energy share in electricity generation which could be achieved by Georgia to 2020-2025 (see Energy sector development strategy, Chapter 5.1.) and promotion to investment attraction for the achievement of this share	• MoE; • Ministry of Energy; • Private sector engaged in renewable energy; • Large energy consumers.	• Enhancement of activities with potential foreign investors and local private sector to implement existing investment projects in renewable energy; • Assessment of regional market (Azerbaijan, Armenia, Turkey) development possibility for power sector.	• Ministry of Energy; • MoE.	• The share of renewable energy, which could be achieved by Georgia in power generation, is assessed; • Relevant project proposals are prepared and implemented.	Renewable energy revolving fund (Georgia), Austria, Norway, Turkey
18.Determination of renewable energy share in heat generation / heat consumption, which could be achieved by Georgia to 2020-2025 and preparation of corresponding project proposals	• MoE; • Ministry of Energy; • Private sector engaged in renewable energy; • NGOs.	• Assessment of renewable heat energy share (solar, geothermal, biogas, biomass) which could be archived to 2020-2025; • Updating of existing project proposal base and preparation of new investment projects; • Continuation of activities with potential investors (especially on the basis of programmatic approach).	• MoE; • Local administration of regions;	• The share of renewable energy that could be generated by Georgia is assessed; • Relevant project proposals are prepared and implemented.	Programmatic CDM
19.Determination of energy efficiency targets for energy (power and heat) consumption	• Cabinet of Ministers; • Ministry of Energy; • Energy Efficiency	• Preparation of energy saving programmes; • Preparation of recommendations on	• Energy Efficiency Centre; • Private sector.	• Excess consumption of energy in different sectors (residential, industry, etc.) is estimated;	Programmatic CDM

sector which could be achieved by Georgia to 2020-2025 and preparation of targeted project proposals	Centre; • NGOs; • Private sector; • Residential sector.	energy saving measures; • Preparation of recommendations on incentives for energy saving process; • Informing public of the economic efficiency of energy saving; • Preparation of specific project proposals (including programmatic approach) and attraction of investments.		• Economic efficiency of various energy saving measures is assessed; • Project proposals on energy efficiency are prepared.	
20. Strengthening (with relevant legislation and incentives) of renewable energy fund and creation of energy efficiency revolving fund	• Government of Georgia; • Banking sector.	• Preparation of recommendations to strengthen the revolving fund and to provide its efficient operation.	• Government of Georgia; • Banking sector.	• The Renewable Energy and Energy Efficiency Revolving Fund is enhanced and effectively finances relevant projects.	Additional finance should be attracted from international funds and government of Georgia
21. Studying the local capacity for development of biomass (energy forests and other biomass) sector Assessment of its role in providing Georgia's energy system independence. Determination of the possible share of biomass in heat supply to 2020-2025	• MoE. • Ministry of Energy. • Cabinet of Minister. • Local administrations. • NGOs.	• Attraction of investments to implement pilot project on biomass energy forest (Dedoplistskaro region); • Preparation of new project proposals on effective utilization of biomass energy (including wood) in heat generation; • Assessment of actual potential of this resource in Georgia.	• MoE.	• Georgia's energy forest and other biomass potential is assessed; • Biomass development strategy is worked out.	GTZ, Government of Italy, Local municipalities (Zugdidi, Dedoplistskaro)
22.Assessment of GHG mitigation potential in road transport sector	• MoE; • Ministry of Economic Development; • Municipalities of large cities.	• Preparation of project proposals (optimisation of traffic network in large cities, increase of the share of motor park on liquefied gas providing corresponding safety measures) to reduce GHG emissions from transport sector; • Attraction of investments to implement pilot projects	• Ministry of Economic Development (Transport Department); • Municipalities of large cities.	• GHG mitigation strategy for transportation sector is prepared; • Pilot projects on the GHG emissions abatement from the transportation sector are prepared and implemented	CDM, GEF, Municipalities of urban areas
Clean and adaptation technologies development and transfer					
23.Promoting (by removing barriers) the development of indigenous technologies and transfer of innovative foreign technologies and their adoption aimed at the mitigation of GHGs and adaptation measures as well	• Government of Georgia; • MoE; • Ministry of Economic Development; • Ministry of Energy; • Private sector; • Research institutes;	• Assessment of country's needs in mitigation and adaptation technologies. • Identification of barriers hampering the transfer of new technologies and recommendation of ways to remove these barriers; • Establishment of indigenous technologies database related to climate change and attraction of funds for their development.	• Government of Georgia; • Private sector; • MoE.	• More projects are implemented adopting up-to-date environmentally friendly technologies; • Indigenous technologies are being developed commercialized.	Government of Georgia, CDM, WB, GEF, Local private sector

	• NGOs.				
Public Awareness					
24.Education, training and raising public awareness (see education training and public awareness strategy, Chapter 6.2)	• Public school and high school students; • Teachers and lectors; • Professionals, managers, other stakeholders; • Policy makers; • Experts; • Mass-media; • Farmers; • Businessmen; • NGOs.	• Integration of climate-change related topics into education programmes; • Training of scientific, technical and managerial personnel to ensure the implementation of UNFCCC Article 6; • Enhancement of participation of different target groups and stakeholders in climate-change related processes; • Promotion and support the preparation and dissemination of information on climate change issues targeted to the public awareness (preparation, printing and dissemination); • Enhancement of policy-makers awareness of the possible results of climate change.	• MoE; • Ministry of Education and Science; • NGOs.	• National roster of experts in all sectors is continuously updating; • In schools and at the relevant faculties (Chemistry, Biology, Geography, Modelling, etc.) of universities the climate change phenomenon and its implications are studied; • Policy makers are systematically informed of latest results.	UNFCCC UNEP UNDP EuropeAid Government of Georgia Bilateral donors (Netherlands, Germany, Austria, Norway)
Long-term strategy (after 2020) • Transfer of Georgia's economy to the sustainable development principles; • Working out and implementation of the National Plan on the possible mitigation of GHGs.			• MoE.		GoG, International donors

Chapter 4

Measures to facilitate adequate adaptation to climate change

4.1. Vulnerability assessments

This section of NC considers ongoing and future climate change in the territory of Georgia and assesses the vulnerability of three priority regions selected during the stocktaking exercise. These regions are the Black Sea coastal zone, Dedoplistskaro (East Georgia) and Kvemo Svaneti (mountainous region).

4.1.1 Assessment of climate change

To investigate the climate change process in Georgia, a survey of climate parameters trends was undertaken for the whole territory and for the priority regions in particular. Changes in air temperature and precipitation were examined, in line with the requirements of various tasks, and other climate elements were assessed as well. These assessments were carried out in two stages: (1) assessment of current changes in climate on the basis of existing statistical data and (2) their long-range forecast for different terms of anticipated change in global socio-economic development.

Assessing current change in climate elements. Current changes in climate in Georgia, and in priority regions in particular, were assessed mainly by statistical methods. Mean air temperature and temperature extremes, precipitation, relative humidity, wetting/moistening regimes and wind were investigated, as well as trends of extreme events (high winds, drought, landslides, floods, etc.), characteristic of each of the examined regions. These trends are discussed in more detail in the respective vulnerability assessments of separate regions.

In the first stage the trends of change in mean annual air temperature, mean annual sums of precipitation, and in the moistening regime, were estimated between the two periods of time: 1955–1970 and 1990-2005. To describe the wetting regime along with the sums of precipitation, the complex index widely used in agriculture meteorology – the hydrothermal coefficient (HTC)[1] was used. The validated database for 1955-2006 meteorological observations was provided by the Georgian Environment Agency, being the responsible body for the observational network in Georgia. This statistical analysis revealed increasing trends in both mean annual air temperature and annual sums of precipitation from the first (1955-1970) to the second (1990-2005) period of time in all three priority regions, accompanied by a decrease in HTC in the Dedoplistskaro region, and its increase in the other two priority regions. At the same time, the changes in air temperature absolute minima and absolute maxima were examined. The analysis indicates a warming trend in these regions both in winter and summer seasons. The obtained results are summarised in Table 4.1.1.1.

Table 4.1.1.1. Change of climatic elements in priority regions, 1955-2005

Priority region (meteorological station)	Average values of mean annual air temperature for respective periods (^{0}C)			Average values of annual sums of precipitation by period (mm)				Average value of air temperature absolute minima (^{0}C)			Average value of air temperature absolute maxima (^{0}C)			HTC
	I	II	II - I	I	II	II - I	II-I (%)	I	II	II-I	I	II	II-I (%)	II-I (%)
The Black Sea coastal zone (Poti)	14.4	14.6	0.2	1837	2078	241	13	-13.0	-10.0	3.0	33.8	35.4	1.6	+0.6 (20%)
Kvemo Svaneti Lentekhi)	9.6	10.0	0.4	1256	1360	104	8	-14.5	-13.8	0.7	34.7	35.2	0.5	+0.6 (28%)
Dedoplistskaro region (Dedoplistskaro)	10.6	11.2	0.6	586	622	36	6	-11.5	-11.5	0.0	32.7	34.8	2.1	-0.2 (-15%)

Designation of periods: I – (1955-1970); II – (1990-2005).

At the same time, the rates of air temperature and precipitation change in priority regions were assessed considering four time intervals of different duration (1906-2005; 1966-2005; 1985-2005 and 1995-2005). This survey demonstrated an exceptionally steep rise in annual air temperature in all three priority regions over the last 20 years.

It is of great interest to compare the trends of the climate parameters discussed above between priority regions and the entire territory of Georgia (according to average statistical values of weather stations in Western and Eastern Georgia separately). The relevant data is presented in Table 4.1.1.2.

Table 4.1.1.2. Change in air temperature and precipitation between climate norms until 1960 and average values of the 1957-2006 period

Climate region	Mean air temperature (^{0}C)	Average maximum temperature (^{0}C)	Average minimum temperature (^{0}C)	Annual sums of precipitation (mm)
Western Georgia	0.2	0.3	0.6	-27
Eastern Georgia	0.3	0.7	0.3	41

This table shows that annual precipitation trends in the Western and Eastern parts of Georgia differ from each other and do not coincide with the results obtained for local conditions of selected regions. For example, the annual sums of precipitation show a decreasing trend in Western Georgia (average value), while locally in Poti (the Black Sea coast) and Lentekhi (mountain zone), until the present time, a small increase is still being observed.

Assessment of anticipated changes in climate parameters. To forecast the possible changes of climate elements in the future, two tools for climate change prediction were used: the Regional Climate Model PRECIS (with a resolution of 25 km x 25 km) and the statistical software MAGICC/SCENGEN (with a resolution of 600 km x 600 km).

Results obtained under the PRECIS model

Methodology. In the framework of the SNC preparation guidelines, various options of the PRECIS model [2] were used by different countries (Azerbaijan, Georgia, Armenia) for diverse scenarios of global socio-economic development, including two GCMs (HadAM3P and ECHAM 4). This process was arranged and directed online by the Hadley Centre, by whom this software was created and which along with the training of experts, transferred this software *gratis* to these countries. The Hadley Centre also defined in advance the area of model validity and boundary conditions. Two runs were implemented by Georgia for the B2 scenario of global socio-economic development: boundary conditions using the ERA40 database to process the data for the past (1961-1990), and the EHAM4 global model. For the A2 scenario, Azerbaijan ran three versions of the ECHAM4 model: 1961-1990 (baseline period which is used to correct future forecasts), 2020-2050, and 2070-2100. With the Hadley Centre, Armenia ran two versions of the HadAM3P global model for the past period of 1961-1990, and for the future 2070-2100 periods, and also for the A2 scenario of global socio-economic development. The Hadley Centre and Azerbaijani colleagues transferred to Georgia the results of the above mentioned runs. Finally, as the correction of ECHAM4 results run by the B2 scenario could not be corrected by the results of the ERA run for the past in Georgia, the results obtained under HadAM3P and ECHAM4 were mainly forecast for the A2 scenario*.

***Evaluated parameters*.** Despite the fact that the PRECIS model incorporates about 180 different parameters, the air temperature and precipitation were mainly assessed for the projection of climate change. However, in case of concrete models (WEAP, CropWat), other parameters (wind velocity, solar radiation, humidity, etc.) were used as well.

Obtained results. As mentioned above, the climate parameters of the baseline period (1961-1990) were assessed for three different boundary conditions: ERA40 (Georgia), HadAM3P (Armenia) and ECHAM4 (Azerbaijan), and the obtained results were validated by comparing to actual observations (CRU). The differences were used to correct the forecast. Data on the mean annual temperature and precipitation obtained under actual observations and calculations, using the PRECIS model for all three boundary conditions, are presented in Figures 4.1.1.1 and 4.1.1.2.

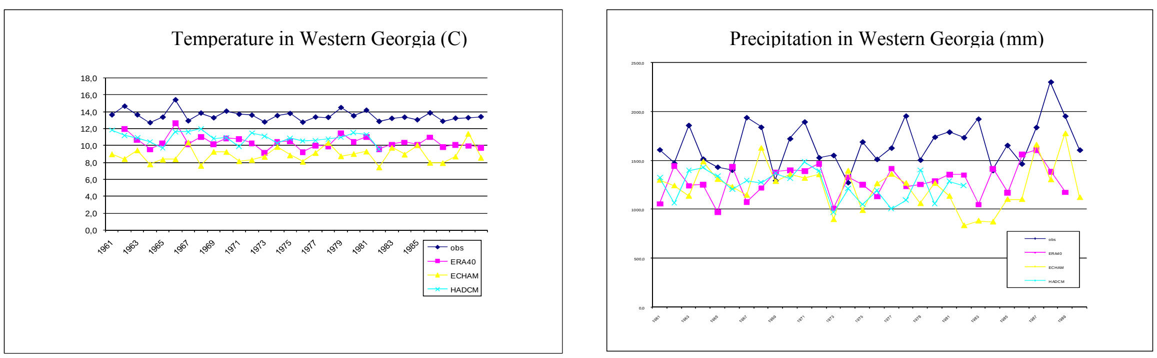


Figure 4.1.1.1. Calculated by PRECIS and actually-observed climate parameters for Western Georgia

* From the standpoint of emissions concentration the A2 family of global socio-economic development scenarios represent the most pessimistic option. According to this scenario, population is permanently growing and the rate of economic development is relatively low and depends on regional interests and trends.

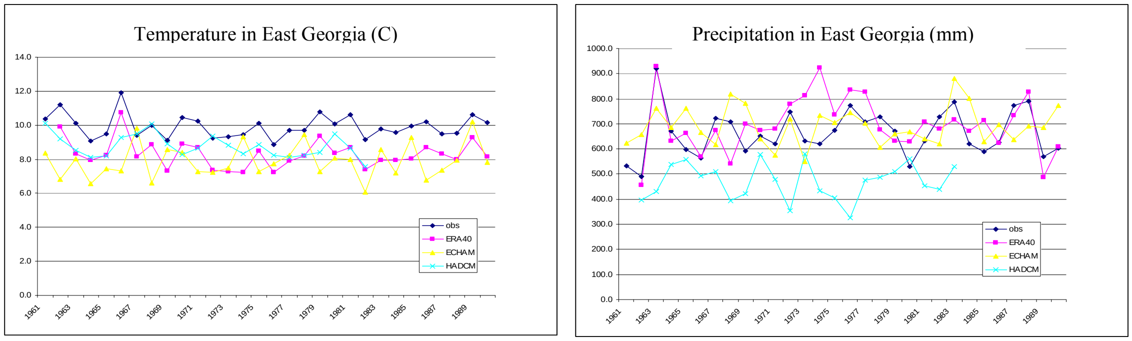


Figure 4.1.1.2. Calculated by PRECIS and actually-observed climate parameters for Eastern Georgia

As can be seen in Figure 4.1.1.1, both the temperature and precipitation, calculated with all three boundary conditions for Western Georgia, are smaller compared to real observations. This comparison was carried out according to season for the separate meteorological stations, and it reveals that for the majority of stations, the values calculated by the model are in sufficiently good agreement with the observations, though there are some exceptions where the difference is marked. For example, for the Lentekhi station, divergence in temperature goes up to 7^0C, and as for precipitation, the most obvious discrepancy was revealed in the Black Sea coastal zone, where the values of precipitation calculated by the PRECIS model are much smaller than the observed data. In particular, the calculated sums of precipitation in Poti are about half, and in Batumi they are 2.5 times smaller, than observed data.

In Eastern Georgia (Fig. 4.1.1.2) the trend in air temperature is the same as in the Western part of the country, and the actual observed data exceeded the simulated data obtained from PRECIS results for different boundary conditions. However, this discrepancy is not observed in the precipitation results.

The climate parameters (temperature and precipitation) were assessed to 2100 using both global climate models HadAM3P and ECHAM4 (A2 scenario) both for the entire territory of Georgia (Western and Eastern part separately) and for the priority regions. The trends of each parameter are evaluated according to seasons.

The assessed forecasts of climate change under the HadAM3P model (A2 scenario) for Western and Eastern parts of Georgia are given in Table 4.1.1.3.

Table 4.1.1.3. Change in air temperature and precipitation to 2100 in Western and Eastern Georgia (HadAM3P)

Region	**Season**	**Spring**		**Summer**		**Autumn**		**Winter**		**Annual**	
	Climate element	ΔT ^{0}C	ΔQ mm	ΔT ^{0}C	ΔQ mm	ΔT ^{0}C	ΔQ mm	ΔT ^{0}C	ΔQ mm	ΔT ^{0}C	ΔQ mm
Western Georgia	Baseline period	9.1	372	19.3	463	10.5	566	-0.6	573	10.9	1554
	Anticipated change Δ	-1.0	50	4.0	-175	2	-50	2.0	100	1.8	-30
	2100	8.1	422	23.3	288	12.5	516	1.4	673	12.7	1524
Eastern Georgia	Baseline climate period	10.9	200	20.1	224	13.1	144	3.4	98	13.3	664
	Anticipated Change Δ	2.5	-50	6.5	-125	2.5	-100	2.5	-50	3.5	-70
	2100	13.4	150	26.6	99	15.6	44	5.9	48	16.8	594

The assessed forecast of climate change under the ECHAM4 model (A2 scenario) for Western and Eastern parts of Georgia are given in Table 4.1.1.4.

Table 4.1.1.4. Change in air temperature and precipitation to 2100 in Western and Eastern Georgia (ECHAM4)

Region	**Season**	**Spring**		**Summer**		**Autumn**		**Winter**		**Annual**	
	Climate element	T ^{0}C	Q mm	T ^{0}C	Q mm	T ^{0}C	Q mm	T ^{0}C	Q mm	T ^{0}C	Q mm
Western Georgia	Baseline period	9.1	372	19.3	463	10.5	566	-0.6	573	10.9	1554
	Anticipated change Δ	3.5	-9	5.0	-54	4.0	-9	4.5	108	3.4	36
	2100	12.6	363	24.3	409	14.5	557	3.9	681	14.3	1590
Eastern Georgia	Baseline period	10.9	200	20.1	224	13.1	144	3.4	98	13.3	664
	Anticipated change Δ	4.2	-72	6.0	0	4.0	45	5.0	-45	3.9	-72
	2100	15.1	128	26.1	224	17.1	189	8.4	53	17.2	592

In Tables 4.1.1.3 and 4.1.1.4 the averaged data of Georgia's meteorological network are used as an initial material for the baseline period. Selected stations (9 in West Georgia and 11 in East Georgia) are evenly distributed at the territory of Georgia and they reflect its climate features.

Results obtained under the MAGICC/SCENGEN models

To forecast the anticipated values of climate parameters in the future, besides the PRECIS model, the MAGICC/SCENGEN software was also used which actually unites two models – MAGICC and SCENGEN, the combination of which provides for the projection of climate elements (temperature and precipitation) on the regional scale [3]. The MAGICC model enables the extraction of global climate data for different socio-economic scenarios, and the SCENGEN applies these data and downscale them to the regional level. At the regional scale, the model predicts the change in mean annual, seasonal and monthly values of temperature and precipitation for any selected period of time (up to 2100).

Methodology. For the creation of future climate change scenarios in the territory of Georgia, values were assessed for the baseline period (1961-1990), calculated using all 17 global models, which were then compared to the observation database CRU (averaged on the 60km x 60km grid). The deviation of examined models from the CRU is given in Annex IV. On the basis of this Table, the best (most reliable) models have been selected for each season and for each parameter for the Western and Eastern parts of Georgia, separately. Among these models are global models HadAM3P and ECHAM4 used in PRECIS. As the SCENGEN, owing to its low resolution, produces only two grids for Georgia, with co-ordinates 40.0-45.0^{0}N and 40.0-45.0^{0}E (Western Georgia), and 40.0-45.0^{0}N and 45.0-50.0^{0}E (Eastern Georgia), relevant future scenarios were assessed for those territories differing in climate. The observational database (CRU) of the MAGICC/SCENGEN was used as baseline data. In Table 4.1.1.5 the models selected from Annex IV are presented for West and East Georgia which most precisely describe the regional season and climate parameters.

Table 4.1.1.5. Models which most precisely describe climate parameters in Western and Eastern Georgia*

Region	Spring		Summer		Autumn		Winter		Annual	
	ΔT ^{0}C	ΔQ %	ΔT ^{0}C	ΔQ %	ΔT ^{0}C	ΔQ %	ΔT ^{0}C	ΔQ %	ΔT ^{0}C	ΔQ %
Western Georgia	BMRC98	IAP_97	GISS95	CSI296	HAD300	IAP_97	LMD_98	CCCL99	GFDL90	HAD300
	0	0.5	0	-10.4	-0.2	-0.8	-0.1	2	0.2	1.7
Eastern Georgia	CSM_98	BMRC98	CSM_98	GISS95	CSM_98	MRI_96	ECH498	CSI296	CSM_98	HAD300
	0.3	0.5	0.1	7	0.4	4	-0.1	16.7	0.5	13.7

As can be seen from this table, the annual averages of precipitation in both parts of Georgia are most precisely described by the HAD300 global model. The same result was obtained by PRECIS. As to the temperature, the most precise models give different results for West and East Georgia. The deviation given by the models compared to actual data all over the territory of Georgia, both in Western and Eastern parts, are highest for East Georgia. It can be concluded that the selection of reference models from the examined 17 global models appears to be more complicated for Eastern Georgia.

Figures 4.1.1.3 and 4.1.1.4 demonstrate the calculated and observed (CRU) values of temperature and precipitation. It can be seen from these figures that for the summer season, the simulated precipitation was less than observed, even in the best models, especially for Western Georgia. In all other seasons, and for the annual mean, the modelled values exceeded observed values, or were very close to them. Different deflections, according to seasons and models, did not affect the annual deviation, by direct summing, as the best models regarding seasonal and annual parameters are different.

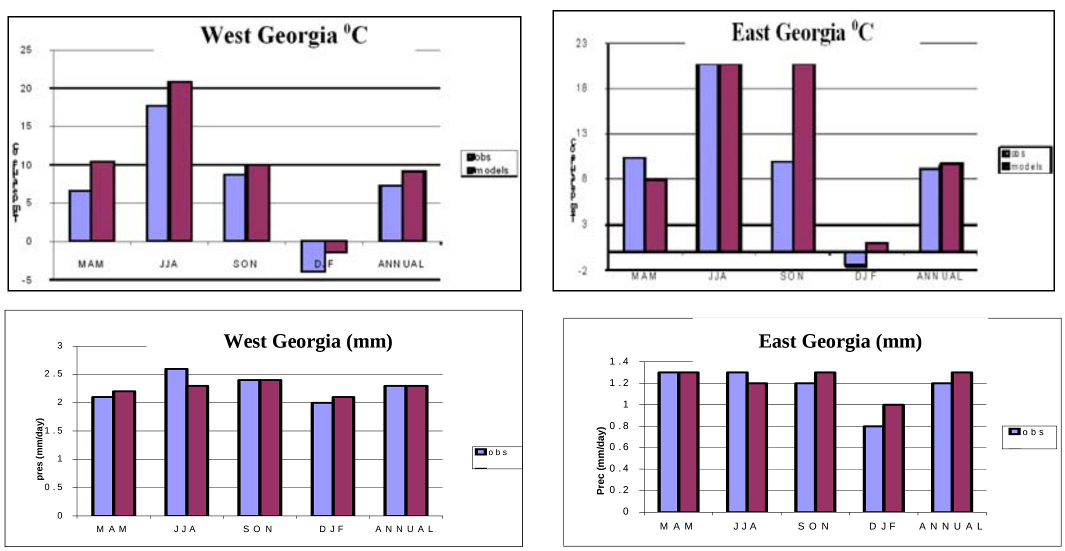


Figure 4.1.1.3. Simulated and observed values of mean temperature (^{0}C) and precipitation (mm/day)

Figure 4.1.1.3 shows that the simulated temperature in Western Georgia always exceeds observed values, and in Eastern Georgia the exception is in the spring, while in summer they are equal.

* Difference in precipitation values are presented in percentages. The differences in temperature and precipitation in this table are designated respectively by ΔT and ΔQ.

Using these selected (reference) models, anticipated climate change scenarios have been calculated for each illustrative case, from all four families (A1, A2, B1, B2) of socio-economic development scenario. The results obtained are presented in Figure 4.1.1.4.

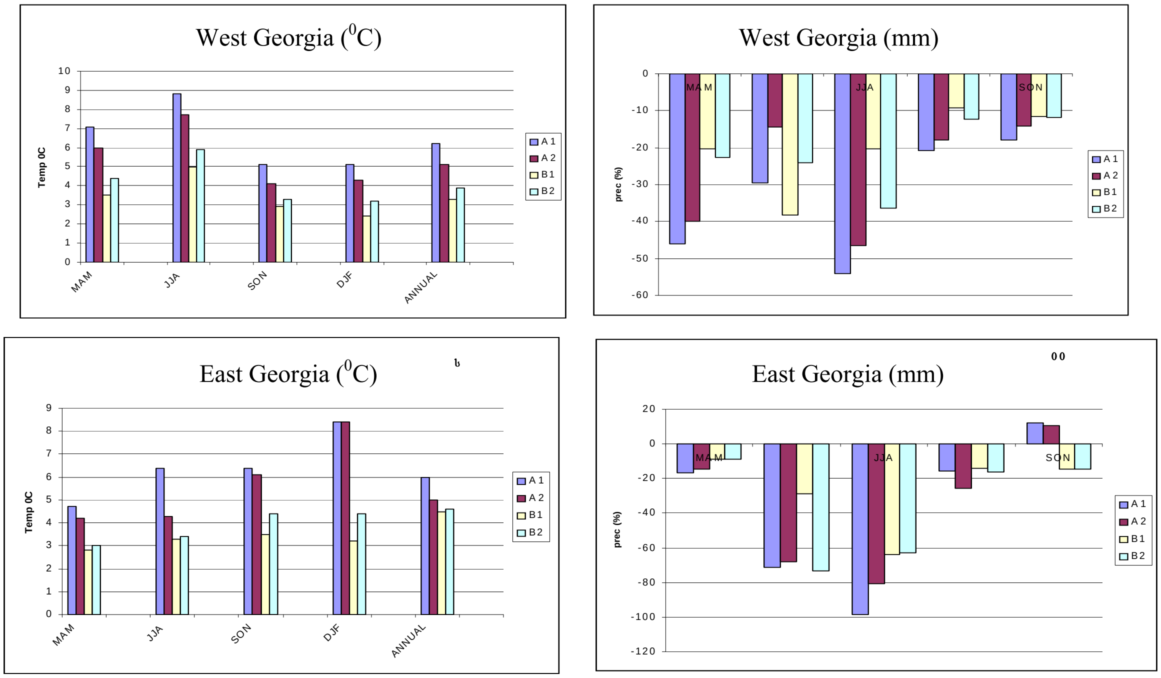


Figure 4.1.1.4. Temperature and annual sums of precipitation change to 2100 in West and East Georgia for different emissions scenarios

Assessment indicates that the maximum increases of global temperature typical for the A group of scenarios are entirely reflected in the territory of Georgia. The pattern of global temperature increase, with some inter-annual variations, is preserved both in the western and the eastern parts of Georgia. It is remarkable that in Eastern Georgia the maximum increase of temperature is anticipated for winter, while in Western Georgia it is anticipated in summer. Unfortunately, sufficiently good results obtained under the climate models for temperature do not correspond to the results derived for precipitation. Of precipitation, according to MAGICC/SCENGEN, it can only be said definitely that a decrease in precipitation is anticipated for the entire territory of Georgia, and this process has slightly different inter-annual distributions in the Western and Eastern parts of the country. In Western Georgia, according to various scenarios, a maximum decrease is anticipated more in transition seasons (spring and autumn), while in Eastern Georgia a maximum decrease is anticipated in summer and autumn. It should be mentioned here that the percentage change, indicated in the figures, stands for the average by territory precipitation, which - especially in Western Georgia from the Black Sea coast to the Likhi Range – varies in a range of numerical values differing by an order of magnitude. In such conditions, the error is very significant, though the trends of the process are reliable.

Assessed parameters. Only temperature and precipitation have been assessed using MAGICC/SCENGEN.

Obtained results. Projected values to 2100 for temperature and precipitation under MAGICC/SCENGEN, using the best global models and the same scenario (A2) for each season and both regions (Western and Eastern), are presented in Table 4.1.1.6. The baseline period data were taken from the CRU database, included in the SCENGEN.

Table 4.1.1.6. Projected values to 2100 of temperature and precipitation in Western and Eastern Georgia under MAGICC/SCENGEN

Region	Season	Spring		Summer		Autumn		Winter		Annual	
	Climate element	T ^{0}C	Q mm	T ^{0}C	Q mm	T ^{0}C	Q mm	T ^{0}C	Q mm	T ^{0}C	Q mm
Western Georgia	Baseline period	6.6	189	17.7	234	8.8	216	-3.9	180	7.3	840
	Anticipated change Δ	5.6	-72	7.7	-36	4.1	-99	4.3	-27	5.2	-110
	2100	12.2	117	25.4	198	12.9	117	0.4	153	12.5	730
Eastern Georgia	Baseline period	7.6	117	20.8	117	10	108	-1.5	72	9.2	476
	Anticipated change Δ	7.1	-72	5.2	-90	5.8	-81	6.1	9	4.9	-106
	2100	14.7	45	26	27	15.8	27	4.6	81	14.1	370

Final climate change scenario for Georgia. To construct the anticipated final climate change scenario in Georgia the averaged values obtained under all three models (HadAM3P, ECHAM4, MAGICC/SCENGEN) were used. For the selection of reliable baseline values, the data taken from the SCENGEN database (1961-1990) were averaged with the actual data of observations, carried out in the same period of time at 20 stations of the Georgian hydrometeorological network, used in Tables 4.1.1.3 and 4.1.1.4. The final scenarios are presented in Table 4.1.1.7.

Table 4.1.1.7. Anticipated to 2100 temperature and precipitation scenarios for Western and Eastern Georgia

Region	Season	Spring		Summer		Autumn		Winter		Annual	
	Parameter	T ^{0}C	Q mm	T ^{0}C	Q mm	T ^{0}C	Q mm	T ^{0}C	Q mm	T ^{0}C	Q mm
Western Georgia	Baseline period	7.9	281	18.5	348	9.7	391	-2.3	377	9.1	1197
	Anticipated change Δ	4.6	-40	5.6	-88	3.4	-52.7	3.6	104	3.5	-70.0
	2100	12.4	241	24.1	260	13.0	338	1.4	481	12.6	1127
Eastern Georgia	Baseline period	9.3	158	20.5	170	11.6	126	1.0	85	11.3	570
	Anticipated change Δ	4.6	-65	5.9	-72	4.1	-45	4.5	-289	4.1	-83
	2100	13.9	93	26.4	98	15.7	81	5.5	56	15.4	487

In summary, it can be concluded that comparing the climate change scenarios obtained under all available methodologies, both in Western and Eastern Georgia, an increase for the years up to 2100, in the mean annual temperature of 3-5^{0}C, will be accompanied by a decrease in precipitation by about 9-13%. This process will be especially sharp in summer, when both the temperature increase and precipitation decrease trends are starker than in other seasons.

4.1.2. Black Sea coastal zone

The Georgian Black sea coastal zone is considered as the most vulnerable to the climate change ecosystem in Georgia having at the same time serious anthropogenic press particularly in the Deltas of rivers Rioni and Chorokhi.

Description of the Black Sea coastal zone. The Georgian Black Sea coastal zone represents the central part of the Caucasian coast of the Black Sea, with an essentially different climate, relief and oceanographic conditions from other parts. The cities of Batumi, Poti and Sokhumi are located here with their ports, as well as the Supsa and Kulevi sea oil terminals, the Batumi Airport, and many other settlements, comprising a core area of economic and tourist recreational activities in the country. A highly developed coastal infrastructure exists here, with a dense network of railways and highways, about 60% of which are stretched along the sea coast. Such a great number of settlements, and multisectoral infrastructure from the old times, created a high population density (about 30 persons / km^2), which will grow even more in future (2030-2050).

Georgia's coastal zone is a part of a shelf where the impacts of river run-off and submarine waters are spreading. In addition, this coastal zone includes a piece of land which experiences the impact of the dynamic processes of the sea during their peak activity (storm surges of rare frequency, rough seas, seiches, currents and eustasies, etc.).

The marine boundary of the coastal zone follows a 130-meter isobath, and only in the mouths of large rivers does it deviate into the sea. In the Kolkheti Lowland, its width is 0.2-0.5 km, widening to 5-30 km in the mouths of the large rivers, and declining to 1-2 meters where the mountain slopes descend into the sea. The above-mentioned parts of sea and land comprise the coastal zone of Georgia, the length of which is 320 km, the average width 10 km, the maximum 30 km (the Rioni Delta, shelves of Gudauta and Ochamchire), and the area is 330 km^2, of which 95% is marine in nature.

Georgia's coastal zone has a complex outline and relief, being partitioned by many tributaries, among which the Chorokhi, Rioni, Enguri, Kodori and Bzipi are the most important. These rivers, according to international classification, form the Black Sea coastal river type, the specific features of which are: catastrophic floods almost in all seasons, and rich sediment and intensive sedimentation processes in the mouths of glacier-fed rivers. The coastal zone is deeply intruded into the sea, where the river gorges descend by some kilometres to the bottom of the sea, in the form of an underwater canyon. In such portions, the river sediment produces spits, peninsulas and islands. At the same time, the accumulation processes are more intensive, where the rate of sinking of the coast is higher, and the sediment richer.

The coastal zone cities with their ports are located on the largest peninsulas, and other areas of accumulation formation: Batumi (Chorokhi River Delta), Poti (Rioni River Delta), Sokhumi (Gumista River Delta) and Gagra (Bzipi River mouth area).

Geological conditions in Georgia's sea coastal zone are exceptionally complex. One of the reasons for this is the different directions and rates of section movements for its separate segments. The Caucasus is a tectonic wrinkle at the bottom of which lies the Kolkheti Lowland, between the deltas of the Enguri River and the Natanebi River, and its wings are the Greater and Smaller Caucasus Mountains. At the bottom of this wrinkle flows the Rioni River, the delta of which represents an area sinking at a maximum rate (C=5.6 mm/yr). To the east of this region, the rate of sinking decreases steadily, and near the city of Samtredia it equals 5.0 mm/yr. The submergence rate also declines to the north of the delta, to the mouth of the Enguri River, and in a southern direction to the mouth of the Natanebi River, where the lines of the tectonic break run through it. Outside these lines, according to an analysis of long-term observations of the sea level, the section movement is positive: in Batumi, Gudauta and Gagra it measures accordingly 12, 37 and 30 cm per century [5].

Climate conditions. The climate of the Black Sea coastal zone is humid subtropical. It forms predominantly as a result of interaction between wet air masses intruding from the Black Sea and the southern slopes of the Greater Caucasus Range, and the western slopes of the Meskheti

Range. The air movement regime is greatly affected by local circulation, resulting from the uneven heating of sea and land surfaces. This kind of circulation is manifested through breezes, monsoons (by modifications relevant to the Black Sea) and mountain-valley winds.
Until the 1990s, an oceanographical and hydrometeorological observation network was sufficiently developed in this coastal zone. According to its data, the mean annual air temperature here varied in the range of 14.4-14.5^{0}C, that of the sea surface in the range of 15.8-16.6^{0}C, and annual sums of precipitation from 1400 mm (Sokhumi) to 2600 mm (Batumi). In the last half-century, hydrometeorological parameters of the Black Sea coastal zone underwent certain changes in relation to global climate change. Over the past century, up to the beginning of the 1990s, the air temperature here had decreased by 0.2-0.3^{0}C, though over the last 16 years it increased by 0.2^{0}C. Compared to the 1960s, precipitation in Poti for the last 15-20 years has grown by 13%, but in Batumi it has declined by 5%. Quite similar to the air temperature, the sea surface temperature had decreased by 1.0^{0}C, throughout 1924-1996. However, in 1990-2006 it had grown by 1.3^{0}C, as a result of which the cooling of the sea surface at present equals 0.8^{0}C, compared to the 1924 value.

Sufficient potential for the development of wind power engineering exists in the Black Sea coastal zone (in deltas of the Rioni River and Chorokhi River). However, according to meteorological stations data, a definite change in the distribution of this renewable energy source is being observed (Figures 4.1.2.1 and 4.1.2.2).

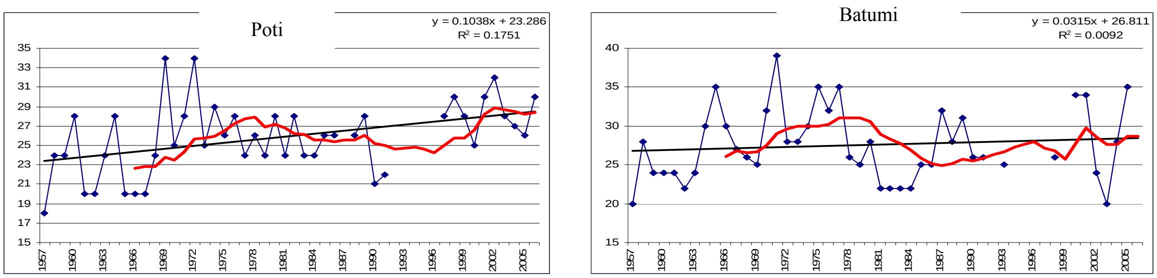


Figure 4.1.2.1 Mean annual wind velocities (m/s)

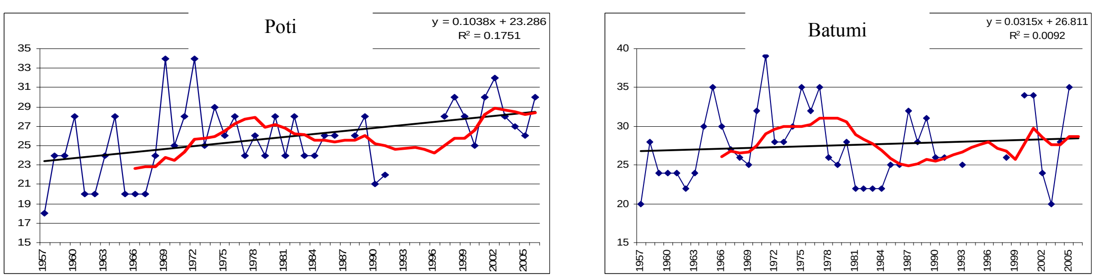


Figure 4.1.2.2 Maximum annual wind velocities (m/s)

Despite the fact that Georgia's sea coastal zone is recognised as the calmest region of the Black Sea, nevertheless about once every 20 years a hurricane here accrues with a wind speed exceeding 47 m/s (Supsa meteorological station). Such gale-force winds predominantly (in 70% of cases) blow in from the sea and initiate powerful storm surges and rough seas (Table 4.1.2.1).

Table 4.1.2.1**.** Numerical and relative change on heavy storms

Years	Force of storms							
	4 Force		5 Force		6 Force		7 Force	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
1961-1971	326	79,7	77	18,8	6	1,5	_	
1987-1988	713	86,2	112	13,5	2	0,2	_	
1997-2007	254	51,8	210	42,9	23	4,7	3	0,6

One of the climatic parameters important for the development of tourism here is the relative air humidity assessed for this region as well. Evaluations have shown that conditions tend to be better in Adjara, though according to Poti weather station data, the relative humidity is increasing even more (Figure 4.1.2.3).

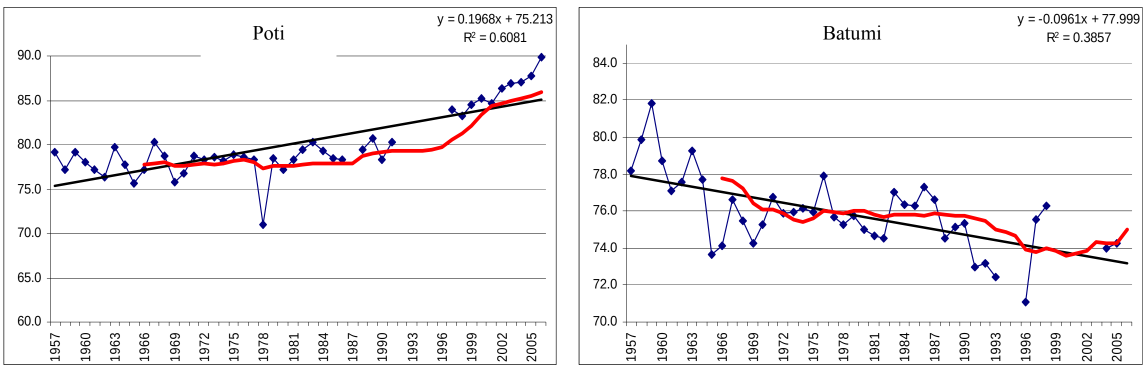


Figure 4.1.2.3. Mean annual relative humidity (%)

Calculations carried out using the PRECIS regional climate model have shown that up to 2050 in the Black Sea coastal zone (Poti area), an increase in air temperature by 1.2^0C is anticipated to have a background precipitation decrease of 8-10%.

These projected changes in climatic elements would affect the development of different branches of the economy of the Black Sea coastal zone, of which one of the most important is the tourist and recreational sector. At the same time, on the same sections of the coastal zone, e.g., at the Kobuleti, Batumi, and Sokhumi portions, an important role is given to agriculture, which is driven by the possibility of growing profitable crops.

From this standpoint, the Kobuleti region is the most desired area of the coastal zone, where citrus plants are successfully grown (60% of Adjara's overall harvest), in addition to tea, tung-trees, bamboo, etc. Among the annual crops, maize and vegetables are grown here. In the last several years, hazelnut has been intensively developed in the region.

Given the predicted climate changes for this region due to global warming, the creation of better conditions for the production of oranges and lemons is anticipated, in view of their preference for warmer climates than the present environment. It should be expected that these plants will gradually supplant the less profitable tangerine tree. This substitution of plants would provide a doubling of income from citrus growing. The increase of the vegetation period for vegetables from the current average of 224 days to 290 days could make it possible to supply the coastal resorts with fresh vegetables all year round.

At the same time, accounting for the anticipated decrease in precipitation, the application of modern irrigation systems would be required in April–May and partially even in the summer months as well.

Oceanographic conditions. During western gale-force winds a rise in sea level of 0.8 m is possible along Georgia's Black Sea coastal zone, causing an increase in the level of water in the river mouths by 1.5-2.5 m, due to the blocking up of river run-off. During spring floods, the sea level is higher by 0.20-0.25 m compared to autumn, and in the case of storm surge super positioning, its increment exceeds 1.0-1.2 m. One of the most powerful and unpredictable events in the coastal zone is the seiche – causing a rapid variation of sea level generated by changes in atmospheric pressure, during which the sea level alters by 0.5-0.7 m in only one or a few hours.

Assessment of the Black Sea coastal zone's vulnerability to climate change. Georgia's Black Sea coastal zone has a special importance for the country's economy: it is the main foreign cargo turnover locale along this route. Special loading comes to the ports (Batumi, and especially Poti). Along the whole length (330 km) this zone is characterised by a dense population, a great number of industrial enterprises, and accordingly, by a developed infrastructure. Any variation of the marine ecosystem parameters caused by climate change seriously affects the infrastructure as well. Taking into account these circumstances, the Black Sea coastal zone's vulnerability to climate change has been assessed, not only considering ecological, but social and economic factors as well, on the level of the whole infrastructure of the region.

Methodology of vulnerability assessment. The sensitivity of the Black Sea coastal zone to atmospheric phenomena is demonstrated on the one hand through the peculiarities of global climate dynamics as a whole, and on the other hand, by the specific character of the Black Sea. The vulnerability assessment of Georgia's Black Sea coastal zone to climate change is based upon a study of this region as a sea coastal ecosystem and as a socio-economic unit. Resulting from this, a vulnerability assessment was made on both levels, and performed according to the following scheme:

- ❖ The phenomena (indicators) showing climate change impacts on the marine ecosystem were selected, the quality of expression of which was assessed quantitatively for different segments of the Black Sea coastal zone;
- ❖ According to summary indicators of the total negative impact, four segments were identified as having the highest risk assessment. Their vulnerability was quantitatively estimated according to the sphere of negative impact, and its probability degree, assessed by so called vulnerability indicators.

The impact of global warming and climate change processes on such a marine ecosystem was assessed using a number of indicators, such as the manifestation powers, which characterise the vulnerability of this ecosystem:

- ❖ **Eustasy** – the rise of ocean (sea) level relative to land as a result of water thermal expansion and a change of fresh water balance in favour of the ocean;
- ❖ **Storms** – increase in frequency of storm surges and their power;
- ❖ **Sedimentation** – activation of solid sediment accumulation processes in glacier-fed river deltas;

- **Change in sea surface water temperature** – essential changes in thermal characteristics of the aquatic environment (sea currents resulting from changes in vertical circulation and other dynamics and thermal features).

Eustasy. Eustasy – a most important indicator for the assessment of marine ecosystem vulnerability – was indicated instrumentally for the first time on the Black Sea in 1924-1925. As a eustasy depends on the thermal expansion of the sea, and on the variation of continental stocks of fresh water, it varies in different regions according to local conditions. The regional and local values of current eustasy of the Black Sea are determined by the latitude of the area and the dynamics and hydrothermal features of the sea.

The Black Sea, since 1873, has been one of the best studied reservoirs using instrumental observations. According to present thinking, due to its huge thermal inertia, the sea is reacting to climate changes with a 22-25 year delay. Accordingly, as eustasies in the Black Sea have been going on since 1924-1925, the warming of its upper layer should have begun as early as 1895-1900.

