EXECUTIVE SUMMARY

Introduction

The problem of global climate change is one of the most critical challenges facing humanity at the present stage of civilization, which has serious social-economic and environmental consequences. With the aim to prevent negative impacts of climate change, about 150 countries signed the United Nations Framework Convention on Climate Change (UNFCCC) at the World Summit held on June 1992 in Rio-de-Janeiro.

The ultimate objective of the Convention is to maintain greenhouse gases concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climatic system, for a period of time, which would be sufficient for natural adaptation of the ecosystem to climate change without endangering production and sustainable economic growth of countries.

The Republic of Azerbaijan signed the Convention in June 1992 and ratified it in January 1995, and in May 1995 it became a Party to the UNFCCC. In April 1997, State Commission on Climate Change was established by the President's Decree. Development of the "First National Communication to the Conference of Parties" is the first step undertaken by the Azerbaijan Republic to meet its commitment under the Article 4 and Article 12 of the Convention.

Within the UNDP/GEF Project of technical assistance to developing countries, the First National Communication has been prepared by the National Climate Change Center established under the State Committee on Hydrometeorology, with participation of local experts from 18 Ministries, Agencies and NGOs.

The First Communication presents findings of studies on national greenhouse gas emissions during 1990-1994, vulnerability assessment, mitigation and abatement plans to reduce negative effects of climate change on ecosystems and different sectors of the economy.

General Information About the Republic of Azerbaijan

The Republic of Azerbaijan occupies a territory of 86.6 thousand km^2, which lies at the western coast of the Caspian Sea, between mountainous systems of the Greater and Lesser Caucasus and the Talish mountains. From the north to the south, territory of the country extends for 400 km, and from the west to the east - for 500 km. Average altitude is 384 m, with drop in altitude from 4,466 m (the Bazar-Duzu Mountain) to - 27 m (coast of the Caspian Sea). Plains and lowlands occupy 57%, with low and middle mountains constituting 39.5%, and mountainous areas (above 2,500 m) 3.5% of the total territory. As of 1999, total number of population is 7.95 million people.

Depending on the altitude and remoteness from the Caspian Sea, several climatic types are identified: arid subtropical, humid subtropical, temperate and cold. Average annual air temperature varies from 14°C in the low lying areas to 0°C and below in the highlands. Average annual temperature in July in low lying areas is 25-27°C, in highlands it does not exceed 5°C, in January, it is respectively 3-6°C and -3 - -5°C. Absolute maximum reaches 43°C, absolute minimum is -30°C.

Major sectors of economy of Azerbaijan are: fuel energy, machinery construction and metal processing, chemical and petrochemical, light and food industries, as well as agriculture. Peak of development of the economy of Republic falls on the period between 1985 and 1990, when out of the total output 85% of industrial and 30% of agricultural products were exported from the country.

After the collapse of the USSR, disruption of traditional economic links has very negatively reflected on the social and economic situation of the country. This process has further aggravated by the unstable public and political situation and occupation of 20% of country's territory, which provided up to 15% of GDP, great amount of refugees and IDPs (more than 1 million people) from the occupied territory of Karabakh and Armenia, as well as transport blockade and some other factors. All these have caused a deep economic crisis, as a result of which GDP and other social and economic indicators have drastically decreased (see Table S.1).

Table S.1. Change in Azerbaijan's social-economic indicators

Indicators	Years								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
GDP, %	100	-0.7	-23.1	-40.9	-52.5	-58.2	-57.7	-55.2	-50.7
Industrial production, %	100	-8.9	-36.6	-49.1	-61.8	-70.0	-72.1	-71.9	-71.3
Agricultural production, %	100	0.3	-23.8	-35.2	-43.6	-47.6	-46.1	-49.9	-48.0
Inflation, %	100	107	912	1129	1664	412	20	3.7	0.8
Population, million people	7.13	7.19	7.30	7.37	7.34	7.49	7.54	7.56	7.76
Unemployment*, thousand people	-	3.81	6.41	19.5	23.6	28.3	31.9	38.3	39.5
Investment in economy, %	100	79	47.4	29	54.8	45	94.5	157.5	225
GDP energy intensity, %	100	102	112	137	156	172	154	138	128

* Officially registered unemployed

As a result of achieving of political stability in the country only since 1995 wide-scale economic reforms became possible. From the mid 1996, the process of privatization started and today, more than 50% of the GDP is formed in the private sector of the economy. At the same time, the Government of Azerbaijan has built a firm fundament for the inflow of foreign investment in the national economy for the nearest decades and fundamental reforms on restructuring of the state owned enterprises and strengthening of the economic laws.

Inventory of Greenhouse Gas Emissions

National Inventory of greenhouse gas emissions in Azerbaijan has been conducted for 1990-1994. The year 1990 has been taken as baseline. Greenhouse gas emissions have been assessed using the IPCC Methodology based on the data of the governmental and various ministerial statistics. Under the "Forestry and land-use change" category national coefficients have been used. Total emissions of greenhouse gases of direct effect are presented in Table S.2.

Table S.2. Total Emission of Greenhouse Gases of Direct Effect, 1990

Gas	Emission amount, Gg	CO_2- eq, Gg	Input, %
CO_2	44703	44703	73
CH_4	723	15183	25
N_20	2,9	899	2
Total		60785	100

GHG emissions totaled 60.8 million tons and 43.4 million tons CO_2-eq in 1990 and 1994 respectively, i.e. GHG emissions decreased by almost 30% between 1990 and 1994. Figure S.1 presents the results of comparative analysis of inputs of gases with direct greenhouse effect for 1990 and 1994. Per capita GHG emission was 8.5 tons in 1990 and 5.9 tons in 1994.

In line with IPCC recommendations, the following main categories of GHG sources and sinks have been addressed: “Energy”, “Industrial processes”, “Agriculture”, “Forestry and land-use . Due to lack of adequate governmental and ministerial statistics, emissions from the sources of the “Solvents” category have not been considered.

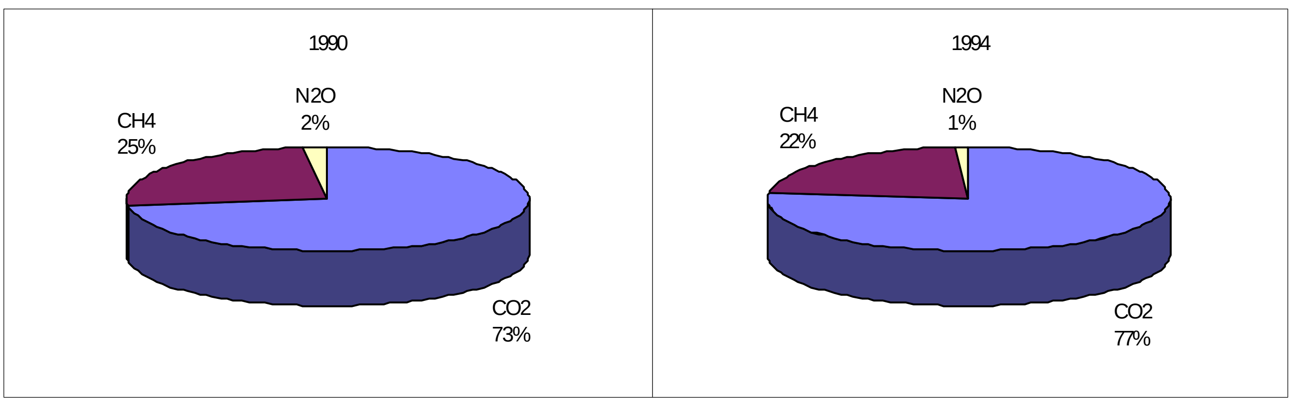

Figure S.1. Comparative Analysis of Inputs of Gases with Direct Greenhouse Effect

The greenhouse gas inventory in Azerbaijan include GHG of direct effect such as: carbon dioxide, methane, nitrous oxide; and indirect effect such as: nitrogen oxides, carbon monoxide, non-methane volatile organic compounds. Emissions and sinks of GHG for 1990 are presented in Table S.3.

Table S.3. GHG Emissions and Sinks in the Azerbaijan Republic, 1990

Category of Source/ Sinks	GHG Emission, Gg					
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
Overall (net) national emission	41194	723	2.9	157	119	403
Total GHG emission	44703	723	2.9	157	119	403
Net of sinks	-3509					
Energy sector	43258	447	0.21	156	115	73
A. Fuel combustion	43258	4.15	0.21	155.78	107.17	61.28
Energy generation and consumption	16616	0.45	0.07	44.44	4.86	1.33
Industry	6886	0.54	0.04	23.49	3.17	0.70
Transport	4433	1.05	0.03	44.73	51.70	51.69
Commercial	6393	0.62	0.02	6.23	4.95	0.54
Households	4923	1.27	0.02	4.76	18.03	2.08
Agriculture and forestry	2715	0.12	0.01	29.04	24.19	4.84
Other	1292	0.09	0.01	3.68	0.28	0.09
B. Fugitive fuel emissions		443.24		1.01	8	12
Oil and gas industry		443.24		1.01	8.14	11.63
Industrial processes	1444				4	330
Non-mining materials	774					320
Chemical industry						1
Metallurgy	670				4	
Others						9
Agriculture		194	1.97			
Enteric fermentation		164				
Animal wastes		30				
Agricultural soils			1.97			
Land use change and forestry	-3509					
Change in forests	-1847					
Grasslands	-822					
Land use change	-839					
Waste		81	0.72			
Landfills		64				
Waste water treatment		17				
Industrial effluents		14				
Domestic		2	0.72			
International bunkers	476			2	3	2

Data presented above show that the main GHG in Azerbaijan is CO_2; its 97% comes from the energy sector, with 38% arising from the energy generation and transformation, 16% - from industry, 10% - from transport, 15% - from commercial sector, 12% from households, 6% - from agriculture and forestry, and 3% from other sectors.

National Strategy on Greenhouse Gases Abatement

According to the Article 4.b of the Convention, as a Party to UNFCCC, Azerbaijan has to produce and periodically update its national programmes containing the measures on mitigating the impacts of climate change through addressing problems of anthropogenic emissions by sources.

National strategy to abate GHG has been developed based on the following general and industrial programmes for the country's development by 2025:

- State Program on macroeconomic stabilization in the Azerbaijan Republic;
- Concept of the energy sector development in the Azerbaijan Republic by 2010;
- Concept of irrigation and water economy in association with the agrarian reforms for the period of 1996-2010;
- National Environmental Action Plan;
- Afforestation Program by 2005;
- The Program on Restructuring and Financing of Agriculture in the Azerbaijan Republic for the period of 2000-2020;
- The Program on Development of Oil and Gas Refining and Petrochemical Industries in the Azerbaijan Republic for the period of 2000-2010.

The strategy is based on forecasts of macroeconomic performance and balance structure of the energy resources, emission rates of greenhouse gases, which were developed in line with the methodology of expert evaluation and empirical mathematical models.

A baseline and optimistic scenarios have been developed for the country development by the year 2025 (Table S.4).

Table S.4. The GDP Forecast and Energy Requirement

Indicators	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Baseline scenario								
Energy consumption, %	100	72	56.64	95.06	117.80	135.45	148.31	154.52
GDP, %	100	41.8	48.3	103.8	195	250	300	350
Energy Intensity, %	100	166	117	92	60	54	49	44
Optimistic scenario								
Energy consumption, %	100	72	56.64	97.03	122.60	149.44	159.75	167.94
GDP, %	100	41.8	48.3	112.41	215	290	355	400
Energy Intensity, %	100	166	117	86	57	52	45	42

Analysis of economic development reveals that, for the period concerned, an increase in the amount of combusted fuel is expected both in the baseline and optimistic scenarios of the economic development, however, it is anticipated that the GDP energy intensity will decrease in both cases.

In Azerbaijan, the main source of GHG emission will be fuel combusted in the energy complex. Dynamics of changes in emissions of gases with direct greenhouse effect demonstrates that after a considerable reduction in GHG emissions between 1993 and 1997 there will be an increase in emissions by 9-10% a year for the period of 2000-2005, followed with the increase of 5.9-6.3% a year within 2006-2010 and 0.9-2.0% a year within 2011-2025. Results of forecasts show that exceeding of the 1990 baseline level would happen no earlier than by 2007-2008.

One of high priority objectives of the National Environmental Action Plan is expansion of the area under forests and plantations. Forest is a natural regulator of $\tilde{N}_2$ in the atmosphere. Depending on forestry development scenarios, sink of $\tilde{N}_2$ by 2025 versus 1990 baseline year may increase by 42 and 112% respectively (see Table S.5).

Table S.5. Predicted Emissions and Sinks of GHG in Azerbaijan, Gg

Indicators	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Baseline scanario								
CO_2	44703	30124	24689	41544	52322	59844	65729	68735
CH_4	723	587	730	1253	1837	1946	2050	2177
N_2O	2.90	2,60	2.80	3.10	3.30	3.50	3.60	3.80
Total CO_2- eq	60785	43257	40887	68818	91922	101795	109895	115630
Optimistic scenario								
CO_2	44703	30124	21689	42396	53828	65883	70698	74543
CH_4	723	587	730	1253	1837	1947	2050	2178
N_2O	2.90	2,60	2.80	2.90	3.33	3.54	3.66	3.82
Total CO_2- eq	60785	43257	40887	69608	93437	107867	114883	121465
Sink of CO_2								
Baseline scenario	1847	253	681	2367	2424	2488	2556	2627
Optimistic scenario	1847	253	681	2383	2550	2865	3329	3922

Rate of GHG emission growth will be decreased due to implementation of active energy-saving policy and introduction of energy-effective technologies through:

- implementation of a special programme of providing all subjects of economic activity with fuel energy resources (FER) control instruments, achievement of which will require investments in the amount of 20.0-24.0 million USD. This measure will provide for reduction of FER requirement by 38-45 PJ by the year 2015, and by 54-60 PJ by the year 2025;

- introduction of automated energy consumption control system, which will require investment of around 14.0-16.0 million USD, which will ensure saving of approximately 9.5-11.0 PJ by the year 2015, and around 13.0-15.0 PJ by the year 2025;

- introduction of modern sources and lighting system, which will allow to save 14.5-17.0 PJ of fuel with the amount of investment predicted at the level of 2.5-3.0 million USD;

- introduction of power electronics facilities (controlled-velocity electric drive, effective electric motors and transformers, compensating devices) will save approximately 80-90 PJ of fuel, with the predicted investment of 28.0-30.0 million USD;

- improvement of the heating system, which requires investment in the amount of 180-210 million USD and which can save 31-35 PJ of fuel.

- increase in utilization of secondary heating energy resources with fuel economy in the order of 38-45 PJ, with the required investment of 145-165 million USD.

- optimization of power generation systems of the country (rehabilitation of the existing and construction of new thermal and hydro-power plants), electric networks and upgrading of electric equipment, which will result in reduction of fuel consumption by 1200-1300 PJ, assuming an investment of 2.5-2.6 billion USD;

- increase in efficiency of gas pumping units with reduced consumption of fuel by 20-30 PJ with the required investment around 115-120 million USD;

- introduction of progressive technologies in oil extraction and refining with economy of fuel in the order of 2200-2400 PJ with required investments of 42-45 million USD.

- introduction of energy efficient technologies will ensure saving of around 4300-4600 PJ of organic fuel for the period up to the year 2025 with the investment of 4.5-5.0 billion USD;

- technologic restructuring of mining industry (exclusion of open-hearth and oxygen-convector processes with transition to electric steel melting and ferrous melting technologies), establishment of new low energy intensive processes, upgrading of production structure, and reduction of energy intensity of final product will ensure saving of around 45-50 PJ of fuel with the required investment predicted at the level of 35-40 million USD.

- use of new energy saving technologies, change in the list of produced items, use of the high quality raw material in the machinery complex will reduce energy consumption by 18-20 PJ with the amount of required investments to be 190-210 million USD.

- upgrading of ethylene-propylene and caustic soda, phosphate fertilizers, and motor wheels production technology, applying of environmentally friendly technologies in production of new types of products in the chemical and petro-chemical industries will reduce energy consumption by 10-12 PJ with the required investments to be 80-90 million USD.

- improvement of technological processes through applying the method of dry cement production, increase in the share of porous brick production, upgrading of glass production furnaces and methods of glass drawing and other measures in the construction materials industry will reduce energy consumption in the field by 100-104 PJ with an investment of around 65-70 million USD.

- improvement and optimization in cattle breeding and increase of its specialization, energy efficient technologies of caw milking, processing of livestock wastes, use of helium dryers and helium heaters of water and air, utilization of heat from ventilation discharges in livestock premises, introduction of biogas installations and wind engines for power generation and for other purposes in the livestock breeding. Implementation of these measures will allow to save energy in the amount of 13.5-15.0 PJ with an investment of 110-140 million USD.

- improvement of the transport infrastructure (increase in the share of low tonnage lorries and buses) and optimization of its use, improvement of technical specifications of engines for all motor vehicles, use of electromobiles in the cities, further expansion of metro in the Baku city, tram and trolley-bus fleet of big cities, improvement of the quality of road pavement, renovation of the railway transport. These will provide energy saving in the amount of 40-50 PJ with an investment required in the order of 420-500 million USD.

- reconstruction of existing hydro and thermal power plants which will provide generation of additional 111.7 billion kW-hour of energy and will allow to save around 740 PJ of organic fuel.

- construction of new large and small hydro-power plants with generation of additional 44.1 billion KW-hour of energy and saving of around 350 PJ of organic fuel.

- use of non-traditional energy sources - wind, solar, geothermal, biogas, and micro hydro-power generating plant - will save around 45-50 PJ of organic fuel by the year 2025 with an investment of around 700-750 million USD.

- minimizing emissions of associated gas during oil production, its trapping and use in heat and power generation installations will provide utilization of approximately 60-62 billion m^3 of associated gas by the end of the period concerned. Predicted amount of required investment is 170-175 million USD.

- replacement of oil origin engine fuel with gas, which by the year 2025 will save around 25-30 PJ with the required investment in the amount of 50-70 million USD.

- reduction of discharges during the natural gas production, storage and distribution, which will be provided through improvement of exploiting the gas pipeline system, increase of the maintenance and detection quality. Reduction in the amount of discharges of the natural gas due to implementation of these measures should make up 63.7-70.7 billion m^3 by the year 2025. Required investment amount would make 450-550 million USD.

- improvement of industrial processes in various sectors of economy will provide reduction of CO_2 discharges by 200-220 Gg, with the required investment in the amount of 22-24 million USD.

- construction of garbage processing plants in Baku and other big cities and regional centers of the country will allow to minimize storing of solid domestic wastes on landfills and reduce methane discharges by around 64 Gg. Implementation of this measure will allow to annually dispose additional 8.0-8.5 million tons of garbage by the year 2025, which will require approximately 360-380 million USD.

- recuperation of methane from the sewage water, which will require reconstruction and construction of new treatment facilities at municipal sewage systems in Baku and other big cities. These will be supplemented with facilities for treatment of sewage water sludge (methane reservoirs, injector pump stations, etc.), which will allow to recuperate methane. Implementation of these measures will allow to reach by the year 2025 reduction in methane discharge by 19.5-21.0 million m^3, with the required amount of investment around 260-270 million USD.

The above measures, proposed by the year 2025, will be elaborated in Section 6.

Climate Change Vulnerability and Adaptation Assessment

With the global warming of the climate its regional changes are being observed as well. In order to identify potential climatic changes in Azerbaijan, long-term (100 year) data of the Azerbaijan State Committee on Hydrometeorology (Hydromet) have been used. Results of the trend analysis show that during recent 100 years air temperature over the whole territory of the country has increased by 0.5-0.6°C. Between 1960-1990 the warming level made up 0.3-0.6°C, and precipitation amount decreased by 10%.

For assessment of future climatic changes on the territory of Azerbaijan, according to IPCC recommendation, General Atmosphere Circulation, GISS, CCCM, UKMO, GFDL-T, GFDL-3 models have been used. The obtained warming results at 4.1-5.8°C have been attributed to the upper boundary of potential climate changes. In order to cover the whole range of possible climatic changes a national scenario has been developed, which takes into consideration regional peculiarities, year-round distribution of real climatic characteristics and the global background. According to this scenario, on the territory of Azerbaijan given the global doubling of CO_2 concentration in the atmosphere, by the year 2100, air temperature increase is expected to be 2°C and the precipitation amount would be stable or insignificantly below the norm.

Vulnerability and adaptive capabilities of natural resources and agriculture of Azerbaijan are estimated on the basis of identification of interrelation patterns between current climatic changes and water resources, agroclimatic resources, forest ecosystems, agricultural productivity, as well as social and economic aspects of effects. Further, on the basis of the optimally selected scenarios vulnerability and adaptation assessment has been conducted.

Water resources. With the two times increase of CO_2 concentration in the atmosphere, and with increase of air temperature by 2.0-4.5°C, reduction of water resources of rivers of Azerbaijan is expected to be 15-20%. With the current water deficiency of 3.8 km^3, till the middle of the 21st century it will constitute 9.5-11.5 km^3. The following measures are being proposed as mitigation: improvement of water resources management system, regulation of river flow, increase of irrigation systems efficiency by 75% and reconstruction of drainage systems, applying of water saving irrigation technologies, reuse of treated drainage water, and setting up shoreline plantations along water reservoirs.

Coastal area of the Caspian Sea. The recent rise of the Caspian sea level by 250 cm is also associated with climate change. Currently, 48.5 thousand hectares of lands have been flooded. Total damage to the economy of Azerbaijan as a result of flooding as of 1995, is 2.2 billion USD. By the years 2020-2040 increase in the sea level is expected to be 120-150 cm. Given that, potential losses of land will make up 130-160 thousand hectares, and direct total damage to social and economic branches is estimated at 4.1 billion USD. Prevention of the expected damage is possible through measures on protection of settlements, industrial and infrastructure facilities in the zone of potential sea impact, as well as improvement of environmental conditions in the coastal area.

Agriculture. With the warming of climate, increase of evaporation is expected to be 30-35%, which will result in degradation of natural humidification and moisture deficiency, with the humidification zones being shifted by 300 m to mountains. Such a condition will further aggravate due to reduction of river water resources. Recurrence of drought and dry winds will increase, especially in the Kura-Araz lowland. Dramatic consequences are expected at winter pastures. As a mitigation measure, the following is proposed: introduction and cultivation of highly productive crops, optimization of planting location and structure of crops, introduction of soil and water saving technologies, provision of drainage of irrigated lands, melioration and recultivation of salinized soils, setting of shelterbelt forests, prevention of desertification processes.

Forest ecosystems. According to scenario, climate change will evoke considerable increase of upper climatic boundary of forest cover on the Greater and Lesser Caucasus, however due to the existing anthropogenic impact, decrease of which should not be expected in the future, most probably the upper boundary will remain at the current level. In the Talish mountains, decrease of the upper boundary is expected to be 50-200 m, with up to 300 m in some places. Lower boundary of forest will rise up to 100-200 m. Share of different draught resistant tree and bush species will increase. Density and estimated productivity of the forests will decrease and as a result of it, wood stock will reduce. Mitigation measures imply afforestation of eroded mountain slopes, afforestation and binding of sands, rehabilitation of near-Kura tugay forests, etc.

Education and Public Awareness. Preparation of specialists according to scientific backgrounds of climate change is carried out in the Baku State University and environmental specialists are being prepared in many Universities of Azerbaijan.

However preparation of specialists on specific fields of climate change is not yet being carried out. Recently, relevant subjects associated with climate change problems have been included in the curriculums of some Universities.

Many specialists received training on various aspects of climate change during preparation of the First National Communication at the National Climate Change Center of the Hydromet. Some specialists received training at international workshops and training courses, including those organized by WMO.

Within the framework of preparation of the First National Communication of Azerbaijan to the Conference of Parties several workshops have been conducted, four scientific bulletins, information booklets, articles in scientific journals and in the newspapers have been published.

Findings of the researches have been reported at international and regional scientific conferences and workshops, meetings of the State Commission on Climate Change, and at the open Parliamentary hearing in the Milli Mejlis (Parliament of Azerbaijan). Many briefings have been conducted for the mass media, as well as radio and TV broadcasts have been organized on the problems of climate change.

INTRODUCTION

One of the factors of dynamic environmental changes under the ever growing anthropogenic impact is the climate change, of which scientists and experts were warning in 1950-1960s. Considerable increase of greenhouse gases (GHG) concentration in the atmosphere has affected the radiation balance of the Earth, which may result in the global increase of the temperature. Climatic events of recent years show that the process is already underway and potentially may result in such irreversible consequences as melting of polar glaciers, world ocean level rise with flooding of vast coastal territories, change of climatic belts, redistribution of precipitation, etc. The ongoing warming process directly threats the world environment and social-economic development of the world civilization.

Understanding the reality of this threat, about 150 countries of the world signed in 1992, the UN Framework Convention on Climate Change (UNFCCC), and in 1997, the Kyoto Protocol of the Convention.

The ultimate goal of the Convention is stabilization of greenhouse gases concentration in the atmosphere at a level which would prevent dangerous anthropogenic interference in the climatic system.

The Republic of Azerbaijan ratified UNFCCC on 10 January 1995. Being a non-Annex 1 party to the UNFCCC, the Republic of Azerbaijan has committed to develop, implement and publish national and regional programmes which would include mitigation measures.

Taking into consideration the vital nature of the problem, which requires a serious and integrated approach, State Commission on Climate Change has been established in Azerbaijan by the Presidential Decree of 30 April 1997. Composed of leaders of 18 ministries and other governmental institutions, the Commission has been entrusted to coordinate implementation of commitments made under the UNFCCC. The State Committee on Hydrometeorology (Hydromet) has been appointed a principal institution for conducting of studies. Financial assistance to the programme has been provided through the UNDP/GEF enabling activities project. The project “First National Communication of Azerbaijan to the Conference of Parties” has been implemented by the National Climate Change Center under the Hydromet and is aimed at bringing to the international community the information with regard to climate change in Azerbaijan. Activities under the project have been implemented in the following major directions:

- conducting inventory of anthropogenic emissions of GHG, which are not controlled under the Montreal Protocol, for the period of 1990-1994;
- assessment of measures on limitation of anthropogenic emissions of GHG in different sectors of national economy and development of a national policy in this field;
- studies of impact assessment and vulnerability of ecosystems and important sectors of the national economy, and development of mitigation measures against potential climate change effects.

1. GENERAL INFORMATION OF THE AZERBAIJAN REPUBLIC

The Republic of Azerbaijan is located at the crossroads of Europe and Asia. In the north, Azerbaijan borders with the Russian Federation, in the south - with Islamic Republic of Iran and Republic of Turkey, in the west - with Republic of Armenia and Republic of Georgia.

Total area of Azerbaijan is 86.6 thousand km^2. Length of the territory from north to south is 400 km, from west to east - 500 km. Baku is the capital city of the Republic.

1.1. Geographic Location, Climate and Natural Resources

Azerbaijan is located on the south-eastern part of the Caucasus. Territory of the country covers parts of the Greater and Lesser Caucasus, Talish mountains and the Kura-Araz lowland located between them. Average altitude is 384 m with drop of altitudes from 4,466 m (Bazar-Duzu pick) to minus 26 m in the Caspian coastal area. Plains and lowlands occupy 57%, of which 18% are below the level of the world ocean, low and middle mountains occupy 39.5%, highlands (over 2,500 m) occupy 3.5% of the country's territory. Territory of the country is seismically active and mud flows are quite frequent here.

