MINISTRY OF NATURE PROTECTION

TURKMENISTAN:

INITIAL NATIONAL COMMUNICATION

ON CLIMATE CHANGE

UN FRAMEWORK CONVENTION
ON CLIMATE CHANGE

GEF

UNEP

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List of abbreviations, acronyms, and terms

JSC	Joint-Stock Company
GDP	Gross Domestic Product
WMO	World Meteorological Organization
WCP	World Climatic Program
GNP	Gross National Product
HFCs	hydrofluorocarbons
HCFCs	hydrochlorofluorocarbons
HPS	hydroelectric power station
GEF	Global Ecological Fund
EC/Tacis	European Community/Tacis
EC	Efficiency Coefficient
IPCC	Intergovernmental Panel on Climate Change
RER	Renewable Energy Resources
NCP	National Climatic Program
NMVOC	Non-methane volatile organic compounds
NGOs	Non-Governmental Organizations
GCM	General circulation model
GHG	Greenhouse gases
GWP	Global Warming Potential
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
CIS	Commonwealth of Independent States
FEC	Fuel and energy complex
GPP	Generating power plants
CFCs	chlorofluorocarbons
ECO	Economic Cooperation Organization
UNEP	United Nations Environment Program
CCC	Canadian Climate Center
GISS	Goddard Institute of Space Studies
GFDL –T	Non-equilibrium model of Geophysical Fluid Dynamics Laboratory, University of Princeton, USA.
GFDL	Equilibrium model of Geophysical Fluid Dynamics Laboratory, University of Princeton, USA
UK89	equilibrium model of the United Kingdom Meteorological Agency

Chemical Symbols

CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
N_2O	Nitrogen oxide
NOx	Nitrogen oxides

Units of Measures

°C	degree Celsius
ha	hectare
GW	gigawatt (10^9 watt)
Gg	gigagram (10^9 g)
Gcal	gigacalorie (10^9 cal)
KWh	kilowatt (10^3 watt) hour
km	kilometer
km^2	square kilometer
m	meter
m/s	meter per second
m^3	cubic meter
MW	megawatt (10^6 watt)
PJ	petajoul (10^{15} joul)
t	ton
toe	ton of oil equivalent
tcf	ton of conditional fuel

The terminological information

"Energy" - all kinds of fuel and energy resources, unless otherwise specified in the text.

"Final consumption" - consumption of energy by the population and in all sectors of economy with the purposes of final use for production of the goods and services, i.e. excepting use for the non-energy purposes and transformation to other kinds of energy.

"Non-Energy use" - energy used as raw and non-fuel materials in branches of the national economy.

"Oil" - crude oil and gas condensate, and also the products of their refinery.

EXECUTIVE SUMMARY

Introduction

Turkmenistan has signed the United Nations Framework Convention on Climate Change (hereinafter referred to as UNFCCC or Convention) on May 01, 1995 and ratified it on June 05, 1995. Turkmenistan does not belong to any Annex of the Convention.

This National Communication presents information related to national conditions of the country, report on national emissions of greenhouse gases (GHG) for the year of 1994 and execution of responsibilities on UNFCCC, and also outlines the main measures addressed to GHG emissions reduction and adaptation to anticipated climate change.

Climate change studies from 1997 to 1999, including GHG Inventory for the year of 1994, and also preparing and publication of the present document, were carried out with assistance and financial support of the UN Program on Environment and Global Ecological Fund.

National conditions and features of the country

Turkmenistan is located in Central Asia between 35^{o} 08' and 42^{o} 48' N and 52^{o} 27' and 66^{o} 41' E, to the north of Kopetdag mountains, between the Caspian sea in west and Amu Darya river in east. Length west-to-east is 1100 kms, south-to-north - 650 kms. Area of the state is 488,1 thousand square kilometers.

Climate of Turkmenistan is sharply continental, with the exception of the inshore zone of the Caspian Sea and the mountains. Average annual air temperature along the whole territory is positive and ranges on plain part of Turkmenistan from 12^{o}C-17^{o}C in the north to 15^{o}C-18^{o}C in the south-east. The coolest month is January with the average temperature from –6^{o}C in the northeast of Turkmenistan to + 4^{o}C in the south-east and + 5^{o}C in the end west. Average temperature of the hottest month - July is 27-30^{o}C. The absolute maximum reaches 48-50^{o}C in Central and south-east Karakum, being a little diminished in the north of Turkmenistan, at coast of the Caspian sea and in mountain areas. The biggest amount of sediments along the territory is observed in the mountains and in forelands - average is up to 398 mm (Koyne-Kesir), the smallest - above Kara-Bogaz-Gol bay (95 mm) and northeast of Turkmenistan (105 mm).

The desert occupies up to 80% of the vast territory of Turkmenistan. Karakum (the Black Sands) is one of the largest deserts in the world and occupies the whole central part of the country stretching up to Kazakhstan. Topographycally four fifth of the territory of Turkmenistan is plain. The mountains and hills are mainly located in the southern part of the country.

The population of Turkmenistan in 1994 was 4.46 million. Average density of the population in the country is 9.1 persons per 1 sq. km. The majority of the population (54.9%) lives in rural areas. Share of the urban population is 45.1%. The are 5 velayats (regions) in Turkmenistan, 20 cities and 81 settlements of an urban type. Turkmenistan is referred to a number of states, in which high and

stable natural growth of population steadily ensures high paces of manpower growth. The total number of population for the last 10 years increased by 41.9%. Average endurance of life in Turkmenistan in 1994 was 65.8 years, that is a medium index for the countries with medium level of progressing (income). High educational level of the population (literacy 99.8%) creates favorable premises for training qualified workers on modern trades of market economy.

The land fund of Turkmenistan is 488100 sq. kilometers, out of which the floor space of pastures of deserted territories in 1994 was 383416 sq. kms, or 78.6% of the total area of the country. During the years of independence of Turkmenistan completely determined specialization of agriculture has been formed – cotton and wheat cultivation, karakul sheep breeding and silkworm breeding. Basic land users are agricultural communities concentrating more than 70% of land tenure of the country. Of the total area of the territory of Turkmenistan, suitable for irrigation and agricultural cultivation area constitutes 17 million hectares, out of which a little more than 10% are being used at present. Irrigated agriculture produces more than 70% of gross yield of agricultural products. Due to natural and climatic specificity of Turkmenistan, lands of forestry facilities occupy small portion of the land fund - 19761 thousand hectares.

Water resources of Turkmenistan differ by extremely irregular placement on the territory of the country: 95% of them are the share of Amudarya river, other 5% - all other rivers, small rivers, springs, discovered deposits of underground waters in the south and southwest of Turkmenistan. The waters of the southern rivers, Murgab, Tedzhen and Sumbar, small rivers of Kopetdag foothills, for a long time already are completely utilized for irrigation purposes, therefore to meet demands in water of western and southwest regions of the country the Karakum-river is implemented. Due to the Karakum-river, inter-basin flow transfer has strongly changed territorial reallocation of water resources in Turkmenistan. The river has removed the centuries mismatch between placement of the large massives of fertile soils in one part of the country, and water resources - in the other. Thus, about 80% of land suitable for agriculture is located in the south and south-east of the country, while water resources, 95% composed of the Amudarya flow, are in the east of Turkmenistan.

Economy of Turkmenistan

The industry is the leading field of Turkmenistan's economy. At present more than 4.8 thousand industrial enterprises of all kinds of ownership operate in the country, with more than 208 thousand people being their employees. Significance of industry in forming the profit of national economy is rather high (80%).

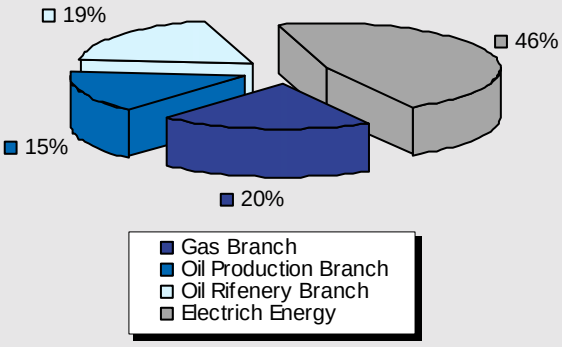
The share of mining branches in the amount of industrial production of the country is 22%. The level of consumer goods production is not sufficient at present. Because of this, the Government of the country pays great attention to investment support of light and food-processing industry. In 1998 the industry managed 2.5 trillion manats of capital investments, that is more than half of total amount of the country's investments.

As a strategic task in the industry, diversification of economy is chosen, that will create large structural transformations. The main emphasis in investment policies is put on a combination of development both export-oriented and import-replacing productions.

The share of fuel and energy complex is 55% of the manufactured industrial products. Turkmenistan is the country - producer of power supplies. Natural gas, oil products, electric energy – are the basic items of industrial export of the country.

The branch structure of the fuel and energy complex is represented in fig. 1.

Fig.1: Branch Structure of FEC



Oil producing and refining branches are being developed by rather stable paces. In 1998 the amount of crude oil production in the country has approximated to 7 million tons.

In 1999 production of crude oil will be increased up to 9 million tons, natural gas – 30.6 billion cubic meters, and in intermediate term outlook the annual amount of crude oil production will make 35-40 million tons.

Priority directions of development in the field of gas recovery are:

- Gas production for home market determined by the Program of Government of Turkmenistan till hundred-percent gasification of the country;
- Gas recovery for production of liquefied gas;
- Gas extraction for the projected production of chemical raw material;
- Gas recovery for electrical energy production with consequent exportation of that;
- Gas recovery for the projected or not operating export gas pipelines (Middle Asia - Center, Pakistan, Turkey, Europe, etc.).

The annual increase of gas recovery is scheduled till the year of 2010, including: in 2005 – 85.0 billion cubic meters, in 2010 – 120.0 billion cubic meters.

Compared to 1998, 3.2 times increase of gas production is projected for the year of 2010.

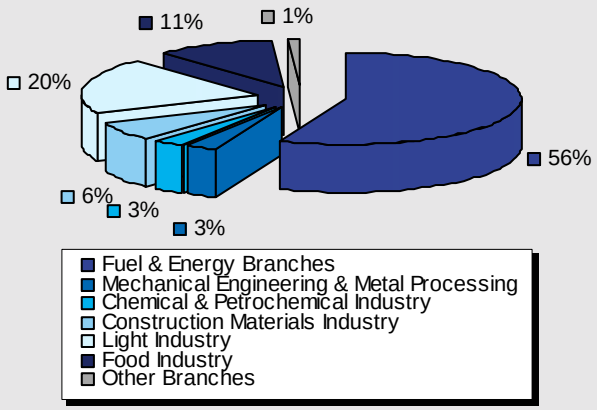
Priority direction in the field of crude oil and gas condensate production is the development of hydrocarbon resources of the Turkmen shelf of the Caspian Sea involving Transnational oil companies on tender basis.

According to the Program of oil and gas complex development, production of oil together with gas condensate in 1999-2010 will total 155.5 million tons, including

in 2005 – 27.5 million tons, in 2010 – 44.5 million tons. Growth in 2010 in relation to 1998 will be 7.4 times. The expansion of exploratory drilling for oil in perspective territories (both inshore and offshore) provides the basis to expect discovery of new fields and to plan putting into operation of those till the year of 2010.

The branch pattern of industrial production (%) is introduced in fig. 2.

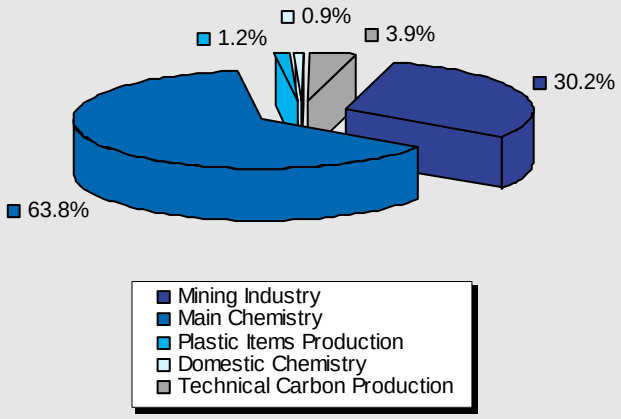
Fig.2: Branch Pattern of Industrial Production



The country annually produces 10 billion kW hours of electrical power. Turkmenistan is the initiator of creation of the common power system of the states – ECO members. Turkmenistan is capable of producing 17 billion kW hours of electrical power, and 47% may be sold to the countries – ECO members.

Such branches represent the chemical and petrochemical complexes of the country as mining chemistry, basic chemistry, production of plastic products, household chemistry and production of technical carbon. Basic chemistry (63.8%) and mining chemistry (30.2%) are the basis of the complex. The structure of chemical and petrochemical complexes is introduced in fig. 3.

Fig. 3: Structure of Chemical and Petrochemical Complexes



According to the investment program of the President of Turkmenistan construction of the following facilities is planned: ammoniac, carbamide factories

in the cities of Mary, Turkmenabat, Sarahs with the total cost of 900 million US dollars; aluminium complex in Mary and cellulose-paper plant in Buzmeyin; calcium bicarbonate factory in Govurdak; caustic factory in Mary and three iodine factories in different regions of Turkmenistan.

Three branches represent mechanical engineering industry of Turkmenistan: mechanical engineering, production of metal constructions and items, repair of machinery and equipment.

Inventory of sources of anthropogenic greenhouse gas emissions and sinks.

National inventory of greenhouse gas (GHG) emissions and sinks in Turkmenistan was complied for the year of 1994, which is recommended by the UNFCCC to be used as a reference year. The Intergovernmental Panel on Climate Change (IPCC) Guidelines of 1996 was taken as the methodological basis for conducting the inventory. The GHG inventory of Turkmenistan consists of 5 sections, which correspond to basic categories of emission sources:

- Power activity, i.e. all activity related to combustion, and also production and processing of fossil fuel;
- Industrial processes;
- Agriculture;
- Variation of land tenure and forestry;
- Household and industrial waste.

The national inventory represents emissions data on three gases with direct greenhouse effect: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O); and on three gases with indirect greenhouse effect: carbon monoxide (CO), oxides of nitrogen (NOx), and non-methane volatile organic compounds (NMVOC), table 1.

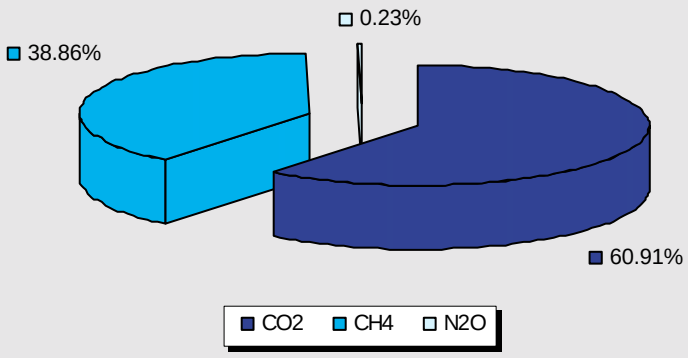
Table 1: Brief Summary Data on National Greenhouse Gas Emission (Gg)

Category of Greenhouse Gas Sources and Sinks	CO_2	CH_4	N_2O	NOx	CO	NMVOC	SO_2
General Emission and Sinks	**31859.07**	**967.865**	**0.40421**	**83.805**	**327.562**	**49.2198**	**22.886**
1. Energy	31019.016	846.46	0.39081	83.805	326.762	44.3578	22.883
A. Fuel Combustion	31019.016	2.46	0.39081	83.575	326.417	41.978	0
Б. Fugitive Emission	0	843.85	0	0.23	0.345	2.38	22.883
2. Industrial Processes	840.054	0	0	0	0.8	4.862	0.003
3. Agriculture	0	110.946	0.0134	0	0	0	0
4. Land Use Change and Forestry	0	0	0	0	0	0	0
5. Waste	0	10.429	0	0	0	0	0

In 1994 greenhouse gas emissions were 52304.766 thousand tons of CO_2 - equivalent, from this amount 31859.07 thousand tons are attributed to CO_2. The relative contributions of the three direct greenhouse gases to total emission for

1994 were as follows: carbon dioxide – 60.91%, methane – 38.86%, nitrous oxide – 0.23% (figure 4).

Fig. 4: Share of Greenhouse Gases Emissions in 1994 (%)



Fuel combustion in Turkmenistan produced 31019 thousand tons of carbon dioxide emissions. The energy production sector is the main source of CO_2 emissions. In absolute terms emissions from this sector amounted 12157 thousand tons in 1994.

Methane emissions in 1994 were 967.865 thousand tons. The main sources of methane emissions in 1994 were oil and gas production and refining (87.2%), agriculture (11.5%).

The main source of nitrous oxide emission in 1994 was the power activity. Emissions amount was 0.4 thousand tons.

The level of uncertainty yielded by national activity initial data in energy-related activities is estimated at 5 to 15%, except in the residential sector, where the inaccuracies could be up to 20%.

The degree of uncertainty for fugitive emissions is equal to 50%. Methane emissions from enteric fermentation in livestock were estimated to contain 25% error. For other categories, the uncertainty is within the limits of 20 to 60%.

According to the preliminary estimations, the greenhouse gas emissions by 2010 will be increased by 62% and in 2000 will exceed the level of 1994. It is directly connected to increase and consumption of oil and gas resources of Turkmenistan. The forecasts will be adjusted in accordance with implementation of the program of social and economic development of Turkmenistan.

Measures for GHG Emissions Reduction

In Turkmenistan, as in the majority of developing and transition countries, GHG emissions reduction and adaptation of the economy to climate change should be integrated with the national and sectoral economic development plans and provision of ecological safety.

Reduction of Greenhouse Gas Emissions

The main efforts in Turkmenistan will be focused on GHG mitigation measures in the energy sector. In the energy and power production sector the following measures are determined:

- Increase of efficiency of fuel utilization at power plants by means of modernization of fossil combustion systems;
- Increase of natural gas share in the energy balance;
- Increase of renewable non-fossil sources of energy in the energy balance.

In electric and heat energy consumption sector the following priority measures were determined:

- To increase the energy efficiency in municipal services and in industry, modernization of heating systems;
- To carry out measures on energy saving in the residential sector and industry.

The Law of Turkmenistan on Energy Saving is at the stage of preparation at present. This law declaratively covers all the aspects of energy saving in both energy production and consumption sectors. The Law defines the framework for governing the energy saving policies at the national level. One of priority measures on GHG emission reduction in the energy production and consumption sector is to design enabling mechanisms to implement the Law on Energy Saving.

Taking into account the availability of resources, existing level of technical development and potential of GHG emissions reduction, the basic technological measures on emissions reduction were chosen. Among those are the programs of modernization of thermal power plants and heating systems, further production increase of hydropower facilities, utilization of wind and solar energy, utilization of gas of oil extraction. All these measures are included in the national programs of energy development.

Realization of the program of rehabilitation and modernization of thermal power plants has the biggest emission potential, followed by construction and operation of wind power plants, small-size hydropower plants, and use of associated gas. At the same time, development of solar energy has the greatest potential for emissions reduction. Implementation of these measures would result in reduction of hydrocarbon utilization in energy sector. Construction of small hydroelectric plants appears to be the most cost-effective and feasible measures.

Modernization of generating plants and building small hydroelectric stations are the most economically effective and feasible measures at present.

Increasing energy efficiency at thermal power plants along with energy-saving and heating systems improvement are included as the main priority for medium and short term in electrical power production sector.

Annual reduction of GHG emission because of development of solar energy at the initial stage can be evaluated in 1-1.5% of the baseline scenario. The sphere of utilization of such installations is possible in the remote and difficult to access areas, where the consumers require small capacities.

Forestry

In the non-energy sector, increasing CO_2 sinks by expanding forest area and converting relatively unproductive arable land into grasslands and rangelands are the most promising measures on the land subject to degradation.

Huge work is being carried out in Turkmenistan related to planting of mainly coniferous trees. A number of Decrees of the Government of Turkmenistan is aimed at achieving this goal:

- About Development of Gardening and Greenery in Turkmenistan, 1993;
- About Creation of Park Zone in Forelands of Kopetdag Mountains, 1998;
- About Establishing of Green Belt Joint-Stock Company (woodland parks surrounding all cities of Turkmenistan), 1999.

Measures like increasing livestock productivity and optimization of rice fields areas, could provide reductions of up to 20% of the methane emissions from agriculture.

