MONGOLIA SECOND NATIONAL COMMUNICATION

Under the United Nations Framework Convention on Climate Change

THE MINISTRY OF NATURE,
ENVIRONMENT AND TOURISM

UNITED NATIONS ENVIRONMENT
PROGRAMME

MONGOLIA SECOND NATIONAL COMMUNICATION

Under the United Nations Framework Convention on Climate Change

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Abbreviations

ADB	Asian Development Bank
AIACC	Adaptation, Impact Assessment of Climate Change
BEEP	Building Energy Efficiency Project
BNaR	Building Norm and Rules
CBD	Convention on Biological Diversity
CCCM	Canadian Climate Center Model
CCCO	Climate Change Coordination Office
CCD	Convention to Combat Desertification
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CFL	Compact Fluorescent Lamps
CMDL	Climate Monitoring and Diagnosis Laboratory
CNDS	Comprehensive National Development Strategy
CHP	Combined heat and power plant
CSIRO	Model developed by Commonwealth Scientific and Industrial Research Organisation
DNA	Designated National Authority
DSSAT	The Decision Support System for Agrotechnology Transfer
ECHAM	Model developed by Plank Institute of Hydrology and Meteorology
ESCO	Energy Service Company
FY2C	Geostationary satellite of China
HadCM3	Model developed by Hadley Center
HFC	Halocarbons
GCM	General Circulation Model
GEF	Global Environment Facility
GFDL	Model developed by Geophysical Fluid Dynamics Laboratory
GHG	Greenhouse gases
GDP	Gross Domestic Product
GoM	Government of Mongolia
GTZ	German Technical Cooperation Agency
ILB	Incandescent Light Bulbs
IMH	Institute of Meteorology and Hydrology
IPCC	Intergovernmental Panel on Climate Change
GHG	Greenhouse gases
GDP	Gross Domestic Product
GoM	Government of Mongolia

GTZ	German Technical Cooperation Agency
ILB	Incandescent Light Bulbs
IMH	Institute of Meteorology and Hydrology
IPCC	Intergovernmental Panel on Climate Change
LEAP	Long-range Energy Alternative Planning
LPG	Liquefied Petroleum Gas
MAP 21	Mongolian Action Programme for the 21st Century
mln.	Million
MDG	Millennium Development Goals
MNET	Ministry of Nature, Environment and Tourism of Mongolia
MODIS	Moderate Resolution Imaging Spectroradiometer Satellite
MRTCUD	Ministry of Road, Transport, Construction and Urban Development
NAMA	Nationally appropriate mitigation actions
NAMHEM	National Agency for Meteorology, Hydrology and Environmental Monitoring
NAPCC	National Action Programme on Climate Change
NCC	National Climate Committee
NDVI	Normalized Difference Vegetation Index
NEMA	National Emergency Management Agency
NGO	Non Government Organization
NMVOC	Non-Methane Volatile Organic Compounds
NOAA	The National Oceanic and Atmospheric Administration
NPP	Net Primary Production
PV	Photovoltaics
REDD	Reducing Emissions from Deforestation and forest Degradation
SDA	Swiss Development Agency
SNC	Second National Communication
SRES	Special Reports on Emission Scenarios
thous.	Thousand
TNA	Technology Needs Assessment
UB	Ulaanbaatar
UNEP	United Nations Environmental Programme
UNDP	United Nations Development Programme
UNFCCC	The United Nations Framework Convention on Climate Change
VAT	Value Added Tax
WB	World Bank
WHO	World Health Organization
WMO	World Meteorological Organization

Units

^0C	degree Celsius
centner	centner (=100 kg)
Cg/m^2	carbon per square meter
g	gramme
Gcal	gigacalorie (=4.18 GJ)
Gg	gigagram (=1,000 metric tons)
Gg CO_2-eq	gigagram of CO_2 equivalent
GW	gigawatt (=1,000 MW)
GWh	gigawatt hour
ha	hectare (=10,000 square meters)
kcal/kg-cl	kilocalorie per kilogram of clinker
kg CO_2-eq	kilograms CO_2 equivalient
km	kilometer
km^3/year	cubic kilometer per year
kWh	kilowatt hour
kWh/m^2/year	kilowatt hour per square meter per year
l	litre
m	meter/metre
$m^2\,^0C/W$	square meter degree Celsius per watt
m/s	meter per second
m^3/s	cubic meter per second
Mln.pass.km	million passenger kilometer
MW	megawatt
sq km	square km
TOE	tonne of oil equivalent
ton	metric ton/tonne (=1,000 kg)
tugrug	national currency of Mongolia
W/m^2	watt per square meters

Preface

The Second National Communication (SNC) of Mongolia under the United Nations Framework Convention on Climate Change (UNFCCC) summarizes the measures and actions which have been taken by the Government of Mongolia to meet its commitments and obligations under the UNFCCC, the government policy and strategies to solve climate change challenges, and the key findings and results of climate change research and studies conducted in Mongolia. The Report will be a useful source of information for decision makers in government organizations, the public and private sectors in formulating and implementing appropriate responses to the challenges and threats posed by global climate change.

The report includes the following chapters:

- Executive summary
- National Circumstances
- Greenhouse gases Inventories for the period 1990 - 2006
- Policies and Measures
- Projections of Greenhouse Gases Emissions
- Climate Change, Impact Assessment and Adaption Options
- Financial Resources and Technology Transfer
- Research and Systematic Observation
- Education, Training and Public Awareness

The SNC was developed by the members of the Thematic working groups on specific topics established under the UNEP/GEF project for “Mongolia: Preparation of Second National Communication under the UN Framework Convention on Climate Change (UNFCCC)” and by leading practitioners and researchers in the field.

A special note of appreciation and gratitude is extended to the Leaders of the thematic working groups, namely L. Natsagdorj, J.Dorjpurev and B.Namkhainyam, who prepared the relevant chapters and to researchers and experts P.Gomboluudev, G. Davaa, G.Sarantuya, B.Delgermaa, G.Burmaajav, B. Erdenetsetseg, B.Bolortsetseg and others, who made valuable contributions to the chapters dealing with specific issues.

Deepest appreciation is extended to Dr.Damdin Dagvadorj, the Mongolia Special Envoy for Climate Change, who supervised the preparation of the SNC, and who, in his role as review editor, extended every effort in integrating, reviewing and finalizing the Report. Thanks are also extended to Ms.Lois Lambert for editing the English version of the SNC.

Also, sincere gratitude must be expressed to the United Nations Environment Programme (UNEP) and Global Environmental Facility (GEF) for the successful implementation of the project for “Mongolia: Preparation of Second National Communication under the UN Framework Convention on Climate Change (UNFCCC)”, and for their financial and technical assistance in the development of this report. In particular, the overall guidance provided by Dr. George Manful, Senior Task Manager, Climate Change Enabling Activities, Division of GEF Coordination, UNEP during the preparation of the Mongolia SNC was essential in making this report available.

Foreword

The global climate change and its impact in Mongolia is inextricably linked to the broader sustainable development agenda of the country. The UN Secretary-General, Ban Ki-moon in his public lecture on Climate Change, during his visit to Mongolia in July 2009, stated that “Here, as elsewhere around the globe, I have seen the human face of climate change. Already, hundreds of millions of people are facing increased hardships. Three-quarters of all disasters globally are now climate related, up from half just a decade ago. You must have seen it.”

Climate change is already a real fact in Mongolia. The results of observations at meteorological stations in Mongolia show that the country’s annual mean temperatures have risen by $2.1^{0}C$ between 1940 and 2007. Scientists are warning that climate in Mongolia will continue to change dramatically during the 21st Century. Because of its specific geographical and climatic conditions, Mongolia is likely to be more heavily influenced by global climate change. The impact of climate change on the ecological systems and the natural resources would have a direct and dramatic affect on almost all sectors of the national economy and all spheres of social life, i.e. it touches all aspects of the life support system. Climate change response measures will help to address the inevitable need to adapt to climate change and to mitigate greenhouse gas emissions, in order to meet the requirements of Mongolia’s sustainable development strategies. We must strengthen our ability to adapt to a changing climate. Adaptation is an essential investment in our common future, in making our communities more resilient and in reducing our vulnerability to climate change and its adverse impacts. It is also an investment in the ecosystems that sustain us.

The Government of Mongolia pays close attention to climate change issues and has been undertaking concerted actions to address the challenges posed by climate change, with a particular emphasis on adaptation and mitigation. On 27 August 2010 the Government of Mongolia held its special meeting at Gashuunii Khooloi, Bayandalai soum, Umnugobi province located in a Gobi desert area 670 km from Ulaanbaatar,, where the effects of rapid land degradation and desertification are being accelerated by climate change, and discussed climate change challenges, including updated National Action Programme on Climate Change. The Cabinet meeting issued a Message from the Gobi Desert by the Government of Mongolia on Climate Change, addressed to the world community as well as to the citizens of the country.

With the aim of establishing and promoting subregional cooperation on climate change and of contributing to the efforts of the global community to deal with climate change, Mongolia has launched an initiative to hold a Northeast Asia Summit on Climate Change. Within this initiative, a series of preparatory meetings, including a Ministerial level meeting, were organized in 2009 in Mongolia. We are confident that the global and sub-regional dialogues and efforts will provide an excellent opportunity for policy and decision makers to gain a common understanding of the threats imposed by climate change and to reach a political consensus.

This Second National Communication of Mongolia under the UNFCCC brings together the findings of climate change research in Mongolia, to raise awareness of decision makers and the general public so that they can develop appropriate responses to the challenges and threats.

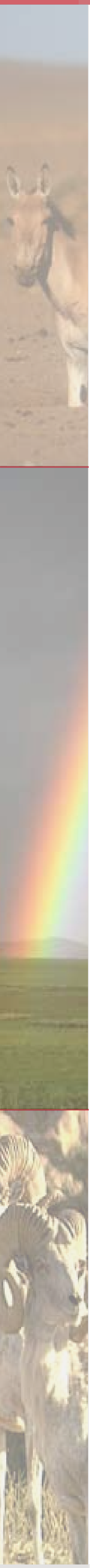
On behalf of the Government of Mongolia and myself I would like to thank UNEP and GEF for both technical and financial assistance in preparing this report. Special acknowledgements and thanks must be given to the Mongolian team for all their efforts in preparing this valuable report. It is my hope that the Report will be a useful and comprehensive source document for the international community and all levels of society in Mongolia, presenting the real status of current and future climate change and its environmental, social and economic consequences, and of government policy and strategy to tackle climate change treats .

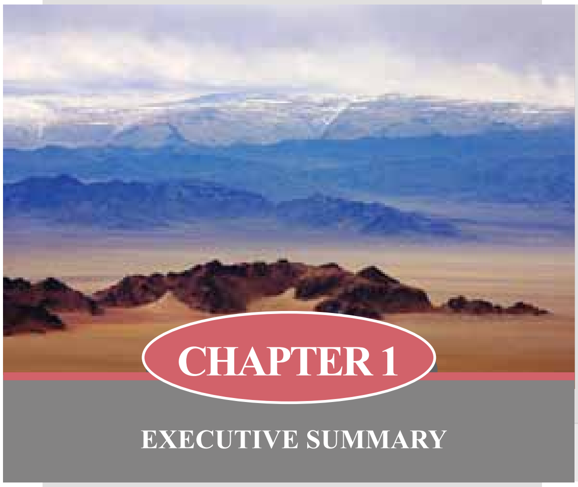
Luimed Gansukh

Member of the Great Khural (Parliament) &
Minister for Nature, Environment and Tourism
of Mongolia

CHAPTER 1

EXECUTIVE SUMMARY





1.1 National circumstances

Geography: Mongolia is a landlocked country bordering with the Russian Federation in the north and the People's Republic of China in the south. Located between 41^0 35' – 52^0 06' north latitudes and between 87^0 47' – 119^0 57' east longitudes, Mongolia occupies 1,564,116 sq km.

Climate: The country has a severe continental climate due to the fact that it is landlocked and a great distance from oceans, surrounded by high mountains and has a high elevation of more than one and half km above sea level. Consequently, the main characteristics of the climate are its four distinctive seasons, high fluctuations of temperature, low precipitation and clear climate differences in latitudinal as well as in altitude zones. The annual mean temperature is about -8^0C to 6^0C and the annual precipitation varies from 50 mm in the Gobi desert to 400 mm in the northern mountainous area. About 85 percent of the total precipitation falls from April to September.

Demography: As of the end of 2009, Mongolia's population stood at 2,735.8 thousand showing an annual growth rate of 1.9 percent, with a gender ratio of 48.9 percent males to 51.1 percent females. In 2015, the population is expected to reach 3,044.9 thousand people. About 62.6 percent of the total population live in urban areas, mostly in Ulaanbaatar, the capital city due to a significant migration flow from rural areas.

Land resource: According to the land resource classification, about 73.9 percent of the territory of Mongolia is agricultural land, 15.9 percent is state special use land, 9.2 percent is forest resource land, 0.4 percent is land of water resources. As of 2009, about 0.3 percent of land is in urban areas and about 0.2 percent is covered by roads and networks. Agricultural land consists of pastureland, crop farmland, hay mowing land and agricultural compounds. Pasture degradation has been substantially extended due to over exceeded livestock density and human carelessness as well as climate change. Desertification has affected about 70 percent of grassland, which has become a natural disaster for Mongolia. During the last 50 years, the population has doubled and economic development has intensified. Unfortunately, a significant proportion of surface and ground water, forest, soil and pasture resources have been exploited causing serious risks.

Economy: In 1991, Mongolia began a rapid transition from central planning to a free market-oriented economy. Subsequently, the abrupt shift Mongolian economy caused many difficulties, resulting in a sharp depression and increasing poverty and unemployment in the first half of the 1990s. At the same time, progress was made in establishing the foundations of a market economy, such as price and trade liberalization, privatization and establishing of commercial banking system.

The transition to democracy and a market economy continues to be difficult, but Mongolia remains committed to the process and has retained donor confidence. In the last few years, economic growth has been relatively buoyant and the prospects are good for the medium term due to increased revenue from mining, good prices of gold and copper, improved fiscal deficit and a stable inflation rate. Mongolia's GDP increased from 105 billion to 6,056 billion Tugrugs between 1990 and 2009 and GDP per capita grew accordingly.