Climatic conditions of the country are specified by its location at the boundary of temperate and sub-tropical belts. Depending on the altitude and remoteness form the Caspian Sea, several climatic types are identified: arid subtropical, humid subtropical, temperate and cold. Arid subtropical climate is characteristic of the Kura-Araz lowland and Apsheron peninsula, humid subtropical climate is characteristic of foothills of the Talish mountain and Lenkoran lowland. Temperate climate, which dominates on the slopes of the Greater and Lesser Caucasus, covered with forests, is divided to arid, temperate warm arid, temperate warm humid, and temperate cold. Cold climate dominates in the high ridges and peaks of the Greater and Lesser Caucasus. Average annual air temperature varies between 14°C in the low lying areas and 0°C and below in the highlands. Average annual temperature in July in low lying areas is 25-27°C, in highlands it does not exceed 5°C; in January, it is 3-6°C and -3 - -5°C respectively. Absolute maximum reaches 43°C, absolute minimum is -30°C. Atmospheric precipitation is distributed unevenly. During the year, precipitation amount on the Apsheron coast is less than 200 mm. In foothills and middle mountainous belt, precipitation is 300-900 mm, with 1,000-1,300 mm on the southern slope of the Greater Caucasus and 1,200-1,400 mm in the Lenkoran-Astara zone.

Distribution of solar radiation over the country's territory is uneven and its magnitude varies between 130-160 $kcal/cm^2$ per year. Number of hours of sun shining during a year is 1,900-2,800 hours.

Annual average wind speed in the coastal areas is 5.4-5.8 m/sec, and in other regions it is 2.4-3.1 m/sec. Number of days with wind speed more than 8 m/sec on the Apsheron peninsula is 226, and 20-70 days in other regions of the country.

Water resources of Azerbaijan constitute 29.2 km^3 per year, of which only 7.5 km^3 are formed on the territory of the country, with the other 21.7 km^3 being formed beyond its boundaries. All rivers belong to the Caspian sea basin and constitute three groups: rivers of the Kura basin, rivers of the Araz basin, and rivers directly running into the Caspian sea. Water provision of the territory is low and makes up 84 thousand m^3/km^2.

There are 450 small and middle lakes with total area of 394 km^2, and water stock of 0.89 km^3 on the territory of the country. A total of 38 water reservoirs with total area of 650 km^2 and water reserve of 19.6 km^3 have been constructed in Azerbaijan.

The Caspian sea is the greatest in the world enclosed water basin with the area of 400 thousand km^2, and water volume of 80 thousand km^3. Length of the Azerbaijan shoreline is 825 km. Coastal area is densely populated and intensively developed. About 40% of the population and major industrial potential of the country are concentrated here. Coastal area and sea bed are rich in oil and gas. The water basin has unique biological resources, including 90 % of the world sturgeon stock.

Top soil and vegetation of Azerbaijan is peculiar due to its variety. Main soil and vegetation belts are: desert and semi-desert belt of the lowland (salinized gray soils with mugwort and saltwort vegetation), semi-desert belt of foothills (gray-brown solonetz-like soils with mugwort - bush vegetation), mountainous forest belt (chestnut-brown and yellow soils with deciduous forests), high mountain subalpine-alpine and high mountain nival.

Flora of Azerbaijan consists of 4,300 species of higher sporous and flowering plants grouped in 125 families and 920 genera. Total area of forest cover is 11.4% (989.5 thousand hectares), and territorial distribution of forests is very uneven. Greater Caucasus assumes 48.8% of forest cover, Lesser Caucasus - 34.2%, Talish - 14.5 %, Kura-Araz lowland - 2.5%, Nakhchivan Autonomous Republic - 0.5%.

Fauna includes approximately 18 thousand species and subspecies: 13 thousand insects, 1,100-arachnoids, 600 - vertebrates, 14 species of mammals. Among these, 36 birds, 13 amphibians and reptiles, 5 fish and 40 insects have been included in the Red Book as endangered species.

1.2. Social-Economic Characteristics

The Republic of Azerbaijan is a democratic legal state. On 28 may 1918, the Azerbaijan Democratic Republic was declared. After dissolution of the USSR in 1991, Azerbaijan again became an independent state.

According to the census of 1999, population of Azerbaijan is 7.95 million people. Average density of population is 91.8 people per km^2, with urban population being 52.7%, and rural 47.3%. About 60% of the population of Azerbaijan live on the territory lying below the world ocean level with high air temperatures. More than 30% of the population live on the Apsheron peninsula. Half of the urban population or 2.07 million people live in Baku. Able bodied population is 54.2%.

As of 1997, 47% of the population was engaged in the services sector, 33% - in the agriculture, 14% - in different branches of industry and construction, 6% - in transport and communications. Share of employment of the population in the private sector grows (Figure 1.1).

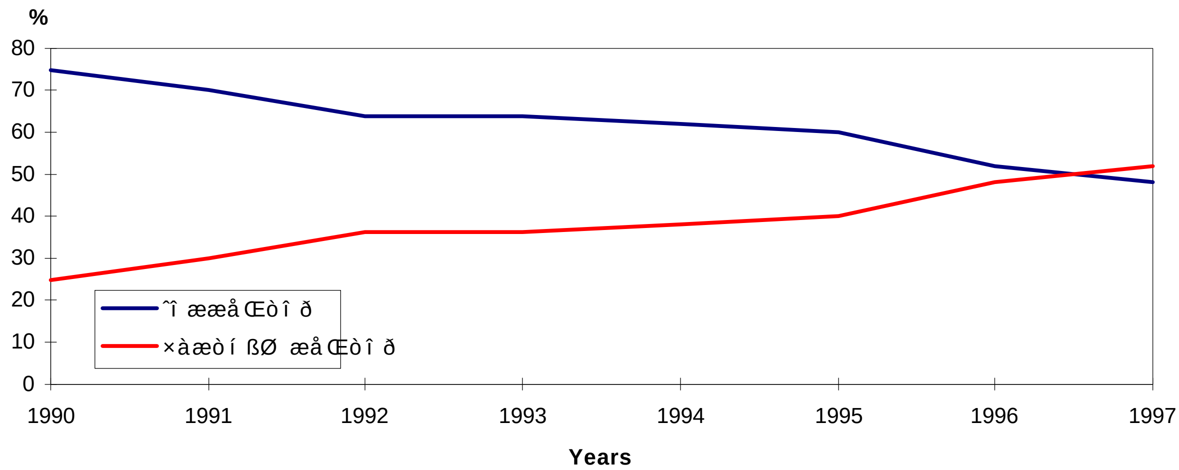

Figure 1.1. Population employment dynamics in the Azerbaijan Republic

Major sectors of economy of Azerbaijan are: fuel-energy industry, machinery construction, metallurgy, chemical and petrochemical, light and food industries, as well as agriculture. Its peak economy of Azerbaijan reached between 1985-1990. Comparative data of main economic indices of Azerbaijan are presented in Table 1.1.

Table 1.1. Main economic indices of Azerbaijan

Indicators	Years	
	1990	1998
1. Population number, million people	7.13	7.95
2. Population growth, %	19.60	9.50
3. Urban population, %	53.80	54.00
4. GDP, billion USD	8.60	3.98
5. GDP per capita, USD	1,206	500
6. Share of industry in GDP, %	39.0	22.30
7. Share of agriculture in GDP, %	23.0	20.30
8. Share of services in GDP, %	30.0	41.00
9. Share of construction in GDP, %	8.0	16.40
10. Main industrial output:		
a) electric power, billion kW-hour	23.03	17.76
b) oil production, million tons	11.51	11.45
c) gas production, billion m^3	9.93	5.57
d) oil refining, million tons	16.30	8.25
e) iron concentrate, thousand tons	501.00	6.60
f) aluminum, thousand tons	26.80	3.40
g) machinery complex, million USD	604.00	49.60
11. Agricultural output:		
a) cereals, thousand tons	1,414	947
b) cotton, thousand tons	543	113
c) tobacco, thousand tons	53	15
d) grape, thousand tones	1,196	144

e) cattle, thousand heads	1,832	1,896
f) sheep and goats, thousand heads	5,419	5,412
g) poultry, millions	29	13

After the collapse of the USSR, disruption of traditional economic links has very negatively influenced the social and economic situation of the country. This process has aggravated by unstable public and political situation and occupation of 20% of the country's territory, which provided up to 15% of GDP, great amount of refugees and IDPs (more than 1 million people) from the occupied territory of Karabakh and Armenia, as well as transport blockade and some other factors. All these caused deep economic crisis as a result of which GDP and other social-economic indicators have drastically reduced (see Figure 1.2).

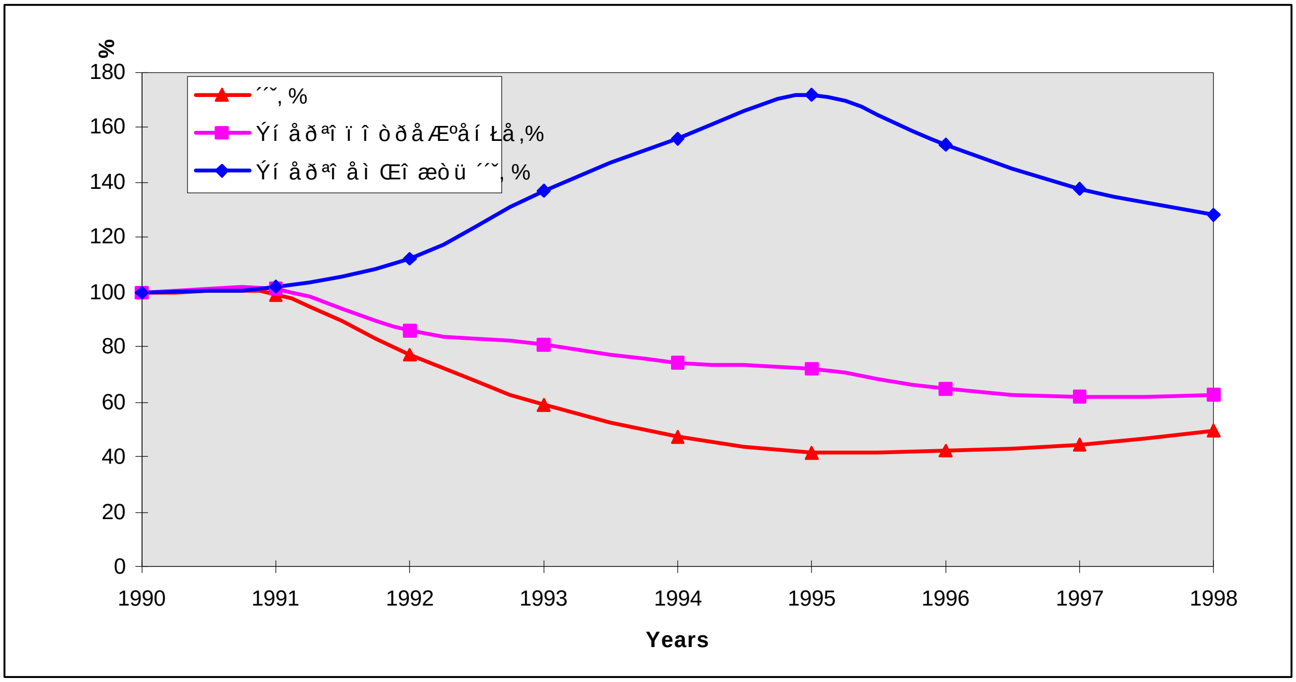

Figure. 1.2. Changes in basic economic indices during 1990-1998

As a result of achievement of political stability starting from 1995, broad scale economic reforms have become possible in the country. From mid 1996, the privatization process has started and today more than 57% of GDP is formed by the private sector. At the same time, Government of Azerbaijan has established firm grounds for inflow of foreign investments in the economy of the country, for undertaking of fundamental reforms on restructuring of state enterprises, and for strengthening of economic laws.

Between 1995-1998, 5.7 billion USD has been invested in the development of economy, including 4.0 billion USD of direct foreign investments, of which 2.3 billion USD has been invested in development of the oil sector and 1.2 billion USD in development of other branches of economy. For the time being, Government of Azerbaijan has signed 15 oil contracts with the leading companies of the world, total amount of which is 50 billion USD, to be delivered up to 2020.

Presently, growth of economy is basically due to non-productive sector and inflow of foreign investments in the oil and other sectors. Major fields, such as machinery construction, electric power generation, chemical, petro-chemical, and food industries are in a crisis because of very outdated technologies. Efficiency of raw material and energy use is very low in these fields and cannot be compared with similar industries in the developed countries.

Agriculture in Azerbaijan is multi-sectoral and is the second field of economy which provided about 25% of GDP during the period of its peak. The major crops of agriculture are cereals, cotton, vine, vegetables, fruits (including subtropical), melons, tobacco and tea. Total area of agricultural lands makes up 4,165.3 thousand hectares. Of this amount 1,351.5 thousand hectares (32.5%) belong to irrigated lands which provide more than 80% of agricultural output produced in the country.

Presently, agriculture of the country is in a deep crisis, which is associated with transition period, wherein state owned farms are being transformed in private ones. During 1991-1998, crop output has considerably dropped and area under crops has drastically reduced because of the lack of funds for purchase of mineral fertilizers, machinery, etc.

1.3. Energy sector

Energy sector of Azerbaijan includes production and refining of oil and gas, electric power and heat generation, energy storage and transportation systems.

Azerbaijan has great stock of energy resources of global significance. Main energy resources of the country are oil and gas. Because of the general crisis in the economy, share of oil sector in the overall industrial output has increased from 11.7% in 1990 to 51.7% in 1998.

Local needs of the country in oil products are provided by local resources. Acute crisis exists in provision of the population, industry, municipal-domestic and power generation sectors with natural gas, where local resources can meet only 50-55% of the total requirement. Natural gas till 1995 had been imported from Turkmenistan, and presently, deficiency is covered by furnace fuel oil produced in the country.

Total production of primary energy resources in Azerbaijan in 1990 made up 719.47 PJ. Comparative analysis of consumed energy in the economy of Azerbaijan for 1990 and 1994 by types of fuel is presented on Figure 1.3.

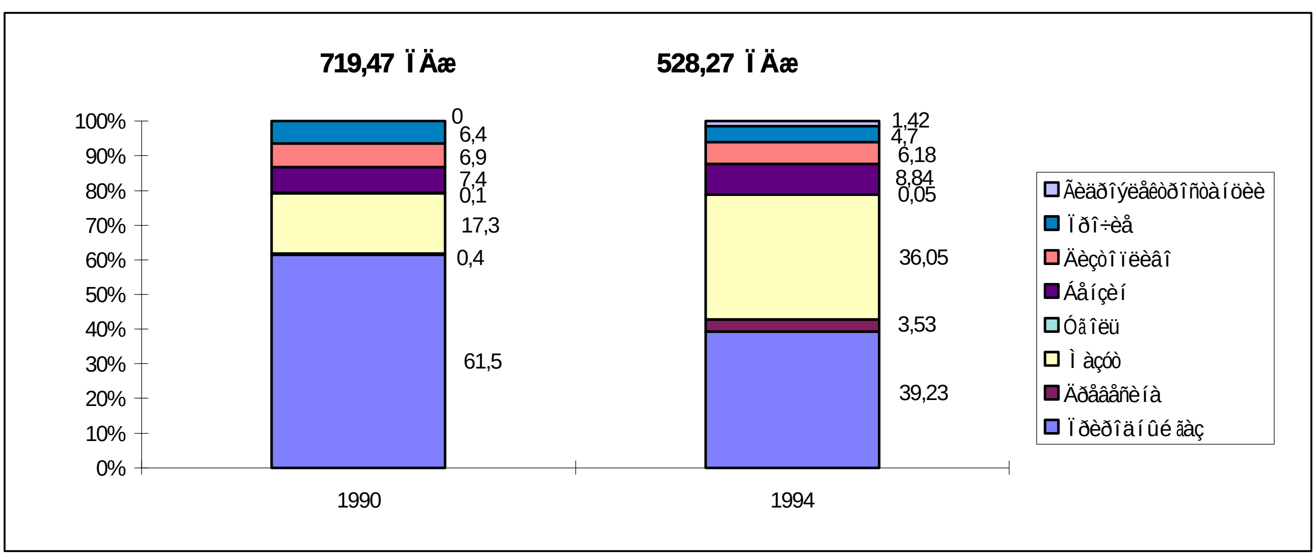

Figure. 1.3. Structure of energy resources consumption in Azerbaijan

As the Figure shows, share of consumed oil products has increased as compared with 1990, in particular, share of fuel oil has increased from 17% to 36% in 1994. Share of natural gas has reduced from 62% to 39%.

General balance of energy resources during 1990-1998 is presented in Table1.2. Natural gas and oil products are prevailing in the balance of energy resources.

Table 1.2. Balance of energy resources, PJ

Products	Years								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
Outputs									
Oil and condensate	526.00	494.02	466.25	433.42	402.28	394.71	389.24	433.84	481.82
Oil products	609.92	605.91	439.10	375.34	338.04	330.02	319.60	328.42	317.19
Natural gas	317.26	275.41	251.45	217.58	203.84	212.15	201.29	190.42	177.96
Timber	5.16	5.16	9.82	13.09	21.14	21.14	21.14	21.14	21.14
Electric power (HPP)	5.98	6.34	6.26	8.35	6.59	5.62	5.51	6.16	7.02
Roll-over residue (as of beginning of year)									
Oil and condensate	40.82	60.60	86.68	117.82	186.41	224.71	372.83	392.19	464.14
Oil products	19.25	67.37	92.23	103.06	87.42	71.38	74.19	81.00	95.44
Natural gas	47.29	99.05	214.38	136.11	42.17	62.94	31.31	50.48	63.58
Import									
Oil and condensate	180.94	197.78	67.33	50.50	29.46	2.52	-	10.94	3.79
Oil products	1.20	0.40	0.40	0.00	5.61	0.40	0.40	0.40	0.40
Natural gas	429.41	447.30	146.33	78.60	75.40	18.53	-	-	-
Coal	0.44	0.02	0.00	0.15	0.30	0.02	0.00	0.00	0.00
Electric power	6.30	5.69	1.62	-	1.94	3.24	3.67	5.90	3.24
Export									
Oil and condensate	-	-	-	-	-	-	-	12,20	130,87
Oil products	290,73	281,10	124,31	78,20	68,17	75,39	76,19	95,04	90,23
Natural gas	173,17	191,38	175,73	146,97	51,44	1,92	-	-	-
Electric power	12,10	11,81	4,68	0,86	1,01	1,80	2,09	2,88	3,60
Consumption (including losses)									
Oil and condensate	687.16	665.70	502.43	419.53	393.44	375.35	366.93	363.57	347.16
Oil products	272.36	305.69	308.07	317.12	294.48	257.30	241.99	224.07	246.93
Natural gas	441.33	415.88	300.07	243.23	207.26	234.93	199.68	190.90	175.75
Coal	0.44	0.02	0.00	0.15	0.30	0.02	0.00	0.00	0.00
Timber	5.16	5.16	9.82	13.09	21.14	21.14	21.14	21.14	21.14
Electric power	0.18	0.22	3.20	6.70	7.52	7.06	7.10	9.18	6.66

Main fuel consumers in 1990 were electric power generation and processing fields (37%), industry (17%), transport (9%), commercial sector (15%), households sector (12%), agriculture and forestry (6%), and others (3%). Due to economic decline fuel consumption structure in 1994 considerably changed (Figure 1.4).

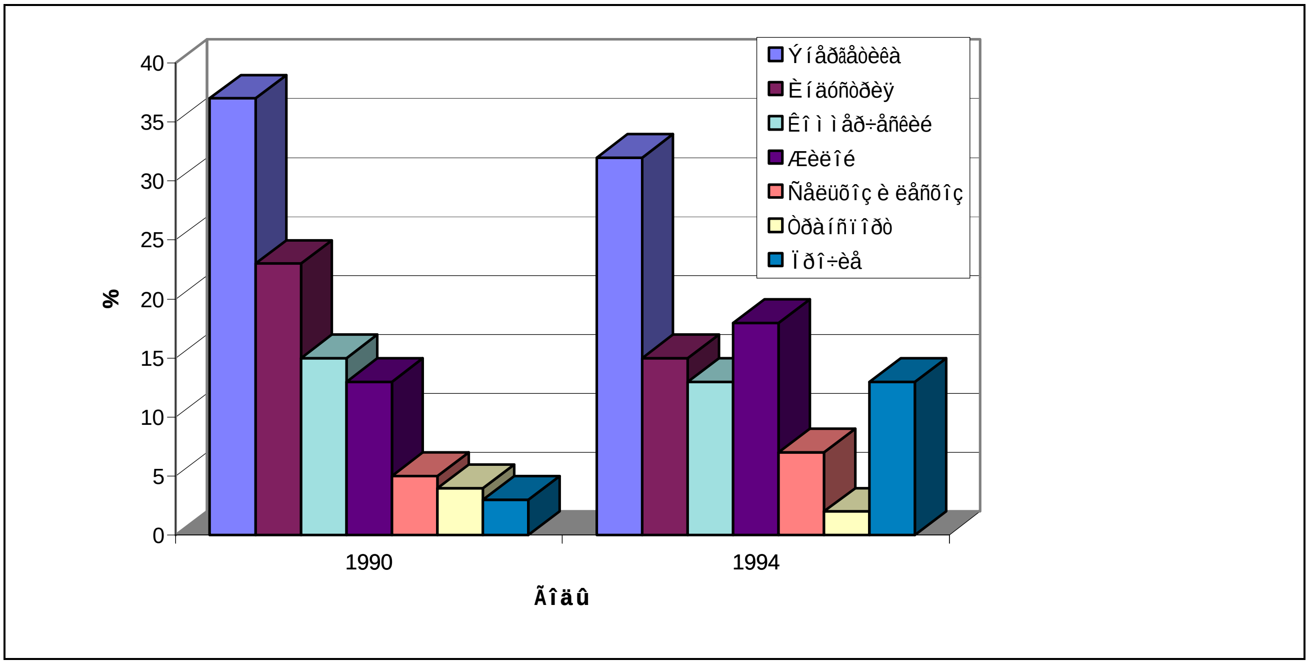

Figure 1.4. Fuel consumption structure by sectors of the economy

The electric power system consists of 9 thermal power plants and 4 large hydro-power plants with total capacity of 5,066 MW, of which 85% is the share of thermal and 15% of hydro power plants. Peak of power generation (23.1-23.4 billion kW-hour) falls on 1990-1991 (Table 1.3).

Table 1.3. Electric power generation and consumption dynamics in Azerbaijan during 1990-1995, billion kW-hour

	Years					
	1990	**1991**	**1992**	**1993**	**1994**	**1995**
Electric power generation, including:	23.06	23.36	19.67	18.86	17.48	16.96
-thermal power plants	21.40	21.60	17.93	16.54	15.65	15.40
-hydro power plants	1.66	1.76	1.74	2.32	1.83	1.56
Import	1.75	1.58	0.45	0.00	0.54	0.90
Export	3.36	3.28	1.30	0.24	0.28	0.50
Consumption	21.45	21.66	18.82	18.62	17.74	16.36

At thermal power plants the main design fuel is natural gas and backup fuel is furnace fuel oil. However, currently because of crisis in supplies, natural gas is used for operating of only 20% of the capacity of plants, with the rest of capacity being operated with oil fuel (Figure 1.5). This results in the increase of GHG emissions.

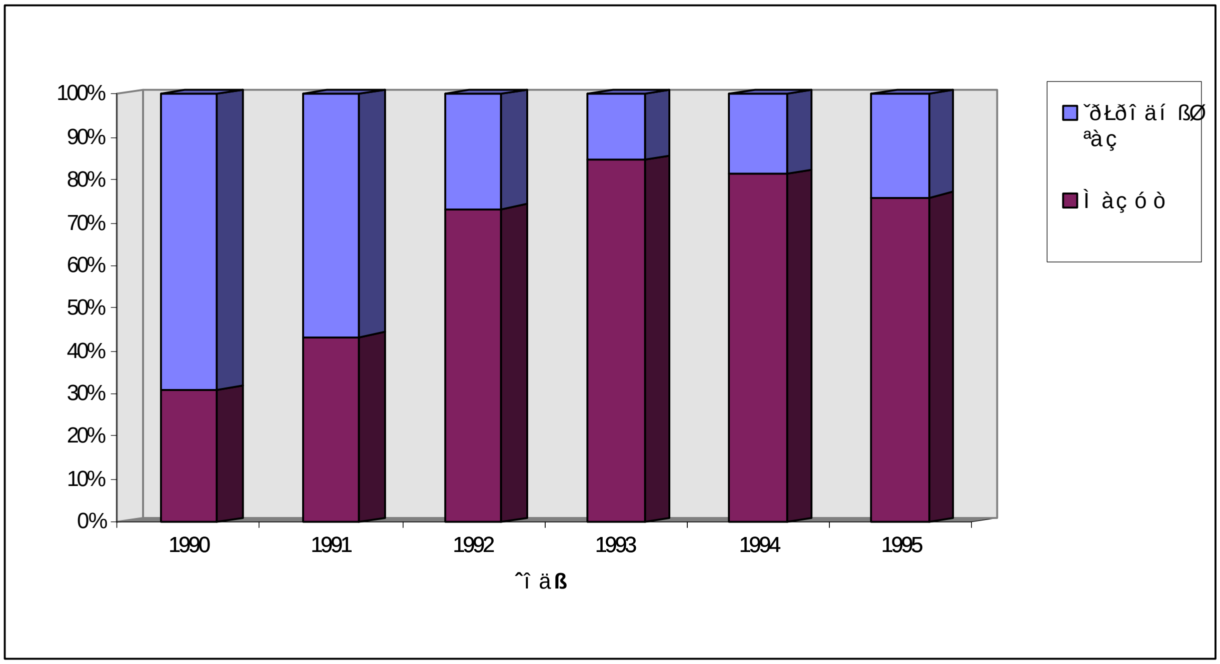

Figure 1.5. Dynamics of natural gas and fuel oil consumption at thermal power plants, (% of the total capacity)

Design capacity of thermal power plants in 1990 was 5,066 MW (Table1.4). Use of physically outdated technologies and furnace fuel oil has resulted in the decrease of technical and economic specifications. Thermal power plants according to characteristics of the installed equipment are designed for base load operation, however because of the lack of peaking operation capacities, plants have to operate in semi-peak regimes, which decreases reliability and efficiency indicators of the energy system. As a result, efficiency coefficient of plants has reduced from 66.9 % in 1990 to 41.9 % in 1994.

Capacity of hydro power plants is 804.2 MW (Table 1.4), with plants at the major rivers Kura and Araz constituting 744.5 MW. Presently, construction of one more power plant at the Kura river with capacity of 140 MW is being completed.

Table 1.4. Structure of Generating Capacity of Power Plants in 1990, Ì W

	Design capacity	Available capacity
Thermal power plants, condensate	3,600	3,135
Thermal power plants, gas-turbine	60	30
Thermal power plants, large	592	340
Thermal power plants, small	10	5
Hydro power plants	804	721
Total	5,066	4,231

Heat in the cities of Azerbaijan is supplied through industrial and heating thermal power plants, heating boilers and apartment heat generators. Equipment at thermal power plants and boilers is typically obsolete. Very difficult situation has established at thermal mains because of their low reliability, bad thermal isolation, and low efficiency of heat supply systems. Therefore, heat generation has reduced almost 5 times as compared with 1990 (Figure 1.6).