Education, Training, Public Awareness and NGOs

Development of educational and public awareness programs on climate change, providing public access to information on climate change issues and public participation (including NGOs) are important parts of both implementation of general obligations of UNFCCC and development of the National action plan.

Extremely poor public awareness in Turkmenistan in the issues of climate change is an obstacle for public support of realization of measures aimed at reduction of GHG effect and adapting strategy towards possible climate change. One of the main directions of the National Action Plan under the UNFCCC is public awareness and training of qualified staff.

The following are the educational programs:

- Educational programs for pupils and students, training for the teachers of high schools;
- Publications in mass media on problems of climate change in popular and accessible form;
- Workshops for the representatives of informal associations, NGOs and local authorities engaged in ecological activity;
- National workshops for official representatives of the ministries and organizations, public figures, persons accepting decision and specialists engaged in development of plans and strategies of development of those economy branches influencing climate or appreciably depending on climate changes.

Follow-up Activities

Formulating, implementing and regularly updating national programs containing measures to mitigate climate change and facilitate adequate adaptation to climate change impacts are the general commitments of all Parties in accordance with Article 4 (1)UNFCCC. These measures should be implemented on a constant basis in all sectors of the economy, including energy, transport, industry, agriculture, forestry, water resources and waste management.

To meet Turkmenistan's obligations under UNFCCC, scientific, socio-economic, technological and other studies are actively carried out, as well as observations of

the climate system and establishing of climate data basis which are necessary for the understanding of climate change to eliminate remaining uncertainties.

As the participant of the Caspian Ecological Program related to creation of regional cooperation and combining efforts of such entities as UNEP, UNDP, World Bank, EC TASIS and GEF, Turkmenistan is interested in creation of adaptation assessments of the Caspian Sea coastal zone to possible variation of its level due to climate changes.

These tasks will be conducted by scientific and research institutions, a group of scientists and specialists in the field of climatology, energy, economy and sociology. Monitoring activities of climate change should be supported financially both by the Government and international organizations.

INTRODUCTION

Turkmenistan signed the United Nations Framework Convention on Climate Change (hereinafter – the UNFCCC or the Convention) on May 01, 1995 and ratified it on June 05, 1995. The FCCC ratified document is lodged with the United Nations Secretary General.

According to Article 2, the final purpose UNFCCC is stabilization of greenhouse gas concentrations in the atmosphere at the level that would prevent dangerous antropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change. Thus, provision with foodstuffs will not be endangered and the economy will be developed further on stable basis.

According to its international commitments, Turkmenistan, as a non-Annex to the Convention country, should develop and provide the Conference of the Parties through the Secretariat with National Inventory of GHG emissions, general description of measures on realization of the Convention and information, relating to achievement of the Convention goals.

Studies on climate change since 1997 till 1999, including GHG Inventory for the year of 1994, and also preparation and publication of the present document have been conducted with assistance and financial support of the UNEP and Global Ecological Fund.

The following main activities have been involved in the framework of the project:

- Developing of national inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol for 1994 base year;
- Conducting vulnerability assessments for important national economic sectors and ecosystems and developing recommendations on adaptation of these sectors to anticipated climate change;
- Conducting evaluation of mitigation measures that reduce GHG emissions in various sectors of economical activity and developing of recommendations for national strategy in this field;
- Developing National Action Plan on UNFCCC.

This National communication of Turkmenistan provides an overview of the national conditions of the country, reports the results of the GHG national inventory for 1994 and implementation of obligations on UNFCCC, and also outlines the main strategies addressed to GHG emissions reduction and adaptation to anticipated climate change.

1. MAIN DATA, NATIONAL CONDITIONS OF TURKMENISTAN

1.1 National Conditions

Turkmenistan is the plainest country of Central Asia. Almost 4/5 of its territories is in the limits of vast Turan lowland, with average 100-200 m above the level of ocean. Narrow strip of middle-high mountains is stretched in the south and south-east.

One of the biggest deserts of the world is located here occupying the largest part of its territory - 80%. The other feature of Turkmenistan is the abundance of solar days (more than 70% in a year). Solar period and excess heat and small amount of atmospheric precipitation are common for Turkmenistan.

Geographic location of Turkmenistan in the south defines not only its climate, but also influences its total natural picture, specially diversity of its natural resources potential. The natural resources of Turkmenistan are characterized by:

- Large forecast stocks of hydrocarbon raw materials;
- Big potassium and salt deposits;
- Iodine and bromide thermal waters;
- Presence of coal and alunite deposits, rare-earth metals and polymetals ore, which need further survey and development;
- Considerable potential opportunities in solar energy for industrial and domestic use;
- Presence of large land and pasture resources for agricultural development;
- Presence of large stocks of raw material for building materials production;
- Lack and irregular distribution of water resources along the territory.

National priorities for social and economic development is stage by stage transition to market economy with high level of foreign investments involved, efficient utilization of power resources, hydrocarbon resources and modernization of infrastructure.

The data on national conditions Turkmenistan for 1994 are presented in the Table 1.1.

Table 1.1: National conditions

Criteria	1994
Population (million persons)	4.46
Area of the related velayats (square kilometers):	
- Total	488100
- Akhal velayat	97132
- Dashoguz velayat	72727
- Balkan velayat	138620
- Lebap velayat	93227
- Mary velayat	86394
GDP (1994, billion USD)	5.8
GDP per capita (1994, USD)	1308
GNP per capita (1994, USD)	1254
Approximate share of informal sector of the economy in GDP (%)	22
Share of industry in GDP (%)	35.6
Share of services in GDP (%)	8.9
Share of agriculture in GDP (%)	33.5
Area of land used for agricultural purposes (square kilometers)	
- Total	399816
- Pastures	383416
- Hayfields	104
- Irrigated land	16296
Livestock population, thousand	
- Cattle (dairy)	478
- Cattle (non-dairy)	626
- Sheep	5682
- Goats	631
- Camels	101
- Horses and donkeys	22
- Pigs	159
- Poultry	3412
Forest area (square kilometers)	197.61
Share of urban population in total number of population, %	45.1
Anticipated duration of life at birth (years)	65.8
Literacy level, %	99


KAZAKSTAN
KAZAKHSTAN
UZBEKISTAN
AFGHANISTAN
ISLAMIC REPUBLIC OF IRAN
CASPIAN SEA
TURKMENISTAN
DASHOGUZ
BALKAN
AHAL
MARY
LEBAP
Nukus
Dashoguz
Urganch
Köneürgench
Sarykamysh Howuz
Bekdash
Kara Bogaz Gol
Chagyl
Kizyl Kaya
Krasnovodskiy Poluostrov
Ufra
Turkmenbashi
Oglanly
Balkanabat
Khazar Aladzha
Koturdepe
Bereket
Kum Dag
Serdar
Bami
Khodzha Kala
Kara-Kala
Bakharden
Yerbent
Bakhardok
Darvaza
Dargan Ata
Bukhoro
Samarqand
Seyid
Farab
Turkmenabat
Repetek
Uch Adzhi
Amu Darya
Atamyrat
Gaurdak
Koytentag
Kara Kum Derya
Okarem
Etrek
Esenguly
Ashgabat
Bazmeyin
Kopet Mountains
Artyk
Babadayhan
Tedzhen
Kaakhka
Dushak
Mary
Bayramaly
Iolotan'
Serakhs
Sandykachi
Murgab
Takhta Bazar
Kalai Mor
Serkhetabat
Chink Kaplankyr
Kara Kum
International boundary
Welayat boundary
National capital
Welayat capital
Town
Main road
Secondary road
Railroad
Airport
0 50 100 150 200 km
0 50 100 150 mi
55°
60°
65°
40°
35°
5°

1.2 Geographic Position, Climate and Natural Conditions

Turkmenistan, a newly state in Central Asia, was created on October 27, 1991, when the Parliament had declared its independence. On December 12, 1995 Turkmenistan was awarded with the status of neutrality, confirmed by the UN General Assembly resolution.

Turkmenistan is located in Central Asia within 35°08' and 42°48' N and 52°27' and 66°41' E at the center of the Eurasian continent, nearly equidistant from the Atlantic and Pacific Oceans. According to its landmass the country occupies the fiftieth place in the world with the total area of 488.1 thousand km^2. Turkmenistan borders with Kazakhstan and Uzbekistan in the north, Uzbekistan and Afghanistan in the east, Afghanistan and Iran in the south, and with Azerbaijan through the Caspian Sea in the west. The total length of its borders is 5646 km.

According to natural conditions, Turkmenistan is located in three main natural landscape zones: deserts, oases and mountains. 13 different natural areas may be distinguished at the territory of the country.

The plains, 15% - mountains and forelands, 12% - water surfaces and non-soil formations (talus, rocks, and precipices), occupy major part of the country - 73%. The Karakum desert occupies northern and central part of the country (about 80% of the territory).

The highest point in Turkmenistan is Ayrybaba peak of Kugitang mountains (3139m above the sea level), the lowest point is Akchakaya hollow in northwest of the Zaunguz Karakum (81 m below the sea level). The length of a coastline of the Turkmen part of the Caspian Sea is 1200 km.

The climate of Turkmenistan is sharply continental and extremely dry. Average monthly temperature in January varies from – 6°C in northeast up + 3°C in the southeast and + 5°C in the end southwest. Average monthly temperature in July, in the territory between Murgab and Tedzhen rivers and in the central part of Low Karakum exceeds 30°C. Temperature in the other territory is 27°C - 30°C declining towards the Caspian Sea shore in the mountains. Average yearly temperature is within the limits of +16.0°C-17.1°C. The absolute temperature maximum in different areas reaches 45°C-50°C, and the highest – 50.1°C was observed in Repetek.

Average annual precipitation is 76 to 398 mm. Four regions may be distinguished:

1. The northeast of the country, Zaunguz Karakum and Karabogazgol bay - less than 100 mm;
2. The Low Karakum - up to 150 mm;
3. Foothill zone, south and southeast - up to 250 mm;
4. Mountain areas - more than 250 mm. Slow and moderate winds (velocity 0-5 m/s) dominate on the whole territory of Turkmenistan.

The agricultural land fund of Turkmenistan is 41 million 302 thousand hectares (413020 sq. km) or 84% of the total area of the Turkmenistan. 399816 sq. km is being utilized in agriculture. Major part of these (383416 sq. km) is used as pastures for animal husbandry. Arable irrigated land occupies 16296 sq. km. The

sums of vegetation period along the whole territory are sufficient for the cultivation of cereals, cotton, vegetables, melons. However, due to a shortage of precipitation and dry climate, only irrigated agriculture is possible. The territory of the south of Turkmenistan, by its agronomic and climatic conditions, is suitable for cultivation of thin-fiber cotton, grape, walnut, fig.

Conditions of the southwest of Turkmenistan that is the subtropical zone are favorable for the related cultures: olive, date palm, persimmon tree, pomegranate, etc.

According to the official statistical data forests covered 0,04% of territory of Turkmenistan or 19761 sq. km in 1994. 95% of this area is made up of saksaul (haloxylon), a deep-rooted, practically leafless tree, typical for desert areas of the Central Asia. The other portion is made up of mountain (juniper) and tugay forests. Forests in Turkmenistan are used mainly for soil and water protection.

The river network has had only limited development. The largest river of Turkmenistan is Amudarya. Smaller ones are Murgab, Tedzhen and Sumbar. The rivers of the country are extremely important for irrigation. However, their uneven distribution on the territory makes limitation of water resources for irrigation agriculture, especially in the south and west of the country. There are 15 lakes and 16 artificial lakes in Turkmenistan. The biggest natural lake is the Caspian Sea in the west of the country.

Turkmenistan is richly endowed with natural and energy resources. Forecast reserves of hydrocarbon resources are estimated at 21-23 trillion m^3 of gas and 12,0 billion tons of oil. It has huge stocks of mining and chemical raw: sulfur, iodine-bromide water, sodium sulfate, potassium and table salt, carbonate raw for chemical industry, etc. Mining raw is presented by bentonite, kaolin, raw for mineral fiber production, marble onyx, ozokerite, etc. The metal minerals are lead, zinc. The country possesses numerous deposits of raw for the building materials production industry.

1.3 Population

In 1994 the population of Turkmenistan was 4.46 million. Turkmenistan is one of the most sparsely populated regions in the world with the average density of 9.1 per sq. km. The distribution of the population is very uneven. The density of population in the river valleys and oases is 150 per sq km and more (low and middle Amudarya, Murgab and Tedzhen oases). In deserts the density of the population is sharply decreased - less than 1 per sq. km. Turkmenistan is a multinational country; more than 120 nationalities live here. Turkmen, Uzbeks and Russians constitute the three most important ethnic groups, representing 77%, 9% and 7% of the population correspondingly. The remaining 7% are distributed among the other nationalities - Kazakhs, Armenians, Azerbaijani, Beludji and others.

There are 5 velayats (administrative regions) in Turkmenistan, 20 cities and 81 towns. The rural population predominates; its share in 1994 was 54.9%.

Average life expectancy in Turkmenistan in 1994 was 65.8 years, which is similar to the average in the middle income countries. Number of newborns per 1000 persons is 22.6. For the last 10 years the population increased by 41.9%. Literacy level in 1994 was 99%. GNP per capita in 1994 was 1254 US dollars.

Emigration process that is common for all CIS countries, has not resulted in decrease of the population. Since 1994 to 1999 the emigration increased by 12.1%. According to the macro-economic scenarios, the number of population in Turkmenistan in 2005 will be 6.5 million, and by the year 2010 - more than 7.25 million.

1.4 Brief Overview of Economy

Till gaining independence in 1991 Turkmenistan was characterized as an agrarian region. Last decade before the disintegration of the USSR, the share of industrial production in GNP of Turkmenistan has decreased and was 22% in 1990 against 30% in 1980, and the share of agriculture has increased. The agricultural industry made up around half of GNP of Turkmenistan in 1990 (43%), evidencing low level of social and economic development of the country. The industry depended mainly on raw material production. Turkmenistan extracted and produced several dozens of raw materials, which were delivered to the Soviet Union market for low prices, and without any processing. Due to this, the amount of the produced national income per capita was 1254 USD in 1994.

Since the first years of independence, Turkmenistan began to develop its fuel and energy complex (FEC). The share of FEC production in the whole industrial production amount in 1994 was 49.3% against 25.8% in 1990. At present the share of FEC is 55.6% of the industrial production in the region.

Turkmenistan's transition to a market economy began in 1993 with tentative property privatization and institutional measures. Gross domestic product (GDP) in purchasing power parity for 1994 amounted to 3128 USD.

According to expert estimations of the UN Development Program, the main macro-economic trends can be characterized by the 19% GDP in real terms decline from 1995 to 1997. The factors caused the output contraction in Turkmenistan and other CIS countries were the breaking down of supply links between enterprises within the CIS and the fall in sale of exported products (natural gas, oil products, chemical raw (salt, sulfur, etc.). The further development of economic reform should provide a more reliable foundation for the sustainable growth and employment for all sectors after overcoming the drastic downfall of the 1990-1998 period.

Turkmenistan is a great producer of natural gas, oil and electrical power. The country possesses considerable reserves of coal, sulfur, iodine, bromine, celestine, mineral salts, deposits of raw for building materials production and other resources in sufficient for the economy amounts. In 1994 the share of natural gas export was 69%, cotton fiber - 18.6%.

Oil production level in 1994 was 3.87 million tons, natural gas – 35.53 billion cubic meters. Oil production is mostly located in the western part of Turkmenistan

near the Caspian Sea. The development of the big gas field has begun in the east of the country near the border with Uzbekistan, on the right bank of the Amudarya river. The two large oil refineries utilizing local raw, are located in the west and in the east of the country.

Currently the oil production increases. The richest oil and gas fields are submitted for joint development to the largest foreign companies (USA, England, etc.) on mutually beneficial basis.

The industry, which share accounted for 35.6% of GDP in 1994 (see Table 1.1), is dominated by mining activities, based on exploiting the rich natural resource base. Oil refineries, and also chemical industry enterprises are mainly located in western and eastern regions close to the mineral deposits.

Turkmenistan faces considerable changes in a variety of agro-processing industries. Food and light industries include meat, fish, vegetable and fruit canneries, wineries, dairy, textile, cotton processing, clothing and other plants.

Agriculture, one of the main sectors in the Turkmenistan economy, was contributing 33.5% in GDP in 1994. The country is a large producer and exporter of cotton-fiber. Cotton growing, cereals, vegetable and melons are common throughout the country. Grapes and gardening are highly developed in the south and southeast. The most important agricultural crops include cotton and wheat. The food and light industry exploit the main industrial crop - cotton.

Livestock is also an important agricultural industry, based on extensive opportunities for grazing. Karakul sheep-breeding activity is the most widely spread traditional branch of the Turkmenistan livestock husbandry. Akhalteke and Yomud horses breeding is traditional in Turkmenistan since ancient times.

The share of services in GDP in 1994 was 8.9% and is increasing because of increasing private sector and retail trade development. The share of non-governmental sector in the total amount of budget income and GDP is 10% at present.

The geographical characteristic of the country influenced the development of the Turkmenistan transport system. The most part of freight transport is dominated by road and railway sector. Length of the general-purpose railways in 1994 was 2.15 thousand km. The railway transport is playing major importance at present for transit transportation to CIS countries and exit of Turkmenistan to the world railway systems of Europe and Asia. The total length of railways in 1998 was 2350 km. The inter-continental Trans Asian main railway was completely formed in 1996, when the new railway Tedzhen-Sarahs-Meshkhed (Iran) was put into operation. Road and air transport is very important for those areas distant from railways and water routes. The total length of hard surfaced road in 1994 was 13.4 thousand km. The international airport complex, which has been erected in Ashgabat has allowed to open new air routes between Europe and Asia.

1.5 Brief Overview of Land Resources and Land Use

According to official statistical data the territory of Turkmenistan is 48810 thousand hectares; the area of desert grazing in 1994 was 38342 thousand hectares or 95.9% of the total area of the country.

The agricultural peasant entities of the country possess more than 70% of the country's land fund. The lands of state fund occupying about 1/5 of the total land fund, during last decades have been reduced by 27% due to development and transfer to other sectors of land tenure.

Out of the total area of Turkmenistan 17 million hectares are suitable for irrigation and agricultural cultivation. A little more than 10% of those are currently used. The area of irrigated lands in 1994 was 1629.6 thousand hectares.

Due to natural and climate circumstances of Turkmenistan, forests occupy only small portion of the territory – 19761 hectares.

The share of the settlements area is 0.15%. This is two times more than 20 years ago, due to considerable increase of urban population development of private plots of land and creation of social infrastructure in the towns.

The area occupied by industrial and transportation enterprises, resorts and other facilities of non-agricultural purposes is 1.28% of the total land fund of Turkmenistan.

The agricultural facilities represent the most widespread form of land use in the arid Turkmenistan. The structural analysis of those shows prevalence of pasturelands – average around 90% throughout the country. Arable lands in the agricultural structure of Turkmenistan cover only 3.6%. Perennials occupy only 0.20% of the total area of the agricultural lands. The area of wastelands and deposits has been considerably reduced due to development of land for agricultural purposes. These lands are the reserve for irrigation development, as mainly they are located within the areas of the existing irrigation systems.

Thus, the system of land use of Turkmenistan, being in general a constant value, during last years has undergone some changes in favor of the agrarian sector development.

Due to nature and climate conditions the income increase from land utilization in Turkmenistan may be obtained only by irrigation. The amount of production in cost expression, yielded from one ha of the irrigated agricultural lands, 20 - 40 times exceeds productivity of a non-irrigated hectare. At present the irrigation agriculture provides not only 99% of the horticulture production, but is also an important item in livestock production as fodder producer.

In Turkmenistan, which is referred to arid zone countries, natural watering can not compete with the irrigation agriculture. Natural watering agriculture had been developed in the country in 1930s, before extensive irrigated structure construction. In 1934 the area of naturally watering land was 41.4 thousand ha. Later, part of these areas had been irrigated; non-irrigated areas came to a minimum due to instability and low productivity.

Despite the fact that the irrigated agriculture is of the biggest value, its present development does not meet the demands of the country, thus decreasing land use incomes. The reasons of this decrease are quite different. One of them is amelioration and ecological land deterioration, in particular increase of ground water level. For example during last 4 years the area with the critical level of ground water in Mary velayat has been expanded by 10 times, while irrigation area increased only by 10%. At major part of the irrigated lands of Turkmenistan ground water was fixed at the depth exceeding 2 m.