A statistical analysis of the long-term observational studies of Black Sea levels has shown that eustasy is highest on its western coast, where it reaches 3.0 mm annually, on the eastern coast 2.6 mm, at the northern coast 2.4 mm, and on the southern coast it doesn't exceed 2.0 mm/yr. For the sea as a whole, eustasy until the 1990s equalled 2.5 mm/yr, on average, though up to the present decade it has accelerated to 2.6 mm/yr. Resulting from this, the absolute value of eustasy on the above-mentioned coasts, up to 2006, amounted to 24 cm, 21 cm, 19 cm and 16cm respectively. A relative eustasy, indicating a sea level rise compared to the land, exceeded by twice or more the above-mentioned values along the sinking coastal areas. A relative eustasy reaches especially dangerous values along the tectonic break line, stretching through the Black Sea hollow, which connects the Rioni and Danube Deltas. For this reason, relative eustasy in the deltas of these rivers is highest when it reaches, correspondingly, 64 cm, 70 cm and 76 cm. Due to this fact, since 2006, eustatic blocking up of, or sea transgression, has lengthened to 300-330 km at the Danube, and up to 40-45 km in the Rioni River bed. These processes have sharply increased the probability of catastrophic floods at the affected portions of these rivers.

Storms surges. The increase in the frequency and force of storm surges is a second indicator of the sea coastline's vulnerability. Storm surges have inflicted heavy losses on the seashore countries, especially in tropical and sub-tropical zones. Hydrometeorological observations carried out in these countries demonstrate that the force and frequency of storms for the last 20-30 years has increased almost by 50-70%. During these same years the phenomenon was more active in the cold period of the year, for about 70-75% of the most severe storms occurred in this winter period. As the power (destructive action) of storm surges is determined by the height of storm waves, which are a function of the location of the wave impact line and the depth of water in this zone, the value of this indicator increases according to the value of eustasy. Hence, it is anticipated that given the background of current climate change, the increase in the frequency and force of storms will continue in the near future.

Sedimentation. The enhancement of the accumulation processes in river deltas represents a vulnerability indicator, reflecting the activation of sedimentation processes going on in the deltas of glacier-fed rivers. The reason for this is the intensive enrichment of river sediment with moraine material originating in the process of glacier retreat. The activation of sedimentation processes is clearly manifested in the deltas of glacier-fed rivers in the Caucasus. The coastal line in the mouth of the Rioni River's new branch (Nabada) has intruded into the sea by about

150 m; this branch has developed a delta with islands similar to the old (historic) mouth, significantly exceeding the previous one. These same processes would have developed in the Enguri River Delta, if the transportation of sediment had not been limited by the Enguri HPP high dam.

Thermal indices of the sea. Sea thermal indices reflect a change in temperature of different layers of water. Before the "cold intermediate layer" of the Black Sea existed and a destabilisation of temperature regimes began in the 60-80 m thick layer above this zone, and since this process has taken place, a fall in sea surface temperature has been ongoing. According to observational data on the Black Sea surface layer temperature, almost everywhere in its coastal zone the temperature decrease has been going on since the beginning of the last century. Likewise, where the shelf is narrow and steep, this process is more active. Exceptions are the Crimean coast, adjusted to the Crimean strait, and the Caucasus coast, influenced by the Azov Sea. Warm water masses coming into the Black Sea from the Kerch strait are neutralising the impact of the cold medium layer at the above-mentioned coastal areas.

A large part of the Black Sea surface from the beginning of the 20th century until the 1990s had been cooled with different intensities, causing the cooling of adjacent layers of air and the coastal land zone as well. This process has been characteristic of the climate cycles and fluctuations as a response of the ocean to the activation of dynamic processes in the atmosphere, and it has been a feature over the centuries. Since the end of the last century, in particular in 1995-2006, the trend of water and air temperature alteration in the Black Sea has changed in a positive direction. The change in thermal conditions of the aquatic environment has caused important alterations in the living conditions of the upper layers of the sea.

According to these indicators, it has been established on the basis of available observational data (statistics) in Georgia and experts' judgements (on a 5-mark system) that the river segments most vulnerable to the global warming process in Georgia's Black Sea coastal zone are: Rioni River Delta, Chorokhi River Delta, the lower reaches of the Rioni River (the section between HPP dam and Samtredia), and the Sokhumi coastal area.

Revealed changes in the marine ecosystem. From the start, changes observed in the marine ecosystem were assessed using the above-mentioned four indicators, and their properties were determined.

In the **Rioni River Delta,** where Georgia's most important city-port Poti is located, with its suburbs, port, and well-developed communications and residential networks, the quantitative values of all four indicators are especially high, caused by the peculiarities of the Rioni River Delta.

Eustasy in this segment is expressed most of all, and its relative value had reached 0.7 m by the end of the last century. The reason for this is that it has the highest rate of sinking (C=0.56 m/century) of the entire coast. As a result, since 1925, or the beginning of observations on this indicator of the Black Sea, the sea level in the Rioni River Delta has been raised by 0.7 m relative to the coast. This causes an increase of Rioni River backwater curve heights up to 0.9 m during the spring floods, when the sea level is higher by 0.20-0.25 m, compared to the average value, and its length almost doubles. Accordingly, this drastically decreases the river-bed capacity and the reliability of earthed-up dams along the river banks. This means that floods, which were not dangerous for Poti in the 1920s, now seriously endanger the city. Clear evidence of this is the 1987 and 1997 floods which resulted in human casualties and in USD 13 million losses. An analysis of these facts shows that the 5% (confidence) floods, or the floods anticipated five times a century, which were not hazardous until the 1930s, have now become critically dangerous and are growing proportionally to the increase of the eustasy. Due to the fact that the eustasy here is the highest for the whole coastal line, its impact has been assessed as a maximum of 5 marks (see Table 4.1.2.3). This phenomenon is especially dangerous for the city of Poti, as it is standing 1.5-2.0 m below the level of the Rioni River.

Storm surges are prominently expressed in this segment as well. During an observation period (1956-2007), the occurrence of storms here rose by 50-60%, and sea level by 0.7 m, resulting from the relative eustasy. This has drastically increased the potential danger coming from storm surges. The city of Poti is not protected from westerly storms in the former mouth of the Rioni River, and storms have already seriously damaged the suburbs of the city. During the initial stage of such surges, the water of the sea intrudes onto a branch of the river, resulting in a pouring out of excess water from the river bed, and in flooding of the suburbs. During the last half-century, such cases took place frequently, causing serious losses to residential areas and communications networks. Since the 1920s, as a result of storms and anthropogenic activity, the sea has washed away a 3.5 km wide coastal line, a large share of which has today been replaced by a hippodrome, residential buildings and crops.

In case of a future (2030-2050) increase in the occurrence of storms and further rises of eustasy by 0.2-0.3 m, storm surges will become disastrous phenomena. As the frequency of storm surges in this segment has already increased by 60%, making it the highest value of the whole Black Sea coastal zone in Georgia, the impact of this indicator has been assessed as 5 marks (Table 4.1.2.3).

Activation of sedimentation processes in deltas of glacier-fed rivers is sharply expressed in this segment because the Rioni River is fed by glacier run-off. In the last century the silting of both beds of the Rioni River (Poti Canal and Nabada) increased, intensifying the process of a decrease in their carrying capacity. Accordingly, the river bed inclination has decreased, the backwater curve has become higher and longer, and the capacity of the beds during the flood period, already complicated by eustasy conditions, has declined. Nowadays this indicator is important for its share in the vulnerability caused by the first two indicators, and its actions are increasing by almost 15-20%, the vulnerabilities caused by eustasies. In the Rioni River Delta, the impact of this indicator has been estimated as 4 marks (Table 4.1.2.3).

Alterations in thermal indices of the sea are less pronounced in the Poti coastal zone, compared to the three indicators discussed above, though the surface layer temperature in this segment experiences certain fluctuations. In particular, a fall in temperature by 0.3^0C was observed from 1924 to 1990. However, in the period 1990-2006, the trend reversed, causing an increase in temperature by 1.6^0C. As a result of these processes, since 1970, the surface temperature of Lake Paliastomi, linked to the Black Sea, has grown by 0.6^0C.

An alteration of sea temperature for this lake causes changes in other indices of the environment, and affects in the first place, the habitat of the plankton and several

> The Rioni River Delta segment includes a coastal zone territory with an area of about 150 km^2. The city of Poti is crossed by an old bed of the Rioni River, on its southern branch, over which the river has been flowing freely since 1939. In the succeeding years, to protect the city from disastrous floods, the river was redirected the shortest way into the sea, using the artificial bed of the Nabada. After this about 60% of the river's maximum discharge (700-750 m^3/c) had to run through the old river bed, stretching through the city. Since 1958, after the construction of a water-distributing dam, the old bed became silted again, to such an extent that its capacity was reduced to 40% (about 300 m^3/c). Until the 1940s, the old branch joined the sea by two currents, forming the so called "Nikoladze Island," built by the alluvium. At present, one of the branches is blocked by the sea, and the island has transformed into a peninsula. As a result of the feeding alluvium stopping at the blocked branch of the river, a rapid degradation of coastal zone has begun, followed by sea transgressions, while at the second branch in the Poti Port area, the intrusion of the land into the sea is still going on.

kinds of fishes feeding on it. It also influences the duration of the recreational season, air characteristics (temperature, humidity), and consequently the vegetation period of the coastal zone, and heightens the probability of infectious diseases spreading. In spite of the possible variety and importance of these results for the marine ecosystem, the value of this indicator has been assessed only as 3 marks, because its impact in the Rioni River Delta is not too significant.

The Chorokhi River Delta includes the coastal territory from the state border of Georgia, with the Republic of Turkey, to the mouth of the Korolistskali River. Its area occupies 85 km^2, of which 40% is land. Its marine border passes over the limit of the Chorokhi River sediment spread, at a distance of 5.5-6.0 km from the coast. About 70% of the Delta land is occupied by the city of Batumi with its suburbs and the Adlia Airport, 15% by cropland and beaches, and the remaining part is covered by the bushes and marshes of the Kakhaberi Plain. The territory of the Delta is built from the alluvium of the Chorokhi River.

The eustasy of the Chorokhi River Delta has been measured since 1924-1925. Here, its relative value reaches 0.15-0.20 m/century, seriously accelerating the process of coastal erosion. In 1970-2006, or in the period of acute activation of anthropogenic components of climate warming, the degradation process intensified markedly, causing the growth of the sea intrusion rate onto the land, from 2-3 m to 8-10 m annually. In 2005-2007, the sea washed away the internal motorway in Adlia, and directly threatened the Batumi Airport runway. In the near future, a further intensification of this process is anticipated. Despite the eustasy and anthropogenic mistakes (erroneous orientation of a concrete wall protecting the right bank of the Chorokhi River), such a forecast is based upon the construction of a cascade of reservoirs on the Chorokhi River, as a result of which the coast will not be able to get the Chorokhi alluvium for 450-500 years.

In spite of the above-mentioned circumstances, the vulnerability caused by eustasy is much smaller here than in the Rioni River Delta, and hence the value of this indicator for the examined segment has been evaluated as 3 marks (Table 4.1.2.3).

The increase in the power and frequency of ***storm surges*** is the direct result of an intensification of atmospheric circulation processes that were forcefully expressed during the 1960s-1970s. According to recent records, the frequency of storms in the cold period of the year, on this section of the Adlia-Batumi coast, has almost doubled. Due to the fact that the wave impact line has been progressing onto the land due to eustasy, the destructive action of storms has been increasing, proportionally to the rate of this line invasion. According to observations going on in this segment, during 2003-2006, or after the cessation of the Chorokhi River alluvium transit to the coast, the width of the land washed away by storms increased from 6-7 m, to 8-10 m annually. This second indicator has been observed here against a background of eustasy, as well as being significantly reinforced by it. Therefore, taking into account intensified storms and the washing off of this coastline; this indicator has been estimated as 5 marks (Table 4.1.2.3).

Sedimentation in the glacier-fed rivers in this segment has not been expressed, as there are no glaciers or centennial stocks of snow in the Chorokhi River basin. Hence its action has been assessed as a zero mark (Table 4.1.2.3).

Alterations of aquatic environment thermal indices are urgent and numerous in the Chorokhi Delta. In line with the changes in sea surface temperatures, the recreational features of the segment have also changed. In 1924-1990, the sea temperature here decreased by 1.0^0C, and in 1924-2006 by 0.8^0C. As for the Rioni River Delta, this fact is explained by an extraordinary warming of the climate throughout 1995-2006, exceeding by 0.6-0.9^0C temperature variations in other time periods. In this period, the air temperature in the area of breeze circulation rose, causing a prolongation of the recreational season and the vegetation period by 7 and 4 days respectively. This means an increase in positive temperature sums took place, which determined the quality of crop yields and dates of harvesting.

At the same time, as a part of the shelf near Adlia is narrower and steeper, the impact of these thermal indices alterations were more pronounced there than on the Batumi coast, which has a relatively wider shelf. According to these alterations of the aquatic environment thermal indices, the habitat of living organisms is changing here as well. The value of this indicator and its anticipated impact in this segment are sufficiently high, resulting in an evaluation of 5 marks (Table 4.1.2.3).

In the middle of the last century, a 300 m long concrete dam was constructed along the right bank of the Chorokhi River for the protection of neighbouring territories from floods. This dam changed the direction of the river, causing a disruption of the Mejina River head, and entirely blocking the sediment filling up the coast. The seashore began eroding, as a result of which by the 1980s the coastal line in Adlia had moved towards the land by about 200 m. In following years, due to the acceleration of this process, the sea invaded the land by another 50 m, in 1998-2006.

Lower reaches of the Rioni River (HPP dam – Samtredia portion). This segment of the lower reaches of the Rioni River includes riverain territory located in a zone of rare floods of the river (P<5%), which spread upward along the river, from the water-distributing unit to the upper limits of the eustatic blocking. The river here flows into the bed, restricted by earthed-up dams, the inclination of which does not exceed 1.0%. About 40 densely populated settlements are located in this segment, supplying Poti with agricultural products and a labour force. The flooded river burst the river dam in some places during the 1987 and 1997 floods. One of its branches joined Lake Paliastomi by a canal cut through the left bank dam, and its level rose to such an extent that it created serious damage to Poti. At present, the destroyed dams have not been repaired at a sufficiently reliable level, so that floods with even the 5% provision could gush over them; moreover, if this phenomenon takes place given the background of spring high levels and other events (surges, storms), it will promote this process.

According to the predicted changes in the Rioni River upper reaches run-off to 2100, its increase by 26% is anticipated by 2050, and a decrease of 36% is then expected compared to the 2050 projected level (see Table 4.1.2.2).

Table 4.1.2.2. Average values of Rioni River discharge in the 30-year periods

Period and version	**Total discharge (billion m^3/year)**	**Change (%)**
1956-1985 observed	1.310	
2021-2050 ECHAM_A2	1.707	+26%
2021-2050 ECHAM_B2	1.649	
2071-2100 ECHAM_A2	1.552	
2071-2100 HADCM_A2	1.049	-36%

This table shows that two climate models give different values for the anticipated change in Rioni River run-off. For a seasonal distribution of discharge, the models give differing results as well.

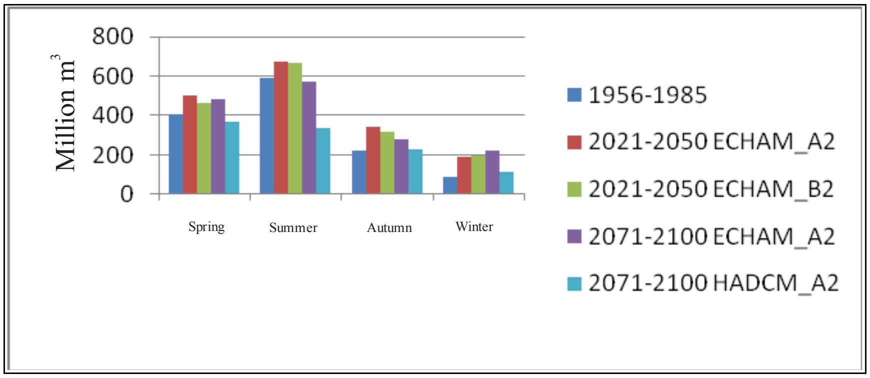


Figure 4.1.2.4. Averaged 30-year seasonal values of Rioni River discharge in the past and future

This figure demonstrates that there is a discrepancy between models, mainly in the spring, for which the ECHAM4 model gives an increase in the discharge up to 2100, though the HadAM3P projects a decrease. Both models agree that the winter and autumn run-off will not decline (on the contrary it tends to increase), and the summer run-off will not grow to 2100 (the HADCM_A2 model projects significant decreases in the summer discharge).

As suggested in [6], the changes in precipitation in the territory of Georgia are better described by the HAD300 family of global models. Most other global models agree as well, that in Western Georgia a decline in precipitation is anticipated. Therefore, the projected outcomes of the HadAM3P model's decrease in discharge seem to be more realistic.

It ought to be mentioned that this forecast is made without taking into account the glacier feeding of the run-off. The share of glacier feeding in the examined period is to be investigated separately.

Eustasy in this segment is a factor defining sufficiently high vulnerabilities, due to the high rate of tectonic sinking (C = 0.5 m/century), with its relative value reaching 0.7 m/century. This relative eustasy has increased the water level an average of 0.6 m (suburbs of Samtredia) in the river bed, and thus has significantly (by 15-20%) decreased its capacity. Hazards related to the river have grown sharply. The river overflowing its bed, after flooding the adjoining settlements, could threaten the city of Poti, especially from Lake Paliastomi. Such an event already took place twice in 1987 and 1997.

The relative eustasy in this segment seriously affects the decline of the riverbed carrying capacity, conductivity and conveyance, as the rise in sea level decreases the inclination of the river, and in this way accelerates the silting of the river bed by moraine sediment. Therefore, this indicator has been evaluated as 4 marks (Table 4.1.2.3).

The impact of the increase in the force and frequency of ***storm surges*** is essential in the lower (10-12 km) part of the segment (water-distributing unit – the mouth of Tsivi River), but only during floods. However, as the overflow of riverain dams and the flooding of adjacent territories and the western suburbs of Poti at the meander section is possible, with a low level of probability ($P \leq 0.01$), the value in this indicator has been evaluated as 1 mark (Table 4.1.2.3).

The silting of the riverbed by glacier sediment sharply decreases the riverbed carrying (discharge) capacity, and its inclination in an area affected by eustasy. The flooding of Samtredia's riverain areas, and consequent losses and discomforts during floods ($P \leq 5\%$), and especially during the spring flood period, are linked to this factor. Therefore, this indicator has been estimated as 4 marks (Table 4.1.2.3).

Under the growing impact of all three indicators discussed above, about 35-40% of croplands in the Rioni River lower reaches are under constant threat of flooding and washing off. Resulting from this, a significant part of the local population (5-7,000), is often forced to settle and search for income in other places. This problem, first of all, is most urgent for settlements around the upper part of this river section, and some 10-12 km beyond the water-distributing unit (Patara Poti, Chaladidi, Sabazho, Sagvamichao, Sakorkio, etc.). In this part of the segment, the river flows in a sharply meandering bed. The radius of such meanders is equal to 0.5-0.8 km, on average, and for the smallest of them (the Sachochuo meander) it makes up only 0.25-0.30 km. Under centrifugal force, the flood level along the outer banks meanderings is 0.5-0.8 m higher than at the inner banks. Thus, the probability of river dam breakthrough is highest at such meanders, and dramatically the destruction of the outer banks of the Sachochuo and Sakorkio meanders caused great loss of human lives and great economic losses in 1987.

A significant part (20-30%) of the lower portion of this segment is occupied by the Kolkheti National Park and other protected areas, which under the joint action of eustasy and riverbed silting processes, have been flooded several times and seriously damaged. The impact of sedimentation on the river bed in this segment is very high, as a result of which it has been estimated as 4 marks (Table 4.1.2.3).

The alteration of aquatic environment thermal indices does not affect this segment, so its value has been evaluated as zero (Table 4.1.2.3).

The Sokhumi coastal zone is one more segment where vulnerability is relatively high along the Black Sea coastal area. This segment is located on the landslide-affected subsiding-terrace, which is submerging into the sea at a rate of 0.2 m/century. The relative eustasy in this segment reaches 0.4 m/century.

The city is crossed by the small river Sokhumura, in the delta of which a port was founded many centuries ago. At present, this river is used as a discharge for the residential wastewater of the city. During disastrous storm surges, this river has represented a dangerous route for the intrusion of sea into the city. All indicators have intensified on the Black Sea under the impact of current climate change, and are critical for the preservation of the Sokhumi coastal area, except sedimentation processes, as glacier-fed rivers and sedimentation processes are absent in this segment.

Given the background of permanent sinking of the Sokhumi terrace, the ***eustasy*** creates growing problems for the city municipality. This is caused mainly by the constant decrease in the inclination of the residential wastewater discharge net. Resulting from a high relative eustasy (C = 0.4 m/century), the city beach has been intensively washed off, the width of which since the 1990s until the current period, presumably has decreased by 20-30% (the forecast was made on the basis of 1980-1990 records).

The action of relative eustasy causes also the salinisation of soil on the plains located beyond the coastal dunes, as a result of the rise of sea level. This process brought about a drying up of citrus orchards, a significant part of which (about 4 ha) perished in the 1980s, and others experienced a serious decrease in productivity. This process is ongoingon at present. Evidently, the eustasy is not directly causing human casualties, and doesn’t destroy the coastal area. However, its results are bringing about significant losses, and that's why this indicator (impact of eustasy) has been assessed as 4 marks (Table 4.1.2.3).

The increase in the force and frequency of ***storm surges*** poses a constant discomfort to the population of sea shore residential areas, their lives and property permanently threatened by waves and surges. In addition, these processes often cause accidents in the coastal infrastructure, especially in communications and sewage networks, being more prolonged and more powerful, the longer is the storm. The frequency of such accidents has been growing in the last half-century, due to climate change, and the occurrence of more dangerous events for this segment has grown by almost 40%. As a result, if the number of storms in the cold period up to the 1950-1960s had been 3-5, for the current decade this feature has risen to 5-7. If these processes continue in the near future at such a rate, special measures will be required to protect the population of the coastal area. Considering this fact, the indicators discussed above for the present stage have been estimated as 4 marks (Table 4.1.2.3).

Sedimentation in this segment doesn't take place as the glacier-fed rivers here are absent and hence this indicator is equal to zero (Table 4.1.2.3).

Alteration of aquatic environment thermal indices is quite topical in this segment. However, due to the fact that the Sokhumi shelf is much larger, the impact of this process is weaker than on the Batumi coastal zone, where the shelf is relatively narrow. Since 1925, the sea temperature in Sokhumi has decreased by 0.6^0C, though in an anomalously warm period of 1995-2006, the temperature of both the sea and the air had sharply risen by $1.0\text{-}1.5^0C$. These phenomena have been followed by the prolongation of recreational and vegetation seasons, accordingly, by 8 and 4 days. The habitat of marine living organisms has been significantly altered as well. According to 1985-1990 expeditions' data, the habitat horizon of some kinds of plankton has dropped by 5-10 m, causing a relevant displacement of habitats for some kinds of fishes, as well as a drastic decrease by 70-80% in kinds and numbers of marketable fish.

The recreation and the marine ecosystem productivity are such important sectors for the Sokhumi coastal area, that the value of this indicator has been evaluated as 5 marks (Table 4.1.2.3).

Here it can be noted that due to its geographical conditions, the Sokhumi coastal area still remains a region with minimum anthropogenic loading. Therefore, it could be regarded as the best territory in the Georgian section of the Black Sea coastal zone to establish a monitoring system for observing natural processes linked to climate change.

In conclusion, it can be assumed that according to the climate indicators discussed above, the most vulnerable segment of the Georgian coastal zone is the Rioni River Delta, the vulnerability of which is evaluated with 17 marks. Compared to other segments, less vulnerable are the lower reaches of the Rioni River, whose total index is estimated with 9 marks.

Table 4.1.2.3. Assessment of segments most vulnerable to climate change in the Georgian coastal zone

Segment	Vulnerability indicators				Vulnerability Assessment, marks
	Eustasy mark/increment, m	Increase in storm surges mark/increment, %	Sedimentation in deltas mark/increment, m	Alteration of thermal indices mark/since 1924/ since 1991, ^{0}C	
Rioni River Delta	5 / 0,7 m	5 / 60%	4 / 0,3 m	3 / 0.0 / 1.6	17
Chorokhi River Delta	3 / 0,2 m	5 / 60%	0	5 / -1.0 / 1.3	13
Rioni River lower reaches	4 / 0,4 m	1 / 40%	4 / 0,45 m	0	9
Sokhumi coastal zone	4 / 0,4 m	4 / 40%	0	5 / -0.6	13

Assessment of high risk segments vulnerability

It is clear that the alteration of the marine ecosystem indicators discussed above seriously affects and will affect the social, economic and environmental spheres of the coastal zone. For each of these spheres, indicators were selected, on the basis of which the vulnerability of four segments connected to the alteration of marine ecosystem parameters, were assessed. The trends of these indicators define the success of chosen adaptation measures as well. The stated indicators are listed in Figure 4.1.2.5.

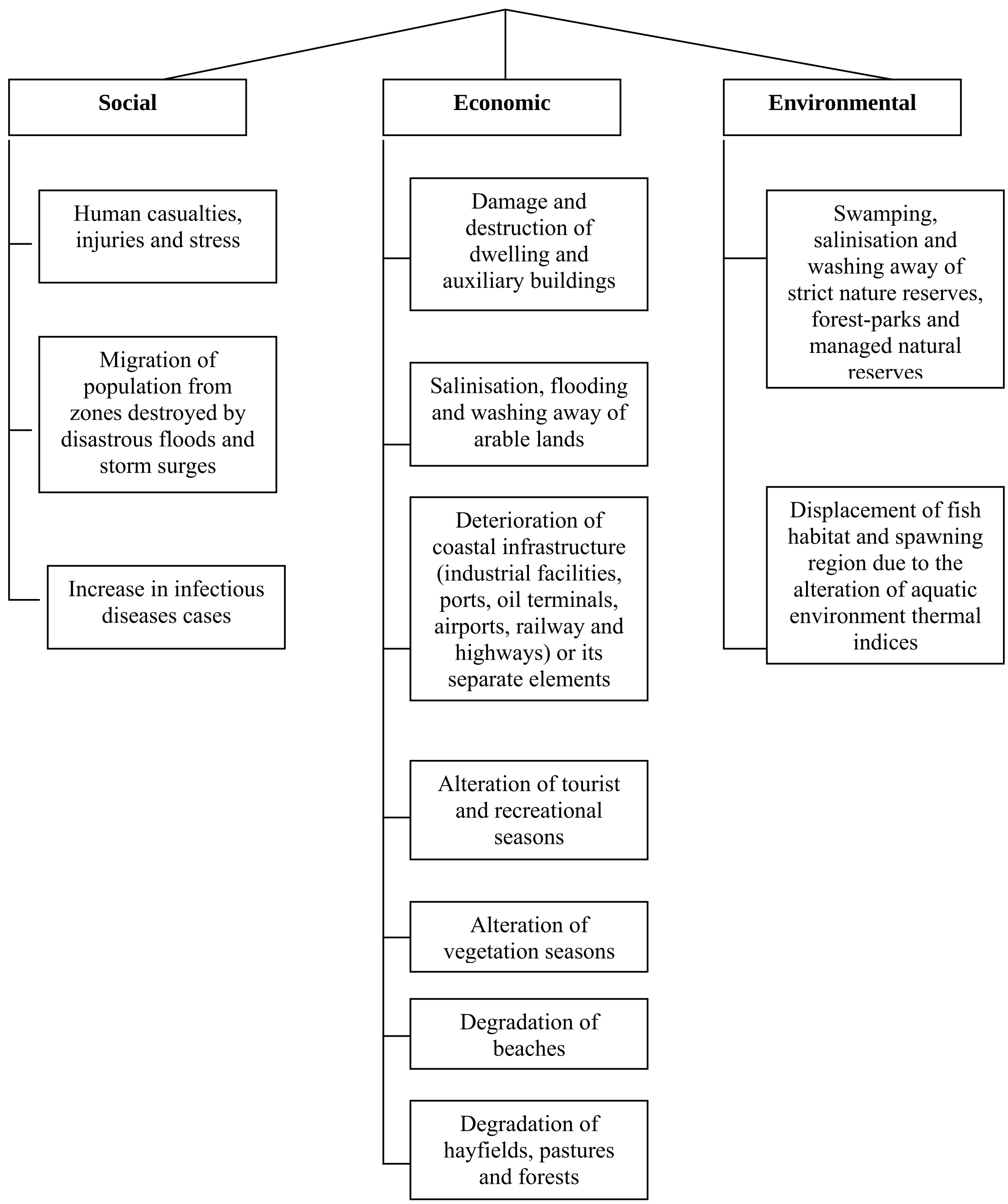


Figure 4.1.2.5. Indicators of Black Sea coastal zone vulnerability

Each of these indicators were estimated by experts in a 5-mark system, according to losses caused by them in the past, or anticipated in future. In particular:

1. Where the loss of human life (death, diseases) is expected, the indicator is evaluated with 5 marks. If the loss caused by a change of indicator in the projected period (2008-2050) is high, and the probability of happening varies in the range of 90-100%, it also gets 5 marks. In other cases, according to the occurrence of the probability and caused losses, the indicator is assessed with 4 marks (80-70%); 3 marks (60-50%); 2 marks (40-30%) and 1 mark ≤ 20%;
2. Economic losses and disintegration of infrastructure, causing starvation and migration, is estimated with a maximum of 4 marks. If the loss is inevitable or very high, it is assessed

by 4 marks. In other cases, the indicator gets the following estimations: 3 marks (80-70%); 2 marks (60-40%) and 1 mark (≤ 30%).

3. Negative impacts on recreation and vegetation seasons, degradation of beaches, and dangers of infectious diseases spread, are estimated with a maximum of 3 marks. If the loss is inevitable, it is assessed with 3 marks. In other cases the indicator gets the following estimations: 2 marks (90-50%) and 1 mark (≤ 40%).
4. Degradation of forests and arable land, as a vulnerability indicator, is estimated by a maximum of 3 marks. If the loss is inevitable, it is assessed with 3 marks. In all other cases the indicator gets 2 marks;
5. Degradation of the natural environment (marine ecosystem, forest, protected territories, etc.) is assessed with 2 marks, for any probability.

Values of social, economic and environmental vulnerability indicators are given as follows: (Figures for all four examined segments and summary assessment of vulnerability are presented in Table 4.1.2.4.

Table 4.1.2.4. Georgia's coastal zone high risk segments vulnerability assessment

N	Segment	Indicators											Vulnerability, mark
		Eustasy (I), Storm surges (II), Sedimentation in glacier-fed rivers delta (III)									Alteration of sea thermal indices (IV)		
		Human casualties, injuries and stress	Damage and destruction of dwellings and auxiliary buildings	Migration of population	Washing down, salinisation and flooding of crop land	Deterioration of infrastructure or fall in its elements efficiency	Degradation of beaches	Salinisation, flooding or washing down of hayfields and forest	Degradation or destruction of environment (strict or managed nature reserves, etc	Impact on tourist –recreational and vegetation seasons	Alteration of aquatic environment indices	Spread of infectious diseases	
1	Rioni River Delta	5	4	4	4	4	3	1	1	2	1	2	31
2	Chorokhi River Delta	5	4	4	4	2	3	1	0	3	1	2	29
3	Rioni River lower reaches	4	3	2	5	5	0	2	1	1	0	1	24
4	Sokhumi coastal area	4	3	2	1	2	2	0	0	2	1	3	20
5	Total	18	14	12	14	13	8	4	2	8	3	8	104

It can be derived from the obtained results that on Georgia's coastal zone, the most vulnerable segment is the Rioni River Delta, and the least vulnerable of all the Sokhumi coastal area. So it can be concluded that a change of climate will seriously affect those segments, where due to anthropogenic or other natural phenomena, the initial equilibrium is being destroyed. We are faced with just a situation in the case of the Rioni River and the Chorokhi River Delta.

The adaptation project proposals worked out for the deltas of the Rioni River and the Chorokhi River are given in the adaptation Chapter 4.2.1.

4.1.3. Dedoplistskaro region

General Overview. The Dedoplistskaro region (DTR), having territories under threat of desertification, was selected as one of the priority regions for consideration in Georgia's SNC. Climate change studies carried out for this region have shown that relevant adaptation measures should be urgently implemented in the region. The DTR is rich in fertile land and vast pastures, but is scarce in water resources and atmospheric precipitation. In summer, air temperature here reaches about 35-40^{0}C, which in combination with long dry periods often results in drought. This fact determines a high degree of vulnerability of the leading sector of the region's economy – agriculture – to the current warming of the climate that makes it urgent to work out adaptation measures and ensure their implementation in the framework of adaptation projects.

The territory of the DTR equals about 2,532 km^2. The lowest point (90 m a.s.l.) is located near the mouth of the Alazani River in the Mingechaur Reservoir, and the highest point (1,001 m) is the top of Mt. Nikorastsikhe near the town of Dedoplistskaro. There are plenty of valleys on this territory (Shiraki, Ole, Taribana, Iori, Chachuna, Eldari Lowland, etc.), as well as hills and heights, separated by ravines and canyons. Some parts of the territory (about 12%) are occupied by badlands, saline lands, and marshes. In general, the territory of the DTR represents an upland elevation on overage of 400-600 m a.s.l. between the beds of the rivers Alazani and Iori.

Despite the relative uniformity of relief, three climatic zones are identified in the territory of the DTR:

- Temperate dry subtropical (steppe) climate with moderately cold winters and hot summers;
- Transient climate from dry subtropical to temperate humid subtropical with moderately cold winters and hot summers;
- Temperate humid climates with hot summers and moderately cold winters.

Numbering of zones in brackets corresponds to the general classification of climates of Georgia [7].

The averaged climate features of these zones are presented in Table 4.1.3.1.

Table 4.1.3.1 Features of climatic zones

Zone #	Zone description	Mean altitude of stations (m)	Average for 30 years	
			T annual mean (^{0}C)	Q annual (mm)
1	Temperate dry subtropical (steppe) climate with moderately cold winter and hot summer (8)	411	12.2	431
2	Transient climate from dry subtropical to temperate humid subtropical with moderately cold winter and hot summer (9)	702	10.6	568
3	Temperate humid climate with hot summer and moderately cold winter (10)	765	10.8	668

In spite of the absence of a great difference of elevations, 8 types of landscapes have been distinguished on the territory of the DTR. Most of the territory is occupied by landscapes typical of steppes and semi-deserts, and only its northern part and water-meadows are occupied by forests. At the same time, sparse arid–type forests are encountered in other parts of the DTR, among them in the Vashlovani Reserve.

Forests occupy 3,360 ha of the region. They make up only 1.3% of the total area of the DTR. They are concentrated mainly in the northern part of the territory, in the Vashlovani Reserve and in water-meadows along the rivers Alazani and Iori.

In the middle of the last century great attention was paid in this region to the planting of forest shelter belts, the total area of which exceeded 1,770 ha in 1988. The main purpose of these belts was to protect the arable lands from wind erosion. Unfortunately, most of them have been cut down as a result of the energy crisis in the 1990s and now the DTR faces an urgent need to restore these wind-breakers and to plant new groves for the protection of crops from violent high winds which are becoming more and more intense and frequent.

To meet this challenge a relevant project proposal has been developed.

The surface water resources of the DTR are represented by just two rivers – the Iori and Alazani and some small lakes, the majority if which are salty.

According to 1943-1954 observational data, the mean annual discharge of the Iori River reached 10.7 m^3/s in its upper part and 17.4 m^3/s in its lower part, within the boundaries of the DTR. During the period 1986-2004, after the construction of two large reservoirs and a number of irrigation systems, the mean annual discharge of the river in its lowest part dropped to 2.6 m^3/s, while the run-off in the river head remained virtually unchanged.

As to the variability of the Alazani River flow, a comparison between the 1955-1970 and 1996-2005 averages indicates an increase of water discharge in the lower part of the river by about 7%, from 104 to 111 m^3/s. This corresponds to a mean growth in runoff of 1-2% per decade. The underground water resources of the DTR are also scarce and their overall amount does not exceed 4.5 – 5.0 m^3/s, that is, five times less than in the neighbouring region of the Alazani Valley.

To protect rare species of flora and fauna, and provide for their spreading over the natural habitat, a number of preserved areas were created at different times in the DTR. Today they are represented by Vashlovani National Park (25,114 ha), which includes the Vashlovani Strict Natural Reserve (10,142 ha) and three Natural Monuments, and also by the Chachuna Managed Nature Reserve (5,200 ha). The total area occupied by these protected entities (30,552 ha) makes up 12% of the DTR territory.

The immense biodiversity in Vashlovani Protected Areas are certainly worthy of conservation efforts. This is the only place in Georgia with such a variety of flora and fauna. Here the steppes turn to shrubbery, deserts change into light forests, and Alazani riparian forests give way to steep ravines. Each habitat hosts its unique inhabitants, and each location is full of life.

According to a 2002 census, the population of the DTR is about 31,000, settled in one town and 14 villages. Compared to the 1989 census, some 6,000 people have left the region as a result of the worsening of socio-economic conditions caused by the disintegration of established systems of agricultural production, rising unemployment, and the disorganisation of irrigation systems.

The dominant sector of the DTR economy is agriculture, in which 94% of population is engaged. In 2001-2005 the region produced on average 32% of the wheat, and 13% of the wine and meat purveyed in the whole Kakheti region.

Other branches of the economy are poorly developed in the region. Industry is represented by some small enterprises processing milk, sunflower and wine, as well as three wells recovering small amounts of oil and natural gas.

The shortage of water has always been the main factor hampering the development of the DTR economy. For the time being, since the destruction of existing irrigation systems, only 2% of arable land is irrigated, which causes a high degree of agricultural vulnerability to drought. Accordingly, the poverty level in DTR is 18% higher than the mean value for the Kakheti region, which is significantly better provided with water.

Climate change. The 1990-2005 period has been selected as the latest observational period, and the 1955-1970 (same sixteen-year length) period is to be compared with the latest one. All examined elements have been averaged in these two periods to assess their change over the past half-century.

Summary results on the variation of air temperature in Dedoplistskaro during the above mentioned two selected periods are given in Table 4.1.3.2, according to which the mean annual air temperature has risen by 0.6^0 C in the past half-century. The maximum increase has been observed in July-October, accompanied by a slight decrease of temperature in winter.

Table 4.1.3.2. Changes in mean air temperature (^{0}C). Dedoplistskaro, 1955-2005

Month / Period	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
1955-1970 (I)	0.4	1.0	3.6	9.6	15.4	18.9	21.6	21.3	16.5	10.7	6.0	2.1	10.6
1990-2005 (II)	0.2	0.6	4.4	10.5	14.7	19.6	22.9	22.8	18.0	12.2	6.2	2.1	11.2
Difference (II-I)	-0.2	-0.4	0.8	0.9	-0.7	0.7	1.3	1.5	1.5	1.5	0.2	0.0	0.6

Corresponding changes are observed in the values of absolute extremes. These data are summarised in Table 4.1.3.3, which shows that the current processes of climate change are mostly reflected in the increase of absolute maximum temperatures that subsequently clearly reveal the growth of drought frequency in the DTR.

Table 4.1.3.3. Average values of air temperature extremes. Dedoplistskaro, 1955-2005

Period	Average value, ^{0}C	
	Abs. maximum ^{0}C	Abs. minimum ^{0}C
1955-1970 (I)	32.7	-11.5
1990-2005 (II)	34.8	-11.5
Difference (II-I)	2.1	0.0

The same analysis was applied to the data on atmospheric precipitation. Average values for selected periods are given in Table 4.1.3.4, according to which the annual sums of rainfall for the last half-century rose by 6%, with maximum increases of monthly precipitation in spring, and maximum decreases in summer.

Table 4.1.3.4. Changes in the mean sums of precipitation (mm).
Dedoplistskaro, 1955-2005

Period \ Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
1955-1970 (I)	21	23	47	61	85	78	58	54	57	50	27	25	586
1990-2005 (II)	20	30	56	74	96	93	31	41	58	49	46	28	622
Difference (II-I)	-1	7	9	13	11	15	-27	-13	1	-1	19	3	36

To check the impact of observed changes in air temperature and precipitation on air humidity, the mean monthly values of relative humidity have been analysed for the selected periods (Table 4.1.3.5).

Table 4.1.3.5. Changes in the mean values of air relative humidity (%).
Dedoplistskaro, 1955-2005

Period \ Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
1955-1970 (I)	80	79	80	75	74	68	65	64	74	82	86	83	76
1990-2005 (II)	81	78	76	78	78	74	70	69	75	79	82	83	77
Difference (II) – (I)	1	-1	-4	3	4	6	5	5	1	-3	-4	0	1

Unlike the air humidity, the changes in temperature and rainfall have produced sensible impacts on the wetting regime of the DTR. For the assessment of this regime, the Selianinov Hydro-thermal coefficient (HTC) has been chosen [1], which is widely used in agrometeorology and which considers monthly sums of precipitation in the period when mean daily temperature exceeds 10^0C (the vegetation period), divided by the sum of mean daily air temperatures, for the same period. This coefficient is obtained empirically and has no dimension.

The HTC varies significantly in different climatic zones. For example, in the Black Sea wet subtropical zone (Batumi), its monthly values vary in the range of 2 to 6, in temperately humid zones (Telavi) from 1 to 2.5 and in arid/semi-desert zones (Gardabani) from 0.5 to 1. The changes in the mean values of HTC in the DTR over the last half-century are presented in Table 4.1.3.6.

Table 4.1.3.6. Changes in the mean monthly values of HTC.
Dedoplistskaro, 1955-2005

Period \ Month	IV	V	VI	VII	VIII	IX	X	Annual
1955-1970 (I)	1.7	1.8	1.4	0.9	0.8	1.1	1.4	1.3
1990-2005 (II)	1.2	2.1	1.6	0.4	0.6	1.1	1.1	1.1
Difference (II) – (I)	-0.5	0.3	0.2	-0.5	-0.2	0.0	-0.3	-0.2

These data confirm that current climate change has caused a worsening of moistening conditions in the DTR in April and July, while improving moisture supply to vegetation in May and June, due to the relevant increase in precipitation. All in all, this process has resulted in the decrease of mean seasonal value of the HTC by 15% over the last 50 years.

Calculations carried out for the vegetation period have revealed as well that due to the current warming, its duration has increased on an average by 12-13 days.

During those months when HTC < 1 or the climate is at the stage of aridisation, the watering conditions could be characterised also by the index called the Desertification Climatic Potential (DCP). This value is calculated [8], both for the air (2 m above the ground) and the soil (0.2 m under ground). The results of these calculations are given in Table 4.1.3.7.

Table 4.1.3.7. Changes in the mean values of DCP.
Dedoplistskaro, 1955-2005.

Value, Month / **Period**	**DCP for air, %**			**DCP for soil, %**		
	VII	**VIII**	**IX**	**VII**	**VIII**	**IX**
1955-1970 (I)	9	18	-	21	25	2
1990-2005 (II)	56	42	-	60	58	9
Ratio II/I	6.2	2.3	-	2.8	2.3	4.5

It can be seen from this table that between the selected two periods of time the value of DCP calculated by air temperature has increased six times in July, and twice in August. As to the values of DCP calculated by soil temperature, an increase is observed both in July-August, and in September. This indicates the intensification of a trend towards possible desertification in the DTR, which needs to carry out urgent measures to combat this progress.

Similar to other climatic elements, the same analysis was undertaken for mean monthly wind speed (Table 4.1.3.8), showing a distant trend towards the weakening of wind.

Table 4.1.3.8. Changes in mean values of wind speed (m/s).
Dedoplistskaro, 1955-2005

Month / **Period**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Annual**
1955-1970 (I)	1.8	2.0	2.2	2.2	2.1	2.1	1.8	1.8	1.6	1.7	1.7	1.3	1.9
1990-2005 (II)	1.4	1.8	1.7	1.5	1.5	1.2	0.8	1.0	0.9	1.2	1.2	1.4	1.3
Difference (II) – (I)	-0.4	-0.2	-0.5	-0.7	-0.6	-0.9	-1.0	-0.8	-0.7	-0.5	-0.5	-0.1	-0.6

Extreme weather events

Drought. Climatological analysis of observational data obtained in Georgia during the past century demonstrates that the DTR is one of the regions most affected by drought in Georgia. The probability of recurrence of this event exceeds 20%. Comparing the different conditions characterising drought in this region, the following criteria were selected to identify this phenomenon: the daily sum of precipitation $P \leq 5$ mm, maximum air temperature $T\ max \geq 28^0$C, and mean daily relative humidity $f \leq 50\%$. Taking into consideration that for Eastern Georgia a duration of drought conditions less than 20 days is not in general fatal for a majority of the crops, aggregated data has been examined on the recurrence and duration of drought in the DTR. Observational series for 1952 – 2007 from the Dedoplistskaro weather station are presented in Table 4.1.3.9. The survey of 60 cases of drought shows that in the second half of this observation period (1980-2007), the average duration of drought (60 days) increased by 22%, compared with the mean value of the first 1952-1979 period (49 days). The frequency of drought also increased from an average of 0.7/yr to 0.9/yr. This trend has been especially marked in the last decade

(1998-2007), when 17 cases were observed during 10 years, resulting in the growth of frequency up to about 1.7/yr, and the rise in mean annual duration up to 72 days.

Table 4.1.3.9. Drought periods in Dedoplistskaro

Years	Average annual duration of drought period, days	Mean frequency of drought period recurrence per year
1952-1965	54	0.5
1969-1975	37	0.7
1976-1985	54	0.9
1986-1995	52	0.8
1998-2007	72	1.0

High winds. Observation records from the meteorological station clearly demonstrate considerable increases in the frequency of high (v ≥ 30 m/s) winds, since the beginning of the 1980s (Fig. 4.1.3.1).

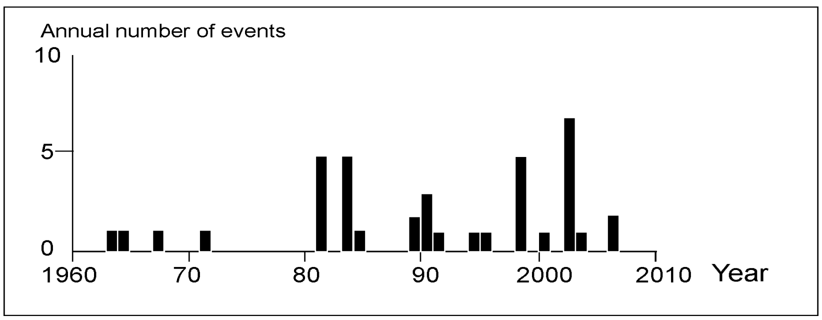


Figure 4.1.3.1. Annual recurrence of high winds (v ≥ 30m/s) at the observation terms in Dedoplistskaro, 1963-2006

An analysis of 44 cases for the period of 1963-2006 indicates that until 1981, only 5 cases of high winds were registered, while in the following period, 34 cases were recorded, which corresponds to a rise of annual frequency from 0.28/yr to 1.44/yr, i.e., a five times increase in the recurrence of high winds between 1963-1981 and 1982-2006.