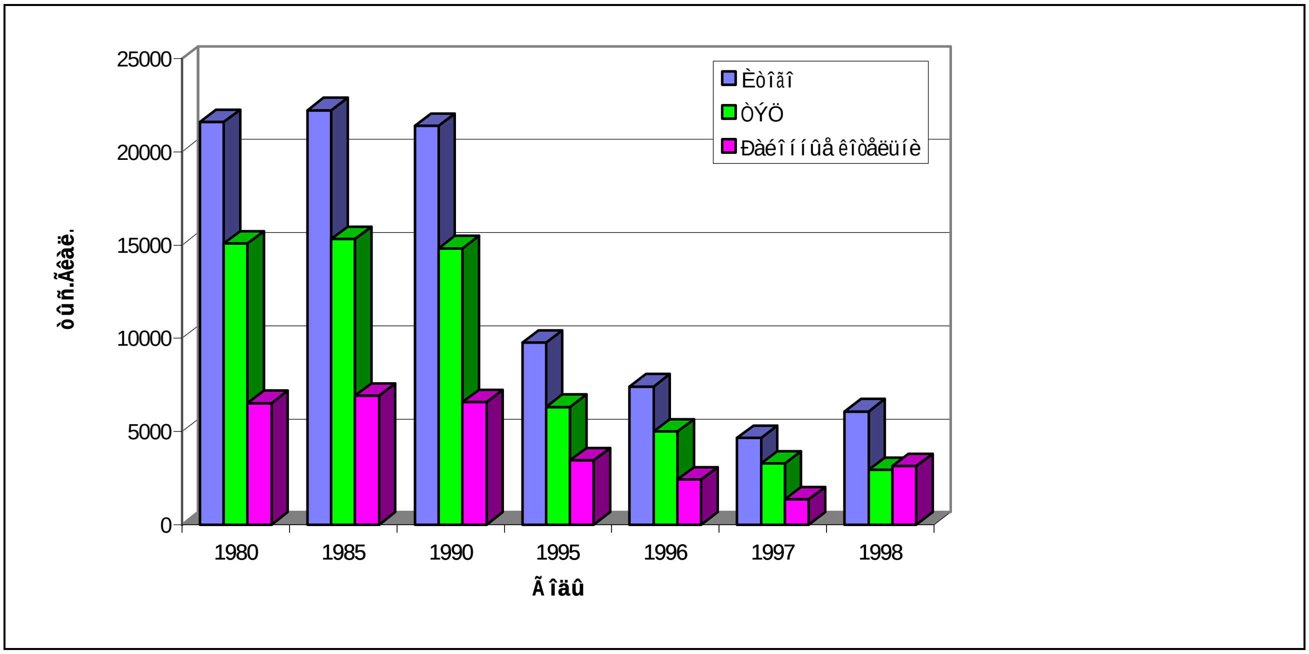

Figure 1.6. Heat generation in the Azerbaijan Republic

Losses of natural gas in the system of production, transportation and use of energy resources in 1990 made up 443 Gg, or 8% of the total natural gas production. Remoteness of power plants from consumption centers results in increase of losses of electric energy by 25-30 % of the generated amount.

2. INVENTORY OF GREENHOUSE GAS EMISSIONS AND SINKS

An important stage of studies on climate change is the conducting of national inventory of greenhouse gases anthropogenic emissions and sinks. National inventory builds a basis for further development and specification of methodology for estimating the sources and sinks of greenhouse gases. It provides a common and consistent mechanism enabling all countries to estimate their greenhouse emissions and their contributions to global climate change. Regularly updated inventory is a prerequisite for evaluating the cost-effectiveness and feasibility of implementation of relevant mitigation measures and abatement strategies in order to minimize the anthropogenic impacts on the climate.

The year 1990 is taken as a baseline for the National Inventory of greenhouse gases anthropogenic emissions. While conducting the Inventory, the coefficients set by the IPCC methodology have been followed [], with exception of the “Land-use change and forestry” category, where the national coefficients have been used. Inventory of emissions for the period between 1990 and 1994 has been carried out based on the governmental and ministerial statistics as well as on the expert estimations.

2.1. Total Emissions and Sinks of Greenhouse Gases

The main gases with direct greenhouse effect include carbon dioxide (CO_2), methane (Ñ$_4$), and nitrous oxide (N$_2$Î). In the atmosphere these gases may occur naturally and as a result of anthropogenic activities. Due to development of power industry and other industries, and vast forest felling areas, concentrations of CO_2, Ñ$_4$ and N_2Î in the atmosphere by the year 1992 had increased by 20%, 145%, and 3% respectively, as compared with the pre-industrial period [ ].

Such a growth in these gases concentrations for the short-wave length solar radiation (, however they absorb the long-wave radiation and re-emit the absorbed energy in all directions, which results in warming of the Earth's surface and lower layer of the atmosphere. This causes a so called "greenhouse effect". In addition, anthropogenic activity has resulted in appearance of greenhouse gases which deplete the ozone layer. These are chlorofluorocarbons (CFC_s), their substitutes hydrofluorocarbons (HFC_s) and perfluorinated carbons (PFC_S), which have not been observed in the atmosphere earlier.

There are other gases such as carbon monoxide (Ñ), nitrogen oxides (NO_{δ}) and non-methane volatile organic compounds (NMVOCs), that are not gases with direct greenhouse effect but indirectly contribute to greenhouse effect due to chemical reactions in the atmosphere. These gases are also included in the inventory.

In compliance with the IPCC Guidelines Azerbaijan National Inventory for Greenhouse Gases includes data on emissions of gases directly contributing to the greenhouse effect, such as carbon dioxide (CO_2), methane (Ñ$_4$), nitrous oxide (N_2O), as well as gases with indirect greenhouse effect, such as nitrogen oxides (NO_x), carbon monoxide (Ñ) and non-methane volatile organic compounds (NMVOCs). The "Industrial processes" category includes estimations of emissions for tetrafluorocarbon (ÑF_4) and hexafluoroethane (C_2F_6). SO_2 emissions have been estimated as well. Table 2.1 presents total emission of greenhouse gases for the period between 1990 and 1994.

Table 2.1. Total emission and sinks of greenhouse gases in Azerbaijan, Gg

Gas		**Years**				
		1990	1991	1992	1993	1994
CO_2	emission	44703	45647	40535	37330	33218
	net of sinks	-3509	-2670	-2205	-1878	-1075
CH_4		723	703	553	485	442
N_2O		3	4	3	2	2
NO_X		157	151	134	124	113
CO		119	116	134	141	174
NMVOCs		403	256	335	353	281
SO_2		59	61	59	56	48

Data on tetrafluorocarbon and hexafluoroethane emissions have not been included in the Table because of their insignificant amounts.

Total GHG emissions in Azerbaijan were 60.8 million tons in CO_2-equivalent in 1990, decreasing by 30% in 1994. Total GHG emissions in CO_2-equivalent were 8.5 tons per capita in 1990 and 5.9 tons per capita in 1994.

Sink of CO_2 for the "Land-use change and forestry" category was 3,509Gg in 1990. In 1994 this figure decreased by 70% due to felling of forests.

Distribution of emission of gases with direct greenhouse effect by category for the baseline year 1990 is given in Figure 2.1.

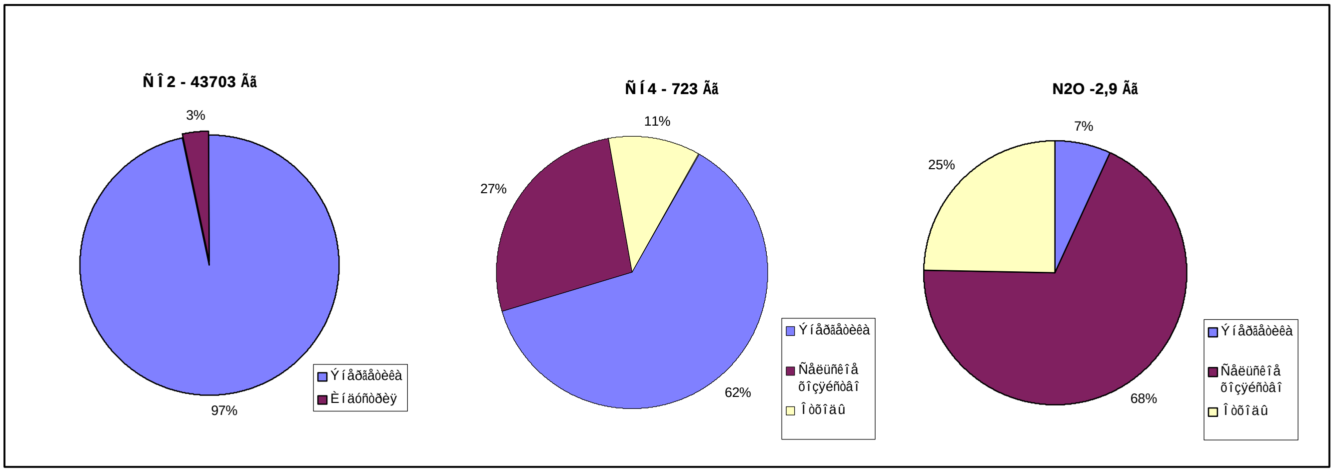

Figure 2.1. Distribution of emissions of gases with direct greenhouse effect by categories, 1990.

While conducting Azerbaijan's National Inventory of anthropogenic GHG emissions, following basic categories have been considered: "Energy", "Industrial processes", "Agriculture", "Land-use change and forestry" and "Wastes". The Inventory does not include emissions in the "Solvents" category due to lack of relevant governmental and ministerial statistics.

2.2. Carbon Dioxide Emission and Sink

Emissions of carbon dioxide, which is the main greenhouse gas in Azerbaijan, made up 73% and 77% of total GHG emissions in CO_2-eq in 1990 and 1994 respectively. The main CO_2 emission sources are the "Energy" and "Industrial processes" categories. In 1994, CO_2 emissions decreased as compared with the baseline year. This indicator was 76% in the "Energy**"** category and 28% in the "Industrial processes" category. Notable drop of CO_2 emissions in the "Industrial processes" category is associated with the crisis in the economy. Figure 2.2 demonstrates the amount of emissions and sinks of CO_2 for the period between 1990 and 1994.

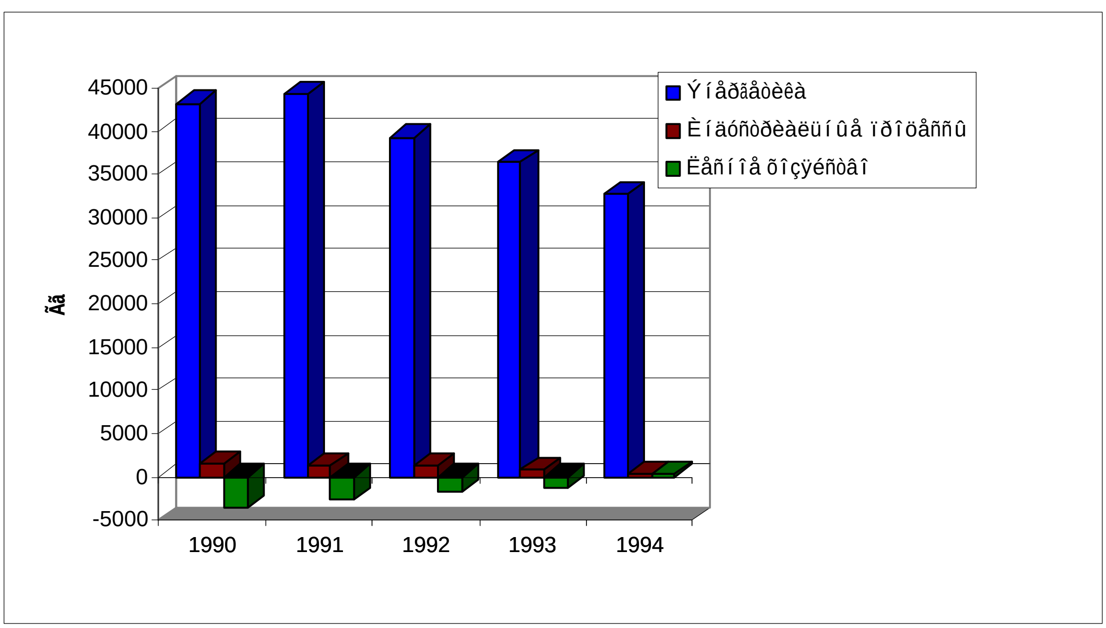

Figure 2.2. Emission and Sink of CO_2 in the Azerbaijan Republic

CO_2 emission in the "Energy" category

CO_2 emissions in this category result from activities associated with fuel combustion in stationary and mobile sources. In 1990, the share of CO_2 emission from these sources constituted 43,258Gg or 96.8% of total CO_2 emissions, while in 1994 it decreased by 24.2 % as compared with 1990 baseline year (see Table 2.2). In 1990 the major contributors to this amount were CO_2 emissions from natural gas (24,635Gg), petrol (3,634Gg), diesel fuel (3,622Gg) and fuel oil (9,532Gg). In 1994, figures for natural gas, petrol and diesel oil decreased by 53%, 12%, and 34% respectively, while share of fuel oil increased by 53%. This is due to reduction in supply of natural gas to the individual branches of economy.

Table 2.2. Contribution of different types of fuel to CO_2 total emission, Gg

Fuel type	Contribution to CO_2 total emission, Gg				
	1990	1991	1992	1993	1994
Liquid fuel	18582	21101	22535	22916	21210
Gaseous fuel	24635	23214	16769	13577	11569
Solid fuel	41	2	0	14	27
Total	43258	44317	39305	36507	32806

Inventory of CO_2 emission from fuel combustion is carried out for fuel processing and power generation, industry, transport, commercial sector, residential sector, agriculture and forestry and other sectors of the "Energy" category. Figure 2.3 demonstrates CO_2 emissions by sectors of this category calculated for the period between 1990 to 1994. Aggregated contribution to CO_2 emissions from agriculture and forestry, commercial and residential sectors is given here as emission from "Other sectors".

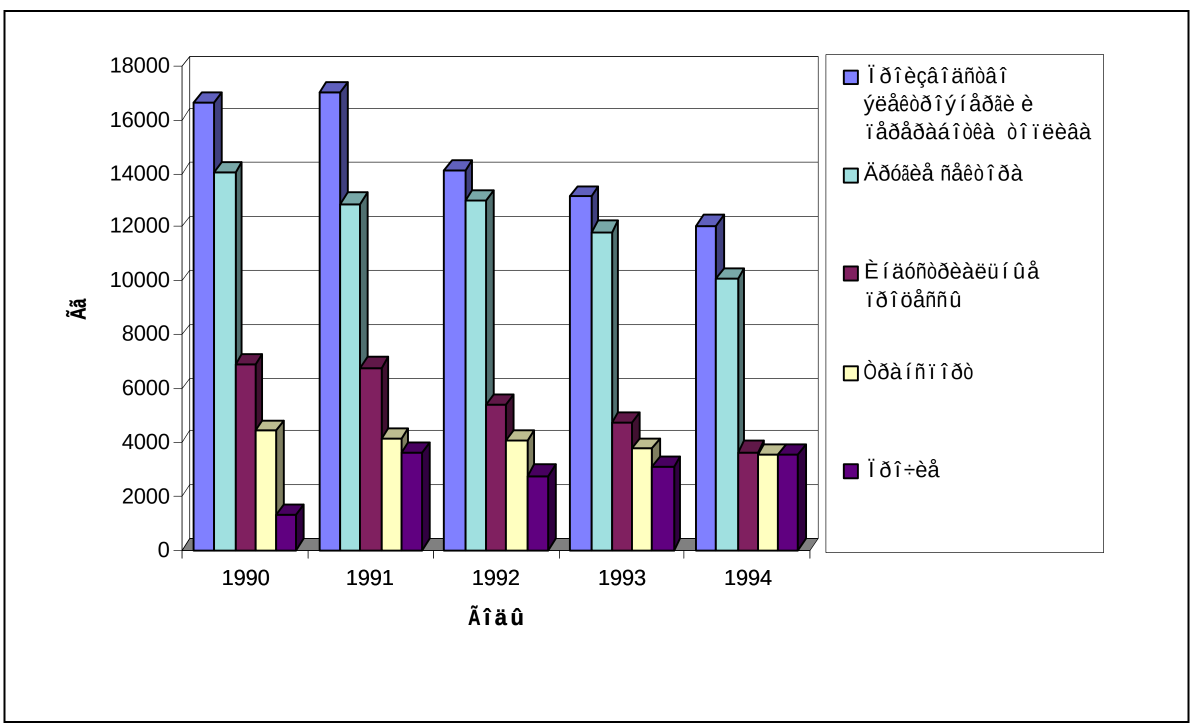

Figure 2.3. CO_2 Emissions by sectors of the "Energy" category

In energy generation and fuel processing CO_2 emissions are mostly formed due to fuel combustion at thermal power plants. In the baseline year 1990, CO_2 emission made up 16,616 Gg. In 1994, this figure decreased by 27%. Its share in total CO_2 emissions made up 38% in 1990 and 36.8% in 1994. Because of stop of import and decrease of production of local natural gas, starting from 1992, furnace fuel oil has been predominantly used as combusted fuel at thermal power plants.

CO_2 emission from fuel use in the industry in the baseline year made up 6,886 Gg. In 1994, it decreased by 53% as compared with 1990. Share of Ñ$_2$ emission in this sector in 1990 was 16%, and in 1994 -8% of total emission in this category. In the industrial sector of the "Energy" category, because of the lack of statistical data on energy consumption by industrial branches, emission estimation has been conducted on the basis of total fuel consumption.

In Azerbaijan, broadly developed are motor, railway, marine and air transports. Mostly used fuels are petrol and diesel fuel. In addition, kerosene (aviation and domestic) and liquefied natural gas are used. CO_2 emission from the transport sector in 1994 decreased by 20% as compared with 1990. Table 2.3 shows CO_2 emissions by types of transport used in the Azerbaijan Republic.

Table 2.3. CO_2 Emissions from transport in the Azerbaijan Republic

Source	Years				
	1990	**1991**	**1992**	**1993**	**1994**
Air transport	148	162	159	144	164
Motor transport	3668	3524	3397	3176	3044
Railway transport	369	325	322	293	230
Marine transport	247	106	159	129	98
Total	4433	4118	4038	3742	3537

Comparative analysis of CO_2 emission by types of transport in 1990 and 1994 is shown on the Figure 2.4. As it is seen from the Figure, share of CO_2 emission has increased in air and motor transport.

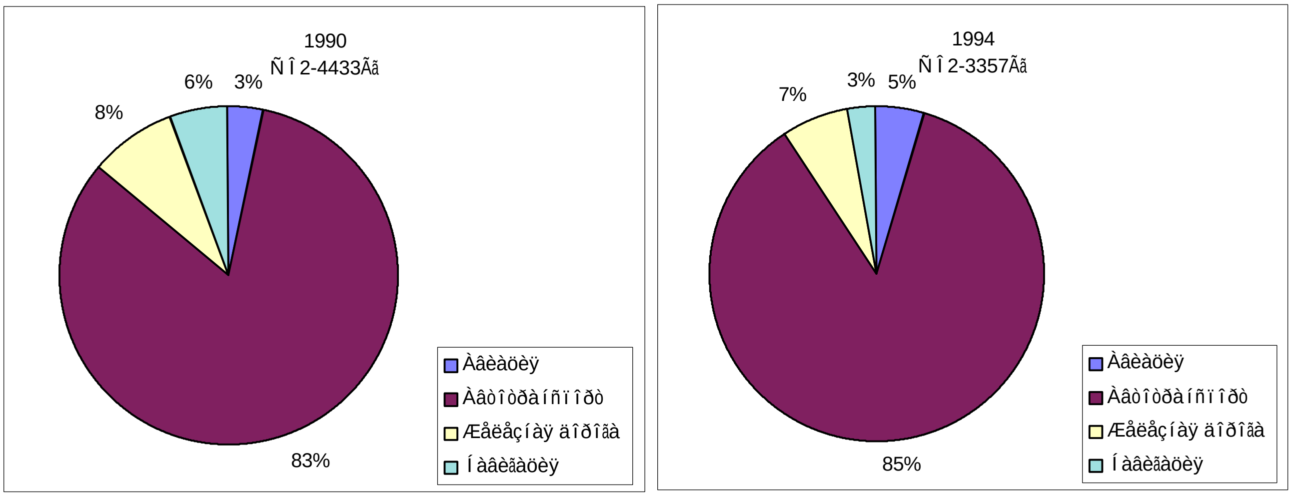

Figure 2.4. CO_2 Emission from transport in 1990 and 1994

CO_2 is emitted as a result of combustion of oil products, natural gas and timber, during heating of residential and commercial sectors. Under commercial sector non-residential administrative and public premises are implied. According to data of “Azerigaz” joint stock company, by 1990, 80% of residential buildings had been supplied with gas, and 20% consumed oil products and timber. In the non-residential sector, gas and furnace fuel oil are mainly used. In general, as compared with 1990, in 1994 energy consumption in the non-residential sector reduced by 39%, and increased by 2% in the residential sector.

On Figure 2.5. results of CO_2 inventory are presented from combustion of fuel in the commercial and residential sectors of Azerbaijan.

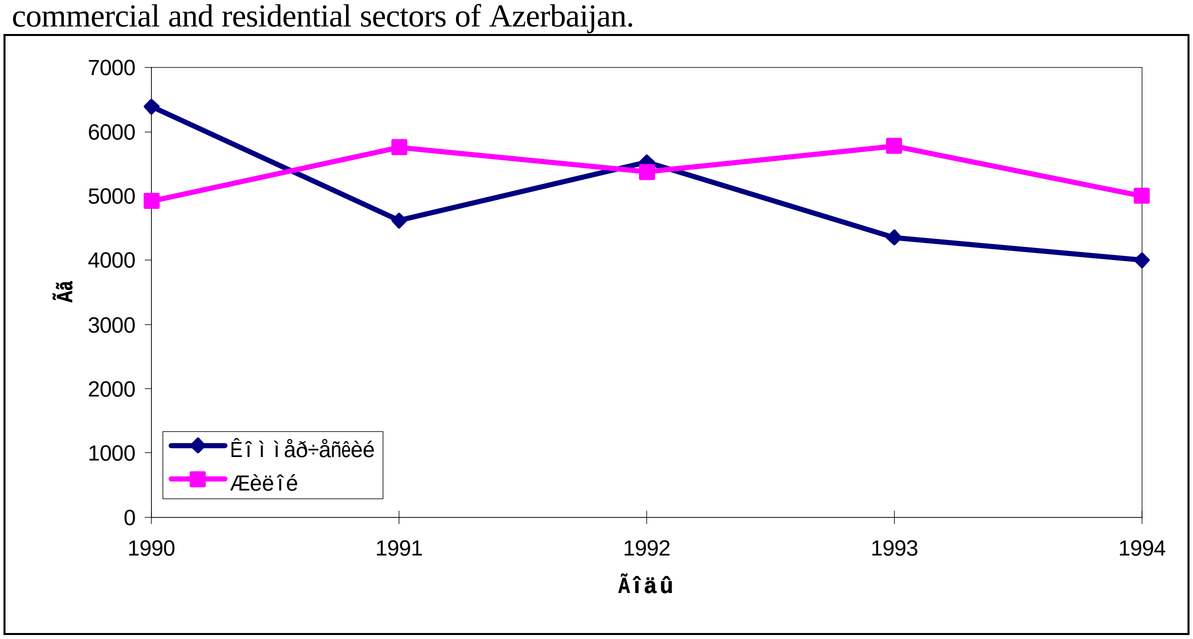

Figure 2.5. CO_2 Emissions in the commercial and household sectors of the “Energy” category

In the agriculture and forestry, CO_2 emissions come from the “mobile” (vehicles and combiners) and “stationary” sources, as a result of diesel fuel, petrol, kerosene, furnace fuel oil and natural gas combustion (Table 2.4).

Table 2.4. CO_2 Emission from agriculture and forestry, Gg

Emission source	Years				
	1990	**1991**	**1992**	**1993**	**1994**
Mobile	1766	1544	1418	1187	1016
Stationary	949	942	683	501	51

In 1990, CO_2 emission from "mobile" sources was 1,766 Gg. In 1994, this figure decreased by 42% due to restructuring of agriculture and forestry. In the stationary sources the main fuel was natural gas. By 1994, decrease in supply of natural gas to the stationary sources had resulted in reduction of CO_2 emissions by 95%.

The "Others" sector includes CO_2 emissions from the military-industrial complex as well as types of fuel which have not been considered in the previous sectors. In this sector, CO_2 emission in 1990 was 1,292 Gg, and in 1994 - 3,503 Gg, i.e. vis-à-vis 1990 it has increased by 2.7 times.

CO_2 emission in "Industrial processes" category

All activities not related with fuel consumption refer to industrial processes. In Azerbaijan, identified sources of CO_2 emission in this category are technological processes: production of non-mining materials and metallurgy.

CO_2 emisions in production of non-mining materials come from cement production, production and use of lime and soda. For calculation of CO_2 emission in cement production coefficient of emission is calculated based on the percentage of lime in cement (0.6783 tons CO_2/t of cement). Due to the lack of statistical data on the use of soda in 1991-1994, CO_2 emission has not been calculated. In the metallurgical complex, CO_2 emissions are formed from steel and aluminum production [ ].

Total CO_2 emission in 1990 made up 1,444Gg or 3% of total CO_2 emission. In 1994, due to the rapid decline in production CO_2 emission as compared with 1990 reduced by 71%. Data on CO_2 emission by individual branches of industry are shown on the Figure 2.6.

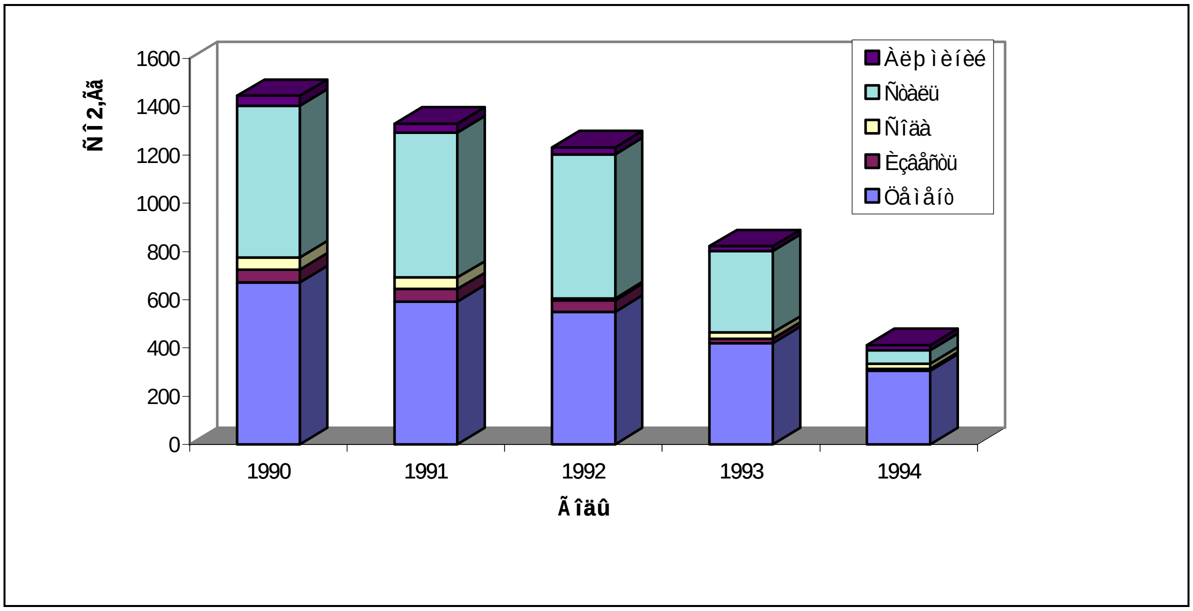

Figure 2.6. CO_2 Emission from industrial processes

CO_2 Emission / Sink in the "Land-use change and forestry" Category

In this category, the sources of CO_2 emissions are combustion of wastes in timbering and use of fire wood. Forests are natural sinks for CO_2 through the photosynthesis process. CO_2 emissions and sinks take place also with the land-use change.

In Azerbaijan, forests are mostly light, with incomplete stand and low productivity. Total wood stock in the forests constitutes 127.4 million m^3 with annual increase of 1.34 million m^3 or 1.67m^3 of wood per hectare in average. Azerbaijan forests are referred to those with middle-aged tree stand, and they have sequestered 43.7 million tons of carbon, with total annual sequester of 516.2 thousand tons or 0.6 t/hectare. CO_2 emission and sink in this category are summarized in Table 2.5.