However, the challenges which remain include a widening income gap, with more than 35.2 percent of the population living below the poverty line, rising underemployment, environmental degradation, and rural stagnation due to lack of access to basic services. Moreover, the recent global economic crisis has also negatively affected the economic development of Mongolia through an economic downturn of 8.9 percent in 2008.

Despite many challenges, the Government of Mongolia launched the Millennium Development Goals based Comprehensive National Development Strategy (MDGs-based CNDS) in 2008, which aims to increase GDP per capita, significant economic growth rate and improved economic structure of Mongolia.

The country's coal, gold and copper reserves are considered to be among the largest in the world. The mining sector accounts for about 20 percent of Mongolia's GDP and half the country's exports, and attracts the majority of foreign investment. The government emphasizes mining sector development as a stimulant of the country's economy. Coal is the primary energy source in Mongolia at present, comprising about 98 percent of total solid fuel consumption. Mongolia has considerable renewable energy resources with high potential including wind, solar and hydropower energy. Along with intensified industrial growth of livestock productivity, the mining sector and the industry and energy sectors, consequences for pollution of air, land and water, and land degradation have been becoming real problems. Consequently, the effective integration of economic, social and environmental policies is required in order to ensure sustainable development.

Animal husbandry is still the main livelihood and the source of wealth for many Mongolians. The production of animal husbandry plays an important role in the country's economy. The livestock herd - predominantly sheep, cattle and goats - grew to 44 million in response to higher cashmere prices, increased demand for meat and other animal products. Agriculture domestic production supplies more than 83 percent of wheat, more than 100 percent of potato and 60 percent of vegetable consumption.

However, Mongolia's fragile ecosystems, pastoral animal husbandry and rainfed agriculture are extremely sensitive to natural disasters and climate change.

Because of the low density of population and vastness of the territory, transportation and communication are considered essential to the socio economic development of the country. The overall volume of freight transported and the number of passengers increased respectively by 3.5 percent and 0.3 percent in 2009, compared to the previous year. According to the State vehicle inspection results of 2009, the total number of vehicles reached 224.1 thousand. As in MDGs based CNDS, the Government is proposing to greatly expand national and regional rail and road networks in the near future and is seeking opportunities to develop sea and water transportation.

Recent increases in the urban population and an improving economy has amplified the need for municipal solid waste management in Mongolia. The total generation of waste in Ulaanbaatar was estimated at 552.8 tons per day. However, the recycling rate is very low at 3.7 percent. Also water is not being recycled and about 70 percent of urban sewage is treated.

1.2 Greenhouse gas inventory

Increased energy consumption is the main reason for the increase in net greenhouse gas emmisions, which rose 7.6 percent from 14,519 Gg in 2005 to 15,628 Gg in CO_2-eq. in 2006. The energy sector was a major contributor of GHG emissions comprising 65.4 percent while the agriculture sector and land use change and the forestry sector contributed 41.4 percent and -13.3 percent, respectively. Other relatively minor sources include emissions from industrial processes

(5.6 percent) and the waste sector (0.9 percent).

The trend of net greenhouse gas emissions between 1990-2006 indicates an average annual reduction of 2.3 percent with per capita emission reducing by 3.6 percent per year since 1990 until 2006 (Table 1.1). The reduction of net GHG emissions is mostly due to the socio-economic slowdown during the transition period from a centrally planned to a free market economy. However, starting from 1995 the net greenhouse gas emissions have stabilized and from 2000 to 2006 the net greenhouse gas emissions increased with average annual increase of 1.6 percent.

The total GHG emissions in Mongolia are comparatively low, but the per capita rate of GHG emissions is relatively high compared to other developing countries because of the cold continental climate and the long heating season, the use of fossil fuels for energy and the low efficiency of fuel and energy. The net national GHG emissions in 2006 were estimated at 15.6 million tons or roughly 6.02 tons per capita (Table 1.1).

In the energy sector, which consists of fuel combustion and fugitive emissions, greenhouse gas emissions were reduced by 1.3 percent per year from 12,529 Gg CO_2-eq in 1990 to 10,220 Gg CO_2-eq in 2006. However, the major reduction of emissions was only until 2000 with an annual decrease of 3.4 percent. The emissions increased by 2.4 percent per year from 2000 to 2006 (Table 1.2).

Methane emissions from domestic livestock increased by 2.3 percent per year between 1990 and 1999 and reduced by 1.6 percent per year to 289 Gg in 2006, due to a change in the numbers of livestock caused by natural disasters. Emissions from industrial processes have increased since 1990 with an average annual growth 6.5 percent due to increased

Table 1. 1. Major indicators of total greenhouse gas emissions (1990-2006)

Characteristic	1990	1995	2000	2001	2002	2003	2004	2005	2006
Net emissions (Source and Sink), Gg CO_2-eq	22,535	15,044	14,247	14,155	13,944	13,332	13,755	14,519	15,628
Population, thousand persons	2103	2249	2407	2446	2475	2504	2533	2562	2595
Per capita GHG emissions, tons CO_2-eq/ person	10.72	6.69	5.92	5.79	5.63	5.32	5.43	5.67	6.02
GDP*, billion 2000 US$ using exchange rate	1.1	1.0	1.0	1	1.0	1.1	1.4	1.5	1.6
Per GDP CO_2 emissions, kg CO_2-eq/US$	20.49	15.04	14.25	14.16	13.94	12.12	9.83	9.68	9.77

** - IEA Statistics. CO_2 emissions from fuel combustion, 2009.*

Table 1. 2. Greenhouse gas emissions by source (1990-2006), Gg CO_2-eq

Characteristic	1990	1995	2000	2002	2004	2005	2006	Average annual growth Rate, %		
								1990-2000	2000-2006	1990-2006
Total emissions (Source)	23,645	17,205	16,896	16,405	16,910	17,582	18,868	-3.3	1.9	-1.4
Energy	12,529	8,710	8,865	9,418	9,247	9,635	10,220	-3.4	2.4	-1.3
Industrial processes	326	166	276	451	972	862	892	-1.7	21.6	6.5
Agriculture	7,695	6,964	6,748	5,338	5,518	5,854	6,462	-1.3	-0.8	-1.1
Land-Use change and forestry	1,887	-906	-1,762	-1,386	-2,112	-1,966	-2,083	-	2.8	-
Waste	96	110	120	124	131	134	138	2.3	2.4	2.3
Net emissions (source and sink)	22,535	15,044	14,247	13,944	13,755	14,519	15,628	-4.5	1.6	-2.3

consumption of halocarbons (HFCs). The total CH_4 emissions gradually increased by 2.3 percent per year between 1990 and 2006.

The total carbon dioxide emissions reduced by 4.7 percent per year in the period 1990-2006 because of the economic decline during the transition period. However, the total carbon dioxide emissions increased since 2000 by an annual 2.6 percent until 2006. CO_2 emissions from fuel combustion comprised 88.5 percent of the total carbon dioxide emissions in 2006. Its annual growth rate was 2.3 percent between 1990 and 2006. Power and heat generation accounted for about 65 percent of the carbon dioxide emissions from fuel combustion in 2006, whereas transportation accounted for 19 percent, industrial processes 4 percent, residential, commercial and agriculture 10 percent and others (Figure 1.1).

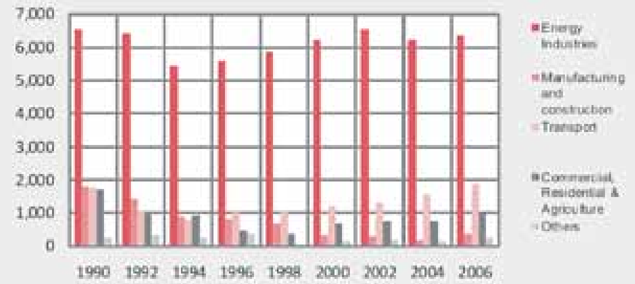


Figure 1. 1. Trend of carbon dioxide emissions from fuel combustion by source, Gg

1.3 Policies and measures

The Government of Mongolia has prioritized the establishment of a safe and healthy environment for its people while sustaining a long term, comprehensive policy on socio- economic development with an emphasis on protecting the environment and the natural resources inherited from our ancestors who maintained the ecological balance, throughout hundreds of years.

The Millennium Development Goals-based Comprehensive National Development Strategy (MDG-based CNDS) of Mongolia identifies the need "to create a sustainable environment for development by promoting capacities and measures on adaptation to climate change, halting imbalances in the country's ecosystems and protecting them". In addition, the MDG-based CNDS includes a Strategic Objective to promote capacity to adapt to climate change and desertification, and to reduce their negative impacts.

At the international level, Mongolia has joined 14 environment-related UN Conventions and Treaties, such as the UN Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD) and the Convention to Combat Desertification (CCD).

The Mongolia National Action Programme on Climate Change (NAPCC), approved in 2000, aims not only to meet the UNFCCC obligations, but also to set priorities for action and to integrate climate change concerns into other national and sectoral development plans and programmes. The NAPCC is based on the pre-feasibility studies on climate change impact and adaptation assessment, GHG inventories, and GHG mitigation analysis. This Action Programme includes a set of measures, actions and strategies that enable vulnerable sectors to adapt to potential climate change and to mitigate GHGs emissions. The starting point was that these measures should not adversely affect socio-economic sustainable development. Recently, the NAPCC has been updated, taking into account the latest developments of policies, research and information on climate change in the country as well as in the world.

The Government has established an inter-disciplinary and inter-sectoral National Climate Committee (NCC) led by the Minister for Nature, Environment and Tourism, to coordinate and guide national activities and measures aimed to adapt to climate change and to mitigate GHG emissions. The NCC approves the country's climate policies and programmes, evaluates projects and contributes to the guidance of related activities. Also, the Government has established the Climate Change Coordination Office (CCCO) under the supervision of the Chairman of the NCC.

As mentioned above, Mongolia has been developing and vigorously promoting various policies and measures to alleviate global warming at all levels of the economy. In particular, the strategies for sustainable development and reduction of greenhouse gases in the energy sector are focused on renewable and other clean energy use, clean coal technologies, improving the efficiency of energy supply, and energy efficiency improvement in buildings and industry (Table 1.3). In the transportation sector, greenhouse gas reducing strategies are to improve traffic conditions, use more fuel efficient vehicles and implement shifts from individual road vehicles to rail and public transport systems.

Table 1. 3. Greenhouse gas mitigation policies and measures by sector

Sector/ subsector	Strategy	Policies and Measures
Energy supply	Increase of renewable and other clean energy use	National renewable energy program
		Renewable energy law
		100000 solar ger program
		Electricity supply of remote soum centers by solar, wind and diesel hybrid systems
		National program of LPG use
	Energy supply efficiency improvement	Reduction of energy losses in transmission and distribution systems
		Efficiency improvement of CHP
		Efficiency improvement of HOB
		Heat efficiency Improvement in ger district area
	Promotion of clean coal technology	Coal program
	Study of nuclear power development	Nuclear energy law
Energy	Demand side energy conservation policy	Issue of energy conservation law
		Promotion of energy efficiency in industry and ESCO activities
Demand	Building energy efficiency improvement	Implement improvements of district heating system and installation of heat meters in buildings
		Insulation improvements for existing buildings and implement new energy efficient standards for new buildings
	Improvement of energy efficiency in Industry	Equipment efficiency improvements and good housekeeping
		Technology changes
Transport	Efficient management of transportation	Enhancement of national transportation system (railway enhancement and electrification; setting up transit logistics centers)
		Eco-transport strategy (efficient traffic management; expansion of public transportation; promotion of fuel efficient car)
Agriculture	Sustainable development of agriculture sector	Limitation of the number of livestock by increasing the productivity of animals, especially cattle.
Land use change and forestry	Land use management	Land degradation and desertification
	Forest conservation and afforestation	Protection of forest from fire
		Measures toward combating harmful forest insects and disease
		Afforestation and measures to support natural regeneration
Waste	Waste management	Improvement of waste management
		Waste recycling

Greenhouse gas reduction strategies in agriculture focus on improving animal husbandry management and technology and increasing the productivity of each type of animal. As for the waste sector, policies and measures to establish a foundation to minimize waste, increase recycling and expand waste management processes should be implemented. Policies to increase removals and decrease emissions are also being implemented in the forestry sector through efficient management and maintenance of forests and afforestation.

Mongolia also submitted a list of nationally appropriate mitigation actions (NAMA) to the UNFCCC Secretariat in January 2010 under the Copenhagen Accord requirement. The NAMA includes the general outlines of GHG mitigation measures that would be implemented with the support under the international mechanisms to strengthen national capacities; to transfer of advanced technologies; and to provide financial resources to developing countries Parties.

Obviously, a country which is vulnerable to climate change, the formulation and implementation of the policy on adaptation to climate change is vital for the sustainable development of the country as well as for accomplishment of its obligations under the UNFCCC. Also, new developments and amendments of policy and legal documents are required in order align with recent climate change and the latest socio-economic development updates.

High priority adaptation options and measures in different sectors vulnerable to climate change are summarized in Table 1.4.