Climate change forecast for 2100. With the general forecast for the changes of climate elements going towards 2100 in Eastern Georgia in mind, some specific calculations were performed for the DTR territory on the basis of the HADAM3P version of the PRECIS model, for the A2 world socio-economic development scenario. Calculations carried out applying another version of the PRECIS (ECHAM4 versions) has shown that for this region the HADAM3P version more precisely simulate the baseline period (1961-1990), thus giving a reason to select it for the specification of the above-mentioned general projection.

According to the results obtained, the mean air temperature in Dedoplistskaro is likely to increase by 4.6^{0}C in 2100, reaching 15.4^{0}C, and the annual sums of precipitation are anticipated to remain at the present level (606 mm). At the same time, calculations have indicated the possibility of a slight decrease (about 3%) in relative humidity, in a background of virtually unchanged wind speed.

The anticipated changes in air temperature and precipitation will be followed by the alteration of wetting regimes on the territory. Using the HTC as an indicator of the watering/wetting regime, it has been derived that the increase in 2100 of mean air temperature by 5^0C, and the decline of precipitation by about 90 mm through the vegetation period, will bring a reduction of HTC by 0.4, thus decreasing its present value in Dedoplistskaro from 1.1 down to 0.7. This result indicates that the predicted climate change in DTR threatens to transfer the already arid climate of the region into a considerably more arid one, with corresponding consequences in the structure of natural landscapes, and the management of agriculture. A predicted warming in the vegetation period will affect its duration as well, which could be increased from its present value of 196 days up to 235-240 days.

The anticipated significant changes in climate elements discussed above are likely to affect the water resources, ecosystems, and different sectors of the economy. An assessment of this impact is given in the following part of this Chapter.

Water resources. *Methodology applied.* To assess the future impact of predicted climate changes on the hydrological regime of two main rivers – the Alazani and Iori – crossing the territory of the DTR, a hydrological model WEAP (Water Evaluation and Planning System) [9,10] was applied. The water resources of these rivers were intensively used in the past for the irrigation of crops and pastures. The model was validated against actually measured values of river run-off in 1951-1965, for the Alazani and in 1964-1990 for the Iori. Relief of rivers catchments, geological structure, types of soil and vegetation cover were used as input values into the WEAP model along with the PRECIS results.

Alazani River. The results of observations in the past and of calculations for the future were averaged over a 30-year period. Resulting data are presented in Table 4.1.310.

Table 4.1.3.10. 30-year mean values of air temperature, precipitation and run-off for the upper part of the Alazani River

Time period	Mean annual temperature, ^{0}C	Precipitation, mm	Total annual runoff, million m^3/yr
1951 – 1980	3.3	2,240	459.7
2071 - 2100	8.4	2,205	420.2
Changes	5.1	-1.5%	-8.5%

As can be seen from this Table, the predicted values of precipitation vary slightly in the background of substantial rises of temperature, in increments exceeding 5^0C to the end of the current century. This correspondingly is reflected in the variation of river run-off which in general is expected to decrease by about 8%, compared with an average for the second half of the 20th century.

Three different hypothetical scenarios of stream flow decrease were considered for the modelling of water deficit for irrigation systems, or for other purposes. Scenarios were constructed on assumptions that river run-off has decreased by 10, 30 and 50%, and at the same time the water demand has been accordingly increased by the same percentages.

The results of calculations performed for all three hypothetical cases of variation in run-off and consumption are presented in Fig. 4.1.3.2.

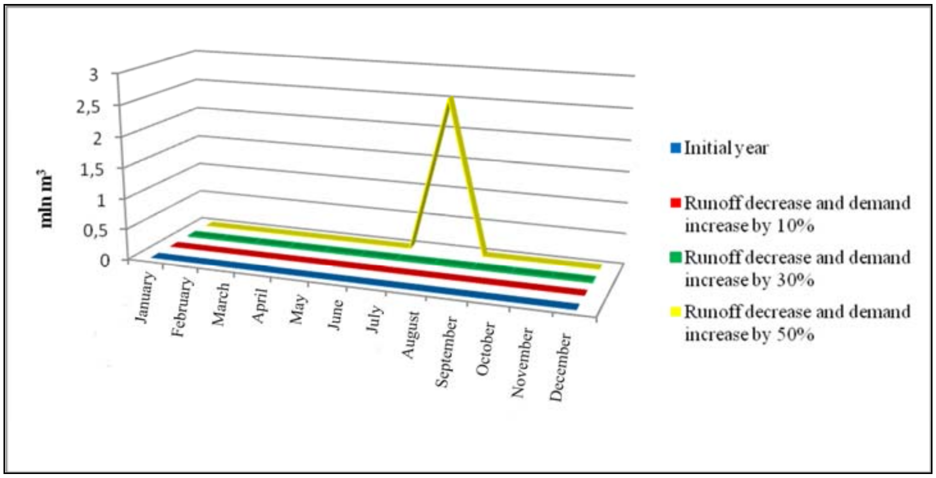


Figure 4.1.3.2. Water deficit in Qvemo Alazani Melioration System for the combined scenarios of water supply and take-off

This figure shows that from the three examined cases in only one case the demand was not met in August by river water flow. Taking into consideration that the conditions in this third case seem to be quite unrealistic, it should be derived that water resources of the Alazani River are sufficient to satisfy in the foreseeable future any realistic demand on water supply for irrigation purposes in the region.

The results of the survey show that the total runoff of the Alazani River in its lower part about 13% exceeds the corresponding value in the middle of the river flow and its variation could be considered as representative of the variation in other parts of the river. At the same time, as a significant decrease of river discharge is not expected, even in the case of a considerable growth of demand a water deficit in the Alazani River is not anticipated by the end of the current century.

River Iori. The same scenarios as above were considered for the projection of Iori River discharge variability, in connection with expected changes of air temperature and precipitation in the river basin (Table 4.1.3.11).

Table 4.1.3.11. Climate change impact on the River Iori in the upper part of the basin

Time period	**Mean annual temperature, ^{0}C**	**Precipitation, mm**	**Total annual runoff, million m^3/yr**
1964 – 1990	6.3	1,323	361.3
2071 – 2100	11.4	1,335	321.5
Change	5.1	1%	-11%

The application to the Iori River of the same methodology used for the Alazani River to assess the water deficit, in case of different scenarios of supply and demand by the main irrigation system, has given quite different results (Fig. 4.1.3.3).

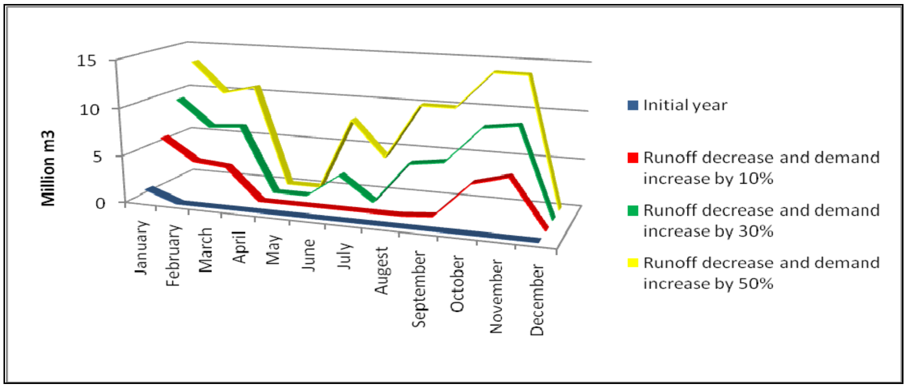


Figure 4.1.3.3. Anticipated deficit of the Iori River run-off for different scenarios (demand site: Zemo Samgori Melioration System)

As can be seen in this figure, even in the case of the first, most moderate scenario, an increase in demand could not be met by the Iori River. The anticipated impact of predicted changes in air temperature and precipitation appears to be the 11% decrease in run-off that surpasses the 10% decline assumed in scenario 1.

Hence, of the two rivers considered above only the Alazani River maintains significant capacity to satisfy increased demand considering the predicted changes in climatic parameters. The Iori River will not be able to meet its current demand at the end of this century even in the case of the first scenario.

Agriculture. The stocktaking exercises carried out in the framework of the SNC, and consultations with local administration and farmers, have revealed that agriculture – the leading branch of the economy in DTR, is the most vulnerable to climate change. As was mentioned above, 94% of the population is engaged in this sector, the absolute majority of which are individual farmers. The area of per-capita arable land in the region equals about 1.90 ha, which exceeds by three times the average value for the Kakheti region. Data on the use of land stock in the DTR is given in Table 4.1.3.12.

Table 4.1.3.12. Data on the use of agricultural lands in the DTR

No.	Purpose	Area, ha
1	Agricultural arable lands	57,500
	Among them: Ploughed fields	35,000
	Rangelands and hayfields	21,150
	Perennials	1,350
2	Winter pastures	131,400
	Total agricultural arable lands	188,900
	Total of DTR	253,200

It emerges from these tables that agricultural lands occupy about 75% of the territory of DTR, of which 52% belong to winter pastures. The remaining part of the territory is occupied by protected areas, abandoned lands, etc.

Land degradation and desertification. Land degradation is one of the most acute problems in the region. The depth of humus in agricultural lands, having been highly productive in the past, is being significantly decreased as a result of growing wind erosion. On average, the humus content in Shiraki soils has decreased from 7.5% in 1983 to 3.2% in 2006. As a result, land fertility has almost halved. Local specialists are confident that the ongoing decline in the productivity of main crops in the region is caused, among other things, by the degradation of soil, caused by wind erosion and lack of watering.

The degraded soils in DTR include saline lands, the total area of which in the region equals 4,975 ha. In the second half of the last century, these lands were periodically, every 6-7 years, cultivated using gypsum that made it possible to use them as arable land. However, for the last 10-15 years, this kind of chemical irrigation has not taken place, so that these lands have become covered by wild grass. At present, for the most part, these lands are abandoned.

Most actively, land degradation in the DTR is going on in the winter pastures which occupy 52% of the region's total area. Until the 1990s, these territories were periodically fertilized and chemically irrigated by gypsum, in salted areas. A significant part of sheep flocks were traditionally driven to winter pastures at the Caspian sea shore, in neighbouring Dagestan. In the beginning of the 1990s, this drive stopped and almost all remaining live-stock were directed to the DTR winter pastures. At present, about 50,000 sheep spend the winter in these territories. As a result, the load on pastures exceeds by 2-3 times the normal value believed to be 3-4 sheep per ha. This overgrazing causes the extermination of grass cover. The stripped parts of land are impacted by solar radiation, strong winds and rainfall, and are thus losing the soil cover which increases the process of desertification. Especially vulnerable to this process are the southern slopes of hills and heights. About 80% of DTR pastures are affected by overgrazing and to some degree subject to degradation.

The process of agricultural land degradation and the decline in their productivity could be schematically summarised in the following form (Fig. 4.1.3.4).

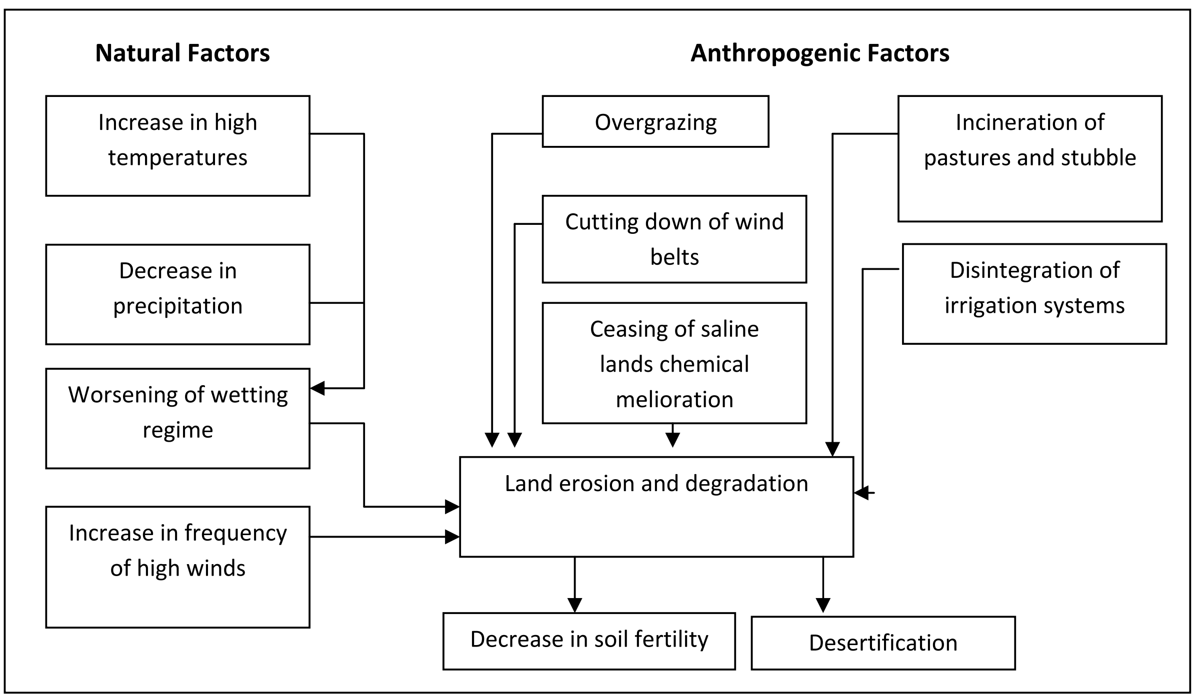


Figure 4.1.3.4. Factors and processes promoting land degradation and desertification in the DTR

The warming of the climate could have some positive effects in the agricultural sector of the DTR. Calculations suggest that the increase of air temperature in the warm period of the year (April-October) has already caused the prolongation of the vegetation period on average by about 13 days. Based on the predicted values of anticipated further growth of temperature, to the end of the current century, the duration of the vegetation period could increase additionally by 43 days. In the case of the ability to provide the vegetation with water, this could significantly improve conditions for getting better harvests of heat-loving plants, and to obtain two harvests of some forage crops.

However, the main climate-related obstacles hampering the development of the agricultural sector in DTR are strong winds and the lack of rainfall. Along with anthropogenic loading, these factors are causing soil erosion, abandonment of land by farmers, and as a final result, the beginning of desertification. To mitigate these processes, since the 1930s, wind-breakers were systematically planted in DTR. In the 1980s they occupied 906 ha (60 metre wind state-owned breakers) and 865 ha (10 metre wind "Kolmeurneoba"-owned belts) of land. Wind-breakers played a significant role in moderating the microclimate of fields and vineyards, and protecting soil from wind erosion. Unfortunately, during the 1990s, these belts almost completely were cut down, as a result of which the productivity of the land has decreased.

Water deficit in the agriculture sector. Another natural factor impeding the development of agricultural production in DTR is the lack of water resources. It can be said that owing to the current minimal anthropogenic interference (arable land is not irrigated, wind-breakers have been removed, part of the land is abandoned, etc.) the situation in the region best reflects the impact of present climate conditions on crops and their yield.

To assess the influence of climate change on some crops and pastures, a deficit of water was estimated, which will cause a decrease of crop harvest and productivity of the pastures. The computer model CropWat (FAO), developed for just such investigations, was applied [11].

The shortage of water in DTR was assessed for winter wheat, sunflower and pastures in the past period of 1960-2005 (reference period) and in 2021-2100 (projected period). The climate change scenario for the future period was taken according to forecast obtained under the regional climate model PRECIS. To achieve better resolution in time, both reference and projected periods were divided into 15-year sub-periods. Values of climate elements fitting the model (air temperature and humidity, wind) were taken according to an observational series of local weather stations, while other parameters concerning specific properties of crops were taken according to FAO recommendations.

Calculations performed for the reference period indicate that in 1960-2005, the annual deficit of water for winter wheat, sunflower and pastures equals 25, 33 and 48% respectively. The analysis of future water demand proves that to the end of this century, on average, wheat is lacking almost half of the water needed, and sunflower even more. This is reflected in the fact that the harvest of this crop is usually very low and farmers prefer not to sow it. Trends of water deficit in the projected period for examined crops and pastures are shown in Table 4.1.3.13.

Table 4.1.3.13. Water deficit in agriculture

Crop	Water deficit, mm						
	1960-1975	1976-1990	1990-2005	2021-2035	2036-2050	2071-2085	2086-2100
Winter wheat	163	147	133	185	181	215	236
Sunflower	229	243	249	230	239	247	293
Pastures	296	292	288	320	326	335	364

The applied model does not link water deficit with crop productivity. The analysis shows that there is no direct correlation between these two elements and in some years outstandingly low wheat productivity corresponds to a relatively small value of water deficit. An additional survey indicates that such cases are linked to the high winds that are demonstrated by data presented in Table 4.1.3.14.

Table 4.1.3.14. Crop yield of wheat in DTR

Year	Water deficit (mm)	Crop productivity (tonne/ha)	Number of months through the vegetation period with the wind speed exceeding 25 m/s
2000	313.6	0	2 (max 40 m/s)
2001	90	4.00	1 (max 28 m/s)
2002	45	1.30	3 (max 40 m/s)
2003	119.6	2.00	2 (max 34 m/s)
2004	137.6	1.80	4 (max 34 m/s)
2005	160.1	2.20	0

As was mentioned earlier, in the absence of wind-breakers, the impact of strong winds on the productivity of crops is becoming gradually evident. This is more pronounced at an early stage of harvest formation, in winter and spring.

Under the anticipated changes, and a growing water deficit, several adaptation measures are to be urgently implemented in the DTR, some of which are considered in the worked out project proposals.

Protected areas and natural landscapes. As was mentioned above, a major part of the DTR territory is used as agricultural land. Hence, the natural landscape is preserved mainly on protected territories. Anticipated climate change in this region could turn a significant part of the DTR territory into subtropical arid steppes, covered by vegetation typical to semi-deserts and desert, with subsequent impoverishment of biodiversity.

As to the anthropogenic causes of changes in natural landscapes, they could be classified in the following way: (1) overgrazing; (2) cutting down of forests; (3) incineration of pastures and stubble; (4) ploughing of pastures and riparian forests; (5) hasty use of water resources.

Overgrazing already has affected about 80% of the DTR pastures, threatening a number of areas with the beginning of desertification.

The unfounded use of water resources also affects in some way the protected territories and natural landscapes. For instance, the construction of the Dali Reservoir has added tangible beauty to the landscapes of the Chachuna Natural Reserve but it has caused significant damage to riparian forests in the lower flow of the Iori River by restricting these territories from spring floods. That process is being aggravated by intensive and irrational use of water resources from the Iori River, and the flood discharge from its lower part does not now exceed 6-8 m^3/s.

The best way to restore natural landscapes in the DTR seems to be to rehabilitate wind belts, which along with the protection of soil from erosion are promoting the preservation of local fauna. At the same time, in appropriate places, natural landscapes should be enriched by plantation groves that could promote both preservation of biodiversity and provision of the local population with firewood, thus protecting wind-breakers from illegal cutting.

The role of protected areas in monitoring natural climatic change impacts on endemic species of flora and fauna is very important. As there is virtually no anthropogenic impact on natural landscapes in the protected areas, the changes in vegetation cover and fauna in these areas could serve as an additional indicator of climate change. For instance, in the last decade, such new species as porcupine and land rabbit are becoming familiar to the region, apparently as a result of migration from the hot and arid areas of Pakistan and Iran. At the same time in many places in DTR populations of pheasant are disappearing that in some way could indicate the beginning of a desertification process in the region. It should also be mentioned that in the natural landscapes of the DTR's protected territories, a number of centuries–old specimens of pistachio trees, Juniper, Black Poplar trees, and other rare plants have been preserved. In the form of their annual rings, they contain valuable information on the variability of climate in the region over past centuries.

Despite the scarcity of forest cover, this region possesses sufficient potential for the development of tourism in the region, owing to its large area of protected territories.

Climate change in the DTR could also affect in some ways the economy. The same applies to agriculture for the vegetation season, and the warming of the climate could bring an extension of the tourist season. However, this warming accompanied by a possible decrease in precipitation, could result in further aridisation of the climate, promoting desertification. Properly arranged adaptation measures should beneficially affect existing flora and fauna, and increase the attraction of tourists to the protected territories.

4.1.4. Kvemo Svaneti

General overview. Kvemo Svaneti (the Lentekhi region) represents one of the priority regions selected in the framework of SNC preparations, and has been identified as a vulnerable area to various and disastrous weather events, significantly enhanced by global warming. As a result of the increased frequency and intensity of these phenomena (floods, landslides, mud torrents, and snow avalanches), land erosion has intensified greatly, damaging agriculture, forests, roads and other communications, buildings, and other constructions, and has caused significant decreases in the standard of life and the acceleration of migration processes.

Considering these facts, in co-operation with local authorities and representatives of agriculture and forestry management expertise, an adaptation for climate change strategies has been worked out for the Lentekhi region, on the basis of which this concrete project proposal has been prepared.

Kvemo Svaneti is located in the central part of West Georgia's northern sector. It comprises the gorges of the rivers Tskhenistskali and Kheledula and is stretched along 85 km from the west to the east. The total area of the territory equals 1,344 km^2.
The terrain of Kvemo Svaneti includes many ranges, gorges, and hollows. From the north the terrain is limited by the Svaneti Range, which divides the watersheds of the rivers Tskhenistskali and Enguri. In the south, the terrain borders the Egrisi and Lechkhumi ranges, between which the Tskhenistskali River flows.

In the Svaneti Range, and over the greater part of the Caucasus Range bordering the Lentekhi region, about 20 small and medium size glaciers are situated, the lower limit equaling about 2,800-2,900 m. The total area covered by glaciers in the region exceeds 10 km^2.

The slopes of the three main ridges mentioned above are rugged, with deep and narrow gorges predominantly covered by forests. On the slopes of these high mountains, glacial circuses and moraines are quite frequent.

Extreme weather events activated by the climatic changes of the past century have produced a definite impact on the relief of the region, reflected in the intensification of erosion processes on the mountain slopes, the deformation of river banks, and the retreat of glaciers, though these processes so far have not produced any significant impact on the main forms of the mountain relief.

The complex relief of Kvemo Svaneti determines the diversity of its climate and due to its great differences in elevations, the climate here is characterised by a pronounced vertical zoning. Five climatic zones have been identified in the region, a short description of which is given in Table 4.1.4.1. In order to identify their climatic features, only two meteorological stations (Lentekhi and Koruldashi) are functioning in the region. To characterise other climatic zones, data from neighbouring meteorological stations have been used.

Similar to the climate zones situation of Kvemo Svaneti, the region comprises a lot of landscapes as well. At present, six types of landscapes [12] have been identified in the region, the most dominant being mountain landscapes, with beech and dark coniferous forests and evergreen bushes that are characteristic of 4-5 Georgian climatic zones.

Table 4.1.4.1. Climate zones of Kvemo Svaneti and their average features

Zone #	**Zone features**	**Range of elevations (m a.s.l.)**	**Averaged elevation of characteristic weather stations (m a.s.l.)**	**Mean annual values**	
				T m. (^{0}C)	**Precipitation (mm)**
1	Humid climate with temperately cold winter and long summer (3)	500-800	627	10.6	1,185
2	Humid climate with cold winter and long summer (4)	800-1,200	864	9.6	1,289
3	Humid climate with cold winter and short summer (5)	1,200-1,800	1519	5.6	1,331
4	High mountain humid climate without real summer (6)	1,800-2,800	2127	2.2	1,346
5	High mountain humid climate with permanent snow and glaciers (7)	> 2,800	3254	-4.2	1,186

Note: Numbering of zones in brackets is given according to M.Kordzakhia [7].

Changes in climate revealed over the past century in the territory of Kvemo Svaneti are still in the range of natural variability, and hence they have not affected the structure of the landscapes yet.

Among the resources of natural wealth in Kvemo Svaneti, along with water resources are the forests, which occupy 83,000 ha of land. 79,000 ha of this area are covered by woods, making up about 60% of the region's territory.

The cutting down of forests, largely practiced over the last two decades, has caused an increase in the area and frequency of landslides, and greatly damaged the forests. For example, in 1994, 80 ha of forests were destroyed by landslides, and in 1996 55 ha of beech forest had been completely dried out as a result of landslides. In an effort to mitigate the landslide processes in the region, this attached project proposal has been worked out in the framework of the current project.

Kvemo Svaneti is one of the richest regions in Georgia for water resources. More than 20 small and medium sized tributaries join the rivers Tskhenistskali and Kheledula, partially being fed by the remaining glaciers.

Similar to other regions of the world, current global warming has affected the Caucasus glaciers, causing their evident degradation. This process is reflected in the glaciers of Kvemo Svaneti, causing changes in the run-off of the rivers. As to the recourses of underground water, their average value in Kvemo Svaneti reaches 86 m^3/c, which exceeds by 3.5 times the resources of the artesian basin in the neighboring Racha-Lechkhumi region. The underground water resources play a significant role in the formation of river run-off. According to the results of a special investigation, the share of underground water discharge in the river run-off in this region varies in the range of 20-40%, making 30% on average.

The population of the Lentekhi region underwent significant change over the past two decades. Until 1987, 14,580 residents (3,200 families) lived here, but as a result of catastrophic snowfalls in 1986-87, and the following devastating floods in the late 1980s, almost 1,000 families were deported. By the end of the 1990s, the population of the region had decreased to 9,800. According to a 2003 census, the population here further decreased to 8,760.

The leading sector of the region's economy is agriculture (animal husbandry), in which a large part of the population is engaged. According to 2006 data, arable land here occupies 1,500 ha, and pastures and hayfields 22,000 ha. The main crops are potato, maize and haricot. The natural conditions of the region are very favourable for the development of animal growing, which in recent years has been progressing significantly. Along with stock-raising, favourable conditions here exist for the development of bee-keeping. Mineral resources are represented by arsenic and mineral waters. In other economic sectors, tourism and recreational facilities are promising.

Climate change. For an assessment of changes in climate elements during the last 15-20 years, only data from the Lentekhi station was available. Similar to the Dedoplistskaro region, to determine the change in climate element in Kvemo Svaneti, two 16-year "Standard" periods were examined: 1955-1970 and 1990-2005.

Data on the variation of the air temperature between these two "standard" periods in Lentekhi, are presented in Table 4.1.4.2, revealing an increase in mean annual temperature by 0.4^0C, in the last half-century.

Table 4.1.4.2. Variation of air temperature (^{0}C) in Lentekhi, 1955-2005

Month / Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
1955-1970 (I)	-1.1	-0.2	3.8	9.6	14.6	17.6	20.1	19.9	15.6	9.9	5.3	0.2	9.6
1990 – 2005 (II)	-1.7	-0.1	4.2	10.2	14.9	18.2	21.5	21.2	16.3	10.8	4.6	-0.2	10.0
Difference (II – I)	-0.6	0.1	0.4	0.6	0.3	0.6	1.4	1.3	0.7	0.9	-0.7	-0.4	0.4

Relevant changes have been observed in the extremes of air temperature (Table 4.1.4.3).

Table 4.1.4.3. Mean values of air temperature extremes (^{0}C) in Lentekhi, 1955-2005.

Period	Mean values	
	Absolute max	Absolute. min
1955 – 1970 (I)	34.7	-14.5
1990 – 2005 (II)	35.2	-13.8
Difference (II – I)	0.5	0.7

It can be derived from this table that in the past 50 years climate change has almost equally affected the rise in both temperature extremes. As with air temperatures, the averaged values of precipitation in the mentioned standard period in Lentekhi are given in Table 4.1.4.4.

Table 4.1.4.4 Variation of sums of precipitation (mm) in Lentekhi, 1955-2000

Month / Years	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
1955-1970 (I)	115	108	121	95	86	87	94	96	95	98	105	153	1,254
1990 – 2005 (II)	89	93	110	140	116	110	113	115	87	136	110	139	1,360
Difference (II – I) (%)	-26	-15	-11	45	30	23	19	19	-8	38	5	-14	106 (8)

According to this table, in the past half-century, precipitation in Lentekhi has increased by 106 mm on average, corresponding to a rate of increase of 30 mm/decade, in relative increments of 10%.

Data on the variation of air relative humidity (RH) are presented in Table 4.1.4.5 below.

Table 4.1.4.5 Averaged values of air relative humidity (%) in Lentekhi, 1955-2000

Month / Years	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
1955-1970 (I)	85	82	77	71	70	72	74	74	78	81	81	86	78
1990 – 2005 (II)	92	89	84	78	76	78	76	79	83	87	91	93	84
Difference (II–I) (%)	7	7	7	7	6	6	2	5	5	6	10	7	6 (8)

This table demonstrates significant changes in the wetting regime of Kvemo Svaneti, resulting in the growth of RH by about 5-7%, in almost all months except July and November. To characterise the changes in the wetting regime of the territory, a variation of the hydrothermal coefficient (HTC) was assessed for the same period in Lentekhi (Table 4.1.4.6). The data in this table clearly demonstrate a significant rise in the value of HTC during the past half-century, making 28% on average for the whole vegetation period. This observed growth in air temperature also caused an increase in the duration of the vegetation period by 3 days in the spring, and by 5 days in autumn.

Table 4.1.4.6 The variation of hydrothermal coefficient in Lentekhi, 1955-2005

Month / Period	IV	V	VI	VII	VIII	IX	X	Seasonal Average
1955-1970 (I)	2.9	1.9	1.6	1.5	1.6	2.0	2.9	2.1
1990 – 2005 (II)	4.1	2.5	2.0	1.7	1.8	1.8	5.1	2.7
Difference (II – I)	1.2	0.6	0.4	0.2	0.2	0.2	2.2	0.6

This observed prolongation of the vegetation period should positively affect stock-raising – the leading sector of agriculture in the region by an increase in the productivity of pastures and hayfields.

The increase in the wetting regime could promote the further spread of pests and diseases in the forests in the region. This tendency has been already revealed for the past 10-15 years. However, the anticipated end-century increase of air temperature in the region by 3-4^{0}C, and the 5% decrease in precipitation, could provoke a breach of the natural equilibrium in the forests, under the impact of a reverse process – i.e., an increase in the dryness of the climate.

The Lentekhi meteorological station is situated at the bottom of a narrow gorge and is surrounded by forests, thus causing negligible values of wind. According to measurements conducted since the 1970s, the average wind speed here varies in the range of 1.2-1.5 m/s.

Extreme weather events. For the last 15-20 years, the frequency of disastrous events caused by heavy precipitation (daily sums exceeding 30 mm) has obviously increased, and this is reflected in the growth of losses caused by floods and landslides, as well as in the growing trend of population migration from the region. One of the main reasons which could explain this process is the rise in intensity of the precipitation.

Heavy Precipitation. The analyses of 2000-2005 data on precipitation at the Lentekhi station show that the share of heavy showers in monthly sums of precipitations, varies in the range of 20-100%, making an average of 60%. It has also been revealed that the sum of precipitation in the months with heavy showers (exceeding the year average values) increased by about 12% in the second "standard" period, relative to the first one, though the number of months with heavy showers remained virtually unchanged, about 5 months per annum. The increase of precipitation in the warm period of the year (April-September) reached 19%, while in the cold period, only 10%. This result could partly be explained by the increase of losses caused by floods and mud streams (Table 4.1.4.7).

Table 4.1.4.7 Average values of monthly precipitation (mm) in months with abundant rainfall/snowfall.

Month / Period	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
1955 – 1970 (I)	192	166	166	135	127	129	142	154	142	146	167	233	1,899
1990 – 2005 (II)	177	131	193	194	154	167	165	183	120	215	180	241	2,120
Difference (II-I)	-15	-35	27	59	27	38	23	29	-22	69	13	8	221
Increment (%)	-7.8	-21.1	16.3	43.7	21.3	29.4	16.2	18.8	-15.5	47.3	7.8	3.4	11.6

Floods. One of the most dangerous events caused by heavy precipitation in Kvemo Svaneti is flooding which greatly damages the local population. Floods are originated by the melting of snow or by heavy showers, or by the combined action of both phenomena.

The available data on the quantitative observations of the Tskhenistskali River floods (hydrological post Rtskhmeluri) includes the period of 1937-1989, from which the unbroken series comprise 1967- 1989. These data are presented in Table 4.1.4.8.

Table 4.1.4.8. Mean values of main features of floods on the Tskenistskali River. Rtskhmeluri, 1967-1989

Features / Period	Number of cases	Duration (day)	Maximum discharge (m^3/s)	Ratio to multi-year mean discharge	Frequency of occurrence (per year)
1967 – 1979	4	7.5	444	6.6	0.3
1980 - 1989	7	5.6	485	7.2	0.7
Difference (%)		-25	+9	+9	230

The presented data averages for two approximately equal periods (13 and 10 years) demonstrate that within the limits of available statistics, in the second period, the recurrence of floods has doubled or more, and the maximum discharge has increased by 9%. At the same time the duration of floods has decreased by 25%, which could explain the growth in intensity and severity of floods.

Landslides. Along with the floods, another type of destructive event caused by heavy precipitation in Kvemo Svaneti is landslides, also very painfully affecting the local population. Until 1980 the 82 landslide plots were registered in the Lentekhi region, in which landslides have occurred systematically. Since then, in the last 20 years, the number of landslide affected areas has increased by 43%, and reached 117. The number of landslides had drastically grown after the catastrophically abundant snowfall in the winter of 1986-1987, which is reflected in Table 4.1.4.9.

Table 4.1.4.9. Dynamics of landslide affected areas in the Lentekhi region, 1980-1998.

Observation period	Number of landslide affected areas		
	Existing	Activated	Newly activated
Until 1980	82		
1980-86	87	44	5
1987-88	110	51	23
1989-91	112	25	2
1992-95	113	19	1
1996	113	13	-
1997	116	20	3
1998	117	10	1
Total	117	182	35

The disastrous events discussed above are affecting more or less all settlements in Kvemo Svaneti. However, according to data gathered from the local authorities, the main risk-factors in the region are land erosion and landslides. One of the ways to combat them is the planting of selected kinds of trees, and other vegetation, in the dangerous and vulnerable plots. In particular, this concerns hazelnuts, which have an exceptionally sturdy root system. Considering this fact, a project proposal has been developed and is presented in chapter 4.2.3.

Mudstreams. In the mountainous conditions of Kvemo Svaneti, heavy showers often bring about mudstreams, which destroy roads and communications, causing intensive erosion of river banks and slopes of gorges and ravines, in the territory of the Lentekhi region. Fifty mudstream-affected ravines were registered in the period 1980-1998, during which the passing of 145 torrents were registered. On average, a passing of 5-10 mudstreams takes place annually in the region. However, after the anomalous snowfalls of 1986-1987, in the winter of 1988, over 45 cases of mudstreams had been registered.

In a long period of time (1921-2005), obvious increases in the frequency of this event have been evident, since 1965 (Figure 4.1.4.1). In this figure, each 5-year period contains a cycle of years featured by extreme mudstream activity.

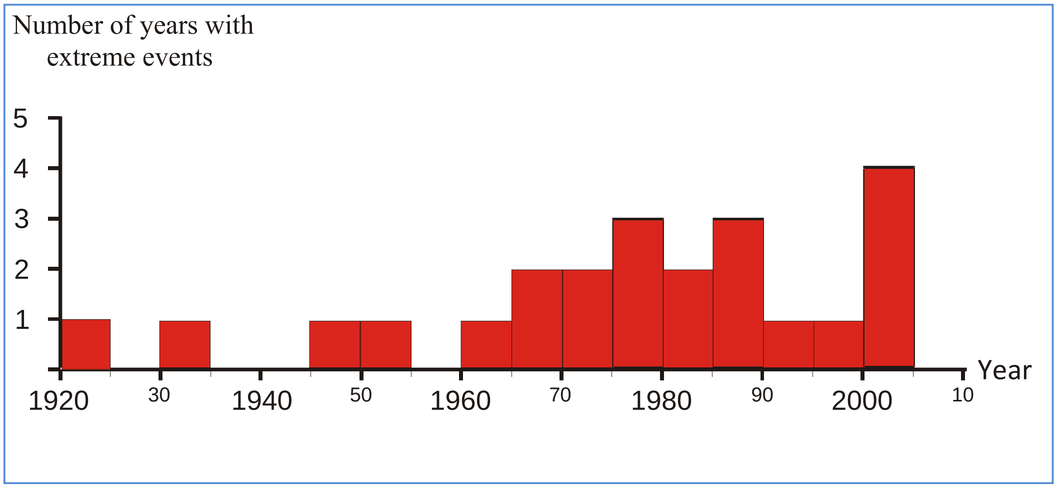


Figure 4.1.4.1. Extreme mudstream activity in the basin of the R. Tskenistskali, 1921-2005

Apart from the above-discussed disastrous events, in winters with abundant snowfall, snow avalanches pose great danger to the population of the region, especially in its upper zone. For example, during the snowy 1987-1988 winters, about 10 villages of Kvemo Svaneti appeared to be endangered by avalanches. Hundreds of families had to be evacuated and many parts of the motorway were blocked up. Moreover, snow avalanches have often damaged the forest cover.

Drought. The Lentekhi region is sufficiently rich in precipitation. Average values of monthly sums here vary in the range of 90-140 mm, and hence drought in the region is not such a devastating phenomenon as it is in the Dedoplistskaro region or in Kvemo Kartli.
According to 1965-2006 records, the annual number of days with drought in Lentekhi amounted to 42 on average, which is significantly less compared to similar values in Dedoplistskaro (about 70). The severity of drought in Kvemo Svaneti has been greatly alleviated by the abundance of small rivers and springs, making it possible to irrigate the arable land, in contrast to the DTR, where such actions are a costly endeavour.

However, similar to the DTR, current changes in climate have affected the duration of the drought period in Kvemo Svaneti. The comparison between the initial (1956-1972) and latest (1991-2006) periods shows that between these two sub-periods, the average number of days with drought has increased from 34 to 47, corresponding to a rise of 38%. The frequency of such events has also grown by 17% (Table 4.1.4.10).

Table 4.1.4.10. Drought periods in Lentekhi, 1956-2006

Period	Average duration of period with drought	Recurrence (year)
1956 – 1972 (I)	34	0.53
1991 – 2006 (II)	47	0.62
Difference (II –I) %	12 (38)	0.09 (17)

This table indicates that in spite of the abundance of surface water, the increase in the duration and frequency of drought could pose definite constraints to some branches of agriculture in the lower and medium zones of the region. The hazards of this are increasingly taking into account the anticipated end-of-century significant growth in temperature and decrease in precipitation, bringing about a corresponding decline in the wetting/watering regime.

Climate change forecast for 2100. Against a background of general forecasts for the changes of climate elements up to 2100 in West Georgia, similar to the Dedoplistskaro region, specific calculations were carried out for the Kvemo Svaneti region, using the PRECIS regional climate model.

Simulations indicate that to the end of current century, increments of annual temperature in the region could reach 3.5^0C, accompanied by a decrease of precipitation by 60 mm, making up about 5% of the baseline period value. According to the data of neighbouring meteorological stations which characterise the Lentekhi climate zone, the mean annual temperature in this zone equals 10.4^0C, thus giving a projected value for 2100 for this zone up to 13.9^0C.

Given this background of changes in temperature and precipitation, the calculations predict a decrease in the mean annual air relative humidity (RH) by 6%, assuming virtually unchanged wind velocity.

These projected changes in climate elements will bring about a corresponding alteration in the wetting regime of the territory. If the value of HTC between the first and second "standard" periods has already increased from 2.1 to 2.7, related to the anticipated changes in temperature and precipitation, it would decrease down to 1.9 for 2100, which would transform the lower part of the region from a temperate-humid category into a category of temperate wetting. At the same time it would bring about the prolongation of the vegetation period from the present 185 days, up to 210-215 days.

The predicted changes in climate elements to the end of current century are considered to produce an impact on water resources, ecosystems, and the economy of the region. The anticipated scale and results of this impact are discussed below.

Water resources. The surface water resources of Kvemo Svaneti are represented by the upper reaches of the Tskhenistskali River and its tributaries. For the assessment of climate change impacts on the run-off of the Tskenistskali River the hydrological model WEAP was applied, using scenarios out to 2100 regarding changes in air temperature and precipitation.

In the first stage, validation was performed for the eastern part of the watershed from the head of the river down to the hydrological post in Luji. The mean monthly values of air temperature and precipitation for this period came from the Koruldashi meteorological station, located in this part of the river basin, as well as from hydrological records for the same period. These data were used to calibrate and validate the model, along with relevant information on the relief, geological structure, types of soil, and vegetation cover of the region.

To assess the anticipated change of input climate parameters the PRECIS regional climate model was used. Unfortunately, validation of WEAP model for this region showed that none of the climate models applied in PRECIS simulates the past (1962-1986) increase in river run-off at the acceptable level. Presumably, this may be explained by the presence of glaciers in the examined territory, which are influencing the local climate, and which were not relevantly accounted in the PRECIS and are not considered in WEAP at all. To tackle this discrepancy, the climate change scenario forecasted for West Georgia (not localized, see section 4.1.1) has been used. Based on this scenario the model showed that to the end of the current century a 9% decrease in run-off at the Luji post can be expected (Table 4.1.4.11).

Table 4.1.4.11: Average annual values of Tskhenistskali River run-off in a 28-year period (post Luji)

Period	**Total run-off (million m^3/yr)**
1958 – 1986	703.0
2072 - 2100	638.7
Difference (%)	(-9%)

In the seasonal distribution of run-off, a significant decrease (by 41%) was derived for summer, with a moderate increase (by 11%) in spring, allowing the anticipation of some decline in the intensity of summer floods. This forecast was made without the consideration of feeding from glaciers, the inclusion of which may bring some future correction of results obtained.

For the application of this result to the whole territory of the upper part of the Tskhenistskali River basin, a correlation between the monthly values of discharge of the hydrological posts of Luji and Rtskhmeluri were analysed for the same period of 1958-1986. The correlation between these two series appears to be sufficiently close, along with their similarities of inter-annual variations. This result makes it possible to assume that the trend of run-off observed in the initial part of the river, from its head to the post Luji, is reflected along its whole upper reaches, down to post Rtskhmeluri, and to the end of the current century (2070-2100), the runoff at this part of the river could decrease by 9%, with a pronounced decline in the summer season.

Agriculture. The location, relief and climate of the Lentekhi region are complicating the development of agriculture. The vertical zoning of climate, steep slopes and erosion processes hamper land cultivation in the region.

The increase in the frequency of disastrous phenomena related to current climate change: heavy precipitation, floods and landslides, etc. have negatively affected the already low efficiency agricultural development of the region. The area of arable land in the period 1990-2007, decreased from 2,200 ha to 1,500 ha, and that of the perennials, from 380 to 130 ha. The area of hayfields declined by 1,300 ha, and of pastures by 6,000 ha, and the number of cattle decreased from 15,000 to 9,000 ha, and that of swine from 12,000 to 5,000.

The intensification of disastrous events and the making of an agriculture sector have engendered the above mentioned depopulation of the region.

Statistical data on the productivity of loading crops during 1958-1970 and 1955-2007 were compared in order to assess the impact of climate change on the agriculture of Kvemo Svaneti, in the second part of the last centuary. The average values of crop yield for these periods are given in Table 4.1.4.12.

Table 4.1.4.12. Productivity of major crops in the Lentekhi region, 1958-2007

Period \ Crop	Maize		Potato	
	Total yield (tons)	**Productivity (ton/ha)**	**Total yield (tons)**	**Productivity (ton/ha)**
1958 – 1970 (I)	1187	1.07	581	4.09
1995 – 2007 (II)	914	1.54	2158	9.40
Difference	-273	0.47	1577	5.31
(II-I) %	-230	+44	+271	+129

It can be derived from this table that between the two examined periods of time, the productivity of both crops increased, which could be explained by the better care of privatised land in the second period. As to cattle breeding, the number of cattle between these periods declined by 26%, from 11,585 to 8,553. At the same time, milk production experienced a significant rise in the yield of milk, after privatising the cattle and the much better care for them in private farms.

To the end of the current century, as a result of climate change, fundamental alterations are expected in the agriculture sector of the Lentekhi region, featured by wide possibilities in the diversification and intensification of production. In particular, the growing potential in citrus, fruit, and vegetable production, will promote development in the regions of tourism and in the recreational sector, being in the forefront of new priority directions for our country. A widening of the forage production area in the high-mountain zones will significantly enhance the development of animal husbandry, promoting the intensification of the mentioned sectors as well.

The projected scheme for this transformation, to the end of the current century, has here been drawn and presented below in Table 4.1.4.13. For the baseline year in this scheme, 1965 was chosen, in which time a comprehensive agroclimatic survey had been undertaken, relevant to conditions, free of significant anthropogenic loading.

Table 4.1.4.13. Anticipated transformation [to 2100] of agroclimatic resources in the Lentekhi region

1965							2100					
Vertical zone (m)	**Temperature, ^{0}C**		**Duration of vegetation period (day)**	**Precipitation in warm period (mm)**	**HTC**	**Agriculture specialisation**	**Temperature, ^{0}C**		**Precipitation in warm period (mm)**	**HTC**	**Agriculture specialisation**
	Mean annual	**Sums of active temperatures**					**Mean annual**	**Sums of active temperatures**			
Piedmont zone, 500-800	11.5-9.5	3,600-3,000	200-180	590-720	1.9-2.3	Growing of vine and fruit, production of maize, soy-bean: vegetables, melons and gourds	15.0-13.0	4,500-4,000	520-650	1.3-1.5	Tillage all year round, citrus growing, 2-3 yields annually of maize and vegetables
Low mountain zone, 800-1200	9.5-7.5	3000-2400	180-150	590-700	2.3-2.6	Production of champagne wine materials, fruit juices, vegetables, maize soy-beam, etc.	13.0-11.0	4000-3600	520-630	1.5-1.65	Tillage through most of the year, high quality wine-making, intensive growing of fruit, maize and vegetables

Mid-mountain zone 1200-1800	7.5-5.0	2400-1800	150-120	570-700	2.6-3.9	Animal husbandry, production of forage, maize for silage, barley and potato	11.0-9.5	3600-3200	500-630	1.65-1.75	Growing of vine, fruits, vegetables, production of forage and maize, early potato
High mountain zone 1800-2400	5.0-0.0	1800-500	120-80	700-800	3.8-7.2	Animal husbandry, production of forage, barley, potato vegetables and protected ground (greenhouse tracks)	9.5-6.5	3200-2200	630-730	1.65-3.4	Growing of vine (champagne), fruits (stone-fruits, hazelnut, nut) vegetables, maize forage, potato
Subnival zone, 2400-2850	0.0-2.5	0	0	600-500	>7.2	High mountain hey fields and pastures	6.5-1.5	2200-1500	530-430	> 3.5	Production of forage, stone-fruits, vegetables (in greenhouse tracks), early potato

Forests. Among the main natural riches in Kvemo Svaneti, along with water resources are forests. Five forestry farms here occupy about 85,000 ha, of which 77,000 ha are covered by forests, taking up about 60% of the region's territory.