Table 2.5. CO_2 emissions / sinks in the "Land-Use Change and Forestry" category, Gg

Source		Years				
		1990	1991	1992	1993	1994
Forests	emission	515	515	980	1306	2109
	sink	-2362	-2362	-2362	-2362	-2362
Net sink in forests		-1847	-1847	-1382	-1056	-253
Forest clearing		-822	-822	-822	-822	-822
Change in stock of mineralized soils (for 20 years)		-839				
Total		-3509	-2669	-2204	-1878	-1075

As indicated in Table 2.5, the volume of CO_2 sinks has decreased for the last years. In 1994 its total sink decreased by 69% as compared with 1990. This is due to stop in supply to rural areas of natural gas starting from 1992 and use of fire wood. According to expert estimations its amount constituted 351.38 thousand m^3 in 1990-1991; 668.46 thousand m^3 in 1992; 890.98 thousand m^3 in 1993 and 1438.74 thousand m^3 in 1994.

2.3. Methane Emissions

In Azerbaijan, methane emissions during 1990-1994 have been identified in the “Energy”, “Agriculture” and “Waste” categories. Results of estimations are given in Table 2.6.

Table 2.6. CQ emissions by category of sources for 1990-1994, Gg

Category	Source	Years				
		1990	1991	1992	1993	1994
Energy	Fugitive emissions	443,24	438,91	297,07	237,98	201,64
	Fuel combustion	4,79	4,85	6,12	6,92	9,10
Agriculture	Enteric fermentation	164,02	153,19	147,83	140,51	131,95
	Manure	29,95	27,44	30,01	28,22	26,47
	Rice cultivation	0,22	0,41	0,34	0,48	0,41
Waste	Solid domestic waste	64,15	64,60	65,59	65,59	67,04
	Industrial waste water	14,45	10,83	3,76	3,02	2,73
	Sewage	2,30	2,33	2,36	2,36	2,93
Total		723.00	703,00	553,00	485,00	442,00
Total in CO_2-eq		15183,00	14763,00	11613,00	10185,00	9282,00

The main sources of methane are leaks during in extraction, transportation and storage of oil and gas, fuel combustion and flaring, enteric fermentation and manure, rice cultivation, solid domestic wastes, municipal domestic and industrial effluents. In 1990, share of methane in the “Energy” category constituted 62% of total methane emission, of which 99% was the share of fugitive emission of methane, which is formed during extraction, transportation, storage and distribution of oil and gas.

It should be noted that during oil extraction from exploratory and production wells associated gas is released to the atmosphere. Methane emissions from this source has not been considered in this GHG Inventory.

Methane emissions in agriculture constituted 27%, out of which 84% is the share of enteric fermentation. Share of methane emission estimated for the “Waste” category was 11%, with the largest proportion falling on solid domestic wastes (79%). Analysis of data for the period between 1990 and 1994 revealed drop in emissions by 39%. For the reviewed period this drop is associated mostly with decrease in natural gas extraction and use, reduction in numbers of live-stock, and considerable decrease in amount of industrial waste waters.

2.4. Nitrous Oxide Emissions

In Azerbaijan, nitrous oxide emissions are less significant as compared with those of carbon dioxide and methane. Table 2.7.presents data on N_2O emissions in Azerbaijan for the period between 1990 and 1994. In 1990, major part of N_2O emissions came from "Agriculture" (69%), "Waste" (24%) and "Energy" (7%).

Table 2.7. N_2O emissions by category of sources, Gg

Source	Years				
	1990	1991	1992	1993	1994
Energy	0.21	0.20	0.17	0.25	0.26
Agriculture	1.97	2.84	1.61	1.20	1.12
Waste	0.72	0.72	0.73	0.74	0.75
Total	2.9	3.76	2.51	2.19	2.13
Total in CO_2-eq	899	1166	778	679	660

In the agriculture, N_2O emissions are formed due to use of nitrogen and mineral fertilizers, decomposition of plant residue on agricultural soils. In 1994, nitrous oxide emissions decreased by 27% as compared with the baseline year.

2.5. Emissions of Gases with Indirect Greenhouse Effect and Sulfur Dioxide

Azerbaijan National Inventory includes emissions of the following gases with indirect greenhouse effect: carbon monoxide (CO), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), tetrafluorocarbon (CF_4) and hexafluoroethane (C_2F_6), as well as sulfur dioxide (SO_2). Emissions of tetrafluorocarbon (CF_4) and hexafluoroethane (C_2F_6) are insignificant. Figure 2.7 presents emissions of gases with indirect greenhouse effect and sulfur dioxide for 1990 and 1994.

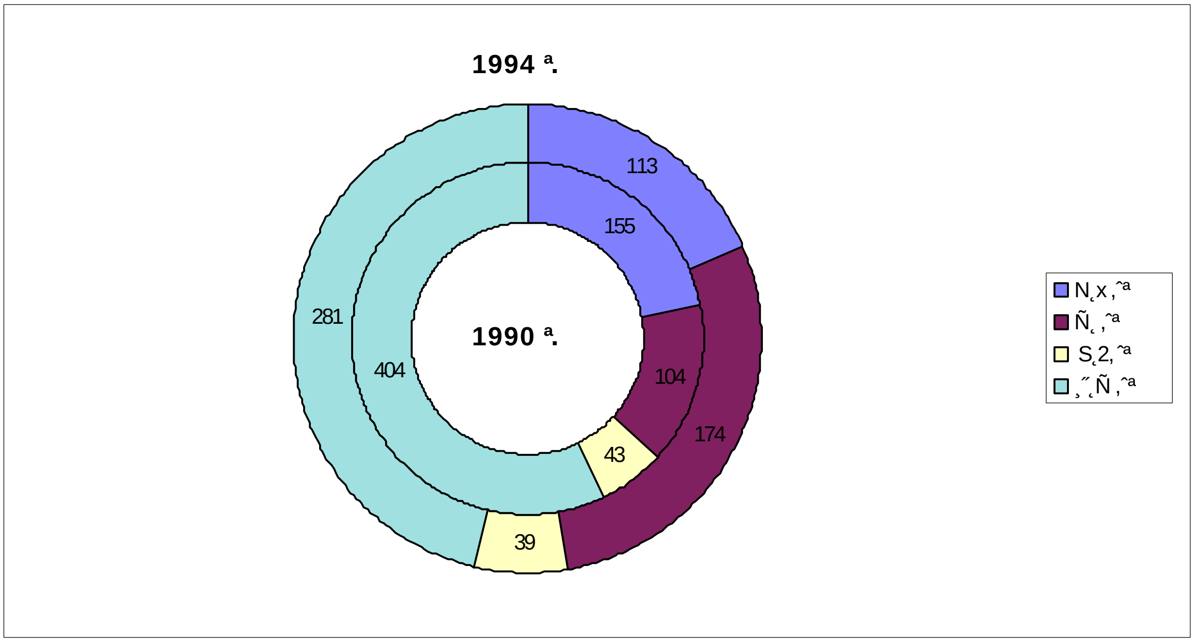

Figure 2.7. Emissions of gases with indirect greenhouse effect and sulfur dioxide

Results show that, as compared with 1990, in 1994 emissions of these gases decreased: for NO_x-by 27%; NMVOCs - 30%; SO_2 - by 10%; while emissions of CO increased by 67%. Increase in C O emissions amount is associated with the increase in biomass usage.

2.6. GHG Emissions from the International Bunker

This Section deals with GHG emissions from the international bunker which has not been included in the National Inventory's general emissions. These include air and marine transports which are refueled in Azerbaijan and leave the country. Among GHG emissions from the international bunker the largest is the share of CO_2 (see Figure 2.7). In baseline 1990 year, share of CO_2 emissions from international air transport constituted 94% of total emissions from the international bunker. Analysis shows that CO_2 emissions in 1994 increased by 8% as compared with 1990. This is due to increase of international airlines following the regaining of independence of Azerbaijan. CH_4, N_2O, and NMVOCs emissions are insignificant. Volumes of NO_x emissions for the period under review were 2-3Gg, and those of CO emissions were almost stable constituting about 1Gg.

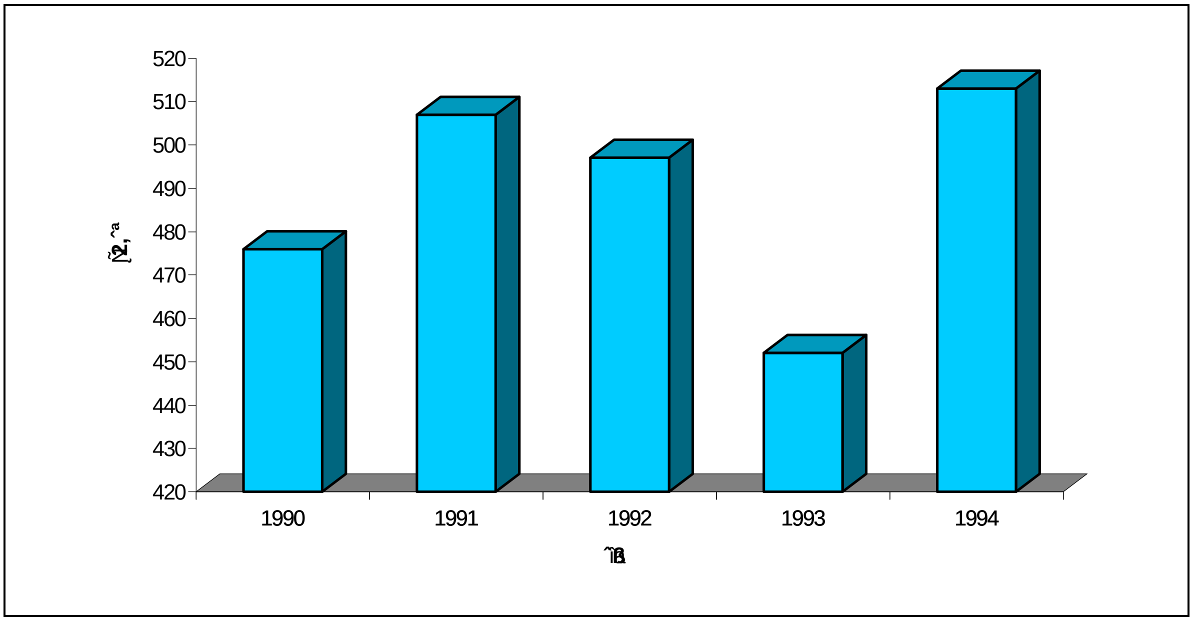

Figure 2.7. NO Emissions from the international Bunker

2.7. Estimation of Uncertainties

GHG Inventory includes estimations of uncertainties for the most important categories and total GHG emissions. Uncertainty intervals for input data, coefficients and estimations of emissions are identified in each category.

Input data for estimation of CO_2 emissions from fuel combustion have been provided by official statistics. Balance of real fuel consumption, use of calculation of fuel consumption and their emissions determined high reliability of input data. According to estimations of national experts general uncertainty was 9-10%. Average uncertainty for CO_2 emissions by the “Energy” and “Industrial processes” categories has been 12%.

In the “Energy” category, uncertainty interval for CH_4 which is emitted in oil and gas extraction as well as their initial refining and distribution was 50%.

Uncertainty for methane emission estimations was 22% in the “Agriculture” category, and 100% in the “Wastes” category. High uncertainty in “Wastes” is associated with lack of accurate data on sites and storage conditions of solid domestic wastes.

Uncertainty for estimations of N_2O emissions in agriculture was 2 orders of magnitude.

3. CLIMATE CHANGE FORECASTS AND MITIGATION MEASURES

3.1 Forecasts on Macroeconomic Development of the Republic of Azerbaijan

Several alternative scenarios of social-economic development of Azerbaijan up to the year 2025 have been prepared with consideration of the industrial, agricultural, regional, social and environmental development targets of the country [ ]. These scenarios envisage the following:

- consistency of the macroeconomic stabilization policy (budget deficiency, inflation rate, development of the securities market);
- completion of enterprises restructuring with their subsequent privatization;
- attraction of foreign investments for radical modernization of electric energy system, oil refinery, machinery, metallurgy, chemical and light industries, as well as construction materials production enterprises;
- modernization and development of the transport system within the TRACECA programme;
- economic growth by no less than 5% a year;
- increase of the export potential through development of export-oriented productions in the major fields;
- increase of effectiveness in the use of energy resources through introduction of scientifically sound technologies and reforming of the communal services;
- development of legislative and other regulative documents with consideration of strategic and economic interests of the country;
- strengthening the policy of integration in the international economic community.

Prospects for further development of the economy of Azerbaijan have been considered with the experts of the World Bank, European Expertise Service**.** The principal plan envisages that future economic policy of the country would aim at maximal involvement of four segments in the economic turnover of the country:

- industrial potential based on the local energy and mineral resources, and oriented at provision of needs of the local market, as well as considerable increase of the export potential not only due to oil but also due to the machinery, ferrous and non-ferrous metallurgy, chemical, petrochemical and light industries products;

- transit capabilities of the country in line with implementation of the large TRACECA programme, where 32 countries of the Europe and Asia participate and Azerbaijan will be playing a key role linking East with West. This transport corridor economically is the most efficient among all existing ones, and the amount of cargo flow through Azerbaijan in the next 25 year will increase by 10-15 times;

- agricultural potential of the country through implementation of the ongoing land reform, which gives rural people right to acquire land free of charge, buy and sell land through support programme of the government, which allows to rapidly reduce dependence on import of agricultural products and promote food security in the country;

- use of the potentials of the country's regions through encouragement of capital investments in creation of new productions, working places and infrastructure.

Due to transition to the market economy, there are some factors which will hamper general development of economy in Azerbaijan. These are:

- existing military and political situation in the region and unsolved problem of refugees and IDPs (about 1 million people);

- international market situation;

- investment process activation level;

- extreme unforeseen circumstances (force major).

With consideration of above mentioned strategic targets and assuming sustainable energy supply in the country, accelerated pace of economic reforms, and further development of investment process, two scenarios have been identified for economic development of Azerbaijan up to the year 2025: baseline and optimistic. Both scenarios are based on experts estimations and imitation-assessment mathematical models, which have been developed at the National Climate Change Center. Elaborating the scenario for development of the economic sector, such factors as country's natural resources, scientific-technical potential, situation on the world market, etc. have been taken into consideration. Both scenarios envisage advanced development of fuel-energy, petrochemical, mining and metallurgical industries. Principal difference between these two scenarios is the speed of development of the economy's individual sectors, as well as scope of measures required for development of these sectors, i.e. introduction of new technologies, modernization and reconstruction of facilities. Baseline scenario envisages relative lag in development of machinery, light industry, construction and agriculture.

Both scenarios envisage high investment activity which already in 1998 exceeded its 1990 level by 2.3 times. Investment prospects in basic sectors of economy for the nearest 25-30 years are also known, as already in 1994-1998 the Government of Azerbaijan signed a number of long-term agreements with the leading companies of the world on extraction of oil and gas and development of petrochemical industry, power system and transport. In line with scenarios of economic development for the period under consideration, targets to be achieved by the year 2025 are presented on Table 3.1).

Table 3.1. Basic macroeconomic indicators in Azerbaijan for the period up to 2025

Indicators	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Baseline scenario								
GDP, %	100	41.8	48.3	104	195	250	300	350
Population, million people	7.13	7.49	8.06	8.35	8.64	9.06	9.48	9.96
Fuel consumption, %	100*	72*	56	94	116	133	146	152
Energy intensity of GDP, %	100	172	116	90	59	53	49	43
Investment in economy, %	100	45.0	219	267	331	397	363	363
Optimistic scenario								
GDP, %	100	41.8	48.3	113	215	290	355	400
Population, million people	7.13	7.49	8.06	8.35	8.64	9.06	9.48	9.96
Fuel consumption, %	100*	72*	56	96	121	147	157	165
Energy intensity of GDP, %	100	172	116	85	56	51	44	41
Investment in economy, %	100	45.0	219	331	397	479	446	446

*including energy of coal, biomass and hydro-power energy

Table 3.2 presents changes in the GDP structure for the period up to 2025.

Table 3.2. Forecast on GDP structure for the period up to 2025

Indicators	Years								
	1990	1995	1998	2000	2005	2010	2015	2020	2025
GDP structure by sectors, including:	100	100	100	100	100	100	100	100	100
Material production:	70.0		59.0	56.8	54	52	50	47.5	45
-industry	39.0		22.3	22.6	24.0	26.0	28.0	29.0	30.0
-agriculture	23.0		20.3	19.6	18.0	16.0	14.0	12.0	10.0
-construction	8.0		16.4	14.6	12.0	10.0	8.0	6.5	5.0
Non-material production:	30.0		41.0	43.2	46.0	48.0	50.0	52.5	55
-transport and communications	4.0		12.9	13.0	14.5	15.5	16.5	17.5	18.5
-trade			5.7	5.7	6.5	7.0	7.5	8.0	8.5
-other services	26.0		22.4	24.5	25.0	25.5	26.0	27.0	28.0

In the GDP structure, an increase is expected in the shares of industry, services and transport.

Forecast on Fuel-Energy System Development

Oil and Gas Industry. Development prospects for oil and gas industry are associated with rehabilitation of existing and development of new oil and gas fields with support from foreign investors. An important place in development policy of oil and gas production industry is given to development of offshore oil fields in the Azerbaijan sector of the Caspian, located at 80-350 m depths. Development of these fields will provide for independence of the country in terms of fuel-energy supply by the year 2010, which implies complete provision of local demand and increase in export potential. Anticipated levels of oil and gas production for the period up to 2025 are given in Table 3.3.

Table 3.3. Forecast on oil and gas extraction up to the year of 2025

	Years								
	1990	**1995**	**1999**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**
Oil extraction, million tons									
Overall	11.50	9.16	12.03	13.66	27.72	48.70	50.50	52.50	55.00
onshore			1.60	1.60	1.60	1.60	1.65	1.70	1.70
offshore			10.43	12.06	26.12	47.1	48.35	50.8	53.3
Gas extraction, billion m^3									
Overall	9.93	6.64	6.48	6.45	13.4	17.50	20.6	22.8	25.6
onshore			0.20	0.20	0.2	0.20	0.3	0.3	0.4
offshore			6.28	6.25	13.2	17.30	20.3	22.5	25.2

By 2025, the amount of investments both domestic and foreign, for rehabilitation and development of oil and gas extraction industry will reach 55-60 billions USD.

Further development will be given to the oil and gas pipeline system, which would provide delivery of oil from Azerbaijan and transit hydrocarbons from Kazakhstan and Turkmenstan to the world markets. The most probable route of the main pipeline is the one that goes through territories of Georgia and Turkey to the Black and Mediterranean seas.

In order to rehabilitate and improve local gas transportation system replacement of most corrosive sections of the distribution net (up to 1,000 km), reconstruction and expansion of underground gas storage facilities, and modernization of gas regulating and gauging stations are being projected. By 2025, the amount of investments in gas system is estimated at 350-400 millions USD.

Development of oil-refining industry will be based on the up-to-date technological units of little energy-intensity. By 2005, anticipated amount of investments in oil-refining industry is estimated at about 200 millions USD. At the same time, volumes of refined oil may reach 15 million tons in 2005 and 30 million tons in 2025 (see Table.3.4).

Table 3.4. Forecast on oil product outputs up to 2025, million tons

Products	Years								
	1990	1995	1998	2000	2005	2010	2015	2020	2025
Oil refining	16.33	8.92	8.25	9.00	15.00	18.00	22.00	25.00	30.00
Petrol	2.010	1.04	0.837	0.913	3.00	3.80	5.00	5.60	6.70
Diesel fuel	3.899	2.19	2.042	2.226	4.90	6.50	8.30	9.40	11.30
Jet engine fuel	1.285	0.51	0.524	0.571	0.70	1.10	1.30	1.50	1.80
Kerosene	0.024	0.095	0.172	0.187	0.20	0.25	0.40	0.50	0.60
Oils (lubricants and motor oils)	0.818	0.126	0.082	0.156	0.26	0.30	0.50	0.75	0.90
Oil asphalt (bitumen)	0.146	0.05	0.025	0.027	0.16	1.00	1.20	1.60	1.90
Coke	0.166	0.004	0.030	0.033	0.05	0.10	0.20	0.25	0.35
Fuel oil	6.853	4.22	4.202	4.551	5.25	4.50	4.70	5.00	6.00
Total	15.20	8.23	7.914	8.664	14.52	17.55	21.60	24.60	29.55

Power system and heat supply. Development of power system and heat supply in Azerbaijan envisages increase of energetic efficiency through phasing out and reconstruction of outdated technologies, increase in the share of combined power and heat generation, decrease of condensed power generation during less intensive periods of energy consumption. The strategy of power and heat supply system development in the country [ ] will target the following problems:

- shift from construction of large thermal power plants to construction of middle and small power units on the basis of steam-gas and gas-turbine plants;

- gradual dismantling of the worn out equipment at thermal power plants (up to 30% of total capacity);

- replacement of the worn-out facilities at the Mingechevir HPP, upgrading its design capacity to 420 MW;

- increase in the share of hydroenergy resources in the energy balance to 25% with priority given to small and micro HPPs for collective and individual use;

- construction of wind power plants at the Apsheron peninsula and Nakhchivan with capacity of 15-20 MW;

- maximum possible provision of TPPs with natural gas and improvement of technical, economic and environmental characteristics of gas-oil plants due to use of gas-turbine units;

- technical modernization of the distribution net and reorganization of management structure of power system in accordance with transition to market relations;

- technical modernization of heat-electric plants and boilers and their provision with natural gas;

- rehabilitation of heat supply lines and reorganization of management structure in the heat supply system;

- use of solar energy and energy of geothermal waters for heating, hot water supply, and air conditioning.

Forecasts on growth in design capacities and in electric power generation for the period up to 2025 are presented in Table 3.5 and Table 3.6 respectively.

Table 3.5. Forecast on power generating capacities up to 2025, MW

Technology	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Thermal power plant (TPP)	3688	3165	3945	4135	4175	4175	4175	4175
Thermoelectric power plant (TEP)	345	345	345	345	415	415	415	415
Hydro-power plant (HPP)	787	721	926	976	976	1147	1557	1857
Non-traditional	-	-	-	30	60	80	100	120
Total	4820	4231	5216	5486	5626	5817	6247	6577

Table 3.6. Forecast on power generation and consumption up to 2025

Years	Design capacity, MW				Output, billion kW/hour	Local consumption, billion kW/hour	Export, billion kW/hour
	Overall	TPP	HPP	non-traditional			
1990	4820	4033	787	-	23.03	23.03	-
1995	4231	3510	721	-	16.90	16.49	0.41
2000	5216	4290	926	-	21.50	20.95	0.55
2005	5486	4480	976	30	26.50	24.00	2.50
2010	5626	4590	976	60	27.00	24.09	2.91
2015	5817	4590	1146	80	27.64	24.64	3.00
2020	6247	4590	1556	100	28.56	25.56	3.00
2025	6577	4590	1856	120	29.52	26.52	3.00

Above presented data show that by 2025, share of HPPs will increase by up to 28% as compared with 1990 due to the HPPs incorporation into the energy system of the country; and starting from 2025, there will be an intensive use of non-traditional energy sources. At present, construction of the Yenikend HPP design capacity of 140 MW is close to completion, and the work is underway on construction of two wind-energy power plants at the Apsheron peninsula and Nakhchivan with total capacity of 15 MW. Figure 3.1 illustrates forecast on generating capacities of electric power system up to 2025.

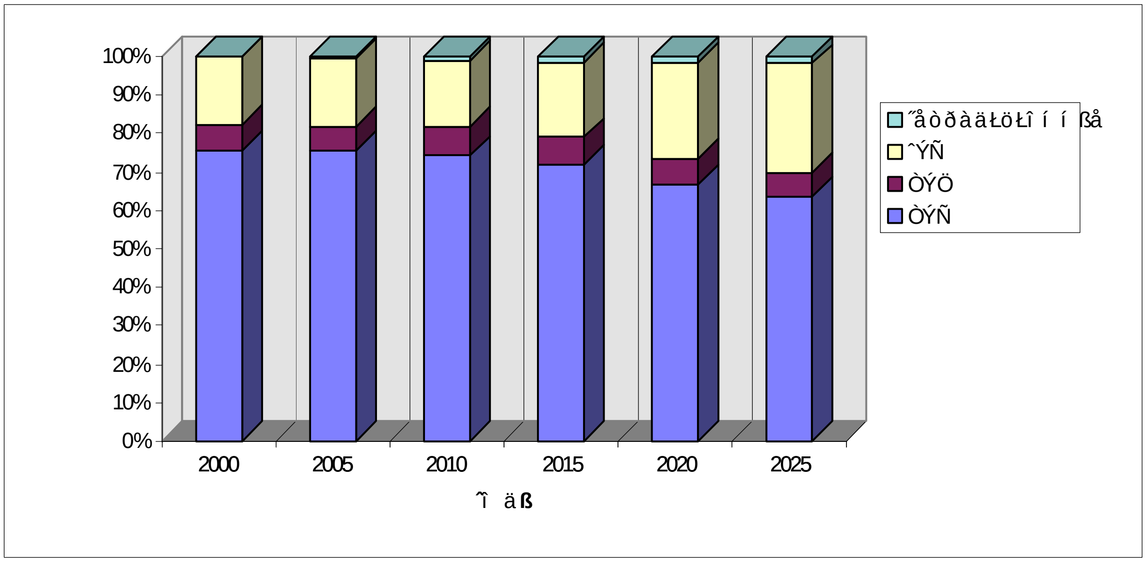

Figure 3.1. Forecast on development of generating capacities up to 2025

It is projected that local heat demand would be met through further expansion of district heating as well as use of small boilers and individual heat supply (Table 3.7). Natural gas is projected to be used as a basic fuel for these purposes.

Table 3.7. Forecast on heat generation up to 2025, million Gcal/year

Technology	Years								
	1990	1995	1998	2000	2005	2010	2015	2020	2025
TEP			2.93	5.1	14.8	24.0	25.1	26.0	26.8
District boilers			3.15	2.4	7.5	7.7	8.1	8.5	8.9
Total			6.08	7.5	22.3	31.7	33.2	34.5	35.7

Based on the forecasts of natural gas and furnace fuel oil outputs, growth in generating capacities and generation of electric power and heat, an estimation of fuel consumption at TPPs and TEPs has been made for the period up to 2025 (Table 3.8).

Table 3.8. Fuel consumption structure in the power generation industry up to 2025

Fuel consumption	Years					
	2000	2005	2010	2015	2020	2025
Fuel oil, PJ	118.50	128.71	108.5	77.89	53.25	-
% of overall	66.9	48.3	36.3	25.3	17.1	-
Natural gas, PJ	58.71	137.84	190.27	229.57	257.79	291.12
% of overall	33.1	51.7	63.7	74.7	82.9	100
Total, PJ	177.21	266.55	298.77	307.46	311.04	291.12

Forecast on Industrial Development

Industrial development policy will target the following problems:

- maximum possible provision of the country's demand in industrial outputs and reduction of dependence on the foreign market;
- rehabilitation and development of mineral resources processing industries, development of metallurgy, chemical and machinery industries, which have competitive advantages;
- restructuring, complete privatization and re-profiling of production capacities, and production of new items of outputs;
- encouragement of scientifically sound and resource-effective productions with consideration of the international market situation;
- optimization of location of production capacities of the country in order to ensure employment of the population and development of industrial infrastructure in the regions.