The absolute and relative data on the size of non-salted lands have been decreased, while middle salted increased. This causes amelioration deterioration of the irrigated lands of Turkmenistan.

The land reform is one of the reforms conducted by the President of Turkmenistan for realization his policy "New Village". Unique and revolutionary transformations in land utilization started with acceptance of "The Land Code of Turkmenistan" on October 12, 1990 and amendments to it on May 30, 1991.

The main issue in conducting the land reform at present is the allocation of the citizens of Turkmenistan, living in rural areas with plots of land for the development of private subsidiaries. Inhabitants of cities and towns are allocated with the same plots for individual and private construction and also for gardening and vegetable growing. This will promote supply of the population with the agricultural products together with the involvement of the citizens in this field of activities.

The following are the norms of free of charge allocation of the plots of land to the Turkmen families: 0.25 ha – to the families living in rural area; 0.32 ha – in etraps (districts) possessing free land and water resources in irrigated areas, or 0.50 ha – in non-irrigated areas for the development of private subsidiaries (melleks); 0.16 ha – to those living in cities and town families for private construction and also for gardening and vegetable growing. Families with many children (4 and more) are allocated with 0.25 ha for lifelong use with the right of inheritance.

New changes in the right of land possession and utilization in rural areas have been introduced to promote income increase, creation of favorable conditions for development of various kinds of property. Utilization of the irrigated lands in the peasants' entities and in the other agricultural enterprises is executed on the bases of long-term rent, for the period of 10 and more years. In particular, the citizens of Turkmenistan may apply and get into private property the land plots with the area up to 10 – 15 ha. They also have the right of land utilization for the development of agricultural industry, product processing on the basis of free enterpreneurship, without the right to sell, present or change.

1.6 Brief Overview of Agriculture and Water Facilities

Agriculture is very important for Turkmenistan's economy. The share of agriculture in GDP was 33.5% (see Table 1.1).

During the years of independence of Turkmenistan, completely determined specialization of the agriculture has been formed – cotton and wheat growing,

karakul sheep breeding and silk breeding. Such agricultural profile, defined by natural and economic circumstances of the country, was the most economically expedient for Turkmenistan and corresponded to the interests of the economy of the whole country.

The most extensive branch is the irrigation agriculture, which provides more than 70% of the agricultural gross production. The land fund, suitable for use in irrigated cultivation is 170 thousand sq. km, including 4.5 million ha of high-fertile land. However, due to the lack of water resources only 10% of this area is irrigated and cultivated in the country.

The main branch of agriculture is cotton growing. The amount of raw cotton produced in 1994 was 1280 thousand tons.

The "Grain" program aimed at complete provision of the country in wheat demand has provided the amount of wheat of 1120 thousand tons in 1994. Major attention is paid to food cereals - wheat and rice.

Melons is the traditional branch of horticulture. Turkmenistan produces various kinds of melons suitable for transportation and long-term storage. At present the amount of melons produced is 190 thousand tons, that allows to satisfy the necessity of the local market and to export about 70 thousand tons of the product.

The amount of vegetable production is around 350 thousand tons.

Production amount of grapes allows completely to meet the demands of the population in fresh product, to process up to 40% of the crop and to export 15-20 thousand tons of the products. However, in total volume of production the technical sorts predominate - about 60%.

Turkmenistan possesses rich experience in desert grazing use. This area provides fodder for about 4 million sheep, mainly karakul, and more than 100 thousand camels (1994).

The radical change of economic policy in the agrarian sector has been reflected in the "New Village" state program. Change of property relations and realization of land reform lay the basis for this program. While the state and co-operative entities are active, the formation of daikhan (farmer) economy will be accelerated.

The country plans the self-supply with wheat and other agricultural products from 1996, and to achieve complete food independence by the year of 2002. In accordance with the "Grain" program by 2002 the country will produce 2.5 million tons of cereals, amount of cotton produced will reach the number of 2 million tons. Comparing with 1992, vegetable production in 2002 will be increased by 1.9 times, melons – 1.7.

Production of milk and meat (both cattle and chicken) during the period 1992-2002 will be increased by more than 2.1 times. All this will allow improving the provisions of the population with agricultural products.

Cultivation of land in Turkmenistan is completely dependent on the irrigation water reserves. All main bulks of cotton and wheat fields, gardens, vineyards, melons are located on the regularly irrigated lands.

Irrigation systems of Amudarya, Murgab, Tedzhen rivers in 1994 provided irrigation for the area of 16296 sq. km.

Turkmenistan is defined by the extremely uneven location of water resources: 95% is the share of Amudarya, the other 5% is the share of all rivers, springs and discovered reserves of the underground water in the south and southwest of Turkmenistan. The water of the southern rivers - Murgab, Tedzhen and Sumbar, and small springs and rivers of Kopetdag foothills, is consumed for irrigation at full amount. The fertile areas in the south and southwest of the country were not cultivated due to the lack of water. This caused the necessity in inter-basin transfer of the Amudarya river water through the Karakum river to these regions for the increase of the irrigated area. The length of the Karakum river from Amudarya is 1300 km. It crosses the territories of all velayats of Turkmenistan except Dashoguz. The major industrial and agricultural changes in the history of Turkmenistan are closely connected with the activity of the Karakum river, uniting Amudarya, Murgab and Tedzhen rivers into one joint system of water economy.

The total capacity of the artificial lakes constructed along the Karakum river is more than 2000 million cubic meters. The main purpose of these lakes is the accumulation of the river's winter water flow to be used during the period of vegetation. These lakes serve also for water supply of the towns located in dry regions. The new lines of the Karakum river delivered the Amudarya water to Balkanabat and Turkmenbashy cities.

The scientists were quite successful in their efforts in the acclimatization and breeding in the Karakum river of the Far East herbivorous kinds of fish**:** white amur and etc**.** In 1958 Karametniyaz fish-nurcery was established for accommodation of these kinds of fish to new conditions. White amur quite quickly spread throughout the Amudarya and the Karakum rivers, and is reproducing in natural conditions.

At present white amur serve purposes in the Karakum river both: to be a biological ameliorator for the irrigation systems and also a food product in the lakes of those desert areas never used as fish production regions.

The inter-basin transfer of flow due to the Karakum river, has sharply changed the territorial re-distribution of water resources throughout Turkmenistan. It has deleted mismatch existed by centuries: location of large bulks of fertile territories in one part of the country and water resources in the other. In particular, about 80% of the arable lands are located in the south and southeast of the country, and water resources, 90% consisting of the Amudarya flow – in the east of Turkmenistan.

1.7 Brief Overview of the Energy Sector

1.7.1 Resources

Turkmenistan has huge reserves of energy resources, sufficient to meet the domestic needs, and also to export the resources in their natural form and in the form of electricity to the other regions.

In the energy resources balance of Turkmenistan the natural gas production sector is dominating. In 1990 the country produced 87.6 billion m^3 of gas, 5.6 million tons of oil.

Before disintegration of the Soviet Union Turkmenistan delivered through main pipelines significant amount of natural gas (65 billion cubic meters in 1990). Turkmenistan was the third largest producer of the crude oil in the former Soviet Union. The part of the crude oil produced was refined by the industrial facilities of the country.

In 1994, the natural gas output in Turkmenistan was equal to 35.5 billion cubic meters. The natural gas is mainly exported to some CIS countries (Kazakhstan, Georgia, Armenia and Azerbaijan).

The renewable energy (RE) resource potential in Turkmenistan is significant but was largely neglected. RE resources development would be suitable for electricity production at national and local level, and is suitable to serve small distributed loads.

Turkmenistan has sufficient solar energy resources potential. The insulation energy is 30.35 million kWh per sq. km. per year. This allows using of the sun water-heater and sun batteries, in particular portable photovoltaic applications in the rural area on the cattle farms.

1.7.2 Energy Production, Consumption and Distribution

Energy sector plays a significant role in the future economic development of the country. Possession of gas as a cheap fuel, promoted further development of the electrical energy. In 1990 the production level was 14611 billion kWh, and in 1994 - 10520 billion kWh. The reason of such decrease in the energy production is the breakdown of deliveries and relations between the enterprises of the former Soviet Union, and also the difficulties of the transit period. In 1994 Turkmenistan delivered to the Joint Electricity Grid of the Middle Asia (now Central Asia) up to 6 billion kWh. Turkmenistan exports its energy to Kazakhstan and Afghanistan.

The consumption distribution of 10520 billion kWh generated in 1994 was as follows: industry – 3404.7, residential sector 1351.1, construction – 147.7, agriculture – 1966.4, the other branches – 590.6 billion kWh. 1712 billion kWh was exported. The length of electric transmission lines of different voltage is more than 51.6 thousand km; the length of the 35 kV and more voltage is 401 km.

The national electric energy sector is completely managed by “Kuvvat” State Electric and Technological Corporation. Due to disintegration of industrial and energy complex of the former Soviet Union, the demand for the Turkmenistan energy exportation has been decreased.

In accordance with the Program of the President of Turkmenistan “The Strategy of Social and Economic Changes in Turkmenistan for the Period till the Year of 2010” the power production is expected to be increased; the amount of energy produced will be 17 billion kWh in 2010.

1.7.3 Development Strategy

The energy strategy in Turkmenistan is elaborated in accordance with the Concept “About Development of Oil and Gas Industry in Turkmenistan till the Year of 2020” and the Program “Strategy of Social and Economic Changes in

Turkmenistan for the Period till 2010", and is based on the analysis of the world power engineering market development and the domestic potential of the country.

The main goal of the Energy Strategy of Turkmenistan is definition of ways and development of the means for most efficient use of the energy resources and power production complex, in order to rise the living standards of the population and the socio-economic development of the country.

New structural policy of the President of Turkmenistan in the field of energy for the next 10-20 years is aimed at:

- Efficient development of the oil and oil products utilization and increase of their share in internal market and for export;
- Increase of the share of natural and associated gas in the energy balance and its increase in the exportation share;
- High priority in having a profound refinery and combine use of the raw hydrocarbons by means of creation of gas-chemical and oil-chemical plants.

2. POSSIBLE CLIMATE CHANGE AND ITS IMPACTS FOR ECOSYSTEM AND ECONOMY

The territory of Turkmenistan is located in the depth of the Eurasian continent, in the area far from the ocean's mild influence. A dry and hot summer and frosty winter characterize the sharply continental climate of Turkmenistan.

Latitudinal position of the territory of Turkmenistan laying in the zone of non-tropical deserts makes the country rather vulnerable to climate change.

However, the main distinctive feature of the Turkmenistan climate is not hot sun and not excess heat but moisture deficiency.

The droughts combined with high temperatures are the limitation factors for agriculture, forestry, and water economy development.

Climate change, especially sharp temperature fluctuations, may negatively influence the human health and be the reason of many kinds of diseases. Heat stress is a big problem for the population of Turkmenistan.

2.1 Climate Observation

Systematic observation, development of data banks and researches related to climate system and intended to further accumulation of knowledge of the climate system influenced by the natural and anthopogenic factors are among the common commitments of the countries – Parties of the Convention.

Considering importance and urgency of obtaining of wide-scale information about features and evolution of the Earth climate, the Eleventh World Meteorological Congress has created the Global system of the climate observation. The international monitoring programs, like the Global Atmosphere service of WMO are of major importance, as they play fundamental role in provision of international data exchange. Supporting activities of WMO, UNEP and IPCC, UNFCCC calls all countries for carrying out additional researches, aimed at development of strategies to mitigate potentially adverse effects of climate change and assessment of climate impact.

Systematic climate change observations require the optimization of the observational network, telecommunications and development of scientific strategies. Therefore, the UNFCCC National Action Plan of Turkmenistan includes active support of state climate observation network. Climate observations and investigations are carried out in accordance with the World Climatic Program.

Currently Turkmenistan maintains meteorological, hydrological, agrometeorological, lake, marine, ozonometric and actinometric observation, and also monitoring of the environment pollution. The climate information is stored in the State Hydrometeorology Data Fund. The computerized basis and climate data banks are currently being created and used in the operational and scientific work. Monitoring and assessment of the climate anomaly can be achieved by using these data in the research work.

2.2 National Climatic Program (NCP)

In April 1993 the intergovernmental meeting in Geneva has adopted four main strategies the World Climatic Program (WCP). It should be noted that WCP is dealing with the climate change observations caused both - by human activity and by natural factors; and also natural climatic variability and its effect on economical and social activity. The satisfaction of necessities of government, national economy, defense and population is the major task of the program.

For achieving its national goal, Turkmenistan carries out the following activities in this regard:

- Accumulation and storage of the climate data, monitoring of the climate system, the climate change observations, monitoring of the climate change impact on the environment, especially on ground-level ecosystems;
- Development of the new and updating of the existing methods for application of the climatic information for the national economic development;
- Development of the assessment methodology of social and economic consequences caused by climate change and working out the strategies of reaction on climate change;
- The studying of climatic processes aimed at updating the methods of a climate prediction.

To provide execution of the Turkmenistan's commitments subject to the Convention and the UN environmental programs, the State Commission has been formed. Its main purpose is to coordinate activities of the ministries, institutes and organizations on NCP implementation, and also to pursue the state policy in the field of mitigation of the negative anthropogeneous influence on climate and stabilization of the greenhouse gas concentration in the atmosphere at a secure level.

Scientific, technological, social and economic and other investigations related to the NCP implementation in Turkmenistan are planned to be continued.

2.3 Observed Climate Change

Meteorological observations at 30 meteorological stations located in all five velayats of Turkmenistan have been studied as the main characteristics of the climate. This included surface air temperature and precipitation data. The meteorological stations have sufficient and long-term observations; 8 of them are the basic stations. The data of these stations are used at the regional climate change observations over the certain period. The two 30-year periods (1931-1960 and 1961-1990) and also the last years (till 1997 inclusively) observations were used for meteorological values change assessment.

Surface Air Temperature

The comparison between average temperatures for 1961 – 1990 and for previous three decades has shown that this period has appeared warmer, especially in northern part of the territory, where the air temperature has increased by 0.6°C in average. In the western part of Turkmenistan warmer spell amounted 0.3°C, in foothills and eastern part – 0.2° C. In Mary velayat air temperature increase made up 0.4°C. The analysis of the air temperature data, averaged for Turkmenistan for 65-year period has been made. The tendency of small increase of average seasonal and annual air temperatures was observed for the period of 65 years (1931-1995) (Table 2.1, fig. 2.1).

The analysis of occurrence and non-interrupted continuity of the periods with the temperature higher and equal to 40°C for a warm period (since May till September) has been done at Serdar, Takhtabazar and Ashgabat stations for 1931-1997. Upon the results of the work done, we may conclude that the quantity of days with temperature higher and equal to 40°C for a warm period is increasing starting form 1983. It should also be pointed out that since 1931 to 1974, there was only 1 year when temperature exceeding 40°C has been observed for more than 15 days; since 1975 to 1997 – 9 years, moreover 1995 – 1997 in succession.

Cotton is a very heat-loving culture cultivated in Turkmenistan. But even for this heat-loving culture the temperature of air higher than 37°C-38°C is not favorable, as it causes overheating of plants and loss of those.

High temperatures obviously result in overexpenditure of electrical energy due to increase of number of operating electrical cooling devices.

The temperature studies may be continued by similar analysis in a combination with different meteorological elements (air humidity, wind velocity, etc.), but this needs further financing for the studies.

Precipitation

The amount of atmospheric precipitation for the period 1961 - 1990, in comparison with foregoing 30 years, has been increased in winter season, mainly in the north, east and in foothill areas of Kopetdag. In the west of Turkmenistan uneven precipitation has been observed. In spring throughout the whole territory of Turkmenistan there was the decrease in precipitation. In the summer the rainfall was slight, generally in the east and foothill areas of the Kopetdag mountains. In the north and west the increase of precipitation has been observed by a number of stations; the other stations fixed decrease. The amount of the autumn precipitation decreased throughout the whole territory of Turkmenistan. The average long-term annual sums of precipitation for the period 1961-1990 increased compared to foregoing period (1931 - 1960).

The sums of annual average atmospheric precipitation for 1931-1995 have slightly increased throughout the whole territory of the country; with seasonal prevalence of the winter period (Table 2.1, Fig 2.2).

In addition to this work the analysis of repetition of the days with daily precipitation 10 mm and more for Ashgabat, Serdar and Karakala stations has been made. Basing on these data, the graphs have been composed for the period 1931-1997. The relation of daily amount of precipitation and mountain torrents occurrence is also analyzed.

The analysis has shown that the most intensive mountain torrents in the foothill areas of Turkmenistan were observed during the period with the daily amount of rainfall more than 10 mm. Mountain torrents repeated in the periods 1950-1969 and 1974-1983.

Table 2.1: Linear Trend of Average Air Temperature and Precipitation for 1931 - 1995 Period in Turkmenistan

Period	Air Temperature, °C/65 years	Precipitation, мм/65 years
Winter	0.1	1.6
Spring	0.2	1.3
Summer	0.2	0.1
Autumn	0.2	1.1
Average annual value	**0.18**	**12**

Fig. 2.1: Time-Series and Linear Trend of Mean Annual Surface Air Temperature (°C) Averaged over the Territory of Turkmenistan for 1931-1995

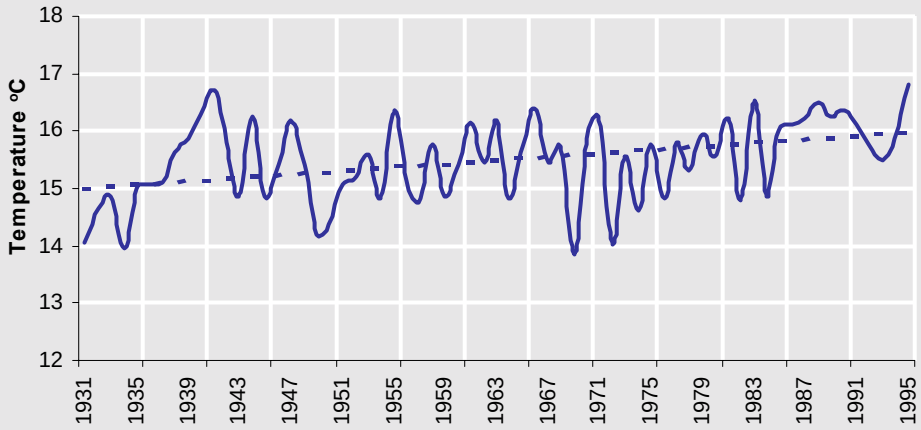
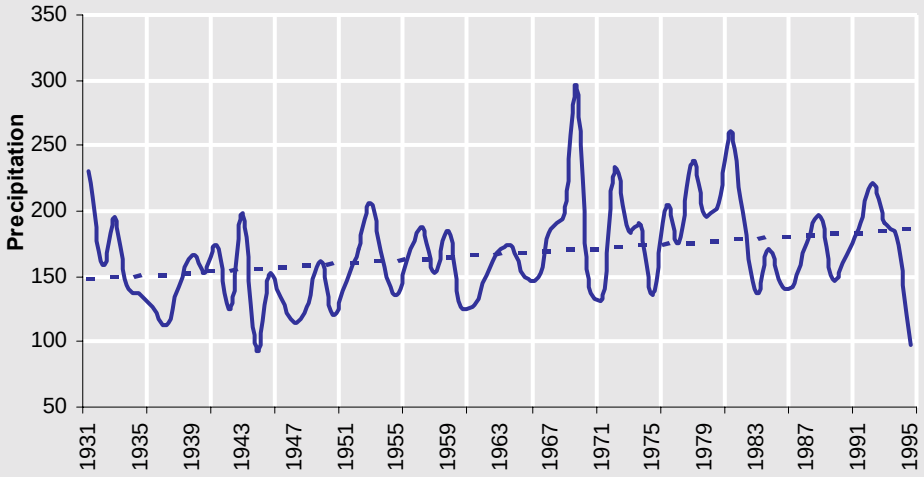


Fig. 2.2: Time-Series and Linear Trend of Annual Sum of Precipitation (mm), Averaged over the Territory of Turkmenistan for 1931-1995



2.4 Expected Climate Change

During many years the idea was wide spread that the modern global climate is more or less constant and there is no reason to expect its significant changes in the near future. The statements of some scientists about possible impact of the carbon dioxide contents increase in the atmosphere formed at hydrocarbon fuel combustion, have not been considered to be trustful and were not supported. The question of anthropogenic climate change first draws the attention of the governmental organizations at the beginning of 1960s. As the anthropogenic climate changes occurring at present have global nature, it is expedient to study those on the international basis.