Table 1. 4. Adaptation strategies and policies by sector

Sector	Strategy	Policies and measures
Animal husbandry	Reducing land degradation and desertification	Improving legislation of pasture leasing, utilization and ownership
		Conservation of natural grassland through proper management
		Cultivation of forage plants and introduction of irrigation technologies
		Introduction new varieties of plants resistant to droughts and pests
	Improved livestock quality and livestock management	Development of legal and economic leverages in order to control number of livestock and herd structure according to pasture capacity and resources
		Improving the quality of biological capacity of livestock
		Improving risk management of pastoral livestock and strengthen livestock insurance system
		Expanding research and experiment on livestock production and efficiency
		Enhancing artificial insemination techniques and veterinary services
		Supplementary feeding of animals
		Planting of forage and pasture production improvement
	Improved herders' livelihood	Capacity building of agricultural managers and herders
		Promoting household and community group based enterprises to process livestock products
		Supply herdsmen with portable and renewable energy sources
		Promoting value added chains of livestock products and improving market competitiveness
		Improving communication system in rural areas
	Increased urban food supply	Promoting food processing enterprises
		Increasing export of meat and meat products
		Expanding farms of milk and meat (cattle, pig, chicken and etc) production in suburban areas

Arable farming	Improved agricultural technologies	Changing sowing period
		Introducing new varieties of crop
		Expanding application of fertilizers
		Extension of irrigated croplands
	Increased agriculture production	Implementing agriculture campaign- 'ATAR3' in order to meet wheat and vegetables demand of the country
		Recovering and vegetating abandoned crop fields unused since 1990
		Developing infrastructure using market economy leverages
		Strengthening agricultural research institution focused on upgrading grain variety, agro chemistry, sowing, technology, agricultural equipments, marketing, pests and diseases, and etc
		Improving the structure of information exchange between local and international agricultural institutions and farmers
Water resource	Improved water resource management	Developing and implementing integrated river basin management policy and plans in the basins and at national level, coping with desertification
		Reinforcing national policy on coverring upper part of runoff formation zones by the protected area network and protect it's ecosystems
		Construct water reservoirs harvesting glacier melting water, lakes and rivers for multipurpose, as regulation of water flows, hydropower generation, drinking and industrial water supply, pasture watering and etc
		Reinforcing water storage policy in the upper river basins
	Increased urban water supply	Encouraging efficient and economic use water resources through water saving technologies, water metering systems, and reuse of water at household and industrial levels
		Maintaining promotional activities on water saving and protection
		Imposing appropriate and modernized tariff system on water
	Increased pastureland and agriculture water supply	Building up an oasis network based on the balance of pasture land and heads of livestock
		Maintaining, equipping and restoring old wells through proper solution of issues pertaining ownership of wells
		Improving efficiency of irrigation system and introducing water saving technologies such as low-flow showers, drip irrigation and night irrigation
		Improving the effectiveness of ground water utility
	Improved water quality	Advancing the level of water purification and sewage water treatment plants in urban areas
		Intensification of water substances and sanitation monitoring
	Changed behavior of population to use water efficiently	Educating public and changing their attitude towards water resource, usage and protection
		Implementing the policy on providing equality on water use
Human health	Reduced risks to human health caused by natural disasters, communicable diseases and climate change	Implementing 'Healthy Mongolian' programme in order to change public behavior to prevent health risks and treats
		Setting up early warning system of human health risks and improve response capacity
		Improving of research capacity of climate change impact on public health
Forestry	Ensured sustainability of forest resources	Strengthening forest resource protection and conservation management
		Expanding green areas and trees in urban areas
		Supporting tree -planting initiatives of individuals and organizations and introduction of advanced technologies
		Increased resource of shrubs and bushes in the Gobi desert area through appropriate solutions of household fire fuels

Strategy and measures to prevent land and pasture degradation and desertification are identified in the National Programme to Combat desertification and National Action Plan on Climate Change. The good management and coordination of activities included in these programmes are essential to reduce the desertification.

Also, it is vital to improve the management capacity of the Government, its institutions and the public with reference to hazards and early warning systems of natural disasters such as drought, zud (severe winter), snow storms and floods. Also, advanced scientific approaches and models need to be used in developing forecasting methods and appropriate computing capacities to predict and estimate future climate change in Mongolia.

The Government of Mongolia has approved 'The Livestock Programme' which addresses issues such as ensuring sustainable development and creating good governance in the animal husbandry's sector; making products and raw materials of a high biological quality and improving the market competitiveness; ensuring the health of Mongolian livestock and protecting social health; creating a network for the procurement and sale of meat and other products. The climate change adaptation strategy in animal husbandry stimulates implementation of the above directions of the programme. The adaptation measures would decrease the adverse impact of climate change on animal weight and production and pasture production. This approach should be consistent with the government policy that promotes community and herders ownership. The basis of state policy is to establish a network of pasture land management.

Moreover, adaptation and prevention measures for climate change must be taken at agricultural/arable farming sector level as well as at national level with immediate effect. Training and educating the general public and the people in the agricultural sector on climate change adaptation measures, is essential. Research on agriculture and animal husbandry should focus on the development of new varieties of crops, resistant to climate change.

The most effective method of adapting to climate change in the water sector is the formulation and stabilization of a water resource management policy. Building the structures that regulate the flow of rivers and lakes are not only the means of adapting to climate change but also the solution to the problems pertaining to water shortage, overcoming of water scarcity, and prevention of floods and so on.

The current issue is not whether it is necessary to adapt to climate change, but how to adapt to it. Adaptation is primarily targeted on studies, assessments and evaluation of the impact of climate change, the harm and risks associated with it and the formulation of methods and measurements to mitigate it. Efficient methods and strategy are needed in the first run in order to implement adaptation policy on climate change. Implementation strategy must include the factors related to legislation, structure, finance, human resources, science and media coherently with other policies and strategies. Also, it is vital to assess subjective and objective impediments to implementing the strategy and to take into consideration how these are correlated with other socio-economic demands, while formulating methodology to facilitate the process of overcoming these impediments.

The sustainable development of Mongolia is largely dependent on the beneficent cooperation of environment and economy, while the economy has a great deal to do with natural resources such as pastureland, animal husbandry, agriculture and natural resource utility. Adaptation technology usually requires a considerable amount of investment initially. On the other hand, the efficiency of adaptation measurements is not recognized in the short term and it takes a considerable time and tremendous effort to achieve visible results.

1.4. Projections of GHG emissions

The total GHG emissions during the projection period are expected to gradually increase due mostly to the increase of energy industry and energy consumption by economic sectors. The total GHG emissions are expected to increase by 7.95 percent annually from 2006 to 2015 and 4.78 percent from 2015 to 2020. The average annual growth rate of total GHG emissions from 2006 to 2030 is expected to be 9.33 percent. The aggregated projections of GHG emissions by sector are shown in Table 1.5.

During the same period, emissions from the energy sector are expected to increase by 4 times. The ag riculture sector is expected to increase only 6 percent and emissions from waste by 3.6 percent annually, whereas removals from land-use change and forestry are projected to decrease by 3 times (Figure 1.3).

According to projections of gases, carbon dioxide, the main gas from energy related GHG, will experience a relatively modest increase from 2006 by 2.2 times to 2020 and by 3.5 times to 2030. Methane emissions will increase only 1.15 times from 2006 to 2030 (Figure 1.4).

Table 1. 5. Aggregated projections of GHG emissions by sector

Sectors	GHG emissions in CO_2-eq, 1000 tons						Average annual growth rate, %			
	2006	2010	2015	2020	2025	2030	2006-2015	2015-2020	2020-2030	2006-2030
Energy	10,220	14,033	20,233	25,930	32,796	41,815	10.89	5.63	6.13	12.88
Industry	891	1,354	1,602	1,836	2,065	2,318	8.87	2.92	2.63	6.67
Agriculture	6,462	6,405	6,573	6,657	6,762	6,867	0.19	0.26	0.32	0.26
Land use change and forestry	-2,083	-1,932	-1,785	-1,420	-1,000	-680	-1.59	-4.09	-5.21	-2.81
Waste	138	158	183	209	254	294	3.62	2.84	4.07	4.71
TOTAL	**15,628**	**20,018**	**26,806**	**33,212**	**40,877**	**50,614**	**7.95**	**4.78**	**5.24**	**9.33**

The growing trend of greenhouse gas emissions in Mongolia since 2006 is expected to continue due to the current industrial development. The projections indicate that Mongolia's GHG emissions would rise above 2006 levels by about 2.1 times in 2020 and 3.2 times in 2030 (Figure 1.2).

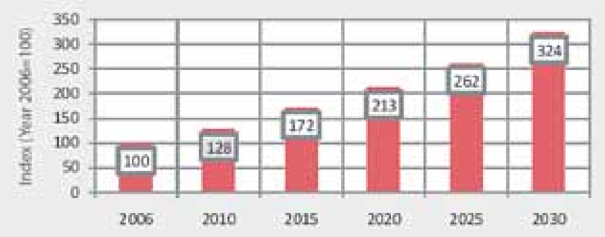


Figure 1. 2. Projected GHG emissions trend

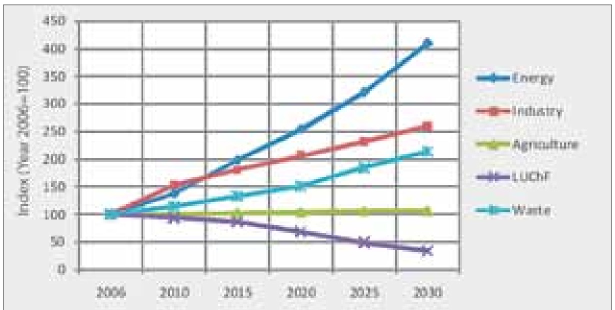


Figure 1. 3. Projected GHG emissions and removals by sources/sinks

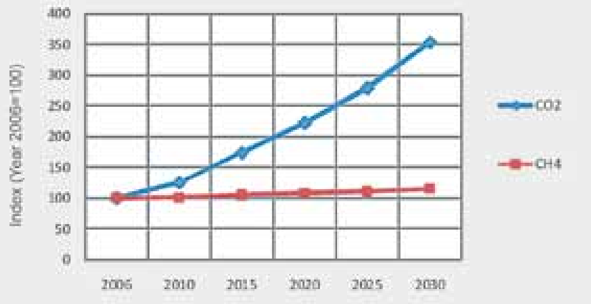


Figure 1. 4. Projected GHG emissions by gases

1.5 Climate Change, Impact Assessment and Adaptation Options

1.5.1 Current climate change in Mongolia

Observation records for the period of 1940 to 2008 show that the annual mean air temperature of Mongolia increased by 2.14^{0}C. Due to global warming, the frequency of extreme high temperatures has grown, while in contrast, the occurrence of extreme low temperatures has dropped. In term of precipitation, there is an increasing trend of winter precipitation and a decreasing trend of summer rainfall.

According to the study, the number of days with dust storms has been increasing significantly during the last few decades from 18 days to 57 days between 1960 and 2007. Apparently, climate dryness is intensified in Mongolia in relation to the pattern of global climate change. The atmospheric drought index in multi years confirms intensified drought in the country.

Nomadic livestock is fully dependent on nature and weather conditions and zud (severe winter condition) causes the death of hundreds, thousands and even millions animals and does enormous damage to the economy of the country. The Zud index dramatically increased in latter years due to the intesified drought index from the 1990s and colder and snowy winters in the 2000s.

1.5.2 Climate change projections for the 21st century

In the climate change projections, 24 climate models developed by 17 World Centers as cited in the Fourth Assessment Report of IPCC were evaluated. Results of the multi model ensemble showed that air temperature will be increased more significantly in the summer season. According to the estimation of the change in winter temperature, most models give a high level of change and amplitude. In other words, the results will be highly variable from year to year.

The assumption was that a model with minimum errors in the calculation of the past climate can project future scenarios of climate change for Mongolia. Based on statistical interpretation of the global climate models, the HadCM3 model of the HADLEY center was the most suitable for the specific conditions of Mongolia.

The HadCM3 model results show that the annual precipitation will generally increase. However, there will be small decline in the summer season between 2011-2030 according to A2 and A1B GHG emission scenarios. Precipitation in the summer season will increase by less than 10 percent, which is smaller than the rise in winter precipitation compared to the normal climate.

Due to climate change, it is anticipated that winter is becoming milder and snowy, while summer is becoming hotter and drier even though there will be a slight increase of precipitation based on overall climate change assessment.

1.5.3 Impacts of climate change

Ecosystem: Remote sensing analysis of different satellites revealed that areas without grass (or barren) increased by 46 percent from 1992 to 2002. In 2006, the barren areas almost tripled, while forest areas decreased by more than 26 percent during the same period.

According to net primary production (NPP) of the ecosystem estimated by the Century 4.0 model, the ecosystems of Mongolia will shift to the north especially in the 2080s due to increased temperature and evapotranspiration. The steppe zone is likely to be pushed by the semi-desert zone from the south and will decrease significantly. Due to climate warming, the semi-desert zone will push the steppe zone to the north, especially in 2080. In 2080, forest-steppe and steppe areas will decrease, as a result of a decrease in rainfall and an increase in temperature in the growing season.

Also, the dryness index, which is characterized by the ratio of total annual precipitation to the annual potential evapotranspiration, was used to confirm ecosystem changes in the future. The future dryness index can reflect possible vegetation and natural zone shifts in the future.

Rangeland: Pasture observation data analysis confirms that pasture biomass has dropped by approximately 20-30 percent and plant species have been impoverished in the last 40 years. Despite many challenges and the complexity of the system, an impact assessment of climate change on rangeland was conducted, based on the Century 4.0 model results. According to biomass changes, the negative effect of high temperature increase of more than 30C cannot be balanced even by 20 percent increased precipitation in the forest steppe and the steppe. However, a precipitation increase by 20 percent would be favorable for pasture in the Altai Mountains and the desert steppe in Mongolia. The pasture biomass would decrease in almost all areas, especially in the forest steppe and the steppe.

Pasture insects and rodents spreading: In recent decades, some insects and rodents have become more widespread due to significant climate change, drought and weather extreme events. In particular, rodents and grasshoppers spread widely during the drought years of 2000 to 2002 and extensively damaged pasture. In addition, pests increased in crop lands leading to significant decrease in harvests. Major challenges of the research have been the non existence of a systematic observation and monitoring system of harmful insects and rodents and a lack of data and information for impact assessment for future time periods.

Desertification: Nowadays, about 70 percent of the grassland of the territory has been affected by decertification to a certain extent. In particular, future temperature increases during the growing season, the increase of potential evapotranspiration, a precipitation decrease in most areas or a lack of precipitation increase to cover raised evapotranspiration needs, hot spells that cause crop stress, intensified heavy rainfall (20 percent), drop in the total number of rainfall hours, early melting of snow cover, longer periods of bare soil from snow cover until the onset of greening and a growing number of dust storms are the major factors leading to desertification.

Water Resources: Surface water inventories conducted in 2003 and 2007 confirmed that many rivers, streams, lakes and ponds dried in the last years.

Current changes in annual and seasonal runoff of rivers in Mongolia are shown in Table 1.6.

Statistically significant changes occur in starting and ending dates of the occurrence of ice phenomena and ice cover in autumn and spring, and in their durations and ice depth. A slightly increasing trend in annual and seasonal flows is observed in small and medium size rivers, draining from the northern slopes of the Altai Mountains and also a slight increase in the autumn and winter flow of the Selenge and Onon rivers.