The kind of structures of the forests varies according to vertical zoning. Changes registered in the forests of Lentekhi region, during the past decades, are presented in Table 4.1.4.14.

Table 4.1.4.14. Changes registered in the forests of the Lentekhi region, 1987-2005

#	Years / Features	1987	1997	2005
1	Area of forestry farms (ha)	80,150	82,989	59,002
	Among them covered by forest (ha)	78,962	78,044	55,617
2	Area of protected territories (ha)			23,140
	Among them covered by forests (ha)			21,512
3	Total area, ha			82,142
	Among them covered by forest			77,129
4	Total stock of timber (million m^3)	13,544	15,495	15,590
5	Area covered by dominant kinds (ha)			
	Beech	35,676	36,347	32,722
	Fir-tree	9,252	9,051	8,595
	Hornbeam	3,173	3,473	4,654
	Birch	8,788	8,730	9,517
	Spruce	4,609	4,643	4,938
	Oak	1,150	4,393	3,867

This table shows that for the examined period, some dominant kinds of trees (beech, fir-tree) have lost some part of their area, though some of them (hornbeam, birch, spruce) have increased their presence. Presumably, the cause of these changes is related to anthropogenic activity.

As to the impact of climate change, the changes in air temperature and precipitation in Kvemo Svaneti, for the past half-century, are still in the range of natural variability and they could not have significantly affected the forests. However, for the last 15-20 years, the growing spread of pests and diseases has been observed in the forests of the region. In particular, if this index in 1986-1996 did not exceed sanitary norms, in 1997-2005, the number of spruce trees hurt by Ips typographus had increased up to 8%, and the number of Dioryctria splendidella up to 7.3%. The spread of Phellinusa pine (7.6%) and Armillatia mellea (3.5%) had also grown in the coniferous species. Given the background of the recent rises in temperature, the number of injured (to 20%) and excessively dry (to 8%) trees, have increased as well, transforming the Lentekhi region forests into a highly vulnerable category. The projected trends of climate change for the region, if they come about, may presumably further increase the vulnerability of the Kvemo Svaneti forests.

Based on the results of the survey of the ecological status of the forests of the Lentekhi region, a number of degraded forest groves were selected in different areas, whose rehabilitation will be necessary to avoid the already developing processes of landslide formation, and the development of other negative phenomena.

Glaciers. According to direct topographic measurements carried out in 1953-1958, twenty small glaciers were registered in the basin of the Tskhenistskali River, a total area which reached 12.5 km^2. Among them, the most significant was the Koruldashi Glacier covering the Caucasus Mountains; the glaciers of the Tskhenistskali River basin are currently undergoing a process of intensive degradation. In particular, direct observations undertaken during 1965-1990 revealed that the rate of retreat of the Koruldashi Glacier varied in different years, from 2.0 m/yr to 4.6 m/yr, making on average a retreat of 3.4 m per annum.

Due to an absence of measurements data since 1990, to assess the trend of this ongoing glacier degradation, in the Tskhenistskali River basin, the results of a co-operative survey of the Central Caucasus glaciers, performed by researchers from the Reading and the Moscow State Universities, were used [14]. According to these results, based upon the analyses of satellite images, obtained for the period 1985-2000, it was determined that in the examined period, the mean rate of the glaciers retreat was equal to 8 m/yr, and that the area covered by glaciers had decreased by 6-9%. The assessment based upon these results has shown that for the past half-century, the total area of glaciers in Kvemo Svaneti may have decreased by 25%, and their total volume may have been reduced from 1.2 km^3 down to 0.8 km^3, which corresponds to the present stock of water in them, equal to 700 million m^3. The projected rise in temperature, up to 2050, may result in the total disappearance of glaciers in Kvemo Svaneti.

4.1.5. Health

The study on the vulnerability and possibilities of human health adaptation to climate change was conducted both for the whole territory of Georgia, and, as far as possible, for the selected priority regions [15]. This survey was also based upon long-term statistics available at the Ministry of Health Care, as well as from the data of major medical centres on the spread of basic diseases, and their trends for recent years.

On the basis of this study, higher risk groups have been identified, those being the most vulnerable in their health to climatic changes. Attention was focused predominantly on the impact of high air temperatures and the probability of heat wave induced disorders being spread. It was determined that the probability of such heat disorders is highest in elderly people, and to a lesser extent in small children. Finally, it was derived that the most sensitive category to changes in climate elements was that of elderly people.

According to studies performed up to 2003, the leading cause of death in the mortality structure of Georgia was cardiovascular disease (65.6%, index 637.5 per 100,000 residents) and oncological illnesses (12.3%, index 131.2). In third place came disorders of the digestive organs (4.8%, index 51.4).

As for the morbidity rate, the main causes of death in the adult population are first blood circulation system illnesses, secondly, infectious and parasitic diseases, then ailments in digestion, and illnesses of the respiratory and endocrine systems. In recent years the trend towards an increase in the frequency of blood circulation system diseases became evident in Georgia as a whole. According to the questioning of physicians of different profiles, the impact of climate factors has been reflected mostly in arterial hypertension and stenocardia/infarction. These diseases are most affected by high temperatures, while pathologies of the respiratory system are primarily caused by low temperatures and high humidity.

As for infectious illnesses, an analysis of the distribution of the vector borne diseases indicated that malaria is spread predominantly in the extreme eastern part of Georgia – in the Kakheti region (including Dedoplistskaro) and leishmaniasis is still localized in Tbilisi.

In the Dedoplistskaro region where for the past half-century an increase in the mean annual temperature of 0.6^0C has been detected, is the first place where the hazards of spreading vector-born diseases and diarrhoea pathologies are to be expected. International experts agree that the manifestation of new cases of transmitted infectious illnesses and the increase in their frequency can be used as an indicator of the changes in local climate conditions.

According to studies conducted in different countries, the optimum temperature range for the activisation of vector–carrying insects is 26 – 30 ^{0}C. The meteorological observations carried out in Dedoplistskaro in 1990-2005 have shown that in summer the mean monthly temperature here at present varies between $19.6–22.9^0$C, which does not create favourable conditions for the massive activity of vector–carrying insects throughout the entire summer period. However, according to the forecast, the increase of monthly temperatures by 5.9^0C is anticipated in summer, resulting in the increase of mean monthly temperatures up to the range of $25.5–28.8^0$C. This means that to the end of the current century the essential deterioration of conditions causing the spread of vector-born diseases is expected in the DTR.

Among the infectious diseases, only malaria and leishmaniasis have already spread in Georgia, and the targeted hotbed of malaria is believed to be Kakheti, and to a lesser extent the neighbouring Kvemo Kartli region. The variability of local cases of malaria throughout 1996-2005, is shown in Figure 4.1.5.1.

From the detected total of 438 cases, 319 cases (73%) were attributed to the Kakheti region.

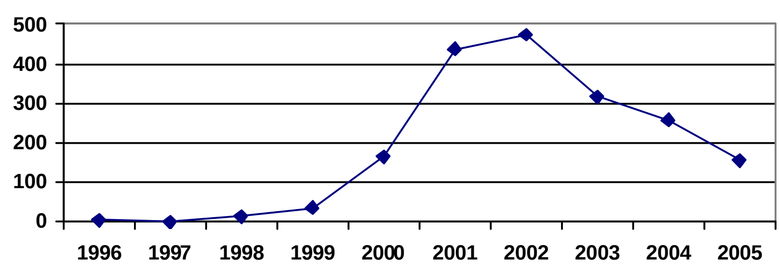


Figure 4.1.5.1. Trend of malaria cases in Georgia, 1996-2005

As a result of efforts undertaken by local health care services, after 2001-2002, a decline in malaria cases became obvious. However, the complete eradication of malaria could not be achieved in Georgia, partly due to the spread of infection from neighbouring Azerbaijan, and Armenia, where the number of people infected is even much greater.

Unlike cases of malaria, the dynamics of leishmaniasis cases in Georgia (mainly in Tbilisi) for the same period of time shows an increase of cases, up from 15 in 1995 to 160 in 2005 (Figure 4.1.5.2).

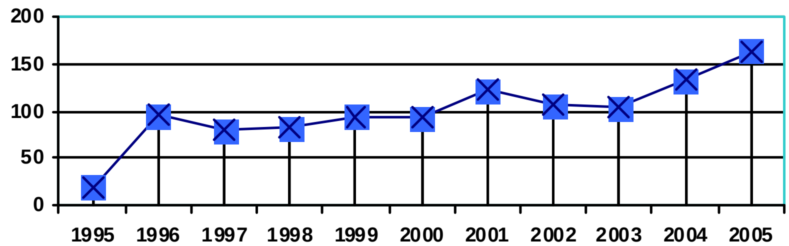


Figure 4.1.5.2. Trend of Leishmaniasis cases in Georgia, 1996-2005

Hence, as the problem of malaria is of special importance for Armenia, leishmaniasis is more widely spread and, consequently, more important in Georgia.

The number of registered cases at the present time does not give enough reason to say that there is an epidemic of leishmaniasis, and moreover of malaria, in Georgia. Nevertheless, in case of a growth in the mean annual temperature, an increase in the frequency of these parasitic infections shall follow this trend. The DTR is a very favourable territory for the spreading of malaria, and hence the health care services have to establish necessary controls to reduce to a minimum the anticipated risks.

Along with air temperature, an increase in the frequency and duration of drought affects the spread of infectious diseases. The risk of a diarrhoea epidemic is sufficiently high in the DTR, with its chronic water deficit. According to some estimates, an increase in the mean temperature of 1^0C causes a growth of diarrhoea cases, by 8%.

Turning to statistics on the spread and frequency of diseases in Kvemo Svaneti and neighbouring Racha–Lentekhi region, in 2003 and 2004, an alarmingly high frequency of blood circulation disorders had been detected there: in a population of about 60,000, 21-22,000 sicknesses and 2,500-2,600 illness cases had been registered there annually, exceeding the average of the Georgia Index by 3.5 (sickness) and 1.6 (illness).

The presence of 8 resorts in the territory of the Lentekhi region indicates that the natural conditions here are favourable to human health, and therefore the reason for cardiovascular diseases should be found in relation to other factors. Presumably, this fact could be caused by hard socio-economic conditions, aggravated in recent years by the impact of disastrous events related to climate change. Another important factor is believed to be the aging of the population, caused by an intensive flow of youth out of the region, in view of the deteriorating socio-economic situation.

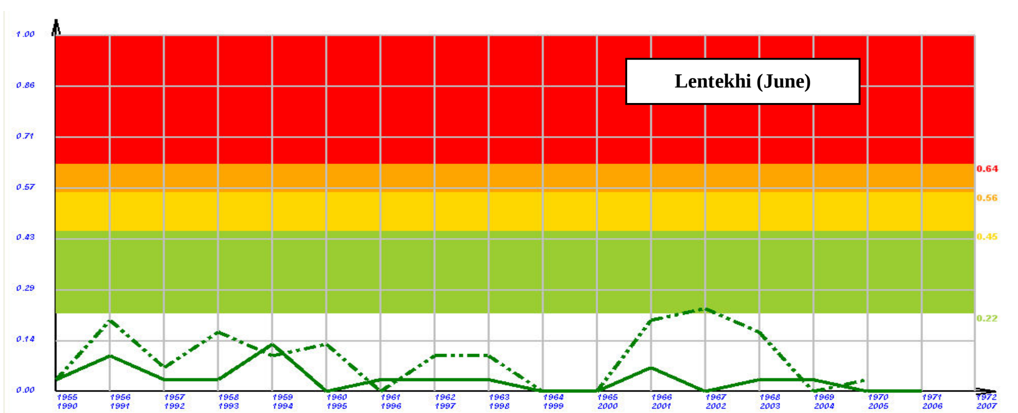
Along with the above-discussed diseases, human health is threatened by heat waves, the frequency of which has increased significantly in relation to global warming. To define the intensity of these waves, different indices are used, including the Heat Wave Index (HWI), which is calculated by a combination of air temperature and humidity, and the wind speed. The value of this non-dimensional index varies in the range of 0 to 1. A value below 0.22 corresponds to comfortable conditions; the value between 0.22 and 0.45 varies in the range of hazards, when a long presence of high temperatures or physical loading causes human tiredness. The index value 0.45 – 0.56 represents extreme hazard limits, with 0.56 – 0.64 denoting clearly hazardous conditions, and more than 0.64 – extremely hazardous conditions.

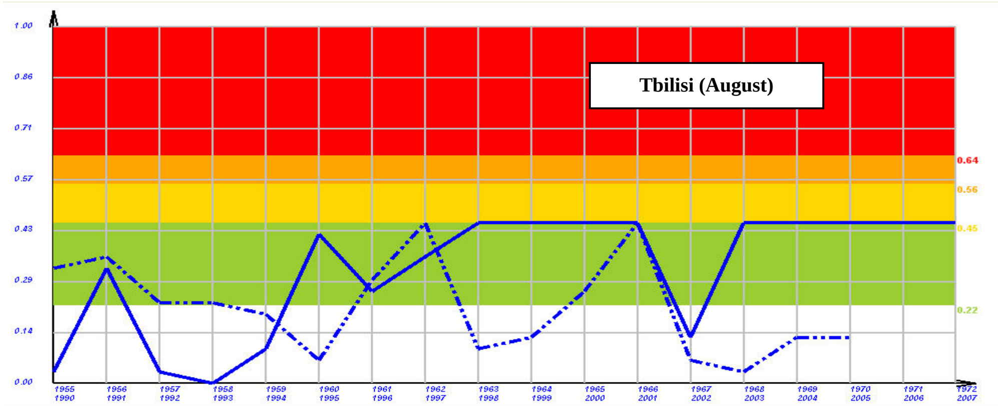
In the framework of the first survey undertaken during the preparation of the SNC, the values of HWI were calculated for the above-mentioned "standard" periods, using the records of the meteorological stations Lentekhi, Tbilisi and Dedoplistskaro. The examined time period included 5 months during the warm season, from May to September. Most of the cases reaching hazardous limits were observed in Tbilisi during the second "standard" period, in July and August, and in Lentekhi for the first period – in May. The variation in the number of years with monthly values exceeding the lower limit of hazard (0.22) is shown in Table 4.1.5.1, according to which the occurrence of HWI values above this limit has significantly decreased over the last years in Lentekhi, and considerably increased in Tbilisi, remaining practically unchanged in Dedoplistskaro.

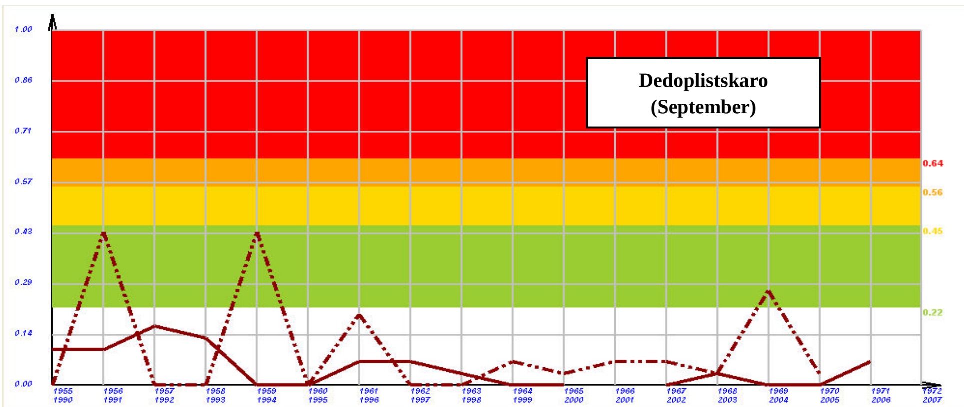
Table 4.1.5.1. Number of cases exceeding critical limit (0.22) of HWI index

Site	Period	Month					Total	Difference (II – I) %
		V	VI	VII	VIII	IX		
Lentekhi	1955-1970 (I)	15	1	0	0	4	20	-35
	1990-2005 (II)	10	0	1	1	1	13	
Tbilisi	1955-1970 (I)	8	2	8	8	2	28	+28
	1990-2005 (II)	8	1	13	13	1	36	
Dedoplistskaro	1955-1970 (I)	13	1	2	0	3	19	+5
	1990-2005 (II)	8	0	5	7	0	20	

To illustrate the above mentioned results in the Figure 4.1.5.3 most critical months are demonstrated for Lentekhi, Dedoplistskaro and Tbilisi.







Figures 4.1.5.3: Course of HWI indices in I and II periods*

Correlation of the obtained results with a variation in the frequency of blood circulation and other diseases, has been hampered by an absence of relevant medical statistics, although it could be said that a clear tendency in the growth of HWI in Tbilisi may be connected to the "urban heating" effect, which has caused a significant rise in mortality in large cities (Paris, London, New York, etc.), especially in the category of elderly people.

4.2. Adaptation measures

4.2.1 Black Sea coastal zone

The Black Sea coastal zone adaptation strategy. In the process of preparing Georgia's SNC, it has once more been confirmed that Georgia's Black Sea coastal zone, and especially its Poti and Adlia sections, are the most vulnerable ecosystems to global warming in the country.

Description of the problem. The global warming and climate change process is accompanied by a number of phenomena provoked by this process itself. These phenomena are regarded as indicators for the assessment of marine ecosystem vulnerability. The vulnerability of marine ecosystems is determined by the intensity of their exposure. To assess the vulnerability to climate change of the Georgia Black Sea coastal zone a number of criteria were selected, on the basis of which the following hazards were identified:

* I period bold line; II period discrete line.

- Given the background of current global warming, four major hazards were revealed for the Black Sea ecosystem: an increasing rate of eustasy (sea level rise relative to land); growing intensity and frequency of storm surges (storms), and change in their seasonal appearance; increasing intensity of sedimentation processes in the deltas of glacier-fed rivers (endangering only the Rioni Delta and its mid-flow) and changing thermal features of the sea. The growing probability of days with heavy precipitation increases the probability and intensity of floods at the Rioni River, as the backwater curve of river discharge into the sea is rising. Besides these four indicators directly connected with the marine ecosystem, an important role is played by air temperature changes and the growing probability of heat waves during the tourist season.

In addition, the above changes are accompanied by:

- Loss of human lives during the storms and floods, stress, injuries, spread of infectious diseases that could cause especially great damage in densely populated deltas having well-developed infrastructure (Poti, Batumi);
- Migration of populations resulting from storms, floods and permanent erosion of coastline, which nowadays is a problem only at the Adlia coastal sector, but which could threaten settlements in the deltas of other rivers;
- Disintegration of infrastructure or decline in the efficiency of its separate elements as a result of storms, floods and constant washing away of shoreline. The sea level rise, without storms and floods by themselves, causes damages to infrastructure that are clearly illustrated by the Sokhumi section of coastal zone. The eustasy causing a permanent sinking of Sokhumi Terrace is also creating growing problems for the city municipality, through the permanent decrease of underground communications inclinations. Since the 1990s, in some districts of the city, the sewage water network has even attained negative inclinations, relative to the sea;
- Storms, floods and permanent erosion of the coast are causing a washing away and degradation of beaches, that could seriously affect the tourism industry;
- Despite the fact that agriculture in this region is not a leading sector of the economy, the salinisation of agricultural soils is greatly damaging and could damage in future that part of the population for which the main source of income is agriculture, and in particular the growing of citruses. Presumably, as a result of eustasy, this process is going on at present and should cause significant losses in the future as well;
- The change in air temperature could affect the tourist and vegetation seasons (for details see the vulnerability section);
- The sea level rise produces profound negative impacts on the preserved territories and on Lake Paliastomi in particular. During the period 1927-2006 the water temperature in the lake had risen by 0.7^0C, which was accompanied by an increase in water-plant coverage. This intrusion of sea water has increased the salinity of water in the lake, causing the substitution of endemic kinds of fish by marine fish;
- The change in sea water temperature jeopardises the fishing sector, as the habitat of fish has been sharply altered.

Measures to be implemented. Considering the hazards discussed above, the following measures have been planned to be implemented in both short and relatively long periods of time:

- Periodically informing the local administration of the ongoing processes of climate change and their economic implications. The hazards of which local governments are to be constantly informed, so that they can take necessary measures for avoiding these risks in the most efficient way, are listed below:

1. The impact of climate change on **marine ecosystems**. The greatest jeopardy related to climate change is the sea level rise that is enhancing wave activity and intensity of coastal erosion. The frequency and intensity of storms could grow even more. Given the background of glacier melting sedimentation processes in the deltas of glacier-fed rivers, this process will intensify further, which makes it more dangerous for both sea rise and storms. The change in sea surface temperature is influencing the tourism industry, and habitats of fish. The increase of air temperature and the frequency of heat waves (if they should occur) will seriously affect tourism.
2. The impact of climate change on the **tourism sector** (sea water and air temperature, heat waves, infectious diseases, degradation of beaches) is one of the most important questions which are to be frequently discussed by local government and the Tourism Department.
3. The impact of sea level rise and storms on agriculture (salinisation of arable land)
4. The impact of sea level rise and intensified storms (storm surges), caused by climate change, on the local infrastructure (transportation network, oil terminals, Poti and its infrastructure, Batumi and its infrastructure, etc.)
5. Climate change impacts on fisheries. The alteration of aquatic environment thermal conditions causes relevant changes in the habitat of plankton, and related kinds of fish. At the same time, as a result of the cooling or warming of upper layers, plankton from the 10-15 m horizon move higher or lower by 5-7 m. Hence, it should find itself in a more favourable or unfavourable environment, provoking an increase or decrease of its population. This circumstance could produce sharply different impacts on the most important ring of the marine ecosystem – some kinds of marketable fish (such as the Black Sea horse-mackerel, scomber, and herring), strengthening or weakening their populations. Moreover, endemic species are being replaced by new kinds of fish.
6. Climate change impact on the Kolkheti Protected Area and on Lake Paliastomi in particular. Since 1970 the surface temperature in the Lake has risen by 0.60C.

Measures to be implemented in the short term

- Creation of permanent monitoring and early warning systems for Black Sea level rise and storm intensity;
- Establishment of a permanent Committee to plan and implement the adaptation measures to climate change,;
- Implementation of coastal zone protection measures in the Rioni Delta;
- Carrying out of sea shore protection measures at the Batumi-Adlia section aimed at the protection of the Batumi coastal zone;
- Preparation and implementation of adaptation measures for Lake Paliastomi.

Long-term measures

- Assessment of climate change impacts on the development of tourism (heat waves, water temperature, beach degradation) and preparation of adaptation measures;
- Rehabilitation of eroded and salinised soils;
- Consideration of anticipated climate changes in the local infrastructure developmental process.

Climate change adaptation strategy for the Black Sea coastal zone

Main strategic objective	Key target groups	Activity	Potential lead entity	Output	Potential donors
Short-term objectives	• GoG; • Poti and Port Administration; • Government of Adjara.	The short-term adaptation to climate change strategy of the Black Sea coastal zone implies the creation of a monitoring system in the Rioni Delta and carrying out of coast-protection measures in the Rioni Delta	• Coast Protection service; • Local administration.		Government of Georgia, Georgia's National Communication, CDM projects
1. Periodically informing local government on the current processes and their economic implications	• Poti and Batumi local municipalities; • Local private sector.	• Assessment of climate change in the Black Sea coastal zone; • Assessment of marine ecosystems indicators (eustasy, storms, sedimentation, thermal parameters) against the background of current and future climate change; • Assessment of the impact of climate and marine ecosystems parameters change on the environment, social sphere and economy (on the basis of selected indicators); • Preparation of reports and publications.	• Hydrometeorology and Climate Change Administration at the Ministry of Environment Protection and Natural Resources.	• Local government informed of current processes and anticipated adverse results.	GEF, Government of the Netherlands, GoG, Local government
2. Creation in the Rioni Delta of a permanent monitoring and early warning system for observing the Black Sea level rise and storm intensity	• Poti and Samtredia municipalities; • Port and oil terminal authorities; • Authority of Kolkheti Protected Area; • Emergency situations staff; • National Environment Agency and it's observation stations (Poti, Samtredia, Zestaphoni); • Private sector.	• Creation of permanent monitoring centre at three locations: Poti, Samtredia and Zestaphoni; • Carrying out of observations: in Poti on meteorological, hydrological and oceanological parameters; in Zestaphoni and Samtredia on meteorological and hydrological parameters (Rioni River); • Provision of communication system functioning between the three observation stations; • Establishment of early warning system for the local government, population and private sector having vulnerable facilities; • Preparation of Action Plan for extreme situations .	• Poti and Samtredia local administrations; • Local authority of Kolketi Protected Area; • National Environment Agency.	• Permanent monitoring system in Poti, Samtredia - Rioni HPP and Zestaphoni installed; • Emergency Action Plan for all vulnerable segments and entities prepared for emergency situations; • Trainings are carried out aimed at all stakeholders for the efficient implementation of existing Action Plan.	Project proposal is submitted to GEF (2006), Port of Poti administration, oil terminal
3.Establishment of Committee to plan and implement the measures for the adaptation to climate change	• Government of Georgia; central authority and local administration.	• Preparation of recommendation for the Georgian government on the establishment of Committee to implement the adaptation strategy for the Black Sea coastal zone;	• Ministry of Environment Protection and Natural Resources;	• Committee on the implementation of adaptation strategy for the Black Sea coastal zone established and has	Government of Georgia, GEF

		• Preparation of enabling legislative basis for the implementation of adaptation measures; • Carrying out of consultations with all stakeholders; • Preparation of Adaptation Action Plan.	• Ministry of Justice.	clearly defined rights and obligations; • Legislative basis for the implementation of adaptation measures created; • Action Plan for the Black Sea coastal zone adaptation to climate change prepared and adopted.	
4.Implementation of coast protection measures in the Rioni Delta	• Poti local administration and Coast Protection Service of the National Environment Agency.	• For a number of coast protection scenarios discussed in the project proposal on the adaptation measures in the Rioni Delta most optimal should be chosen; • Measures planned in the framework of selected scenario should be implemented. Presumably, these measures are: construction of sediment keeping mole at the Poti Canyon, and boons to the south of “Didi” Island.	• Coast Protection Service of the National Environment Agency.	• The rate of sea shore erosion and washed away areas decreased; • Floods on the Rioni River become less dangerous and destructive; • The adverse impact of storms upon the coastal zone lessened; • Local infrastructure and population more protected, economic loss decreased; • The impact of climate change on protected territories decreased.	International aid programmes, Government of Georgia, local budget
5.Carrying out of coast protection measures at the Adlia-Batumi section aimed at the protection of Batumi coastal zone	• Batumi local administration and Coast Protection Service of the National Environment Agency.	• For a number of coast protection scenarios discussed in project proposal on the adaptation measures in the Chorokhi Delta (Adlia-Batumi section) most optimal should be chosen; • Measures planned in the framework of selected scenario are to be implemented. Presumably, these measures are: building of sediment keeping hydrotechnical constructions, artificial refilling of existing deficit in the coastal sediment budget.	• Coast Protection Service of the National Environment Agency.	• The rate of sea shore erosion and washed away areas decreased; • The adverse impact of storms upon the coastal zone decreased; • Local infrastructure (airport, transportation network, etc.) and population are more secure; • Anticipated economic loss decreased; • The negative impact of climate change on tourism decreased.	Government of Turkey, (Debt-for-Environment), the Chorokhi HPPs cascade Authority, Government of Georgia, local budget

6.Preparation and implementation of the Lake Paliastomi adaptation measures	• Administration of Kolkheti Protected Territory.	• Detailed investigation of climate change impact on the Lake Paliastomi (water temperature, salinisation and their impact on fish); • Preparation of adaptation measures; • Searching for investments to implement the adaptation measures.	• Department of Protected Areas Administration of Kolkheti Protected Territory.	• Report on climate change impact on the Lake Paliastomi prepared; • Adaptation measures selected; • Adaptation measures implemented.	International aid programmes
7.Assessment of climate change impact on tourism (heat waves, water temperature, degradation of beaches) and preparation of adaptation measures	• Adjara Tourism Department.	• Study of heat waves trend at the Adjara coastal zone and assessment of future trend; • Examination of the impact of heat waves on the tourist season; • In case of revealing serious negative impact of heat waves on the tourist season adoption of permanent monitoring and early warning system during the tourist season.	• Ministry of Labour, Health Care and Social Security of Adjara; • Adjara branch of Tourism Department.	• Report on the trend of heat waves in the Adjara coastal zone; • Report on the impact of heat waves on the tourist season; • In case of revealing serious negative impact of heat waves effectiveness of early warning system.	USAID, GEF, Third National Communication on Climate Change
8.Rehabilitation of eroded and salinised soils	• Ministry of Agriculture; • Local government and population engaged in agriculture.	• Assessment the status of salinised (areas, degree of salinisation, etc.); • Identification of measures to rehabilitate salinised soils (where it is possible); • Implementation of planned measures.	• Different research institutions related to the soil science and land degradation; • NGOs working in agriculture sector; • Ministry of Agriculture.	• Detailed report on the status of salinised soils affected by the sea (sea level rise, storms); • Portfolio of recommendations on the rehabilitation of agricultural land and management measures; • Planned measures implemented; • Carrying out of periodical monitoring.	GEF, UNFCCC Adaptation Fund, local population engaged in agriculture
9.Taking into consideration anticipated climate change in the process of local infrastructure development	• Poti, Batumi and Samtredia Local municipalities, Permanent Steering Committee on planning and implementation of adaptation measures to climate change.	• Informing local authorities and Steering Committee of risks related to long-term climate change; • Preparation of recommendations on measures to be implemented; • Preparation of recommendations to foresee possible hazards in the development plan; • Arrangement of adaptation Committee meetings. Involvement of stakeholders in the discussion process.	• Government of Georgia; • Local authorities.	• Hazards related to climate change incorporated in the development plan.	UNDP, Georgia's' Third National Communication, Government of Georgia
Long-term strategy	Ministry of Environment	Study of the adverse impact of anticipated	Ministry of		State budget,

	Protection and Natural Resources	changes in climate and marine ecosystem on the Kolkheti Protected Area. Assessment of heat wave impact on the development of tourism. Survey of the influence of glacier degradation process on the Black Sea coastal zone	Environment Protection and Natural Resources, Government of Georgia		National Communications, other programme

Adaptation proposals

(A-1) Management of climate-change driven risks in the Rioni Delta

***Project Objective*:** The project objective is to reduce the vulnerability of existing coastal settlements, the city of Poti, and infrastructure in the Poti Port area and the Rioni Delta, to climate-change driven coastal hazards. The goal of the project is to achieve sustainable development in the low lying coasts of the Georgian Black Sea by the adoption of an early warning system and risk management in the Rioni River Delta.

***Project participants*:** Poti Municipality, Poti Port Administration, Coast Protection Service, local observation network, HPPs on the Rioni River, Private Sector and Government of Georgia.

***Problem*:** The main barriers to addressing the adverse impacts of climate change on the target coastal area are:

- The absence of appropriate knowledge, technologies and policy frameworks for adaptation. As a result, instead of implementation of preventive measures responses to climatic extremes are reactive so far, placing significant burdens on local economies, including local budgets;
- The lack of a monitoring system to permanently control and ensure adequate coastal protection and provide for a timely warning to the population;
- Integrated coastal area management is not a well-established practice in the Georgian Black Sea coast region, which could if it was developed accommodate adaptation needs into its coastal development planning.

***Activities to be implemented in the project framework*:** To achieve the project objective and get over the above-mentioned barriers the following tasks are to be carried out:

1. Creation and development of local capacity to assess the vulnerability of the Rioni River Delta and to implement preventive measures. In particular:

   - Introduction of an early warning system to monitor the impacts of climate change on the selected area of the Rioni River Delta and prevent unexpected hazards, including the possibility of long-term forecasting;
   - Preparation of Adaptation Guidelines in cooperation with local administration;
   - Awareness raising among stakeholders by training, including on-job training and direct participation in activities.

2. Creation of a legislative and regulatory basis to promote the implementation of adaptation measures in the Rioni Delta:

   - Development of an adaptation planning mechanism for the vulnerable communities and sectors of economy;
   - Improvement of the legislative basis and activation of the planning mechanism with stakeholder participation;
   - Consideration of climate-change driven hazards in the Integrated Coastal Area Management (ICAM) plan.

3. Rising of awareness of local stakeholders on climate-change induced anticipated hazards and adaptation measures to mitigate them. Awareness-raising and preparedness to implement the measures:

    - ❖ Introduction of mechanisms and procedures to monitor and assess project results;
    - ❖ Gathering, analysis and dissemination of information using the Adaptation Learning Mechanism (ALM) and other mechanisms.

***Project cost*:** USD 1,000,000

(A-2) Adaptation measures in the Rioni Delta

***Project Objective*:** The project objective is to reduce the vulnerability of Poti Port and the infrastructure of the city of Poti to climate-change driven coastal hazards. The goal of the project is to provide sustainable development of Poti Port and the infrastructure of the urban area by protecting the coastal line of the Rioni Delta from the impact of sea waves and river floods by heaping up inert material and using special constructions.

***Project participants*:** Poti Municipality, Coast Protection Service.

***Problem*:** The construction in the 19th century of a Poti port and in the 20th century of four hydropower plants on the Rioni River drastically altered the transportation of sediment conditions at the sea-shore line, provoking the erosion of beaches south of the port and formation of a new delta north of the port. The first of these processes resulted in the permanent loss of land in the city coastal area, while the second process caused constant silting of the entrance to the port, thus hampering its activity. The silting of the coast has affected the new bed of the Rioni River as well, significantly decreasing its capacity. This has increased the frequency of floods damaging the city. This process in turn has been intensified over the last few decades by the increasing run-off of the Rioni as a result of global warming. The situation is additionally aggravated by the climate-change driven sea level rise and growing storm intensity, blocking the river discharge into the sea.

Several attempts have been made since the 1940s to suppress the natural balnce of this ecosystem: a new branch of the river (the Nabada Canal) was constructed to the north of the city, the old river-bed was transformed into a concrete channel, rows of piles and broken stone dams were built along the coast in the sea, artificial deliveries of sand to the emergency coastal areas were made, the piled-up stone dam was reinforced and elevated, the refilling of sand was continuously undertaken for 7 years at the emergency parts of the coast, the entrance canal to the port is being constantly cleaned up. These activities have with varying success mitigated for a time the coastal erosion and silting processes. However, since 1993 coast protection activities have ceased and after 1994 the coastal zone began to return to emergency status, like the one existing before 1986.

To mitigate the results of these processes and to adapt to their impact a number of proposals were prepared.

***Activities to be implemented in the project framework*:** Based on the above-discussed consideration and the analysis of available data, five options of coast protection measures have been worked out for different parts of the Poti coastal zone, that are summarised in Table (A-2) - 1.

Coast protection scenarios have been assessed both from the morphological and economic standpoints. The morphological criteria were: "Flexibility" – the adaptation potential of a protection scenario to changes in natural conditions (river run-off, sea level rise, etc.); "Reliability" – its actual effectiveness in relation to the assumed one; The "Risk Factor" – expected destabilisation of the coastal zone during the implementation of protection scenarios, e.g., the activation of a submarine canyon (Table (A-2) -1).

Table (A-2) -1. Estimation of protection scenarios from the morphological and financial viewpoint

Type of scenario	N	Protection scenario	Flexibility	Reliability	Risk	Total cost, USD million
Soft	1	Heaping up of inert material from the Nabada delta in the area of "Didi" Island and the mouth of the Supsa River	++	++	-	76.7
	2	Heaping up of inert material from the bed of the Rioni River in the area of "Didi" Island and the mouth of the Supsa River	++	-	-	107.1
	3	Increase of City Canal capacity	0		--	38.9
Hard	4	Construction of sediment-retaining pier at the Poti Canyon and of boons to the south of "Didi" Island	-	0	-	54.4
	5	Construction of piled rock and stone along the coast of "Didi" Island and of boons south of the island	-	0	0	58.3

Notes: (++) – very positive; (+) – positive; (0) – neutral; (-) – negative

Analysis of the scenarios discussed above shows that the optimum option for the protection of the Poti sea coast is a combination of scenarios 1.2 and 2.1 with the exclusion of the system south of the "Didi" Island, and the possibility of substitution of the 1.2 scenario by the 1.1 scenario.

Project cost: Based upon estimations of the total cost of different scenarios and the above-mentioned consideration the total cost of the project is estimated to vary in the range of USD 100-130 million.

(A-3) Coast protection measures in Batumi-Adlia sea shore zone

Project Objective: The project objective is to reduce the vulnerability of Batumi-Adlia sea-shore zone to climate-change driven coastal hazards, enhanced by anthropogenic loading. The goal of the project is to protect Batumi-Adlia coastal resort area and the infrastructure of Batumi Airport from the devastating impact of sea waves by piling up beach-forming material and retaining sediment.

Project participants: Batumi Municipality, Coast Protection Service, Batumi Airport, Government of Adjara.

***Problem*:** The construction of the Batumi Port at the end of the 19th century had a crucial impact on the development of the Adjara coastal zone, and on its Batumi-Adlia section in particular, by disturbing the natural process of sediment distribution along the sea coast. As a result, a Batumi accumulation cape formed in the 20th century, accompanied by the erosion of the Adjara-Batumi coastal zone, fed by the sediment of the Chorokhi River. The situation has been drastically aggravated since the beginning of the 2000s after the construction on the Chorokhi of a cascade of dams at hydropower plants in Turkey, the number of which will grow to 10. This further blocking of sediment by dams will destabilise the Adlia coastal zone even more. At present the rate of sea shore erosion here has increased to 3-5 m/yr, while in the 20th century it equalled 2.2 m/yr.

That process of coastal erosion is being enhanced by the permanent sea level rise at a rate of about 2.5 mm/yr, caused by global warming. Current climate change has also provoked a marked increase in the frequency and intensity of storms in the region, additionally contributing to the accelerated erosion of the coastal zone.

Coastal protection measures have been carried out in the Adjara coastal zone since the beginning of the 20th century. Reinforced concrete coast-consolidating constructions of various types were built, but they have failed to solve the Adjara sea shore protection problem. Since 1982 a new method for the rehabilitation and management of coast-forming processes has been adopted, based upon the artificial filling of existing deficit by beach-forming material, transported from the mouth of the Chorokhi River.Following these measures, it became possible to stop the erosion of the Adlia coastal line and to prevent danger to both the Batumi Airport runway and the dwellings of the local population.

Since 1991, coastal protection measures have not been carried out, as a result of which the process of coastal retreat has reactivated sharply.

***Activities to be implemented in the project framework*:** In the last period, a number of coast-protection measures were worked out to protect the sea shore at the Batumi-Adlia section, which are summarised in Table (A-3) – 1.

Table (A-3) -1. Short description of coast protection options, their objectives and term for obtaining results

N	Protection scenario	Flexibility	Reliability	Risk	Total cost, USD million
1	Refilling of beach-forming material at the Adlia emergency section Piling of 150-200,000 m^3 of material at the coastal zone	+ +	+	0	65
2	Construction of sediment retainers in front of Batumi underwater canyon and refilling of beach-forming material at the Adlia emergency section (combined method) Permanent filling up of the sediment stock	+ +	-	-	88
3	Construction of the boon system in the Batumi-Adlia coastal zone Piling up of 750,000 m^3 of inert material over 25 years	-	0	0	65 (without creation of beaches)

	For the optional creation of recreational beaches amid boons, filling up of 2 million m^3 of beach-forming material in the same period				
4	Creation of stone piles at the emergency strip (about 2 km) in Adlia Heaping of 50,000 m^3 of beach-forming material annually	-	0	0	18-20

Notes: (++) – very positive; (+) – positive; (0) – neutral; (-) – negative

Analysing these scenarios it has been derived that preference is to be given to the artificial piling up of beach-forming material, i.e. to the first and second options.

Project cost: Estimations of total cost of different options of the project are given in the final column of the table. Hence it can be assessed that the total cost of the project is to vary in the range of USD 65-88 million.

4.2.2 Dedoplistskaro region

Dedoplistskaro region adaptation strategy. The adaptation proposals presented below have been elaborated in the framework of the SNC since the beginning of its preparation. One of them devoted to the rehabilitation of wind-breakers is already being implemented with the financial support of the German government (GTZ) and another related to the rehabilitation of degraded arable land through planting of energy groves is under consideration by the same donor.

Description of the problem. The DTR was traditionally considered to be one of the most vulnerable regions in Georgia. In spite of high climate-related risks, its role in the country's economy has always been important. The only sector of the economy developed in the region has been agriculture, and in particular grain and sunflower production, and animal husbandry. At present, grain production and live-stock farming remain the only sources of income for the region. However, since 2003, the enlargement of protected territories and their use in the development of a tourism infrastructure has been considered a new priority of the local government.

Certain anthropogenic measures were systematically carried out in the region because of its high ecological vulnerability. In particular, the artificial watering of territories was systematically undertaken on the basis of four irrigation systems, but today they have been completely destroyed. Wind-breakers were established to protect the soil humus against high speed winds, but now they have been totally cut down and used as an energy resource. These protective measures were organised and carried out by socialist collective farms called "Kolmeurneoba".

After the collapse of the Soviet Union and the subsequent disintegration of the collective farms, a period emerged when the legislation on land ownership was fuzzy and the process of agricultural land distribution (privatisation) among the local population was not explicit enough. The new land owners (farmers) came across new sets of problems and, suddenly on their own, were not able to overcome them individually (e.g., problems such as their lack of experience in cultivating and managing thousands of hectares of agricultural lands and pastures, the absence of effective agricultural techniques for land cultivation, the absence of initial investment, the absence of information systems advising farmers on anticipated climatic conditions and their potential impact on harvests, etc.). It became a challenge (and still is) to mobilise locals in village communities to take care of and manage such common objectives as irrigation systems, wind-breakers, forests, common pastures, etc. As a result, the methods used in the past, such as protection systems including irrigation, wind-breakers, etc., that protected the agricultural sector from severe climatic conditions, couldn't survive. However, it should be highlighted that even if the former irrigation systems and wind-breakers could have survived anyway, it would have been necessary to reinforce them to meet current climate change challenges. Now everything has to be restored and created all over again to stop ecological migration from the region, and to stop the abandonment of territories and accomplish a full rehabilitation of the region.

The process of abandonment of the land by the local population usually starts by converting the arable lands into pastures and later, after full degradation of the pastures, they are abandoned. In the face of natural calamities and other problems, most farmers do not have enough capacity to mobilise the initial investments for carrying out a complete set of agricultural activities. Gradually, uncultivated and unmanaged arable lands and pastures become eroded and degraded. Even for those farmers who are progressive and clever enough to mobilise the necessary investment for land cultivation, it is not easy to gain from the investments due to the gradual decrease of soil fertility. Little by little the initial arable land is transformed into pasture because the "management" of pastures is less expensive. Afterwards, often owing to improper management and ill treatment, these lands become unsuitable even for pasture, and in the final stage they are abandoned. Up to now this process has been more intensive in Taribana Valley, where alkali soils prevail. Due to inactivity, the same processes could spread to Shiraki Valley in the near future.

For the most part former pastures have already been privatised but it's hard and even impossible for the farmers to care for and properly manage them. Currently, the management of the grazing process does not take place at all except on a few privatised pastures where the grazing is relatively limited. One of the methods used by shepherds in common pastures is to burn them in order to provoke quick growth of the grass, which causes complete exhaustion of the soil and gradually transforms it into unusable land. Assisting farmers to implement the proper management process is a little bit complicated, and a political issue in this region, bordering Azerbaijan. For the time being these pastures are illegally used by the shepherds of both countries.

About 4,500 hectares of land have been abandoned in the region as a combined result of climate change and anthropogenic factors, and their impact on the productivity of the remaining lands that are still in use has decreased by at least three times compared to the 1980s. A survey conducted in 2004 in the Kakheti region showed that the median annual per-capita income equalled GEL 756.1 (1 USD = 2.0 GEL). The same survey showed that GEL 1,164 annually would be required as per-capita income, that is, for being provided with food and other necessities. Hence, the actual income in 2004 was 35% less than the necessary minimum. The Deprivation Index, calculated for the DTR, appeared to be 54%, which is 13% higher than the Kakheti region as a whole. This fact has caused the decrease of the region's population by 18%, from the beginning of the 1990s.

Taking into consideration that Dedoplistskaro is a border region, from a political standpoint, it should be a priority policy of the government to stop the migration process and to develop the local infrastructure. Decreases in soil and pasture productivity cause serious economic loss to the government. In the short-term, considering the hard natural conditions and the impact of climate change in the region, it's obvious that the investment necessary for the adaptation of the region is much greater compared to the benefit that could be achieved in the next 10 years, as a result of continuing with former measures.

However, if political, social, and economic losses are assessed from a long-term perspective (20 years or more), in which these limited fertility agricultural lands could become serious problems for the country, it can be seen that present investments will help the region survive and promote its sustainable development. The later investments are made, the more expensive it will be. Considering the abandoned lands, departing population, and lost flora and fauna, the total investment for each year of delay is significantly growing.

As for tourism, the impact of climate change on our tourist routes should be studied thoroughly, because tourists are passing through the protected territories. These areas improve the microclimate of adjacent territories and mitigate the adverse influence of climate change on agricultural lands and pastures. At the same time, the protected territories in DTR are the best spots to monitor the actual impact of climate change on the natural ecosystems, for in these territories, any anthropogenic activity is prohibited.

Anticipated risks. Anticipated risks in the DTR can be summarised as follows:

- Anticipated changes in climatic parameters will accelerate the wind erosion of land and extend the duration of drought. According to this forecast, the air temperature will increase and air humidity index will decrease. This process will be accompanied by unchanged and even declining rainfall resulting in increased soil erosion;
- The fertility of agricultural lands and pastures will be further decreased by the growing erosion and increased deficit of water;
- Water deficit for wheat will probably grow by a further 73% which will affect its quality and especially its nutritional value. A further 17% deficit of water is predicted for sunflower crops, and a 29% deficit for pastures;
- Abandonment of lands by the population (farmers) and a rise in unemployment and poverty;
- Increase in the number of ecological migrants and as a result a depopulation of the region;
- High risk in the growth of malaria cases;
- Degradation of endemic species of flora and migration of endemic species of fauna;
- Decrease in the number of migrating birds and a change in their kinds.