Since the middle of 1970s considerable attention to the problem of anthropogenic climate change is paid by different international bodies; among those WMO, UNEP and others.

Application of climate modeling method provided considerable progress in climate change issues, but the results are still far from those providing clever answer to many questions about expected antropogeneous climate changes.

Several approaches are mainly applied while preparing the climate scenarios:

1. Method of paleoconstructions.
2. Statistical methods.
3. General atmosphere circulation modeling.

Climate scenarios may be prepared either from general atmosphere and ocean circulation model (GCM) or using the data on the past climate as an example for the future climate.

Significant success has been achieved in the climate change system modeling. At present, however, the GCMs can not really reproduce the process of climate

change at regional level. Similarly the analogs of future climate can not be esteemed as the reliable forecast. Hence, it is expedient to use several scenarios of climate change.

The possible climate change scenarios in the territory of Turkmenistan were prepared by IPCC method from general atmosphere and ocean circulation models (GCM) output, in particular the following models:

- GISS Model - equilibrium model of Goddard Institute of Space Studies, USA;
- CCC Model - equilibrium model of the Canadian Climate Center;
- UK89 Model - equilibrium model of the United Kingdom Meteorological Agency;
- GFDL Model - equilibrium model of Geophysical Fluid Dynamics Laboratory, University of Princeton, USA;
- GFDL-T Model – non-equilibrium model of Geophysical Fluid Dynamics Laboratory, University of Princeton, USA.

The numerical experiments for 12 months of a year at a modern level and at doubling concentration CO_2 have been carried out.

The factual climate data for the period of 1961 - 1990 are applied in the models. The extent of actual climate reproduction by GCM models was verified by comparing the results of the climate modeling calculations at 1 x CO_2 concentration, that is – existing level concentrations of carbon dioxide and the data of the real climate.

According to the scientists' forecasts, the doubling of CO_2 concentration in the atmosphere will take place by the middle or by the end of next century. It can cause the increase of average annual and seasonal air temperature in the territory of Turkmenistan.

However, according to all scenarios, undermarking of temperature values is observed in comparison with the real climate. The UK89 model provides the best results on air temperature (temperature is undermarked, but is uniform for the whole year).

The majority of the scenarios provide excessive increase of precipitation values comparing to the actual climate. In comparison with the other scenarios, GFDL model provides more realistic picture of the precipitation distribution (see Table 2).

The analysis of results of all scenarios, used for the studies of the main climate features in Turkmenistan, leads to the following conclusions:

- The maximum warming is observed by CCC scenario model. According to this scenario the increase of mean annual air in Turkmenistan under doubling CO2 conditions will make 6.10^{o}C; precipitation will be decreased by 15%. According to this scenario data the "maximal warming" will take place in the winter period, and considerable precipitation increase in the spring period;

- The minimal warming is observed under the GDFL model scenario. According to this scenario the increase in annual average temperature is 4.2°C, the annual sums of precipitation being constant (0.0%);
- The other scenarios predict the increase of average annual air temperature by 4.6 – 5.5°C, with the decrease of precipitation amount by 17 - 56%;
- The seasonal variation of average surface air temperature under the scenarios looks as follows: the maximal increase of air temperature under CCC model scenario is observed in winter period, under UK89 model - in summer period, GISS model - autumn period, GFDL-T model - winter period, and under GFDL model - in summer period.

Table 2.2: Change of Average Annual Air Temperature (ΔT) and Precipitation (ΔR) in Turkmenistan

Model	ΔT,°C	ΔR,%
GISS	4.6	-56
GFDL	4.2	0.0
UK89	5.5	-17
CCC	6.1	-15
GFDL - T	4.8	-4.4

2.5. Vulnerability Assessment of Natural Resources and Economy to Expected Climate Change

Assessment of the potential climate change impact was conducted on the base of average monthly air temperature changes and sums of annual precipitation upon the data of meteorological stations, representing different zones of Turkmenistan.

On the basis of initial forecast values of different climate component, which are stated above, the expected changes in annual sums of evaporation from aqua surface were defined; average regional increase is expected by 760 mm, i.e. 48%.

2.5.1 Humidity Deficiency

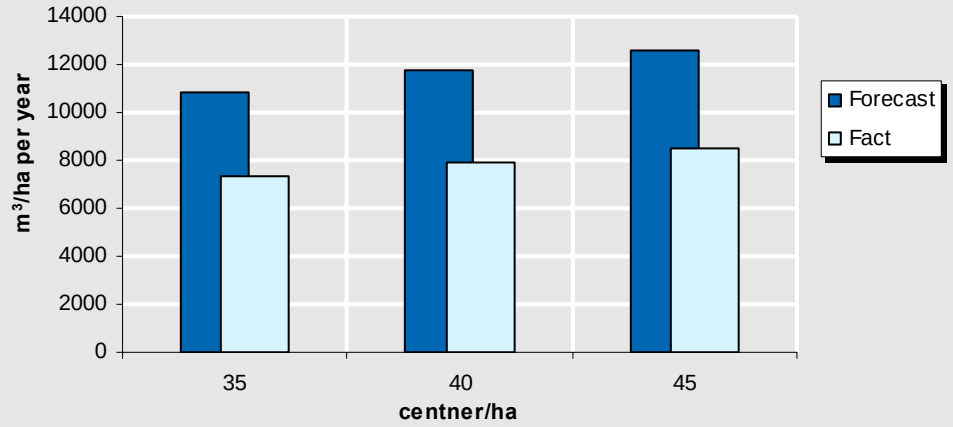
This work presents the values of factual and expected humidity deficiency, which, depending on a zone, is higher than factual by 1.4-1.6 times during the vegetation period. Also the trial-and-error dependencies between the values of actual temperature and humidity deficiency are determined. According to this dependencies the change of the humidity deficiency is calculated.

2.5.2 Water Consumption by Agriculture

The obtained values of evaporation and humidity deficiency made it possible to determine the changes of the physiological needs of plants in water, taking into account different values of their productivity. Such calculations have been made

for main cultures: cotton, wheat and lucerne. The calculations have been made under the conditions of Prikopetdag – Murgab zone at yield being cotton -35 centner/ha, wheat - 35 centner/ha and lucerne - 100 centner/ha. The obtained values of the needs of the cultures in water were extrapolated for conditions of Low Amudarya and Middle Amudarya zones with the coefficients 0.75 and 0.82 respectively.

Fig. 2.3: Change in Water Consumption at Different Levels of Cotton Yeild



The needs of plants in water are increased not only due to the temperature value increase, evaporation and humidity deficiency, but also with the increased yield. If to assume the yield of cotton at the level 35 centner/ha then under the existing climate circumstances the need in water will be increased by 16% for the yield 45 centner/ha. In case of the predicted climate components, the same yield will need the 71% increase of water (Prikopetdag-Murgab zone). The similar scenario can be traced for all cultures throughout all irrigated zones.

2.5.3 River Water

The major ecological problem of the Turkmenistan water resources is the steady tendency of exhaustion and pollution both, surface and underground water caused by a number of natural and anthropogenic reasons, including precipitation decrease.

The stable process of the glacier area reduction, which may become more intensive due to the global climate warming, will cause changes in surface water resources. In accordance with the prediction of the scientific the glacier areas of Pamir-Altai, feeding the Amudarya river will be decreased by 40% in average.

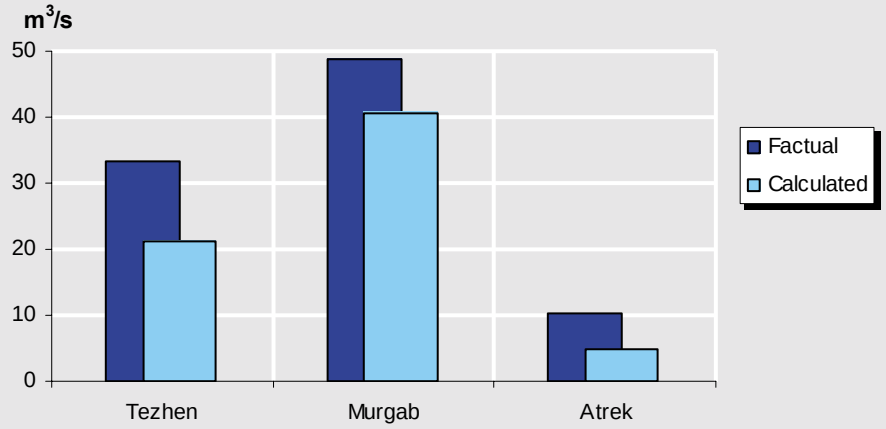
It is obvious already, that the the water resources are not renewable natural resource any more, as it was generally accepted, and it is necessary to undertake the special (extreme) universal measures for their rational use, protection, and recovery.

One of the critical ecological problems is the surviving of the Aral Sea, where the irreversible negative processes take place, potentially threatening the health of the people and significantly influencing the economy of the Central Asia countries.

The loss of area and bulk of Pamir-Altai glaciers will have negative impact on the Amudarya water resources and water supply for the irrigation agriculture of Turkmenistan, as almost 90% of water resources needed by Turkmenistan is the share of Amudarya. The problem of water shortage which already exists in Turkmenistan, will hardly be diminished, on the contrary it may become even more severe with further climate change.

The analysis of influencing of monthly average temperatures and calculated sums of precipitation allowed defining the variation of the Turkmenistan rivers water resources. According to their status, the rivers of Tedzhen, Atrek and Murgab are the trans-border rivers with the water collection basins lying outside the territory of Turkmenistan. Such location makes it difficult to define possible changes of the rivers' water resources, as the data on actual precipitation observations in the basins of flow formation are absent. Precipitation data for Herat station, located in the basin of the Tedzhen river have been discovered. Basing on these data interdependence curve between factual annual sums of precipitation for Kushka and Herat stations has been constructed. Upon the obtained trial-and-error dependence, predicted values of sums of monthly and annual precipitation for Herat station have been defined. The regression equation of dependence of average annual flow of the Tedzhen river and sums of annual precipitation for Herat station has been calculated. The estimated annual water consumption of the Tedzhen river made up 21.14 m^3/s. Basing on the Tedzhen river values, interdependence of annual consumption of the Atrek and Murgab rivers are presented.

Fig. 2.4: Change of Mean Annual Consumption of Rivers in Turkmenistan



The water resources of the three rivers will be decreased: Tedzhen by 36%, Atrek by 51% and Murgab by 17%. In the long-term perspective the amount of water resources can be decreased by 252 million m^3. Such small value of the decrease is explained by the fact, that the Amudarya river is the major compound in the balance of water resources. According to the preliminary forecasts its water resources amount will remain at the existing level, or 8 – 11% increase is possible (against annual long-term value).

Basing on hydrological series of the Tedzhen, Atrek and Murgab rivers, the analytic forecast curves of provision of the flows of these rivers have been determined and constructed.

The results obtained in this chapter have served as basic arguments for assessment of the opportunities of agriculture and water facilities adaptation to predicted climate change and have allowed to determine necessary measures aimed at mitigation or liquidation of the negative and stress situations, caused by natural circumstances in the foreseeable future.

3. GREENHOUSE GAS ANTHROPOGENIC EMISSIONS AND SINKS INVENTORY

In accordance with the Articles 4 and 12 of the United Nations Framework Convention on Climate Change each Party must include in the National Communication national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases, not controlled by the Montreal Protocol to the extent its capacities permit, using comparable methodologies. For the Annexes 1 and 2 countries the Convention requires annual reporting of greenhouse gas inventories, for all other countries the 1990 and 1994 are recommended to be included into the national communications.

This chapter provides a summary of anthropogenic greenhouse gas emissions and sinks in Turkmenistan in 1994, as well as brief description of the methodologies used to estimate them and the associated uncertainties.

3.1 Methodology

The main greenhouse gases are water vapor, carbon dioxide (CO_2), methane (CH_4), nitrogen oxide (N_2O) and ozone, which may have either natural or anthropogenic origin. Some other compounds, which are products of human industrial activity, such as chlorofluorocarbons (CFCs) and their substitutes, hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs) and some other compounds are also greenhouse gases. However, the FCCC excludes those gases, since their production and consumption is regulated by the Montreal Protocol.

There are some other gases, such as carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC), although not direct greenhouse gases, do contribute indirectly to the greenhouse effect by creating tropospheric ozone, which absorb thermal radiation of the Earth surface. Therefore, these gases should be subjects for an inventory. According to the IPCC assessments as of the end of 1980s, the contribution of carbon dioxide emissions to the enhanced greenhouse effect was estimated at 66%, methane – 17%, nitrous oxide – 5%, the rest 12% was attributed to chlorofluorocarbons.

The main requirement in concluding national GHG inventories is to apply the calculating methodologies agreed upon and adopted by the Conference of the Parties which ensures international comparability of results. The IPCC Guidelines were taken as the methodological basis for estimating GHG emissions and sinks while conducting the national GHG inventory. In accordance with the IPCC Guidelines, the inventory consists of five main categories: energy activities, industrial processes, agriculture, land use change and forestry and waste management.

The national GHG inventory represents emission data on three gases with a direct greenhouse effect (carbon dioxide, methane and nitrous oxide) and the group of gases with an indirect greenhouse effect (carbon monoxide, oxides of nitrogen and non-methane volatile organic compounds (NMVOC). Two approaches were used

to estimate emissions of carbon dioxide, the most significant greenhouse gas. In the first case, CO_2 emissions were estimated for each fuel type, based on the total annual national consumption, and then the values were summed. In the second approach, emissions were estimated for separate sectors and source categories, and then emissions were also summed.

Usage of these two approaches in the inventory allows in the first case to judge about the fuel spectrum of the carbon dioxide emissions, and the second case – about the sector distribution. In both approaches, the default IPCCC emission factors for each type of fuel were used.

Methane emissions were calculated for the fuel industry and for agriculture. To evaluate the amount of methane emissions form hydrocarbon fuel extraction the amount of extracted fuel was multiplied by the emission factor, which depends on the type of production or upon the stage of fuel processing.

Methane emissions from livestock were evaluated by multiplying the livestock population by the corresponding emissions coefficients.

Nitrogen oxide emissions from fossil fuel combustion were obtained by multiplying the energy content of oil products and gas consumed by the corresponding emission factors, given in the IPCCC Guidelines.

Emissions of indirect greenhouse gases such as carbon monoxide and nitrogen oxides were not calculated, but were taken directly from the national statistical reports since these gases are toxic and are therefore recorded in accordance with the ecological regulations of Turkmenistan. The IPCCC recommends to present the inventory results in both real units and relative units of CO_2 – equivalent. The latter are used to compare the various gases emissions contributions to the global emissions and depend upon the value of the global warming potential (GWP).

3.2 Total Greenhouse Gas Emissions

This section provides an overview of the greenhouse gas inventory in Turkmenistan in 1994. According to the results of the inventory by four main categories recommended by the IPCCC, total net greenhouse gas emissions in Turkmenistan were 52304.76 thousand tons of CO_2 - equivalent.

Table 3.1 presents emissions of direct greenhouse gases broken down in a number of main subcategories in CO_2 - equivalent.

Figure 3.1 shows percentage share of greenhouse gases in CO_2 - equivalent.

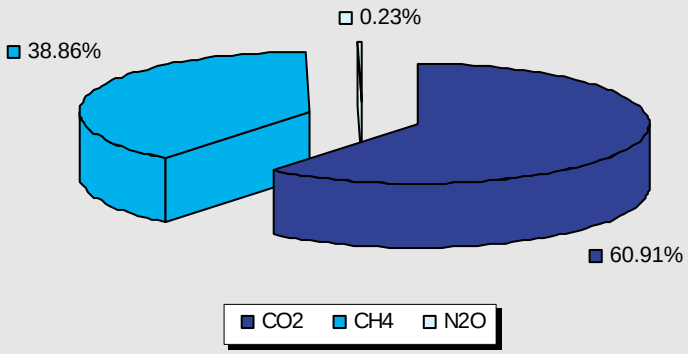
Table 3.1: Emission of gases with direct greenhouse effect in 1994, thousand tons of CO_2-equivalent

Category of GHG Sources and Sinks	CO_2	CH_4	N_2O	Total
1. Energy Activity:	31019.016	17776.29	119.6011	48914.9071
- Fuel Combustion	31019.016	0	119.6011	31138.171
- Fugitive Emission	0	17776.29	0	17776.29
2. Industrial Processes:	840.054	0	0	840.054
- Mineral Products	343.92	0	0	343.92
- Chemical Industry	496.134	0	0	496.134
3. Agriculture:	0	2329.866	0.93	2330.796
- Enteric Fermentation	0	1912.638	0.93	1913.568
- Manure	0	356.748	0	356.748
- Rice Cultivation	0	60.48	0	60.48
4. Land Use Change and Forestry	0	0	0	0
5. Waste:	0	219.009	0	219.009
- Solid Waste	0	219.009	0	219.009
- Wastewater	0	0	0	0
National Net-Emission	31859.07	20325.165	120.5311	52304.766

Table 3.2: Greenhouse Gas Emission in 1994, thousand tons

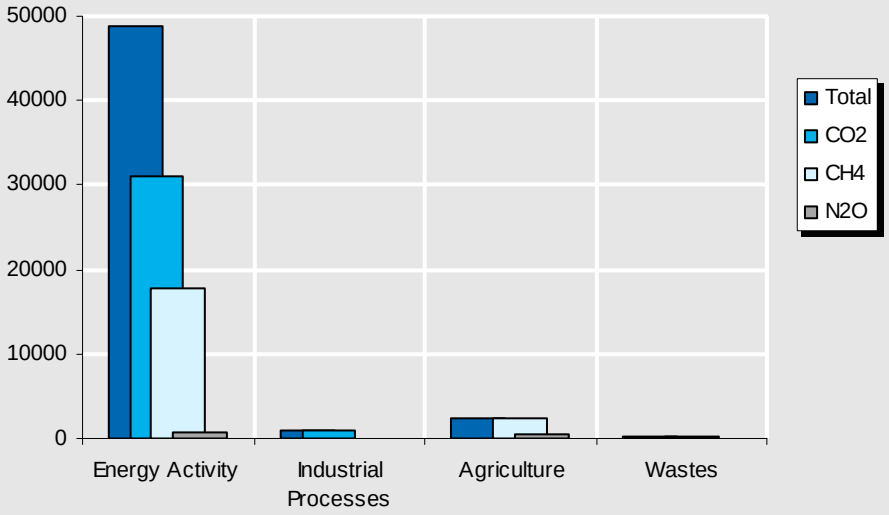
Category of GHG Sources and Sinks	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1. Energy Activity	31019.016	846.49	0.38581	83.275	326.765	44.3578
A. Fuel Combustion		2.64				
- Energy Industries	12156.964	0.22	0.022	32.774	4.497	1.091
- Manufacturing Industries	7653.678	0.552	0.297	15.222	3.243	0,215
- Transport	2884.76	1.112	0.04621	27.134	301.612	40.2088
- Commercial/Institutional	557.126	0.05	0.001	0.499	0.499	0.05
- Residential	3040.82	0.274	0.0057	2.742	2.701	0.029
- Agriculture	1985.456	0.127	0.0082	2.153	13.718	0.166
- Other Sectors	2740.212	0.305	0.0107	3.051	0.147	0.218
B. Fugitive Emission from Fuels						
- Solid Fuels	0	0	0	0	0	0
- Oil and Natural Gas	0	843.85	0	0.23	0.345	2.38
2. Industrial Processes	840.054	0	0	0	0.8	4.862
A. Mineral Products	343.92	0	0	0	0	0
B. Chemical Industry	496.134	0	0	0	0.8	0.48
C. Metal Production	0	0	0	0	0	0
D. Other Production (Food and Alcoholic Drink)	0	0	0	0	0	4.382
3. Agriculture	0	110.95	0.034	0	0	0
A. Enteric Fermentation	0	91.078	0	0	0	0
B. Manure Managment	0	16.988	0.003	0	0	0
C. Rice Cultivation	0	2.88	0	0	0	0
D. Agricultural Soils	0	0	0.0103	0	0	0
4. Land Use Change and Forestry	0	0	0	0	0	0
5. Waste						
- Removal Solid Waste	0	10.429	0	0	0	0
National Net-Emission	**31859.07**	**967.869**	**0.3992**	**83.275**	**327.565**	**49.2198**

Fig. 3.1: Share of Greenhouse Gases Emissions in 1994 (%)



The results of all greenhouse gases inventory in absolute units with the brake down of the sources categories are presented in Table 3.2 and Figure 3.2.