The starting date of spring flood gets earlier by 20 days in rivers draining from the southern slope of the Mongolian Altai and Khangai Mountains, by 5-10 days in rivers draining from the northern slope of the Khangai and Khuvsgul Mountains and by 5 days in rivers draining from the Khentii Mountains. For instance, 60 years of hydrological records show that the spring flood in the Tuul river starts 20 days

Table 1. 6. Current changes in annual and seasonal runoff of rivers

Rivers group	Trend
Rivers draining from the glaciers of the Altai mountain range, rivers of continuous permafrost catchment of the Khuvsgul Mts. and Bogd river raising from the Otgontenger glacier in the Khangai Mts	Annual and seasonal flows show an increasing trend
Rivers draining from continuous and discontinuous permafrost catchment of the Northern slope of the Khangai mountain range and Khentii mountain ranges	Annual and warm season's flow has decreasing trend, but show a slightl increase in autumn and winter
Downstream reaches of big rivers	Annual and season's flow has decreasing trend, but it is slightly increasing in winter
Rivers draining from the Southern slopes of the Altai and Khangai mountain range and streams draining from the Gobi Altai and Gobi and steppe regions	Annual and all season's flow has decreasing trend

earlier compared to the date at the start of the observation.

The starting date of rainfall flood tends to be observed 2-3 days earlier in rivers which originate from the western slopes of the Khentii Mountains, 10 days earlier in rivers draining from the southern slopes of the Khentii Mountains, 2-7 days earlier in rivers formed in the Khangai, Khuvsgul, and Khan Khukhii Mountains. However, the date tends to be later by nearly one month in the Khalkh River, draining from the Ikh Khyangan Mountains. The duration of the rainfall flood tends to be shortened by 5-10 days in rivers draining from the Khangai, Khuvsgul, and Khan Khukhii Mountains. Therefore, its peak discharge and its potential causes tend to increase.

Hydrological changes driving climate change impact and anthropogenic influences are very complex and reflect also the effects of melting glaciers and permafrost.

Current water balance elements in river basins were assessed using both historical hydrological and meteorological data records and conventional methods. Their future projections of changes were assessed based on the HADLEY center climate model (HadCM3) output results in accordance to GHG emission scenarios A2, A1B and B1 for the periods of 2020 (2011-2030), 2050 (2046-2065) and 2080 (2071-2099) in comparison with the average air temperature, humidity, wind speed and precipitation data for the period of 1980-1999.

It is projected that the annual potential evaporation or evaporation from open surface of water will be increased by 2.5 times in mountainous areas, by 2 times in steppe zones and 1.5 times in the desert areas in accordance with A1B GHG scenarios.

Water temperature is a key environmental factor of aquatic life. However, according to climate change A1B GHG scenarious, the average water temperature for warm peiods of the year such as April-October is projected to increase in the Arctic Ocean basin by 2.2 - 3.5 ^{0}C, in the Pacific Ocean basin by 2.3 - 3.8^{0}C and in the Central Asian Internal drainage basin by 2.4 - 3.8 ^{0}C above its average during the period of 1980-1999.

Study results show that according to the A1B GHG scenarious, river runoff in the Arctic Ocean basin will increase by 2-9 mm in different future periods. However, the projected increase in evaporation from open surface water will be exceeding the increase in runoff by much higher rates in different basins. That will lead to dryer conditions and to an imbalance between inflow and outflow components of water bodies.

Cryosphere: The change in the average depth of snow cover over the last 30 years shows that the snow depth has decreased in the northern mountainous region of Mongolia. However, it tends to be increasing in the eastern and southern steppe and the Gobi desert region. The date of the disappearance of stable snow cover tends to be earlier by 1 month. The area of stable snow cover will be decreased in future periods.

Currently, the permafrost extends to 63 percent of the country's territory. The permafrost area commonly extends and continuous permafrost prevails in the northern part of Mongolia. Over the past 30 years, a seasonal thawing in the active soil layer in the permafrost regions has increased by 0.1-0.6 cm in the Khentii and Khangai Mountains and by 0.6-1.6 cm in the Khuvsgul Mountains. The seasonal freezing depth in the active layer has been decreasing by 10-20 cm in the eastern part of Mongolia during the last 30 years. Permafrost phenomena such as thermocarst, solifluction, thermoerosion and icing have intensified over the last 50 years.

Future projections of changes in permafrost extension were assessed, based on the ratio of average air temperature in the coldest and warmest months using SRES A2 and B2 GHG emission scenarios. The results showed that permafrost will retreat and shrink in mountainous areas, and, decade by decade, its higher geographical classes would be replaced by lower classes of permafrost. The continuous permafrost extent in the Altai, Khangai and Khuvsgul Mountains will be changed into discontinuous, common patchy and rare patchy in the 2040-2099 and 2070-2099 periods. That will lead to a 3 times reduction in permafrost extension and the non-permafrost area will be increased by 2 times.

All glaciers are distributed in the Altai Mountain except Otgontenger glacier in the Khangai Mountains and the Munkhsaridag glacier in the Khuvsgul Mountains. Fifty to seventy percent (50-70 %) of the annual flow is formed from snow and ice melting water in the rivers draining from the Altai Mountains. The terminious line of glaciers such as Potanin and Aleksander shifted upwards, indicating a retreat by 550 m during the period of 1945-1981 and 185 m during the period of 1981-2001. The rate of retreat was 12 m/year in the first period and increased to 15 m/year in the second period mentioned. The retreat of Kharkhiraa and Turgen glaciers has been drastically increasing since the 1940s.

1.5.4 Vulnerability and adaptation of socio economic sectors

The Mongolian economy is very sensitive to climate change due to pastoral livestock, rainfed agriculture and uneven surface water resources distribution. As a result, the vulnerability of the country's economy, livelihood and traditional nomadic culture is potentially very high under future climate changes.

Table 1.7 presents the summary of vulnerability of socio economic sectors and natural ecosystems and recommended adaptation measures.

It is necessary to take into the consideration the possible constraints and barriers to the implementation of adaptation methods. It is certain there will be specific difficulties and impediments while implementing the adaptation measurements, depending on the geographical, geophysical and environmental features and the level of socio-economic growth of the country. The most likely impediments and ways to overcome them are mentioned in Chapter 6.

1.6. Financial resources and technology transfer

1.6.1 Financial mechanism / resources

Commonly, the implementation of measures and action taken, in the course of GHG mitigation and climate change adaptation, requires advanced techniques and technology, an adequate legal and institutional environment, sufficient human resources and high investment. However, developing countries, including Mongolia, have limited capacity to provide such resources and assets. Under the UNFCCC, de-

Table 1. 7. Vulnerability and adaptation of socio economic sectors and natural systems

Sector	Vulnerability and impact	Recommended adaptation measures
Animal Husbandry	• Decreased weight and productivity of sheep • Shortened grazing time due to biophysical abilities of animals	• Planting forage plants • Development of new model of combined practices of pastoral and modern intesified livestock farming • Improving animals tolerance abilities and rearing local best breeds • Strengthening of risk management of pastoral livestock and insurance system • Diversifying livelihood sources of herders and supporting farming initiatives • Building capacity of livestock managers and herders through various methods • Introduction of the best technologies of processing of livestock raw materials • Support to household and community based enterprise intitiatives • Defining regions or areas for pastoral and intesified animal husbandry • Regulation of animal numbers through taxation policy and pasture carrying capacity • Strengthening livestock insurance system • Supporting investment sources for pasture improvement through pasture usage tax or charge etc. • Supplying herders with portable and renewable energy sources • Prevent pasture degradation through tax policy in a reasonable and feasible way.
Rangeland and ecosystems	• Decreased biomass of pasture • Intensifying pasture degradation and desertification • Increase of pasture-harmful insects, locusts and rodents • Deterioration of biodiversity and rare species	• Development of pasture appropriate management system • Imposing legislation on pasture leasing, utilization and ownership • Comprehensive assessment and mapping of degraded lands by each provincial level • Ensuring sustainable pasture utilization through improving pasture water availability • Biological management of insects and rodents of rangelend • Strenthening land use monitoring and information system and its usage in operational manner • Conservation of rare and endangered plants for food and medicines and support their planting • Establishment of community ownership of area with hunting wild animals and introduction of endangered species of animals • Cultivation of forage plants and introduction of the best soil conservation management • Setting up pastureland irrigation system • Introduction of new varieties of plants, resistant to droughts and pests
Arable farming	• Decreasing trend of crop yield • Shortened development stages	• Development of drought and hot weather resistant local varieties of spring wheat • Establishment of irrigation systems • Establishment of protection of tree strips around cropland • Application of extended agricultural practices • Extension of fertilizer production, process and convert dung, manure wastes from swine and cow farms into organic fertilizer • Coordination of cultivation of wild land and crop farming in remote areas through economic policies • Promotion to best soil tillage practices and technologies through taxation and economic policies and etc. • Carrying out research on winter wheat planting • Education of farmers and cultivators on climate change response actions
Forestry	• Increasing frequency of forest fires • Extension of forest insects	• Decreasing trend of crop yield • Shortened development stages • Carrying out comprehensive research forest and steppe fires risk and its distribution • Promotion of afforestation and reforestation activities • Ensuring tree and bushes seeds production • Carrying out forest insects and diseases distribution survey • Regulation of annual logging limit • Strengthening forest fire prevention and fighting system • Introduction of community based forestry management methods

Human health	• Increased tendency of cardiovascular diseases • Expansion of food borne diseases • New contagious diseases outbreak (tropical)	• Carrying out research on human health risks induced by climate change in the short and long term • Improving diagnostic capacity to detect cardiovascular diseases caused by heat waves, and strengthening first aid, particularly in the countryside; • Expansion of diagnoses, treatment and prevention system in response to new infectious diseases arising from climate changes • Strengthening preventive system of food-borne diseases and other threats to human health caused by air pollution, water and soil contamination; • Setting up medical registration and information data base of health cases related to climate changes
Water resource	• Increasing scarcity of surface water resources • Deterioration of cryosphere • Increased tendency to flooding	• Implementation of Integrated River Basin Management policy and plans at local and national level • Introducing national policy on coverring upper part of runoff formation zones • Supporting individual and community initiatives to protect origins of rivers and streams, and lakes • Harvesting melting water of glaciers • Reinforcement of water storage policy • Encouraging efficient and economic use water resources are essential for saving water • Harvesting rain water and using it for non-food consumption such as car washing, lawn irrigation and waste removal • The minimizing soil and water pollution sources • Application of irrigation systems for sustainable crop production. • Intensification of environment monitoring and starting the research on possibility of effusing the flux of rivers flowing from the Arctic into steppe • Public awareness and educational activities on using water efficiently and protection
Natural disaster	• Increasing frequency and magnitude of natural disasters	• Strengthening early warning and response capacity • Improving flood prevention, protection and forecasting system • Expansion of capacity of medical institutions to prevent human and animal communicable diseases

veloped countries are obliged to fully support measures and actions of developing countries to cope with climate change challenges. In accordance with this principle, international agreements and documents on long term collaborations of countries that ensure the financial comprehensive mechanism are being developed within the UNFCCC framework. The financial mechanism needed to maintain new, additional, sufficient and predictable financial resources for developing countries are being considered.

Moreover, developing countries are obliged to align climate change issues with national development policies and strategies.

Financial resources for GHG mitigation and climate change adaptation measures and actions consist of Government funding, private sector investments, and international financial mechanisms.

1.6.2 Technology needs

Advanced technologies play a vital role in the mitigation of GHG and adaptation to climate change. Particularly, the replacement of old, inefficient and outdated equipment, the improvement of efficiency in energy production and consumption, the application of renewable energy, water saving and harvesting technologies, the introduction of new crop varieties resistant to heat and drought etc are required in order to enable the country to tackle the challenges of climate change.

In 2005 to 2006, the Climate Friendly Technology Needs Assessment (TNA) was conducted for the first time for the energy sector. In terms of technology, Mongolia is not positioned at a satisfactory level. Per GDP CO_2 emissions were 7.5 kg CO_2 eq/US$ in 2006, which is 10 times higher than the global average. Moreover, technological deterioration in the infrastructure, particularly in energy production, industry, transportation and construction sectors is the main reason for inefficiency and the negative impact on the environment.

Based on the technology needs assessment, highly prioritized advanced technologies were identified and have been incorporated into the sector's master plans and strategies. However, there are economic, financial and human resource constraints to introducing advanced technologies in the country. The implementation and introduction of these technologies require high investment and Mongolia is unable to be economically independent in implementing them. Consequently, as a developing country, Mongolia considers that international financial and technology transfer mechanisms and the assistance of developed countries are the basic prerequisites of introducing environment friendly technologies. The energy sector of the country has a high potential in terms of reducing GHG emissions. Therefore, technology of electricity and heat production of low fuel consumption, renewable energy technology, construction technology to reduce heat loss of buildings, regulation systems of building heating, and technologies to save electricity and heat energy consumption are urgently required in the country's near future.

In the near future, while coal will remain the basis of energy production, the following technologies need to be introduced and implemented:

- Introduction of clean coal technology and production of clean fuel
- Establish power plant of integrated-coal gasification combined-cycle
- Set up carbon capture and storage (CCS) plant

Therefore, renewable energy and nuclear energy are the central concerns of Mongolia's energy sector. Techniques and technologies towards saving of energy consumption provide an opportunity to utilize internal resources and potentials.

In order to utilize the Clean Development Mechanism (CDM) under the Kyoto protocol in the reform of technologies, the CDM Designated National Authority has been set up and a CDM projects evaluation committee has been established.

Mongolia highly emphasizes adaptation to climate change. Modern technologies are being implemented through projects of surface water and grassland conservation and reducing natural risks to livestock, with international financial support.

1.7. Research and systematic observation

The National Agency for Meteorology, Hydrology and Environment Monitoring (NAMHEM) is the government institution to monitor the environment and climate in the territory of Mongolia. NAMHEM was first founded in 1924 and started officially operating in 1936. The agency has being observing surface water since 1942, upper air observation since 1941, solar radiation observation since 1965, observations of crop and plant phenology, soil moisture and vegetation pests and diseases from the 1960s, environment pollution observation since 1976, animal husbandry meteorological observations from 1976, greenhouse monitoring since 1992 and glaciers and permafrost observations since 2000.

Since 1970, Mongolia has been receiving information and images from the Polar orbit satellites which is an analogue system. Further, not only cloud image, but also analysis of rapidly changing natural resources has been enabled due to the installation of a digital information station in 1987. Since 2007, Mongolia has been receiving satellite images of resolutions of 250 m from MODIS and geostationary FY2C satellites which have increased monitoring quality significantly.

Currently, 120 operational weather stations in Mongolia are working according to the guidelines and procedures of the World Meteorological Organization (WMO), monitoring and measuring the air pressure, atmosphere and soil temperatures, air humidity, rainfall, wind velocities, snowfall, depth (when snow) and other weather phenomena 8 times a day.