As compared with 1990, within the period up to the year 2025 ferrous metallurgy production increase is predicted to be 10-20 times, non-ferrous metallurgy - 1.3-4.1 times; in 2010, production of copper and polymetals is envisaged. By 2020, the amount of machinery production will have reached the level of 1990. Chemical and petrochemical industries will increase the amount of production for the local and international markets, as well as will provide production of the new chemical products and materials for provision of local demand.

In the machinery construction, in 2010-2025, achievement of qualitatively new level of development of production potential is planned, which will considerably meet requirements of the national economy. It is expected that new items of production will be launched (lorries, buses, vessels, electric appliances, agricultural and medical machinery) as well as previously exiting productions will be rehabilitated.

Azerbaijan has a potential to achieve maximum in production of light industry goods. During rehabilitation and use of overall production capacities export potentials of the field may account for 37-40%.

Forecast on the development of main items of industrial output is presented in Table3.9.

Table 3.9. Forecast on production of main items of industrial outputs up to 2025

Types of product	Years						
	1990	2000	2005	2010	2010	2020	2025
Rolling of ferrous metal, thousand tons	521.7	15.0	700	1600	2300	4300	5200
Steel, thousand tons	27.1	2.5	1000	2000	3000	5000	6000
Steel pipes, thousand tons	492.6	31.0	200	400	500	600	600
Aluminum, thousand tons	26.8	5.0	50	90	95	100	110
Rolling of non-ferrous metals, thousand tons	37.6	2.0	25	40	42	45	50
Polyethylene, thousand tons	493	80	120	120	150	150	150
Caustic soda, thousand tons	106	25	50	55	60	60	60
Phosphate fertilizers, thousand tons	150	20	35	50	80	100	120
Cement, thousand tons	990	400	2000	2400	2800	3200	3500
Machines, %	100	10.2	25.5	51.0	82.0	105	125

Transport

Stabilization of macroeconomic situation in the country, current growth and expected development of the country economy coupled with increasing strategic role of Azerbaijan as a transit state for trans-regional cargo flow through the North-South and West-East corridors - all these factors determine the development of transport system in the country.

As a result of implementation of a number of measures, all the types of transport will develop, with simultaneous changes in the structure of cargo flow.

Commissioning in 1999 the Baku-Supsa oil pipeline, proposed construction and commissioning of the main oil pipeline Baku-Tbilisi-Djaikhan (Turkey) as well as the Trans-Caspian gas pipeline will have increased the share of pipeline transportation in overall volume of cargo flow up to 40% by 2005.

At the International Conference which was held in Baku in 1998 on rehabilitation of the Historic Silk Road, 12 states have signed a principal multilateral agreement on Transport Corridor between Europe, Caucasus and Asia (TRACECA) [ ]. In accordance with this agreement, cargo flow through the territory of Azerbaijan will significantly increase.

Strategic task in development of transport infrastructure is the economy and rational use of fuel energy resources due to introduction of resource efficient technologies. In this regard, in the nearest years, it is planned to complete electrification of the railway transport and effectively use potentials of he marine transport.

In the motor transport, it is planned to undertake measures on regulation of import of used motor cars in the country, use of effective types of motor transport, and rationalization of the motor fleet structure for its effective use. By 1998, main state motor fleets had been privatized, customs duties had been increased for import of motor transport, purchase of old motor cars had become less cost-effective. Annually the number of motor cars operating on condensed gas is increasing.

Due to transition to market relations and in order to effectively use the motor transport, it is envisaged to optimize the structure of motor car fleet by tonnage and types of consumed fuel (Table 3.10).

Table 3.10. Dynamics of change in the structure of motor transport by types (thousand pcs.) and types of consumed fuel (%)

Types of motor transport	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Lorries, of them operating on:	100	79.7	68.7	80.0	105	164	201	232
petrol	78.7	78.5	76.7	70.0	62.0	56.7	51.0	44.0
diesel oil	19.5	20.3	22.0	26.0	30.0	33.0	37.0	40.5
condensed gas	1.0	0.9	1.0	2.5	5.0	7.0	8.0	11.0
compressed gas	0.8	0.3	0.3	1.5	3.0	3.5	4.0	4.5
Buses, of them operating on:	14.1	12.8	14.8	15.5	16.0	16.7	18.2	19.0
petrol	80.3	88.1	85.0	78.5	72.0	65.0	57.0	50.0
diesel oil	10.3	11.9	14.5	20.5	26.5	33.0	40.0	46.0
condensed gas	4.7	-	0.3	0.6	0.9	1.2	1.6	2.0
compressed gas	4.7	-	0.6	0.9	1.2	1.6	1.6	2.0
Motor cars, of them operating on:	260	278	286	395	680	1020	1300	1500
petrol	100	99.98	99.95	98.50	96.0	91.5	85.0	78.0
diesel oil	-	-	0.02	1.44	3.85	7.5	10.5	2.5
condensed gas	-	0.02	0.03	0.05	0.12	0.5	2.5	6.0
battery	-	-	-	0.01	0.03	0.5	2.0	3.5

Agriculture

Azerbaijan Republic has a considerable potential as a big producer and exporter of agricultural production. In the nearest future, agricultural development will be influenced by a number of constraints:

- lack of adequate agricultural infrastructure;
- shortage of private financial resources and unreliable supply of energy resources;
- decrease of productivity of lands because of the shortage of agricultural machinery and insufficient provision with fertilizers, chemicals, poor irrigation system;
- use of the outdated technology at processing enterprises;

- lack of reliable system of procurement, storage and selling of agricultural products.

Analysis of the situation on the agriculture shows that in the nearest 3-5 years rapid increase of the agricultural output is not expected. Strategic task of the agriculture is to solve financial-loan, tax, banking problems, as well as logistics issues, procurement and sell of agrotechnical and veterinary services [ ]. In this regard, it has already been decided to relieve agricultural producers from all taxes for 5 years, 2 times decrease energy prices, etc.

According to the state programme on development of agriculture and experts forecasts, agricultural sector will continue to play, in the future, a leading role in the economy of the country, as a result of ongoing reforms on intensification of agricultural production and creation of management mechanisms under the market relations. By 2025, agricultural output is planned to have increased by 1.5-2.4 times in average as compared with 1995 (Table 3.11).

Table 3.11. Forecast on main agricultural outputs up to the year 2025

Products	Years						
	1990	2000	2005	2010	2015	2020	2025
Cereals, thousand tons	1414	1000	1400	1700	1800	1900	2000
Cotton, thousand tons	543	200	300	400	450	470	500
Vegetables and watermelons, thousand tons	874	640	750	850	900	950	1000
Tobacco, thousand tons	53	20	30	35	40	45	50
Fruits, thousand tons	367	370	420	480	520	560	600
Grapes, thousand tons	1196	150	200	500	550	600	700
Tea leaf, thousand tons	31	3,5	10	20	25	30	35
Cattle, thousand heads	1832	1950	2180	2440	2600	2800	3000
Sheep and goats, thousand heads	5419	5560	6250	6600	6700	6859	7000
Poultry, millions	29.1	13.5	17	22	26	30	35

In the increase of export potentials of agriculture important role will play production of cotton, level of which by 2025 is expected to reach 500 thousand tons.

In order to provide high productivity of agriculture it is planned to reconstruct and develop the irrigation system [ ] and increase the area of irrigated lands to 1,600-1,650 thousand hectares by the year 2025.

Forestry

One of the main functions of forests is absorption of carbon dioxide from the atmosphere and its sequestration in wood. Forests occupy only 11% of the territory of Azerbaijan, while in 18-19 centuries this figure was 30-35% [ ].

All forests of the country are under the state property and perform water protecting, soil protecting, and climate regulating functions. Therefore, only sanitary felling is allowed in forests. However current forest cover of the country does not allow forests to effectively perform those functions and provide country's demand in commercial timber.

Status of forest reserves of Azerbaijan remains unsatisfactory with an increasing trend of forest degradation associated with insufficiency of state allocations to maintenance of forests, illegal felling, as well as other factors.

Presently, forestry institutions annually undertake forest rehabilitation on about 5 thousand hectares, including up to 2 thousand hectares of forest planting. Annually, 6-8 millions of valuable tree species are cultivated [ ].

With such a speed of new forest planting forest area of the country may reach the optimal level (18-20%) only by years 2360-2380.

For achievement of optimal forest cover of the territory in the nearest future (2025-2030) it is required to rapidly intensify forest rehabilitation activities with involvement of investments and improvement of material and technical base of the forestry. This is possible only with increasing the area of new plantations to 25-26 thousand hectares annually.

Perspectives of forestry development envisage creation of new forest plantations due to state allocations and municipal expenses on tree planting in settlements as well as forest-irrigation activities.

In the baseline scenario, unlike the optimistic scenario, set of forest plantations does not imply use of new technologies, methodology and genetically improved planting materials. With the speed of establishment of new forests according to the baseline scenario (5.0-5.1 thousand hectares annually) forest cover of the county may be reached optimal level (20%) only by 2140-2150, and according to optimistic scenario, by 2025 under conditions of increase of forest plantations in 2020-2025 to 50-55 thousand hectares annually (Table 3.12)

Table 3.12. Forecast on forest planting in Azerbaijan up to 2025

Scenario	Total area of afforestation, thousand hectares				
	2001-2005	2006-2010	2011-2015	2016-2020	2021-2025
Baseline	20.1	30.2	34.6	38.2	31.0
Optimistic	29.7	81.0	150.4	216.3	260.0

Waste

Expected growth of the population especially of urban population and intensification of industrial output predetermine the increase of the sewage and solid domestic wastes.

Operational municipal treatment facilities have the capacity of 0.84 million m^3 of sewage per day. As a result of construction of new treatment facilities and provision of the existing ones with methane tanks, their total capacity will make 1.1-1.2 million m^3 by the year 2025.

Presently, more than 200 landfills and damp areas exist in the country with total area of 900 hectares, which are in unsatisfactory condition. Total amount of solid wastes reaches 6.0-6.5 million m^3 per year. The only plant on their treatment in Baku can process only 12% of the total amount of domestic wastes of the city.

In the perspective, accumulation of solid wastes will exceed the existing sanitary norm of 1.55 m^3 per one urban dweller, and by 2015 it will make up 1.8-1.9 m^3, by 2025 - 2.5 m^3. Annual amount of solid wastes in 2025 - 12.9 million m^3 will be by 2.2 times more than the level of 1990.

Development of municipal economy envisages undertaking of activities on reconstruction of water supply and sewage systems, collection, transportation and utilization of solid domestic wastes within Baku megalopolis and other cities of the country.

Forecast on Energy Consumption

Estimations aimed at identifying amounts of combusted fuel have shown that due to intensive growth of GDP both in baseline and optimistic scenarios of economic development amount of the majority of combusted fuel types is likely to grow.

According to results from state programs and statistical data on current status of economy with the use of imitation models anticipated demand for the main fuel energy resources has been obtained both by sectors and types of fuel.

Increase in consumption of petrol and diesel fuel is mostly due to considerable development of the motor fleet of the country, agricultural machinery, as well as rehabilitation and increase of the volume of cargo transportation on the marine and railway transports. Forecast of demand in these types of fuel shows that by the consumption amount this indicator will reach the baseline 1990 only in 2011-2013 (Table 3.13, table 3.14).

Table 3.13. Petrol demand projection by the economy sectors, PJ

Sectors	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Baseline scenario								
Industry	2.11	1.32	0.81	1.61	2.89	4.39	5.38	6.18
Transport	48.84	30.46	18.55	37.09	66.36	100.98	123.65	142.20
Agriculture	1.62	0.99	0.60	1.21	2.16	3.29	4.03	4.64
Others	0.40	0.34	0.20	0.41	0.72	1.10	1.34	1.54
Total	52.97	33.11	20.16	40.32	72.13	109.76	134.40	154.56
Optimistic scenario								
Industry	2.11	1.32	0.81	1.61	3.17	5.09	6.18	7.06
Transport	48.84	30.46	18.55	37.09	72.96	117.11	142.10	162.39
Agriculture	1.62	0.99	0.60	1.21	2.38	3.82	4.63	5.30
Others	0.40	0.34	0.20	0.41	0.79	1.27	1.55	1.76
Total	52.97	33.11	20.16	40.32	79.30	127.29	154.46	176.51

Table 3.14. Diesel fuel demand projection by the economy sectors, PJ

Sectors	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Baseline scenario								
Industry	5.05	3.89	1.30	2.17	3.03	4.55	6.28	7.79
Transport	10.78	8.55	2.86	4.77	6.67	10.01	1.38	17.14
Agriculture	22.57	17.88	5.98	9.97	13.95	20.93	28.90	35.83
Others	11.00	8.56	2.86	4.76	6.68	10.01	26.27	17.14
Total	49.40	38.88	13.00	21.67	30.33	45.50	62.83	77.90
Optimistic scenario								
Industry	5.05	3.89	1.30	2.34	3.34	5.29	7.23	8.93
Transport	10.78	8.55	2.86	5.15	7.34	11.63	15.91	19.64
Agriculture	22.57	17.88	5.98	10.76	15.35	24.32	33.26	41.06
Others	11.00	8.56	2.86	5.15	7.33	11.62	15.90	19.63
Total	49.40	38.88	13.00	23.40	33.36	52.86	72.30	89.26

By the year 2025 demand in the engine fuel will increase by 2.23 times as compared with 1990. In this year, considerable increase is expected to be in the industrial sector (3.5 times). Increase of consumption in petrol, diesel oil and engine fuel associated with more intensive sped of expansion and modernization of the motor transport fleet of the country in individual fields of the industrial production, will be provided with considerable reserves of the oil refinery products.

Due to the planned acrtivities on optimization of the structure of power generating capacities in the power system multifold reduction of furnace fuel oil consumption is projected by the end of 2025. Replacement of outdated technologies in the metallurgy, rejection of coal as furnace material are the objective factors for more than tenfold reduction of consumption of this fuel type in the country. Total demand of fuel oil in 2025, according to the baselkine scenario of the economy development, will make 0,03% of the 1990 level. With the optimistic scenario with indicator will be 0.02% (Table 3.15).

Table 3.15. Fuel oil demand projection by the economy sectors, PJ

Sectors	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Baseline scenario								
Power generation	89.00	122.81	131.69	151.92	130.22	98.39	72.35	8.68
Industry	13.00	18.76	20.12	23.21	19.89	15.03	11.05	1.33
Commercial	16.05	22.17	23.78	27.43	23.51	17.76	13.06	1.57
Households	1.70	1.73	1.82	2.11	1.81	1.37	1.00	0.12
Others	4.70	5.10	5.49	6.33	5.43	4.10	3.02	0.36
Total	124.45	170.57	182.90	211.00	180.86	136.65	100.48	12.06
Optimistic scenario								
Power generation	89.00	122.81	131.69	151.92	130.22	119.80	73.79	16.50
Industry	13.00	18.76	20.12	23.21	19.89	18.30	11.27	2.52
Commercial	16.05	22.17	23.78	27.43	23.51	21.63	13.32	2.98
Households	1.70	1.73	1.82	2.11	1.81	1.66	1.02	0.23
Others	4.70	5.1	5.49	6.33	5.43	5.00	3.08	0.68
Total	124.45	170.57	182.90	211.00	180.86	166.39	102.48	22.91

As to the other types of fuel, considerable demand is not forecasted (Table 3.16) because preference will be given to electric devices.

Table 3.16. Forecast on total demand for other oil products, PJ

Scenarios	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Baseline	39.85	14.51	15.96	14.69	23.98	31.60	38.21	43.06
Optimistic	39.85	14.51	15.96	14.18	23.98	29.97	39.75	44.70

Of all types of fuels, according to the forecast, dominating will be consumption of tye natural gas. Demand for it both in the baseline and optimistic scenarios will increase in all sectors of activity (Table 3.17), which is asociated with the projected development different fields of the industry, provision of needs of the households and motor trandsport, as well as replacement of furnacxe fuel oil with TPPs. Povision of additional amounts of combusted gas will be due to the produced biogas, increase in the natural gas production.

Table 3.17. Natural gas demand projection by the economy sectors, PJ

Sectors	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Baseline scenario								
Power generation	174.83	93.97	67.59	154.53	210.68	254.20	285.63	322.57
Industry	71.00	37.59	27.04	61.65	84.27	101.68	114.25	129.03
Commercial	92.50	49.34	35.49	80.92	110.61	133.45	149.96	169.35
Households	86.20	46.99	33.80	77.06	105.34	127.10	142.82	161.28
Agriculture	16.80	7.04	5.06	11.16	15.8	19.06	21.42	24.19
Total	441.33	234.93	168.98	385.32	526.70	635.49	714.08	806.42
Optimistic scenario								
Power generation	174.83	93.97	67.59	159.24	220.20	272.60	304.80	342.25

Industry	71.00	37.59	27.04	63.70	88.08	109.04	121.92	136.90
Commercial	92.50	49.34	35.49	83.60	115.61	143.11	160.02	179.68
Households	86.20	46.99	33.80	79.62	110.10	136.30	152.40	171.12
Agriculture	16.80	7.04	5.06	11.94	16.51	20.44	22.87	25.67
Total	441.33	234.93	168.98	398.10	550.50	681.49	762.01	855.62

From the forecast of total demand for energy by fuel types considerable increase is expected for petrpol (2.9 times), disel fuel (1.6 times) and natural gas (1.8 times). These indicators in the baseline scenario of economy development in the year 2025 will make 154.56; 77.99 and 806.42 PJ respectively. It is projected that oil fuel consumption will increase approximately by 10 times (Table 3.18, Figure 3.2).

Table 3.18. Forecast on total energy demand by the fuel type, PJ

Fuel type	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Baseline scenario								
Petrol	52.97	33.11	20.16	40.32	72.13	109.76	134.40	154.56
Diesel oil	49.40	38.88	13.00	21.67	30.33	45.50	62.83	77.90
Fuel oil	124.45	170.57	182.90	211.00	180.86	136.65	100.48	12.06
Other oil products	39.85	14.51	15.19	14.69	23.98	31.60	38.21	43.06
Natural gas	441.33	234.93	168.98	385.32	526.70	635.49	714.08	806.42
Total	708	492	401	673	834	959	1050	1094
Optimistic scenario								
Petrol	52.97	33.11	20.16	40.32	79.30	127.29	154.46	176.51
Diesel oil	49.40	38.88	13.00	23.40	33.36	52.86	72.30	89.26
Fuel oil	124.45	170.57	182.90	211.00	180.86	166.39	102.48	22.91
Other oil products	39.85	14.51	15.96	14.18	23.98	29.97	39.75	44.70
Natural gas	441.33	234.93	168.98	398.10	550.50	681.49	762.01	855.62
Total	708	492	401	687	868	1058	1131	1189

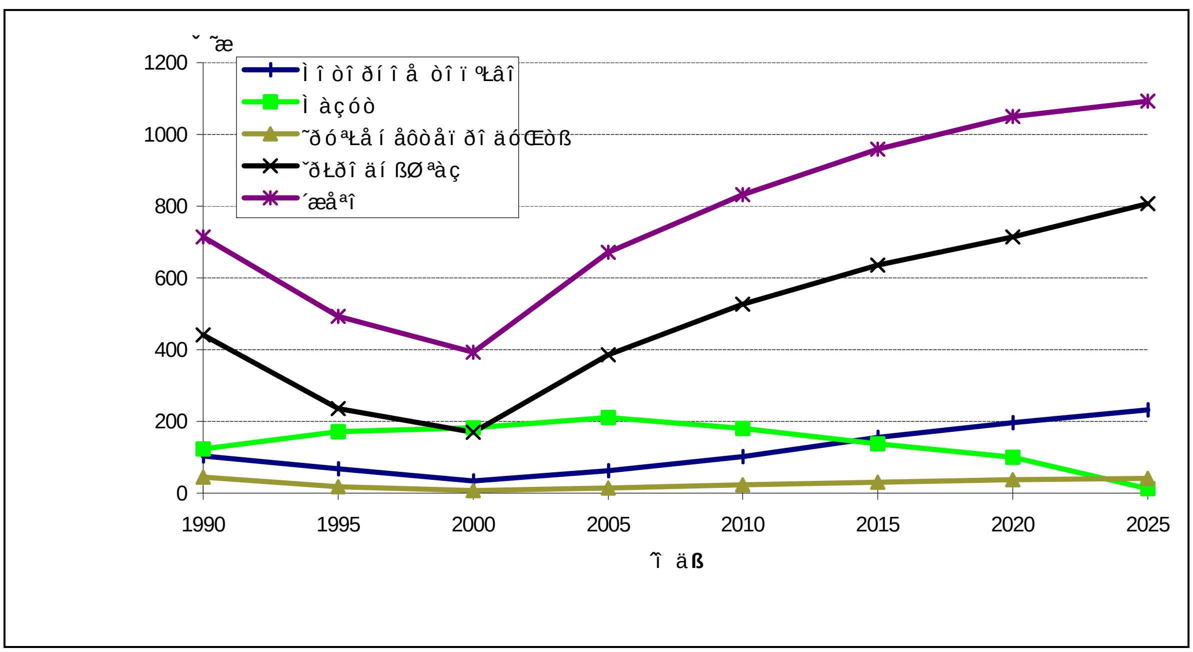

Figure 3.2. Energy demand projection by the fuel types

Total energy consumption as compared with the baseline year will increase by 1.5-1.7 times. It is projected that the amount of consumed energy will reach the level of the baseline year by 2007-2008. By the end of 2025, the level of consumed energy will make up 1,094-1,189 PJ (Table 3.19).

Table 3.19. Energy demand projection by the economy sectors, PJ

Sectors	Years							
	1990	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**
Baseline scenario								
Power generation	266	184	199,28	306,45	340,9	352,59	357,98	331,25
Industry	123	85	62,84	101,13	130,46	152,51	169,44	180,93
Transport	64	44	23,17	43,48	75,67	114,47	129,23	164,08
Commercial	109	76	59,27	108,35	134,12	151,21	163,02	170,92
Households	88	61	35,62	79,17	107,15	128,47	143,82	161,4
Agriculture	41	28	11,64	22,34	31,91	43,28	54,35	64,66
Others	17	14	9,18	12,08	13,79	16,47	32,16	20,76
Total	708	492	401	673	834	959	1050	1094
Optimistic scenario								
Power generation	266	184	199,28	311,16	350,42	392,4	378,59	358,75
Industry	123	85	62,84	102,91	134,86	163,19	180,39	193,41
Transport	64	44	23,17	43,8	82,94	132,04	162,38	186,95
Commercial	109	76	59,27	111,03	139,12	164,74	173,34	182,66
Households	88	61	35,62	81,73	111,91	137,96	153,42	171,35
Agriculture	41	28	11,64	23,91	34,24	48,58	60,76	72,03
Others	17	14	9,18	12,46	14,51	19,09	22,12	23,85
Total	708	492	401	687	868	1058	1131	1189

Depending on the scenario of economy development, energy consumption levels considerably change, however tendency of decrease in the GDP energy intensity after the year 2000 is characteristic of both cases. With the increase of GDP and energy consumption due to the energy saving measures and new technologies energy intensity will be in contrary decreased. By 2025 this indicator will make up 42 to 44% of the the year 1990. (Figure 3.3).

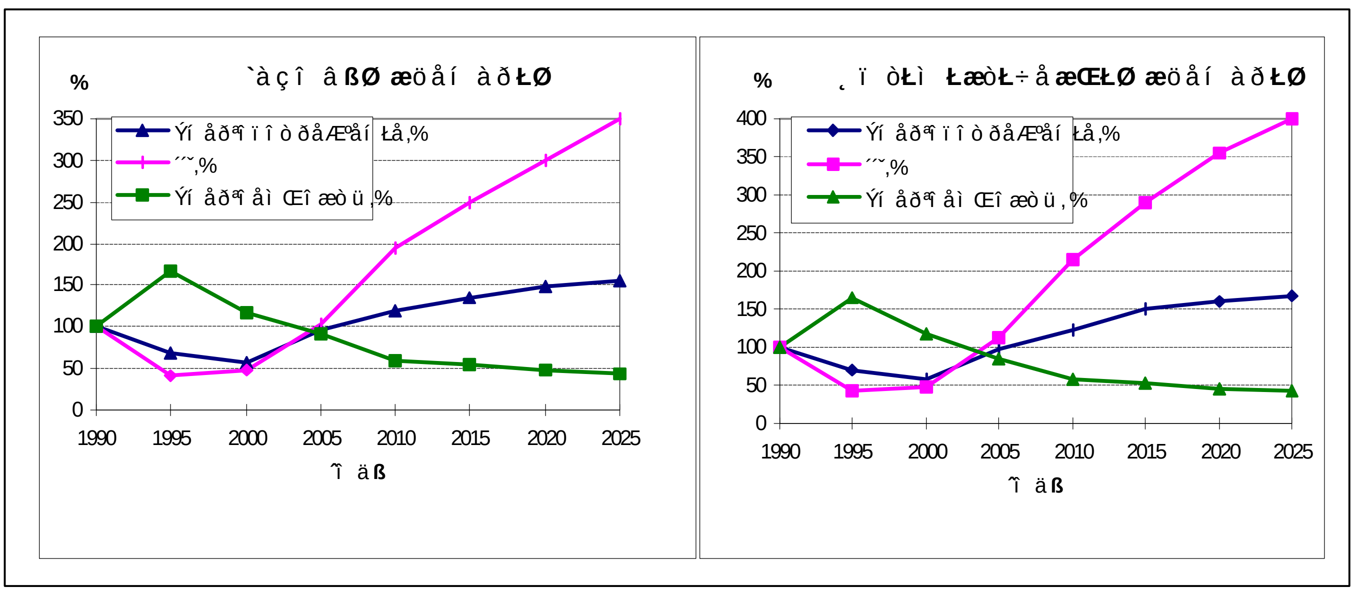

Figure 3.3. Forecast on dynamics of energy intensity for different scenarios of economic development

3.2. Greenhouse Gas Emissions Projections

based on the forecast of economy development and consumption of energy resources up to the year 2025, estimation of the expected emissions of the main greenhouse gases (CO_2, CH_4 and N_2O) of direct impact has ben conducted (Table 3.20) with the use of imitation mathematical model. Projection has been made according two scenarios for the “Energy”, “Industrial processes”, “Agriculture” and “Waste” categories.

Table 3.20. Greenhouse gas emissions projections up to 2025

Greenhouse gases	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Baseline scenario								
CO_2	44703	30124	24689	41544	52322	59844	65729	68735
CH_4	723	587	730	1253	1837	1946	2050	2177
N_2O	2.91	2,60	2.80	3.10	3.30	3.50	3.60	3.80
Total in CO_2-eq	60787	43257	40887	68818	91922	101795	109895	115630
Optimistic scenario								
CO_2	44703	30124	21689	42396	53828	65883	70698	74543
CH_4	723	587	730	1253	1837	1947	2050	2178
N_2O	2.91	2,60	2.80	2.90	3.33	3.54	3.66	3.82
Total in CO_2-eq	60787	43257	40887	69608	93437	107867	114883	121465

Estimations show that as compared with 1990, by the year 2025 emissions level of GHG will be by 1.8-2.0 times higher, and per capita emissions will be by 1.3-1.4 times higher. Increase of the GHG emissions in the period of 2000-2010 will make up 11.2-11.7% per year, during the period of 2006-2010 - 5.9-6.3%; 2011-2025 - 1.9-2.0%. Exceeding of the level of 1990 is expected in 2007-2008 (Figure 3.4).