Activities to be implemented

Short-term measures

- Establishment of an infrastructure ensuring supply of information to the local population and farmers on the ongoing processes related to climate change and their economic implications;
- Sustainable provision to the local population of renewable energy resources (biogas, solar energy, energy-efficient wood stoves, biomass);
- Facilitating the local private sector to participate in renewable energy (biomass, firewood) supply projects and particularly in PPP (Public Private Partnership) programmes. Maximum utilisation of solar energy in the framework of the Poverty Alleviation Programme. Assessment and application of the hydro potential of the Alazani River;

- Establishment of plantation forests (fast-growing tree species, having high thermal capacity and soil rehabilitation properties) at the degraded lands where the simple restoration measures are already insufficient;
- Fertilizing the unusable arable lands and pastures' soils by traditional methods (gypsum, irrigation). Provision of farmers with modern technologies for land cultivation and management.
- Mobilisation of farmers and village communities. Initially farmers' communities could be mobilised through such pilot projects as the establishment of energy forests (groves), rehabilitation of central wind-breakers (60 m width), pasture management, improvement of legislative basis, etc.
- Creation of a climate change monitoring system. Along with climatic elements, continuous observations must be carried out on soil, flora, and fauna. For this reason a protected area has been selected, which is free from anthropogenic impact. Changes observed on the territories of protected areas could be easily linked with climate change;

Long-term measures

- Restoration of central wind-breakers (60 m width) and branches (10 m width).
- Cost-effective restoration of irrigation systems considering only the utmost need for irrigation. Rehabilitation of central irrigation canals in the framework of a Regional Infrastructure Development Programme. Rehabilitation of village irrigation canals (mobilisation of local populations) mobilising Poverty Alleviation, and other programmes.

Climate change adaptation strategy for Dedoplistskaro region

Key Strategic Objective	Key Target Groups	Activity	Potential Lead Agency	Output	Potential donors
Short-term objectives	• Population of DTR; • Farmers of DTR; • Local government.	The objective of short-term strategy is the rehabilitation of wind-breakers and irrigation systems	• Ministry of Environment Protection and Natural Resources Hydrometeorology and Climate Change Administration.		Government of Georgia, International aid programmes
1.Establishment of permanent monitoring system on the territory of protected areas in order to monitor the climate change impact on land degradation and endemic species of flora and fauna excluding the anthropogenic impact	• Local farmers and government, different research institutes, UNFCC implementation unit at the Ministry of Environment, Ministry of Agriculture.	• Incorporation of climate change monitoring plan in protected territories development plans; • Monitoring of land degradation; • Monitoring of the changes in endemic species of flora and fauna; • Identification of the most vulnerable parameters; • Assessment of climate change and its impact.	• Dedoplistskaro regional office of the Department of Protected Areas.	• Annual reports on climate change impact on the protected areas prepared.	GTZ, German
2.Mobilisation of local farmers and establishment of farmers communities	• Independent farmers of Dedoplistskaro region.	• Implementation of pilot projects focused on local farmers community mobilisation; • Participation of farmers' communities in rehabilitation of wind-breakers; • Participation of farmer' communities in implementation of plantation forests.	• Local government; • Local NGOs; • Ministry of Agriculture.	• Local farmers communities established; • Community-consumer of irrigation water; • Community farming the bio-forests; • Community supplying population with wood.	In-kind
3.Mobilisation of village communities	• Pilot villages.	• Implementation of pilot projects focused on mobilisation on village communities; • Participation of village communities in rehabilitation of wind-breakers; • Participation of village communities in implementation of plantation forests.	• Local Government; • Department of protected territories (local office).	• Communities of village population established: consumers of irrigation water, consumers of wood fuel established; • Communities protecting the rehabilitated wind-breakers established.	In-kind
4.Establishment of PPP (Public Private Partnership) for energy supply purposes	• Local Governments and local private sector.	• Establishment of PPP programmes supplying the local population with biomass fuel; • Strengthening the role of private sector in increasing the renewable share in energy supply.	• Local Governments; • Local private sector • NGOs.	• Private sector providing biomass as energy resource established; • Private sector participation in increasing the share of renewable resources strengthened.	Government of Germany
5.Establishment of plantation forests estates using the abandoned, eroded lands (see proposals for 40 ha plantation bio-energy forest)	• Local Government and local farmers (private sector).	• Identification of abandoned territories with eroded lands which could be allocated for estates; • Fertilization and preparation of land for plantation of forests;	• Local Government; • Ministry of Agriculture • Ministry of Environment (UNFCCC, UNCCD);	• Bio-forests established; • Private sector involvement in development of biomass energy ensured; • Eroded lands rehabilitated; • Population supplied by renewable (carbon	GTZ, Government of Germany. GEF, UNFCCC

		• Selection of tree species with high thermal and CO_2 absorption capacities. Land rehabilitation capacity and drought (dry weather) resistance are requirements to the plant; • Plantation of energy forests; • Mobilisation of local farmers and settlements; • Supply of local population by fuel wood.	• Forest Department; • Department of land use; • Department of protected territories; • NGO.	neutral) energy resource; • Wind-breakers and preserved areas protected from illegal logging; • Socio-economic condition of local population improved; • CO_2 absorption increased.	adaptation fund. CDM
6.Rehabilitation of wind-breakers (see proposal for rehabilitation of 906 ha 60 m width and 865 ha 10 m width wind-breakers)	• Local farmers and Department of protected areas.	• Gradual rehabilitation of wind-breakers.	• Department of protected areas; • Local Government.	• Productivity of agricultural lands and pastures increased; • Corridors for protected areas fauna network established; • Socio-economic conditions of local farmers is improved; • CO2 absorption is increased.	GTZ, Government of Germany. GEF, UNFCCC adaptation fund. CDM
7.Rehabilitation of irrigation systems (see proposals on irrigation)	• Local farmers; • Population of villages.	• Identification of irrigation systems for urgent rehabilitation with minimum expenses (3 sites); • Preparation of projects for rehabilitation of irrigation systems and their implementation; • Supplying local farmers and settlements (near the selected sites) with irrigation water.	• Department of irrigation.	• Selected irrigation systems rehabilitated; • Local farmers and households provided with irrigation water; • Productivity of agricultural lands and pastures increased; • Socio-economic conditions of the households and farmers improved; • Billing system in irrigation sector established.	GTZ, Government of Germany. GEF, UNFCCC adaptation fund
8. Preparation of package of cultivation measures for agricultural lands and pastures. Recommendations on drought-resistant plants and proper land management.	• Local farmers; • Local population.	• Identification of drought-resistant agricultural plants; • Testing the adaptive capacities of selected plants to the local climate through the pilot sites; • Establishment of local communities promoting the new selected plants (wheat, grass); • Preparation of package of cultivation measures.	• Different scientific-research institutes; • NGOs working in agriculture sector; • Ministry of Agriculture.	• New types of plants adapted to the local conditions recommended; • Awareness of local farmers and villagers on ongoing processes and ways to adapt to the new situation raised; • Recommended package of agricultural land rehabilitation and maintenance measures implemented and permanently updated.	GEF, UNFCCC adaptation fund
9.Biogas Mobilisation of farmers engaged in live-stock raising and their involvement in biogas development programmes	• Farmers engaged in stock-raising sector.	• Survey of biogas resources; • Rising awareness of farmers; • Installation of biogas production pilot units.	• Biogas producing organisation (on the tender basis).	• Farmers engaged in live-stock raising involved in biogas development programmes).	GEF, UNDP and local farmers
Long-term strategy	• Local administration; • Local farmers; • Population of DTR.	In the long-term strategy the emphasis should be made on the rehabilitation of degraded pastures and agricultural lends and implementation of proper land management strategy, as well as on the selection of drought-resistant kinds in agriculture and forestry sectors	• Ministry of Environment Protection and Natural Resources.		State budget, National Communications, other programme

Adaptation proposals

(A-4) - Rehabilitation of wind-breakers in Dedoplistskaro region

Project objective: The objective of the project is to mitigate the climate change impacts of drought and land degradation (erosion) processes in the DTR by the rehabilitation of wind shelter belts. The goal of the project is to provide sustainable development of the leading sector of the economy – agriculture – thus promoting higher living standards in the region.

Project participants**:** Local government, local farmers, population of villages.

Problem**:** Analysis of existing information about the region and consultations with local stakeholders have shown that the most vulnerable ecosystem in the region is land and, consequently, the economic sector depending on land-use: agriculture. The DTR is rich in fertile land, but has scant atmospheric precipitation. Against a background of high summer temperatures and frequent strong winds, this causes high recurrence of drought, causing land erosion and desertification processes. To combat these processes, in the second half of the 20^{th} century a system of wind-breakers was arranged in the region, covering about 1,800 ha of the territory. The existence of these wind-breakers was vitally important not only for the preservation of farm lands and pastures, but also for retaining the fauna of protected areas. The energy crisis in the 1990s led to virtually complete logging of wind-breakers, exacerbating the adverse impact on the land of the above-mentioned processes. The situation is being aggravated by current changes in climate resulting in a rise in temperature and the frequency of high winds and drought, as well as by the disintegration of irrigation systems in the region. At present the area of degraded lands in the DTR makes more than 25,300 ha and 20,000 ha of these are wind-eroded. Soil degradation is causing a marked decrease in the productivity of the main crops and animal husbandry, thus causing a fall in the living standard of the local population.

Activities to be implemented**:** Activities planned under the submitted proposal are:

- Identification of the wind-breaker areas needing rehabilitation, which could significantly contribute to the mitigation of climate change impacts;
- Rehabilitation of selected (pilot) wind-breaker areas, deteriorated as a result of the energy crisis;
- Mobilisation of local farmers for project implementation, and further steps to protect the rehabilitated wind-breakers.

Project should be implemented step-by-step. The final goal is to rehabilitate 906 (60 m width) ha and 865 (10 m width) ha of wind-breakers on the territories previously covered by wind-breakers.

Project cost**:** The total cost for the rehabilitation of 60 m wide belts including three years maintenance expenses is USD 12.6 million, and of 10 m wide belts USD 11.5 million, making USD 24.1 million in total.

Project emissions**:** Emission reduction (sequestration) calculated in case of planting the same type of tree (acacia) as previously planted equals to 278 tonnes of CO_2 annually per hectare.

(A-5) - Plantation of 40 ha of energy forest in order to rehabilitate the eroded farm-lands

Project objective**:** The objective of the project is to mitigate the climate change impacts of drought and desertification processes on the DTR. The goal of the project is to rehabilitate eroded and degraded lands as well as to improve the supply of local settlements with firewood, thus preventing illegal cutting of trees forming the wind-breakers.

Project participants: Local government and local farmers.

Problem**:** Analysis of existing information about the region and consultations with local stakeholders has indicated that soil degradation is one of the most acute problems of the DTR. Assessments of vulnerability have revealed that the region faces significant climate change impacts along with anthropogenic pressures from local farmers and the indigenous population.

Ongoing climate change has already resulted in an increase in annual air temperature by 0.6^0C, and an almost doubling of the recurrence and duration of drought in the region, as well as in the frequency of high winds.

The main negative anthropogenic factors identified during the assessment, and having the heaviest impact on the land degradation process, are the following:

a. An energy crisis occurred in Georgia after the collapse of the Soviet Union, which resulted in a cutting down of wind-breaker forests artificially planted in the 1960s in order to protect the adjacent agricultural lands and pastures from strong winds, periodically reaching 30-40 m/s
b. Improper management of agricultural lands, using outdated technology of soil cultivation, misuse of fertilizers, disregard for crop rotation, etc.
c. Destruction of irrigation systems (the high price and shortage of electricity necessary for water pumping)
d. Uncontrolled grazing of sheep.

At present the area of degraded lands in the DTR makes more than 25,300 ha and 20,000 ha of these are wind eroded. The content of humus in arable land has almost halved here over the past half-century, bringing a marked fall in the productivity of the main crops.

The planting of 40 ha forest at the territory affected by the above-mentioned processes will contribute to the improvement of the local environmental situation through the following ways:

- Prevention of further erosion of adjacent agricultural soils (including pastures)
- Rehabilitating degraded soils and increasing their productivity in the territory of the estate farms;
- Improvement of the fertility of soil through the accumulation of leaves and bough humus in the land of the estate farms;
- Mitigation of GHGs (absorption of CO_2)
- Reduction of anthropogenic impact on wind–breaker forests which are in addition used as corridors by fauna in the protected territories.
- Enabling recreation capacities.

This proposed project will change the living conditions of the local communities for the better as well:

- Supplying the local population with firewood, which is currently the only widely used energy source;
- Facilitating the local private sector to participate in the bioenergy production process;
- Alleviating poverty through selling produced firewood on the market;
- Improving housekeeping conditions as a result of ensuring the provision of cheaper energy resource;
- Mobilising local communities for project implementation and creating new jobs.

Activities to be implemented:

- Planting and operation of a forest farm of 40 ha as a pilot phase (in total 200 ha of lands are degraded and unusable nearby which could be afforested in case of successful implementation of the project) consisting of fast growing wood species resistant to drought in order to: a) partly satisfy the demand of local communities for firewood, usually produced from natural forests; b) fertilize and rehabilitate the unusable lands in the valley of "Taribana"; and c) ensure the additional volumes of CO_2 sequestration.
- Mobilisation of local farmers for project implementation
- Introduce the energy forest management technology.

Project cost: Project initial cost for the first 8 years equals USD 128,249. Annual maintenance expenses amount to USD 21,000, thus making total cost of planting 40 ha of energy forest and its 8-year maintenance equal to USD 296.2. However, the harvesting and commercialisation of firewood will provide definite income as well.

Project emissions**:** Estimations of absorption rates by poplar (potential specie for plantation), using data obtained in Russia and Azerbaijan, have indicated that average annual sequestration of CO_2 in this project is 1,866 tonnes.

Three following proposals are for rehabilitation of different segments of the large irrigation system constructed during Soviet time when electricity was subsidies by the government. Main barrier for all of them is high cost of power utilized by pumping stations which makes inefficient land irrigation. Moreover, that consumers of this water are low income local population and eco-migrants.

(A-6) - Irrigation of pastures from the Dali Reservoir

Project objective**:** The objective of the project is to reduce the vulnerability of pastures to climate-change induced hazards in the most arid zone in Georgia, by providing irrigation from the nearby Dali Reservoir. The goal of the project is to demonstrate sustainable management of livestock husbandry and pasters in the DTR, affected by the worsening impacts of drought under current global warming.

Project participants: Local farmers, "Alazani M" Ltd.

Problem**:** The Dali Reservoir is situated in the most arid zone of Georgia. Precipitation here is less than in other parts of the DTR. It would be possible now to store 70 million m^3 of water in the reservoir if the escape tower were to be rehabilitated. In the first stage of this pilot project the watering of 170 ha in the nearby to reservoir pastures is planed using the existing tunnels. In the second stage, construction of new irrigation network is envisaged. This stock of water could be used to irrigate an area of more than 10,000 ha. This territory nowadays represents winter pastures where almost all livestock farms of the Kakheti region hibernate. Hence, the Dali Reservoir is to play an important part in the provision of stock-raising development here. The livestock hibernate in winter pastures from September until May. In September the herds of livestock return from the summer pastures to the rangelands that have been burnt down and faded by heat and drought. The watering of these areas is very important for farmers, as they could then avoid the loss of sheep caused by the absence of foraging reserves in this period of time.

Activities to be implemented: In the first stage, to provide 170 ha of pasture by irrigation water from the Dali Reservoir via existing tunnels, it is planed to repair the operational water escape tower.

Project cost**:** The total cost of the project is USD 124.242.

(A-7). Rehabilitation of Zilicha I Pumping Station

Project objective**:** The objective of the project is to reduce the vulnerability to climate change of more than 5,200 ha of irrigated arable land in the easternmost part of the DTR, suffering from drought and threat of desertification. The goal of the project is to rehabilitate one of the pump-stations to provide the existing irrigation system with water.

Project participants**:** Local farmers, "Alazani M" Ltd.

Problem**:** The Zilicha I irrigation system was serving 5,221 ha of irrigated area but is not in operation now. Ziliha I elevating pump-station was mounted over three floating pontoons on the Alazani River. Two out of three pontoons are submerged and only one is operational consequently very limited amount of water is being supplied to the vineyards. Villages served by this irrigation system deserve special attention because they are located in the border area of the country and households are eco-migrants from the high mountain areas of Adjara, which were resettled here after natural disasters happened there in the 1980s. In the absence of water for irrigation, there would be no vineyards here, and consequently the villages could become unpopulated. Hence, the provision of these villages with water has not only economic, but political importance as well.

Activities to be implemented**:** For the rehabilitation of the irrigation system it is necessary to repair the 3,200/75 type pump at Zilicha-1 pumping station, replace back bids at the pipes with new ones, rehabilitate separate water-gates and sections of pipelines, to clean the main canal from sediment, etc..

Project cost: The total cost of these works equals USD 35,800, 30% of which make up the canal cleaning expenses

(A-8). Watering 900 ha of Taribana arable land

Project objective**:** The objective of the project is to reduce the vulnerability of the Taribana arable land tracts in Dedoplistskaro to climate-change induced hazards. The goal of the project is

to provide water to 900 ha of Taribana cropland, thus promoting the sustainable harvest of major crops cultivated in the region and enabling the local population to improve living conditions.
Project participants**:** Local farmers, "Alazani M" Ltd.

Problem**:** The Taribana irrigation system was served by the pumping station mounted at the Alazani River. At present this station is disabled and out of action. According to experts' judgement the rehabilitation of this pump-station at this stage is not expedient because the difference in altitudes between the station and the main water-taking tank exceeds 100 m, which makes the use of electricity by the system economically unjustified. From this tank the pipeline supplied two reservoirs: the "Kushis-khevi" and the "Kranchis-khevi" reservoirs. These two reservoirs are being partially filled by atmospheric precipitation and a flow in a small ravine that makes it possible to irrigate a part of Taribana arable lands by self-flow.

The catchments area of both reservoirs equals about 90 km^2. The average annual run-off makes 1.2 million m^3. After the implementation of rehabilitation works, it would be possible to utilise for irrigation about 1.0 million m^3 of water, by regulating flow emerging from atmospheric precipitation and the water running in the ravine. This will enable a one-time occasional irrigation of 900 ha of arable land in summer. Hence, this measure could make available new lands to cultivate cereals (wheat, maize, sunflower).

Activities to be implemented**:** The Taribana irrigation system rehabilitation activities include the repair of high-pressure pipeline coming out of the "Kushis-Khevi" reservoir and other pipelines, as well as repairing values, or replacing them with new ones.

Project cost: The overall cost of the project equals to 44,242. USD

4.2.3. The Lentekhi region

Lentekhi region adaptation strategy. In selecting the most vulnerable regions to climate change on the territory of Georgia, attention has been focused on the Lentekhi region in view of the fact that it is typical of a mountain zone of West Georgia with its climate and landscape features. The economically-active population still remains there, though due to recent disastrous events and consequent worsening of socio-economic conditions it experiences tangible migration. Therefore, this region could be regarded as an indicator of the impact of climate-change driven processes on natural ecosystems and the economy. At the same time, the existence of population and some sectors of economy make it possible to plan and implement in the region a number of adaptation measures, which could serve as an example for implementing the same activities in Georgia's other mountain regions.

Like other mountain regions in Georgia, such hazardous events as floods caused by heavy precipitation, landslides, mud streams and snow avalanches are quite present in the Lentekhi region. These processes in turn cause land erosion, demonstrated in the erosion of river banks, loss of arable land, and destruction of forests. Over the last two decades, climate change has markedly increased the frequency and intensity of these processes causing the speeding up of migration processes among the local population.

In 1987 almost 15,000 people lived in Kvemo Svaneti. Owing to the abundant snowfalls and destructive floods at the end of the 1980s about 3,000 residents were evacuated from the region, followed by a second wave of migration after the disintegration of the Soviet Union. As a result, the population of the Lentekhi region has declined to just less than 9,000 in 2007.

The deteriorating demographic situation created in the region is directly linked with the economic slowdown. In the leading sector of region's economy – agriculture – disastrous events since 1990 have caused the loss of arable land area from 2,200 to 1,500 ha, the area under perennials from 380 to 130 ha, the decrease of hayfields territory by 1,300 ha, and that of pastures by 6,000 ha. Significantly the number of domestic animals fell as well. However, it should be mentioned that the privatisation reforms carried out in recent years in agriculture have led to the evident increase in the yield of major crops and in livestock productivity. In particular, compared to the 1960s the harvest of maize in the 2000s has grown by in the region of 30%, that of potato by 60%, and of fruits by 66%. The same pattern takes place in animal husbandry – productivity has risen on average by 45%, mainly due to better care conditions for privatised cattle.

All the aforesaid indicates that despite climate-change driven disastrous events, the Lentekhi region would, if suitable conditions were created, have sufficient capacity to develop the key sector of its economy – agriculture. For the creation of these conditions, the elaboration of an adaptation to climate change strategy is required, which should be based upon existing data and anticipated changes in climate, and on analysis and assessment of the region's natural ecosystems and agriculture. Adaptation measures should be aimed at the mitigation of disastrous event impacts, measures to forecast and prevent them that will finally ensure the development of agriculture, the improvement in livelihoods and the stabilisation of the demographic situation in the region. Along with agriculture, the development of other sectors of the economy – tourism, manufacturing of farm produce and wood processing, etc. is to be envisaged. Proper restructuring of the region's economy would widen its development possibilities even more.

Anticipated risks. The expected risks caused by climate change in the Lentekhi region can be summarised as follows:

- The changes in climate, described above in detail, will intensify land erosion. First, this process will be provoked by the growth in precipitation, and afterwards by the increase in the duration of drought, the trends towards which is being already observed. According to the forecast, in the second half of the current century, against a background of rising temperature and declining precipitation a decrease in air relative humidity by 6% and in the value of hydrothermal coefficient by about 30% is anticipated, that will cause a fall in soil moisture content;
- In the first half of this century an increase in precipitation and floods is expected, after which the process could reverse;
- The growth in the pest population both in crops and in forests is anticipated. These processes are being already observed;
- The abandonment of settlements by the population resulting from the high risk of landslide activity, causing in turn a rise in unemployment and in poverty;
- The migration of population (rise in the number of eco-migrants);
- Further decline in the quality of forests;
- The tangible increase in air temperature and the decrease in the moistening index are expected to bring about the transformation of climate zones in the region, expressed by the setting in the lower zone of the temperature regime, typical at present for the Black Sea coastal area, and the disappearance of glaciers in the highest zone.

Climate change adaptation strategy for Kvemo Svaneti (mountainous) region

Key Strategic Objective	Key Target Groups	Activity	Potential Lead Agency	Output	Potential Donors
Short-term objectives (2009-2025)	• Local government; • Population of the region.	The objective of the short-term strategy is the creation of landslide monitoring system and preparation of preventive measures for the residents in landslide-endangered zones. Improvement of forest management	• Ministry of Environment Protection and Natural Resources; • Local government; • Rural communities.		Government of Georgia International donors
1. Creation in the region of permanent landslide monitoring and early warning service (optimum version)	▪ Local government; ▪ Local population.	▪ Carrying out of monitoring in the landslide endangered territories; ▪ Recommendations of the landslide prevention measures.	▪ Local government; ▪ National environment agency.	▪ Preparation of annual reports on the status of landslide dangerous areas affected by climate change.	Government of Georgia Local government
2. Mobilisation of rural communities and their involvement in the implementation of preventive measures at the landslide dangerous plots	▪ Local government at region and village level; ▪ Population of exceptionally vulnerable villages.	▪ Preparation of recommendations for the population living in landslide endangered zones; ▪ Organising permanent warning trainings on preventive measures for the families living in landslide endangered zones; ▪ Formation of local communities.	▪ Local service on landslide monitoring; ▪ Local NGOs.	• Village communities formed primarily in the most vulnerable settlements; • For each family in the landslide affected zones the package of preventive measures prepared; • Population in landslide affected zones permanently informed about the existing status and on the necessity to carry out preventive measures.	Government of Georgia Local government
3. Implementation of the pilot project on the landslide prevention measures (small plantations of hazelnut)	▪ Population living in landslide affected zones; ▪ Local administration ▪ Ministry of Environment Protection and Natural Resources.	▪ Planting of hazelnut at previously selected plots; ▪ Carrying out of permanent monitoring; ▪ Study of the possibility to submit this pilot projects to the CDM.	▪ Ministry of Environment Protection and Natural Resources; ▪ Local government.	• Plots of land for hazelnut plantations selected; • Pilot project prepared to be submitted to the CDM.	Italian investors Ferrero in the framework of CDM, Adaptation funds
4. Carrying out of rehabilitation and proper management of most damaged parts of forests	▪ Local administration; ▪ Local population; ▪ Department of Forestry; ▪ NGOs.	▪ Selection of most damaged areas in local forests; ▪ Preparation of the strategy for the rehabilitation of damaged areas in forests and proper management as well as pilot projects; ▪ Attraction of local and foreign investments to implement pilot	▪ Local administration; ▪ Ministry of Environment Protection and Natural Resources (Department of Forestry).	▪ Permanent monitoring undertaken on the forest quality, especially in the damaged areas; ▪ Package of measures prepared to be implemented for the restoration of forest quality and improvement of the management; ▪ Forestry projects prepared to be submitted to the CDM.	Government of Georgia International donors, CDM, Adaptation funds

		projects on the technical assistance; ▪ Carrying out of permanent monitoring on the selected areas.			
5.Restoration of the landslide preventive function of forest ecosystem. Planting of new plots	▪ Local administration; ▪ Department of Forestry; ▪ Ministry of Environment Protection and Natural Resources; ▪ National Environment Agency.	▪ Selection of forest plots having the landslide retaining function; ▪ Preparation of project proposals for the restoration of landslide retaining forests; ▪ Creation of monitoring system at the selected plots; ▪ Provision of local population with the firewood.	▪ Local administration; ▪ Department of Forestry; ▪ Ministry of Environment Protection and Natural Resources; ▪ NGOs.	▪ Forest plots having special landslide retaining function selected and project proposals prepared for the restoration of such forests; ▪ Permanent monitoring at the landslide retaining plots organized; ▪ PPP structure organised to supply population with firewood.	Government of Georgia International donors, GEF and other Adaptation funds, CDM
6.Inventory of climate caused landslides (distant from settlements but near to the roads) and preparation of preventive recommendations	▪ Government of Georgia; ▪ Department of Tourism; ▪ Local administration.	▪ Preparation of a map demonstrating the distribution of climate caused landslide areas; ▪ Preparation of recommendations for adaptation activities; ▪ Setting up of monitoring system at the vulnerable sections of tourist routs.	▪ Department of Tourism; ▪ Local administration.	▪ Project proposals for the rehabilitation of tourist paths prepared; ▪ Permanent monitoring on the vulnerable section of tourists paths organised; ▪ Adaptation projects implemented.	Government of Georgia Adaptation funds
7. Creation of flood monitoring and early warning system	▪ Local administration; ▪ National Environmental Agency.	▪ Selection of best sites to carry out flood monitoring; ▪ Training of local staff to carry out this monitoring.	▪ Local administration.	▪ Sites to monitor the floods selected; ▪ Permanent monitoring of floods organised.	Government of Georgia, GEF, UNFCCC Adaptation Fund
8. Preparation of package of measures aimed at the reduction of casualties and losses caused by floods	▪ Local administration; ▪ Local administration; ▪ National Environmental Agency; ▪ Local communities.	▪ Preparation of package of preventive and protection measures to reduce losses at vulnerable facilities in case of floods; ▪ Carrying out of trainings for residents of flood-endangered zones and local authorities, at which the package of recommendations will be discussed.	▪ Local administration; ▪ Local communities.	▪ Flood consequences and losses reduced.	Government of Georgia, GEF, UNFCCC Adaptation fund
9. Recommendation of measures for monitoring and rehabilitation (maintenance) of vulnerable tourist	▪ Department of Tourisms; ▪ Department of Roads; ▪ Local administration.	▪ Selection of tourist routes which are vulnerable to climate change; ▪ Creation of permanent monitoring system at the selected vulnerable sections; ▪ Preparation of adaptation measures for these sections.	▪ Department of Roads; ▪ Local administration.	▪ Permanent monitoring on vulnerable sections of tourist routs organised; ▪ Adaptation (preventive) measures for these sections prepared.	Government of Georgia, International donors, Adaptation funds

10. Preparation of preventive measures package to protect local forests from the intrusion of pests	▪ Institute of Forestry; ▪ Research institutes; ▪ Department of Forestry; ▪ Local administration.	▪ Selection of forest areas damaged by pests; ▪ Preparation of package of measures to rehabilitate the damaged plots; ▪ Preparation of preventive measures package to protect new plots; ▪ Implementation of rehabilitation measures at the damaged plots.	▪ Local administration;	▪ Forest areas damaged by pests rehabilitated; ▪ Preventive measures against pests carried out permanently.	Local budget, International donors, Adaptation funds
11. Gradual inclusion into the biogas programmes of families having large number of cattle (20-30 heads)	▪ Farmers engaged in tourism and cattle-raising.	▪ Study of biogas resources; ▪ Awareness raising among farmers; ▪ Installation of biogas generators.	▪ Biogas producing organisation (on a tender basis.).	▪ Involvement of farmers (involved in tourism and cattle-breading business) a in biogas programmes.	GEF, UNDP, local farmers
Long-term strategy (after 2025)	▪ Local administration; ▪ Population of Lentekhi region; ▪ Ministry of agriculture; ▪ Research institutions related to agriculture sector.	▪ Preparation of adaptation measures in case of the climate zones transformation; ▪ Study of snow avalanche hazards increase due to climate change (both regions of Svaneti); ▪ Study of historical monuments vulnerability to climate change (both regions of Svaneti).	▪ Local Administration; ▪ MOE.		Government of Georgia, Local administration, International donors

Adaptation measures

(A-9) - Planting of hazelnut in the Lentekhi region

Project objective: The objective of the project is to reduce the vulnerability of the Lentekhi region to landslides, being significantly activated under current climate change in the region. The goal of the project is to plant hazelnut, which has a sturdy root system, at landslide-endangered slopes to combat further erosion of land in the region, which at present greatly damages cropland and forests, roads and other communications, promoting the worsening of living conditions of the local population and causing migration processes.

***Project participants*:** Local population

***Problem*:** Land degradation is one of the most acute problems in the Lentekhi region. Its impact is significant not only on agriculture, but on forestry, transportation, the public sector and the demographic situation as well. For the last two decades the population of the region has decreased by 40%.

The disastrous events enhanced by climate change (heavy showers, abundant snowfalls, floods and drought) have become more frequent in the region, causing the intensification of erosion processes. The agriculture sector of the region has suffered great losses. The area of arable land has decreased from 2,200 ha (1990) to 1,500 ha (2007).

Along with natural causes, the main anthropogenic factors affecting land degradation processes are:

- After the disintegration of the Soviet Union the decentralised management system has provoked the non-systematic exploitation of natural resources, including forests and alpine hayfields and pastures.
- The implementation of centralised measures aimed at the protection of forests and soil has been stopped. This has led to land degradation - the intensity of erosion processes at the logged and stripped plots has increased.
- The cultivation of maize, potato and other plants on slopes has enhanced the erosion of arable land as well.

To combat the land degradation processes provoked by the above-mentioned processes the piloting of hazelnut plantations is regarded as a highly efficient measure, serving two objectives: increasing the stability of landslide-endangered slopes and promoting income generation for the local low income population as a result of selling the hazelnut harvest.

***Activities to be implemented*:** The activities in the pilot phase of the project include planting of of hazelnut initially on an area of 50 ha, its introduction into the operation stage, harvesting and realization. If the pilot project is successful it could be possible to rehabilitate some hundreds of hectares of degraded and abandoned land which became useless under the impact of climate change and anthropogenic activity.

***Project cost*:** The total cost of the project is USD 281,700.,

Project emissions: According to the tentative estimations the annual absorption of CO_2 from its pilot area (50 ha) would reach 950 tonnes, after the entering of the project into operation,.

Glaciers

Considering the fact that the degrading glaciers of Central Caucasus are causing serious hazards for the adjacent regions, along with the above project proposals, one proposal has been developed in the framework of catastrophic events associated with this process.

(A-10) - Mitigation of disastrous glacial phenomena in the Dariali Gorge

Project objective: The objective of the project is to mitigate the adverse impact of climate change on the main highway passing through the Stephantsminda region, which connects Georgia and Russia, and on the main pipeline between Russia, Georgia and Armenia. The goal of the project is to elaborate proper adaptation measures which will provide a reduction to the minimum of losses caused by glaciers to the highway and the pipeline, having great economic and political importance.

Project participants: Government of Georgia, local administration

***Problem*:** Four glaciers in the Tergi/Terek River Gorge (Chachi, Devdoraki, Abano and Gergeti, correspondingly 3.2, 6.5, 2.5 and 8.5 km long) are causing periodic disastrous events in the Dariali Gorge, during which the river gorge becomes blocked at the length of 8-12 km. The volume of debris carried out reaches 14-16 million m^3 with a depth of 80-100 m. The flooding originated after the bursting of a blocked up section affected large areas of lower territory, inflicting heavy losses to settlements, flooding arable land, destroying roads, bridges and other communications. In the past 100 years, such disasters have occurred at the Devdoraki Glacier in 1953, 1968 and 2007, at the Abano Glacier in 1909 and 1910, and at the Gergeti Glacier in 1953.

The losses related to the single disaster causing the interruption in the functioning of the highway and the gas pipeline reach USD 23-25 million. The cost of repair works necessary to restore the road and the pipeline amount to USD 35-40 million (tentative).

Activities to be implemented: The complete prevention of the disastrous events described above exceeds human capability, though the mitigation or partial avoiding of their impact is nevertheless possible by undertaking certain technical and organisational measures. They include:

- Specification of hazard zones from the bottom of the Dariali Gorge up to 80-100 m high in the canyons of the Amali, Devdorakistskali, Chkheri and Blota rivers, as well as at the 300-400 m long sections of the Tergi River Gorge at the mouths of the Amali and Chkheri rivers.
- Arranging an early warning system in the above-mentioned canyons to guarantee the quick evacuation of people from dangerous zones in case of hazardous alteration of river run-off and crumbling of glacier avalanches. Creation of an observation system in Stephantsminda and vil. Gveleti. Perfection of this monitoring system using modern technical means;
- Artificial demolition by explosion of Devdoraki Glacier cornices in case of their transformation to the hazardous stage;
- Laying of artificial drain canals in the Devdoraki Glacier tongue, as well as for draining the water from the blocked up moraine and glacier lakes;

- ❖ Laying of 2-3 drain canals at the lower terraces of the Amali and Chkheri rivers' right banks to partition bursting floods and the streamflow, and decrease midstream intensity in the main beds of the rivers;
- ❖ Construction of a 700-800 m draining and ventilation tunnel at the right bank of the Tergi River near the mouth of the Amali River. In case of blocking up of the Tergi River Gorge this tunnel will pass the blocked water, thus avoiding the disastrous flooding of areas at the lower reaches of the river;
- ❖ Carrying out specialised observations in the blocked up region to construct the map demonstrating the distribution of expected hazard parameters and elaborate recommendations for the reduction to a minimum of possible losses.

***Project cost*:** Project expenses are to be estimated after carrying out a specialised engineering survey at the Devdoraki Glacier and in the Tergi River Gorge and preparation of full feasibility study.

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Chapter 5
Policies and measures to mitigate climate change

5.1. Energy sector evolution scenarios

Introduction. The greenhouse gases inventory prepared within the SNC of Georgia for the years 2000-2006 demonstrated that the leading sector in GHG emissions is the Energy sector (including the Transport subsector). That is why the main accent was placed on this sector in the planning of mitigation measures. However, this does not mean that other sectors, such as solid Waste, Agriculture and Forestry were not considered in the mitigation strategy, but rather that their share (excluding Forestry as a GHG sink) compared to the Energy sector is not significant in Georgia.

To estimate future trends of GHG emissions under different mitigation policies, the software model LEAP (Long-range Energy Alternatives Planning system) [1] was used, which was provided free of charge by the National Communications Support Programme (NCSP) which also organised the training workshop.

Methodology. LEAP software was used for estimating Georgia's mitigation potential for the energy sector. LEAP is a flexible, easy to use, scenario-based system for the integrated management of the energy sector. The software enables forecasting of the evolution of the energy sector, integrated planning of resources, analysis of mitigation policies and inventory of GHGs and energy balances. LEAP is a scenario-oriented model which is different from forecasting models.

Creation of the structure of the Energy sector (Current accounts)

LEAP is a bottom-up, demand driven model. The structure of the Energy sector in this model consists of three subsectors:

- **The Energy Demand Sector**
- **The Transformation and Distribution Sector**
- **The Energy Resources Sector.**

In the process of applying of this model the country's Energy sector structure was established as a,first step and then possible evolution scenarios were modelled and compared. The structure of Georgia's Energy sector was based on the year 2006, which was taken as baseline year. For the construction of current accounts and scenarios, the different studies carried out in Georgia have been used. Main studies applied are: the Energy Efficient Potential in Georgia and Policy Options of Its Utilisation, Rural Energy Programme, Fund World Experience for Georgia, 2007 [2]; Renewable Energy Potential in Georgia and Policy Options of Its Utilisation, Rural Energy Programme, World Experience for Georgia, 2007 [3]; Energy Balance of Power Sector of Georgia: Part 2: Balances from 1960 to 2005, USAID, Advisory Assistance to the Ministry of Energy of Georgia, 2006 [4]; Energy Balance of Georgia 2001, State Department of Statistics of Georgia [5] and the web page of the Ministry of Energy of Georgia (http://www.minenergy.gov.ge) [6].

The energy resources of Georgia. Georgia is not rich in fossil fuels and other energy resources, but different quantities of nearly all types of resources can be found on its territory. Such resources are: hydro, wood, coal, peat, oil, associated gas, and thermal water. Also there are quite favourable conditions for the use of solar and wind energies. From the traditional fuel and energy resources of Georgia, hydro power resources, coal and oil are especially interesting. But it must be underlined that their theoretical (geological) reserves greatly exceed their technical balance, and this is especially true in relation to coal and oil resources.

Hydro energy resources: Georgia is especially rich in hydro energy resources. This is mostly due to the mountainous relief of the country. West Georgia has remarkable hydro power potential. In total, there are 26,000 rivers on the territory of Georgia, with a total approximate length of 60,000 km. According to data from the Georgian research institute “Hydroproject”, out of the total number of Georgian rivers, 319 are especially interesting due to their hydro power potential, with an aggregate annual potential of 15.63 million kW, and an annual average power of 135.80 billion kWh. In conditions of optimal usage of these resources, the GHG emissions from the Georgian electricity generation sector could become zero. 40% of the technical hydro resources of these 319 rivers come from the eight biggest rivers of Georgia (Mtkvari, Rioni, Enguri, Tskhenistskali, Kodori, Bzipi, Khrami and Aragvi). This creates favourable conditions for hydro power development in the country. But it must be mentioned that the seasonal distribution of these resources is not even and this fact must be considered in terms of Georgia’s energy sustainability. The list of projects offered by the Ministry of Energy of Georgia for investment includes projects for the construction of small and medium hydro power plants, as well as the construction and rehabilitation of large energy plants, which will additionally give the country annually approximately 5 billion kWh of electricity from small and medium plants, and about 10 billion kWh from the big plants (http://www.minenergy.gov.ge).

Wood: Wood and forest resources hold second place in the resources section of the local energy balance. Georgia is rich in forests, but they are not evenly distributed in East and West Georgia, and some regions are poor in firewood. The real 'hands-on' wood cutting volumes significantly exceed the limits permitted for wood cutting, and skew the official statistics. This imbalance is criticised by many national experts. In energy balances based on statistical data, the annual demand for wood is equal to 300-350,000 tonnes of oil equivalent (toe), while some independent researchers show that it amounts to 450-550,000 toe [7]. The wood potential of Georgia is so great that it could be successfully employed to provide its entire energy security. First of all, this concerns the plantation forests which can produce firewood to replace natural gas in winter for heating, and reduce the country’s dependence on imported fuel. Due to the fact that the projects of plantation woods have not been discussed in future plans for the development of the energy sector, their potential has not been considered in the LEAP model either. But its potential is promising, and it has been considered as a recommendation in the overall strategy of Georgia’s energy sector, and already prepared, considering the requirements of the UNFCCC. This resource needs better estimation in elaborating the concept for the future energy security of the country.

Coal: For the energy security of the country, coal is quite interesting, from locally existing resources, especially due to the scale of coal reserves and the extraction experience. Georgia is the only country among the South Caucasus republics possessing this resource. There are seven coal fields in Georgia. Out of them, only three have industrial importance. These are the Tkibuli-Shaori, the Tkvarcheli coal deposit, and the Akhaltsikhe brown coal deposit. Total resources are estimated at 13.7 million tonnes. Despite such reserves, the geological conditions for the extraction of coal in Georgia are quite difficult. The fields are located at great depth, the relief is mountainous, and the content of methane is quite significant (from 20 to 45 cubic metres per tonne). Owing to these and other reasons (insufficient financing, absence of consumers, costly extraction, etc.) the coal industry is nearly at a standstill at present. Nevertheless, the Georgian government considers this resource as one of its priorities to solve the social problems of the region.

Oil: The geological study of oilfields in Georgia started in the 19th century, and this work acquired a systematic and intensive character in 1929-1930. But it did not result in discovery of oil rich fields. In 2008, only 68 thousand tonnes of oil was extracted.

Natural gas: Significant gas fields in Georgia have not been discovered on Georgian territory yet. In various places, there are small deposits of natural gas. Georgia nowadays mostly uses imported natural gas. According to 2008 data about 20 million m^3 of gas has been recovered in Georgia.

Alternative energy sources: Georgia is rich in alternative sources of energy.

- ***Wind energy*****:** Measurements of wind speed have been carried out in Georgia at 165 meteorological stations over several decades. It has been proven that total wind energy potential amounts to 1,300 GWh. Technical potential has been estimated at 5 GWh. The calculations show that about 2,000 MW of capacity and 5 GWh, or about 60% of current electricity consumption in Georgia, can be obtained from wind farms. This estimate covers only the most promising areas with the highest wind potential. It has to be noted that the highest share of wind energy is in winter months when hydro power plants suffer shortage of water, and the country depends on imports. Annex V depicts the map of highly productive potential wind farms showing the capacity and potential generation data.
- ***Thermal waters***. Georgia is a moderate thermal region, where the temperature of hydrothermal resources does not exceed 110^0C. There are approximately 250 wells and springs of geothermal water with temperatures between 30 and 110^0 C. Their total output is 160,000 m^3 per day. Different sources estimate our technical potential of thermal resources at 300 MW. About 80% of this geothermal potential is concentrated in West Georgia. Thermal waters in Georgia have great potential due to the positive quality characteristics of the water, and low mineralisation (0.22-2.9 grammes per litre). Besides this, most of the waters do not cause intensive corrosion on metals and do not form salt sediment. All these are conducive to a wider use of thermal waters. In this proposed strategy, we consider the use of several prospective deposits (Lisi, Zugdidi-Tsaishi, Poti, Senaki-Menji, and Tskaltubo).
- ***Solar energy***. Georgia is a country known for its mountainous relief and for its villages high in the mountains, with a total number of about 100 (or 500 households), one of the most promising alternative sources of energy is solar energy. At the same time, it is the cleanest and most permanent primary energy resource. Georgia, as a southern country, is rich in solar energy, and is located in the so-called sun zone of the world (north latitude 45^0 and south latitude 45^0). The theoretical amount of solar energy reaching our territory during a year is 10^{14} kWh. In most localities in Georgia, the duration of annual sunshine is quite long, and it fluctuates between 1,300 and 2,400 ha. At the same time, regions of East Georgia are sunnier than regions on the Black Sea coast and in the Kolkhida Lowland. The highest figure of sunshine is in Rodionovka (2,433 h), the lowest in Sairme (1,300 h). During winter months the sun shines an average of 80-120 h, in summer months sometimes 285-300 h, and in droughty years 300-360 h.
- ***Biogas***: Biogas potential has not been well studied in Georgia. With crude expert estimations [8], the total annual amount of animal manure is about 15-20 million tonnes,

out of which 3-5 million tonnes could be transformed into biogas (120-200 million m^3), which is equivalent to 70-120 million m^3 of natural gas. Maybe this amount is not very impressive, but it is a very significant resource in such a mountainous country as Georgia, which does not have large resources of fossil fuel.

Energy transformation and distribution in Georgia. The energy transformation subsector includes the energy generation segment, where one kind of energy is transformed into another. In Georgia, the main segments of the transformation subsector are that of electricity generation, and oil refineries.

Oil refinery: Oil processing has a rich history in Georgia. The Batumi oil refinery was the product of the planned economy. Its annual production was oriented towards the processing of 5 million tonnes of crude oil, and the products included nearly all petroleum products. In the course of time, due to the development of the oil processing industry in neighbouring countries, and the ecological problems of the Batumi operational capacity of the factory, annual production was gradually reduced. The obsolete technological equipment had not been replaced with new ones, and thus, in the 1990s, the factory had a decreased range of products, and ceased work. Oil processing had been transferred to outside Tbilisi, to a new factory, which operated during 2001-2005 with low capacity and periodic stoppages. In different regions of Georgia, there were so called "mini" factories, which mainly imported the remains of oil products and diesel fuel from neighbouring Azerbaijan. Due to different ecological and legislative limitations, at present no oil refinery is functioning in Georgia, and hence the petroleum products consumed in Georgia are imported.

Electricity generation and distribution: There are two types of electricity plant in Georgia: hydro power plants and thermal plants, which produce electricity from imported natural gas.

The following factors characterise electricity generation in Georgia:

- Thermal plants operate only in autumn-winter and serve to cover electricity deficits.
- The import of electricity is also performed in winter (because of an increase in electricity demand, and decreases in hydro generation, as well as the insufficient capacity of thermal plants alone), to secure the stability of the electricity supply.

The figure below shows the dynamics of electricity generation for the years 2002-2007.