More than 200 soums center have weather sites which measure temperatures of atmosphere and soil, moisture, wind, atmosphere occurrence 3 times a day at 00,06, 12 GMT. The weather stations and posts (comprising 39 units) in the agricultural areas of Mongolia observe phenology phases, heights, density, thickness, damage rates, causes and harvest of grains, potatoes and vegetables. In some areas, precipitation and other crop productivity (e.g. weight of 1000 seeds) are carefully being observed.

Mongolia established, jointly with the National Oceanic and Atmospheric Administration (NOAA) of USA, the first monitoring site in Central Asia to measure the atmospheric greenhouse gas concentrations in Ulaan Uul, Dornogovi aimag in 1992. Based on the data, the atmospheric greenhouse gas concentrations are defined in the Climate Monitoring Diagnosis Laboratory (CMDL) in the USA. The observation data are being archived in the world greenhouse gas database in Tokyo Centre, Japan.

Surface water monitoring started in 1942 and at present, 126 observation sites are measuring the daily water level, water charge, ice occurrence, ice thickness, flow speed and water temperature. A number of observation points collect samples for further analysis. Observations are conducted on another 16 small and big lakes. In addition, water plankton, benthos organisms and plant samples are collected in 64 observation points and, water chemistry research samples are collected in more than 140 points.

Climate change study has been conducted since 1980s and numerious national, regional and international projects have been implemented.

1.8. Education, training and public awareness

The implementation of natural conservation, climate change, adaptation and mitigation measures requires the active participation of every citizen as well as civil society. The government of Mongolia has endorsed a ‘Program of Ecological Education for the Public’ in 1997 and currently the second phase of the programme is being implemented.

Environmental and natural protection and conservation have become part of the compulsory curriculum in primary to high school levels. Moreover, about 500 -700 students are studying environment and natural conservation as major courses in state and private colleges and universities. Also, the citizen’s education program has a section on environment education. In addition, trainings and workshops on climate change and disaster management focus on atmospheric disaster prevention and practices.

Researchers and experts on climate studies are trained by the National State University of Mongolia and Darkhan College of the Agriculture University of Mongolia. In addition, students of the University of Science and Technology study energy saving technologies, natural conservation, and impact assessment on nature and the environment.

Climate change related studies and researches are conducted mainly by the Institute of Meteorology and Hydrology and are conducted by experts and specialists in the fields of agriculture, animal husbandry, biology, botany, geography and cryopedology. Such surveys and studies are usually conducted within the framework of particular projects or programmes. There is much demand to prepare qualified specialists in each sector who can understand, evaluate adequately climate change as a systematic issue. To expand and intensify the studies on climate change and climate change monitoring, it is necessary to take certain actions in preparing, training and specializing young researchers by getting them involved in local, international and occupational trainings and seminars, after their degree studies.

In recent years, the issue of climate change has become the focus of the general public and negative environmental and social consequences as a result of climate change are being explained. Hundreds of NGOs have been initiated by people who are working toward the protection and conservation of nature and the environment. However there are very limited organizations that focus on climate change issues, including adaptation and mitigation measures.

The participation and assistance of experts and specialists is essential in training, fertilization, selection and invention of new breeds and irrigation construction. The importance of taking action to increase public awareness of climate change, and government willingness to cooperate with NGOs and the public and to be supported by them and providing them with adequate information is now obvious. The participation and support of the people of Mongolia have contributed to forming a basis for solidifying the energy conservation campaign and lowering energy and resource consumption. To further motivate adaptation measures and energy conservation efforts by the people, the government runs the campaign in close cooperation with civic groups and related organizations and distributes publications on climate change issues.

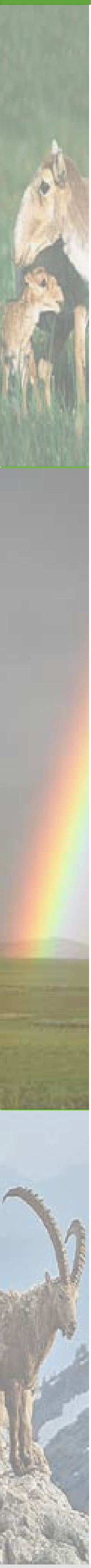
The government is working to enhance public awareness on climate change and its impacts and is forming partnerships with industries and NGOs to enhance the effectiveness of the measures for mitigation and adaptation to climate change. Moreover, the adverse effects of global warming are being publicized throughout the country to motivate the people to participate in adaptation and mitigation measures.

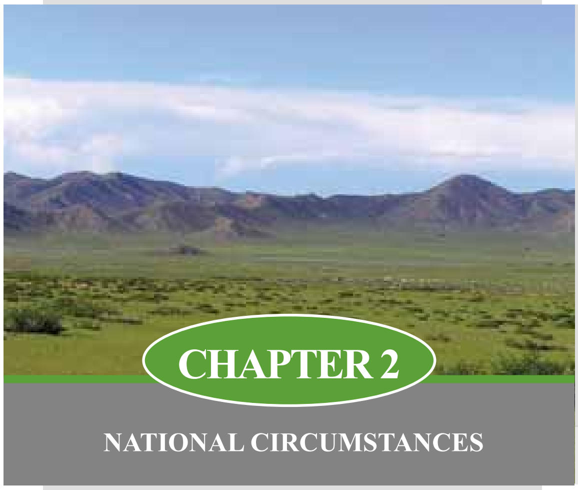
The role of the media in disseminating the government's strategy and policy on adaptation to climate change and mitigation of GHG emissions, in the context of national development goals, is essential. Furthermore, various information regarding the outcome of related international conferences, active measures to adapt to climate change, adverse effects and consequences of climate change, and how the public can help reduce greenhouse gas emissions are all available at related web-sites operated by the government and public organizations.

Public awareness is being raised through alternative means of advertisement, to convey the importance of practicing adaptation of sectors vulnerable to climate change and resource and energy conservation. These include outdoor advertisements for lasting visual effects various publications, advertisements on public buses and other means of transportation and hand-outs.

CHAPTER 2

NATIONAL CIRCUMSTANCES





2.1 Geography

Mongolia is a landlocked country located in Northeast Asia bordering with the Russian Federation in the north and the People's Republic of China in the south (Figure 2.1). The country occupies 1,564,116 sq. km, which is larger than the overall combined territory of Great Britain, France, Germany and Italy. It is ranked as the seventh largest country in Asia and the 19th largest in the world. Mongolia lies between 41⁰ 35' – 52⁰ 06' north latitudes and 87⁰ 47' – 119⁰ 57' east longitudes.

Generally, average altitude is 1580 m above sea level. The highest point is the Khuiten mountain peak (4653 m) in the west and the lowest is the Khokh Nuur lake depression in the east - 518 m above sea-level. Ulaanbaatar, the capital city is located at about 1310 m above sea level.

Figure 2. 1. Geographical map of Mongolia

The country is located in a transition zone at the crossroads of the northern Asia and Boreal Arctic regions where the Siberian Taiga meets the Asian deserts and steppe. Therefore, Mongolia has diverse geographical features such as high mountains, forest steppe, the steppe and the Gobi desert regions. The unique features of these ecosystems are widely recognized in comparison with those of other countries in the same latitude of the northern hemisphere. Geographical features and the dry and cold climate support these fragile natural ecosystems. Therefore, nature and the environment, the flora and fauna of the country are being changed significantly due to socio-economic stress as well as climate change.

The land covers a major continental watershed of the Arctic and Pacific Oceans and the Central Asian internal drainage. Also, Mongolia is dotted with hundreds of lakes, the largest being Uvs-Nuur (covering an area of 3,350 sq. km), Khuvsgul (2,620 sq. km) and Khar Us-Nuur (1,852 sq. km).

During the last 50 years, the population has doubled and economic development has been intensified. Unfortunately, during this time, surface and ground water, forest, soil and pasture resources have been heavily exploited causing serious risks.

2.2 Climate

Mongolia has a severe continental climate due to its long distance from oceans, the high mountains which surround it and a high elevation of more than one and half km above sea level. The main characteristics of the climate are that it has four distinctive seasons, huge fluctuations in temperature, low precipitation and clear climate differences in latitudinal as well as in altitudinal zones.

The annual mean temperature in Altai, Khangai, Khentii, and Khuvsgul mountainous regions is lower than -4^0C, and between the mountains and the basins of large rivers, the average temperature is lower than –6 to -8^0C. In the steppes and the Gobi desert regions it is lower than 2^0C, while in the south Gobi, the average temperature is higher than 6^0C.

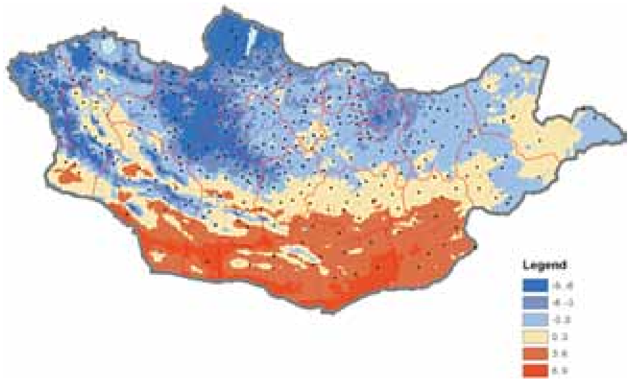


Figure 2. 2. The annual mean temperature map
Source: IMH, 2010

In general, the amount of precipitation in Mongolia is low. The annual mean precipitation is 300-400 mm in the Khangai, Khentii and Khuvsgul-mountainous regions, 250-300 mm in the Mongol Altai and forest-steppe zone, 150-250 mm in the steppe zone and 50-100 mm in the Gobi desert. Precipitation distribution depends very much on relief and landscape and decreases from north to south and from east to west (Figure 2.3). About 85% of the total precipitation falls from April to September, of which about 50-60 percent falls in July and August.

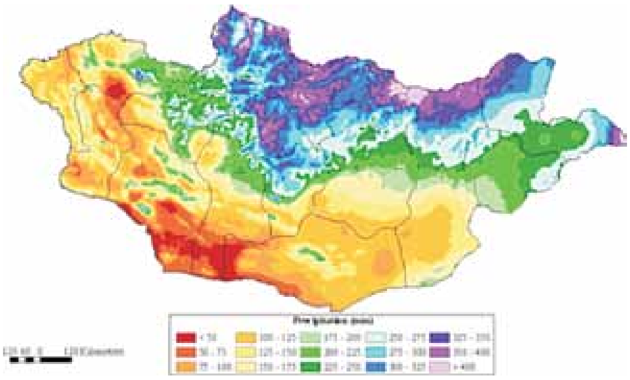


Figure 2. 3. The annual mean precipitation map
Source: Climate source Inc., 2002

Although the annual precipitation is low, its intensity is high. The maximum amount of daily precipitation (138 mm/day) recorded since 1940 occurred on 5 August 1956 at Dalanzadgad, and the second highest (121 mm/day) on 11 July 1976 at Sainshand. It is possible, however, that during an intense rainstorm, 40-65 mm may fall in a single hour.

The total amount of precipitation is much lower than the potential evapotranspiration. The potential evapotranspiration is less than 500 mm in the mountain regions, 550-700 mm in the forest-steppe zone, 800-900 mm in the forest-steppe, 650-750 mm in the steppe zone, and 800-1,000 mm in the Gobi desert zone.

Mongolia has less cloud and more sunshine. Consequently, Mongolia receives an average of 230-260 days of sunshine annually, which is 2,600-3,300 hours of sunshine a year.

In terms of wind, the Mongolian steppe and desert-steppe zones are very windy. The annual average wind speed in these areas is in 4-6 m/s, and in other areas is 2-3 m/s. The wind speed is 1-2 m/s in the Altai, Khangai, Khuvsgul and Khentii mountain valleys and in other areas is around 2-3 m/s. According to meteorological data, the annual mean wind speed is more than 4.0 m/s in one-fourth of the country's 250 settlements. West-northwest-north wind dominates, but the wind depends very much on relief and landscape.

Dust storms are prevalent in the Gobi desert zone that comprises 41.3 percent of the entire territory of Mongolia. The number of days with sand-dust storms in a year in this area is 30-100 while it is 120 in the southern part of the Mongol Els.

Mongolia is considered to be a disaster prone country, which frequently experiences natural disasters such as zud (severe winters), droughts, heavy snow fall, floods, snow and windstorms, extreme cold and heat waves etc. In recent years, the magnitude and frequency of natural disasters has tended to increase due to climate change. Every year, Mongolia has experienced approximately 25-30 atmosphere related natural hazardous phenomena, and almost one-third of these have met the criteria of natural disasters and caused five to seven billion Tugrugs (national currency) in damage for society. In the last decade, excluding droughts and zuds, occasional severe weather conditions have caused 10-12 billion Tugrugs in damage each year.

2.3 Demography

At the end of 2009, the resident population of Mongolia was 2,735.8 thousand, representing an increase of 52.3 thousand or 1.9 percent in comparison to the previous year. In 2015, it is estimated that the population will be 3,044.9 thousand people. The flow of migration to Ulaanbaatar city remains high and its population is increasing year by year. The population of Ulaanbaatar was 567.3 thousand in 1989. However, in 2007, Ulaanbaatar has become a city of more than a million (1 million and 31.2 thousand people) and the population density has reached to 219.4 people per square m. In 2009, about 62.6 percent of the total population of Mongolia, or 1,713.3 thousand people were living in urban areas. In 2009, Mongolia had 716.5 thousand households and the average family size was 3.8 persons. Although the population net growth had been decreased since 1990, in the last 4 years, the birthrate has been increasing. In 2009, the crude birth rate per 1000 population reached 25.5, increasing by 1.5 percentage points compared to 2008. In 2009 the life expectancy at birth at the national level was 67.96 years (female -71.79 years; male - 64.33 years) in 2009, an increase by 0.73 point compared to the previous year.

The literacy rate of adults or the population aged 15 and above is estimated at 97.7 percent. The net enrolment ratio in primary education has remained relatively stable in recent years. The gender ratio in primary education was 1.01 in 2000 and 0.97 in 2008 while the gender ratio in secondary education was 1.2 and 1.08 respectively for these years, showing a trend toward a relatively equal ratio. Gender disparity increases at senior grades and the disparity persists in tertiary education.