Fig. 3.2: Emissions of Gases with Direct Greenhouse Effect in 1994, thousand tons CO_2-equivalent



The most important source of GHG emission is the energy. Its share in 1994 was 48914.9 thousand tons of CO_2 - equivalent (93.5%).

Emissions in the "Energy activities categories" (emissions not related to fuel combustion in industry), "Agriculture", "Waste" were 1.6%, 4.5%, 0.4% respectively.

The major sources of methane emission, which is the second important greenhouse gas, are extraction, transportation and storage of oil and gas (87%) and agriculture (12%).

3.3 Carbon Dioxide Emissions

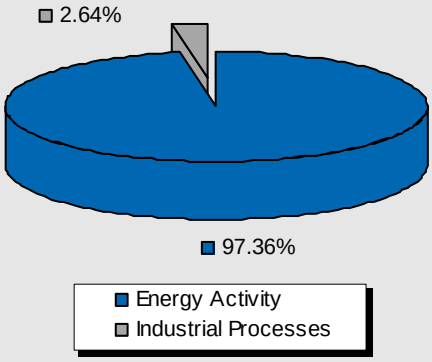
3.3.1 Energy activities

The main source of carbon dioxide emission is the energy activities, in particular fuel combustion activities.

Fuel combustion activities in Turkmenistan in 1994 produced 31.019 million tons of carbon dioxide.

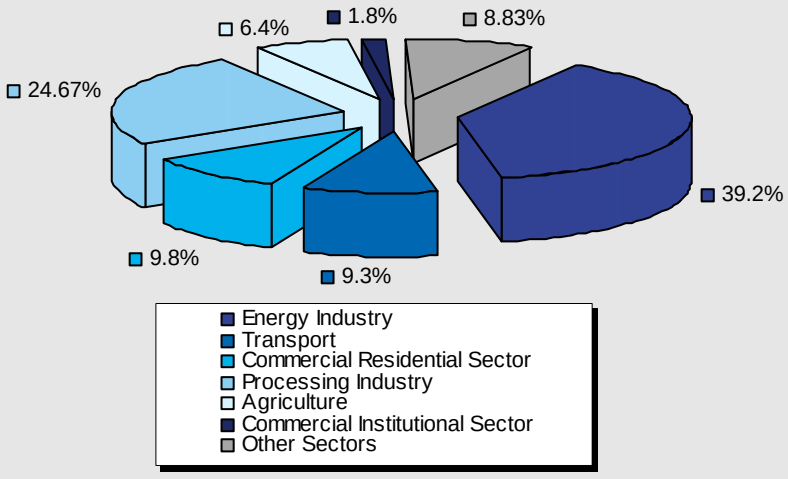
Figure 3.3 represents percentage share of CO_2 emissions from the "Energy" and "Industrial Processes" categories.

Fig. 3.3: Share of CO_2 Emissions from Main Categories in 1994 (%)



Percentage share of CO_2 emission from fuel combustion is represented in Figure 3.4 by various economic sectors.

Fig 3.4: CO_2 Emission from Fuel Combustion in 1994



The major part of all emissions from fuel combustion is the emission from the energy activities sector. In absolute expression the carbon dioxide emissions from the Ministry of Energy and Industry in 1994 were 12.157 million tons.

This inventory presents the data on carbon dioxide emissions from road, railway, water and air transport, and also from the building and agricultural equipment. Emissions from transport devices were 2884.76 thousand tons.

3.3.2 Non-Energy Activities

According to the IPCCC classification, non-energy processes include all type of activity not associated with the fuel consumption. The main category producing CO_2 emissions is the "Industrial Processes". Contribution of this source to the total CO_2 emissions equals to 2.6%.

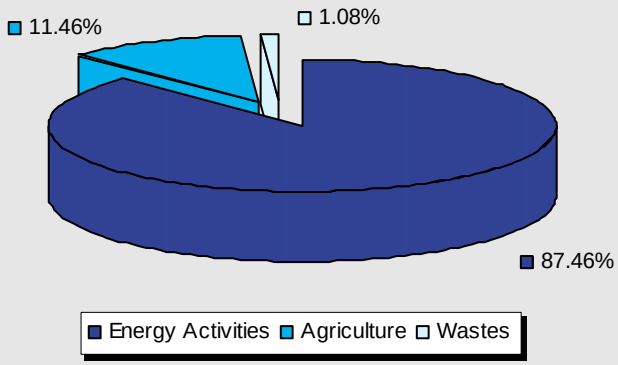
For this category, carbon dioxide emissions from cement and ammonium nitrate were assessed. The IPCC coefficients were used for estimation.

Total CO_2 emissions from industrial processes in 1994 were 840.054 thousand tons, out of which cement production made up 343.92 thousand tons and ammonium nitrate production - 496.134 thousand tons.

3.4 Methane Emissions

Methane emissions in 1994 amounted to 0.968 million tons. Figure 3.5 illustrates the shares of methane emissions from different sources – categories.

Fig. 3.5: Methane Emission by Categories in 1994



It should be noted that main source of methane in Turkmenistan is the energy sector, which includes oil and gas production and refinery.

According to the calculations, methane emissions from the oil and gas extraction, transportation and refinery were 87.5%.

3.4.1 Fugitive Emissions

Methane emissions from extraction, transportation and refinery of oil and gas in absolute expression were 843.85 thousand tons.

3.4.2 Agriculture

Cumulative methane emissions from agriculture equal to 110.429 thousand tons. Of this amount, 97.4% was from livestock and 2.6% - from rice fields. In absolute

expression, emissions from livestock amounted to 108.066 thousand tons of methane. Emissions were mainly (84.2%) from enteric fermentation. Cattle, sheep breeding, poultry farms and camel breeding produce methane emission from livestock.

Anaerobic (without air) decomposition of organic substance at periodically flooded rice fields caused 2.88 thousand tons of methane emissions.

3.4.3 Wastes

According to the IPCC methodology, per 2.1556 million of urban population there were 375.34 thousand tons of waste, 55.6% of which was disposed on land. Taking into account carbon content fraction in wastes and actual decomposition fraction it was assessed that in 1994 methane emissions from waste accounted to 10.429 thousand tons.

Emissions from wastewater were not included into the inventory due to the absence of information.

3.5 Other Emissions

In this inventory the cumulative emissions of carbon monoxide, oxides of nitrogen and NMVOC were estimated, which amounted to 3.27, 0.83 and 0.49 million tons, correspondingly. Emissions of non-methane volatile organic compounds were 17% of the main greenhouse gases. The main source of these emissions (80%) is transport.

3.6 Carbon Dioxide Sinks

In general in Turkmenistan the land resources may be separated by the following categories of land use (Table 3.3):

Table 3.3: Land Use Categories

Land Category	Area, thousand hectares	%
Agricultural Lands	39981.6	81.93
Residential Lands	86.8	0.17
Parks and Others	787.8	1.61
Forests	2158.2	4.42
Lands of Water Fund	427.2	0.87
State Lands	5368.4	11.00
TOTAL:	**48810.0**	**100.0**

On the background of physical and chemical and ecological properties in the surface layer of the atmosphere, the major role in CO_2 absorption and accumulation in the territory of Turkmenistan is played by vegetation communities of different ecosystems. Grazing plants in this aspect are in the leading position, as of 48 million 810 thousand ha of the land of Turkmenistan, 38 million 341 thousand ha, i.e. more than 95% are pastures.

According to the area of fields occupied by different agricultural vegetation and annual sink (calculated depending on photosynthesis), assessment of sink by kinds of plants may be executed (Table 3.4.):

Table 3.4: CO_2 Sink

Category of Agricultural Culture	Area in thousand hectares	Annual Sink of CO_2, kgs/hectare	CO_2 Sink, tons/Gg
Wheat	431	20.0	6620/8.6
Corn	84	40.0	3360/3.36
Barley	72	20.0	1440/1.44
Rice	48	20.0	960/0.96
Cotton	557	45.0	25065/25.06
Lucerne	207	760.0	157320/157.32
Grapes and melons	57	350.0	19950/19.95
Gardens	5	1000.0	5000/5.0
Total:	**1461**		**221715/221.7**

Thus, the main agricultural cultures cultivated in the territory of Turkmenistan consume from the atmosphere more than 221.7 Gg of CO_2 annually.

Large amounts of the carbon dioxide of anthropogenic origin are utilized by grazing vegetation of different ecosystems of Turkmenistan. Although despite of the big area occupied, the biomass increase remains insufficient because of small projected covering.

Table 3.5 below provides annual and seasonal possibility of CO2 utilization from air by plants of different natural ecosystems in the territory of Turkmenistan.

Table 3.5: CO_2 Utilization by Plants

Ecosystems	Area, thousand hectares	Efficiency of Pasturable Vegetation of Different Ecosystems, centers/hectare				Annual Volume of UtilizedCO_2, tons(Gg)
		Spring	Summer	Autumn	Average Annual Value	
Sandy Desert	26413.6	2.3	3.4	3.2	2.97	100350 (100.35)
Gypsum Desert	4587	3.9	3.9	4.4	3.3	10550 (10.55)
Clay Desert	2250	2.9	4.0	4.1	3.6	9595 (9.595)
Foothills and Foothill Plains	2793	5.3	5.0	4.1	4.8	18593 (18.593)
Lower Mountain Range	1749	6.1	5.8	4.0	5.3	13915 (13.915)
Medium Mountain Range	310	6.8	7.0	6.4	6.7	3317 (3.317)
Higher Mountain Range	239	6.4	7.0	6.8	6.7	2557 (2.557)
TOTAL:						**158877 (158.877)**

As it is shown in the Table, the desert plants despite low indexes of yearly productivity occupy the first place in CO_2 sinks. Considerably high is the percentage of CO_2 sinks by the plants of mountain ecosystems, especially during hot summer time. This is why it is evident that in summer time main CO_2 sinks take place towards the Kopetdag mountains. The plants of pre-maintain plain ecosystem are in the intermediate position in this Table. The total CO_2 sink by the plants of different natural ecosystems was 158.9 Gg.

The total amount of carbon dioxide sinks from the territory of Turkmenistan is 380.6 Gg.

3.7 Uncertainty Assessment

According to the results of the uncertainty assessment of the GHG inventory, errors of the results of emissions estimations, associated with errors in initial statistical data for "Energy Activities" category is estimated to be equal to 5-15%, except for the residential sector, where errors may be up to 20%.

Fugitive emissions were estimated with level of uncertainty of 50%. Methane emissions from enteric fermentation in the livestock breeding were estimated with the 25% error. For the rest categories, the level of uncertainty varies from 20 to 50%.

3.8 Carbon Dioxide Emission Projection

At the moment, it is difficult to provide a reliable long-term projection of GHG emissions. Baseline scenario of CO_2 emissions, that is the emissions dynamics, which assumes no mitigation measures to be implemented for Turkmenistan, as a transitioning country, will not be consistent with long-term trends. This projection will be determined, first of all, by long-term projections, of the Turkmen economy development and of the energy use efficiency, construction of these projections, in its turn, is a rather complicated task.

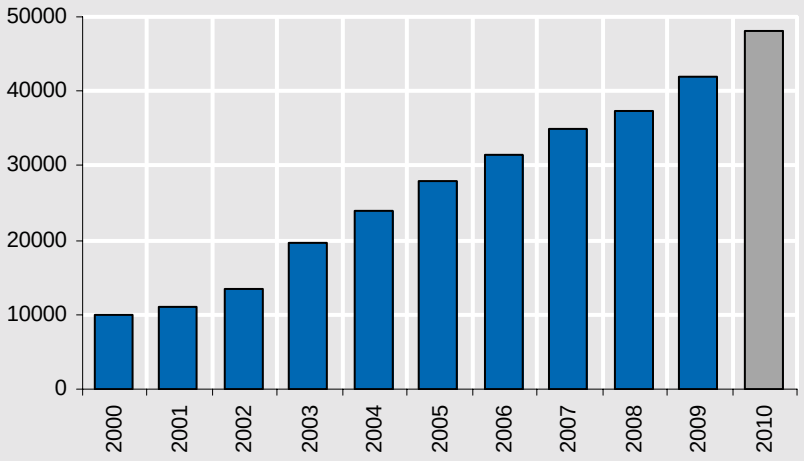
The intensive development of the fuel and energy complex, is one of the priorities of the Turkmenistan economy for the next ten years.

Taking into account, that the maximal contribution to emissions falls on this sub-category (Energy), it is possible to make preliminary GHG emissions predictions according to the projected plans of oil and gas extraction and refinery.

According to the national Program of oil and gas complex development, the total production of oil with gas condensate in 1999 and 2010 will be 155.5 million tons, including in 2005 – 27.5 million tons and in 2010 – 44.5 million tons.

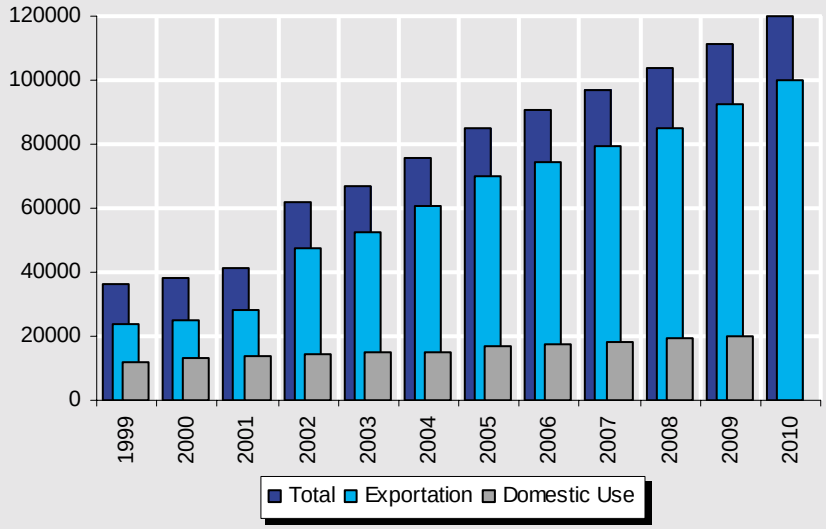
The dynamics of the oil production increase is characterized by data, illustrated in Figure 3.6.

Fig. 3.6: Projected Oil Production Including Gas Condensate in Turkmenistan for 2000-2010 (thousand tons)



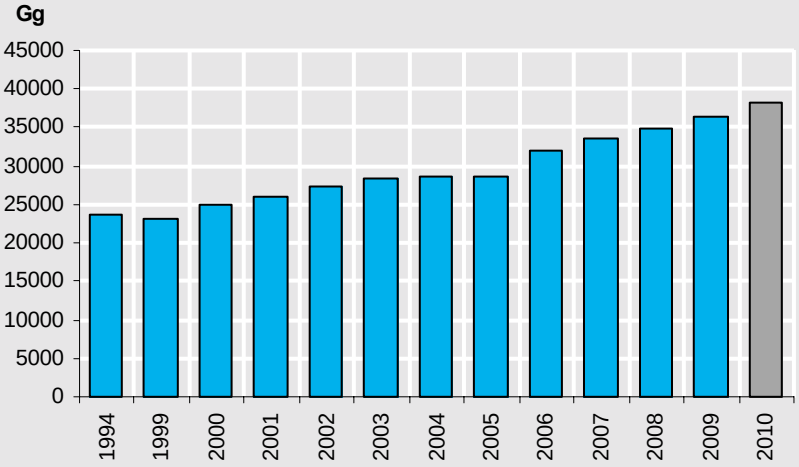
The planned amount of total gas production till the year 2010 will be 524.9 billion cubic meters, including in 2005 – 85 billion cubic meters and in 2010 – 120 billion cubic meters (Figure 3.7).

Fig. 3.7: Projected Gas Production in Turkmenistan for 1999-2000 (million cubic meters)



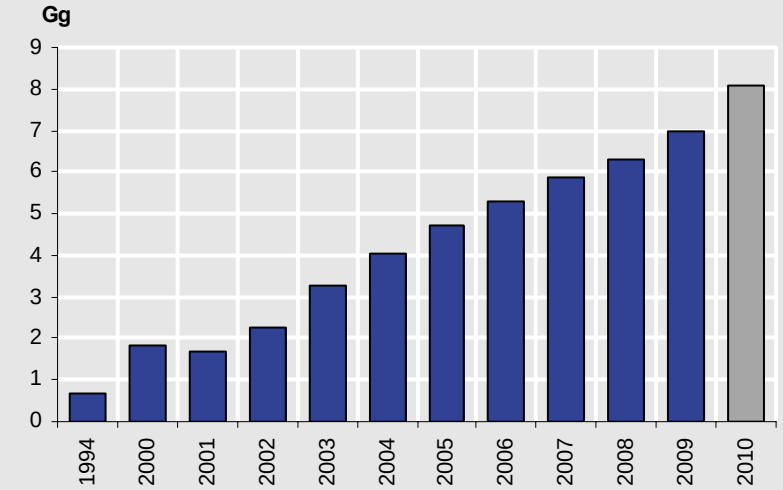
Expected increase in CO_2 emissions by the year 2010 will be 38211 tons (Figure 3.8).

Fig. 3.8: Carbon Dioxide Emission Projection from Natural Gas Combustion for the period till 2010



Expected increase in methane emissions by 2010 will be 330 tons (Figure 3.9).

Fig. 3.9: Methane Emission Projection from Oil Production for the Period till 2010



4. POLICY AND MEASURES ON ANTHROPOGENIC GREENHOUSE EMISSIONS REGULATION AND ADAPTATION TO CLIMATE CHANGE

In accordance with the provisions of the UN Framework Convention on Climate Change, measures on anthropogenic emission limitation and increase of greenhouse gases are carried out in Turkmenistan. Main attention in anthropogenic greenhouse gases emission is paid to registration and limitation of the greenhouse gases technogenic emission in the energy sector of the country, first of all, in fossil fuels utilization and products of their processing in all sectors of the national economy: energy, transport, industry, residential sector, agriculture. While planning and realizing the system of measures on regulation of anthropogenic greenhouse gases emissions and sinks, the main attention is paid to economic and ecological efficiency of the activities, taking into account their influence on natural economic and social systems. The State Commission for implementation of the Turkmenistan's commitments under conventions and other UN environmental programs is coordinating activities on regulation of anthropogenic greenhouse gases emissions and sinks.

In Turkmenistan, as in any developing country and transition country, reduction of GHG emissions and adaptation of the economy to climate change should be directly connected with national and sector plans of the economic development and preservation of the environment.

Table 4.1: Measures on GHG Emissions Reduction

Sector of Economy	Measure
Sector of electricity and heat energy production	To develop enabling mechanisms to implement the energy-saving policies.
	To improve efficiency of fuel utilization at power stations.
	To include renewable sources of energy into the energy balance.
	To use the 100 % natural gas share in the energy balance.
Sector of electricity and heat energy consumption	To improve efficiency in the energy consumption in residential sector and industry, to modernize heating systems.
	Energy saving measures in residential sector and industry.
Agriculture	To increase the livestock productivity and to optimize the livestock population.
	To reduce the areas of low-production lands in agriculture and to promote production of cotton and wheat.
Forestry	To increase the areas covered by forests.

4.1 Measures Evaluation

Selection of the GHG mitigation and adaptation measures for each sector is based both on expert judgments from the related ministries and organizations and on the results of the work done according to the National program of natural preservation.

The main efforts on reduction of GHG emissions in Turkmenistan will be aimed at the emissions reduction in the energy sector. The following measures are defined for the electricity and heat energy production sector:

- To increase efficiency of fuel utilization at generator power plants (GPP);
- To increase renewable non-fuel sources in the energy balance.

The following priority measures were recommended for sector of energy consumption:

- To improve the energy efficiency in residential sector and industry; heating system improvements;
- To carry out energy saving measures in residential sector and in industry.