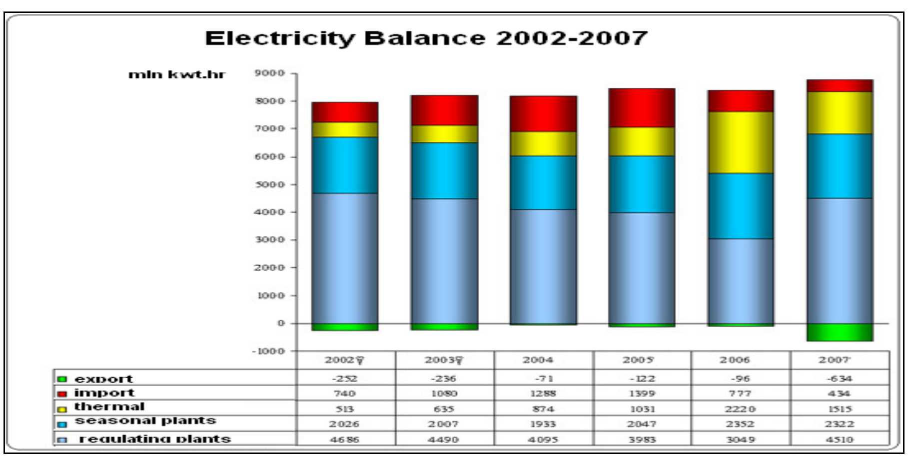

Figure.5.1. The dynamics of electricity generation, 2002-2007. Source: the web page of the Ministry of Energy (http://www.minenergy.gov.ge)

A more recent (2005-2007) trend in Georgia's Energy sector has been to reduce electricity imports and replace them with gas imports, for the local thermal generation of electricity. Since there is no significant production of fossil fuel in Georgia, the thermal plants can not directly contribute to the country's energy independence and energy security. For these thermal plants the country needs to import natural gas. Of course, in this way electricity imports decrease but also increase demands on natural gas (or other fuel). Because it is possible to create reserves of natural gas in case of instability of the electricity system, the operation of thermal plants can add to the diversity of supply by allowing the import of gas instead of electricity. What is being achieved by the construction of new thermal plants, is more capacity in converting the energy of imported fossil fuel into electricity. Thermal plants are needed for the stability of the power system, and in optimising the production of hydro plants; however, their contribution to energy security is of secondary importance. On the other hand, electricity generation by thermal plants increases GHG emissions from the electricity generation sector from the territory of Georgia, which does not happen in the case of electricity imports.

Over the last two years, Georgia has made significant progress in accounting for energy consumption and increasing cost collection. In the electricity sector, large industrial consumers pay the costs of consumed energy almost in full. By 1 June 2007, commercial losses of electricity were down to 16%, which is a very important achievement.

In the total energy system of the country, the winter peak load has decreased from 1,600 MW in 2005 to 1,200 MW in 2007, since metering was improved. This was an important step forward.

According to the Energy Balance for 2006 [2], electricity generation and transmission losses amounted to 13.2%.

***Natural gas distribution*:** As already mentioned, Georgia consumes imported natural gas. The biggest distributors of imported gas are "Kaztransgas-Tbilisi" and "Itera-Georgia" (it owns most of the regional gas distribution companies). Commercial losses in distribution companies are unfortunately high. According to "Kaztransgas-Tbilisi" data, losses amounted to 30-40% of purchased gas income. Natural gas is also used for electricity generation. According to the Georgian Oil and Gas Corporation data, the losses in the main gas pipelines are far less than 10%. For this reason, losses of gas transmission and technical distribution losses in this study are assumed to be 10%.

Energy demand sector. During transition to a market economy, radical changes took place in the structure of the energy demand sector. The pie-chart below shows the distribution of energy consumption between demand sectors in 2006:

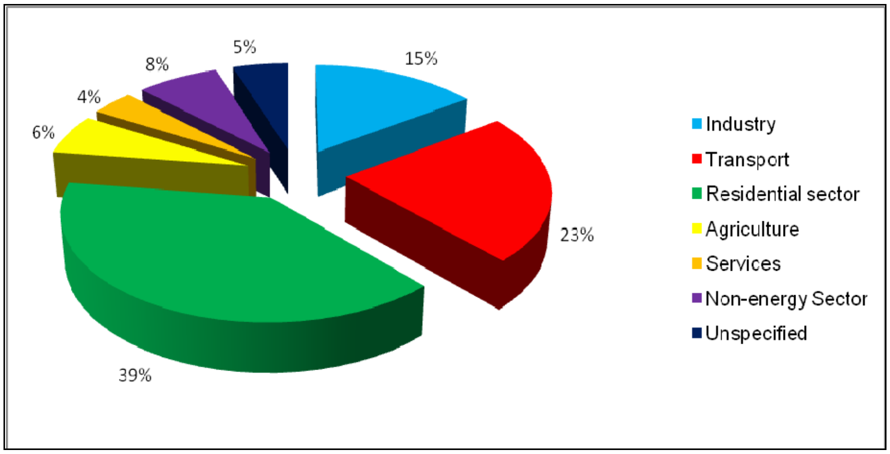

Figure. 5.2. The distribution of energy consumption between demand sectors, 2006 [2].

As can be seen, the largest share of energy consumption is in the residential sector (39%), which is almost twice as large as the transport sector (23%), the second largest energy consumer. Industry (15%) is placed in the third place of the total energy consumption in Georgia; these three sectors are discussed in more detail below:

Industry**:** The industrial sector includes: metallurgical enterprises, chemical and petrochemical materials, non-metal enterprises, and all the others, among them small enterprises. This classification is used by the International Energy Agency as these enterprises can be disaggregated on the basis of energy consumption. The industrial sector was the major consumer of energy during the Soviet period. After the breakdown of the Soviet Union, digressive processes in all the sectors of industry soon appeared. The situation was especially difficult for big energy-consuming enterprises, the majority of which either stopped functioning or were functioning at very low capacities. Nowadays, energy consumption by the industrial sector is much less than that of the residential and transport sectors. In 2006, industry used five times less oil products than the transport sector. Most of this fuel was consumed by other enterprises, and used for non-power needs. In the Soviet era, the biggest consumer of natural gas was heavy industry. At present the only distinguished consumer of gas resources is the energy sector. From industry, the only large consumers of natural gas are “Energy Invest” with its fertilizer-producing enterprise “Azot” (in Rustavi) and “Heidelberg-Cement Georgia”, producing cement in Rustavi and Kaspi.

The construction of Georgia’s industrial sector (as well as the services sector) structure and estimation of its evolution with high accuracy is a complex task. To solve it, one needs to have information about the end-user’s internal structure regarding energy consumption, the technical conditions of equipment, efficiency, their work regimes, the statistics of energy consumption, the load curves for production, future plans, etc. Gathering such information means performing an energy audit for each end-user, which takes significant time and resources and is not being practiced by industrial sector. That is why in scenarios for these sectors (industry and services) a simplified aggregated approach has been used, along with the results from already performed surveys. In particular, to project the evolution of these sectors, the approach introduced in the report on a Natural Gas Strategy for Georgia [7] was applied, where the growth of demand for fuel was taken to be proportional to GDP growth. To estimate the energy efficiency potential of these sectors, the evaluations from a study of energy efficiency potential in Georgia and policy options of its utilisation [2] were used.

***Transport*:** The transport sector is the largest consumer of oil products (petrol, diesel). In 2006 it consumed 65% of total oil products consumed by Georgia. There exist no reliable statistics in Georgia about fuel consumption by transport, transport types, quantities, and freight and passenger turnover. Current data is not valid either. The statistics of the transport sector, as well as statistics of its fuel consumption, need considerable improvement. There has not been any research performed concerning the efficiency of the transport sector, the optimisation of fuel consumption, or upon emissions mitigation in this sector. There exists no state legislation for the development and optimisation of this sector. That is why a simplified aggregated, GDP-dependent approach was used for estimating the evolution of this sector in future. No mitigation measures were considered for this sector. This question needs to be resolved in future.

***Residential*:** The residential sector is the largest consumer of energy in Georgia. It mainly consumes electricity, natural gas, and firewood. The major portion of commercial losses of electricity and natural gas by distribution companies is localised in this sector. That is why this sector is considered the one with highest potential for energy savings. Energy consumption in the residential sector is characterised by sharp seasonality. The ratio of Georgia's domestic consumption minimum in summer to its maximum in winter (seasonality coefficient), is about 55%. Consumption's seasonal variations are especially high in large cities, where a great number of consumers use electric heaters in the winter period, and in the summer they leave their permanent dwelling places for extended periods to take holidays. Monthly energy consumption in villages and the regions is more even than in the larger towns. The urban population consumes electricity mainly for lighting. Natural gas and wood are used for heating and hot water supply. As for air conditioning, initial research shows that its share in total energy consumption is insignificant and does not have any serious impact on Georgia's seasonal character of energy consumption. Georgia's population mainly uses electricity, natural gas and firewood for heating and hot water supply, firewood being mostly used in non-gasified regions. As already mentioned, existing official and expert estimations of firewood consumption differ significantly. This question must be better examined in the future.

Georgia's energy sector evolution scenarios. According to a bottom-up analysis procedure, in addition to describing the structure of Georgia's Energy sector, several scenarios were developed that explored a range of possible future energy pathways. They combined narrative (scenario storylines) and modelling methods (using LEAP) to illustrate alternative contexts, and to analyse potential outcomes. At this stage, only three possible scenarios were explored: a Baseline scenario (BAU scenario 0), a Split Public scenario (scenario 1) and a National Policy scenario (scenario 2).

The storylines for these scenarios have to be discussed separately.

- **Baseline scenario (BAU scenario 0)**

The Baseline scenario depicts a world formed by the outcomes following Georgia's energy crisis in the 1990s. The country had not developed any integrated vision for the future and just tried to solve the energy crisis. The government currently tries to ensure a supply of electricity and natural gas by any means. The economic development of the country is one of the top priorities.

The following assumptions were made to construct this scenario:

- Changes in the residential, transportation, commercial, and industrial sectors are shaped by incremental trends, but based on old technologies. New technologies have not been developed nor implemented.
- The Baseline pathway is characterised by steady but small population growth, the development of the economy, and GDP growth.
- GDP growth in the Baseline scenario is based on plans of the Georgian government [7, 8] and expert estimations. The source of GDP information for 2007 and 2008 is the Department of Statistics.

Table 5.1. GDP Growth

Years	2007	2008	2009	2010	2011	2012	2015	2020
Real GDP Growth	11.2%	9.0%	10%	9.5%	8%	8.5%	7%	5%

- For each demand sector, GDP growth depends on recent trends and expert estimations.
- The state economy grows enough for consumers to increase the size of their homes and use private appliances and consequently consume more energy. The population remains uninformed about the necessity of the effective use of energy. The GDP growth of the residential sector is less than state GDP growth (only 65% of the state GDP growth).
- The transportation sector reflects the economy's growth, but without changes in transportation technologies. The overall national transportation policy context has not changed, and the national fuel economy standard remains unoptimised. A significant part of the population purchases bigger cars (a majority of which are second hand) and they drive more often. Large, non-efficient cars remain popular in society. With the development of the TRACECA (Transport Corridor Europe-Caucasus-Asia) transportation corridor, the freight turnover has increased and the railway has developed. The transportation sector reflects government policy, represented by the following statement: "Implement "open policy" for every type of transport to ensure mobility, international integration and transportation attractiveness" [9,10]. According to this, the GDP growth from transportation sector increases by 16% more than the national GDP growth.
- The industrial and services sectors also reflect the growth of the national economy. The GDP growth from these sectors increases by 35% and 13% respectively more than the national GDP growth.
- The GDP growth of agriculture was 29% less than the national GDP growth. Non-energy and other sectors grew proportionally to the national GDP.
- In the electricity generation sector, Georgia continued its recent tendency to decrease its electricity imports and replace them with locally-generated electricity. The plan of the state government [11] to construct wind plants started with delays and by 2025 the share of wind farms in electricity generation should be only 3%.

- **Alternative scenario 1 – Split Public scenario**

Split Public is a scenario that explores how a set of energy activities motivated by individual and community interests, with neither a common national policy nor an organised co-ordination of processes, can influence Georgia's energy pathway.

In the Split Public scenario, a motivated segment of the public has begun to organise and initiate clean energy activities, on individual and local levels. Self-labelled ‘‘progressive energy enthusiasts’’ (NGOs, local government, municipalities) under their projects and programmes promote efficiency activities in the domains where they exert influence – in households, consumer preferences, and communities. Split Public highlights public interest as a critical agent in Georgia’s future energy pathway. The following assumptions were made to construct this scenario:

- The domestic sector plays a pro-active role in energy saving initiatives. Significant increases in the share of energy efficient lights, windows, and wood stoves in households.
- The electricity and natural gas distribution companies pay more attention to the reduction of commercial losses. Precise metering and higher incomes from cost collection represent a better economic stimulus for consumers to reduce energy consumption, or invest in energy efficient technologies.
- There has been no change in the transport sector.
- The industrial sector remains the same as in the Baseline scenario. Large industrial consumers don’t implement energy efficient technologies.
- There has been some change in the services sector, where small commercial companies and municipalities implement energy efficient projects. Energy efficiency has improved by 14%. Nevertheless, the process is unorganised.
- Despite dynamism in certain areas, the reach of Split Public is limited by a lack of additional co-operation and co-ordination by national government, national policy, and the industrial sector. Without state government and private sector engagement, industrial energy and larger-scale electricity generation are outside of local control and do not differ significantly from the Baseline scenario.
- In the electricity generation sector this scenario assumes the wind plant share will be 6% by 2025. Here, maximum activity of foreign donors and a Kyoto Clean Development Mechanism is expected. But without state policy and good will, wind plants reaching a significant share in electricity generation is not very realistic.

- **Alternative scenario 2 – National Policy scenario**

National Policy is a scenario of co-ordinated activities at the individual, local, and national levels. This scenario integrates the local and community-led activities of Split Public with a progressive state energy policy and a planning mandate focused on clean energy and emissions reductions. To achieve these objectives, state agencies underwent significant reorganisation to consolidate, integrate, and reassert authority to collect energy information and initiate long-term policy and planning. The state has implemented a significant campaign to inform a wide audience about efficient and renewable energies. It assists in the implementation of clean energy projects, the involvement of the banking sector, research in the development of emissions reduction technologies, and in the spheres of energy efficiency and renewable energy, etc. This National Policy scenario explores how joint state, individual and community activities might affect the future of Georgia’s energy system. The following assumptions were made to construct this scenario:

- The National Policy scenario incorporates the same energy saving initiatives in the residential activities as in Split Public. However, these changes are to be adopted more quickly than in Split Public through the organisation of processes and support from the national government. This includes information campaigns, energy-efficient labels, special taxing policies, new construction codes, etc. A new national policy supports the establishment of new markets for renewable energy. Geothermal water is to be used more intensively for heating and hot water supply. In the mountainous regions, solar energy is developed, and solar heaters are to become more widespread. Solar energy will become one of the priorities in the high mountainous villages, as well as in tourist zones, and mostly in Adjara.

- A flexible taxation policy will help large industrial and commercial consumers to implement new energy efficient technologies and services. In the tourist sector (hotels), new heaters will be implemented based on renewable energy sources (solar, geothermal).
- The agriculture sector will develop further and geothermal waters will be more intensively used in agricultural complexes.
- The only sector which will not undergo any change is the transport sector.
- Electricity generation by thermal plants will be decreased and become zero by 2025. It is to be replaced by other kinds of energy. According to the national policy, new small and medium hydro plants are to be constructed. By 2025, the share of wind plants will be 9%. In addition, the distribution and generation of electricity is to be managed effectively. When needed, electricity will be imported, but this import is to be compensated by the export of extra electricity in summer.

Quantitative characteristics of Energy sector evolution scenarios. According to the above storylines the modelled parameters were chosen and estimated quantitatively. The scenario elements are modelled using explicit assumptions of how energy, technology, and activity parameters change over time. This approach links contextual narratives to specific physical changes in use patterns, technology attributes, and demographic drivers.

The modelled parameters are presented in the second column of Table 5.2. It is important to recognise that scenarios do not aim to make any distinct claims about how the future will actually unfold. Rather, the results demonstrate a subset of the many activities and outcomes that are possible. This subset includes activities which are in accordance with scenario storylines and our present knowledge of energy systems, and which enable us to estimate critical uncertainties present in Georgia’s energy system.

Table 5.2.Quantitative characteristics of Energy sector evolution scenarios

Sectors	Current accounts (2006)	BAU scenario (0)	Split Public scenario (1)	National Policy scenario (2)
Residential sector	Population 4.4013 m, average family 3.6 persons	Population growth rate 0.5%	Population growth rate 0.5%	Population growth rate 0.5%
		Energy consumed per family increases proportionally to GDP.	Energy consumed per family increases proportionally to GDP.	Energy consumed per family increases proportionally to GDP.
	18% of rural households are gasified	Regions are gasified. By 2015 35% of rural households are gasified. By 2025 70% of rural households are gasified. Natural gas consumed per family increases proportionally to GDP.	Regions are gasified. By 2015 35% of rural households are gasified. By 2025 70% of rural households are gasified. Natural gas consumed per family increases proportionally to GDP.	Regions are gasified. By 2015 35% of rural households are gasified. By 2025 70% of rural households are gasified. Natural gas consumed per family increases proportionally to GDP.
	20% of light bulbs used by the population are energy efficient.	20% of light bulbs used by the population are energy efficient. The overall quantity of energy efficient bulbs increases, but population increases as well as consumed electricity, which is why the share of this parameter remains the same.	By 2020 30% of light bulbs used by the population are energy efficient; by 2025, 50%	By 2020 60% of light bulbs used by population are energy efficient; by 2025, 80%
	20% of population uses energy efficient refrigerators.	20% of population uses energy efficient refrigerators. The overall quantity of energy efficient refrigerators increases, but population increases as well as consumed electricity, which is why the share of this parameter remains the same.	By 2020 30% of population uses energy efficient refrigerators; by 2025, 50%.	By 2020 60% of population uses energy efficient refrigerators; by 2025, 80%.
	Energy efficient windows and doors are installed in 5% of dwellings.	In 5% of dwellings energy efficient windows and doors are installed. The overall quantity of energy efficient windows and doors increases, but population increases as well as consumed heat, which is why the share of this parameter remains the same.	By 2025 energy efficient windows and doors are installed in 40% of dwellings.	By 2025 energy efficient windows and doors are installed in 70% of dwellings.
	0% of rural households use energy efficient wood stoves (research shows that even in gasified regions population uses firewood as well for heating)	Firewood consumed per family increases proportionally to GDP.	By 2025 20% of rural households use energy efficient wood stoves.	By 2025 90% of rural households use energy efficient wood stoves.

	The commercial losses of energy distribution companies are: -Telasi 16.1% -Energopro 23.7% -Gas distribution companies 42%		By 2015 electricity distribution companies reduce their commercial losses to 6% causing the population to decrease their consumption by 5%.	By 2015 electricity distribution companies reduce their commercial losses to 6% causing the population to decrease their consumption by 5%.
			By 2020 gas distribution companies reduce their commercial losses to 30% causing the population to decrease their consumption by 12%.	By 2020 gas distribution companies reduce their commercial losses to 30% causing the population to decrease their consumption by 12%.
	Nowadays population in mountainous villages of Adjara uses firewood for heating and hot water supply.	Consumption increases proportionally to GDP.	Consumption increases proportionally to GDP.	Consumption increases proportionally to GDP. By 2020 in non gasified regions (Mountainous Adjara) solar heaters are installed (142.00 mgwt/hr).
	The population (10,000 inhabitants) of Saburtalo district in Tbilisi is supplied by hot water from Lisi Geothermal deposit.	Consumption (electricity, natural gas) increases proportionally to GDP, consumption of geothermal heat remains the same.	Consumption (electricity, natural gas) increases proportionally to GDP, consumption of geothermal heat remains the same.	Tbilisi Geothermal heating/hot water project is implemented based on Lisi geothermal deposit: starting from 2012 hot water is supplied to 30,000 inhabitants of Saburtalo district, from 2015 the heating system is provided for same 30,000 inhabitants. From 2019 heating and hot water is supplied to 100,000 inhabitants. (142,793 MWh = 12,278 toe)
	Nowadays population in Zugdidi uses electricity, natural gas and firewood for heating and hot water supply.	Consumption increases proportionally to GDP.	Consumption increases proportionally to GDP.	From 2021 Zugdidi Geothermal heating/hot water project is implemented with 70 mgwt capacity, under which heating and hot water is supplied to 69,000 inhabitants of Zugdidi (75,781 MWh = 6,516 toe). Remaining heat is supplied to agriculture objects.

	Nowadays population in Poti uses electricity and firewood for heating and hot water supply.	Consumption increases proportionally to GDP.	Consumption increases proportionally to GDP.	From 2021 Poti Geothermal heating/hot water project is implemented with 11.6 mgwt capacity, under which heating and hot water is supplied to 30,000 inhabitants of Poti (6,780 MWh =583 toe). Remaining heat is supplied to agriculture objects.
	Nowadays population in Senaki-Menji uses electricity and firewood for heating and hot water supply.	Consumption increases proportionally to GDP.	Consumption increases proportionally to GDP.	From 2021 Senaki-Menji Geothermal heating/hot water project is implemented with 9.2 mgwt capacity, under which heating and hot water is supplied to 52,100 inhabitants of Poti (57,231 MWh = 4,921 toe). Remaining heat is supplied to tourism objects.
Industry and Service sectors	In 2006 the share of energy consumption from these sectors equals 19%.	Consumption from these sectors increases proportionally to GDP. In 2025 their share equals 29%.	Consumption from these sectors increases proportionally to GDP. By 2025 energy efficiency of small industrial, commercial and service sectors increases by 14%.	Consumption from these sectors increases proportionally to GDP. By 2025 energy efficiency of small industrial, commercial and service sectors increases by 14%, of large industry by 20%.
	Tourist business in Adjara region uses electricity and (natural gas, firewood) for heating and hot water supply.	Consumption increases proportionally to GDP.	Consumption increases proportionally to GDP.	By 2020 in Adjara hotels solar heater are installed with 523,260 mgwt/hr heat mainly for hot water supply.
	Tourist business in Tskaltubo uses electricity and (natural gas, firewood) for heating and hot water supply.	Consumption increases proportionally to GDP.	Consumption increases proportionally to GDP.	From 2021 Tskaltubo Geothermal heating/hot water project is implemented with 7.7 MWh capacity, under which heating and hot water is supplied to tourism objects. (133,745 MWh = 11,500 toe).

	Tourist business in Senaki-Menji uses electricity and (natural gas, firewood) for heating and hot water supply.	Consumption increases proportionally to GDP.	Consumption increases proportionally to GDP.	From 2025 Senaki- Menji Geothermal heating/hot water project is implemented with 9.2 mgwt capacity, under which the heat not supplied to the population (about 64%) will be supplied to tourism objects. (100,937 MWh = 8,679 toe)
Agriculture	Those branches of agriculture which use heat energy (poultry farms, greenhouse objects, etc.) nowadays are not significantly developed in Zugdidi region and near city of Poti.	Agriculture is developing (greenhouses, poultry farms, and swine breeding) and energy consumption increases proportionally to GDP.	Agriculture is developing (greenhouses, poultry farms, and swine breeding) and energy consumption increases proportionally to GDP.	Agriculture is developing (greenhouses, poultry farms, and swine breeding) and energy consumption increases proportionally to GDP. From 2021 95% of 70 mgwt capacity of Zugdidi Geothermal project and 11.6 mgwt capacity of Poti Geothermal project are used for agriculture objects.
Remaining subsectors	The share of these sectors in total consumption is 36%	Energy consumption increases proportionally to GDP and their share equals to 40%.	Energy consumption increases proportionally to GDP. Their share depends on implemented energy efficiency measures in all sectors.	Energy consumption increases proportionally to GDP. Their share depends on implemented energy efficiency measures in all sectors.
Electricity generation	2006	2025	2025	2025
	Hydro generation -72%	Hydro generation -81%	Hydro generation -85%	Hydro generation -91%
	Thermal generation – 28%	Thermal generation – 16%	Thermal generation – 9%	Thermal generation – 0%
	Net (import-export) import - 53 thousand toe	Net import -0	Net import -0	Net import -0
	Wind generation - 0%	Wind generation - 3%	Wind generation - 6%	Wind generation - 9%

Modelling Results

Energy consumption. According to the BAU scenario, energy consumption of demand sectors in future will significantly increase. Results show that by 2025 the largest energy consumption will be in the transport sector, followed by the residential and industrial sectors (Fig. 5.3).

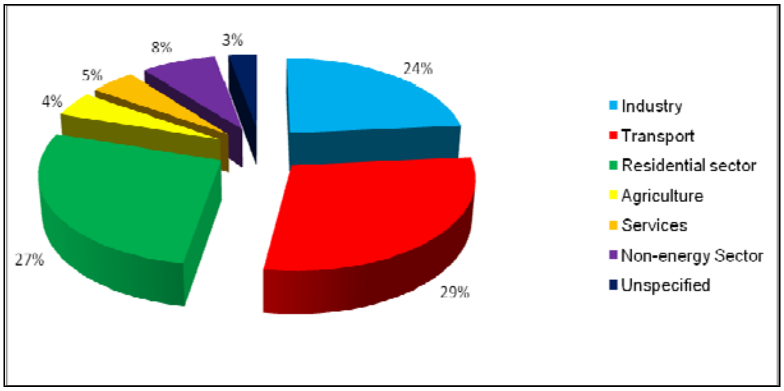

Figure. 5.3. Distribution of energy consumption in demand sectors in 2025 according to the 'BAU scenario'

Each of the alternative scenarios demonstrates energy savings compared to the BAU scenario in 2025, with the National Policy scenario showing greater energy savings (10%) than the Split Public scenario (6%). The largest component of these savings is to be derived from the industrial sector (51%), with residential (44 %) and service sector (4%) activity savings making up smaller shares. At this stage, alternative scenarios have not considered the possibilities of savings in transportation and other demand sectors (Fig. 5.4).

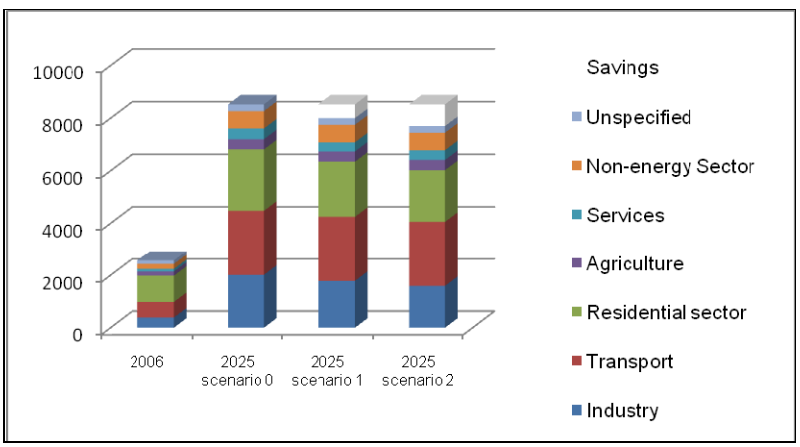

Figure 5.4. Energy consumption and energy savings by demand sector according to the BAU and alternative scenarios (thousand toe)

Table 5.3 below shows the possibilities of energy savings for each demand sector and each type of fuel separately.

Table 5.3. Energy consumption and energy savings for demand sectors and fuel types according to the BAU and alternative scenarios

	Current accounts	BAU scenario	Split Public scenario		National Policy Scenario	
	2006	**2025**	**2025**		**2025**	
	Consumption (thousand toe)	**Consumption (thousand toe)**	**Consumption (thousand toe)**	**savings (%)**	**Consumption (thousand toe)**	**savings (%)**
Residential sector						
Energy Consumption:	**1,000.8**	**2,336.4**	**2,098.5**	**10%**	**1,967.1**	**16%**
composed by:						
Renewable	0.0	0.0	0.0		36.5	
Oil Products	75.2	34.0	34.0	0%	34.0	0%
Natural gas	201.2	885.5	764.2	14%	718.1	19%
Electricity	395.6	875.7	802.4	8%	768.8	12%
Biomass	328.8	541.3	498.0	8%	409.8	24%
Industry and service sectors						
Energy consumption:	**490.0**	**2,421.5**	**2,136.2**	**12%**	**1,965.3**	**19%**
composed by:						
Solid fuel	3.0	6.0	5.5		5.5	
Renewable	0.0	0.0	0.0		65.2	
Oil products	102.7	521.8	392.9	25%	352.3	32%
Natural gas	195.0	981.4	880.5	10%	788.9	20%
Heat	28.0	126.8	114.8	9%	106.5	16%
Electricity	132.0	667.8	641.4	4%	545.6	18%
Crude Oil	5.3	21.2	18.3	14%	18.3	14%
Biomass	24.0	96.5	83.0	14%	83.0	14%
Agriculture						
Energy consumption:	**160.0**	**388.7**	**388.7**	**0%**	**388.7**	**0%**
composed by:						
Renewable	0.0	0.0	0.0		114.1	
Oil products	64.0	155.5	155.5	0%	98.4	37%
Natural gas	58.0	140.9	140.9	0%	83.8	40%
Heat	4.0	9.7	9.7	0%	9.7	0%
Electricity	14.0	34.0	34.0	0%	34.0	0%
Biomass	20.0	48.6	48.6	0%	48.6	0%
Transportation and other sectors						
Energy consumption:	915	3,379.6	3,379.6	**0%**	3,379.6	**0%**
Total energy consumption:	**2,565.8**	**8,526.2**	**8,002.9**	**6%**	**7,700.6**	**10%**

Residential, agricultural, industrial and service sector savings are to be achieved in the alternative scenarios, through energy efficiency and renewable energy activities. Results show that small but wide-spread actions (such as the replacement of light bulbs) have measurable impacts on the whole system.

Electricity Generation. The structure of Georgia's future electricity sector is highly uncertain. The BAU, Split Public and National Policy scenarios all explore different shares of wind energy in the electricity generation sector. That is why the structure of the electricity generation sector is different in all these scenarios. But all scenarios show that to fulfil the increased demand on electricity caused by a growing economy, the country needs to apply maximum efforts to ensure its electricity supply.

In all scenarios there is the need to maximise the use of hydro resources and implement a majority of those projects that nowadays exist in the country (Annex VI) – this concerns small and medium hydro plants (504 MW) as well as large hydro plants (1,426 MW). If energy-efficiency measures are not implemented, the country will need an additional 300 MW thermal plant, and as small as a 300 MW wind plant. The Split Public scenario does not necessarily need a thermal plant, but an additional 590 MW capacity will be needed. In the National Policy scenario, the capacity of wind plants will increase to 810 MW, and the energy savings in the demand sector will make it possible to reduce thermal generation to zero.

Table 5.4. Electricity generation in BAU and alternative scenarios

Current accounts	BAU scenario	Split Public scenario	National Policy scenario
Total generation 7,419 mln kWh	Total generation 24,316 mln kWh	Total generation 22,978 mln kWh (saving 6%)	Total generation 21,245 mln kWh (saving 13%)
Hydro – 5,316 mln kWh	Hydro – 19,696 mln kWh	Hydro – 19,531 mln kWh	Hydro – 19,331 mln kWh
Thermal – 2,103 mln kWh	Thermal – 3,891 mln kWh	Thermal – 2,068 mln kWh	Thermal – 0
Wind - 0 kWh	Wind – 729 mln kWh	Wind – 1,378 mln kWh	Wind – 1,912 mln kWh

Greenhouse-gas emissions. Reducing absolute and per-capita emissions from the Energy sector will require alternatives to the current trends. In order to explore opportunities for change, this analysis investigates the GHG implications of the scenarios, and considers their potential for mitigating emissions.

Figure 5.5 shows the trends of emissions from Georgia's Energy sector, according to the BAU (Scenario 0) and alternative scenarios (scenario 1 and 2).

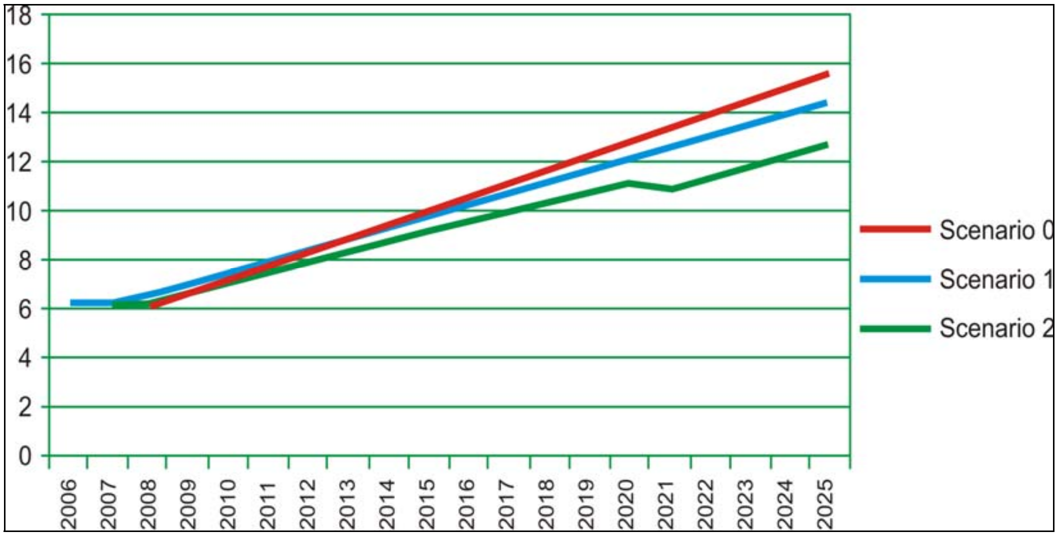

Figure 5.5. Emissions from Georgia's Energy sector according to the BAU and alternative scenarios (thousand Gg CO_2-eq.)

In 2006, the GHG emissions from the Energy sector in Georgia equalled about 6.506 thousand Gg in CO_2-equivalent. According to the traditional (BAU) scenario, by 2025, emissions will approximately triple compared to 2006 emissions, but will be less compared to the 1990 level (36.592 thousand Gg.). Each of the alternative scenarios demonstrate emission reductions compared to the BAU scenario in 2025, with the National Policy scenario showing greater reductions (24%) than the Split Public (12%). In the National Policy scenario, the largest component of these reductions is to be derived from electricity generation (55%) followed by the industrial (20%) and residential sectors (11%). The results show how different measures influence GHG emissions (Figure 5.6).

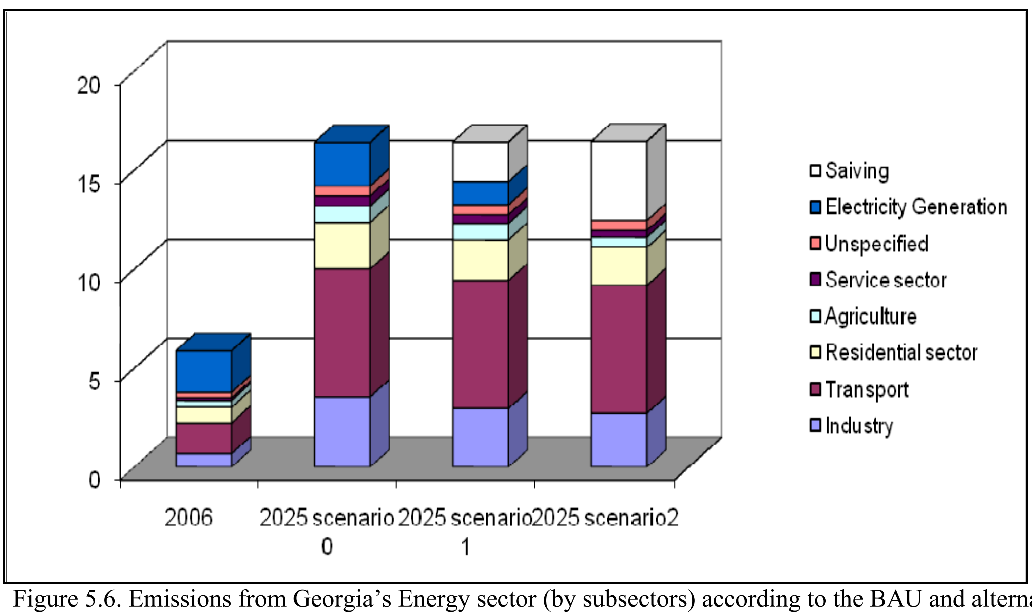

Figure 5.6. Emissions from Georgia's Energy sector (by subsectors) according to the BAU and alternative scenarios (thousand Gg CO_2-eq.)

The largest emitter of GHGs is the transport sector. In 2006, its share in total emissions from Energy sector was 23%. Emissions from the transport sector increased along with the growth of the population, driving intensity, and the economy, and in 2025 it should be represented by 39%. This fact once more indicates that national government must pay more attention to the necessity of modern policy adoption in the transportation sector.

Table 5.5. Emissions from Georgia's Energy sector and emission reductions by subsector according to the BAU and alternative scenarios

	Current accounts	BAU scenario	Split Public scenario		National Policy scenario	
	2006	2025	2025		2025	
	Emissions (Gg CO_2-eq.)	Emissions (Gg CO_2-eq.)	Emissions (Gg CO_2-eq.)	Emission reduction (%)	Emissions (Gg CO_2-eq.)	Emission reduction (%)
Total emissions	**5,964**	**16,397.0**	**14,422.0**	**12%**	**12,461.0**	**24%**
composed by:						
Industry	668	3,547	2,970	16%	2,729	23%
Transport	1,286	6,456	6,456	0%	6,456	0%
Residential sector	1215	2,358	2,060	13%	1,922	18%
Agriculture	654	825	825	0%	516	37%
Service sector	526	507	436	14%	331	35%
Unspecified	76	507	507	0%	507	0%
Electricity generation	1,539	2,197	1,168	47%	0.00	100%

A significant result would be the possibility to reduce emissions in the electricity generation sector by increasing the share of plants working on renewable resources. According to the National Policy scenario, in 2025, the share of renewable resources in electricity generation sector will be at a maximum in 2025, and emissions will be reduced to zero. The figure below shows emissions from the electricity generation sector, according to different scenarios.

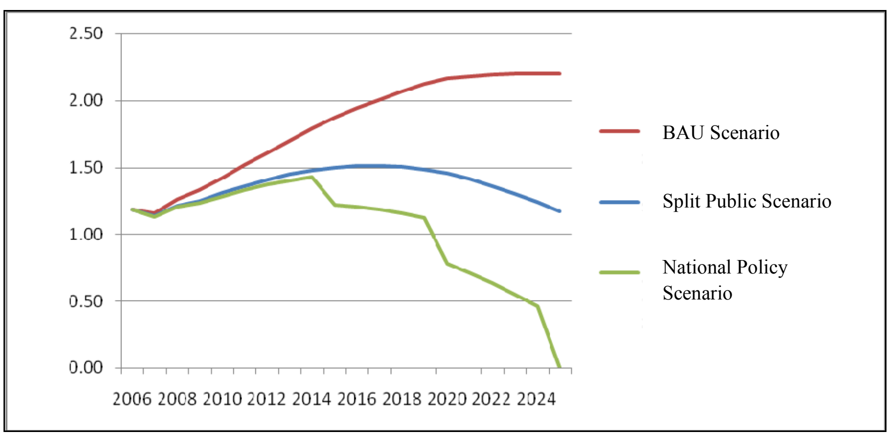

Figure 5.7. Emissions from Georgia's electricity generation sector according to the BAU and alternative scenarios (thousand Gg CO_2-eq.)

Conclusions and recommendations. The above energy scenarios were used as a tool to provide an opportunity to explore the context of current choices and priorities for the future. Below is a summary of important conclusions and policy implications that emerged from the scenario analysis, and which could serve as a basis for the strategy of development of Georgia's energy sector for 2025:

1. *The Georgian economy is highly dependent on fossil fuels.* The BAU scenario (scenario 0) reveals increasing fossil fuel (oil products, natural gas) dependence, which is available in very limited quantities on the Georgian territory. Currently, fossil fuels satisfy 71% of the country's primary energy demands. Expectations of gasification of Georgian territories, the growth of thermal electricity production, the increasing number of vehicles, and greater freight and passenger turnover, would take Georgia down a pathway toward even greater reliance on fossil fuels. These scenario analyses show that energy efficiency measures in the residential sector, and an increase in shares of renewable energy in electricity generation, would provide critical opportunities for achieving more diverse energy pathways.
2. *Transportation is and will remain in the next 20 years the major emitter of greenhouse gases in the country.* Transportation accounts for 31% of total emissions, which will grow to 39% by 2025. This sector also bears responsibility for national oil dependence and local air quality concerns. Recent trends of the transportation sector show that GDP growth from this sector is more than the average GDP growth. Georgia's population has the tendency to purchase bigger and less efficient cars. Such growth of the transportation sector will place it in first place in energy consumption by 2025. That is why major attention must be paid to finding and implementing ways of optimising this sector (especially in large cities). Correct transportation policies, consumer preferences, or technologies that serve to increase fuel economy or promote alternative fuel uses, offer large opportunities for reducing future energy consumption, decreasing pollution, and increasing energy diversity. The magnitude of the share of this sector in dependence of our country on imported fuel, as well as in GHG emissions, provides hearty justification for assertive transportation policy and planning on state levels.
3. *The diversity of Georgia's future electric power sector is highly uncertain.* On the one hand, there is a statement of the Georgian parliament which plans the increase of wind generation. On the other hand, it is already obvious that this statement has not been implemented. The current trend in the electricity generation sector shows a decrease in electricity imports and an increase in thermal generation (which increases dependency on imported natural gas). Electricity generation at thermal plants currently accounts for nearly 28% of electricity generation in Georgia. Consequently, the future composition of Georgia's power sector is uncertain, and current activities and expectations lead in competing directions.
4. *Alternative energy pathways are relevant and deserve attention.* Georgia has significant resources of renewable energy, which can and must be used to diversify and secure Georgia's energy system. As shown in these scenario analyses, renewable resources can significantly reduce emissions from Georgia's power sector. As the pressures associated with continuing down a fossil fuel pathway continue to increase, alternative energy pathways will likely be viewed as even less ''alternative'' and more ''necessary'' in the future. Recognising the value of alternatives earlier in the country's energy pathways offers even greater gains from earlier adopted measures.
5. *A combination of individual initiatives, and local and national approaches, offers the greatest gains in emission reductions.* It is obvious that not only individual and local efforts can significantly reduce GHG emissions, but also well thought out and planned policies on the state level will be necessary. On the other hand, the level of public interest, responsibility, and understanding, are very important factors in the country's pathway. As an example, in the considered scenarios, taking into account only individual

or community activities, these led to a 50% share of energy efficient lighting by 2025; with a planned policy and programmes, this share can become as high as 80%.

6. *Demand-side energy management offers important opportunities.* Demand-side energy savings can play a significant part in reducing GHG emissions. Equally important is the recognition that energy savings involve both energy efficiency and decreasing energy consumption, as both technology and social choices have a role to play in Georgia's energy pathway. Energy savings and energy efficiency are the simplest methods of emission reductions.
7. *Long-term planning and co-operation must start now.* Georgia is now in a transitional stage. The future of Georgia's Energy sector depends on which development paths it chooses now. Based on past experience and research, the future successful evolution of Georgia demands new vision. In order for a new vision to emerge, it is necessary for the public, industry, government, and other critical stake holders to co-operate closely. State leadership is needed to facilitate active discussion and the consideration of alternatives for the future. Now is a critical time for the country to reorganise its energy planning activities, reassert its mandate for information gathering, and to incorporate new ideas into its planning and forecasting purview.

NATIONAL GHG MITIGATION STRATEGY (2010-2025)

Georgia does not consider the abatement of GHG emissions a priority matter, as the emission of these gases from the country's territory is small, making up less than 0.1% of global emissions. However, recognising the importance of each country's share in reducing emissions as a valuable contribution to the mitigation of global climate change, Georgia is actively engaged in GHG emissions mitigation efforts and supports the implementation of any project and programme aimed at the reduction of GHG emissions from the territory of Georgia and putting the country on a sustainable development pathway. Georgia's main priority in this direction is the maximum development of its own renewable resources, thus reducing the country's dependence on imported fuel, and serving two objectives – the abatement of GHG emissions and the provision of independence in energy supply. The policy and measures to combat the inefficient use of energy resources, inherited from the Soviet period, are also important steps on the way to independence in energy and in provision of significant reduction of GHG emissions.

The main mechanism regarded by the country at present as one of its priorities in the transfer of environmentally-friendly technologies and clean investments is the Kyoto Protocol's "Clean Development Mechanism".

Considering all the above circumstances, a strategy has been prepared to provide the independence of the Georgian energy system and the reduction of GHG emissions. This strategy was developed in the framework of the preparation of Georgia's SNC to the UNFCCC and is based on the results discussed above. The strategy is primarily focused on the energy sector (energy consumption), as it is considered by the IPCC. From the energy-consuming sectors the largest emitter of GHGs in Georgia is the transport sector, for which measures are too general and their scale not specified. More detailed and thorough examination of this sector is planned for the Third National Communication.