Population: 2.74 million (2009)
Population breakdown:
- 48.9 % men
- 51.1 % women
- 62.6 % live in cities and towns
- 35.2 % living below the poverty line

GDP per capita in 2009 - US$ 1536 (at current price)
Life expectancy at birth - 67.96 years[1]
Literacy rate – 97.6 %[2]

There has been progress in the country's mother and child health indicators despite fluctuations in the last 2 years due to the population increase. Between1990-2008, mortality of children under five dropped 3.8 times and child mortality decreased by 3.3 times. This downward trend indicates the potential of achieving new targets of the MDG by 2015.

[1] Third National Report MDG implementation, 2010
[2] National statistical yearbook, 2009

2.4 Government structure

Mongolia is a democratic parliamentary republic. According to the 1992 Constitution, the President of the State is directly elected by all residents for a four-year term, eligible for a second term, and he/she presides over the army and the National Security Council.

The unicameral legislature (State Great Khural) has 76 members, elected for a four-year term. After the legislative elections, the leader of the majority party or coalition chairs the Government. The Cabinet is established by the Prime Minister in consultation with the President and approved by the State Great Khural.

Mongolia has four levels of governance – one central and three subnational tiers. The highest level of subnational government is the province (aimag) and the capital city. Provinces are divided into regions (soums), and the capital city into districts. The lowest tier consists of communities of two types: rural sub-districts (bag) and urban sub-districts (khoroo). There are 21 aimags, with 329 soums and 1550 bags; the capital city has 9 districts and 132 sub-districts.

The 1992 Constitution organizes administrative units of Mongolia on the basis of self-governance and state management, each unit having its own Governor and Assembly (khural). The Governor is the local representative of the central or higher levels of subnational government, whereas the Assembly is elected by the lower assemblies. Governors are proposed by the assemblies and appointed by the immediately higher level of government. Thus, the governor of a soum is proposed by the soum assembly and formally appointed by the aimag; the governor of the aimag is proposed by the aimag's assembly and appointed by the Prime Minister. All citizens have the right of representation in the bag assembly. Bag assemblies elect the soum assemblies, and soum assemblies elect the aimag assembly.

Governors' offices prepare, implement, monitor and evaluate local policies, and provide administrative services such as civil registration, civil services, licenses and permits. Due to the mechanism of nomination, governors connect citizens to the higher levels of government. Assemblies, as representative bodies of the people, pass regulations for their jurisdictions, monitor local administrative bodies, approve local budgets and control their execution.

Mongolia's subnational governments are very fragmented and aimags and soums vary greatly in size. The average size of a community is 5,000, but some have less than 1,500 inhabitants. In smaller communities where people lead a semi-nomadic life, administrative capacity is low, with virtually no economies of scale in service delivery. Mongolia currently discusses a regional development strategy to consolidate and reduce the number of subnational governments.

The Public Sector Finance and Management Law distinguish between local government responsibilities, financed locally, and central government mandates, delegated by contract and financed centrally. Local government revenues consist of taxes decided by the assemblies, shared taxes, and non-tax revenues. Local governments have little revenue autonomy, with local taxes (livestock tax, inheritance and gift tax, property, city tax, transport and stamp duties) representing 6 percent of consolidated government expenditures.

Despite many challenges in decision making and coordination between local and the central government institutions, political and financial decentralization process has been gradually undertaken since the 1990s.

[3] National Statistical Yearbook 2009

2.5 Land resource and biological diversity

As of 2009, by the land resource classification, about 73.9 percent of the territory of Mongolia is agricultural land, 15.9 percent is state special use land, 9.2 percent is forest resource land, 0.4 percent is land of water resources and about 0.3 percent is taken up by urban areas and about 0.2 percent is covered by roads and networks. Land category changes in the last years are presented in Table 2.1.

Commensurate with its physical variety, Mongolia is home to many unique indigenous and exotic species. Historically, the animals and plants living in the various ecosystems played key roles in the nation's economic well-being and culture but today many species are threatened or endangered. Biodiversity reduction is caused by several factors such as excess and illegal hunting, deforestation, rangeland degradation, deterioration of wetlands etc. In order to protect biological diversity, approximately 14 percent of the country lies in nationally protected areas, well chosen to represent the country's different ecozones by the end of 2009.

Table 2. 1. Land categories, thousand ha

No	Land categories	2005	2006	2007	2008	2009
1	Agricultural lands	115,232.7	116,037.7	116,992.9	115,824.7	115,586.2
2	Cities, villages and settlements	446.0	489.8	507.9	530.0	543.8
3	Transportation and network land	355.4	359.2	366.7	371.3	383.6
4	Forest resource land	14,748.1	14,299.4	14,226.5	14,227.3	14,315.4
5	Water resource land	967.6	666.1	666.1	665.5	665.5
6	State special use land	24,641.8	24,559.4	24,651.5	24,792.7	24,917.1
	Total	156,411.6	156,411.6	156,411.6	156,411.6	156,411.6

In recent years, pasture degradation has been significantly extended and threats have become realistic. In 2009, about 10 million ha of pastureland were counted as degraded to a certain extent. At the end of 2009, a total of 44 million livestock heads were counted, which was higher by 0.7 million heads or 1.7 percent compared with the previous year. Consequently, animal density has exceeded pasture carrying capacity in some areas, which leads to serious degradation and furthermore to desertification.

Aridity is one of factors that make the country very vulnerable to desertification. On the other hand, Mongolia's traditional grassland animal husbandry practices protected the natural environment and pastureland throughout four seasons. Therefore, desertification has become one of the specific extreme natural disasters in Mongolia. According to some data sources, 72 percent of the grassland in Mongolian territory has been affected by desertification.

2.6 Water resource

The land of the country covers three major continental drainage basins aligned roughly east-west. North of the divide, drainage is to the Arctic Ocean, via the Lena River and Lake Baikal, and to the Pacific Ocean via the Amur and Yenisei rivers. South of the divide, drainage terminates in dry lakes and salt pans – with no outlet to the sea. Water availability is limited by low and variable precipitation and high evaporation rates so that little water is available on a renewable basis.

The total surface water resource of Mongolia is estimated at 599 km^3/year, and is composed mainly of water stored in lakes (500 km^3/year) and glaciers

(62.9 km³/year). Only 5.8 percent of the total surface water resources, i.e. 34.6 km³/year, are in rivers, with 2.1 percent in base flow and 3.7 percent in direct runoff of rainfall and from snow melting, as determined from a flow separation analysis. It is noted that the amount of 34.6 km³/year consists of the river runoff formed within Mongolia (30.6 km³/year) and water inflow from adjacent countries (4 km³/year) (Myagmarjav and Davaa, 1999). The amount of water resources in renewable ground water (i.e., groundwater with smaller residence time that can be replenished relatively quickly) has been estimated at 10.8 km³/year (Jadambaa, 2002).

The runoff is formed mainly from rainfall in the rivers draining from the Khuvsgul, the Khangai and the Khentii Mountains (56-75 percent of annual runoff), from snow and ice melting waters in the rivers originating from the Altai Mountain (50-70 percent), and from snow melting or rainfall and ground water in other rivers. This indicates that a specific proportion of runoff components varies in time and space. The base flow component fed by groundwater has been estimated as 15-40 percent within the country with an average of 36.1 percent of the total annual runoff (Myagmarjav and Davaa, 1999).

Despite their limited amount, surface and groundwater resources play vital roles in the country's economy, especially in agriculture, livestock production, industry and domestic water supply. For example, 31 percent and 25 percent respectively of the total population of Mongolia receive water from a tap or a distribution tank, which mostly comes from groundwater, 36 percent directly from groundwater wells and 10 percent from rivers.

There is evidence that lakes and rivers have diminished in volume over recent years. Reasons for this include climate change, deforestation, irrigation and agriculture, mining and land degradation (mostly due to adverse human activities). Surface and ground water levels have dropped. Aggravated desertification, salinization and poor water quality are major problems in the arid and semi-arid regions.

2.7 Forest resource

Mongolian forest, which covers 8.1 percent of the territory, is the southern border of the Siberian taiga. However, Mongolian forest stretches for 2000 km from the Altai mountains in the west to Soyolz Mount of Ikh Khyangany Mountains in the east and also from Khuvsgul mountains in the north to the Gobi steppe area in the south (Figure 2.4). It survives a severe climate of low precipitation, low moisture content in the soil and great temperature difference between days and between years. A specific feature of Mongolian forest is that it mostly lies in the area of permafrost.

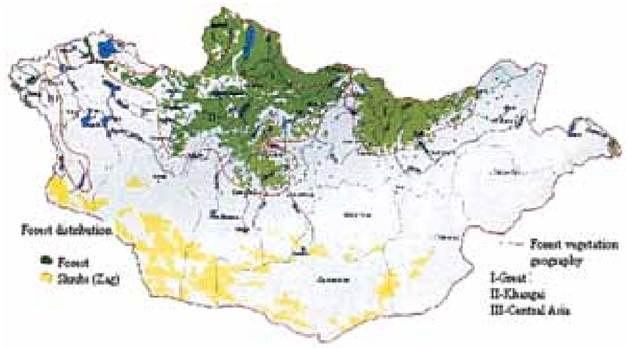


Figure 2. 4. Forest map of Mongolia
Source: National Remote Sensing Center, 2010

The forest stock of Mongolia consists of all types of trees and shrubs including saxauls and cultivated trees. This forest stock is composed of 140 species of trees and shrubs, such as larch, cedar, fir, conifer, spruce and Siberian fir, along with broad-leafed trees such as birch, aspen, poplar, elm and willow. Saxaul forest occupies 25.3 percent of the total forest area. This vegetation covers spacious geographical areas such as flat steppe areas of mountains and mound downhill, ravines with laved soil, dunes, gravel soil and sand cover at the flat surface of the desert-steppe zones over the areas of the Great Lakes Depression, the Olon Nuur Valley, the Dornogobi, Gobi Altai mountain, the Dzungarian Gobi, Southern Altai Gobi and Alashan Gobi.

The nationwide average forest reserve indicators are estimated as follows: average quality is 4.2; average density 0.53; 132 cubic meter reserve in 1 ha of land; the average life expectancy for a coniferous tree is 128 years and 44 years for a deciduous tree.

The coniferous forests of Mongolia serve important purposes. They provide soil and water conservation, runoff regulation and mountain ecosystem balance. In accordance with the implications of these important purposes, all forest areas are classified into one of three zones: special (prohibited or strictly protected), protected, and industrial or utilization.

Fire and harmful insects cause particular damage to the forest resources of Mongolia, and in addition, human-related activity including illegal logging, especially near settlements, has had a significant effect during the last 100 years.

In 2000, 84.6 thousand cubic meters of round wood were logged by commercial harvesting and 6,384 thousand trees were planted. In 2006, the commercial harvest fell to 41 thousand cubic meters of round wood and 3,395 thousand trees were planted. However, forest logging has dramatically increased in recent years and reached up to 612 thousand cubic meters in 2008[4].

Mongolia is one of the most steppe and forest fire prone countries in Asia due to its low humidity and strong winds in the driest seasons of spring (from March to May) and autumn (from September to October). In the meantime, fire occurrences have increased from year to year because of improper human activities. Human activity accounts for up to 95 percent of the total occurrences of fire each year. Moreover, climate change and global warming, desertification, and recurrent dryness have facilitated conditions conducive to the occurrence and spread of fire.

2.8 Economy

In 1991, Mongolia began a rapid transition from central planning to a free market-oriented economy. Subsequently, the abrupt shift of the Mongolian economy caused many difficulties, resulting in a sharp depression and increasing poverty in the first half of the 1990s. Moreover, industry failures and the malfunction of enterprises gave rise to massive unemployment.

At the same time, progress was made in establishing the foundations for a market economy. Reforms included price and trade liberalization, the reduction of lending to state owned enterprises, the creation of a commercial banking system and an extensive programme of privatization, which saw the proportion of the economy in private hands rise from 4 percent to over 70 percent between 1990 and 2000. The transition to democracy and a market economy presented difficulties, but Mongolia has remained committed to the process of market economy. In recent years, economic growth has been relatively buoyant and the prospects are good for the medium term, due to increased revenue from mining, good prices of gold and copper, improved fiscal deficit and stable inflation rate.

Among the development strengths of the country are improving macroeconomic indicators, improved age and gender ratio of population a high literacy rate, the proximity to huge markets of Russia and China, abundant mineral resources, vast land areas, unique natural ecosystems and cultural heritage etc.

However, the challenges are myriad, from a widening income gap, where more than 35.2 percent of the population lives below the poverty line, rising under-employment, environmental degradation and rural stagnation due to lack of access to basic services. The key weaknesses of the economy of the country are as follows:

[4] Research data of Mongolian Forestry policy and coordination department, MNET, Ulaanbaatar, 2008)

Table 2. 2. National macroeconomic indicators

No	Indicator	1990	1995	2000	2005	2006	2007	2008	2009
1	Population, thous.	2,103.3	2,312.8	2,407.5	2,562.4	2,594.8	2,635.2	2,683.5	2,735.8
2	GDP, bln. tugrugs	104.7	550.3	1,018.9	2,779.6	3,715.0	4,599.5	6,019.8	6,055.8
3	GDP per capita, thous. tugrugs	504.2	239.9	426.2	1,091.0	1,440.7	1,758.8	2,263.7	2,234.5
4	Share of industry in GDP	35.6	27.8	21.9	25.0	37.7	37.0	30.0	29.5
5	Share of agriculture in GDP	15.2	11.2	29.1	21.9	19.5	20.6	21.6	21.2
6	Agricultural land, thous. ha	1257	1185	1176	697	697.8	704.5	835.7	623.9
7	Urban population, percentage of the total	43.1	50.4	57.2	60.2	60.9	60.8	61.8	62.6

Source: National statistical yearbook, 2009

- ***Poverty, inequality and unemployment:*** Despite a period of strong GDP growth, there has been little decrease in the number of people living in poverty, which is estimated at between 30-35 percent of the population. At the same time, the richest 30 percent of the population have a 65 percent share of the income. Low domestic savings, especially household savings, imply that households have few reserves to fall back on during hard times and are economically vulnerable.
- ***Remoteness and landlockedness:*** The geographical remoteness and low density of population throughout the vast territory of Mongolia are handicaps because of the high cost of transport and the distance from principal markets. Landlockedness, coupled with the vastness of the country and already prevalent internal transportation difficulties, poses additional difficulties for economic development and competitiveness of Mongolia. Consequently, energy supply and infrastructure such as transportation networks, buildings and construction of the country remains inadequate to provide the necessary impetus to employment generation and economic development of the country.
- ***Export reliance:*** Mongolia's export is heavily dependent on a few commodities (minerals, cashmere, and textiles) that constitute 80 percent of total exports and on international market prices which are highly volatile and unpredictable. While the mining economy offers promising potential for development, there are associated social and environmental risks.
- ***Financial vulnerabilities*** such as a narrow based economic structure, excessive government expenditures, and limited financial capacities are existing challenges for the country. The cost of borrowing (interest rates) remains very high, which poses a great challenge to the rapid development of small and medium enterprises.