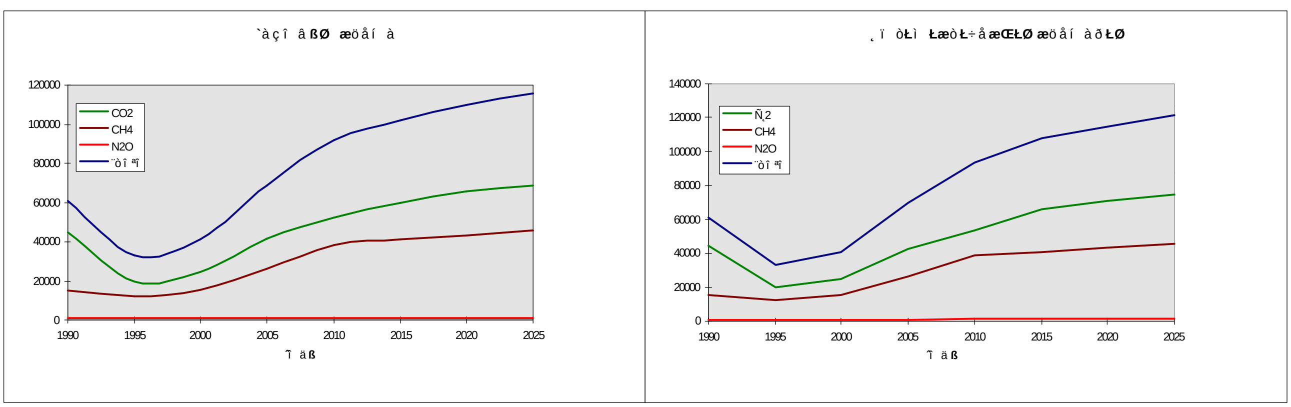

Figure 3.4. Greenhouse gas emissions projections for different scenarios, in ÑÎ₂-eq

Carbon dioxide emission projections

In the future carbon dioxide will remain the main GHG and its share in the total emission of GHG by the year 2025 will make from 59 to 61% against 73.5% in 1990. Total emission of ÑÎ$_2$ as compared with 1990 will increase by 1.5-1.6 times. The level of 1990 will be reached, according to the baseline scenario, in 2015-2016, according to the optimistic scenario, in 2012-2013, with 97-98% of emissions being generated in the "Energy" category. As compared with 1990, increase of ÑÎ$_2$ by 2025 by sectors of this category will make: power generation - 123-134%, industry - 147-157%, transport - 255-291%, commercial sector - 157-169%, household - 184-195%, agriculture - 158-175% and "others" sector - 121-127% (Table 3.21).

Table 3.21. ÑÎ$_2$ emission projections by the economy sectors, Gg

Categories	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Baseline scenario								
1.Fuel combustion, including:	43258	29493	24542	41176	51586	58660	64213	66930
Power generation	*16616*	*11409*	*12355*	*19000*	*21136*	*21861*	*22195*	*20538*
Industry	*6886*	*4758*	*3519*	*5663*	*7306*	*8541*	*9491*	*10132*
Transport	*4433*	*3048*	*1599*	*3000*	*5221*	*7898*	*8917*	*11312*
Commercial sector	*6393*	*4457*	*3497*	*6393*	*7913*	*8921*	*9618*	*10084*
Households	*4923*	*3412*	*1995*	*4434*	*6000*	*7194*	*8054*	*9038*
Agriculture	*2715*	*1854*	*768*	*1474*	*2106*	*2856*	*3597*	*4268*
Others	*1292*	*1005*	809	1212	1904	1389	2341	1558
2.Industrial processes	1444	181	147	368	736	1184	1516	1805
Total	44703	30124	24689	41544	52322	59844	65729	68735
Optimistic scenario								
1.Fuel combustion, including:	43258	29493	21542	42028	53092	64699	69182	72738
Power generation	*16616*	*11409*	*12355*	*19292*	*21726*	*24329*	*23473*	*22243*
Industry	*6886*	*4758*	*3519*	*5763*	*7552*	*9139*	*10102*	*10831*
Transport	*4433*	*3048*	*1599*	*3022*	*5723*	*9111*	*11204*	*12900*
Commercial sector	*6393*	*4457*	*3497*	*6551*	*8208*	*9720*	*10227*	*10777*
Households	*4923*	*3412*	*1995*	*4577*	*6267*	*7726*	*8592*	*9596*
Agriculture	*2715*	*1854*	*768*	*1578*	*2260*	*3206*	*4010*	*4754*
Others	*1292*	*1005*	809	1245	1356	1468	1574	1637
2.Industrial processes	1444	181	147	368	736	1184	1516	1805
Total	44703	30124	21689	42396	53828	65883	70698	74543

Forecast of methane emissions

Due to the expected development of new oil and gas fields, in 2025 methane emission will increase by more than 3 times. Share of methane in the total emission will increase from 25% in 1990 to 38-40% in 2025. Fugitive emission will make up 80-85% of total ÑÍ$_4$ emission (Table 3.22).

Table 3.22. CH_4 emission projections by the economy sectors, Gg

Categories	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Baseline scenario								
1. Energy, including:	448	330	454	951	1515	1614	1704	1817
a) fuel combustion	5	2,81	2,24	3,76	4,95	5,37	5,88	6,12
b) fugitive emissions	443	327	452	947	1511	1609	1698	1811
2. Agriculture	194	182	186	209	225	232	242	252
3. Waste	81	75	90	93	96	100	104	108
Total	723	587	730	1253	1837	1946	2050	2177
Optimistic scenario								
1. Energy, including:	448	330	454	951	1515	1614	1704	1817
a) fuel combustion	5	2,81	2,24	3,85	4,86	5,94	6,34	6,65
b) fugitive emissions	443	327	452	947	1511	1609	1698	1811
2. Agriculture	194	182	186	209	225	232	242	252
3. Waste	81	75	90	93	96	100	104	108
Total	723	587	730	1253	1837	1947	2050	2178

As compared with 1990, expected growth of methane emission in the “Agriculture” category by the year 2025 will make up 130%, with 133% in the “Waste” category. Level of 1990 will be reached in 2000-2001.

Nitrogen monoxide emission projections

Nitrogen monoxide emission will be reduced till the year 2000, and then slowly increasing will reach the level of 1990 in 2004-2005.

Dynamics of total N_2O emission is dominantly influenced by emissions from the “Agriculture” sources, and minimal influence being made from the “Energy” category (Table 3.23). In the perspective, considerable increase of N_2O up to the year 2025 is not projected.

Table 3.23. N_2O emission projections by the economy sectors, Gg in CO_2 -eq

Categories	Years							
	1990	1995	2000	2005	2010	2015	2020	2025
Baseline scenario								
Energy	0.22	0.15	0.12	0.20	0.24	0.28	0.31	0.32
Agriculture	1.97	1.80	1.84	2.06	2.22	2.29	2.39	2.50
Waste	0.72	0.67	0.81	0.84	0.86	0.90	0.94	0.97
Total:	2.91	2.60	2.80	3.10	3.30	3.50	3.60	3.80
Optimistic scenario								
Energy	0.22	0.15	0.12	0.20	0.25	0.31	0.33	0.35
Agriculture	1.97	1.80	1.84	2.06	2.22	2.29	2.39	2.50
Waste	0.72	0.67	0.81	0.84	0.86	0.90	0.94	0.97
Total:	2.91	2.60	2.80	2.90	3.33	3.54	3.66	3.82

3.3. Potential Assessment and Mitigation Measures

Perspectives of development of the economy of Azerbaijan as well as estimations on the expected amounts of consumption of combusted fuel show that in the nearest future GDP growth will mainly be associated with production and consumption of fuel and energy resources. Under these conditions, for the period up to 2025 it is expected that GHG emissions will increase.

Restriction of GHG emissions in Azerbaijan is possible through rational use of fuel and energy resources, applying of energy efficient technologies, improvement of regulatory and legislative base of the use of energy resources and introduction of economical mechanisms of incentives of energy efficiency. Organization and achievement of rational use and economy of fuel energy resources in the production and consumption fields envisage establishment, development and improvement of the following mechanisms:

- legal framework providing basis for energy saving policy, norms and standards on limitation of emissions;
- normative framework setting norms and standards for energy consumption, emission levels of greenhouse and other gases for different branches of economy and technology, machinery and equipment;
- economic and taxation mechanisms of incentives for introduction of energy effective technologies;
- financial mechanism of preferential loaning and direct targeting of financial means for implementation of energy saving and nature protecting measures;
- administrative organizational mechanism of establishment of structures of energetic and environmental audit, state certification system of energy using equipment;
- instrumental stock taking and automated management of fuel and energy consumption, administrative regulation of distribution and consumption of energy resources;
- provision of adherence to the laws, norms and requirements on limitation of emissions through enforcement measures (fines, close of operations, etc.).

Creation of these mechanisms as well as relevant management, training and control structures should be provided before the year 2005, which will enable in the perspective to maximally involve measures on reduction of GHG to the minimal possible level.

Measures on abatement of GHG by branches of economy have been developed on the basis of the following general and sectoral programmes of development of the country up to the year 2025:

- State Program on macroeconomic stabilization in the Azerbaijan Republic;
- Concept of the energy sector development in the Azerbaijan Republic by 2010;
- Concept of irrigation and water economy in association with the agrarian reforms for the period of 1996-2010;
- National Environmental Action Plan;
- Afforestation Program by 2005;
- The Program on Restructuring and Financing of Agriculture in the Azerbaijan Republic for the period of 2000-2020;

- The Program on Development of Oil and Gas Refining and Petrochemical Industries in the Azerbaijan Republic for the period of 2000-2010.

The conducted studies and analysis of measures show that predicted general potential of reduction of emissions of GHG in 2025 may constitute 39 million tons in ÑÎ$_2$-eq (Table 3.24).

Table 3.24. Gross potential for greenhouse gas emission reduction by the economy sectors

Categories	Reduction in ÑÎ$_2$- eq, Gg	Investment, million USD
Energy	36765	3982.8
Industry	210	23.0
Agriculture	714	125.0
Waste	1659	635.0
Total	39348	4765.8

The most potential for reduction of GHG has the “Energy” category - 93%.

Presently in the country, energy of wind, solar, geothermal energy are not being used, and hydroenergy resources have not been developed completely. Involvement in the energy balance of non-traditional and non-fuel renewable energy sources will considerable increase the potential of GHG emission reduction. Technical potential of energy saving and ÑÎ$_2$ abatement with impolementation of the planned measures by the year 2025 will make up 13.3 PJ and 873 thousand tons respectively.

In general, in he energy sector of Azerbaijan implementation of the potential abatement of GHG emission up to the year 2025 is planned through undertaking of active energy saving policy, introduction of energy efficient technologies through:

- optimization of the structure of generating capacities of the energy system and application of new highly effective technologies at thermal power plants;
- improvement of the system of production, distribution and consumption of heat, gas and electric energy, introduction of the automated systems of management and control of the electric energy consumption;
- technological modernization of energy intensive productions, including chemical and petro-chemical, mining industries and construction material industries;
- involvement in the energy balance of hydro-energy resources of large and small rivers and increase of their share in the energy balance of the country from 15 to 28% through construction of new hydro power plants;
- use of non-traditional sources of energy - wind, solar, geothermal - share of which in the energy balance will constitute 2%.

Forecast on reduction of carbon dioxide emissions

Sources of CO_2 emission are the “Energy” and “Industrial processes” categories. In the “Energy” category, according to the forecast, measures will be undertaken which will enable 2025 to save 130.7 PJ of energy and achieve abatement of ÑÎ$_2$ by 9,045 Gg. For implementation of these measures about 3.5 billion USD will be required. The projected activities have been presented in Table 3.25.

Table 3.25. List of measures for reduction of ÑÎ$_2$ emissions under the energy sector

Measure	Energy-saving, PJ	Reduction ÑÎ$_2$ emission Gg.	Investment required, USD
Energy-saving options			
1. Power generation and fuel refining:			
-installation of a 400 MW SGU at "Severnaya" HPP supported by credit from the Japan Fund for Economic Cooperation and Development	11.7	715	320.0
-construction of a 56.5 MW SGU at Baku TEP -1 supported by credit from ABB company (Switzerland)	2.9	177	55.0
-commissioning of the 9th unit at Az. HPP with 300 MW capacity	17.6	1075	240.0
-increasing of capacities of 8 units at Az .HPP through technical upgrading (480 MW)	9.7	593	300.0
-installation of a 400 MW SGU at Ali-Bairamly HPP	11.7	715	320.0
-Installation of SGU at Sumgait TEP -1 (400 MW)	11.7	715	320.0
-increasing of capacity of Mingechevir HPP (by 60 MW) supported by credit from EBRD	0.7	104	50.0
-construction of Enikend HPP with capacity of 112.5 MW (credit from EBRD - 53 million USD)	4.1	250	73.0
-commissioning of Ordubad HPP (32 MW)	0.4	24	20.0
-construction of mini-HPPs	8.0	489	150.0
-construction of wind-energy power plants at the Apsheron peninsula and Nakhichevan with total capacity of 15 MW	0.1	6	20.0
-introduction in fuel industry of update technologies for oil extraction and refining	3.5	214	161.0
2. Industry:			
-in metallurgy, shift to a electro-steelmaking and ferroalloy technologies	4.8	293	37.5
-in machinery, introduction of up-date technologies, use of raw and materials of high quality	1.9	116	200.0
-in chemical and petrochemical industries, upgrading of technologies of ethylene-propylene production (including installation of steam generator units) etc.	1.1	67	85.0
-shift to dry technology for cement production	5.7	345	25.0
-reconstruction of brick producing plants	2.9	177	20.0
-installation of a furnace with air compressor at glass works	1.6	99	22.5
3. Transport:			
-improvements of motor fleet structure, technical characteristics of engines, and quality of roads	4.5	275	460
4. Agriculture:			
-energy-saving due to introduction of update equipment and techniques	1.4	86	125
5. Cross-sectoral:			
-introduction of update sources and systems of lighting	1.6	98	2.8
-introduction of power electronics techniques	8.5	519	29
-improvements in heat supply system	3.3	202	195
-increase of secondary thermal energy resources	4.2	257	155
-installation of devices controlling fuel-energy resources consumption	5.7	348	22
-introduction of automatic control systems	1.4	86	15
Replacement of motor fuels with gas	0	1000	60.0
Total	130.7	9045	3482.8

Energy saving measures in the “Energy” category will result in reduction of ÑÎ$_2$ by 2025 by 12-13% vis-a-vis the forecast.

Industrial processes, according to results of the forecast, will develop slowly. Improvement of industrial processes in different sectors of the economy (mainly the mining complex and non-mining materials) in general will allow to reduce ÑÎ$_2$ emission by 200-220 Gg, with the required investment of 22-24 million USD.

Assessment of methane abatement

Main sources of methane emission are “Energy”, “Agriculture”, and “Waste” categories. In the “Energy” category measures are envisaged to reduce methane losses in the gas production and utilization of associated gas (methane) during oil production. The most important from the GHG emission point is the reduction of emissions in the gas production industry of the country during production, storage and distribution of natural gas, which may be achieved as a result of improvement of the main and distributive networks of the gas pipeline, increase of the quality and maintenance conditions of the pipeline, upgrading of the early detection techniques. Reduction of the emissions of natural gas due to these measures may make up 63.7-70.7 billion m^3 at the level of 2025. Amount of the required investment is 450-550 million USD. Minimization of emissions of the associated gas during oil production through its trapping and use in the heat and power generation units will allow by the end of the period under review to provide utilization of approximately 60-62 billion m^3 of associated gas, which will result in reduction of methane emissions. Projected investment amount is 170-175 million USD.

Methane emission during oil production has not been taken into consideration on the GHG inventory because of the lack of statistical data and relevant coefficients in the IPCC methodology. Therefore forecast of these emissions has not been made and the amount of assumed methane utilization has not been included in the overall abatement of GHG.

In the Agriculture measures on methane utilization in order to obtain energy for local needs will be undertaken in the regions, where large cattle breeding and poultry farms. Recuperation of methane from animal waste by the year 2025 may make 34 Gg. For undertaking of these measures investment of 125 million USD is required.

In the “Waste” category measures are envisaged on methane utilization on the landfills and recuperation of methane from sewage. Construction of wastes treatment plants in Baku and other large cities, provinces will allow to minimize storing of solid wastes and reduce methane emission by approximately 60-68 Gg. Implementation of this measure envisages annual additional treatment of about 8.0-8.5 million tons of wastes, which requires approximately 360-380 million USD.

For recuperation of methane from the sewage sludge, reconstruction of old and construction of new treatment facilities in the sewage system of Baku, other cities and provinces is envisaged, which will be supplemented with facilities on treatment of sewage sludge, methane tanks, ejector pump stations, etc. Implementation of these measures will allow to reach in 2025 reduction of methane emissions by 15 Gg with investment amount around 260-270 million USD (Table 3.26).

Table 3.26. Methane emissions reduction by categories

Measures	Reduction volume, Gg		Investment required, million USD
	CH_4	ÑÎ$_2$-eq	
1. Energy			
- reduction of losses in gas industry	1320	27720	500
2. Agriculture			
- methane utilization from animal wastes	34	714	125
3. Waste			
- methane utilization from solid domestic waste	64	1344	370
- methane utilization from sewage	15	315	265
Total	1433	30093	1260

As it is seen from the table, about 92% of total predicted decrease of methane emission is expected from the sources of gas industry.

Analysis of estimations by activities shows that in the “Energy” category decrease of emissions will make up 36,765 Gg in CO_2-eq. Of them 75% is the share of methane.

Introduction of projected activities in will result in 2025 in reduction of methane emission in the “Agriculture” category by 14%, and in the “Wastes” category by 73%. Total reduction of methane emission in 2025 will make up 66% of the expected amount.

Taking into consideration the proposed measures, in 2025, GHG emission with the baseline scenario will make 75 million tons of CO_2-eq, or 122% of the baseline year 1990. With the optimistic scenario, these indicators will be 81million tons in CO_2-eq and 133% of the year 1990.

Potentials for carbon dioxide sink

The main way for CO_2 abatement is the preservation of forest cover of the Earth, improvement of structure of forests, increase of their productivity, rehabilitation and plantation of forests.

Forests occupy 11.45% of the territory of Azerbaijan, while 150-120 years ago this figure reached 30-35%. Forests of the country which perform water protecting, soil protecting and climate regulating functions belong to the first group. Therefore only maintenance and sanitary felling is allowed in these forests. However current forest cover of the country does not allow forests to effectively perform those functions and provide the needs of the country in commercial timber. Therefore, for achievement of optimal forest cover, share of forests in the overall land stock should be 18-20%. However forestry as well as the other fields of economy of Azerbaijan in the transition period is under difficult economic conditions. Illegal felling of forests and shelterbelts has increased, mainly for heating purposes, due to the rapid reduction of natural gas supply in the rural areas. Biological resources of forests of the country allow to produce annually only 57 thousand m^3 of timber. Under the acute energy crisis annual estimated fire wood consumption by the population should make up 2.5-3.0 million m^3 of timber. With this, minimal annual damage to the forestry of the Republic is estimated at 30-40 million USD. Therefore, the problem of forest rehabilitation and new forest plantation is not only an environmental and economic but also social and political problem. Under these conditions it is absolutely necessary to review the policy in the forestry sector with regard to economic, environmental and social aspects.

Use of the forest cover of Azerbaijan for increasing carbon sequestration is very urgent problem. In terms of institutional approach, it requires increase of the level of forestry management, detailed assessment of many benefits presented by forests. Solution of these tasks is associated with considerable increase of expenditures on forestry development and necessity of additional sources for its financing.

Inventory of the forestry resources of the Azerbaijan Republic has been taken as of 01.01.1988. After that, inventory of forest resources has not been conducted which is associated with lack of necessary funds. Therefore, all estimations on the inventory of GHG and forecast on forestry development have been based on the data of this source.

The conducted studies have shown that carbon stock of the forests of Azerbaijan make up 60 million tons, and annual rate of its sequestration is 670 thousand tons.

Results of the analysis indicate to serious aggravation of the state of forests of Azerbaijan during recent 10 years. Having been destroyed by illegal felling forests in some cases have lost their potential for self-rehabilitation. Rehabilitation of these forests requires considerable investments and implementation of a complex of measures providing for effective use of the resources and environmental potential of forests. First of all this requires implementation of measures on protection of forests, expansion of works on forest regeneration, improvement of the forestry management system.

Implementation of a complex of these measures would allow to optimize the age structure of forests, increase their productivity and respectively will create preconditions for the increase of the carbon sink. These measures will result in additional increase of sink by 2025 in the amount of 6,670 thousand tons (Table 3.27).

Table 3.27. Forestry measures up to 2025

Indicators	Years					
	2000	2001-2005	2006-2010	2011-2015	2016-2020	2021-2025
Wood planting (thousand hectares)	2.09	29.66	81.07	150.36	216.34	260.17
ÑÎ$_2$ uptake, thousand tons	7.0	174	875	2080	4027	6670
Total investment (million USD)	0.93	18.18	56.13	115.69	180.12	248.91
Investment on ÑÎ$_2$ sink (t /thousand USD)	7.53	9.57	15.59	17.98	22.36	26.80

Analysis shows that from the view point of carbon sequestration important and feasible measures are improvement of the forests stand and planting of new forests. Estimations show that implementation of measures aimed at rehabilitation of forests, improvement of their dendrocomposition and increase of their biological productivity, as well as restriction of illegal felling will result in the 190 times increase of CO_2 by 2025 as compared with 2000. Share of expenditures on one ton of CO_2 in 2025 as compared with 2000 will decrease approximately by 30%. Rehabilitation of forests with incomplete stand and low-value species will allow to considerably improve the structure and composition of forests and planting of new forests will allow to reach optimal forest cover of the territory of the country.

Figure 3.5 reflects the projected sink of carbon dioxide by the existing and proposed forests.

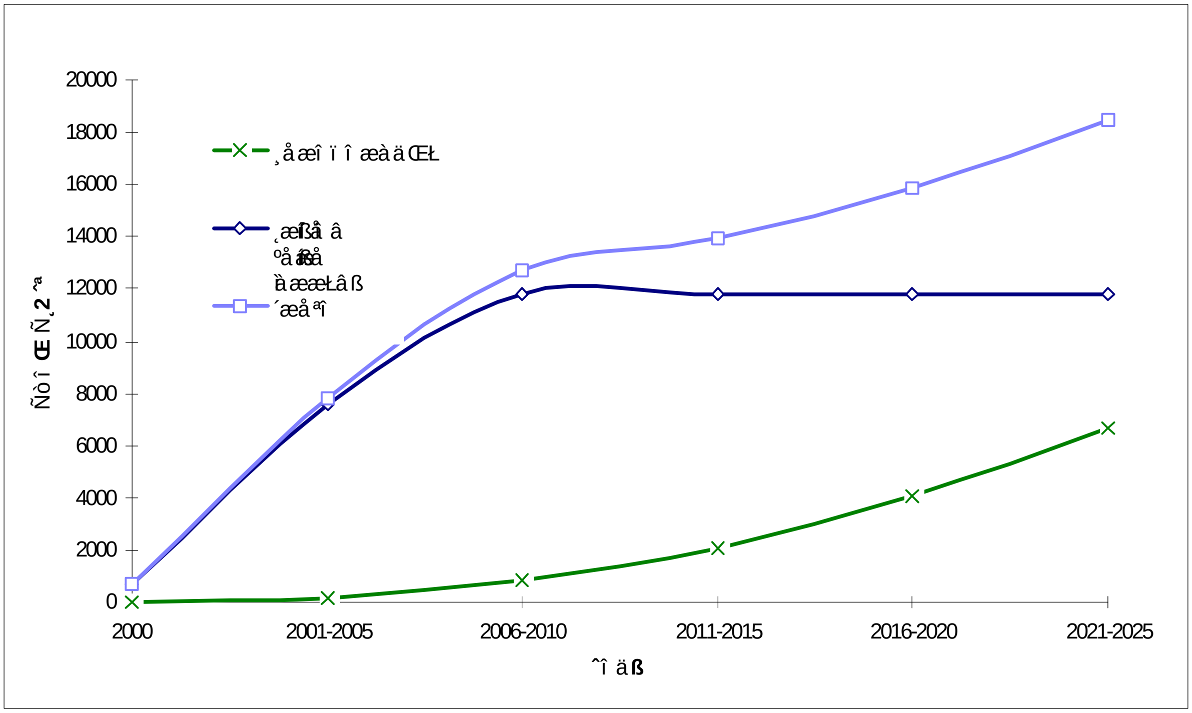

Figure 3.5. CO_2 sink projections with consideration of forestry adaptation measures

Possible potential of afforestation and rehabilitation of forests in Azerbaijan according to the experts by the year 2025 will make about 740 thousand hectares. With implementation of all measures total sink by forests during 25 year will make 70,056 thousand tons. Of them 20% will be the share of new forest plantations, 80% - that of existing forests. As compared with the baseline 1990, in 2025 total sink of CO_2 by forests may increase by 2.1 times. It should be mentioned that potential land resources of Azerbaijan allow to increase the total area of new forest plantations up to 1,500 thousand hectares.

4. CLIMATE CHANGES RESEARCH

4.1. National Climate Change Monitoring System

First stationary meteorological observations were conducted in the 18th century. Regular monitoring of the climate has started between 1830 and 1847 with establishment of meteorological stations in Nakhchivan, Shemakha, Baku, Shusa and other cities of the country. The Caspian sea level has been monitored since 1830, and monitoring of the Kura River hydrological regime has started since 1888 [ ]. Presently, hydrometeorological network of the country involves 77 meteorological posts, 100 hydrological and 12 marine stations. Monitoring of the atmosphere contamination is being carried out at 29 posts, and monitoring of the agricultural crops is being carried out at 46 posts. Five meteorological stations have been incorporated in the global monitoring system, 18 - in the global climate monitoring system.

The existing monitoring network of the State Committee on Meteorology does not meet requirements of the WMO. Lack of financial resources does not allow to provide stations with up-date devices and equipment, and set up new stations in the mountainous regions and on the islands of the Caspian Sea.

The major part of the hydrometeorological information is concentrated in tables, monthly and annual bulletins. Since 1992 an automated databank has been established on meteorology, water inventory, the Caspian hydrology, atmosphere contamination and agro-meteorology.

4.2. Monitored Climatic Changes

Against the global warming of the climate its regional changes also take place. Data of long-term (100 years) observations from 16 region-representative meteorological stations have been used in order to identify possible climate change effects over the territory of Azerbaijan.

Results of the trend analysis show that during a 100-year period air temperature over the territory of concern has increased within 0.5-0.6^{0}C (Figure 4.1). Between 1961 and 1990, warming magnitude made up 0.3- 0.6^{0}C.

In general, warming has taken place in all climatic areas of the country. Maximum of warming is observed over the Greater Caucasus, Kura-Araz lowland (0.50-0.65^{0}Ñ), minimum - in the mountains of the Lesser Caucasus and coastal areas of the Caspian Sea (0.14-0.20^{0}C). Precipitation amount has insignificantly changed for the long-term period (Figure 4.2).