The policy and measures on limitation of carbon dioxide technogenic emissions in the Turkmenistan's energy sector are based on the provisions of Concept of the strategical development of the country is energy sector, which is aimed at energy consumption and energy production efficiency improvement.

At present the Law of Turkmenistan about the energy saving is under preparation. This law includes all aspects of energy saving both in the sphere of production, and in the sphere of energy consumption. This law determines inter-sector scheme of energy saving management at the governmental level. One of the prime measures on emission reduction both in production and consumption of energy, is the development of the enabling mechanism to implement the energy-saving policies.

Proceeding from such criteria as presence of resources, level of technical development and potential of GHG emissions reduction, the following technical measures on emissions reduction in power sector were selected: improvement of efficiency of fuel utilization at GPP and improvement of heating system; use of wind and solar energy; utilization of associated gas of oil extraction industry. All these measures are included into the national energy development programs.

The realization of the program of improving the efficiency of fuel utilization at GPP, construction and operation of wind power plants, utilization of associated gas, provide the biggest possible emission reduction. Development of solar energy has the greatest effect in the greenhouse emissions reduction. The realization of all these measures will result in decrease of hydrocarbon materials utilization in the energy sector. Construction of small hydroelectric power stations (HPS) is one of the options leading to energy cost reduction and financial savings.

At present modernization of GPPs and construction of small HPSs are the most cost effective and easy to execute measures. Among middle term and short term measures in the energy production sector, increase of efficiency of fuel utilization

at power stations together with energy saving and improvement of heating systems are the priority measures.

The annual GHG emission reduction caused by the solar energy development may at the initial stage be evaluated at 1% of the base scenario emissions. Application of such installations is possible in the difficult to access areas, where consumers do not need big amount of heat and power.

4.2 Measures on Reduction of CO_2 Emissions

In new conditions of the development of the country, the limitation of CO_2 emission level is possible, first of all, alongside with implementation of measures aimed at solution of social and economic together with ecological tasks for the country's energy supply, and transfer to the new ecological relations. The most promising in this respect in non-energy sector are the measures on increase of carbon dioxide sequestration by expansion of wood plantings and rehabilitation of perennial grass and bushes vegetation on degraded or taken out from cultivation lands. Such measures as efficiency increase of livestock breeding and optimization of rice fields areas would allow to reduce up to 15% of methane emissions from agriculture.

4.2.1 Energy Sector

With acquisition of independence Turkmenistan gained great opportunities for the intensive development of power industry, as well as the other branches of the economy. These can be realized by means of capacity increase of the existing power plants together with construction of new ones. In case the feasibility studies confirm the economical advantage of production, transmission and stable consumption of electric energy, it is possible to build new power powers in any point of Turkmenistan, as natural gas in sufficient amounts is available practically throughout the whole territory of the country.

The calculations clearly demonstrate that by the year 2010, without imposing additional measures, it will not be possible to reduce the level of greenhouse gases emissions to the level of 1994.

Thus, new and ecologically clean methods of fuel combustion should be worked out at power plants; steam turbine energy blocks must be changed for modern gas turbine installations.

In 1999, the new gas turbine unit with the 123 MWt power has been put into operation at Buzmeyin power plant which consumes 39.75 thousand cubic meters of gas per hour. The existing 5 old steam-electric generating units produce 125 MWt, consuming 56 thousand cubic meters of gas per hour. In perspective, obsolete units at Buzmeyin and Balkanabat power plants will be substituted by modern turbine installations. Thermal power stations in Serdar town with the capacity 246 MWt and in Dashoguz - 100 MWt, will be equipped with the same turbine units. The modernization of generator plants and power plants will allow reducing the CO_2 emissions by 30% without decrease of capacity.

At present the project of heating supply de-centralization of Turkmenabat city is launched with the UNDP assistance.

In spite of the fact that the internal consumption of electric energy in Turkmenistan will increase in future, nevertheless to create more powerful energy system, it is necessary to be oriented on export of electric energy. This will reinforce the country's economy. And this is possible if to create reliable energy system with the neighboring countries. Turkmenistan offers to establish the unique electric energy system of the Central Asian states, i.e. Turkmenistan, Afghanistan, Pakistan, India, Iran, Turkey, Tadjikistan, Uzbekistan, Kyrgyzstan and Kazakhstan on the basis of the existing electric power systems of these countries. Such a system could provide not only mutual power exchange, but also to smooth out the peaks of loading.

The Turkmen energy system already has connection with the Central Asian countries energy systems by 500 kV line. The existing and projected 400 kV and 500 kV power transmission lines can be used to create common energy system for the Central Asian countries.

The internal consumption of electric energy in Turkmenistan intensively grows. Increase of domestic electric units, agriculture and development of the industry cause this. In total energy growth dynamics, significant place is occupied by export necessity, which is supported by real capabilities of Turkmenistan. The perspective internal and external power consumption may be covered by the growth dynamics of the electric energy of Turkmenistan, which is presented in Table 4.2.

Table 4.2: Balance of Electric Power of Turkmenistan, million KWh

Parameter	1995	2000	2005	2010
Electric Power Production	9834.3	17500	19250	21170
Domestic Consumption	695.8	1580	1730	1900
Technological Consumption for Transportation	1155.97	1640	1820	1960
Industrial Consumption	60.8	120	130	150
Export	1754.1	6000	6500	7300
Consumption	8399.3	11300	12750	13870
Domestic Consumption	6484.3	8160	9070	9860

The following measures are accepted to prevent and reduce the emissions of fuel combustion by the locomotives of the Turkmendemirellary Railway Division:

- In the nearest future, it is planed to convert to the trains powered by electricity.

The road transport became the most intensive source of the environmental pollution for the last years. As a source of environmental pollution it has some particular features, which make the problem solution more difficult. One of the reasons is the constant increase of this source. In existing situation the most effective could be introducing different systems of neutralizers, which at present are quite expensive. In this field of activities support is required both of the country and international entities.

The following measures are taken on the mitigation of greenhouse gases emissions from fuel combustion by the Turkmenhovaellary National Division aircraft engines:

- More intensive operation of planes and helicopters of modern models having engine, complying with the ICAO norms for the fuel combustion. In perspective it is planned to completely change the obsolete aviation equipment to modern planes and helicopters.
- Installation of the new Thomson system near Ashgabat has allowed significant reducing of airtime during landing.

4.2.2 Non-Energy Sector

Annually Turkmenistan produces 4 million tons of domestic and industrial wastes. Mainly this is household waste, and also wastes of construction materials and heaps of mining industry.

There are two ways to solve the methane emission problem:

- Utilization for energy production purposes of methane, formed at waste dumps.
- Processing or destroy of household waste at small waste processing stations or installations.

Agricultural cattle-breeding production in Turkmenistan is based mainly on small cattle breeding. There is a tendency in increase of big cattle farms construction, where small installations may produce biological gas for farms or large livestock facility purposes.

4.3 Renewable Energy Resources

Price increase for traditional sources of energy and ecological problems make utilization of non-traditional and renewable kinds of energy more attractive. At present many countries pay special attention to new ideas and projects on industrial utilization of non- traditional energy sources. The intensive studies in search of an alternative to fuel energy are carried out, in particular, for residential and industrial spaces heating, hot water production, road transport fuel conversion, etc. In this regard, the natural and climatic conditions of Turkmenistan form good basis for utilization of solar energy in different agricultural fields of activities.

Renewable energy resources of Turkmenistan include the Sun, wind and river sources of energy. Turkmenistan is located in the region rich with solar irradiation. The daily average density of solar irradiation in the territory of Turkmenistan is 23760 j/м^2. The annual energy amount per each sq.meter is 8.672 x 10^6 kJ. Total solar energy for the whole territory of Turkmenistan amounts to 4.233 x 10^{15} kJ. This amount (1.76 x 10^{15} kWh) is 120 times more than the amount of energy produced by all power plants in Turkmenistan in 1994. However, the utilization of the really existing solar energy is rather complicated. This is connected with the solar energy diffusion and other circumstances creating difficulties in the solar energy production and consumption balance. Nevertheless,

at present water heaters are designed with the efficiency coefficient equal to 30-40% and photovoltaic converters with 10% efficiency.

Thus, solar energy can be utilized for water heating or be converted into electricity. The price of solar water heaters without installing expenditures is 100-200 dollars per sq. м. The photovoltaic energy production is 100-200 times more expensive compared to its production by usual methods. This is why, the wide-scale utilization of solar energy in Turkmenistan, possessing huge resources of oil and gas is today economically not beneficial.

Nevertheless, the solar energy plants may be beneficial in the places remote from electric transmission lines and railway, i.e. in desert and semi-desert conditions. Taking into account the fact, that 71.7% of the Turkmenistan's territory is occupied by desert, the possibility of efficient use of the solar energy can not be excluded, especially by independent consumers, despite the fact of possession of traditional sources of energy.

Wind energy. Frequent winds are observed in the western part of Turkmenistan, i.e. in the regions of Balkan velayat. However, even in these regions wind energy facilities can not produce stable and comparatively significant amounts of energy due to several reasons: irregular wind speed and duration, wind space dispersion, high cost price of wind power facilities. Nevertheless, wind energy can be effectively used for the peak offloading of independent consumers, provided by the development of reliable method of power accumulation, in combination with solar energy.

In future the most perspective can be wind power plants with 2-20 thousand kW capacity, consisting of dozens of wind energy installations. The operation of wind energy installation depends mainly on wind speed, which according to the opinion of specialists, should not be less than 3.5-4 м/s. Assessment of wind resources, installation type and location are controlling factors at wind power plant building and effective utilization of wind energy. Average annual wind speed at open plains of Turkmenistan is 2-4.2 м/s; maximum monthly average speed 5-10 м/s is observed at the shore of the Caspian sea and in Kopetdag mountains.

According to practical experience, wind energy installations with 6-24 m blade diameter at wind speed 6 м/s, can annually economize 2.8-54 tons of conditional fuel. There are considerable opportunities of small wind power facilities utilization on desert pastures, where wind speed reaches 4 м/s and more. These facilities of small capacities may be used for electricity production and well water extraction.

River energy. Out of the total reserve of the Central Asian region hydro energy resources, 80% belong to Kyrgyzstan and Tadjikistan, and the rest 20% - Kazakhstan, Uzbekistan and Turkmenistan. Turkmenistan is not rich with water energy resources. The biggest river in the territory of Turkmenistan is Amudarya. The average long-term flow of Amudarya makes the river one of the biggest. The total length of Amudarya river is 2540 km; 1000 km is in the territory of Turkmenistan. Mainly this is a plain. Very often the river washes away its bunks and changes its bed. To convert hydro energy of Amudarya to electricity in Turkmenistan, it is necessary to build huge dams, which need large capital investments. The flows of the other Turkmenistan rivers (Murgab, Tedzhen, and Atrek) can not be effectively used for large hydroelectric stations building, due to insufficient amount of water reserves. These rivers are fed by melting snow and

precipitation. Therefore 80% of water reserves of these rivers are available only in spring. 14 water reservoirs existing in Turkmenistan can not be used for hydroelectric station construction, as it is not real in practice.

The energy water utilization is of certain interest while working out non-waste technological systems, using renewable and traditional sources of energy and in view of natural conditions of the regions of Turkmenistan.

Implementation of small power-intensive, non-waste, ecologically clean facilities of different functional purpose combined with the use of traditional and non-traditional sources of energy is an alternative to traditional energetic, which may provide energy supply both industrial, and agricultural facilities.

The main measures in the activities regulating the level of fossil fuel consumption in the country and CO_2 emission are:

- To increase efficiency of energy consumption and energy production in all fields of the national economy;
- To use modern technologies, which increase the economy, energy and ecological efficiency at the stage of extracting, processing, distribution and utilization of energy resources;
- To update price and tax policy of energy supply and effective use of energy in new market conditions.

4.4 Increase of Carbon Dioxide Uptake from the Atmosphere

The most promising measure on CO_2 emission reduction in the atmosphere is the increase of its uptake by plants. Increase of forest areas and rehabilitation of perennial grass and bush vegetation in the degraded and non-cultivated lands can achieve it. Only limited part of the territory of Turkmenistan, river oasis and foothills have possibility to increase the CO_2 uptake.

Intensive work is carried out in Turkmenistan on planting of perennial and mainly coniferous woods. A number of the Decrees of the Government of Turkmenistan support this activity, namely:

- About Development of Gardening and Greenery in Turkmenistan, 1993;
- About Creation of Park Zone in Kopetdag Forelands, 1998;
- About Establishing of Green Belt Joint Stock Company (creation of forest and park zones around all cities of Turkmenistan), 1999.

4.5 Possible Adaptation Measures

4.5.1 Water Facilities

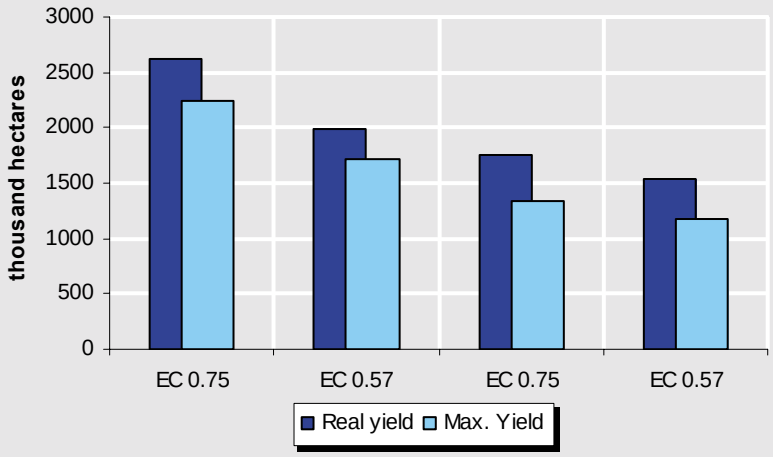
The present chapter provides studies on adaptation aspects of water facilities aimed at meeting the demands of the agricultural industry. In this respect amelioration activities may increase the land fund productivity. Among these

measures are the following: duly delivery of sprinkling water in needed amounts, regulation of the irrigated lands water and salt balance. This will result in transfer of lands from middle and strong salty categories into the categories of non-salty and weak salty. The realization of measures on adaptation of water economy to the new conditions should be commenced today, so that in a calculated temporal level the parameters of the whole water economy complex and its separate components meet the requirements of the new climatic conditions.

4.5.1.1 Irrigated Lands

The analysis of water consumption by agriculture shows, that under existing level of productivity of main cultures and existing state of water economy complex, the area of irrigated lands will not exceed 1987 thousand hectares, and in case of CO_2 doubling will be reduced to 1330 thousand hectares. In case the productivity is increased to the projected amounts, the area of irrigated lands will be 1709 and 1170 thousand hectares correspondingly.

Fig. 4.1: Change of Irrigated Area at Different Efficiency Coffecient (EC) of Irrigation Systems



To provide irrigation for the areas stated above the amount of 23257 million m^3/year of water resources is needed.

If the works are done to increase the irrigation systems efficiency coefficient from

0.57 to 0.75, then the irrigated area under existing productivity may amount 2615 thousand hectares, and at CO_2 doubling - 1715 thousand hectares. With the increase of productivity till maximum level, the irrigated area will be 2249 and 2540 thousand hectares accordingly.

4.5.1.2 Use of Water Resources

The reduction of the irrigated area is connected to the increase of water consumption by agricultural plants, when increasing their productivity. This situation remains both, under existing state of environment, and at change of certain climatic conditions.

The forecast water resources may be increased to 25750 million cubic meters per year by utilization of part of drainage water at the formation places at the amount of 1123 million cubic meters per year in Lebap velayat and 750 million cubic

meters in Dashoguz velayat. Also 620 million cubic meters per year of ground water may be utilized (in total 2493 million cubic meters per year).

Basing on these data, production amounts of main agricultural products have been calculated. The comparison analysis shows, that at reduction of irrigated lands area with the increase of the cultures' yield, the total production amount is increasing. This dependency remains also in the case of CO_2 doubling.

The variation of CO_2 contents may provoke a temperature increase, humidity deficiency, reducing of annual precipitation norms. In such a case, additional production amount will be significantly lower, even provided by the increase of irrigation systems productivity and of water resources of the country.

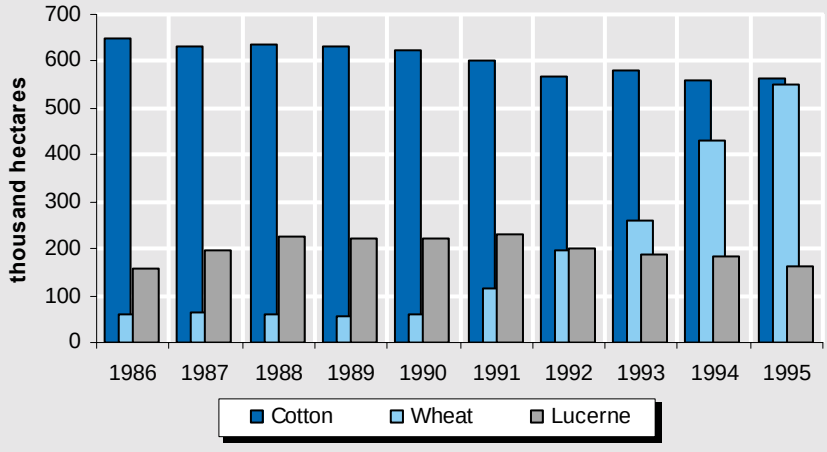
4.5.2 Agriculture

4.5.2.1 Existing State

The analysis of the existing state of agricultural production is executed on the basis of data for 1986-1995. This period is characterized by steady economical state of the agricultural sector. The data of recent years (1996-1998) can not serve as basic. During this period agricultural production and yield reduced due to various reasons.

The agriculture of Turkmenistan plays important role in the national economy. During last years the share of agriculture in Gross Domestic Product (GDP) was 16%. Total amount of gross production in 1997 was 2670 billion manats (in actually valid prices), including vegetable growing share - 1286 billion manats (48%) and cattle breeding share - 1384 billion manats (52%).

Fig. 4.2: Change in Main Cultures Areas



The average productivity of raw cotton during the analyzed 10-year period (1986-1995) was 1329.8 thousand tons (in 1990 - 1468.7 thousand tons), cereals - 637.6 thousand tons (in 1995 - 1109.2 thousand tons, including wheat - 878.7 thousand tons), vegetables - 362 thousand tons (1989 - 413 thousand tons), melons - 255.2 thousand tons (1989 - 365 thousand tons). During last years the priority in the agricultural sector development in Turkmenistan is given to the realization of "Grain" Program.

It is necessary to point out, that in the analyzed period the average productivity of

cotton was 22.0 centner/hectare, cereals - 20.1, vegetables - 133.6, lucerne - 52.8, fruits - 31.2, grapes - 75.8 centner/hectare. In some certain years these numbers were much higher (see Table 1). For example, the average productivity of cotton in Turkmenistan in 1991 was 24.0 centner/hectare, cereals (1988) - 22.7, vegetables (1995) - 163.7, lucerne (1986) - 61.3, grapes (1986) - 91.6 centner/hectare. In separate farms the productivity of cotton reached 34-37 centner/hectare, cereals - 35-38 centner/hectare, vegetables - 370 centner/hectare, lucerne - more than 100 centner/hectare, fruits – 100-115 centner/hectare, grapes – 150-170 centner/hectare.

Essential transformations are observed in the structure of agriculture at present. Two equal sectors are functioning on equal conditions:

- State (daikhan entities, subsidiary facilities of enterprises and organizations). The number of daikhan entities is 570, subsidiary facilities of enterprises and organizations - 700;
- Non-state (daikhan farms, private producers, individual facilities, cooperatives and small enterprises). Number of daikhan farms - 1800, private producers - 6086, individual facilities – 565504, cooperatives and small enterprises - 6300.

The most important cultures as cotton and wheat are produced upon the state order, and daikhan entities lease the land. This is why the share of the state sector in this field in 1997 was 85%, and non-state - 15%. The total cost of the cultures produced was 1286 billion manats (in actually valid prices); the share of the state sector was 1094 billion manats.