The recent global financial and economic crisis has also negatively affected the economic development of Mongolia. Economic growth fell to 8.9 percent in 2008, representing a drop of 1.3 percent from the previous year.

Despite many challenges, the Government of Mongolia approved the Millennium Development Goals-based Comprehensive National Development Strategy (MDG-based CNDS) in January 2008 in order to efficiently utilize opportunities from the intensified regional and global economic and trade environment. The MDG-based CNDS proposes two phases of implementation in 2007-2015 and 2016-2021. Objectives for the first phase are to achieve an average annual economic growth of 14 percent, increase the GDP per capita to at least 5,000 US$ and to establish the basis for intensive economic development. In the second phase, the objectives have been defined as follows: to maintain an average annual economic growth at no less than 12 percent, to develop a knowledge-based economy, to increase the GDP per capita to a minimum of 12,000 US$, and to create economic capacity and resources to reach the level of the world's middle income countries.

2.9 Industry

After the dramatic decline throughout the 1990s, Mongolia took several measures resulting in about 20 percent growth in the processing sector in the beginning of the 21st century. Although the industry sector accounts for 29.5 percent (in 2009) of Mongolia's GDP, it actually possesses a higher potential. Mongolia has vast unexploited mineral deposits, specifically coal, copper, gold and other rare minerals.

Mongolia's industry sector has a production growth rate of 3 percent (steady since 2007). The sector also employs 5 percent of the total work force. Major industries are mining, cashmere and other sectors such as construction materials, oil, food and beverages and processing of animal products.

The country's coal, gold and copper reserves are believed to be among the largest in the world. The mining sector accounts for about 20 percent of Mongolia's GDP and half the country's exports, and attracts the majority of foreign investment.

The government expects that the growth of mining sector will boost the country's economy and is making efforts to approve two major mining projects of Tavan Tolgoi and Oyu Tolgoi. The Tavan Tolgoi coal mining project has been approved recently and proposes to involve many parties including the state owned company, national and international enterprises. Agreement with global investors such as Ivanhoe Mines and Rio Tinto to develop Oyu Tolgoi mine, one of the world's biggest untapped copper and gold deposits, was signed in 2009.

In addition, Mongolia has rich oil resources and exploration and extraction of crude oil has been going on since 2000 in the eastern part of the country. Oil exploration and exploitation have been notably intensified in the last years. Moreover, the ura-

Table 2. 3. Composition of gross industrial output, percentage share

No	Sub sector	2005	2006	2007	2008	2009
1.	**Mining and quarrying**	**66.3**	**69.9**	**63.3**	**56.4**	**57.8**
	1.1 Mining of coal and lignite, extraction of peat	5.0	4.5	4.8	6.0	12.8
	1.2 Extraction of crude petroleum and natural gas	0.7	0.8	1.0	1.3	1.7
	1.3 Mining of metal ores	58.7	62.7	55.9	47.1	40.7
	1.4 Other mining and quarrying	1.9	1.9	1.6	2.0	2.5
2.	**Manufacturing**	**21.0**	**21.5**	**28.7**	**34.5**	**32.1**
	2.1 Manufacture of food and beverages	7.1	6.7	7.8	12.1	14.6
	2.2 Manufacture of textiles	4.5	4.8	6.9	6.6	7.2
	2.3 Manufacture of basic metals	3.4	3.3	7.4	6.9	2.7
	2.4 Manufacture of clothing and fur clothes	2.1	1.6	1.2	0.8	0.4
	2.5 Manufacture of non metallic mineral products	1.0	1.3	1.5	2.5	2.0
	2.5 Other processing and manufacturing	3.0	3.8	3.9	5.6	5.2
3.	**Electricity, thermal energy and water supply**	**12.7**	**8.6**	**8.0**	**9.1**	**10.1**
	3.1 Electricity, thermal energy and steam	11.4	7.5	7.0	7.7	8.6
	3.2 Collection, purification and distribution of water	1.3	1.0	0.9	1.4	1.5

Source: National statistical yearbook, 2009 nium resources of the country have attracted enormous attention in recent years. Consequently, the Government has established the Agency for Nuclear Energy in order to collaborate with international investors in the field of nuclear energy, with regard to the exploration and exploitation of uranium.

However, a strategy for the development of the manufacturing sector is required to focus on enhancing the productive and transaction efficiency of enterprises, diversifying export products and markets, and value-added productions, investing in the necessary physical infrastructure and upgrading the technical, managerial and marketing capacity of domestic enterprises.

The processing industry of the country consists of wool, cashmere, leather, wood, metal, textile, and food production. A recession in the processing industry has occurred, due to a lack of financial resources, which limited the ability of enterprises to secure raw materials, resulting in an under utilization of capacity. The Government put efforts into supporting industrial development.

Mongolia is considered to be the second largest producer of cashmere in the world. As of today, the processing of animal-originated raw materials such as leather, cashmere and wool is playing a dominant role in the processing industry. In particular, Mongolia processed about 5.8 thousand metric tons of cashmere, about 20.8 thousand metric tons of sheep wool, around more than 9.9 million skins in kind to the domestic market as well as exporting de-haired cashmere, scoured wool, processed leather, knitwear, blankets and carpets to more than 40 countries such as USA, the European Union, China, Russian Federation, Japan etc.

Alongside the intensified industrial growth of livestock productivity, the mining sector and the industry and energy sectors, the consequences of the resulting pollution of air, land and water, and land degradation are becoming real problems. The effective integration of economic, social and environmental policies is required in order to ensure sustainable development.

2.10 Energy

Coal is the main primary energy source in Mongolia at present, covering about 98 percent of total solid fuel consumption. Coal is expected to remain the most important primary energy resource in the foreseeable future, because of the great coal reserves in Mongolia dwarfing the reserves of other energy resources, such as oil and gas. Most open cast coal mines in Mongolia are operating at a shallow depth. There are around 320 coal deposits and occurrences (80 deposits and 240 occurrences) according to the Geological Information Center of Mongolia.

The total geological coal resources are estimated at approx. 150 billion metric tons, including about 24 billion metric tons explored. Currently, there are 29 coal mines operating. The large-scale Baga nuur, Shivee-Ovoo, Aduunchuluu, Shariingol and Tavan tolgoi coal mines provide all of the coal used by the power plants of the central region, the country's main industries and most of the small consumers in the main urban centers. Small coal mines in various provinces of the country provide coal for local heat systems and local consumers. Over 70 percent of the total coal production is consumed by thermal power stations with the remainder going to heating plants, industry and individuals. Table 2.4 shows coal production and consumption by country.

Table 2. 4. Coal production and consumption by country, thous. Metric tons

Area	2000	2005	2006	2007	2008	2009
Coal production	5,186.0	7,517.1	8,074.1	9,237.6	10,071.8	14,442.1
Export	0.6	2217.8	2380.0	3268.1	4169.3	7,113.2
Coal consumption	5,211.4	5,472.6	5,691.2	5,906.1	5,843.2	6,609.6

Source: National statistical yearbook, 2009

Approximately 40 percent of the overall utilized coal was burnt with outdated technologies. Combined Heat and Power Plants (CHP) produces approximately 98 percent of the country's electrical power energy. Although Mongolia is rich in renewable energy sources of wind, solar and water, utilization of these sources has not yet reached an efficient level. Currently, small scale hydrological power plants produce electrical power generation that does not exceed one percent of the total energy generation. CHPs produce 70 per cent of the country's total heat energy production, while small and medium capacity boiler houses and home stoves produce 20 percent and 10 percent respectively.

Primary energy consumption from 1990 to 2009 is presented in Table 2.5 and was estimated at 3,628.0 thousand TOE in 2009.

About 23 percent of total coal consumption of the country is consumed by electrical power stations. The Energy generation of the country is shown in below Table 2.6

The priority goal of the energy sector is to reduce fuel consumption. About 40 percent of heat generated from fuel burning is lost and goes unutilized. From the study conducted, it was estimated that only 45 percent of heat generated from overall fuel burning is used efficiently.

Renewable energy source. Mongolia has considerable renewable energy resources including wind, solar and hydropower energy. It has a significant hydropower potential of 6400 MW with 3,800 rivers and streams. Based on this potential, the number of small hydropower plants has been increasing during recent years.

Table 2. 5. Primary energy consumption by source, thousand TOE

Year	coal	oil	LPG	hydraulic	biomass	Total
1990	2,329	775.4	-	-	460.0	3,564.4
1995	1,757	358.5	-	-	466.0	2,581.5
2000	1,815	428.0	-	-	472.5	2,715.5
2001	1,980	470.0	0.407	0.1	478.8	2,450.5
2002	2,000	460.0	0.712	0.1	482.5	2,943.3
2003	1,850	500.0	1.07	0.4	487.9	2,839.4
2004	1,860	560.0	1.58	0.6	491.2	2,913.4
2005	1,970	580.0	2.48	0.98	474.3	3,027.8
2006	2,050	640.0	4.07	1.2	504.0	3,200.0
2007	2,067	780.6	4.20	2.3	512.0	3,366.1
2008	2,045	832.0	5.2	2.8	515.0	3.400.0
2009	2,313	758.5	5.9	2.6	521.0	3,628.0

Source: B. Namkhainyam, 2010
Note: 1. Heating value for LPG-11300 kcal/kg; for coal-3500 kcal/kg; for biomass-2500 kcal/kg

Table 2. 6. Energy generation by country

Area	1990	2000	2005	2006	2007	2008	2009
Electricity generation, million kWh	3,100.0	2,946.0	3,418.9	3,544.2	3,700.7	4,000.6	4,038.8
Import, million kWh	165.0	181.0	167.5	168.3	195.4	197.6	156.5
Export, million kWh	20.0	25	11.9	20.8	10.1	15.9	18.1
Thermal energy generation, thous. Gcal	5,330.0	6,885.4	7,805.6	7,850.4	7,723.5	7,759.6	8,320.5

Source: National Statistical Yearbook, 2009

Considerable wind energy resources of 30 thousand MW are possessed by the country. In the steppe and Gobi regions the annual average wind speed is 4 m/s. Forty-seven percent of Mongolia is classified as territory with the "highest possibility" for wind energy installations. In particular the southern provinces have wind regimes of 150 -200 W/m^2 with wind durations of 4,000-4,500 hours per year. It has been estimated that more than 10 percent of the country has good-to-excellent potential for wind energy applications on a commercial scale.

The total solar energy resources, evaluated as the annual solar radiation on the entire national territory, have been calculated to have the potential to achieve 2.2 x 1012 kWh. The potential solar energy varies from 1,200 kWh/m^2/year to 1,600 kWh/m^2/year in the different regions of Mongolia.

According to the "Master Plan Study for Rural Power Supply by Renewable Energy in Mongolia", up to 20 percent of the country's electrical power energy will be supplied from renewable energy sources by the end of 2020.

2.11 Agriculture

2.11.1 Animal husbandry

Animal husbandry is still the main livelihood and source of wealth for many Mongolians. The production of animal husbandry plays an important role in the country's economy. The value added of agriculture sector is about 17.4 percent of the GDP of Mongolia in 2009. Livestock production comprises 82.5 percent of the total agriculture production. In particular, 264.4 thousand metric tons of meat, 493.7 thousand metric tons of milk, 22.4 thousand metric tons of wool, 4.6 thousand metric tons of cashmere, 1.0 thousand metric tons of camel wool and 12.7 million pieces animal leather were produced in 2009.

The livestock herd - predominantly sheep, cattle and goats - grew to 44 million (Table 2.7) in response to higher cashmere prices, increased demand for meat and other animal products. Pasture degradation has become a serious issue in the country due to increased numbers of livestock and frequent natural disasters. Also, the balance of animal types has been lost and goats constitute almost half of the herds. Cattle with high productivity have been diminishing in numbers. Subsidiary farms producing pigs and chicken have shown a tendency to grow and have played a certain role in food security in urban areas since 2000.

Animal husbandry is heavily affected by the weather and natural disasters. For example, herders experienced the harshest zud during the last winter of 2009-2010. Animal deaths were estimated to be more than 8 million heads, representing about 20 percent of the total number of animals counted in the beginning of 2009. It has severely affected the livelihood of herders and about 8.7 thousand herder households were left without any animals. The zud is a multiple natural disaster consisting of a summer drought resulting in inadequate pasture and production of hay, followed by a very heavy winter with deep snow, strong winds and lower-than-normal temperatures. Since early January 2010, there has been heavy and continuous snowfall, blizzards and a sharp fall in daily temperatures–dropping below -40 ^{0}C in 19 of Mongolia's 21 aimags (provinces). The zud brought severe consequences such as high meat prices, deterioration of rural livelihoods, increased poverty levels and migration to urban areas, and worsening of food security among vulnerable groups of the population.

Apparently, climate change will exacerbate the negative impact of natural disasters such as zud, heavy snow, droughts and other disasters on traditional livestock.

2.11.2 Arable farming

Before 1990, the agriculture sector's policy objective was to fully meet domestic demand for crops, potatoes, vegetables and livestock fodder and provide an adequate supply for winter as well as for export. The annual production was 700-880 thousand metric tons of crops, 100-120 thousand metric tons of potatoes and 500-700 thousand metric tons of livestock fodder. During 1990-1996 the Government policy followed the principle that the "ownership of the property insures better operation", and land cultivation was transformed through joint stock companies in partnership with state ownership. As a result, crop production dropped significantly due to reduced direct and indirect support from the Government and lack of management skills and capacity to run the new businesses within the concept of a market economy. During this period, the country could meet only 54.4 percent of the demands for grain, 72.8 percent of vegetables and 79.1 percent of potato demands. In 2007, the government launched the Third Agricultural Campaign- 'ATAR-3' in order to improve agricultural production. As a result, domestic production was able supply 83.8 percent of wheat, 114 percent of potato and 60 percent of vegetable consumption in 2008.