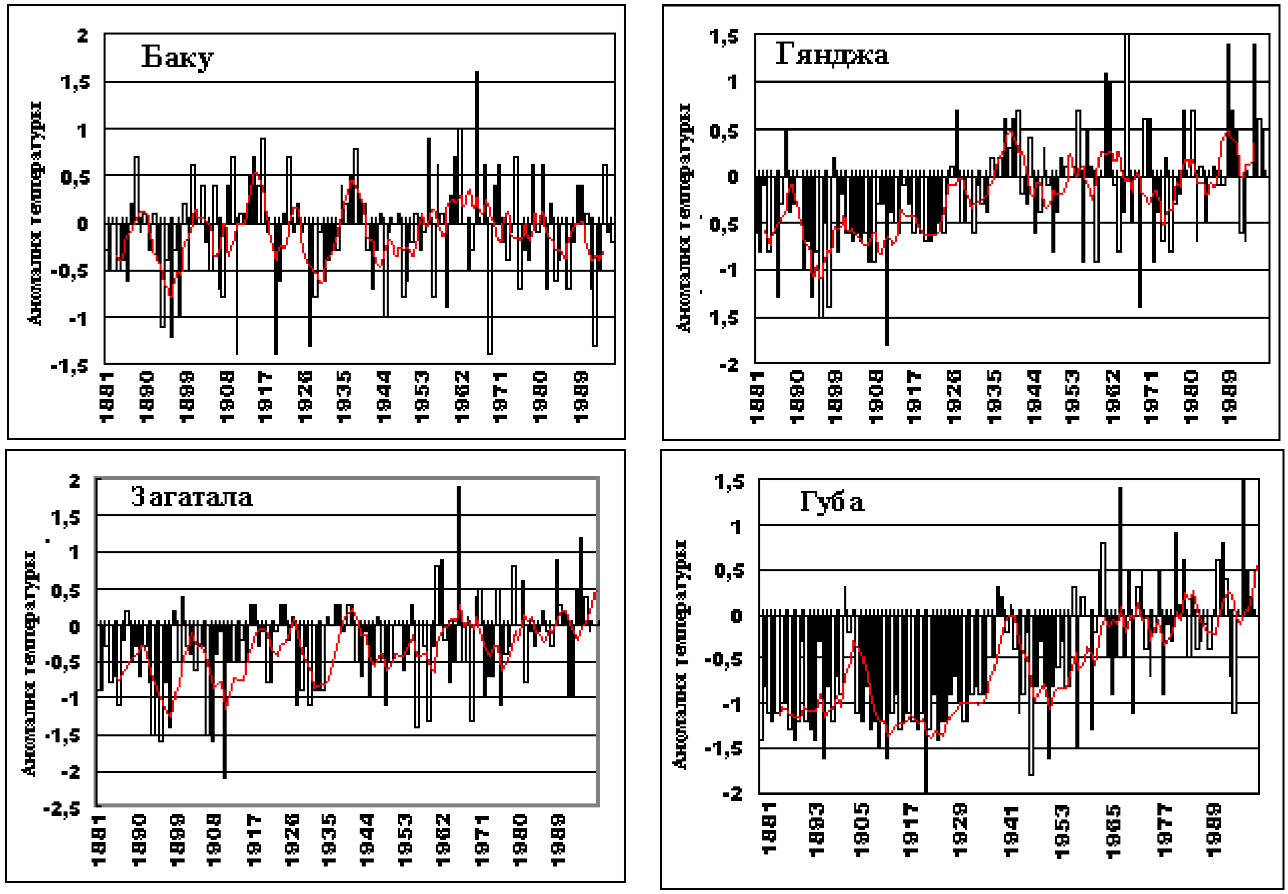

Figure 4.1. Dynamics of annual distribution of air temperature, ^{0}C

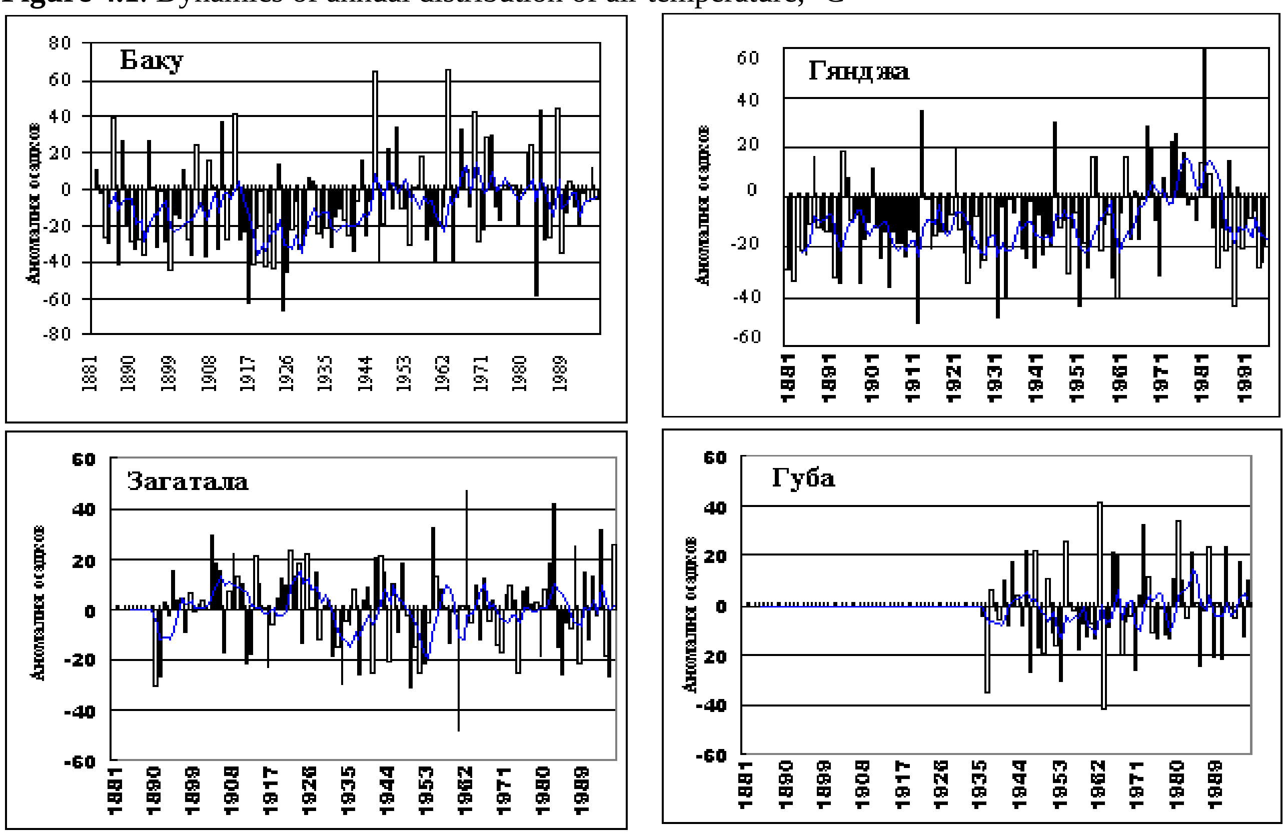

Figure 4.2. Dynamics of annual precipitation distribution, %

4.3. Expected Climate Change

According to the IPCC Guidelines, if measures on reduction of GHG emissions are not taken in the nearest future, then by the mid of the next century global air temperature will rise by another 2-3^{O}C and average level of the world ocean will rise by another 50 cm. This in its turn will result in irreversible consequences, i.e. loss of vast coastal areas, as well as of some island countries, deterioration of provision with food products and water and increase of various diseases [ ].

Modern science still cannot predict future climatic changes, therefore “climatic scenarios” are used, which describe relatively realistic climate situation. There are numerous scenarios, however in the international practice mostly used are scenarios based on modeling of general atmosphere circulation (GAC).

In order to assess future climate change effects over the territory of Azerbaijan according to the IPCC Guidelines, national experts have used models of GAC: by Goddardov Institute of Space Surveys, USA (GISS), Canadian Climatic Center (CCCM), United Kingdom Meteorological Office (UKMO), Geophysical laboratory of hydrodynamics of USA (GFDL-3 and GFDL-T).

Studies have been conducted with the use of data and software of GRADS. Real monthly meteorological data from 16 stations for the period between 1961 and 1990 have been used as a basis for climatic modeling. All calculations have been interpolated in the stations coordinates, and the models potentials have been tested through reproduction of real climatic conditions over the country’s territory between 1951 and 1980.

According to these models, with the doubling of CO_2 concentration in the atmosphere the expected increase in the annual average temperature will make up 4.11-5.82^{O}C by the end of the next century. Data on the annual average temperature increase from both GISS and GFDL-3 models are very close to each other and are within 4.2-4.4^{O}C, however there are considerable differences in the structure of annual distribution of these changes. With doubling of CO_2 annual precipitation amount will increase by 4-12% according to the UKMO and GISS models, and will decrease by 1-19% according to the CCCM and GFDL-T models. The GFDL-3 model predicts insignificant spatial change in the precipitation amount. According to all models the amount of winter precipitation will increase and summer precipitation will decrease (by 23-62%). Only in the GISS model summer precipitation increases by 17-40% (Table 4.1).

Table 4.1. Air temperature (dT, ^{O}C) and precipitation (R,%) expected variations over the territory of Azerbaijan as compared to the base norm

Climate scenarios by models	Seasons								Year	
	Winter		Spring		Summer		Winter			
	dT°C	R,%	dT°C	R,%	dT°C	R,%	dT°C	R,%	dT°C	R,%
CCCM	4.1	103	5.0	85	7.2	51	4.5	102	5.1	85
UKMO	4.0	99	4.6	107	5.4	90	4.9	118	4.7	106
GISS	4.9	119	3.5	98	4.0	125	5.1	97	4.4	107
GFDL-3	3.2	108	5.4	105	4.4	91	4.3	100	4.3	101
GFDL-T	4.6	115	4.5	100	5.3	66	4.6	101	4.7	98

For better description of the real climate, data obtained from these models have been compared with actual ones. Similar results on air temperature have been obtained in the GISS model, and on precipitation - in the GFDL-3 model (Figure 4.3 and Figure 4.4).

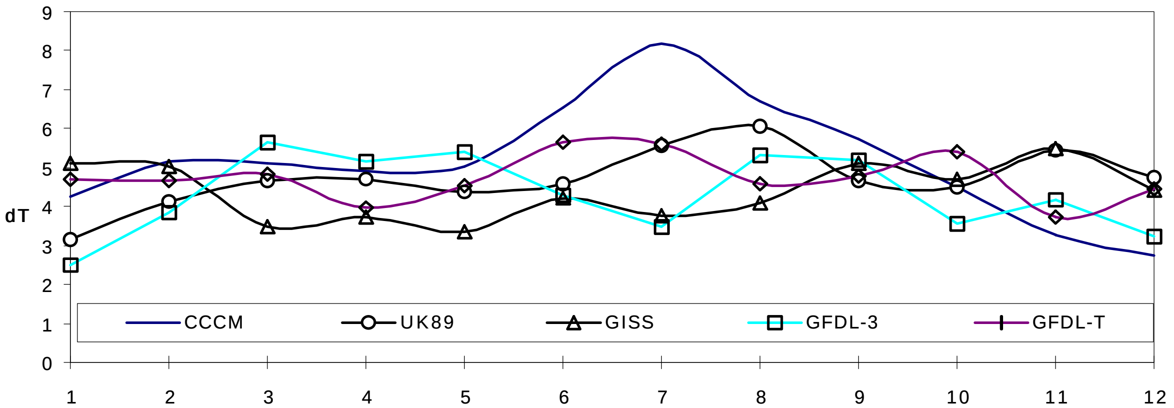

Figure 4.3. Scenarios of monthly air temperature increase with doubling of CO_2 concentration as compared to the base norm, °C

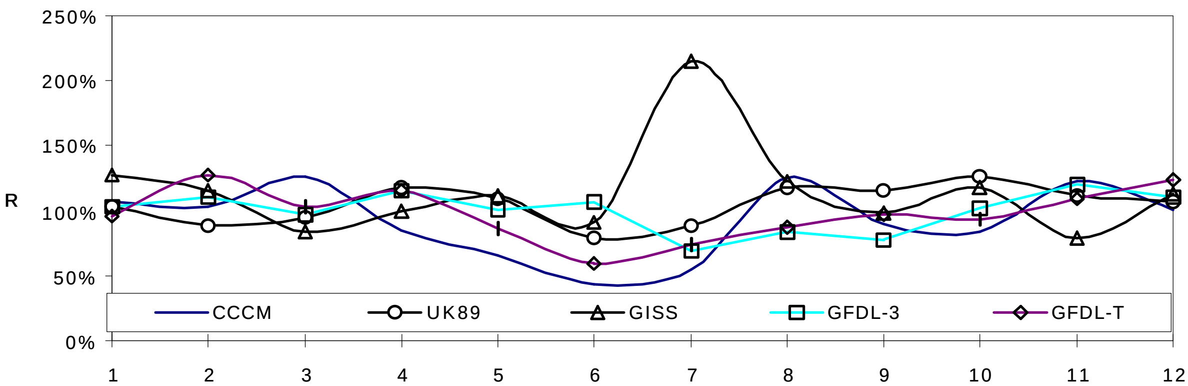

Figure 4.4. Scenarios of monthly precipitation amount variation with doubling of CO_2 concentration as compared to the base norm, %

In general, non of the models can describe all climate components in complex. On the other hand, these models do not take into account role of sulfate aerosols in the atmosphere in mitigation of the greenhouse effect. With their consideration, temperature decreases from 0.3-1°C to 3°C [ ]. Employment of models taking into account sulfate aerosols would give lower figures for warming with CO_2 doubling. Therefore increase in the air temperature by 4.11-5.82°C should be referred to the upper limit of possible changes. In order to cover the whole range of possible climate change effects one more scenario should be considered which reflects the lower limit of the expected warming. Such a scenario is an artificial scenario developed by Azerbaijan specialists. It takes into account the regional peculiarities of real climatic parameters change and global background. According to this scenario, increase of the air temperature by 2°C is expected with global doubling of CO_2

concentration over the territory of Azerbaijan, while precipitation amount would be stable or insignificantly below the norm.

5. ASSSESSMENT OF VULNERABILITY TO CLIMATE CHANGE AND ADAPTATION MEASURES

Assessment of vulnerability to climate change and development of adaptation strategy have been undertaken for water, agro-climatic, land, forestry resources and agriculture, and coastal areas of the Caspian Sea.

Climate change impact assessment and adaptation measures selection have been undertaken based on original studies, analysis of published papers and expert estimations. Depending on the target and expected results priority adaptive measures have been selected, which are presented in the Table 5.5.

5.1. Water Resources and Water Consumption

Water resources vulnerability assessment has been undertaken on the basis of statistical models, with consideration of flow formation patterns depending on the main climatic elements [ ]. Estimations have been made for the Kura River and Araz River as well as those rivers which directly run into the Caspian Sea. Expected change of water resources has been estimated for the GISS and GFDL-3 scenarios and artificial scenario. For calculations data have been used from more than 150 hydrological and 60 meteorological monitoring posts located on the territory of Azerbaijan, Armenia, Georgia, Russia and Turkey.

Results of studies of water resources changes indicate to some reduction of the river flow during the recent years with evident redistribution of flow within the year. The share of snow alimentation has rapidly decreased and seasonal snow line has risen from 1,300-1,500 m to 1,800-2,000 m.

Water resources change assessment according to the GISS and GFDL-3 scenarios shows that a rise in air temperature by 4.0-4.5°C will result in reduction of flow: up to 15% according to the GISS scenario, 20% - according to the GFDL-3 and 10% according to the artificial scenario.

According to the GFDL-3 scenario, a drop in precipitation amount in the summer-autumn period will result in reduction of flow during these seasons and increase of flow during winter and spring seasons (Figure 5.1).

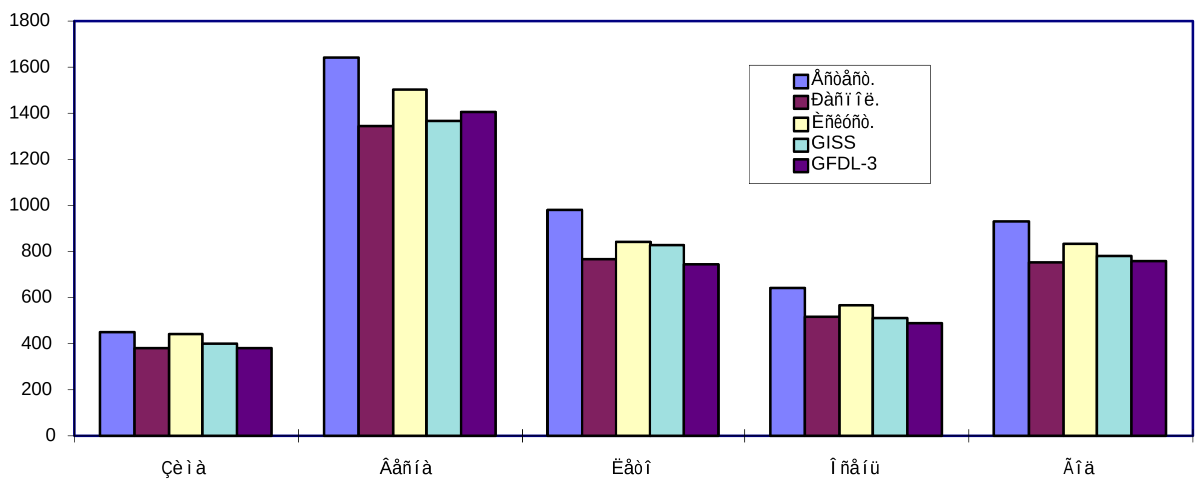

Figure 5.1. Expected situation with water resources in different climate change scenarios

Estimations have shown that with realization of all the scenarios it is expected that water resources will reduce by 5.7-7.7 km^3. With present water deficiency of about 5 km^3, by the mid of 21st century its level may increase to 9.5-11.5 km^3 (Table 5.1). The most vulnerable branches of economy will be energy, agriculture, and drinking water supply.

Table 5.1. Expected situation with water resources and river water consumption in Azerbaijan in different scenarios of climate changes, km^3 /year

Indicators	Base situation	Expected situation in different scenarios		
		Artificial	GISS	GFDL-3
Natural (with consideration of water intake by neighboring states)	29.3	26.4	25.0	23.5
Available (with consideration of water intake from the Samur River)	24.8	22.0	21.2	20.9
Water consumption	22.8	26.0	26.0	26.0
Sanitary flush	6.99	6.47	6.47	6.47
Water deficiency with consideration of flush	5.02	9.48	11.3	11.5

In the present conditions, the main part of water deficiency is being formed due to losses in the water consumption system. In the future, its magnitude may increase also due to water consumption on the territory of neighboring countries where main water catchment areas of the Kura and Araz rivers are located.

In order to identify adaptation measures aimed at mitigation of negative effects of water resources change it is necessary to undertake proper additional assessment of water sources, develop the strategy to elimination of shortcomings in the existing water management system as well as mechanisms for regulation, distribution and efficient use of water resources.

Present water deficiency and its expected increase resulting from climate change and anthropogenic impact will require urgent measures on improvement of the water resources management system, regulation of river flow, increase of effective operation of irrigation systems, employment of water saving technologies in irrigation, and re-use of treated drainage water.

Priority adaptation measures on the use of water resources are presented in the Table 5.5. Analysis of measures shows that the potential for elimination of water deficiency in Azerbaijan is great and expected amounts of water deficiency with climate change can be reduced by 90-95%.

5.2. Agro-climatic Resources

5.2.1. Current Status

Thermal resources. Azerbaijan is a mountainous country on the territory of which warm ($\sum t > 10^0$ - $> 3800^0$), temperate ($\sum t > 10^0$ - 3800 - 800 ^{0}) and cold ($\sum t > 10^0$ - $< 800^0$) thermal belts exist [1,29,30]. Boundaries of these belts in the mountainous areas are presented in Table 5.2.

Table 5.2. Boundaries of thermal belts in mountainous areas of Azerbaijan (m, above sea level)

Belt	Greater Caucasus		Lesser Caucasus		Nakhichi-van AR	Talish
	Southern slope	North-eastern slope	Northern slope	Eastern slope		
Warm	600	400	500	700	1250	500
Cold	2300	2400	2400	2450	2800	-

Thermal resources in the temperate and warm belts vary within wide ranges reaching $4,800^0$ and more in some regions of the Kura-Araz lowland and in the near-Araz plains of the Nakhchivan Autonomous Republic.

Moisture resources. Annual amounts of precipitation over the territory of the country vary within 150-1,900 mm. In the lowland areas and lower parts of the mountainous areas precipitation amount is not considerable as compared with water demand of the majority of plants, therefore semi-desert and dry-steppe natural complexes are formed here, and cultivation of agricultural crops requires artificial irrigation.

Regional peculiarities of precipitation / evaporation ratio have conditioned existence of a variety of humidification zones in Azerbaijan - from very dry to excessively humid. About 65% of the country’s territory is referred to the arid zone with vast dry areas on the east and west of the Kura-Araz lowland and near-Araz plains of the Nakhchivan Autonomous Republic. Humid zone involves no more than 15% of the country’s territory in the middle- and high mountain areas of the Greater and Lesser Caucasus as well as plain and foothill parts of the subtropics of Talish mountains. Thus, considerable part of the Azerbaijan territory is characterized with insufficiency of natural moisture. In summer months, even in the regions, where in general during the year moisture is excessive, evaporation exceeds precipitation, which results in reduction of moisture provision of the vegetation.

Variety of soil-climatic conditions on the territory of Azerbaijan have conditioned availability under the natural humidification of lands considerably differing according to productivity of the climate. The largest are areas with low and very low biological productivity on the low-lying territories, and the smallest are those with high productivity which are only within two agro-climatic regions - Lenkoran-Astara and western part of Zagatala-Gabala.

5.2.2. Assessment of Possible Changes of Agroclimatic Resources

Thermal resources. According to estimations, on the territory of the Republic, with realization of the considered scenarios $\sum t > 10^0$ may increase by $1,000-1,250^0$ **(GISS)**, $1,000-1,500^0$ **(GFDL-3)** and $300-850^0$ (**artificial** scenario) depending on the regional peculiarities. Duration of the period with the air temperature higher of this limit may respectively increase by 20-40, 30-50 and 3-30 days. The borders of thermal belts in the mountains as compared with present ones will shift upwards by 550-850 m **(GISS),** 700-950 m **(GFDL-3)** and 250-450 m (**artificial** scenario), which will result in expansion of the warm and temperate thermal belts and reduction of the cold thermal belt. With this, maximum changes will take place in realization of the **GFDL-3** scenario, and minimum - **artificial** scenario.

Moisture resources. According to the **GISS** model on the territory of the country an increase of the annual precipitation amount by 6-12% is expected. Maximum increase of precipitation will take place in summer (by 15-40%). In winter, it will make up 15-21%, and in spring and autumn will vary from -9 to +17% depending on the regions. Realization of the **GFDL-3** model presumes change in the annual amount of precipitation from -5 to +4%. In summer, almost in all regions with exception of the north-eastern slope of the Greater Caucasus where precipitation will not differ from the present norms, everywhere decrease of precipitation amount is expected, which in individual regions may reach 16-17% of the norm (Nakhchivan AR).

Thus, realization of the **GISS** scenario is more favorable as compared with the **GFDL-3** scenario. However, taking into account that maximum increase in precipitation amount is expected in the relatively well humidified areas of the Republic which constitute a little part of its total territory, then it can be concluded that this increase will not play a significant role. As to humidification by precipitation during the warm and especially summer period of the year, this will be insignificant with considerable rise in temperatures and subsequent increase of evaporation rate.

Estimations show that with realization of the **GISS** scenario intensification of evaporation is possible in average by 35%. In absolute amounts this will make up 180-540 mm per year, 120-470 mm during the warm period and 20-290 mm during summer. With realization of the **GFDL-3** scenario the expected increase in evaporation will be approximately the same as in the **GISS** scenario. Relatively favorable condition may form with realization of the **artificial** scenario, when evaporation may increase in average by 15% as compared with the base norms, which in the absolute values will make up 70-220 mm during a year, 50-190 mm during the warm period and 20-120 mm during summer.

Evaporation more considerable increase as compared with precipitation will result in worsening of conditions of natural humidification of the Republic territory with realization of all three scenario. With doubling of CO_2 in the atmosphere the borders of humidification zones on the territory of Azerbaijan may be shifted upwards by 100-200 m, in places up to 400 m according to **GISS** scenario; by 150-250 m, in places up to 500 m - **GFDL-3** scenario; and by 50-150 m with realization of **artificial** scenario.

Estimations on Bio-Climatic Potential (BCP) of changeable climate for each climate change scenario have shown that with realization of the **GISS** scenario the BPC value over the Republic territory may increase by 4-22% depending on regions, while under **GFDL-3** it will change from -2 to +13%, and under the **artificial** scenario it may increase by 8-23%, with exception of Talish, where its decrease by 7% is expectable. If in mountainous and well humidified plain areas the BCP increase is possible beyond the limits of current assessment scale of bio-climatic productivity, i.e. lands will become more productive (the **GISS** scenario), then in dry-steppe and semi-desert areas BCP increase will be too insignificant to influence those lands' natural productivity increase. With realization of the **GFDL-3** scenario it is possible to suggest that in the country's western part the productivity will to a certain extent rise and will remain at current level in the eastern part, as it is possible to ignore the BCP decrease by ~1,5% in the north-eastern slope of the Greater Caucasus and in Talish. With the **artificial scenario** realization, considerable increase in BCP is expectable in the north-east part of the country. Although the BCP may decrease by 7% in Talish, however this figure will be within the limits of a range which is assessed as very high.

In general, a conclusion should be drawn that boundaries of lands with very low and poor productivity will actually not change under all the climate change scenarios. At expense of lands with middle productivity located in the foothill - low-mountainous belt the area of higher and high productivity lands will increase.

5.3. Land Resources

Land resources vulnerability to climate change and their adaptation potential have been assessed based on studies on possible impact of expected agroclimatic conditions on topsoil. The main criteria for assessment was provision with the heat and moisture. The study has revealed:

- forthcoming climate change will lead to decrease in productivity for all types of soils, with the exception of those in the alpine sub-zone (sod mountain-meadow and peat mountain-meadow soils). Chemical and biochemical processes and soil weathering will be speeded up. Conditions will be created for soil formation in the deeper layers. In the alpine zone it is expected that meadow vegetation productivity will increase, income in the soil of organic residues will increase, which will lead to some increase of the humus content and improvement of soil fertility;

- general decrease of humus in soils starting from the meadow steppe soils of the sub-alpine zone till the gray-brown soils of semi-deserts will lead to deterioration of their structure, and physical and chemical characteristics. Decrease of water-stable aggregates will take place, along with increase of density of soils and deterioration of their water-air and gas regime. This process will be more intensive in the areas subject to erosion and salinizaion, moderate in brown and cinnamon soils of mountain forests and poor in the mountain-forest yellow soils of humid subtropic forests;

- deterioration of physical characteristics of soils, rarefying and loss of the vegetation at considerable areas will reduce resistance of the topsoil to erosion processes, and expected summer precipitation as rain falls will considerably aggravate these processes, which will result in the increased areas of eroded lands (by 10-15%);

- at the Kura-Araz lowland, a 10-15% increase of the area of lands with different level of salinization will take place. The process will be particularly intensive in the irrigated lands not covered by the collector-drainage network.

Climate change mitigation strategy includes all measures aimed at maximal conservation of soils and maximal use of available land resources. As the main measures the following have been identified:

- forest rehabilitation on the territory of existing summer pastures;
- anti-erosive agro-forest melioration;
- melioration of salinized lands.

Thus for mitigation of the climate change impact on the country land resources already now it is necessary to undertake preventive adaptation measures on the area of approximately 1.7 million hectares.

5.4. Agriculture

Cotton. Considerable increase of thermal resources with realization of the **GISS and GFDL-3** scenarios (by 1,000-1,500^0) and subsequent extension of the vegetative period (up to 40-50 days) will favor for the crops. First, climatic area of potential cultivation of the crop will expand and second, this will enable to replace traditional middle-matured species of cotton with more valuable fine-fibred late-matured ones on large areas. Negative effect of air temperature rise will be considerable (1.5-2 times) increase of recurrence of dry wind arid days number of which may reach 50-60 days and more in the warmest regions in the Kura-Araz lowland.

Increase of winter precipitation may favorably influence pre-sowing humidity of soil which will enable to save water supplied to the field during the pre-winter irrigation. Moisture deficiency will considerably increase (climatic irrigation norm), by 350-450 mm (3.5-4 thousand m^3/hectare) during the vegetation period in the warmest and most dry regions. With availability of irrigation water climate warming will be favorable for cultivating of cotton and it may be expected that productivity will increase by 10% and respectively it will decrease in average by the same amount with undertaking of arduous irrigation regime.