National GHG Mitigation Strategy (2010-2025)

Key Strategic Objective	Key Target Groups	Activity	Potential Lead Agency	Output	Potential Donors
Electricity generation sector					
Short-term objectives	▪ Ministry of Energy; ▪ Energy Efficiency Centre; ▪ Industrial enterprises; ▪ Private sector dealing with renewable energy; ▪ Population.	GHG mitigation short-term strategy implies maximum promotion of renewable energy using the CDM potential. Energy saving measures are predominantly implemented by the population	▪ Ministry of Environment Protection and Natural Resources; ▪ Ministry of Energy; ▪ Parliament of Georgia.	In case of active facilitation of the government and carrying out of targeted policy the consumption of energy and relevant emissions of GHGs should be reduced by 24% compared to the Business As Usual scenario, and power generation will be totally covered by renewable energy (hydro and wind)	Government of Georgia, International aid programmes, CDM
Energy generation sector					
1. Increase the share of renewable sources (wind energy) in electricity generation up to 9% for 2025 (3% for 2015, 6% for 2020)	▪ Government of Georgia; ▪ Large electricity consumers.	▪ Adoption of laws and regulations facilitating the implementation of wind farms; ▪ Development of CDM PINs and PDD for priority sites with large consumers (Rustavi, Gori, Poti, Batumi,, Kutaisi, Paravani, Mta-Sabueti); ▪ Submission of PINs to potential investors and development of PDD; ▪ Removing all potential barriers to the installation of wind farms; ▪ Maintenance of enabling environment (including CDM and other mechanisms) for realisation of wind energy projects in Georgia; ▪ Facilitation of installation of minimum d 810 MW wind farm capacity; ▪ Increasing the awareness of policy makers and large consumers of electricity (potential owner of wind farms); ▪ Introduction of incentives for promotion wind energy in Georgia.	▪ Ministry of Energy; ▪ Ministry of Environment Protection and Natural Resources; ▪ Parliament of Georgia; ▪ Private sector (large consumers of electricity).	▪ Minimum 4 pilot wind farms (total installed capacity 120 MW) for the generation of wind electricity established and monitored by 2015; ▪ By 2025 installed capacity of wind farms reach 810 MW .	Clean Development Mechanism (CDM)
2. Increase the share of small HPPs (renewables) in electricity generation up to 14% for 2025 (installation of new and rehabilitation of existing plants)	▪ Regional Governments; ▪ Government of Georgia; ▪ Small enterprises (private sector) acting in hydro energy sector.	▪ Development of CDM PINs and PDD for priority sites: financially and technically most attractive projects are implemented initially; ▪ Realisation of all SHPP offered by the Ministry of Energy; ▪ Removing all potential barriers to the implementation of SHPPs projects;	▪ Ministry of Energy; ▪ Ministry of Environment Protection and Natural Resources; ▪ Regional Governments; ▪ Private sector.	▪ Small hydro power plants are operational; ▪ Total installed new capacities 504 MW for 2025; ▪ Share of small hydro in electricity generation reaches 14% for 2025.	CDM, bilateral investors (Norway), Government of Georgia-Revolving Fund for Renewables, Private sector,

		▪ Maintenance of enabling environment (including CDM and other mechanisms) for implementation of SHPPs; ▪ Introduction of incentives system.			PPP
3. Increase the share of large HPPs up to 77%	▪ Government of Georgia; ▪ Cabinet of Ministers.	▪ Financially and technically most attractive projects with the lowest environmental impact are implemented initially (Khudoni, Namakhvani Cascade-1, Namakhvani Cascade-2, Namakhvani Cascade-3, Oni Cascade); ▪ As the second step all large HPPs offered by the Ministry of Energy are realized; ▪ All environmental issues related to the construction and rehabilitation of large power plants should be considered and solved for all large HPPs; ▪ Facilitating the creation of electric energy regional market.	▪ Ministry of Energy; ▪ Ministry of Environment Protection and Natural Resources.	▪ Large hydro power plants operational; ▪ Total installed capacity 1,426 MW for 2025; ▪ Share of large HPP in electricity generation 77% for 2025.	EBRD, WB, Bilateral donors, Government of Georgia (in-kind)
Fuel switching in heat energy demand					
4.Increase the share of geothermal energy up to 2% in heat demand sector (population, agriculture and tourism)	▪ Urban population ; ▪ Local municipalities.	▪ Removing all potential barriers to the installation of geothermal heat and hot water supply systems; ▪ Creation of enabling environment (including CDM and other mechanisms) for maximum utilization of geothermal energy in Georgia; ▪ Introduction of incentives for promotion the utilization of geothermal energy; ▪ Preparation of PINs for heat and hot water supply in Tbilisi, Zugdidi, Poti and Tskaltubo.	▪ Municipalities of cities with geothermal heat supply; ▪ Ministry of Environment Protection and Natural Resources; ▪ Private sector acting in heat supply sphere.	▪ 100,000 residents of Tbilisi supplied with geothermal heat and hot water; ▪ Zugdidi (population, agriculture); ▪ Poti (population); ▪ Tskaltubo (population, tourism); ▪ Senaki-Mendji (population, tourism); ▪ Total for population 282,6 GWh to 2025; ▪ Total for agriculture 1327.0 GWh to 2025; ▪ Total for tourism sector 234.7 GWh to 2025.	UNDP, GEF, Revolving Fund for Renewable Energy established in Georgia, CDM
5.100% of households in Adjara region will be supplied by solar heaters of water, aimed at maximum use of solar energy in hot water supply making 0.7% of country's total energy demand	▪ Department of tourism; ▪ Population of Adjara; ▪ Private hotels.	▪ Introduction of incentives for the consumers of solar energy; ▪ Preparation of PINs for hot water supply of hotels (pilot projects having the best technical and economic parameters) in Batumi and Kobuleti; ▪ Awareness raising among hotel owners and high mountain households on the advantage of solar energy use.	▪ Leading NGOs in (solar energy) application field; ▪ Owners of hotels in Batumi and Kobuleti.	▪ Buildings in Batumi and Kobuleti (primarily hotels) supplied with solar energy generated hot water (pilot phase); ▪ Households of high mountainous villages supplied with hot water; ▪ Living conditions of population in Adjara improved.	Different grants: UNDP, USAID CDM Hotel owners (private sector)
6.Increase the share of biomass fuel in heat	▪ Rural population; ▪ Government of Georgia.	▪ Adoption of legislation facilitating the increase of biomass share in heat (cooking)	▪ Local government; ▪ Local NGOs;	▪ Plantations of energy forests established in Dedoplistskaro	Local municipalities,

supply sector		energy supply; ▪ Identification of the appropriate territories for planting new energy forests; ▪ Identification of potential energy forests amongst the existing ones and preparation of proposals for their rehabilitation and management;. ▪ Rehabilitation of existing (natural) energy forests and improvement management component; ▪ Establishment of PPP (Public Private Partnership) in fuel-wood supply sector; ▪ Establishment of plantation forest estates using the abandoned, eroded lands (see proposal for 40 ha plantation of bio-energy forest); ▪ Piloting the pellet/briquette industry in Georgia.	▪ Ministry of Environment and National Resources; ▪ Parliament of Georgia ; ▪ Department of Forestry; ▪ Private sector.	region (pilot 40 ha); ▪ Local private sector/farmers organised PPP in fire-wood production and supply sector; ▪ Pellet/briquette plant installed in West Georgia (Zugdidi region); ▪ Local population supplied by biomass fuel particularly in the remote regions (far from forested areas or settled near the protected territories) and facing the energy crisis.	GEF, CDM, PPP GTZ, Government of Germany
Heat and electricity consumption (energy efficiency measures)					
7.Increase the energy efficiency in electricity consumption sector by 12 % for 2025 (population)	▪ Residents; ▪ Energy distribution systems.	▪ Dissemination of energy-efficient bulbs among 80% of residents for 2025 (among 50% for 2020); ▪ Dissemination of energy efficient refrigerators among 80% of residents for 2025 (50% for 2020); ▪ Reduction of commercial losses up to 16.1% by “Telasi”, 23.7% by “Energopro” (these are power provider companies); ▪ Development and implementation of governmental programmes on energy efficiency labeling; ▪ Introduction of incentives for energy efficiency.	▪ Small NGOs; ▪ Different grant programmes; ▪ Individuals.	▪ 80% of households have energy-efficient bulbs; ▪ 80% of residents have energy efficient refrigerators; ▪ 70% of households have insulated windows and doors; ▪ Commercial losses of “Telasi” and “Energopro” reduced by 16.1 and 23.7% accordingly.	CDM (programmatic approach), EBRD, GEF
8.Increase the energy efficiency (electricity + other energy sources) at large (20%) and medium size (14%) enterprises	▪ Representatives of energy system (generation, distribution); ▪ Large and small enterprises.	▪ Carrying out energy audit of large and small enterprises (grant system); ▪ Preparation of recommendations on energy efficiency measures for each enterprise; ▪ Establishment of ESCO and energy efficiency fund; ▪ Assessment and introduction of energy; ▪ efficiency target and relevant regulations.	▪ Large and medium enterprises; ▪ ESCOs; ▪ Ministry of Energy.	▪ Large and small enterprises involved in energy efficiency programmes; ▪ Energy consumption by large and small enterprises reduced in total by 19%.	CDM, EBRD, ESCO
9.Increase the energy efficiency in heat generation and	▪ Residential sector; ▪ Rural population of villages; ▪ Natural gas distribution	▪ Implementation of programmes facilitating the increase of number of households having insulated windows and doors;	▪	▪ For 2025 the 70% of households have energy insulated windows and doors (40% for 2020);	CDM, WB, EBRD, ESCO

consumption sector by 18 % for 2025	companies; ▪ Construction companies.	▪ Preparation and implementation of governmental and other programmes for distribution of efficient stoves and boilers amongst the biomass consumers in villages; ▪ Preparation of PINs and PDDs for gas leak reduction from distribution systems; ▪ Raising awareness on energy efficiency among biomass consumers; ▪ Raising awareness on CDM perspective amongst gas distributors.		▪ Efficient wood stoves disseminated amongst the biomass consumers. (20% of households have efficient wood stoves for 2020 and 50% for 2025); ▪ Commercial losses reduced down to 30% by gas distribution companies.	
10.Reduce fuel consumption in transport sector and increase the share of gas fueled cars (This sector is mainly considered in long-term perspective)	▪ Municipalities of big cities ▪ Private sector	▪ Carrying out feasibility studies for assessment the potential ways of optimisation of city transportation system (Tbilisi, Kutaisi, Batumi, Rustavi, etc); ▪ Development of portfolio of recommendations for optimisation of city transportation system and decrease in fuel consumption; ▪ Development of package of recommendations for reduction of electricity consumption by metro and railway; ▪ Development and implementation of programmes for facilitating the fuel switch-on (from diesel to LPG) process ensuring at the same time high safety measures; ▪ Facilitate research works for producing the bio-fuel in Georgia.	▪ Municipalities of big cities; ▪ Private sector acting in LPG fueling in road transport sector; ▪ "Institute of Isotopes".	▪ Electricity consumption by metro and railway reduced; ▪ City transport system optimised; ▪ Possibilities of bio-fuel production in Georgia evaluated.	CDM, EBRD, Government of Georgia
Long-term strategy	▪ Ministry of Energy ▪ Ministry of Environment Protection and Natural Resources ▪ Ministry of Agriculture ▪ Department of Transport ▪ Municipalities of big cities	In the long-run (after 2025, and possibly earlier) one of the priorities should be the increase in biomass (bioenergy) production in forest-poor regions of Georgia, transport and heat-supply sectors should be more actively involved in mitigating GHG emissions. Country's economy in general is transferred to sustainable development principle	▪ Ministry of Environment Protection and Natural Resources, Hydrometeorology and Climate Change Administration ▪ Ministry of Energy ▪ Ministry of Agriculture		Government of Georgia

5.2. Clean Development Mechanism in Georgia

In 1999 the Parliament of Georgia ratified the Kyoto Protocol. Since ratification, activities in Georgia have been ongoing in a number of directions: local capacity-building to provide the strategy of full-scale activation of the CDM, contacts with donors as well as the preparation of specific projects and of national procedures. To solve these problems develop CDM potential, the country has requested assistance from international donors and the developed countries.

In 2002, ICF Kaiser, in the framework of a World Bank-financed project carried out the first international study on the potential for Georgia's participation in the CDM, focusing on the forestry sector. In this survey, in particular, it was suggested that to provide efficient participation of the country in the CDM process it is necessary to create a Designated National Authority (DNA). This recommendation promoted the appointment of such an entity in Georgia – in 2003 according to the CDM Rules and Procedures the National Agency on Climate Change was appointed as a DNA. In January 2005, according to a new government decree on the DNA, the functions of this authority were handed over to the Ministry of Environment Protection and Natural Resources.

In November 2004 a Memorandum of Understanding was signed between the government of Georgia (Ministry of Environment Protection and Natural Resources) and the government of Denmark (Ministry of Environment) on co-operation in implementing CDM projects. In the framework of this Memorandum several proposals were selected aimed at the mitigation of GHG emissions.

In 2004-2006 the EuropeAid (TACIS) project "Technical Assistance to Armenia, Azerbaijan, Georgia and Moldova with respect to Global Climate Change Commitments" was implemented in Georgia. In the context of this project local capacity was created to prepare and approve CDM projects. Very serious work was undertaken with potential private sector actors. The National Board on the CDM was created to assess proposed projects according to sustainable development criteria and to approve them before submission to the international registration. For the Georgian participants in the projects Georgian versions of PIN and PDD forms were prepared as well as guidelines for the preparation of CDM projects.

At the present time only one project from Georgia has been registered by the CDM Executive Board, which was prepared in co-operation with the Japanese company "Shimidsu Corporation" and concerns methane recovery from landfills and its combustion.

In co-operation with the Norwegian enterprises "Norsk Energy" and "Econ", and the Georgian Energy Efficiency Centre the project "Clean Development Mechanism – a way to the development of industry and alleviation of poverty in the South Caucasus" was implemented. The goal of the project was the strengthening of state and/or private industrial sectors in the Caucasus and their preparation for active participation in carbon markets and for the application of Kyoto mechanisms.

This project consisted of four phases, which included the following elements: a training programme to develop CDM projects; elaboration of a potential projects list and selection of priority projects; preparation of PINs for the selected projects; submission of detailed documents to potential investors and financial institutions; preparation of PDDs for the selected projects.

The list and the status of projects currently under consideration in Georgia is given in the table below:

Database of ongoing CDM projects in Georgia

Project ID #	Project title (PDD)	Project participants	Sector	Project status	Methodology #	Estimated annual reductions in total CO_2-eq
0001	Landfill Gas Capture and Power Generation Project in Tbilisi	Government of Japan/ Tbilisi City Municipality	Energy industries (renewable-/non-renewable sources)	Registered	AMS-I.D, ACM0001	33,000
0002	Refurbishment of Enguri Hydro Power Plant	Engurhesi Ltd./ EBRD	Energy industries (renewable-/non-renewable sources)	Validated	ACM002	1,788,000
0003	Leak Reduction in Above Ground Gas Distribution Equipment in the KazTransgaz-Tbilisi Gas Distribution System-Tbilisi, Georgia	"KazTransGas - Tbilisi"/ Climate Change Capital Fund II s.a.r.l.	F Energy/ Fugitive emission from fuels	Validated	AM0023	3,795,700
0004	Georgia Small Hydro Rehabilitation Project, Number 1	Energy Efficiency Centre Georgia (Bundling agency)/ International Bank for Reconstruction and Development (IBRD) as the Trustee of the Community Development Carbon Fund	Energy industries (renewable-/non-renewable sources)	Validated	AMS-I.D	1,275
0005	Georgia Small Hydro Rehabilitation Project, Number 2	Energy Efficiency Centre Georgia (Bundling agency)/ International Bank for Reconstruction and Development (IBRD) as the Trustee of the Community Development Carbon Fund	Energy industries (renewable-/non-renewable sources)	Validated	AMS-I.D	18,500
0006	Guar Small Hydropower Project	Energo Aragvi Ltd/ Kommunalkredit Public Consulting GmbH (Austria)	Energy industries (renewable-/non-renewable sources)	Validated	AMS-I.D	495,596
0007	Rehabilitation of the unit 2 of the Vertices Hydro power plant	Vertices 2005 Ltd./ Unilateral	Energy industries (renewable-/non-renewable sources)	Feasibility	AMS-I.D	
0008	Wind Farm "Rustavi"	"Energy Invest" (Private company, project host), "Karenergo" Ltd (NPO, project advisor)	Energy	PIN	ACM0002	19,705
0009	Wind Farm "Skra"	"Heidelberg Cement - Georgia" (Private company, project host), "Karenergo"	Energy	PIN	ACM0002	22,267

		Ltd (NPO, project advisor)				
0010	Wind Farm “Poti”	“Port of Poti” (Private company, project host), “Karenergo” Ltd (NPO, project advisor)	Energy	PIN	ACM0002	9,852
0011	Wind Farm “Batumi”	“Batumi Airport” (Private company, project host), Batumi Municipality (project owner), “Karenergo” Ltd (NPO, project advisor)	Energy	PIN	ACM0002	29,558

Project proposals to mitigate GHG emissions

Four project idea notes have been prepared within the SNC for CDM consideration as a part of Georgia’s GHGs mitigation strategy. All of them consider the installation of wind farms with maximum capacity 30 MW. Four different sites (Rustavi, Skra, Poti, Batumi), located nearby the large consumers of electricity, were selected for pilot projects. One of them “Rustavi” wind farm is presented here as a sample of these proposals.

(A-11) - Wind farm “Rustavi”

Project objective**:** Electricity generation and supply to the grid aimed at reducing energy deficiency, especially in winter, as well as the partial substitution of fuel-based power with wind-generated energy.

Project participants**: “**Heidelberg Cement Georgia” (Private company, potential participant), “Karenergo” Ltd (NGO, project advisor)

Problem: Georgia’s need for electricity is constantly increasing. Government policy for the development of the Energy sector will increase the gas-turbines installations, along with a maximum utilisation of wind energy. However, no wind turbines have been installed in Georgia so far. As a result, the country more and more is becoming dependent on imported fossil fuel.

The barriers to utilisation of wind energy in Georgia include:

- There is no regulation or incentive to make the grid less fossil fuel-dependent or requesting an increase in the share of renewables;
- Project implementation requires a large amount of initial investment (about EUR 1 million per 1 MW capacity of wind turbines);
- Risk is very high because it is a totally new technology for Georgia; no appropriate expertise or infrastructure has been developed so far.

Activities to be implemented in the project framework**:** This project activity includes installation of a wind farm with 30 MW capacity (10 turbines of 3 MW each), providing 60 GWh electricity annually. The plant load factor is assessed as 26% The project owner, being one of the largest energy-users in Georgia, will supply the generated 60 GWh electricity annually to the grid, and get from the grid the same amount for its own needs. Electricity will be delivered to the Georgian grid through a transmission line, to the existing 110 kV sub-station located near the project site.

The chosen wind farm site is situated on the ridge near the city of Rustavi, being one of the windiest places in East Georgia. Rustavi is one of the most industrialised cities in Georgia, consuming a huge amount of energy for its enterprises.

Project cost: Total project cost, including projection and construction works, purchase and transportation of turbines, their installation and launching, is EUR 26.9 million,

Project emissions: Estimated annual abatement of greenhouse gases equals 19,705 t CO_2/yr at a load factor equal to 22%.

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Chapter 6
Other Information

6.1 Climate change research and systematic observation

Systematic meteorological observations in Georgia started in 1844, and hydrological observations in 1905.

The observational network both quantitatively and qualitatively reached its peak in the 1980s, when the whole territory of the country was covered by observations, including high mountains and difficult-to-access regions. Both standard and specialised (aerological, radar, aviation and marine) observations were being carried out.

From the beginning of the 1990s these observation systems have disintegrated. The number of observation sites and measured parameters has decreased essentially. The costly aerological and radar observations were ceased entirely, and standard measuring devices became obsolete and outdated.

At present, systematic hydrometeorological observations are being conducted at about 40 stations and posts. The Tbilisi meteorological station is included in the GCOS system.

With the aim of rehabilitating the hydrometeorological observation network, measures are being taken to get assistance from relevant international bodies and donor countries. In particular:

- With the assistance of the WMO, modern measuring devices have been installed at the Tbilisi weather station to carry out observations on major climate elements.
- With the assistance of USAID, automatic measuring devices have been mounted on three hydrological posts at Transboundary Rivers (Kura, Alazani and Debeda). The river discharge measuring device operating on the Doppler Effect is also supplied to the network.
- With the assistance of Finnish Government, water level automatic measuring devices are being installed at seven hydrological posts in the Rioni River basin. The discharge measuring Doppler device was purchased in the framework of this project.
- With the assistance of the Canadian Government, water level and precipitation measuring automatic gauges have been installed at four hydrological posts in the mountain region of West Georgia.

At the same time the installation of the following appliances is planned to be undertaken in 2009, financed by the state: 2 units to carry out aerological observations; 2 automatic units to conduct aviation meteorological observation; 10 automatic meteorological stations; 10 automatic raingauges. These automatic meteorological observation units are to be predominantly mounted in high mountains and difficult-to-access regions.

Negotiations are underway with the Japanese on assistance in the purchase and installation of two meteorological radar units (Tbilisi and Poti) and one high resolution satellite imagery reception unit.

As for scientific research, in the past 10 years since the preparation of the INC a number of research projects have been implemented by Georgian research institutions and scientific organisations. The research was mainly conducted at the Institutes of Hydrometeorology, Geography and Geophysics, the High Technology National Center and I. Javakhishvili Tbilisi State University. The research dealt with the problems of the impact of global warming on the dynamics of atmospheric circulation, on changes in surface and underground water resources, as well as in the frequency of floods, the survey of climate change in different regions in Georgia, the assessment of climate change impacts on the Black Sea coastal zone, the recreational-climatic division by regions of the Georgian territory, the development of an energy balance model of climate change, etc. Research on the modelling of climate change impacts on glacier dynamics and river run-off is underway in the framework of the relevant regional projects. A significant share in financing the scientific research, along with the government of Georgia, is made by international organisations – UNDP, EU, INTAS and others. In the period 2000-2008, total expenditures on carrying out scientific research amounted to more than USD 1.57 million.

In parallel to scientific research, proper attention was paid to the conduct of applied activities which along with the government of Georgia were financially supported by international donors as well. The main objective of these activities is the development of forests partly in the role of CO_2 sink, the promotion of the implementation of UN Conventions on Climate Change, Biodiversity and to Combat Desertification, the development of small hydro power, the application of clean energy technologies in the mountain regions of Georgia, assistance to enabling activities for the transfer of new technologies to the country, the raising of energy efficiency in heat and hot water municipal systems in large cities of Georgia, the promotion of renewable energy resources for local energy supply, the implementation of the Kharagauli forestry pilot project. A number of relatively small projects have been implemented on raising public awareness of the climate change problem and on the training of local experts in the use of renewable energy.

These activities were undertaken mainly by the Ministry of Environment Protection and Natural Resources of Georgia. A major share in financing the activities was made by the World Bank, GEF and UNDP, the governments of Georgia, the United States, the Netherlands and Italy. Along with them a number of non-governmental and private funds participated.

Total expenses of carrying out these activities through 2000-2008 came to USD 35.730 million.

During this time period, along with the projects mentioned above, Georgia took part in implementing a number of regional projects. Among them are to be mentioned the projects on the reduction of transboundary degradation in the Kura-Aras basin, on the Water Problem in South Caucasus and Moldova, on the improvement of the GHG inventory, on the development of environment networks and information systems, on the monitoring of floods, on raising energy efficiency in different sectors of the economy and on the sustainable development of mountain regions. Participants from Georgia in implementing these projects were the Ministry of Environment Protection and Natural Resources, the Ministry of Energy, the National Environmental Agency, the Georgian Energy Efficiency Centre, the Caucasian Regional Environmental Centre (REC) and others.

The financing of the projects listed above for the mentioned time period amounted to USD 3.930 million. The greatest shares were contributed by the World Bank, the GEF, and the governments of Germany, Norway, the United States, France and Georgia.

6.2. Education, training and public awareness

In view of the dimensions of problems related to global warming, climate change topics, in our opinion, should be studied from the early years in secondary schools, with items being widened as students get older. This would make it easier for the population to actively participate in some climate-change related activities, and for decision-makers to win support for measures to be carried out in this area.

Following on from this principle, and in accordance with Article 6 of the UNFCCC, recommendations to integrate climate-change related issues in the educational programmes of secondary and high schools, special curricula were worked out within the SNC. The public awareness strategy for 2009-2012 has been prepared. As a result of all public awareness raising activities, a manual for decision-makers has been prepared and published, in which the principles of sustainable development and the UNFCCC are discussed along with the possibilities of their application to the Georgian economy.

Strategic Action Plan for Implementation of Article 6 (education, training and public awareness) of the UNFCCC (2009-2012)

Key strategic objective	Key target groups	Activities	Potential lead entity	Output	Potential donor parties
Short-term objectives	▪ MoE; ▪ MoEdS; ▪ Schools and Institutes.	The short-term strategy is mainly oriented towards the facultative teaching of climate change issues in the education system (schools and universities). At the same time policy-makers are informed as much as possible	▪ MoE; ▪ MoEdS.	▪ Climate change problems are being learned in schools and universities; ▪ Climate Change impact accounted for in decision-making process.	Government of Georgia, International donors
EDUCATION					
1. Mainstream climate change issues into curricula	▪ Students from secondary and high schools, teachers and lecturers.	▪ Initiation of the consultations with the Ministry of Education on integration of climate change issues into curricula; ▪ Development of tutorial and methodical materials for teachers and lecturers; ▪ Development of secondary school- manuals and lectures for high schools; ▪ Development & procuring of visual education materials on climate change; ▪ Preparation of climate change manuals oriented on the reformed education system.	▪ MoE; ▪ MoEdS; ▪ Universities.	▪ Guidelines for integration of CC into curricula developed; ▪ Revised programmes and syllabuses in place; ▪ Methodical books for teachers and lectures; ▪ School-oriented manuals (for different levels), high school oriented manuals for different profiles; ▪ Materials developed & equipment procured; ▪ Climate Change Cabinets with access to internet and visual materials provided; ▪ New programmes containing climate change issues prepared; ▪ New programmes containing climate change issues adopted in schools; ▪ Programmes containing the climate change issues implemented at schools and universities.	GoG, UNEP, Third National Communication of Georgia (TNC)
TRAINING					
2.Initiate and promot training of scientific, technical and managerial personnel in order to facilitate implementation of Article 6 activities of UNFCCC	• Trainers; • Teachers; • Lecturers; • Professionals; • Managers; • Extension.	• Preparation of the materials and training the trainers; • Implementation methodical guidelines/manuals for school teachers; • Organisation of annual training courses for school teachers; • Implementation of methodical guidelines/ manuals for high school professors/lecturers; • Organization of annual training courses for high school lecturers; • Development & implementation of targeted & tailor-made professional courses on climate change.	• MoE; • MoEds; • Universities; • NGOs.	• Materials prepared; • Min 10 trainers are trained; • Targeted training courses developed and teachers trained; • Targeted training courses developed and lecturers trained; • Schedule of targeted workshops developed for 2009-2012.	GoG, TNC, Renewable Energy Project
Public awareness public participation and public access to information					

3. Strengthen the participation of different target groups and stakeholders in CC process	• Policy makers; • Managers; • Professionals; • Media; • Private sector; • Extension staff; • General public.	• Organising climate change awareness seminars for policy makers and Government members; • Facilitation of the participation of policy-makers at national and international conferences and meetings; • Informing the representatives of international organizations in Georgia on climate change impact and needs for adaptation and mitigation activities; • Ensuring the participation of private sevtor managers at national and international conferences and seminars; • Facilitation of the participation of professionals at regional and international workshops and seminars; • Ensuring the participation of media in national and international climate change public awareness campaigns; • Organising climate change public awareness workshops or briefings for target groups and interpreting target related problems; • Ensuring the wide involvement of stakeholder groups in climate change awareness campaigns; • Ensuring the participation of national experts at short-courses on communicating environmental education messages including climate change related convention; ▪ Supporting the public participation in climate change related events and decision making process.	• MoE; • HGOs; • Energy Efficiency Centre; • Georgian Greens.	• CC items integrated in sectoral and strategic plans; • Seminars on CC issues held; • Private sector managers awareness raised; • National experts actively participate in seminars; • Media well informed and provided with latest information on CC; • Private sector involved in projects development process; • Wide spectrum of stakeholders engaged in CC-related discussions.	GoG, MoE, UNEP, GEF UNFCCC, NCSU

4.Promote and facilitate development and dissemination of public awareness materials on climate change (preparation of materials, printing and dissemination)	• Professionals and stakeholders; • Media; • Private sector/ industry; • Policy makers; • Managers; • General public.	• Preparation of professional guidelines (on national language) for different sections of CC such as: GHGs inventory, V&A, mitigation and CDM. Dissemination of guidelines; • Preparation of information sheets on the latest findings of IPCC and decisions of COPs; • Organizing thematic workshops, distribution of workshops results (minutes) among professionals; • Maintaining the continuously updated website on CC issues, news and ongoing projects in Georgia ; • Distributing news through existing networks (CENN, etc); • Enabling environment that enhances access to climate change information; • Production of visual materials on GHG sources in Georgia and potential GHGs mitigation project sites; • Publication of press releases, bulletins, thematic calendars; • Production of public awareness materials such as posters, flyers, booklets, brochures, drawings, maps, etc; • Preparation of scientific and political articles; • Dissemination of climate change related messages through radio, TV and other forms of communication such as newspaper articles; • Preparation of materials on the policy and economic aspects of CC; • Developing of guidelines for participation of private sector in CC and SD process; • Ensuring the Georgian version of a project design forms; • Distribution and increasing access to the copyright-free materials in accordance with regulations on intellectual property protection; • Distribution of climate change information (news) on national language.	• MoE.	• Guidelines prepared in Georgia for all climate change related sectors. Materials disseminated among experts; • Latest information got and delivered to stakeholders; • New experts trained for different sectors; • Climate change Website continuously updated and contains latest information; • Network systematically provided with information; • Short information kit on current projects compiled; • Visual material prepared; • Information material; produced and distributed • Climate change related articles published and disseminated; • TV and radio programmes prepared and aired National procedures and enabling environment for full participation of private sector created; • Private sector actively engaged in CC mitigation measures; • Standard forms for donor submission prepared in Georgia; • Copyright –free materials easily accessed; • Latest information on climate change negotiation prepared in Georgia; • Materials for decision making prepared and available.	GoG, GEF, UNFCCC, IPCC

International co-operation, networking, funding and policy					
5.Participate in regional and international co-operation programmes and activities on climate change	• Policy makers; • managerial personnel; • Scientific professionals; • National experts.	• Facilitation of participation in conferences and workshops on climate change and related areas; • Encouraging the exchange of scientific and technical experts and secondment of personnel; • Enhancement of negotiating skills of national delegates; • Facilitation the participation of different target groups in relevant regional and international networks on climate change and environment in general; • Development and linking the national website/national network to other websites and networks; • Mobilisation of funding to enable scientific personnel to attend regional and international workshops and conferences on climate change; • Initiation of climate change-related programmes.	• Universities; • MoE.	• No. of experts and international negotiators increased; • Scientific articles prepared and Bulletins published; • Network information available to scientists.	GoG UNFCCC UNEP IPCC WMO CIDA SIDA UNDP USAID TACIS
6.Strengthen national institutions and exchange of personnel to train experts in climate change activities	• Scientific and technical personnel, natural resource managers.	• Mobilisation of funding and identification of international programmes for training of national experts; • Establishment of climate change related climate databases; • Facilitation collaborative linkages between national and international climate change institutions.	• GoG; • MoE.	• Number. of skilled experts increased; • Roster of national experts covers all climate change related sectors and issues.	GoG International dodnors
Funding					
7.Identify resource requirements to support implementation of climate change activities	• GoG; • Private sector; • NGOs	• Development of target project proposals to potential bilateral and multilateral donors e.g. GEF/UNDP, UNEP, WB, etc; • Identification of financial needs of respective line ministries in order to tackle from their perspective the climate change related problems; • Facilitation of the volunteery participation of stakeholders in implementation of Article 6 (in particular, provision of services in- kind); • Co-ordination of volunteerism and volunteering services in Georgia.	• MoE.	• Projects and programmes prepared and funded.	GoG International dodnors
Policy					
8.Develop a national policy on climate change and related activities	• GoG; • Stockholders.	• Preparation and continuous revision of draft national policy on climate change (action plan); • Organisation of workshops to deliberate on the draft proposals for national policy; • Facilitation of broad discussion process of the draft national climate change policy in order to reach the	• MoE.	• Draft CC Action Plan prepared and approved.	GoG, UNFCCC, UNEP, UNDP, GEF, NCs

		national consensus get its approval by parliament; • Updating the results of survey on needs assessment conducted in 2006-2009; • Revision of the current strategy to the end of 2012.			

At the same time, over the past 10 years, local experts engaged in the preparation of both the Initial and Second National Communications dealt with questions of climate change in their regular lectures delivered at the I. Javakhishvili State University and other higher educational institutions. In particular, in 2007-2008 under the guidance of SNC modelling team leader three students prepared their Diplomas on the questions of climate change impact on forests and public health in Georgia, and on database processing in the regional climate model PRECIS.

In the process of SNC preparation, systematic weekly seminars were held with local experts working in different sectors, at which items related to the GHG inventory, vulnerability and adaptation and mitigation were discussed. A number of experts were sent for training in leading centres to master the LEAP and PRECIS models.

Over the past three years the following publications have been published: the Guidelines for local experts for the preparation of adaptation projects, two Bulletins comprising the results of activities conducted in 2006 and 2007, a popular scientific book concerning the climate change impact on human health (focused on Georgia), climate change tale adapted for children (in Georgian and English), as well as the Final Report on the second National GHG Inventory (Georgian version), which was disseminated among all relevant organisations.

In significant numbers, bilingual wall calendars “Dedoplistskaro – 2008” and “Svaneti-2009” were published, discussing in popular form the topic of climate change impacts on the corresponding regions.

In 2008 and 2009 two exhibitions were organised. One of them was devoted to the portrayal of the climate change problem in childrens’ paintings, and the other to the development by local experts of climate-friendly technologies for the solution of problems caused by climate change and for the application of renewables for various purposes.

Systematic interviews were held with representatives of the mass media aimed at the raising of public awareness of climate change problems, and articles were published in local magazines and newspapers.

To provide active participation in the project by local stakeholders in 2008 and 2009, a series of workshops and meetings were held in Dedoplistskaro, Lentekhi, Batumi and Poti, the comments and recommendations of which were accounted for in the adaptation strategies.

At the Ministry of Environment Protection and Natural Resources, regular seminars were held with the participation of representatives from the Ministry and other stakeholders (TACIS, REC, Tbilisi State University, National Environmental Agency, research institutions), at which the results of current project were discussed.

Members of the SNC preparation group took part in several international meetings, including a conference devoted to the Year of the Planet Earth held in Tbilisi in November 2008.

6.3. Capacity-building at national and regional levels

Over the last six years, the most important capacity-building activities in Georgia included the appointment of DNA (the Ministry of Environment Protection and Natural Resources) for CDM and strengthening its potential. The Ministry of Environment Protection and Natural Resources being the Focal Point for UNFCCC leads all activities related to the climate change.

In 2004-2006 Georgia took part in implementing two regional projects in this area. The first, supported by the UNDP/GEF, was aimed at capacity-building in order to improve the quality of the GHG inventory, and the second project, performed with EU financial support, was to render assistance to the South Caucasus countries and Moldova in the creation of an adequate basis for the implementation of CDM projects.

At the same time, in 2005-2007 Georgia participated in the UNDP/GEF regional project on the creation of a management system in the Kura-Aras basin, and in 2005-2008 Georgia participated in the USAID-supported project aimed at the institutional and scientific capacity-building of the water management system in the South Caucasus region.

Earlier, in 2003 Georgia took part in the UN project on environmental networking in the Caucasus, and in 2004-2009 with German government support a project on promoting clean energy technologies in mountain regions of Georgia is being implemented, which partly deals with climate change impacts on socio-economic and environmental conditions in Georgia's mountain settlements.

At national level, capacity-building activities were mainly concentrated on promoting CDM development in the country. Constraints and barriers hampering this process in Georgia are discussed in Chapter 7 below.

Chapter 7
Constraints and financial needs revealed in the process of SNC preparation

7.1. Barriers to implementing the UNFCCC in Georgia

Chapter 6 of this document reviews the projects and programmes which are directly or indirectly related to the climate change problem. In implementing these projects various barriers arise, the tackling of which partially occurs in the framework of ongoing projects, and part of which are losing urgency as a result of political or economic changes taking place in the country. However, some important barriers still exist, the overcoming of which is urgently necessary for the country's economy to comply with the fundamental principle of the Convention – the principle of sustainable development. At present, existing barriers can be mainly classified into three groups: constraints to the preparation of SNC, constraints to the technology transfer process and barriers to the CDM process.

In the process of SNC preparation, the following main constraints have been identified:

- **The lack of national experts** having complex vision of environmental, social and economic development issues. Problems related to global warming were not studied in the Soviet period and the new scientific community is not still developed to the required level due to political and economic problems,. It ought to be mentioned, however, that the professional skill of local experts is sufficiently high. It is to be emphasised here that young experts having a good command of languages and modern techniques (including modelling expertise) do not have sufficient sectoral knowledge, while sectoral experts possessing great experience in their field do not have adequate skill in foreign languages and contemporary models that is required for making assessments and obtaining results at an up-to-date level.

- **The absence of necessary statistics or the unreliability of existing ones** has proved to be one of the most important barriers in the process of SNC preparation. The lack of statistics particularly affects the assessments of GHG emissions, though it is no less important in the estimation of economic development scenarios and in development of adaptation strategies.
- **The absence of relevant scientific assessments and research.** Assessing the negative economic impact of global warming and climate change processes on different sectors of the economy and ecosystems is the first stage in the adaptation measures planning process. The absence of such assessment studies is seriously decreasing the importance of adaptation strategies in the decision-making process.
- **Co-ordination and information-sharing between projects and programmes going on in the country.** The SNC preparation process has confirmed once more that co-ordination between programmes being implemented in the country is still insufficient.
- **Taking on interests of local stakeholders in the climate change problem.** Of the three priority regions examined in the framework of the SNC, only in one region did representatives of local government and other stakeholders (farmers) take serious interest in the climate change problem.
- **Environment protection is not a priority for the country**. In spite of the fact that Georgia has signed almost all environment protection conventions and agreements and the country is seeking as much as possible to contribute to global or local environmental processes, against the background of complex political and economic problems facing the country, the Georgian government does not yet regard the protection of the environment as its priority. This barrier is most of all hampering the integration of climate change issues into the development plans of separate sectors and branches, including infrastructure. It prohibits the adoption of the relevant legislative basis.

In the technology transfer process there are two kinds of barriers: one is barriers existing in the international process and another is the constraints existing at recipient country level. In this document the barriers existing in Georgia are discussed.

- **Low awareness** of decision-makers, private sector and population of the role of energy efficient and renewable energy technologies in providing energy independence and in the process of energy sector sustainable development.
- **Energy audit practice is not yet usual among Georgia’s industry sector representatives**
- **An incentives mechanism** as a tool for acceleration of the transfer of modern technologies has not yet been seriously discussed in the country .
- The **private sector** operating in the renewable energy sector has no management experience, as most of them are newcomers from the field of science.

Barriers to the Clean Development Mechanism:

- **The Kyoto Clean Development Mechanism is based upon market economy principles** and for its success it is necessary that the market infrastructure to be already developed in the country. Therefore this mechanism has been successfully implemented in those countries which have well-developed market infrastructure (China, India, Brazil, etc.). Despite the fact that Georgia has transitioned to the market economy, the market infrastructure and its separate elements are not still sufficiently developed here. That is why the CDM is struggling to develop in Georgia and why there are many constraints in achieving success.

- **Of the market economy elements, special attention should be** focused on the frequent changes of CDM project owners (due to selling of enterprises) and lack of experience among private sector enterprises to make a deal with foreign partners. Resulting from these cases, a number of large projects have not been registered in Georgia in spite of serious interest from the side of investors. These are: natural gas transportation project, reduction of nitrous oxide emissions in ammonia manufacture, cement production, methane extraction from landfill and its flarin on- site.
- **Unavailability of data to construct the baseline scenario.** In the past (often at present as well) there was no monitoring of parameters, which are necessary to estimate the baseline emissions of GHGs. Hence, a defined period of monitoring is required to collect these data, which causes constraints and delays in the registration and implementation of the project.
- **Scale of CDM project and emissions reductions.** The main interest of inventors is concentrated on large-scale projects, while Georgia is a small country having a limited number of such projects on its territory. After the disintegration of the Soviet Union the Georgian economy has not still gained sufficient strength. The largest emitter of GHGs in the country at present is the transport sector, suffering from the lack of methodologies and scarcity of statistics that hampers the inclusion of this sector in the CDM. The scale of other projects is not large enough, and thus the interest of investors is lower. As for the energy efficiency and energy generation sectors, one of the barriers here is the low emission factors of the grid. In the Georgian energy network more than 72% belongs to hydro power.
- **Approval of new methodology.** Some delays in the CDM process are caused by constraints emerging in the process of working out and approving new methodologies.

7.2. Capacity needs assessment

Since 1994, when Georgia joined the UNFCCC and later, since 1999 after joining the Kyoto Protocol, capacity-building activities began aimed at implementing the country's obligations under the Convention and the Protocol. In spite of this, significant gaps are still present in the existing potential, which require serious updating and strengthening. In this context, the following measures are especially important.

- **Training of local experts** for different sectors. It is important in this process to carry out on-the-job trainings and experts certification during the solution of specific problems.
- **Fellowship programmes.** A group of Tbilisi State University students was actively involved in the process of SNC preparation. They were working on the perfection and adaptation to Georgia's conditions of various models (assessment of future climate change scenarios, revelation of heat wave trends, and estimation of CO_2 sequestration by forests). It is necessary to strengthen this tradition and to adopt special facilitative courses at the Modelling faculty, where the students should be trained in specific sectors (healthcare, agriculture, water resources, energy, etc.). The participation of students in exchange programmes on these subjects is valuable as well.
- **Maximum involvement of national experts** in various international programmes.
- **The improvement of national statistics** and provision for their compliance with international requirements should be promoted.
- The programmes are to be carried out in the country that will financially assess the **anticipated losses** caused by changes in climate.

7.3. Financial needs of the country to assist efficient implementation of the Convention.

The country's financial needs to tackle climate change problems, assessed for the present time, are mainly reflected in the concrete project proposals presented in the relevant chapters of this document. The total funding required for the implementation of the projects discussed above is assessed to be about USD 370 million. Nevertheless, this figure can be regarded only as the start of a broader assessment process.

Annexes

Country	Georgia
Inventory Year	2000

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

(Gg)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	**3,705.7**	**0**	**242.77**	**5.87**	**20**	**107**	**73**	**0.97**	**0**	**0**	**0**	**0**	**0**	**0**
1 Energy	**3,177**	**0**	**114**	**0.02**	**17**	**101**	**19**	**0.80**						
A Fuel Combustion (Sectoral Approach)	3,177		1	0.02	17	101	19	0.80						
1 Energy Industries	975		0.02	0.002	3	0.34	0.09	0.02						
2 Manufacturing Industries and Construction	413		0.03	0.002	1	0.18	0.04	0						
3 Transport	1,112		0.26	0.010	10	94	18	0						
4 Other Sectors	636		0	0.01	3	7	1	0						
5 Other (please specify)	41		0	0	0	0	0	0						
B Fugitive Emissions from Fuels	0		113		0	0	0	0						
1 Solid Fuels			0		0	0	0	0						
2 Oil and Natural Gas			113		0	0	0	0						
2 Industrial Processes	**528**	**0**	**0**	**1.53**	**3**	**1**	**1**	**0.17**	**0**	**0.00530**	**0**	**0**	**0**	**0**
A Mineral Products	279					0	0	0.17						
B Chemical Industry	204		0	2	3	1	1	0.0041						
C Metal Production	46		0	0	0	0	0	0.000005	0	0	0	0	0	0
D Other Production	0				0	0	0	0						
E Production of Halocarbons and Sulphur Hexafluoride									0	0	0	0	0	0
F Consumption of Halocarbons and Sulphur Hexafluoride									0	0	0	0	0	0
G Other (please specify)	0		0	0	0	0	0	0				0		0

									P	A	P	A	P	A
3 Solvent and Other Product Use	**0**			**0.0137**			**53**							
4 Agriculture			**74**	**4.03**	**0**	**5**								
A Enteric Fermentation			61											
B Manure Management			12	0										
C Rice Cultivation			0											
D Agricultural Soils				4										
E Prescribed Burning of Savannas			0	0	0	0								
F Field Burning of Agricultural Residues			0	0	0	5								
G Other (please specify)			0	0										
5 Land-Use Change & Forestry [(2)]	**(1) 0**	**(1) 0**	**0**	**0**	**0**	**0**								
A Changes in Forest and Other Woody Biomass Stocks	(1) 0	(1) 0												
B Forest and Grassland Conversion	0		0	0	0	0								
C Abandonment of Managed Lands		0												
D CO_2 Emissions and Removals from Soil	(1) 0	(1) 0												
E Other (please specify)	0	0	0	0	0	0								
6 Waste			**55**	**0.28**	**0**	**0**	**0**	**0**						
A Solid Waste Disposal on Land			44											
B Wastewater Handling			11	0										
C Waste Incineration														
D Other (please specify)			0	0										
7 Other (please specify)														

P = Potential emissions based on Tier 1 Approach. A = Actual emissions based on Tier 2 Approach.

(1) The formula does not provide a total estimate of both CO_2 emissions and CO_2 removals. It estimates "net" emissions of CO_2 and places a single number in either the CO_2 emissions

or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
(2) Note that if you have used the IPCC Good Practice Guidance on Land Use, Land-Use Change and Forestry, you will have to use a mapping back procedure before entering emission/removals here

Country	Georgia
Inventory Year	2001

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

(Gg)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	**3,875**	**0**	**205.9**	**5.46**	**20**	**118**	**73**	**1.26**	**0**	**0**	**0**	**0**	**0**	**0**
1 Energy	**3,418**	**0**	**74.5**	**0**	**18**	**107**	**20**	**1.09**						
A Fuel Combustion (Sectoral Approach)	3,418		1	0	18	107	20	1.09						
1 Energy Industries	909		0.02	0.002	2	0.31	0	0.04						
2 Manufacturing Industries and Construction	424		0.03	0.003	1	0.20	0	0.354						
3 Transport	1,132		0.27	0.010	10	97	18	0.319						
4 Other Sectors	917		0	0.01	4	9	1	0.377						
5 Other (please specify)	36		0	0	0	0	0	0						
B Fugitive Emissions from Fuels	0		74		0	0	0	0						
1 Solid Fuels			0		0	0	0	0						
2 Oil and Natural Gas			74		0	0	0	0						
2 Industrial Processes	**457**	**0**	**0.0**	**0.61**	**1**	**0.46**	**0.27**	**0.18**	**0**	**0.00558**	**0**	**0**	**0**	**0**
A Mineral Products	302					0	0	0.174						
B Chemical Industry	87		0	1	1	0	0	0.0017						
C Metal Production	68		0	0	0	0	0	0	0	0	0	0	0	0
D Other Production	0				0	0	0	0						
E Production of Halocarbons and Sulphur Hexafluoride									0	0	0	0	0	0
F Consumption of Halocarbons and Sulphur Hexafluoride									0	0	0	0	0	0
G Other (please specify)	0		0	0	0	0	0	0				0		0

											P	A	P	A	P	A
3 Solvent and Other Product Use		**0**				**0.0149**			**53**							
4 Agriculture					**77**	**4.54**	**0**	**11**								
A Enteric Fermentation					64											
B Manure Management					13	0.25										
C Rice Cultivation					0											
D Agricultural Soils						4.27										
E Prescribed Burning of Savannas					0	0	0	0								
F Field Burning of Agricultural Residues					1	0	0	11								
G Other (please specify)					0	0										
5 Land-Use Change & Forestry [(2)]	**(1)**	**0**	**(1)**	**0**	**0**	**0**	**0**	**0**								
A Changes in Forest and Other Woody																
Biomass Stocks	(1)	0	(1)	0												
B Forest and Grassland Conversion		0			0	0	0	0								
C Abandonment of Managed Lands				0												
D CO_2 Emissions and Removals from																
Soil	(1)	0	(1)	0												
E Other (please specify)		0		0	0	0	0	0								
6 Waste					**54**	**0.28**	**0**	**0**	**0**	**0**						
A Solid Waste Disposal on Land					43											
B Wastewater Handling					11	0.28										
C Waste Incineration																
D Other (please specify)					0	0										
7 Other (please specify)																

P = Potential emissions based on Tier 1 Approach. A = Actual emissions based on Tier 2 Approach.