4.5.2.2 Perspectives

A number of factors create the most favorable conditions for plants, like natural and climatic conditions of the production zone of culture. And, duly and high-quality implementation of all fieldwork (soil cultivation, fertilizing, sowing, treatment, harvest). Fieldwork can be fully controlled and influenced by people. Natural and climatic conditions should be considered as a fact, which people should adapt to.

The factors, influencing the main agricultural cultures (temperature regime and water demand), and also the vulnerability of agriculture and water facilities of Turkmenistan to possible climate change has been studied and analyzed.

The three cultures have been studied: winter wheat, cotton and lucerne, which occupy more than 70% of the areas used in agriculture in Turkmenistan (1986-1995). In 1997 the share of these three cultures in total area of agricultural land was 82.6%. This is why these cultures have been selected for this work.

The national programs “10 Years of Stability”, “Grain”, “New Village” and others, regulating activities of water and agricultural complexes became the program documents used as a basis to define the perspectives of the Turkmenistan agriculture development. One of the major goals of these program documents is the solution of tasks on supply of the population with own foodstuffs products and increase of social and economic level of life of the Turkmenistan citizens.

The perspective of foodstuffs production was defined on the basis of the population increase indexes and in accordance with the program documents

determining supply of the population with main products of the own manufacture. In accordance with the recent statistic data, there are 5 million 80 thousand people in Turkmenistan at present. In case the average long-term population growth remains at the same level (2.0-2.5% per year), the number of population of Turkmenistan by 2050 will be 18 million. The calculations demonstrate, that if the irrigation system efficiency coefficient is 0.75 and the projected yield is achieved, then the amount of raw cotton produced will be 3000 thousand tons. Same picture is observed at analyzing the wheat production data. Taking into account the climatic changes, adjusting of irrigated areas for the other cultures will be needed.

The foodstuffs production perspective is determined on the potential level of productivity. The level of potential productivity is accepted according to the data available at the Scientific and Research Institute of Agriculture and Water Economy (former Institute of Agriculture).

Water Consumption

In accordance with the above stated facts and in view of meeting the demands of the population in main foodstuffs products, the total irrigated area by 2025 should be 2550 thousand hectares, and by 2050 not less than 3000 thousand hectares. If the irrigation systems efficiency coefficient remains at the present level (0.57), the irrigation water shortage by 2050 will make not less than 14 cubic kilometers. The only way to meet the demands of agriculture in irrigation water is the increase of the irrigation systems efficiency coefficient by 2025 to the level 0.75 and engaging additional sources of water. Such as, weak mineralized drainage water, ground water, industrial and urban wastewater after treatment, etc.

The most dangerous in this respect is the probability of water resources reduction. As it was stated above, demand in irrigation water will be considerably increased due to the increase of irrigated areas. In regard of these circumstances, two shall aspects have to be studied.

First, the UK89 model data analysis demonstrates possible air temperature increase and reducing of the sum of precipitation. This will directly influence the amount of the river water reserves and cause some changes for hydrograph.

Second, anticipated climate change will cause the increase in evaporation and result in necessity of the irrigation norms increase. The calculations demonstrate, that the irrigation norm (net) may be increased (for Prikopetdag and Murgab-Tedzhen zones): for cotton – from 7347 m^3/ha to 10797 m^3/ha; wheat - 6509 m^3/ha to 8964 m^3/ha; lucerne - 8651 m^3/ha to 13451 m^3/ha.

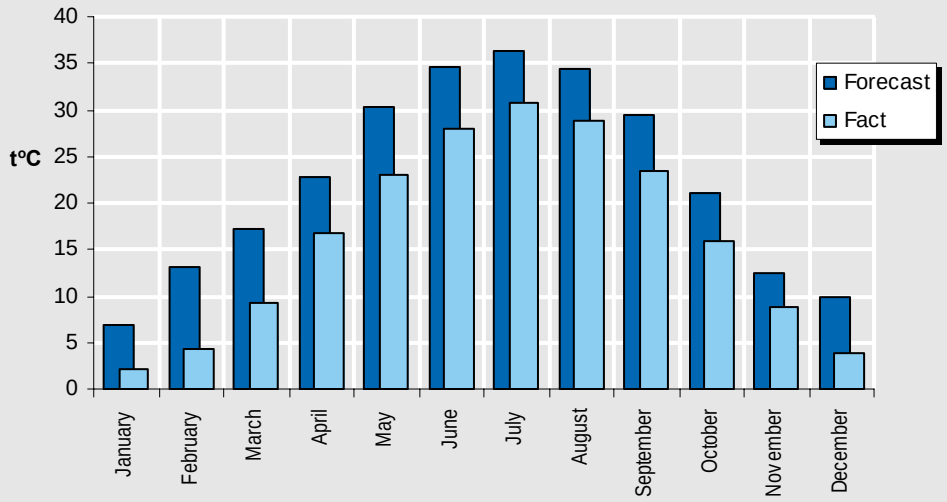
Temperature Regime

In defining the adaptation measures in the agriculture and water economy activities in connection with possible climate change for the period to 2050, the estimation of the main parameters variation (air temperature and precipitation) was executed on the basis of data obtained at the UK89 model calculations.

The average monthly air temperature data were obtained upon the results of modeling (UK89 model). However, this is not enough for assessment of influence of the air temperature on plants growth. Due to this, the following approach was used.

Basing on the data of long-term average monthly air temperatures (1881-1980) for five stations (Ashgabat, Bairamaly, Kunyaurgench, Turkmenabat and Serdar), the composition year was modeled with the relevant levels of average monthly temperatures. And average daily temperatures were defined on this basis.

Fig 4.3: Averagy Monthly Factual and Forecast Temperatures for Ashgabat Station



Acceptable deviation of the obtained parameters does not exceed the statistical error, which is 0.1-0.2°C for warm six months and 0.2-0.5°C for cool six months. After that, the optional versions of variation of daily average temperatures were determined according to data of UK89 model. The data of this index may provide real assessment of the influence of temperature on plants growth and development, possibilities of sowing and harvesting terms shift, correspondence of the sums of effective temperatures to vegetation demands, etc. Besides that, the quantity of days with critical air temperature (more than 40°C for cotton) was determined, which directly causes the yield decrease. It is necessary to take into account the duration of the period with these days. In case the duration of the period with critical temperatures is small (1-2 days), there will be practically no productivity loss.

In forecasting the grain production development (winter wheat), it is necessary to pay attention to the fact, that high temperatures are the most negatively influential during the period of "coming up and rising". In this case the reverse correlation connection of harvest with the temperatures sums above + 10°C is observed. Due to this, the shift of sowing period to an earlier time may be expedient.

The calculations show that the expected warming will in general favorably influence the growth and development of plants.

The assessment of probable location distribution of daily air temperatures demonstrates that the days with critical temperatures are possible in any of the velayats, however probability does not exceed 1%. Besides this, the other indexes important for agriculture were defined: increase of quantity of days with the temperature more than 35°C in spring period and with temperature more than 40°C in summer period, and the sum of effective temperatures.

The calculations showed that the two factors stated above, in the aspect of negative

influence on agricultural production are not of special concern. The number of days with critical temperatures does not exceed acceptable limits, and their probability is very small. The sum of effective temperatures is being increased. These circumstances allow making a conclusion that the climate change will not negatively influence the agricultural production. Moreover, favorable influence may be observed (shift of sowing to earlier period and, probably, small reducing of the period of vegetation).

4.5.2.3 Measures

It is evident that there is no opportunity to increase water resources of the country. In accordance with this, a number of adaptation measures on anticipated climate change aimed at rational water utilization (increase of irrigation systems efficiency coefficient, implementation of modern methods of irrigation, regulating of river flow, etc) should be executed. All these measures require large capital investments. However, we believe that considerable economizing in water resources at irrigation can be achieved by updating of organizational measures and economical relation between the state and water consumers.

Summarizing all stated above, it is possible to state that due to possible climate change, the following priority tasks must be included in the list:

- Reconstruction of irrigation systems with the purpose of efficiency coefficient increasing;
- Implementation of modern irrigation methods;
- Building of long-term regulation water reservoirs;
- Modernizing of economical mutual relations between the state and water consumers;
- Promoting of selection works aimed at breeding of drought-resistant and high productivity breeds of main agricultural cultures, etc.

4.5.3 Grasslands

4.5.3.1 Existing state

Grasslands of Sand Desert

The total area of the Turkmenistan grasslands is 21 million hectares. Pastures of sand desert occupy the biggest portion of this area. Annual average eatable stock of fodder at different types of pastures fluctuates within the limits 0.6-2.3 centner/hectare.

Gypsum Desert Grasslands

Grasslands of gypsum desert are mainly located in the northwest part of Turkmenistan, occupying 5 million hectares area.

Annual average eatable fodder stock at various kinds of wormwood pastures is in the limits 0.6-2.8 centner/hectare.

Clay Desert Grasslands

The total area of clay desert grasslands is about 4 million hectares.

Annual average eatable fodder stock at various kinds of pastures is in the limits 0.8-4.2 centner/hectare.

Secondary Eolian Soil Hilly Grasslands

These are located in the southern end of Turkmenistan and occupy the area of 3 million hectares.

Average annual fodder yield at various types of pastures varies between 1.5 and 3.1 centner/hectare.

Combination of Sand and Gypsum Desert Grasslands

This type of pasture occupies the area more than 1.8 million hectares and is located in southern and southwest parts of Zaunguz Karakum. Fodder reserves are in the limits 0.7-1.0 centner/hectare.

Combination of Sand and Clay Desert Grasslands

The total area is about 1 million hectares. Fodder reserves are in the limits of 1.0-2.1 centner/hectare.

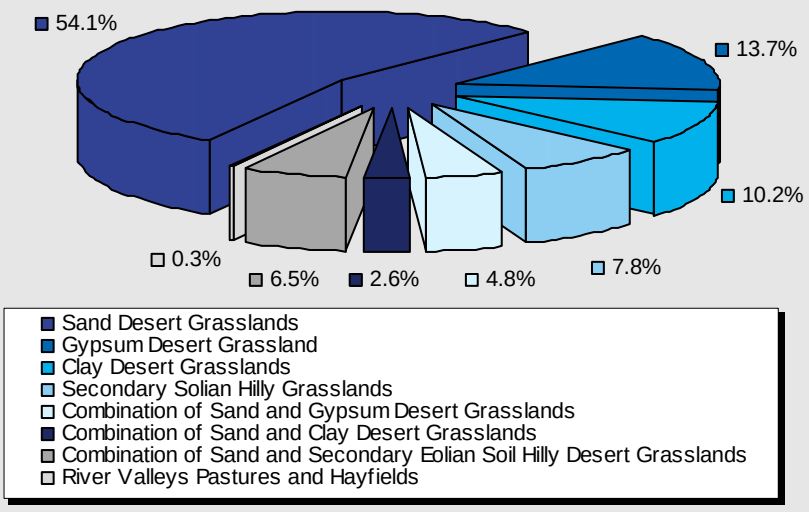
Combination of Sand and Secondary Eolian Soil Hilly Desert Grasslands

Its total area is about 2.5 million hectares. Fodder reserves are in the limits of 1.3-2.3 centner/hectare.

Pastures and High Fields of River Valleys

Grasslands of this kind do not have big areas and are located in the irrigated land zones.

Fig. 4.4: Structure of Grasslands Types



Total area of desert grasslands is 38 million hectares, including those irrigated 22.4 million hectares. Annual average norm of grasslands in Turkmenistan, depending on type, varies in the limits from 3 to 12 hectares per one sheep; average index is 7.8 hectares per one sheep.

4.5.3.2 Perspective Assessment of the Grasslands

Assessment of climate change and its impact on vulnerability of grasslands showed that the grassland productivity would be decreased in future.

Although plants are adapted to dry and hot conditions, nevertheless drought occurs 1-2 years within the 10-year period with productivity decrease. The decrease of moisture in soil (0-20 cm layer) to 4 mm is the criteria of the soil drought. To estimate the air drought, humidity shortage index is used:

- Weak drought - from 50 to 60 mbar;
- Average drought - from 60 to 70 mbar;
- Hard drought - from 70 to 80 mbar;
- Very hard drought - more than 80 mbar.

Besides air humidity shortage, the following data are used for assessment of spring period dry conditions:

- The sum of precipitation for autumn-spring period;
- The sum of air humidity shortages from temperature crossing the + 5^{o}C point to temperature crossing the + 15^{o}C point;
- The quantity of days with air temperature more than 35^{o}C and with relative humidity less than 30%, exceeding long-term quantity;
- During the summer period the quantity of days with air temperature more than 40^{o}C.

At this stage of studies, the assessment was made by sums of annual precipitation (this will directly result in decrease of moisture in 0-20 cm layer of soil) and by humidity shortage in the month of April.

The analysis of these parameters demonstrates, that the predicted annual sum of precipitation in autumn-spring period (September - May), compared to factual value, will be decreased in:

- Balkan velayat - by 45 mm/year;
- Akhal velayat - by 60 mm/year;
- Mary velayat - by 14 mm/year;
- Lebap velayat - by 49 mm/year;
- Dashoguz velayat - by 16 mm/year.

Concerning humidity shortage, in general during the period of vegetation it can be increased in:

- Balkan velayat - by 7.8 mb;
- Akhal velayat - by 11.7 mb;
- Mary velayat - by 14.4 mb;
- Lebap velayat - by 10.4 mb;
- Dashoguz velayat - by 8.8 mb.

Humidity shortage in April in the same velayats will be:

- Balkan - by 14.5 mb;
- Akhal - by 10.1 mb;
- Mary - by 11.5 mb;
- Lebap - by 9.0 mb;
- Dashoguz - by 7.7 mb.

The above stated facts demonstrate that under condition of climate change according to the scenario (UK89 model), the grassland productivity may be decreased by 10-15%. However, there is a possibility to irrigate additional grassland territory and to execute measures on preservation and rehabilitation of pastures. This allows making a conclusion, that in general capacity of the utilized grasslands will not decrease, and thus will not damage the sheep breeding.

The system of measures on preservation and rehabilitation of grasslands should include the following:

- Realization of phytoamelioration works;
- Creation of grassland protecting fodder fields with wood and bush plants;
- Introducing and strict observance of grasslands circulation.

However, the climate change, especially temperature increase may negatively influence the livestock that will create decrease of sheep productivity (meat, wool, and reproduction).

4.5.4 Sheep Breeding

The quantity of sheep for the analyzed 10-year period (1986-1995) fluctuated in the limits from 4816 thousand to 6574.2 thousand (average index for the 10-year period was 5708.5 thousand). Average annual amount of mutton production during the period 1986-1995 was 38 thousand tons. Besides, 17 thousand tons of wool and more than 700 thousand pieces of karakul pelts were produced.

As was state above, climate change according to the scenario under study (UK89 model) may lead to some grassland productivity decrease (by 10-15%). However, to some certain extent this process may be regulated, i.e. the grassland productivity may be kept at the existing level provided by execution of measures on the grasslands preservation and rehabilitation.

Anticipated climate change (especially temperature increase of both average daily and number of days with high temperature) will cause the sheep productivity reduction, resulting in mutton, wool and reproduction decrease. According to the specialists' estimation, the sheep reproductivety may be decreased by 5-25%, wool production by 10-20%.

Thus, while evaluating the agriculture industry development, possible productivity decrease of small cattle should be taken into account.

The present chapter studies the questions of separate climate components change due to CO_2 contents doubling and their impact on practical activities in the field of irrigated agriculture (cultivation and water facilities). A number of aspects, which need further detailing by separate components, are defined.

First of all it concerns irrigation regimes for the cultures, which should be adapted to anticipated natural conditions change: average daily temperatures, soil root-layer, evaporation, etc. It requires reconsideration of periods and norms for some certain irrigation areas. While planning the increase of the agricultural yields, the conditions, which determine the value of irrigation norms should be taken into account.

In connection with stated above, it is necessary to review the water and salt balance of irrigated lands, that entails variations of the drainage sinks amounts and salts migrations.

Also, the set of main cultures should be revised with due consideration of their drought resistance, duration of vegetation period, yield productivity, water demand. The cultures selection should be executed on the basis of the outside existing sorts, which meet the requirements of the stated above conditions. And also by intensifying the selection work on new own sorts breeding.

The reduction of water resources together with their increased demand for stabilizing and increasing agricultural production, cause necessity in reconsideration of methods of irrigation water use and modernization of irrigation systems.

At consequent stages, this chapter should comprise the problems of agricultural complex stability at stress natural circumstances (mountain torrents, change of springs and rivers hydrograph, regression and transgression of locked pools, etc.), which, due to anticipated climate change may face qualitative and quantitative changes.

The problems and questions stated in this chapter, do not have full-scale coverage and will be supplemented in the process of work. Solution of these problems consists of two stages: analytical and practical, which is aimed at execution of measures worked out at the first stage.

Thus, the development and realization of measures on adaptation of agriculture and water economy require certain amount of capital investments. Determination of list and amounts of works necessary to bring agriculture to the new forecast level will be done at the first stage and their physical implementation at the second stage.

4.6 Education, Training, Public Awareness and NGOs

Among general obligations of Turkmenistan under the UNFCCC (Article 6) is development of educational and public awareness programs on climate change, providing public access to this information, public training and participation, including NGOs in developing adequate responses. The general public in Turkmenistan are not well informed and do not have good understanding of the implications of climate change in order to take part in the activity to achieve the ultimate objective of the UNFCCC: stabilizing and decrease of the greenhouse gases emissions.

The general public must be informed about the fact, that the majority of measures on GHG emissions reducing and adaptation of the economy and the environment

to global climate change will lead to positive results. They lead to decline of harmful emissions into the atmosphere, improve fresh water and ecologically clean foodstuffs supply for population, and increase in the agricultural productivity. Besides that, social problems will be solved, new workplaces will be created, environment will be improved, and unfavorable climate change impacts on human health will be decreased.

The extremely poor awareness of the public in Turkmenistan in climate change problems creates an obstacle to public support of realization of measures on greenhouse gases effect mitigation and adaptation strategies to anticipated climate change. Therefore, public awareness and information, training programs are an important part of the work to be done within the frames of the National Action Plan of the Turkmenistan's obligations under UNFCCC.

The following programs of education and public awareness are accepted:

- educational programs for secondary schools and Universities, training for teachers of secondary schools;
- popularization campaign in mass media on the problems of climate change in accessible shape;
- conducting workshops for representatives of non-formal entities, non-governmental organizations (NGO) and local communities engaged in ecological activity;
- conducting national workshops for the official representatives of the ministries and organizations, public figures, decision makers, and specialists, who are responsible for plan and strategy development in different sectors of economy, that influence the climate or depend on climate change.

Professional knowledge of the climate change scientific basis can be obtained in two Universities of Turkmenistan. There is the education course "Fundamentals of Meteorology and Clymatology" at the department of meteorology of the geographic faculty of Turkmen State Pedagogical Institute named after S.Seydy and at the department of Ecology and Hydrometeorology of the Nature and Geography faculty of Turkmen State University named after Magtymguly. The program of this course is added by information on climate change obtained from the study results of the National Communication of Turkmenistan.

The problem of anthropogenic climate change, besides purely scientific aspects of changes in climatic system, includes a number of economic, technical, technological and social political tasks requiring immediate reacting and decision making.

Turkmen Polytechnic Institute trains engineer technologists–ecologists specializing in the subject "Environment Protection and Rational Use of Natural Resources". These specialists may apply their forces in projecting and research activities, in the field of industrial waste treatment and utilization technology, development of ecologically safe and resource-saving technologies. The main special subjects are: "Applied Industrial Ecology", "Theoretical Basis of Environment Protection", "Chemistry of Environment", "Air Pollution Protection", "Non-Waste Production and Secondary Resources", "Ecological

Monitoring", "Fundamentals of Engineering and Ecological Expertise", "Human Ecology".

It is planned to elaborate and put into education courses on ecology in the other Institutes, the program covering wide range of climate change problems.

The meetings of scientists with pupils are organized at the schools of Turkmenistan. Wide range of climate change problems is the main theme of these meetings. In future it is planed to elaborate the programs for the lessons on climate change problems and to put those into the Geography and Nature courses.

Within the framework of the project, a number of workshops on climate change subject were held. Representatives of the Government, ministries and organizations, scientists, teachers of the Universities and schools and students took part in the workshops. The results of studies are constantly published in the Problems of Desert Development magazine and newspapers, are broadcasted by radio and television. One issue of Tebigat magazine is completely devoted to problems of climate change. Also a scientific film was produced in CD version.