Winter wheat. As a result of climate change in the traditional areas of grain growing it can be expected that vegetation period will be reduced by 13-40 days. Climatic potential will appear for expansion of winter wheat in middle mountains. However because of restriction of land resources considerable expansion of areas will not take place. As in the present time, in the future the main yield will be collected from the irrigated fields. Therefore productivity of fields will mostly depend on provision with irrigation water. In the dry-farming zone with realization of the **GISS** scenario reduction of yield by 3-4% is expected and with **GFDL-3** scenario its increase will make 7-9%.

Grapes. With the climate change all scenarios, the temperature increase in warm period will allow to involve middle-mountainous area under wine-growing, while its increase in winter period will allow to cultivate vine in the open ground. Though these conditions enable expansion of vine to considerable altitudes, in the commercial scale its cultivation in the open ground will be efficient till the altitudes 1,200-1,400 m, and up to 800-900 m on the north-eastern slope of the Greater Caucasus. Increase of air temperature, particularly during the period of maturation of grapes may contribute to decrease of acidity and increase of sugar content and sugar-acid coefficient, i.e. quality of juice. This will probably be favored by some decrease in precipitation amount in the autumn period particularly for late-matured species. Decrease in precipitation amount in spring may result in reduction of productivity of dry-farmed vines, which will not be compensated even with increase of precipitation in summer. The same may occur at the irrigated vineyards if in spring they do not get water. The main shortcoming in the realization of the **GISS** and **GFDL-3** scenarios is the rapid increase in the number of days with extremely (stress) for plants temperatures of air, moisture deficiency and associated recurrence of dry wind days. Implementation of relevant meliorative measures will allow to considerably reduce negative consequences of climate warming.

It is expected that the climate change will result in decrease in productivity of dry-farmed vines in average by 10% according to the **GFDL-3** scenario and in its increase by 5% according to the **GISS** scenario. Climatic conditions during the period of grapes maturation will favor for improvement of the quality of juice: it can be expected that sugar content will increase by 5% in average while acidity will decrease by 1%. With realization of the artificial scenario changes will be not very significant and will make up +3 and - 0.5% respectively.

Winter pastures. Forthcoming climate changes will result in considerable expansion of climatic borders of winter pastures, however actually the area of winter pastures will not increase, as these territories are being intensively used for plant growing. On the existing pastures, where the air temperature in winter will be mostly positive, increase of temperature will ensure winter vegetation of ephemeral plants. However on this background, insufficient amount of precipitation in winter (**GISS**) and in spring (**GFDL-3**) may negatively influence their productivity. With realization of the **GISS** scenario productivity of winter pastures during winter grazing will deviate from the present norm from +2,9 to to 5,7%, and in general its insignificant (by 1.9%) decrease is expected. In general, spring productivity of the country pastures will also change in average by 1.2%, ranging in different regions from +2.4% to - 4.5%. With realization of the **GFDL-3** scenario average decrease of winter yield over the country territory will make up 1%, with the maximum decrease being observed at the pastures of the Shirvan (3%) and Adjinour (4,5%) steppes. Spring productivity of pastures will increase in average by 3.5%. It will decrease by 1-1.5% on the pastures of the Shirvan steppe and Gobustan and increase by 3-13% at others. As a result of climate change (**GISS**) number of non-grazing days on the majority of pastures in average will be close to zero. Non-grazing will be observed only in the mountainous parts of Gobustan and at the pastures of Nakhchivan AR, though with less duration as compared with the present one. With realization of the **GFDL-3** and **artificial** scenarios the number of non-grazing days in Gobustan will make up 22 and 32 days respectively, and in the near-Araz plains with both scenarios it will make up 12 days. As a result, decrease of the amount of reserve forage is expected which is needed for case of possible non-grazing on the pastures of the Nakhchivan AR by 55% and up to 100% on the other territories (**GISS**). With realization of the **GFDL-3** scenario they will reduce by 55% in Gobustan and 40% in the Nakhchivan AR, and with realization of the **artificial** scenario - by 34 and 40% respectively.

For mitigation of negative impacts of climate change the farming system of Azerbaijan in the future should be even more based on the water and soil saving technologies, aimed at optimal utilization of solar radiation and atmospheric CO_2 in order to obtain as much as possible yields, i.e. maximal realization of the BCP. With this, it is necessary to take specific adaptation measures aimed at:

- prevention and mitigation of salinization, water and wind erosion, droughts and dry winds;
- optimizing the field works periods;
- expansion of the areas of dry-farming for grain-growing in the middle mountain zone with favorable soil conditions;
- selection and introduction in the most arid and dry wind areas of the drought-enduring breeds of winter wheat;
- selection and introduction of breeds of winter wheat resistant to lodging;
- selection and introduction of the most thermofilic and late-matured breeds of cotton in the traditionally cotton-cultivating areas; expansion of areas under cotton involving newly warming areas;
- selection and introduction of highly productive breeds of cotton with routine maturation periods;
- terracing of the mountain slopes;
- expansion of areas of mountainous wine-growing with consideration of the optimal ratio of technical and table breeds; creation and rehabilitation of wine-yards on the terraces;
- selection and introduction in the warmest and dry areas of drought-enduring breeds of vine, creation of high-stem bushes;
- expansion of the area under orchards and tea plantations on the terraces;
- expansion of tea plantations in the foothill area on the southern slope of the Greater Caucasus.

5. 5. Forestry Resources

Azerbaijan belongs to regions with little forest cover constituting as of 01.01.1988 in average 11%, which is 2.5-3 times less than standard accepted in the world practice. Over the territory of the country forests are distributed unevenly. Almost 95% of forests are in mountains. Forest cover in mountains varies within 18-43%, while in low-lying areas it constitutes 0.5 - 2% (Figure 5.2).

Figure 5.2. Forests of Azerbaijan

Forests of Azerbaijan play first of all environment-forming and nature-protecting roles. Therefore they all belong to the first group. Only sanitary and maintenance cutting is allowed in these forests. Because of the expected climate change this role of forests not only will remain but will also increase. With total wood-stock in the forests of Azerbaijan equal to 127.44 million m^3 and with annual increase of 1.34 million m^3, these indices are distributed unevenly by regions and vary within 0.002-48.81 million m^3, and increase of wood varies within 0.86-1.89 m^3 [3], with average value of 1.67m^3 per hectare of the forested territory.

Diversity of the soil and climatic conditions over the country territory have conditioned existence of forests with very rich dendrocomposition. More than 350 woody and bush species grow here, however the majority (87.8%) of woody species belong to the stiff-leafed ones. Soft-leafed and coniferous species constitute 2.2 and 1.6% respectively.

Low average growth and low woody stock in the country forests are associated with wide-spread forests with incomplete stand, light forests, forests with low-value woody species, as well as non-optimal soil and climatic conditions and ever-growing anthropogenic pressure on forests. However, the Azerbaijan forests have climatic potential for high productivity [4]. Estimations have shown that the climatic index of the Republic forests' potential productivity may increase by 23 to 53% with realization of the climate change scenarios.

Maximum impact on forests will make realization of the **GISS** and **GFDL-3** scenarios, when the upper climatic border of the forests may rise to 550-950 m on the Greater Caucasus and Lesser Caucasus, while in the Talish mountains it will decrease by 100-200 m. Lower climatic border of forests may be shifted upwards by 50-200 m. At the same time given the present anthropogenic load at the upper and lower borders of forests it can be concluded that in fact the forests borders will not change. Some changes will take place in the dendrocomposition and productivity of forests.

As a result of the expected warming of climate with realization of the **GISS** and **GFDL-3** scenarios it can be assumed that area of stiff-leaved species will decrease approximately by 2-2.5 %. It is expected that the areas under oak and beech forests will reduce (by ~3-3,5 % and ~15% respectively), and under hornbeam forests will increase (by ~ 19%). The total area under stiff-leaved species may decrease by approximately 17 thousand hectares. Decrease is expected of soft-leaved species by ~4 thousand hectares (~20%). Area of other woody species may increase approximately by 12%, and bushes - approximately by 70% or 13-14 thousand hectares. In general over the Republic territory, area of forests will decrease by 7.6 thousand hectares. As a result of this, changes will take place in stocks and annual growth of carbon sequestered in the wood. Due to the change of the species composition on the area of 13.5 thousand hectares and reduction of the area of forests by 7.6 thousand hectares decrease of the total carbon stock in the forests will reduce as compared to baseline by 859.4 thousand tons, and annual growth of sequestered carbon will decrease by 10.3 thousand tons or approximately by 2%.

Thus it can be assumed that forthcoming climate change will not have direct considerable impact on present borders, composition and productivity of forests. However, in combination with anthropogenic pressure its role in intensifying the degradation process of forests will notable increase. Mitigation of the climate change consequences will be achieved through measures aimed at increasing the resistance of forests:

- following to forest protecting legislative acts;
- promotion of natural forest rehabiliatation;
- prohibition of life stock grazing;
- fighting with pests and diseases ;
- introduction of highly productive forest species;
- expansion of forest cover.

Considering the very important environment-forming and nature-protecting functions of the forests, **the adaptation strategy** of the forestry to the forthcoming climate change should target the rehabilitation of forests. Preliminary estimations with consideration of interests of different branches of the country economy (first of all agricultural sector) show that optimal forest cover in Azerbaijan is 18-20%. At the Kura-Araz lowland, forest cover can be reached up to 5-7%, in the foothill area of the Greater and Lesser Caucasus - 20-25%, and in the mountainous forest zone - 35-40%. Reserve for further expansion of forest area are non-covered areas of the forestry fund, lands non-applicable or little applicable for agriculture as well as lands to be re-cultivated. Considerable reserve for afforestation can be old felling areas grown with low-value trees and bushes, glades, pastures and burnings.

Afforestation measures should be undertaken with consideration of the following tasks:

- to achieve optimal balance between branches of economy
- to increase the productivity of forests;

The first task can be addressed through involvement in the forestry area of territories little applicable or not applicable for other sectors of economy. The second one - through selection of highly productive woody species capable to adapt to forthcoming climate changes, improvement of the structure and productivity of existing forests, etc. Therefore, for undertaking of forest rehabilitation measures, the most suitable wood and bush species should be selected.

For mountain conditions of Azerbaijan the most perspective dominant species are oaks (different), beech, hornbeam, birch, pine and others. In the steppe forests - oak, pine**,** turpentine-tree, ailanthus, elm-tree and other drought-enduring species. The best associated species for mountain conditions are maple**,** lime, ash, cherry-plum, cherry-tree, hazel and others. For the steppe regions - maple, Japanese pagoda, hawthorn, apricot-tree, mulberry and others.

With afforestation of mountain slopes, sandy lands and shelterbelt forests perspective are land-protecting bushes: acacia, *Rhus*, elder, dogrose, hornbeam and others. For afforestation of sandy lands the following species may be recommended: pine**,** fig-tree, tamarisk, pomegranate-tree, bindweed, etc. The most resistant and effective species for afforestation of salinized soils are acacia, mulberry, tamarisk, pomegranate-tree and others.

In order to achieve these targets, by the year 2020, forests on the area of 200 thousand hectares should be rehabilitated. Low-value plantations on the area of 190 thousand hectares should be rehabilitated. Forests with incomplete stand on the area of more than 100 thousand hectares may be transformed into full-stand forests through encouraging the processes of natural regeneration as well as nursery production of valuable tree species, providing for increase of productivity of these forests by 2 -3 times.

In order to protect the country agricultural lands and plantations from the water and wind erosion, droughts and dry winds it is necessary in the nearest 20 years to set up about 16 thousand hectares of shelterbelt forests on these lands, with further expansion of this area by another 9-10 thousand hectares.

The summarizing Table 5.5 shows priority measures which reflect possible ways to achieve these targets. These measures would play an important role in adaptation of other natural complexes and sectors of the economy as well.

5.6. Coastal Areas of the Caspian Sea

Social-economic and environmental problems of the coastal area of the Caspian sea have evolved as a result of development of natural resources of the sea itself and coastal areas. These problems are aggravated with fluctuations of the sea level which is a result of mainly global climatic changes.

Changes of the Caspian level in the temporal scale is classified in the following order: secular (historical), long-term, annual (seasonal) and short-term. Summarizing the findings on dynamics of the Caspian level fluctuations obtained by a number of authors [10,18,36]it can be concluded that the sea level historically was within a range from -20 to -34 m of the abs., i.e. the range of variation made up 14 m. In the historical view, the Caspian sea level fluctuations are of cyclic nature with different periods. However, the most characteristic are levels from -25 to -27 m (40%). According to data from the State Committee on Hydrometeorology, between 1978 and 1995 the sea level has risen by 2.5 m and achieved -26.42 m. This is the most intensive and prolonged rise of the level for the whole period of instrumental observations (Figure 5.2), which is associated with the increase of humidity in the basins of river flow (by 10-11%) and decrease of irreversible consumption of river waters [   ].

Having risen during the recent 18 years the sea level caused damage to a number of industrial facilities and infrastructure of Azerbaijan. This is first of all associated with the fact that during the whole 20th century (up to the 1980s) development of the coastal area took place under the regressive phase of the variation. Therefore many current problems are consequences of flooding of the previous shelf zone of the sea. For the time being, 485 km^2

of the coastal area have been flooded. The damage area covers 50 settlements, 250 industrial enterprises, 10 thousand hectares of irrigated lands, and recreation facilities for 200 thousand people. Total damage by sectors of economy as of 1994 is estimated at approximately 2.0 billion USD [16].

As a result of flooding of the coastal area critical situation has emerged at the Lenkoran-Astara section of the coastal zone and the Apsheron peninsula, where settlements have been flooded and secondary contamination of the sea from oil fields is taking place.

In the majority of recent studies data presented by a number of researchers coincide that with warming of the climate increased humidification in the basin of the Caspian sea in the nearest future will remain and the sea level will vary within -26.0 to -25,0 m of abs. [19,33,37]. Analysis of literature data on the level during the period of 1830-1996 allows to conclude that for potential assessment of the climate change impact on the coastal areas of the Caspian sea it is necessary to base on the rise of the sea level up to the level of -25.0 m of abs (similar rise was observed in 1882).

Estimations show that with the Caspian level rise by another 150 cm flooded will be additional 87.7 thousand hectares of the coastal area and by 2030-2040 flooded area will total 136.2 thousand hectares or 1.6% of the total area of the country (Table 5.3). Social and economic damage to economy of Azerbaijan will make up 4.1 billion USD (Table 5.4).

Table 5.3. Estimations on flooded area in the coastal territory in Azerbaijan

Areas	Shoreline length, km	Flooded area, hectares	
		As of 1995 (-26.5 m abs)	Expected by 2030-2040, (-25.0 m abs)
Northern coastal plain (from the Samur river mouth to the Apsheron peninsula)	152	4230	12400
Apesheron peninsula	290	3820	6010
Kura river delta and Kizilagag bay	208	37230	111800
Lenkoran-Astara zone	87.7	3170	5980
Total over Azerbaijan	738	48450	136190

Table 5.4. Expected social and economic damage to the coastal area in Azerbaijan with the Caspian sea level rise up to -25.0 m abs. (million USD in prices of 1998)

Social-economic complexes	Years	
	1994	2030-2040
settlements, agricultural facilities	385	693
flooded agricultural lands	159	287
railways and roads	371	697
ports and other constructions	155	287
oil and gas industry	573	1107
sanatoria and recreation facilities	189	369
fishery	217	410
others	103	205

Aimed at maximum reduction of losses from the coastal areas flooding adaptation strategy for the nearest 30-40 years has been developed for the levels -26 and -25 m. Within these levels development of the areas flooding of which would result in serious economic and environmental consequences should be stopped.

Adaptation strategy to the rise of the Caspian sea level has been developed with consideration of the following protective measures:

- setting back from the advancing sea. Settlements and facilities left in the area are locally protected by a ring dam scheme or through man-made embankments with communication facilities with the main territory;

- local protection of existing locations through containment with ring dams or through man-made embankments with reconstruction of facilities. Resettlement and dislocation of facilities are to a considerable extent less as compared with the previous version;

- maximum protection of the existing premises, facilities and important areas. The main protection facilities - frontal dams to protect the facilities and intensively developed coastal areas; ring dams - to protect individual facilities. Resettlement and dislocation are minimal.

Taking into account the sea level expected rise, dislocation of industrial facilities, construction of dams, and implementation of environment protection measures are considered as priority actions (Table 5.5).

Table 5.5. Priority adaptation measures listed in NCCAP of the Azerbaijan Republic

Sector	Objective	Measure	Expenditure, million USD	Expected results
1	2	3	4	5
Water resources	Reduction of losses of available resources and their rational use	Construction of water reservoirs of complex destination and increase of efficiency of the existing water reservoirs on mountain rivers Improvement of the water resources management system Reconstruction of mains of channels and irrigation systems Use of water-saving technologies in water consumption system, introduction of update irrigation technologies Afforestation and setting of anti-abrasion shelterbelts around the lakes and water reservoirs; shelterbelts along the rivers banks and the irrigation and collector-drainage network lines on the area of 13.8 thousand hectares	305.5 12.0 to be identified by the project 418.0 9.7	Saving of more than 10 million ì^3 available water resources
II. Agriculture	Improvement of meliorative state and increase of productivity of agricultural lands	Agro-climatic regioning of the Azerbaijan territory for changeable climate conditions Optimizing of location and structure of agricultural lands with introduction of crops and breeds resistant to expected climate change Reconstruction and restructuring of irrigation systems Implementation of desalinization measures on irrigated lands with to area of 218 thousand hectares Setting of shelterbelts on the area of 25 thousand hectares	0.4 to be identified by the project to be identified by the project 545.0 17.8	Introduction of highly productive breeds of agricultural crops, optimizing of location and structure of agricultural lands, melioration and introduction of the new lands in agricultural use

1	2	3	4	5
II. Agriculture		Setting of orchards, vineyards, tea leaf plantations on terraced slopes on the area of 107 thousand hectares Setting of shelterbelts on the area of 57.3 thousand hectares	50.0 40.1	
III. Coastal zone	Protection of settlements, industrial facilities and infrastructure in the sea influence zone Improvement of ecological status of the coastal zone	Re-settlement of people from 15 settlements Dislocation of 15 industrial complexes and administrative promises Rehabilitation, dislocation, and protection of land transport infrastructure Engineering protection of recreation facilities Protection of port constructions in the Baku city Re-cultivation of oil-contaminated lands Construction of regional drainage network and water treatment facilities on the Apsheron peninsula Clean-up of the Baku bay from oil contamination and solid wastes	72.0 180.0 19.8 85.0 425.0 74.0 164.0 200.0	Protection of coastal lands, settlements and recreation facilities, land transport infrastructure, port and hydro-technical facilities from floods, leakage and destruction Elimination of coastal lands and waters contaminating sources
IV Forestry resources	Optimum forest cover, increase of the forests productivity	Rehabilitation of mountain forests on the area of 200 thousand hectares Regeneration of low-value plantations on the area of 190 thousand hectares Improvement of forest stand on the area of 100 thousand hectares Rehabilitation of tugay forests on the area of 36 thousand hectares	140.0 100.0 50.0 25.2	Expansion of forested area, rehabilitation of environment-forming and nature-protection functions of the forests, increase their productivity
V. Land resources	Conservation of land resources	Implementation of engineering-protective measures in the basins and beds of the rivers subject to mud flows Terracing of mountain slopes on the area of 105 thousand hectares Binding and afforestation of sands on the area of 26.4 thousand hectares.	120.0 131.5 18.5	Protection of the lands from mud flows, mitigation of desertification and erosion processes, introduction of new lands in agricultural use

6. EDUCATION AND PUBLIC AWARENESS

One of the important components in implementing the commitments under UNFCCC is the development and promotion of public awareness on climate change and its consequences, preparation of scientific and technical specialists.

During the period of preparation of the National Communication in the National Climate Change Center of the Hydromet training of specialists in all fields of climate change has been organized, including experts from 18 state institutions of Azerbaijan. Some specialists have received training in the international training centers in Israel, Germany, Russia, Iran, UK and other countries. Experts of Azerbaijan actively participated in the forums which were held by WMO, IPCC, UNEP, GEF, UNDP, Tacis and other organizations, which address different aspects of the climate change.

Scientific foundations of climate change are being taught at the Baku State University and environment protection is included in the curriculum of many universities in Azerbaijan. However there is no training on climate change specific aspects, as relevant changes in the tertiary education curriculums have been made only recently.

Educational, institutional and scientific workshops have been held on all aspects of the climate change. These workshops have been held with active participation of representatives of the Government, ministries and agencies, scientific communities, local and international NGOs dealing with the climate change problem. In April 1999, an international workshop was held in Baku by the GEF National Communications Support Programme and UNDP, with participation of representatives from the Eastern Europe, Caucasus and Central Asia.

Findings of researches have been presented in 4 scientific bulletins, as well as information leaflets and articles published in journals and newspapers.

Results of the work on producing the National Communication have been presented at Climate Change State Commission meetings and at open hearings of Milli Medjlis (Parliament) of Azerbaijan. A number of briefings for mass media have been held and special radio-and TV programmes have been organized.

7. CHALLENGES AND PROSPECTS OF FUTURE STUDIES

Production of the Azerbaijan First National Communication on Climate Change is the first step in fulfillment of the country's commitments under the UN Framework Convention on Climate Change. Results of the conducted work show that within the frames of this document it is impossible to address all the problems associated with the climate anthropogenic change. Some of these problems are caused by local factors, such as lack of research methodology in some sectors, insufficient level of national system of initial data collection, etc..

Therefore some additional research should be undertaken in the future, including:

- improvement of GHG inventory with consideration of update data and system of producing of national inventory on a regular base;

- development of research methodology on inventory of fugitive gases (associated gas with low pressure) from oil fields with consideration of local conditions;
- assessment of potentials of voluntary commitments to reduce greenhouse gas emissions amounts;
- additional assessment of agriculture and forestry vulnerability and adaptation potential;
- assessment of fish resources vulnerability to climate change and adaptation measures;
- impact on desertification process from climate change and mitigation measures;
- assessment of biodiversity vulnerability to the climate change and development of measures on its conservation;
- assessment of the Kura river water resources vulnerability with consideration of economic activity over the entire basin;
- paleogeographic research on climate change and the Caspian sea level fluctuation;
- development of national legislative framework on the problems of climate change.

Apart from above mentioned measures, it is necessary to develop and improve the climate monitoring system including its technical upgrading, and carry out observations in the highland areas and Caspian water basin.

Also it is necessary to carry out additional surveys in order to reduce uncertainties in economic forecasts. Implementation of measures on greenhouse gas emissions reduction may differ from forecasts due to economic difficulties in the country, possible changes in the Government policy, legal and regulation bases etc. Changes in scientific understanding on the climate change problem also may force to review the developed measures.

However, Azerbaijan cannot implement the above listed activities under existing situation due to lack of financial resources, therefore additional financial support is required.

INSTITUTIONAL STRUCTURE FOR UNFCCC COMMITMENTS IMPLEMENTATION IN AZERBAIJAN

In line with the Article 4 and Article 12 of the UNFCCC all the Parties to the Convention are on the regular base to develop, produce, publish and update their national programmes containing mitigation measures on climate change effects through addressing the problem of greenhouse gases emissions from anthropogenic sources.

Understanding the necessity of prevention of the climate change effects and in order to implement commitments under the Convention, a State Commission on Problems of Climate Change was established in 1997 by the Decree of the President of Azerbaijan Republic, G.A. Aliyev, which has been headed by the Deputy Prime Minister A.G. Sharifov. Heads of the following organizations are the members of the Commission:

- State Committee on Hydrometeorology
- Ministry of Finance
- Ministry of Agriculture
- Ministry of Health
- Ministry of Foreign Affairs
- State Committee on Science and Technology
- State Committee on Melioration and Water Resources
- State Committee on Ecology and Nature Utilization Control
- Academy of Science
- State Oil Company
- “Azerenergy” Joint Stock Company
- “Azerchemistry” State Company
- “Azerbaijan Air Lines” State Concern
- “AzerAutotransport” State Concern
- “Azerbforest” Production Association
- “Azerigaz” Joint Stock Company.

According to the resolution of the Government of Azerbaijan, State Committee on Hydrometeorology has been appointed the main coordinating institution in association with the UNFCCC. Chairman of the State Committee on Hydrometeorolgy, Z.F. Musayev has assumed the positions of Deputy Chairman of the State Commission and National Coordinator of the UNFCCC. In the National Climate Change Center of the Azerbaijan State Committee on Hydrometeorology a group of experts has been established for inventory of GHG, study of the climatic system and vulnerability, development of adaptation and climate change mitigation measures. Leaders of the Center are M.R. Mansimov and I.R. Aliyev.

During the implementation of the project UNDP/GEF “Preparation of the First National Communication of Azerbaijan on Climate Change” in the NCCC of the Hydromet a database has been established, a complex of programmes has been developed, as well as close cooperation has been organized with relevant national institutions and international organizations.

Studies of the climatic system, ecosystem vulnerability assessment and development of adaptation measures have been implemented by experts of the Hydromet, Institute of Geography of the Academy of Science, “Azerforest” Production Association, Ministry of Agriculture, State Committee on Melioration and Water Resources, State Committee on Ecology.

GHG inventory and climate change mitigation measures have been developed by experts of the State Committee on Hydrmeteorology, Ministry of Economy, Radiation Sector of the Academy of Science, Research Institute on Resource Saving, “Azerforest” Production Association, Ministry of Agriculture, SOCAR, “Azerenergy” Joint Stock Company, “Azerigaz” Joint Stock Company, Ecology Department of Baku Municipality, “Azerchemistry” State Concern.

Abbreviations

AS - Academy of Science
JSC - Joint Stock Company
AR - Autonomous Republic
GDP - Gross Domestic Product
WMO - World Meteorological Organization
Baku c. - Baku city
y. - year
yy. - years
SOCAR - State Oil Company of the Azerbaijan Republic
SRPS - State Regional Power Station
HPP - Hydro Power Plant
GEF - Global Environment Facility
USD - US Dollar
EBRD - European Bank for reconstruction and Development
CJSC - Closed Joint Stock Company
EC - Efficiency Coefficient
IGCC - Intergovernmental Group on Climate Change
MW - Mega Watt
mill. - million
bill. - billion
NCCAAP - National Climate Change Adaptation Action Plan
NCCC - National Center on Climate Change
UN - United Nations
GAC - General Atmosphere Circulation
GHG - Greenhouse Gases
STU - Steam-Gas Units
PA - Production Association
UNDP - United Nations Development Programme
Araz r. - Araz River
Fig. - Figure
UNFCCC - United Nations Framework Convention on Climate Change
USSR - Union of Soviet Socialist Republics
USA - United States of America
Tab. - Table
TRACECA -
CFT - Conventional Fuel Ton
ths. - thousand
FEC - Fuel Energy Complex
FER - Fuel Energy Resources
TPP - Thermal Power Plant
TPM - Thermal Power Main
pcs. - pieces

Measurement units:

Gg - Gigagram
Gcal - Gigacalorie
kW - kilowatt
kW-hour - kilowatt hour
km - kilometer
m - meter
PJ - Peta Joul
cm - centimeter
t - ton

Chemical formulation:

ÑÎ$_2$ - carbon dioxide
ÑÎ$_2$-eq - carbon dioxide equivalent
ÑH$_4$ - methane
N$_2$Î - nitrous oxide
NO$_{õ}$ - nitrogen oxides
ÑÎ - carbon monoxide
NMVOC - non-methane volatile organic compounds

Titles of models:

GISS - Goddardov Institute of Space Studies, USA
CCCÌ - Canadian Center on Climate Meteorology
UKÌ Î - United Kingdom Meteorological Office
GFDL-3 and GFDL-T - Geophysical Laboratory of Hydrodynamics, USA
GRADS - Programme Complex