(1) The formula does not provide a total estimate of both CO_2 emissions and CO_2 removals. It estimates "net" emissions of CO_2 and places a single number in either the CO_2 emissions

or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

(2) Note that if you have used the IPCC Good Practice Guidance on Land Use, Land-Use Change and Forestry, you will have to use a mapping back procedure before entering emission/removals here

Country	Georgia
Inventory Year	2002

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

(Gg)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	**3,681**	**0**	**205.1**	**6.66**	**20**	**119**	**73**	**1.28**	**0**	**0**	**0**	**0**	**0**	**0**
1 Energy	**3,131**	**0**	**72**	**0.02**	**18**	**110**	**20**	**1.10**						
A Fuel Combustion (Sectoral Approach)	3,131		1	0	18	110	20	1.10						
1 Energy Industries	358		0.01	0.001	1	0.12	0.03	0.02						
2 Manufacturing Industries and Construction	541		0.04	0.003	1	0.27	0.05	0						
3 Transport	1,192		0.28	0.011	11	102	19	0						
4 Other Sectors	996		0	0.01	4	8	1	0						
5 Other (please specify)	44		0	0	0	0	0	0						
B Fugitive Emissions from Fuels	0		72		0	0	0	0						
1 Solid Fuels			0		0	0	0	0						
2 Oil and Natural Gas			72		0	0	0	0						
2 Industrial Processes	**550**	**0**	**0**	**1.26**	**2**	**1**	**1**	**0.18**	**0**	**0.00821**	**0**	**0**	**0**	**0**
A Mineral Products	325					0	0	0.181						
B Chemical Industry	167		0	1	2	1	1	0.003						
C Metal Production	58		0	0	0	0	0	0	0	0	0	0	0	0
D Other Production	0				0	0	0	0						
E Production of Halocarbons and Sulphur Hexafluoride									0	0	0	0	0	0
F Consumption of Halocarbons and Sulphur Hexafluoride									0	0	0	0	0	0
G Other (please specify)	0		0	0	0	0	0	0				0		0

									P	A	P	A	P	A
3 Solvent and Other Product Use	**0**			**0.0153**			**52**							
4 Agriculture			**78**	**5.07**	**0**	**9**								
A Enteric Fermentation			65											
B Manure Management			13	0										
C Rice Cultivation			0											
D Agricultural Soils				5										
E Prescribed Burning of Savannas			0	0	0	0								
F Field Burning of Agricultural Residues			0	0	0	9								
G Other (please specify)			0	0										
5 Land-Use Change & Forestry [(2)]	**(1) 0**	**(1) 0**	**0**	**0**	**0**	**0**								
A Changes in Forest and Other Woody Biomass Stocks	(1) 0	(1) 0												
B Forest and Grassland Conversion	0		0	0	0	0								
C Abandonment of Managed Lands		0												
D CO_2 Emissions and Removals from Soil	(1) 0	(1) 0												
E Other (please specify)	0	0	0	0	0	0								
6 Waste			**55**	**0.28**	**0**	**0**	**0**	**0**						
A Solid Waste Disposal on Land			43											
B Wastewater Handling			11	0										
C Waste Incineration														
D Other (please specify)			0	0										
7 Other (please specify)														

P = Potential emissions based on Tier 1 Approach. A = Actual emissions based on Tier 2 Approach

(1) The formula does not provide a total estimate of both CO_2 emissions and CO_2 removals. It estimates "net" emissions of CO_2 and places a single number in either the CO_2 emissions or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

(2) Note that if you have used the IPCC Good Practice Guidance on Land Use, Land-Use Change and Forestry, you will have to use a mapping back procedure before entering emission/removals here

Country	Georgia
Inventory Year	2003

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

(Gg)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	**3,931.6**	**0**	**220.3**	**7.00**	**21**	**120**	**73**	**1.38**	**0**	**0**	**0**	**0**	**0**	**0**
1 Energy	**3,302**	**0**	**85.38**	**0.03**	**18**	**109**	**20**	**1.19**						
A Fuel Combustion (Sectoral Approach)	3,302		0.94	0	18	109	20	1.19						
1 Energy Industries	527		0.01	0.002	1.4	0.16	0.04	0.09						
2 Manufacturing Industries and Construction	463		0.03	0.003	1	0.23	0.04	0						
3 Transport	1,138		0.27	0.010	10	97	18	0						
4 Other Sectors	1,126		0.63	0.01	4	11	2	0						
5 Other (please specify)	48		0	0	0	0	0	0						
B Fugitive Emissions from Fuels	0		84.44		0	0	0	0						
1 Solid Fuels			0		0	0	0	0						
2 Oil and Natural Gas			84.3		0	0	0	0						
2 Industrial Processes	**630**	**0**	**0**	**1.40**	**2**	**1**	**1**	**0.19**	**0**	**0.01228**	**0**	**0**	**0**	**0**
A Mineral Products	337					0	0	0.188						
B Chemical Industry	186		0	1	2	1	1	0.004						
C Metal Production	106		0	0	0	0	0	0	0	0	0	0	0	0
D Other Production	0				0	0	0	0						
E Production of Halocarbons and Sulphur Hexafluoride									0	0	0	0	0	0
F Consumption of Halocarbons and Sulphur Hexafluoride									0	0	0	0	0	0
G Other (please specify)	0		0	0	0	0	0	0				0		0

									P	A	P	A	P	A
3 Solvent and Other Product Use	**0**			**0.0163**			**52**							
4 Agriculture			**80.79**	**5.27**	**0**	**10**								
A Enteric Fermentation			67											
B Manure Management			14	0										
C Rice Cultivation			0											
D Agricultural Soils				5										
E Prescribed Burning of Savannas			0	0	0	0								
F Field Burning of Agricultural Residues			0	0	0	10								
G Other (please specify)			0	0										
5 Land-Use Change & Forestry [2]	**(1) 0**	**(1) 0**	**0**	**0**	**0**	**0**								
A Changes in Forest and Other Woody Biomass Stocks	(1) 0	(1) 0												
B Forest and Grassland Conversion	0		0	0	0	0								
C Abandonment of Managed Lands		0												
D CO_2 Emissions and Removals from Soil	(1) 0	(1) 0												
E Other (please specify)	0	0	0	0	0	0								
6 Waste			**54.13**	**0.28**	**0**	**0**	**0**	**0**						
A Solid Waste Disposal on Land			43											
B Wastewater Handling			11	0										
C Waste Incineration														
D Other (please specify)			0	0										
7 Other (please specify)														

P = Potential emissions based on Tier 1 Approach. A = Actual emissions based on Tier 2 Approach

(1) The formula does not provide a total estimate of both CO_2 emissions and CO_2 removals. It estimates "net" emissions of CO_2 and places a single number in either the CO_2 emissions

or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

(2) Note that if you have used the IPCC Good Practice Guidance on Land Use, Land-Use Change and Forestry, you will have to use a mapping back procedure before entering emission/removals here

Country	Georgia
Inventory Year	2004

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

(Gg)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	**4,843**	**0**	**212.0**	**6.29**	**22**	**121**	**73**	**1.48**	**0**	**0**	**0**	**0**	**0**	**0**
1 Energy	**4,041**	**0**	**75**	**0.03**	**19**	**111**	**20**	**1.23**						
A Fuel Combustion (Sectoral Approach)	4,041		1	0	19	111	20	1.23						
1 Energy Industries	690		0.02	0	2	0.22	0.06	0.09						
2 Manufacturing Industries and Construction	609		0.04	0.003	2	0.31	0.06	0						
3 Transport	1,202		0.29	0.010	11	100	19	0						
4 Other Sectors	1,470		1	0	5	10	1	0						
5 Other (please specify)	70		0	0	0	0	0	0						
B Fugitive Emissions from Fuels	0		74		0	0	0	0						
1 Solid Fuels			0		0	0	0	0						
2 Oil and Natural Gas			74		0	0	0	0						
2 Industrial Processes	**802**	**0**	**0**	**1.51**	**3**	**1**	**1**	**0.25**	**0**	**0.01741**	**0**	**0**	**0**	**0**
A Mineral Products	426					0	0	0.248						
B Chemical Industry	197		0	1.51	3	1	1	0.004						
C Metal Production	180		0	0	0	0	0	0	0	0	0	0	0	0
D Other Production	0				0	0	0	0						
E Production of Halocarbons and Sulphur Hexafluoride									0	0	0	0	0	0
F Consumption of Halocarbons and Sulphur Hexafluoride									0	0	0	0	0	0
G Other (please specify)	0		0	0	0	0	0	0				0		0

									P	A	P	A	P	A
3 Solvent and Other Product Use	**0**			**0.0179**			**52**							
4 Agriculture			**83**	**4.45**	**0**	**9**								
A Enteric Fermentation			68											
B Manure Management			14	0.26										
C Rice Cultivation			0											
D Agricultural Soils				4.18										
E Prescribed Burning of Savannas			0	0	0	0								
F Field Burning of Agricultural Residues			0	0.01	0	9								
G Other (please specify)			0	0										
5 Land-Use Change & Forestry (2)	**(1) 0**	**(1) 0**	**0**	**0**	**0**	**0**								
A Changes in Forest and Other Woody Biomass Stocks	(1) 0	(1) 0												
B Forest and Grassland Conversion	0		0	0	0	0								
C Abandonment of Managed Lands		0												
D CO_2 Emissions and Removals from Soil	(1) 0	(1) 0												
E Other (please specify)	0	0	0	0	0	0								
6 Waste			**54**	**0.28**	**0**	**0**	**0**	**0**						
A Solid Waste Disposal on Land			43											
B Wastewater Handling			11	0										
C Waste Incineration														
D Other (please specify)			0	0										
7 Other (please specify)														

P = Potential emissions based on Tier 1 Approach. A = Actual emissions based on Tier 2 Approach

(1) The formula does not provide a total estimate of both CO_2 emissions and CO_2 removals. It estimates "net" emissions of CO_2 and places a single number in either the CO_2 emissions

or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

(2) Note that if you have used the IPCC Good Practice Guidance on Land Use, Land-Use Change and Forestry, you will have to use a mapping back procedure before entering emission/removals here

Country	Georgia
Inventory Year	2005

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	**5,044.5**	**0**	**195.9**	**7.60**	**23**	**123**	**73**	**1.35**	**0**	**0**	**0**	**0**	**0**	**0**
1 Energy	**4,015**	**0**	**57.9**	**0.03**	**20**	**112**	**21**	**1.00**						
A Fuel Combustion (Sectoral Approach)	4,015		0.9	0	20	112	21	1.00						
1 Energy Industries	783		0.02	0.003	2	0.25	0.07	0.09						
2 Manufacturing Industries and Construction	607		0.042	0.003	2	0.27	0.05	0						
3 Transport	1,212		0.29	0.011	11	101	19	0						
4 Other Sectors	1,352		0.5	0	5	10	1	0						
5 Other (please specify)	61		0	0	0	0	0	0						
B Fugitive Emissions from Fuels	0		57.0		0	0	0	0						
1 Solid Fuels			0		0	0	0	0						
2 Oil and Natural Gas			57.0		0	0	0	0						
2 Industrial Processes	**1,030**	**0**	**0**	**1.80**	**3**	**1**	**1**	**0.35**	**0**	**0.02414**	**0**	**0**	**0**	**0**
A Mineral Products	594					0	0	0.346						
B Chemical Industry	228		0	1.80	3	1	1	0.005						
C Metal Production	208		0	0	0	0	0	0	0	0	0	0	0	0
D Other Production	0				0	0	0	0						
E Production of Halocarbons and Sulphur Hexafluoride									0	0	0	0	0	0
F Consumption of Halocarbons and Sulphur Hexafluoride									0	0	0	0	0	0
G Other (please specify)	0		0	0	0	0	0	0				0		0

									P	A	P	A	P	A
3 Solvent and Other Product Use	**0**			**0.0194**			**52**							
4 Agriculture			**83.86**	**5.48**	**0**	**9**								
A Enteric Fermentation			69											
B Manure Management			14	0.27										
C Rice Cultivation			0											
D Agricultural Soils				5.20										
E Prescribed Burning of Savannas			0	0	0	0								
F Field Burning of Agricultural Residues			0	0.01	0	9								
G Other (please specify)			0	0										
5 Land-Use Change & Forestry [(2)]	**(1) 0**	**(1) 0**	**0**	**0.00**	**0**	**0**								
A Changes in Forest and Other Woody Biomass Stocks	(1) 0	(1) 0												
B Forest and Grassland Conversion	0		0	0	0	0								
C Abandonment of Managed Lands		0												
D CO_2 Emissions and Removals from Soil	(1) 0	(1) 0												
E Other (please specify)	0	0	0	0	0	0								
6 Waste			**54.15**	**0.28**	**0**	**0**	**0**	**0**						
A Solid Waste Disposal on Land			43.04											
B Wastewater Handling			11.11	0										
C Waste Incineration														
D Other (please specify)			0	0										
7 Other (please specify)														

P = Potential emissions based on Tier 1 Approach. A = Actual emissions based on Tier 2 Approach.

(1) The formula does not provide a total estimate of both CO_2 emissions and CO_2 removals. It estimates "net" emissions of CO_2 and places a single number in either the CO_2 emissions or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

(2) Note that if you have used the IPCC Good Practice Guidance on Land Use, Land-Use Change and Forestry, you will have to use a mapping back procedure before entering emission/removals here

Country	Georgia
Inventory Year	2006

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	**5,873**	**0**	**198**	**8**	**27**	**115**	**69**	**1.51**	**0**	**0**	**0**	**0**	**0**	**0**
1 Energy	**4,730**	**0**	**58**	**0**	**23**	**110**	**20**	**1.12**						
A Fuel Combustion (Sectoral Approach)	4,730		1	0	23	110	20	1.12						
1 Energy Industries	1,538		0.033	0.004	4	0.51	0.13	0.11						
2 Manufacturing Industries and Construction	666		0.04	0.003	2	0.28	0.06	0						
3 Transport	1,276		0.30	0.011	12	98	18	0						
4 Other Sectors	1,174		1	0	6	11	2	0						
5 Other (please specify)	76		0	0	0	0	0	0						
B Fugitive Emissions from Fuels	0		57.19		0	0	0	0						
1 Solid Fuels			0.11		0	0	0	0						
2 Oil and Natural Gas			57.08		0	0	0	0						
2 Industrial Processes	**1,142**	**0**	**0**	**2.064**	**3.670**	**1.361**	**0.810**	**0.39**	**0**	**0.03273**	**0**	**0**	**0**	**0**
A Mineral Products	676					0	0	0.39						
B Chemical Industry	258		0	2.064	3.670	1.361	0.810	0						
C Metal Production	208		0	0	0	0	0	0	0	0	0	0	0	0
D Other Production	0				0	0	0	0						
E Production of Halocarbons and Sulphur Hexafluoride									0	0	0	0	0	0
F Consumption of Halocarbons and Sulphur Hexafluoride									0	0	0	0	0	0
G Other (please specify)	0		0	0	0	0	0	0				0		0

									P	A	P	A	P	A
3 Solvent and Other Product Use	**0**			**0.0210**			**48**							
4 Agriculture			**84**	**6**	**0**	**4**								
A Enteric Fermentation			70											
B Manure Management			14	0										
C Rice Cultivation			0											
D Agricultural Soils				5										
E Prescribed Burning of Savannas			0	0	0	0								
F Field Burning of Agricultural Residues			0	0	0	4								
G Other (please specify)			0	0										
5 Land-Use Change & Forestry [(2)]	**(1) 0**	**(1) 0**	**0**	**0**	**0**	**0**								
A Changes in Forest and Other Woody Biomass Stocks	(1) 0	(1) 0												
B Forest and Grassland Conversion	0		0	0	0	0								
C Abandonment of Managed Lands		0												
D CO_2 Emissions and Removals from Soil	(1) 0	(1) 0												
E Other (please specify)	0	0	0	0	0	0								
6 Waste			**55**	**0**	**0**	**0**	**0**	**0**						
A Solid Waste Disposal on Land			44											
B Wastewater Handling			12	0										
C Waste Incineration														
D Other (please specify)			0	0										
7 Other (please specify)														

P = Potential emissions based on Tier 1 Approach. A = Actual emissions based on Tier 2 Approach

(1) The formula does not provide a total estimate of both CO_2 emissions and CO_2 removals. It estimates "net" emissions of CO_2 and places a single number in either the CO_2 emissions or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

(2) Note that if you have used the IPCC Good Practice Guidance on Land Use, Land-Use Change and Forestry, you will have to use a mapping back procedure before entering emission/removals here

Annex II

Fuel consumption in Georgia by sectors in 2000

Fuel / Sector	Coal	Cox	Oil	Liquid gasPG	Naphtha	Gasoline	Aviation Kerosene	Kerosene	Diesel Fuel	Black oil	Lubricants	Natural gas	Timber and it's residues
	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 m^3	m^3
Electric energy and heat production			2			1			10			497 205	
Processing industry	5	9		1					42	39 613	1	105 494	6 655
Transport													
Road (motor)						250			83			10 249	
Aviation							39 698						
Railway	8								39 693				
Pipelines												5 865	
Other sectors													
Residential	5			39 479				39 508				197 255	6 161 520
Commercial	4											38 893	
Agriculture								1	52				110 984
Other	5											17 344	
Total	**27**	**9**	**2**	**39 449**	**0**	**251**	**39 698**	**39 449**	**190**	**39 613**	**1**	**872 305**	**6 279 159**

Fuel consumption in Georgia by sectors in 2001

Fuel / Sector	Coal	Cox	Oil	Liquid gasPG	Naphtha	Gasoline	Aviation Kerosene	Kerosene	Diesel Fuel	Black oil	Lubricants	Natural gas	Timber and it's residues
	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 m^3	m^3
Electric energy and heat production			4			1		1	20			441 182	
Processing industry	6	19		1					46	16	1	86 586	9 114
Transport													
Road (motor)						259			86			8 412	
Aviation							9						
Railway									3				
Pipelines												4 814	
Other sectors													
Residential	6			50				56				161 900	8 438 603
Commercial												31 922	
Agriculture								1	67				152 000
Other					1				1		2	14 235	
Total	**12**	**19**	**4**	**51**	**1**	**260**	**9**	**58**	**223**	**16**	**3**	**749 051**	**8 599 717**

Fuel consumption in Georgia by sectors in 2002

Sector \ Fuel	Coal	Cox	Oil	Liquid gasPG	Naphtha	Gasoline	Aviation Kerosene	Kerosene	Diesel Fuel	Black oil	Lubricants	Natural gas	Timber and it's residues
	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 m^3	m^3
Electric energy and heat production			2			1			12			165 248	
Processing industry	6	19		1					46	16	1	150 040	6 655
Transport													
Road (motor)						272			89			10 253	
Aviation							10						
Railway									4				
Pipelines												5 867	
Other sectors													
Residential	6			53				59				172 360	6 161 520
Commercial												39 680	
Agriculture								1	65			17 360	110 984
Other					1				1		2	19 840	
Total	**12**	**19**	**2**	**54**	**1**	**272**	**10**	**60**	**217**	**16**	**3**	**580 648**	**6 279 159**

Fuel consumption in Georgia by sectors in 2003

Sector \ Fuel	Coal	Cox	Oil	Liquid gasPG	Naphtha	Gasoline	Aviation Kerosene	Kerosene	Diesel Fuel	Black oil	Lubricants	Natural gas	Timber and it's residues
	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 m^3	m^3
Electric energy and heat production			9			2			46			183 587	
Processing industry	7	22		1					45	16	1	105 000	6 655
Transport													
Road (motor)						260			85			9 540	
Aviation							9						
Railway									4				
Pipelines												5 460	
Other sectors													
Residential	7			54				60				251 343	6 161 520
Commercial												49 558	99 558
Agriculture								1	62				110 984
Other					1				1		2	22 099	
Total	**14**	**22**	**9**	**55**	**1**	**262**	**9**	**62**	**243**	**16**	**3**	**626 587**	**6 378 717**

Fuel consumption in Georgia by sectors in 2004

Fuel / **Sector**	**Coal**	**Cox**	**Oil**	**Liquid gasPG**	**Naphtha**	**Gasoline**	**Aviation Kerosene**	**Kerosene**	**Diesel Fuel**	**Black oil**	**Lubricants**	**Natural gas**	**Timber and it's residues**
	10^3 t	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 m^3**	**m^3**
Electric energy and heat production			10			2			48			266 112	
Processing industry	7	22		1					47	16	1	178 337	9 895
Transport													
Road (motor)						268			88			20 381	
Aviation							8						
Railway									4				
Pipelines												11 664	
Other sectors													
Residential	7			57				64				389 216	9 161 912
Commercial												76 742	
Agriculture								1	65				165 029
Other					1				1		1	34 222	
Total	**14**	**22**	**10**	**58**	**1**	**270**	**8**	**65**	**253**	**16**	**2**	**976 674**	**9 336 836**

Fuel consumption in Georgia by sectors in 2005

Fuel / **Sector**	**Coal**	**Cox**	**Oil**	**Liquid gasPG**	**Naphtha**	**Gasoline**	**Aviation Kerosene**	**Kerosene**	**Diesel Fuel**	**Black oil**	**Lubricants**	**Natural gas**	**Timber and it's residues**
	10^3 t	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 m^3**	**m^3**
Electric energy and heat production			10			2		1	48			315 621	
Processing industry	3	8		1					48	17	1	199 236	10 445
Transport													
Road (motor)						271			90			18 609	
Aviation							9						
Railway									3				
Pipelines												10 649	
Other sectors													
Residential	3			57				64				340 428	9 670 907
Commercial												67 123	
Agriculture								1	65				174 197
Other					1				1		1	29 932	
Total	**5**	**8**	**10**	**58**	**1**	**273**	**9**	**66**	**254**	**17**	**2**	**981 598**	**9 855 549**

Fuel consumption in Georgia by sectors in 2006

Fuel / Sector	Coal	Cox	Oil	Liquid gasPG	Naphtha	Gasoline	Aviation Kerosene	Kerosene	Diesel Fuel	Black oil	Lubricants	Natural gas	Timber and it's residues
	10^3 t	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 t**	**10^3 m^3**	**m^3**
Electric energy and heat production			12			2			62			402 028	
Processing industry	3	7		1					62	16	1	253 781	10 445
Transport													
Road (motor)						258			116			23 703	
Aviation							10						
Railway									4				
Pipelines												13 565	
Other sectors													
Residential	3											85 499	
Commercial				58				64				433 627	9 670 907
Agriculture								2	84				174 197
Other									1		1	38 127	
Total	**6**	**7**	**12**	**59**		**260**	**10**	**66**	**329**	**16**	**2**	**1 250 330**	**9 855 549**

Annex III. Quantitative estimation of uncertainties in GHG national inventory

IPCC source category	Gas	Base year emissions	t year emissions	AD uncertainty	EF uncertainty	Combined Uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by EF uncertainty	Uncertainty in trend in national emissions introduced by AD uncertainty	Uncertainty introduced into the trend in total national emissions	EF quality indicator	AD quality indicator
		Input data	Input data	Input data	Input data	√E2+F2	G*D/∑D	Note B	D/∑C	I*F Note C	J*E*√2, Note D	√K2+L2	Note E	Note E
		Gg CO2-eq.	Gg CO2-eq.	%	%	%	%	%	%	%	%	%		
Coal: 1A2	CO2	8,61	4,48	10	5	11.18	0.01	0.00	0.00	0.00	0.00	0.01	D	D
Coke 1A2	CO2	23,97	21,57	10	5	11,18	0,01	0,00	0,00	0,01	0,01	0,01	D	D
Crude oil 1A1	CO2	6,11	29,33	10	3	10,44	0,02	0,00	0,00	0,01	0,02	0,02	D	D
LPG: 1A4	CO2	3,54	168,37	20	9,5	22,14	0,19	0,01	0,01	0,13	0,19	0,23	D	D
1A2	CO2	2,66	2,95	10	9,5	13,79	0,00	0,00	0,00	0,00	0,00	0,00	D	D
Mazuth 1A2	CO2	44,94	50,79	10	5	11,18	0,03	0,00	0,00	0,02	0,03	0,03	D	D
Jet kerosene 1A3 a	CO2	24,93	29,67	5	5	7,07	0,01	0,00	0,00	0,01	0,01	0,01	D	D
Other Kerosene 1A4 ab	CO2	4,14	203,13	20	2	20,10	0,22	0,01	0,01	0,03	0,23	0,23	D	D
1A4 c	CO2	2,55	3,18	20	2	20,10	0,00	0,00	0,00	0,00	0,00	0,00	D	D
Diesel 1A1 a	CO2	31,77	152,51	10	2	10,20	0,08	0,01	0,01	0,02	0,09	0,09	D	D
1A2	CO2	133,44	150,92	10	2	10,20	0,08	0,00	0,01	0,02	0,08	0,09	D	D
1A4 c (stationary)	CO2	31,77	206,2	20	2	20,10	0,23	0,01	0,01	0,03	0,23	0,23	D	D
1A5	CO2	0	2,22	20	2	20,10	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A3 b	CO2	264,03	285,63	10	2	10,20	0,16	0,00	0,02	0,05	0,16	0,17	D	D
1A3 c	CO2	9,21	9,85	10	2	10,20	0,01	0,00	0,00	0,00	0,01	0,01	D	D
Nat. gas 1A1 a	CO2	935,3	593,72	10	3,5	10,59	0,35	-0,02	0,03	0,17	0,34	0,38	D	D
1A2	CO2	198,45	374,79	10	3,5	10,59	0,23	0,01	0,02	0,11	0,23	0,25	D	D
1A4 a	CO2	73,16	126,27	20	3,5	20,30	0,15	0,00	0,01	0,04	0,15	0,16	D	D
1A4 b	CO2	371,06	640,38	20	3,5	20,30	0,77	0,02	0,04	0,19	0,79	0,81	D	D
1A5	CO2	32,63	56,31	20	3,5	20,30	0,07	0,00	0,00	0,02	0,07	0,07	D	D
1A3 b	CO2	19,28	35,01	10	3,5	10,59	0,02	0,00	0,00	0,01	0,02	0,02	D	D
1A3 e	CO2	11,03	20,03	10	3,5	10,59	0,01	0,00	0,00	0,01	0,01	0,01	D	D
Lubricants 1A2	CO2	1,31	1,46	10	2	10,20	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A5	CO2	0	1,9	20	2	20,10	0,00	0,00	0,00	0,00	0,00	0,00	D	D
Gasoline 1A1	CO2	1,54	7,38	10	5	11,18	0,01	0,00	0,00	0,00	0,00	0,01		
1A3 b	CO2	769,63	831,71	10	5	11,18	0,58	0,00	0,05	0,37	0,53	0,64	D	D

Naphtha 1A5	CO2	0	0,57	20	5	20,62	0,00	0,00	0,00	0,00	0,00	0,00	D	D
2 Industrial processes	CO2					0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
2A Mineral products	CO2					0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
Cement 2A1	CO2	173,5	264,21	5	5	7,07	0,12	0,01	0,02	0,12	0,09	0,15	D	D
Clinker 2A1	CO2	102,4	315,42	5	5	7,07	0,15	0,01	0,02	0,15	0,11	0,18	D	D
2A2 lime	CO2	2,6	13,92	50	15	52,20	0,05	0,00	0,00	0,02	0,05	0,05	D	D
2B1 ammonia	CO2	204	228	5	7	8,60	0,13	0,00	0,02	0,15	0,08	0,17	D	D
2C1 a steel	CO2	0,2	0	5	25	25,50	0,00	0,00	0,00	0,00	0,00	0,00	D	D
						0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
2C2 a ferromanganese	CO2	10,7	22,19	5	25	25,50	0,04	0,00	0,00	0,05	0,01	0,05	D	D
2C2 b silicomanganese	CO2	34,9	185,98	5	25	25,50	0,33	0,01	0,01	0,45	0,06	0,46	D	D
Coal:	CH4					0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A2	CH4	0,067	0,053	10	80	80,62	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A3 c	CH4	0,031	0			0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A4 a	CH4	0,0156	0	20	150	151,33	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1 A4 b	CH4	0,585	0,3	20	150	151,33	0,00	0,00	0,00	0,00	0,00	0,00	D	D
Natural gas:	CH4					0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A1	CH4	0,352	0,2234	10	80	80,62	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A2	CH4	0,373	0,7	10	200	200,25	0,01	0,00	0,00	0,01	0,00	0,01	D	D
1A3 b	CH4	0,363	0,66	10	65	65,76	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A4 a	CH4	0,138	0,24	20	80	82,46	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A4 b	CH4	0,7	1,2	20	80	82,46	0,01	0,00	0,00	0,01	0,00	0,01	D	D
Gasoline	CH4					0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A3 b	CH4	4,71	5,09	10	70	70,71	0,03	0,00	0,00	0,03	0,00	0,03	D	D
Jet kerosene:	CH4					0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A3 a	CH4	0,0037	0,0044	10	70	70,71	0,00	0,00	0,00	0,00	0,00	0,00	D	D
Diesel:	CH4					0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A1	CH4	0,034000	0,17	10	45	46,10	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A2	CH4	0,105	0,118	10	20	22,36	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A3 b	CH4	0,378	0,41	10	75	75,66	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A 3c	CH4	0,0132	0,014	10	75	75,66	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A4 b	CH4	0,024	1,166	20	80	82,46	0,01	0,00	0,00	0,01	0,00	0,01	D	D
1A4 c (mobile)	CH4	0,192	0,3	20	80	82,46	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A4 c(stationary)	CH4	0,099	0	20	80	82,46	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1B fugitive emissions	CH4					0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1B1 a I (coal)	CH4	1,68	0	10	200	200,25	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1B 1 a ii (coal)	CH4	0,21	0	10	300	300,17	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1B2 a (oil)	CH4	0,21	0,21	5	75	75,17	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1B2 b I (Nat. gas production)		22,05	3,36	5	100	100,12	0,02	0,00	0,00	0,03	0,00	0,03	D	D
1B2 b ii (Nat. gas distribution)	CH4	2357,25	1192,8	5	100	100,12	8,42	-0,08	0,08	11,64	0,41	11,64	D	D

4A1 cattle	CH4	1135,89	1266,97	25	20	32,02	3,12	0,00	0,10	2,95	2,61	3,94	D	D
4A2 buffalo	CH4	40,32	38,43	30	30	42,43	0,14	0,00	0,00	0,15	0,10	0,18	D	D
4A3 sheep	CH4	58,17	72,45	30	30	42,43	0,26	0,00	0,01	0,28	0,20	0,34	D	D
4A4 goats	CH4	8,4	12,18	30	30	42,43	0,04	0,00	0,00	0,05	0,03	0,06	D	D
4A6 Horses	CH4	12,81	16,8	30	30	42,43	0,06	0,00	0,00	0,07	0,05	0,08	D	D
4A8 swine	CH4	8,61	10,08	30	30	42,43	0,04	0,00	0,00	0,04	0,03	0,05	D	D
						0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
4B Manure management	CH4	260,4	298,1	30	30	42,43	1,09	0,00	0,03	1,16	0,82	1,42	D	D
4B1 a	CH4	217,77	237,3	25	30	39,05	0,82	0,00	0,02	0,95	0,56	1,10	D	D
4B1 b	CH4	9,87	10,71	25	30	39,05	0,04	0,00	0,00	0,04	0,03	0,05	D	D
4B2 Buffalo	CH4	1,47	1,47	30	30	42,43	0,01	0,00	0,00	0,01	0,00	0,01	D	D
4B3 sheep	CH4	1,89	2,31	30	30	42,43	0,01	0,00	0,00	0,01	0,01	0,01	D	D
4B4 goats	CH4	0,21	0,42	30	30	42,43	0,00	0,00	0,00	0,00	0,00	0,00	D	D
4B6 horses	CH4	1,05	1,47	30	30	42,43	0,01	0,00	0,00	0,01	0,00	0,01	D	D
4B8 swine	CH4	34,44	40,74	30	30	42,43	0,16	0,00	0,00	0,17	0,12	0,20	D	D
4B9 poultry	CH4	3,15	3,78	30	30	42,43	0,01	0,00	0,00	0,02	0,01	0,02	D	D
4F	CH4	5,25	9,24	50	200	206,16	0,17	0,00	0,00	0,25	0,04	0,26	D	D
6A	CH4	922,11	903,84	31,5	30	43,50	3,59	-0,01	0,09	3,71	2,75	4,62	D	D
6B1	CH4	12,81	23,10	56	58	80,62	0,19	0,00	0,00	0,20	0,14	0,24	D	D
6B2	CH4	215,04	210,21	5	44	44,28	0,93	0,00	0,02	1,39	0,11	1,40	D	D
Coal:	N2O					0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A2	N2O	0,14	0	10	85	85,59	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A3 c	N2O	0,0645	0	10	90	90,55	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A4 a	N2O	0,032	0	20	50	53,85	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A4 b	N2O	0,04	0	20	50	53,85	0,00	0,00	0,00	0,00	0,00	0,00	D	D
Natural gas:	N2O					0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A1	N2O	0,52	0,33	10	90	90,55	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A2	N2O	0,11	0,21	10	40	41,23	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A3 b	N2O	0,01	0,02	10	65	65,76	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A4 a	N2O	0,04	0,07	20	90	92,20	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A4 b	N2O	0,21	0,356	20	90	92,20	0,00	0,00	0,00	0,00	0,00	0,00	D	D
Gasoline:	N2O					0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A3 b	N2O	2,1	2,255	10	85	85,59	0,02	0,00	0,00	0,03	0,00	0,03	D	D
Diesel:	N2O					0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A1	N2O	0,1	0,49	10	45	46,10	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A2	N2O	0,462	0,52	10	265	265,19	0,01	0,00	0,00	0,02	0,00	0,02	D	D
1A3 b	N2O	0,67	0,72	10	85	85,59	0,01	0,00	0,00	0,01	0,00	0,01	D	D
1A3 c	N2O	0,23	0,025	10	90	90,55	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A4 b	N2O	0,021	1,03	20	45	49,24	0,01	0,00	0,00	0,01	0,00	0,01	D	D
1A4 c (stationary)	N2O	0,087	0	20	45	49,24	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A4 c (mobile)	N2O	0,341	0,53	20	45	49,24	0,00	0,00	0,00	0,00	0,00	0,00	D	D
Jet kerosene:	N2O					0,00	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1A3 a	N2O	0,22	0,26	5	90	90,14	0,00	0,00	0,00	0,00	0,00	0,00	D	D
Industrial Processes	N2O									0,00	0,00			
2B2 Nitrous	N2O	32,13	37,8	5	20	20,62	0,08	0,00	0,00	0,12	0,02	0,12	D	D

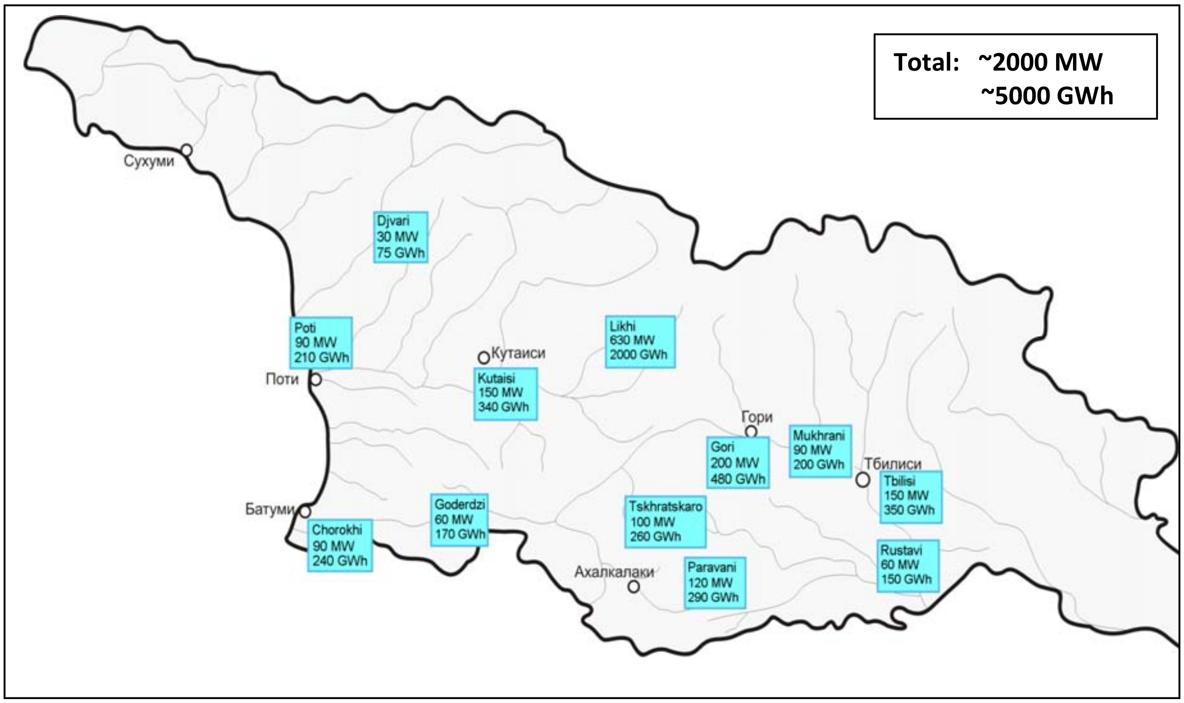
acid														
4 Agriculture	N2O									0,00	0,00			
4B Manure management	N2O	4,83	5,67	40	70	80,62	0,05	0,00	0,00	0,06	0,02	0,07	D	D
4D1 Direct emissions from soils	N2O	30,24	45,99							0,00	0,00			
4D1 a	N2O	17,43	28,35	20	100	101,98	0,30	0,00	0,00	0,44	0,06	0,44	D	D
b	N2O	6,72	7,77	20	100	101,98	0,08	0,00	0,00	0,12	0,02	0,12	D	D
c	N2O	0,21	0,84	15	35	38,08	0,00	0,00	0,00	0,00	0,00	0,00	D	D
d	N2O	5,88	9,03	35	30	46,10	0,04	0,00	0,00	0,04	0,03	0,05	D	D
e	N2O	0	0	20	30	36,06	0,00	0,00	0,00	0,00	0,00	0,00	D	D
4D2	N2O	18,27	21,63	30	100	104,40	0,23	0,00	0,00	0,34	0,07	0,34	D	D
4D3 a	N2O	5,25	6,3	50	150	158,11	0,10	0,00	0,00	0,15	0,03	0,15	D	D
4D3b	N2O	25,41	32,76	102	150	181,39	0,62	0,00	0,00	0,77	0,37	0,85	D	D
4F	N2O	0,21	0,21	50	200	206,16	0,00	0,00	0,00	0,01	0,00	0,01	D	D
Waste	N2O									0,00	0,00			
6B human sewage	N2O	5,88	5,88	5	70	70,18	0,04	0,00	0,00	0,06	0,00	0,06	D	D
Total emissions (all sources):		9030,461	9615,7108			Total H:	9,93	Level uncertainty			Total M:	13,45		

Annex IV

MAGICC/SCENGEN results of assessment of the best GSMs for Western (W) and Eastern (E) Georgia

	^0C %	Spring		Summer		Autumn		Winter		Annual	
		W	E	W	E	W	E	W	E	W	E
BMRC98	T	0	1.2	7.7	7.2	3.1	3.5	3.4	2.0	3.5	3.5
	Q	-10.7	-3.0	-96.4	-95.3	-74.3	-75.2	3.4	44	-48.3	-39.3
CCCL99	T	1.9	3.6	3.0	1.2	2.7	5.0	4.2	6.3	2.9	4.0
	Q	47.2	129.5	-35.5	26.6	-35.7	-16.8	2	39.3	-8.3	46.2
CCSR96	T	7.6	7.2	11.6	11.6	8.3	7.4	9.0	7.4	9.1	7.7
	Q	-26.6	12.9	-94.6	-91.1	-69.3	-49.6	19.7	153.6	19.5	153.6
CERF98	T	8.0	8.4	8.9	6.4	6.8	6.9	12.0	10.7	9.0	8.1
	Q	9.3	23.5	-73.5	-66.4	-7.4	22.4	48.3	165.5	-10.0	23.9
CSI296	T	1.1	1.8	-0.7	-2.8	0.3	1.2	4.5	4.2	1.3	1.1
	Q	-2.8	36.4	-10.4	42.2	-42.2	5.6	-29.1	16.7	-21.3	26.5
CSM_98	T	-0.6	0.3	0.6	0.1	-0.9	0.4	2.5	1.7	0.4	0.5
	Q	36.4	66.2	-43.2	-7.8	-44.7	-22.4	17.2	35.7	-12.2	17.1
ECH395	T	1.7	0.8	3.9	4.0	3.4	3.4	5.0	2.3	3.5	3.2
	Q	-9.8	6.8	-55.6	-45.3	-63.1	-62.4	2.5	40.5	-33.9	-18.8
ECH498	T	-0.2	1.7	2.1	4.9	1.9	2.4	3.5	-0.1	1.8	2.2
	Q	31.9	52.3	-49.4	-18.0	-18.0	-4.8	44.8	77.4	-5.2	22.2
GFDL90	T	-2.9	-3.4	3.8	1.5	0.7	-0.5	-0.6	-3.7	0.2	-1.5
	Q	80.8	198.5	-25.1	48.4	-13.5	49.6	10.8	120.2	10.4	104.3
GISS95	T	-1.2	3.2	0.0	2.1	0.2	3.1	2.4	3.7	0.3	3.0
	Q	154.7	110.6	-28.2	-7.0	23.0	39.2	225.6	156.0	84.3	67.4
HAD295	T	-0.1	5.1	2.8	4.4	0.3	5.3	3.0	6.5	1.5	5.3
	Q	82.2	71.7	-29.0	-35.2	4.5	63.2	56.2	114.4	24.3	50.4
HAD300	T	0.1	1.1	0.9	-0.9	-0.2	2.4	1.1	3.2	0.5	1.5
	Q	59.6	63.6	-34.7	-46.1	-32.8	-12.8	13.3	61.9	1.7	13.7
IAP_97	T	1.5	1.5	7.5	4.9	3.5	2.9	4.2	2.6	4.2	3.2
	Q	0.5	39.4	-82.2	-64.1	-0.8	78.4	12.3	97.6	-20.4	33.3
LMD_98	T	-4.4	1.3	2.5	-0.5	0.6	4.9	-0.1	6.1	-0.4	2.9
	Q	69.2	106.8	33.2	218.0	51.2	163.2	93.1	152.4	59.6	160.7
MRI_96	T	7.1	5.7	12.4	8.7	6.9	4.9	8.5	5.1	8.7	6.1
	Q	-8.4	87.9	-72.6	-25.8	-55.7	4.0	26.6	158.3	-31.3	47.9
PCM_00	T	-2.2	-1.8	-1.5	-3.2	-1.2	-2.2	0.8	-0.7	-1.0	-2.0
	Q	29.0	107.6	20.5	112.5	-49.2	-22.4	-17.7	19.0	-4.3	52.1
WM_95	T	6.4	5.9	13.9	11.1	8.8	7.6	10.1	7.6	9.8	8.0
	Q	79.0	162.1	-81.1	-60.2	-3.3	57.6	93.6	251.3	16.1	91.5

Annex V


Total: ~2000 MW
~5000 GWh
Сухуми
Djvari
30 MW
75 GWh
Poti
90 MW
210 GWh
Поти
Кутаиси
Kutaisi
150 MW
340 GWh
Likhi
630 MW
2000 GWh
Гори
Gori
200 MW
480 GWh
Mukhrani
90 MW
200 GWh
Тбилиси
Tbilisi
150 MW
350 GWh
Батуми
Chorokhi
90 MW
240 GWh
Goderdzi
60 MW
170 GWh
Tskhratskaro
100 MW
260 GWh
Ахалкалаки
Paravani
120 MW
290 GWh
Rustavi
60 MW
150 GWh

Annex VI

№	Name	Installed capacity MGW		№	Name	Installed capacity MGW
1	Magana	21.3		43	Tazara	6.0
2	Lekarde	20.0		44	Sakhvlari	5.3
3	Medani	4.4		45	Khunevi	11.3
4	Lebarde I	4.56		46	Gubazeuli 2	5.06
5	Lebarde II	4.16		47	Gubazeuli 5	11.6
6	Erjia	24.4		48	Gubazeuli 6	5.0
7	Tskhimra	29.0		49	Bakhvi hesi-1	15.0
8	Nobulevi	18.5		50	Bakhvi hesi-2	20.0
9	Lechaxa	17.8		51	Bakhvi hesi-3	6.0
10	Lesulukhe	6.7		52	Khala	13.0
11	Tekhuri 1-6	19.2		53	Merisi	11.5
12	Nakra hesi-1	19.6		54	Skhalta	5.3
13	Nankra	29.16		55	Iori	9.7
14	Nenskra 1	22.4		56	Dzegvi	10.0
15	Nenskra 2	14.0		57	Tergi	11.4
16	Nenskra 3	10.8		58	Dariali	50
17	Nenskra 4	25.43		59	Samkuristskali I	12.4
18	Nenskra 5	14.70		60	Samkuristskali II	22.2
19	Khumpreri	16.37		61	Avani	4.6
20	Kheledula 1	8.5		62	Duruji	1.74
21	Kheledula 2	8.0		63	Uraveli	5.0
22	Kheledula 3	12.0		64	Arakli	18.2
23	Stori hesi-1	10.0		65	Ninotsminda	9.4
24	Cheshura I, II	8.5		66	Abuli	12.5
25	Samitsao	10.0		67	Poka	0.5
26	Jejora	15.8		68	Stori hesi-2	10.0
27	Khobi hesi-1	27.0		69	Cheltii hesi-1	4.8
28	Khobi hesi-2	31.0		70	Cheltii hesi-2	4.8
29	Khobi hesi-3	9.0		71	Ksanis hesi-1	4.2
30	Janauli	13.0		72	Ksanis hesi-2	2.1
31	Alpana	69.0		73	Ksanis hesi-3	3.2
32	Tsala	9.14		74	Ksanis hesi-4	3.6
33	Jria	9.2		75	Ksanis hesi-5	6.0
34	Boriti	6.4		76	Marelisi	4.6
35	Tsablari 1	5.80		77	Mtkvari hesi	28
36	Tsablari 2	10.2		78	Bakhvi hesi-4	1.0
37	Xan-tsablari 3	8.30		79	Bakhvi hesi-5	2.0
38	Khani 7	6.4		80	Khudoni	700
39	Zestafoni 1	10.0		81	Namakhvanis kaskadi - Namakhvanis	250
40	Zestafoni 2	11.9		82	Namakhvanis kaskadi - Zhoneti	100
41	Zestafoni 3	15.9		83	Namakhvanis kaskadi - tvishi	100
42	Zestafoni 4	15.9		84	Onis kaskadi	276