4.7 Follow-Up Activities

While preparing the Initial National Communication of Turkmenistan under the UNFCCC on climate change, a number of problems have arisen, some of them were resolved in the process of work on this Communication, the other problems require further efforts and support.

The implementation of the national greenhouse gases inventory has discovered necessity of studies related to the local emission factors, and also updating the statistical reporting system and the data collection mechanism in the country.

Separate task is advancing the existing data bank of greenhouse gases and software on the inventory.

According to Article 4 UNFCCC, the Parties to the Convention should elaborate measures to mitigate climate change consequences, which have two major directions:

- To elaborate measures on reducing greenhouse gases emission in the sectors of economy, which directly influence the climate (energy, industry, transport, household sector, agriculture etc.);
- To develop adaptation measures for environment, separate components of ecosystems and branches of economy, most vulnerable to climate change (agriculture, water facilities, etc.)

The first direction has one major problem. This is the absence of the unified method of economical estimation of the projects on greenhouse gases emissions reduction. For implementation of this work, additional study is necessary.

Elaboration of the second direction is preceded by the assessment of anticipated climate change in the region and constructing the climatic scenarios. The major difficulty in this respect is large share of uncertainty of the existing climatic scenarios. Many sectors of economy (agriculture, water resources) need scenarios with a seasonal and monthly resolution. The used models of general circulation

(GCM), recommended by IPCC for constructing the climatic scenarios, are constantly improved. Therefore it is necessary to elaborate the methods of statistical interpretation of the global models results for assessment of changes of the different regional climatic characteristics.

For the climate change assessment, IPCC recommends to use different approaches: with due regard of affect only, taking into account interaction and complex approach. The first approach does not take into account the impact of non-climatic factors on the affected subject. Within the framework of the second approach, apart from climate, the combination of factors is taken into account, which in their turn may be impacted by the subject under study. This approach allows taking into consideration the reverse connections, which may strengthen or weaken that or another influencing. The complex approach is most comprehensive study of mutual relations between climate and society. It comprises coverage of interrelations within the sectors, sector-to-sector relations; reverse links and also includes adaptation.

The assessment of the Aral sea water resources vulnerability at present is carried out in view of only climatic factor impact. It is necessary to provide the complex vulnerability assessment with due regard of the development of agriculture and water economy of the whole basin. It is planned to apply in future comprehensive approaches at carrying out the vulnerability assessment of the environment components and separate sectors of economy. Therefore, the necessity of additional studies and application of special models is obvious.

Necessity of developing programs on public awareness in the problems of climate change and its consequences is stipulated in Article 6 of the Convention. Development and modernization of the regional climatic monitoring system therefore is very important. Development of climate monitoring in ecologically ill behaved areas, such as Priaral region, shore of the Caspian sea, is extremely necessary.

The observed regional climate response on global warming causes necessity of improving efficient computing, analysis and propagation of the climatic information and its distribution among consumers in a friendly, suitable and informative shape. Different periodical reviews and bulletins of global and regional climate systems change are issued in many countries and regions of the world.

Till now Turkmenistan does not issue the reviews of climate system change (bulletins of climate monitoring) on the constant basis, as it is accepted all over the world. Therefore it is necessary to create the technology of issuance of such periodic editions to provide public access to the information on climate change in understandable and accessible shape.

For the purpose of rational preparation and wide-scale and open distribution of the reviews of state and changes in the Central Asia climatic system, a number of separate tasks should be solved. Among these are the integration of high quality uniform representation data from the available sources and data banks of different disciplines into the climate database, developing the system of its implementation and replenishing, creation of technology for issuance the climate change monitoring bulletins on a regular round basis.

The regular issuance of the regional climate-monitoring bulletin will help to draw attention of public, politicians and decision-makers, to the problems of climate change in both regional and global scales.

The major problem of all Central Asian countries is the limitation of water resources. After gaining the independence, all states simultaneously declared the rights on water resources formed at their territories, and legislatively fixed this doctrine. Unequal provision of the population and territories with water resources, different level of intensity of agriculture and industry and the related demands in water, and also the existing features in approaches to the property right in different national water economy legislations makes unique the problem of joint utilization of water. Assessment of water resources for the whole region and for separate countries is needed for development of measures on adapting to climate change conditions. Creation of such a system will require assistance of different international entities, such as WMO, UNEP, UNDP and others.

One more problem demanding solution is the use of renewable sources of energy. Turkmenistan has huge reserves of organic fuel. According to the perspective plans of economical development, the amount of exported hydrocarbons will be increased for deriving hard currency. At the same time, the obligations under UNFCCC require gradual reducing of the amount of burnt organic fuel and increase in utilization of non-traditional sources of energy. Real assessment of wind and solar energy resources available in the region requires the study of predictability of territorial and temporal variation of this energy, taking into account the features and technical parameters of the wind and solar energy installations to be used. The combination of the two processes should be studied: source energy and energy production by the installations for distribution to the consumers. This will provide real evaluation of the amount of energy produced and also necessity in accumulation or additional utilization of the other sources of energy. The related calculations should be carried out on the basis of data of wind and solar irradiation surveys on a meteorological web and included in the corresponding register. Preparation of wind and solar energy resources register will promote more active utilization of the wind and solar energy producing installations in the territory. In such a case, excessive expenditures on the use of low effective for the local conditions technical devices may be avoided. For some separate areas, it is necessary to estimate expediency of use of different energy producing installations, and also necessity in additional sources of energy.

The information on climate system state problems related to climate change will help at solution of a number of social, economical and ecological tasks. It is also necessary for prediction of originating of the spontaneous phenomena, evaluation of irrigation necessities, energy demands and in many other fields of human activity. Wide awareness of public and politicians of the climate conditions and changes is also needed for making the optimal decisions and knowledge sharing.

The priority list of the probable projects, which require financing, is given below.

Greenhouse Gases Inventory

- Study of the domestic factors of emission and specifying coefficients for some kinds of fuel.
- Modernizing the system of data collection.

- Updating the software on GHG inventory developing the existing data bank.
- Creation of the method of economical assessment of the projects on greenhouse gases emission reduction.

Climatic studies

- Complex assessment of vulnerability of the Aral sea basin water resources taking into account the agriculture and water economy development.
- Development of statistical interpretation methods of the global climatic models results for assessment of changes of the regional climatic characteristics.
- Complex assessment of the coastal zone vulnerability caused by the Caspian sea level fluctuations.

Development and modernizing the regional climate monitoring system and distribution of information

- Support of efforts on preservation and development of the observational net of the region, especially stations, being detecting instruments of antropogeneous climate change.
- Creation of the unified climate database and development of the mechanism of its implementation and updating.
- Development of the technology for regular issuance of the Regional bulletin of climate monitoring.
- Creation of the common system of information exchange for assessment of water resources of both the whole Central Asian region and separate states.
- Creation of registers of renewable sources of energy on the basis of solar irradiation and wind speed survey data.
- Creation of greenhouse gases monitoring system.

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Supplement

THE SUMMARY TABLES OF INTRODUCED DATA FOR 1994 IN STANDARDIZED FORMAT

Table 7A: SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (sheet 1 of 3)

	(Gg)												
Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_X	CO	NMVOC	SO_2	HFC_S		PFC_S		SF_6	
									P	A	P	A	P	A
Total National Emission and Removals	31859.07	380.6	967.865	0.40421	83.805	327.562	49.2198	22.886						
1 Energy	31019.016	0	846.49	0.39081	83.805	326.762	44.3578	22.883						
A Fuel Combustion (Sectoral Approach)	31019.016	0	2.64	0.03981	83.575	326.417	41.978	0						
1 Energy Industries	12156.964	0	0.22	0.022	32.774	4.497	1.091	0						
2 Manufacturing Industries and Construction	7653.678	0	0.552	0.297	15.222	3.243	0.215	0						
3 Transport	2884.76	0	1.112	0.04621	27.134	301.612	40.2088	0						
4 Commercial/Institutional	557.126	0	0.05	0.001	0.499	0.499	0.05	0						
5 Residential	3040.82	0	0.274	0.0057	2.742	2.701	0.029	0						
6 Agriculture	1985.456	0	0.127	0.0082	2.153	13.718	0.166	0						
7 Other Sectors	2740.212	0	0.305	0.0107	3.051	0.147	0.218	0						
B Fugitive Emission from Fuels	0	0	843.85	0	0.23	0.345	2.38	22.883						
1 Solid Fuels	0	0	0	0	0	0	0	0						
2 Oil and Natural Gas	0	0	843.85	0	0.23	0.345	2.38	22.883						
2 Industrial Processes	840.054	0	0	0	0	0.8	4.862	0.003						
A Mineral Products	343.92	0	0	0	0	0	0	0						
B Chemical Industry	496.134	0	0	0	0	0.8	0.48	0.003						
C Metal Production		0	0	0	0	0	0	0						
D Other Sectors (Food and Drink)	0	0	0	0	0	0	4.382	0						
E Production of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0	0						
F Consumption of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0	0						
G Other (please specify)	0	0	0	0	0	0	0	0						

Table 7A: SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (sheet 2 of 3)

	(Gg)													
Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_X	CO	NMVOC	SO_2	HFC_S		PFC_S		SF_6	
									P	A	P	A	P	A
3 Solvent and Other Product Use	0	0	0	0	0	0	0	0						
4 Agriculture	0	0	110.946	0.0134	0	0	0	0						
A Enteric Fermentation	0	0	91.078		0	0	0	0						
B Manure Management	0	0	16.988	0.003	0	0	0	0						
C Rice Cultivation	0	0	2.88		0	0	0	0						
D Agricultural Soils	0	0	0	0.0104	0	0	0	0						
E Prescribed Burning of Savannas	0	0	0	0	0	0	0	0						
F Field Burning of Agricultural Residues	0	0	0	0	0	0	0	0						
G Other (please specify)	0	0	0	0	0	0	0	0						
5 Land - Use Change & Forestry	0	380.6	0	0	0	0	0	0						
A Changes in Forest and Other Woody Biomass Stocks	0	158.9	0	0	0	0	0	0						
B Forest and Grassland Conversion	0	221.7	0	0	0	0	0	0						
C Abandonment of Managed Lands	0	0	0	0	0	0	0	0						
D CO_2 Emission and Removals from Soil	0	0	0	0	0	0	0	0						
E Other (please specify)	0	0	10.429	0	0	0	0	0						
6 Waste	0	0	10.429	0	0	0	0	0						
A Solid Waste Disposal on Land	0	0	0	0	0	0	0	0						
B Wastewater Handling	0	0	0	0	0	0	0	0						
C Waste Incineration	0	0	0	0	0	0	0	0						
D Other (please specify)														
7 Other (please specify)														

Table 7A: SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (sheet 3 of 3)

(Gg)													
Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_X	CO	NMVOC	SO_2	HFC_S		PFC_S		SF_6	
									P	A	P	A	P	A
Memo Items:														
International Bunkers	408.706	0	0	0	0	0	0	0						
Aviation	408.706	0	0	0	0	0	0	0						
Marine	0	0	0	0	0	0	0	0						
CO_2 Emissions from Biomass	0	0	0	0	0	0	0	0						

Table 7B: SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (sheet 1 of 1)

	(Gg)												
Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_X	CO	NMVOC	SO_2	HFC_S		PFC_S		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	31859.07	380.6	967.865	0.40421	83.805	327.562	49.2198	22.886						
1 Energy Reference Approach	31019.016	0	846.46	0.39081	83.805	326.762	44.3578	22.883						
Sectoral Approach	0	0	0	0	0		0	0						
A Fuel Combustion	31019.016	0	2.64	0.39081	83.575	326.417	41.978	0						
B Fugitive Emissions from Fuels	0	0	843.85	0	0.23	0.345	2.38	22.883						
2 Industrial Processes	840.054	0	0	0	0	0.8	4.862	0.003						
3 Solvent and Other Product Use	0	0	0	0	0	0	0	0						
4 Agriculture	0	0	110.946	0.0134	0	0	0	0						
5 Land - Use Change & Forestry	0	380.6	0	0	0	0	0	0						
6 Waste	0	0	10.429	0	0	0	0	0						
7 Other (please specify)	0	0	0	0	0	0	0	0						
Memo Items:														
International Bunkers	408.706	0	0	0	0	0	0	0						
Aviation	408.706	0	0	0	0	0	0	0						
Marine	0	0	0	0	0	0	0	0						
CO_2 Emissions from Biomass	0	0	0	0	0	0	0	0						

Table 8A: SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (sheet 1 of 3)

Overview Table

Greenhouse Gas Source and Sink Categories	CO_2		CH_4		N_2O		NO_X		CO		NMVOC		SO_2		HFC_S		PFC_S		SF_6		Documentation	Disaggregation	Footnotes
	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality			
Total National Emissions and Removals																							
1 Energy	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	PART	M	NA		NA		NA		H	2	
A Fuel Combustion Activities																							
1 Energy Industries	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	PART	M	NA		NA		NA		H	2	
2 Manufacturing industries and Construction	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	PART	M	NA		NA		NA		M	1	
3 Transport	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	NE		NA		NA		NA		M	1	
4 Commercial/ Institutional	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	NE		NA		NA		NA		M	1	
5 Residential	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	NE		NA		NA		NA		M	1	
6 Agriculture	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	NE		NA		NA		NA		M	1	
7 Other Sectors																							
B Fugitive Emissions from Fuels																							
1 Solid Fuels	NO		NO		NO		NO		NO		NO		NO		NO		NA		MA				
2 Oil and Natural Gas	NE		PART	M	NE		PART	M	PART	M	PART	M	PART	M	NA		NA		NA		M	1	
2 Industrial Processes																							
A Mineral Products	PART	M	NE		NE		NE		NE		NE		NE		NA		NA		NA		M	1	
B Chemical Industry	PART	M	NA		NA		NA		PART	M	PART	M	PART	M	NA		NA		NA		M	1	
C Metal Production	NO		NO		NO		NO		NO		NO		NO		NO		NO		NO				
D Other Production	NE		NE		NE		NE		NE		NE		NE		NA		NA		NA				
E Production of Halocarbons and Sulphur Hexafluoride	NO		NO		NO		NO		N0		N0		NO		NO		NO		NO				

Table 8A: SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (sheet 2 of 3)

Overview Table

Greenhouse Gas Source and Sink Categories	CO_2		CH_4		N_2O		NO_X		CO		NMVOC		SO_2		HFC_S		PFC_S		SF_6		Documentation	Disaggregation	Footnotes
	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality			
Industrial Processes (cont...)																							
F Consumption of Halocarbons and Sulphur Hexafluoride																							
Potential	NO		NO		NO		NO		NO		NO		NO		IE		IE		NO				
Actual																							
G Other (please specify)	NE		NE		NE		NE		NE		NE		NE		NA		NA		NA				
3 Solvent and Other Product Use	NO		NO		NO		NO		NO		NO		NO		NO		NO		NO				
4 Agriculture																							
A Enteric Fermentation	NA		ALL	H	NA		NA		NA		NA		NA		NA		NA		NA		H	2	
B Manure Management	NA		ALL	H	PART	M	NA		NA		NA		NA		NA		NA		NA		M	2	
C Rice Cultivation	NA		ALL	H	NA		NA		NA		NA		NA		NA		NA		NA		H	2	
D Agricultural Solid	NE		NE		NE		NE		NE		NE		ME		NA		NA		NA				
E Prescribed Burning of Savannas	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA				
F Field Burning of Agricultural Residues	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA				
G Other (please specify)	NE		NE		NE		NE		NE		NE		NE		NA		NA		NA				
5 Land-Use Change & Forestry	NE		NE		NE		NE		NE		NE		NE		NA		NA		NA				
A Changes in Forest and Other Woody Biomass Stocks																							
B Forest and Grassland Conversion																							

Table 8A: SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (sheet 3 of 3)

Overview Table

Greenhouse Gas Source and Sink Categories	CO_2		CH_4		N_2O		NO_X		CO		NMVOC		SO_2		HFC_S		PFC_S		SF_6		Documentation	Disaggregation	Footnotes
	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality			
5 Land-Use Change & Forestry (cont...)																							
C Abandonment of Managed																							
D CO_2 Emission and Removals from Soil																					M	1	
E Other (please specify)																							
6 Waste																							
A Solid Waste Disposal on Land	NA		ALL	M	NA		NA		NA		NA		NA		NA		NA		NA				
B Wastewater Handling	NA		NE		NA		NA		NA		NA		NA		NA		NA		NA				
C Waste Incineration	NE		NA		NE		NE		NE		NE		NE		NA		NA		NA				
D Other (please specify)	NE		NE		NE		NE		NE		NE		NE		NA		NA		NA				
7 Other (please specify)																							
Memo Items:																							
International Bunkers																							
Aviation	ALL	H	NE		NE		NE		NE		NE		NE		NA		NA		NA		H	1	
Marine	NO		NO		NO		NO		NO		NO		NO		NA		NA		NA				
CO_2 Emission from Biomass	NO		NO		NO		NO		NO		NO		NO		NA		NA		NA				

National Key for Overview Table							
Estimates		**Quality**		**Documentation**		**Disaggregation***	
code	*Meaning*	*code*	*Meaning*	*code*	*Meaning*	*code*	*Meaning*
PART	Partly estimated	**H**	High Confidence in Estimation	**H**	High (all background information included)	**1**	Total emissions estimated
ALL	Full estimate of all possible sources	**M**	Medium Confidence in Estimation	**M**	Medium (some background information included)	**2**	Sectoral split
NE	Not estimated	**L**	Low Confidence in Estimation	**L**	Low (only emission estimates included)	**3**	Subsectoral split
IE	Estimated but included elsewhere						
NO	Not occurring						
NA	Not applicable						
* See following table for a complete explanation of each code							

Table 8B: EXPLANATION OF DISAGGREGATION KEY FOR OVERVIEW TABLE (sheet 1 of 2)

Disaggregation Key for Overview Table

Disaggregation 1		Disaggregation 2		Disaggregation 3
Total National Emissions and Removals				
1 Energy				
1 A Fuel Combustion	1 A 1 to 1 A 5	Energy Industries to Other	1 A	Any Subsectors of 1A1 to 1A5. For example, rail transport of industry sectors
1 B Fugitive Emissions from Fuels	1 B 1	Solid Fuels	1 B	Any Further breakdown, for example gas venting or post-mining activities
	1 B 2	Oil and Natural Gas		
2 Industrial Processes	2A	Mineral Product	2	Any Further quantitative breakdown by industrial sector, for example, paper, nitric
	2B	Chemical Industry		acid, cement
	2C	Metal Production		
	2D	Other Production		
	2E	Production of Halocarbons and Sulphur Hexaflouride		
	2F	Consumption of Halocarbons and Sulphur Hexaflouride		
	2G	Other		
3 Solvent and Other Product Use	3 A to 3D		3	Any further quantitative breakdown by product
4 Agriculture				
4 A Enteric Fermentation	4 A		4 A	Animal types e.g. cattle, goats
4 B Manure Management	4 B		4 B	
4 C Rice Cultivation	4 C		4 C	Any further duantitative breakdown
4 D Agricultural Soils	4 D	Breakdown by type of Fertilizer or another characteristic	4 D	Several characteristics takeninfo account, such as type of fertiliser, soil crop or area
4 E Prescribed Burning of Savannas	4 E		4 E	
4 F Field Burning of Agricultural Residues	4 F		4 F	Any further duantitative breakdown
4 G Other	4 G		4 G	
5 Land - Use Change & Forestry	5 A	Changes in Forests and other Woody Biomass Stocks	5 A	Any further duantitative breakdown, e.g. by type of forest
	5 B		5 B	
	5 C		5 C	

Table 8B: EXPLANATION OF DISAGGREGATION KEY FOR OVERVIEW TABLE (sheet 2 of 2)

Disaggregation Key for Overview Table				
Disaggregation 1		Disaggregation 2		Disaggregation 3
Land - Use Change & Forestry (cont...)	5 D	CO_2 Emissions and Removals from Soil	5 D	
	5 E	Other	5 E	
6 Waste	6 A	Solid Waste Disposal on Land	6 A	Any further quantitative breakdown
	6 B	Wastewater Handing	6 B	
	6 C	Waste Incineration	6 C	
	6 D	Other	6 D	
7 Other	7		7	