In the case of Mongolia, its fragile ecosystems, pastoral animal husbandry and rainfed agriculture are extremely sensitive to climate change.

One of the challenges facing Mongolia is a high reliance of food imports. In fact, the country imports most of the food requirements, such as flour, rice, potato, vegetables, fruits and other produce from foreign and neighboring countries, with the exception of meat and meat products. This fact reveals the extent of food insecurity or reliance on other countries.

Commonly, food security consists of food availability, food safety and nutrition factors. Food safety and quality is becoming more challenged because of a lack of control of imported food reaching the customers and the poor condition of transportation, storage and selling. Malnutrition (iron deficiency and anemia, iodine deficiency disorders, vitamin A and D deficiencies and zinc deficiency) are commonly found among vulnerable groups of children and women etc.

Table 2. 7. Agriculture and livestock indicators

Indicator	1990	1995	2000	2005	2006	2007	2008	2009
Livestock number, thousand head	25856.9	28572.3	30227.5	30398.8	34802.9	40263.8	42195.8	44023.9
Crop farming area, thousand ha	1140	372,6	209,3	174,7	142,8	202.7	192.5	282.2
Cereal harvest, thousand metric tons	718.3	261.4	-	75.5	138.6	114.8	212.9	391.7

Source: National Statistical year book, 2009

2.12 Transportation and communication

Because of the low density of population and the vastness of the territory, transportation and communication are considered essential in the socio economic situation of the country. Since the country shifted to a market economy, state transportation enterprises have been privatized and private companies have been playing a vital role in the transportation sector. As of today, passengers and freight transportation between cities and taxi services are carried out by private enterprises.

So far, liquid fuels are imported only from Russia and China. The liquid fuels consumption of transport sector is shown in Table 2.8

Table 2. 8. The liquid fuels consumption of transport sector, thous. Metric tons

Fuel type	1990	1995	2000	2005	2006	2007	2008	2009
Diesel oil	364.3	113.2	161.5	270.9	310.0	346.2	366.0	323.0
Gasoline	341.2	189.2	233.6	254.8	280.4	387.6	428.3	416.2
Jet fuel	3.6	20.4	18.4	18.9	41.4	39.2	31.6	14.7

Source: Mongolian Statistical Yearbook, 2009

In 2009, the freight turnover reached 9,016.5 mln. metric tons.km, while passenger turnover become 3,178.5 mln.pass.km. The overall volume of freight transported and the number of passengers have increased respectively by 3.5 percent and 0.3 percent in 2009, compared to the previous year.

The Mongolian railway is now executing 92.6 percent of national freight turnover, with 1,815 km of railways connecting Russia and China. The Ulaanbaatar Railway plays a critical role in linking the country with Europe and the East, and South East Asia through our two neighboring countries, Russia and China.

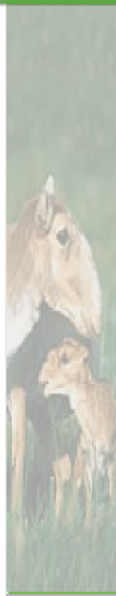
According to the State vehicle inspection results of 2009, the total number of vehicles reached 224.1 thousand, of which about 153.9 thousand are sedans, 47.3 thousand trucks, 16.1 thousand buses, 4.7 thousand special equipped vehicles and 2.0 thousand are tank cars.

As from the end of 2009, the total length of road that has been improved has reached 6,692.3 km, and 2,824.0 km have been paved,. Therefore, improved roads have been extended by 147.3 km, and paved roads have been extended by 152.8 km, in comparison with the previous year.

As in the MDGs based CNDS, the Government is proposing to greatly expand rail and road regional and national networks in the near future and is seeking opportunities to develop sea and water transportation.

Digital information technology has been effectively and rapidly introduced into Mongolia since 1992. Mongolia takes a highly placed in the international arena in terms of the number of computers and mobile phones per person. The telecommunications network of the country was renovated and installed according to international standards. During recent years the number of cellular mobile phone subscribers has considerably increased. There were 1,745.9 thous. users in 2008. In 2009, this figure has grown up to 2,208.7 thous. users and rose by 26.5 percent. Consequently, the number of telephone lines has decreased. The first cable television set was established in 1996, and by 2009, over 112.9 thous. users were using cable television sets.

Information technology is being introduced in Mongolia very rapidly, and the total speed of the outgoing line has been significantly improved. Mongolia has made considerable progress in developing its information and communications infrastructure in recent years, particularly in the area of availability of modern basic service and cellular services. The Internet service market is fully liberalized and Internet users have increased dramatically.



2.13 Waste

Recent increases in the urban population and an improving economy have amplified the need for municipal solid waste management in Mongolia. The total generation of waste in Ulaanbaatar was estimated at 552.8 metric tons per day. Of that total, it is believed that 321.6 metric tons of that waste (58.2 percent of the total amount) ends up in final disposal sites, while 21.4 percent of that waste is dumped illegally along the main streets in the suburbs or in open spaces. The total solid waste produced by a mainly urban population is presented in Table 2.9

The recycling rate was calculated at 3.7 percent. More than half of it is collected and recovered by waste pickers either on the streets or at the disposal sites. It is expected that waste amounts will increase as the population grows and the economy expands. All waste collected in Ulaanbaatar is disposed of in three landfills (Dari ekhiin ovoo, Ulaanchuluut, Moringiin davaa) without any further processing. The lack of management of municipal waste is emerging as a problem of prime importance.

Currently, water is not being recycled and about 70 percent of urban sewage is treated. Domestic waste water in rural areas is mostly discharged into the environment without any treatment. In Mongolia, most domestic and commercial wastewater is handled by sewer systems with aerobic treatment 30 percent of the waste water is treated through a centralized system, 70 percent from a non centralized system.

Every day, Ulaanbaatar city consumes about 150-170 thousand cubic m of water[5]. Water consumption disparities between apartment and ger households remain a great challenge for Ulaanbaatar. House holds in ger areas use 5-10 l of water per person, which is much less than the standard.

Table 2. 9. Total solid waste generated of Mongolia by urban population.

Year	Solid waste, thousand Metric tons	Industrial waste water, million Metric tons
2001	170.7	62.55
2002	173.5	63.90
2003	179.0	65.70
2004	183.0	67.50
2005	188.6	69.30
2006	193.0	71.10
2007	197.2	72.60
2008	203.5	74.2
2009	208.6	76.0

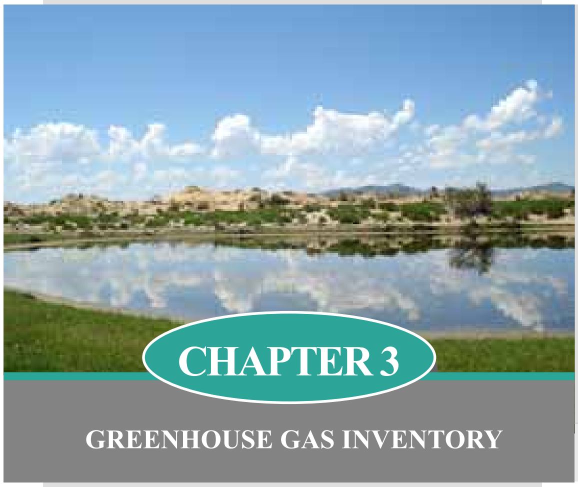
Source: B.Namkhainyam, 2010

There are 4 small and 1 big water treatment plants in Ulaanbaatar city that have a treatment capacity of 230 thousand metric tons for industrial and domestic waste water[6]. However, due to outdated facilities and lack of maintenance and operation, the sewage treatment plans and the collection system is frequently malfunctioning.

[5] Urban water vulnerability to climate change in Mongolia, 2010
[6] Solid Waste Management, JICA of Japan, 2007

CHAPTER 3

GREENHOUSE GAS INVENTORY



This chapter summarizes data on Mongolia's anthropogenic emissions by sources and removals by sinks of main greenhouse gases (GHG): carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6) as well as the indirect gases CO, NO_X, NMVOC and SO_2. It also shows the annual inventories for the period 1990-2006 and trend analyses during this period on the emissions and removals of the greenhouse gases. The national inventory comprises the emissions resulting from Energy, Industry, Agriculture, Land Use Change and Forestry and Waste sectors according to the IPCC 1996 revised Guidelines.

Although Mongolia is a developing country and not assigned greenhouse gas emission reduction targets, Mongolia has made great efforts in preparing an inventory of greenhouse gas emissions and removals along with efforts to reduce its own emissions of greenhouse gases.

3.1 Greenhouse gas inventory in 2006

In accordance with the revised 1996 edition of the IPCC Guidelines, Tier 1 methodology was used in compiling the national greenhouse gas emissions inventory. For the agriculture sector, which requires more detailed inventory, emissions from enteric fermentation in livestock were estimated using the Tier 2 methodology.

In 2006, Mongolia's net greenhouse gas emissions (source, sink) were 15,628 Gg in CO_2-eq. and showed a 7.6 percent increase from 14,519 Gg in 2005, as a result of the increase in energy consumption. The energy sector, including stationary energy, transport and fugitive emissions, was the largest source of GHG emissions, comprising 65.4 percent (10,220 Gg) of emissions. The second largest source of GHG emissions was the agriculture sector (41.4%). For Land Use Change and the Forestry sector, in 2006 the total CO_2 removals amounted to more than the total CO_2 emissions of 2,083 (-13.3%) Gg due to an increase in the area of abandoned crop lands and a reduction of newly cultivated land. Other relatively minor sources currently include emissions from industrial processes (5.6 percent) and the waste sector (0.9 percent) (Figure 3.1).

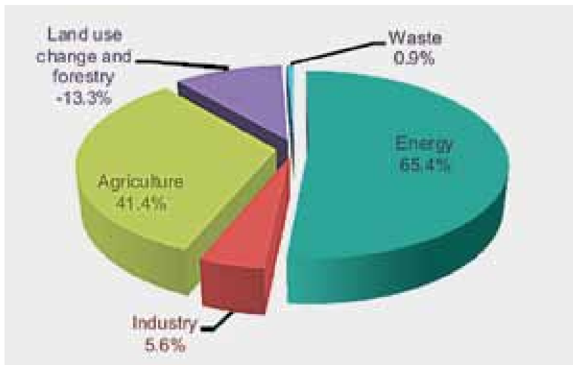


Figure 3.1. Total greenhouse gas emissions (sources) by sectors in 2006

Carbon dioxide is the most significant source of greenhouse gases in Mongolia's inventory with a share of 50.4 percent (7,874 Gg including removals) of the net CO_2-eq emissions in 2006, followed by methane, which comprises 41.8 percent (6,529 Gg). The remaining gases (N_2O, HFCs) make up 7.8 percent of Mongolia's GHG Emissions (Figure 3.2). GHG emissions in 2006 are summarized in Table 3.1.

Table 3. 1. Summary of greenhouse gas emissions in 2006

Greenhouse gas source and sink	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs	PFCs	SF_6	Net emissions/ removals
	Gg							Gg CO_2 -eq
Total greenhouse gas emissions and removals	11,113.54	-3,239.87	310.90	1.48	0.59	0.00	0.00	15,628
1. Energy	**9,831.10**	**0.00**	**15.40**	**0.21**				**10,220**
A. Fuel combustion (Sectoral)	9,831.10		8.24	0.21				10,069
• Energy industries	6,366.77		0.07	0.10				6,399
• Manufacturing and construction	356.92		0.03	0.00				356
• Transport	1,874.01		0.32	0.02				1,887
• Commercial, residential & agriculture	989.10		7.82	0.09				1,181
• Others	244.30		0.00	0.00				244
B. Fugitive emissions from fuels	0.00		7.16	0.00				150
• Coal	0.00		7.16	0.00				150
• Oil and natural gas	0.00		0.00	0.00				0
2. Industrial processes	**125.15**	**0.00**	**0.00**	**0.00**	**0.59**	**0.00**	**0.00**	**892**
A. Mineral products	125.15							125
B. Chemical industry	0.00		0.00	0.00	NO	NO	NO	0
C. Metal production	0.00		0.00	0.00		NO	NO	0
D. Other production	0.00							0
E. Production of HFCs, PFCs, SF_6					0.00	0.00	0.00	0
F. Consumption of HFCs, PFCs, SF_6					0.59	0.00	0.00	767
3. Solvent and other product use	**NE**			**NE**				**0**
4. Agriculture	**NE**	**NE**	**288.95**	**1.27**				**6462**
A. Enteric fermentation			280.72					5895
B. Manure management			8.19	0.00				172
C. Rice cultivation			0.00					0
D. Agricultural soils	NE	NE		1.27				393.7
E. Field burning of agricultural residues	NE	NE	0.04	0.00				0.84
5. Land-use change and forestry	**1,157.29**	**-3,239.87**						**-2,083**
A. Changes in forest and other woody biomass stocks	963.96	0.00						964
B. Forest and grassland conversion	193.33	0.00						193
C. Abandonment of managed land	0.00	-3,239.87						-3240
D. CO_2 emissions & removals from soil	NE	NE						0
E. Others	NE	NE	NE	NE				0
6. Waste			**6.55**	**0.0**				**138**
A. Solid waste disposal on land	NE		2.43					51
B. Wastewater handling			4.12	0.0				87
C. Waste incineration	NE		NE	NE				0
D. Others	NO		NO	NO	NO	NO	NO	0

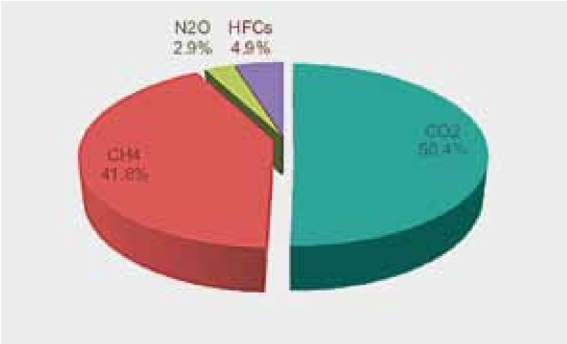


Figure 3.2. Net Greenhouse gas emissions by gases in 2006

3.1.1 Energy

The inventory from energy is comprised of the emissions resulting from fuel combustion as well as fugitive emissions from the extraction of solid fuels. Apparently, the energy sector is the most significant source of carbon dioxide emissions in Mongolia. In 2006, the greenhouse gas emissions from fuel combustion totaled 10,069 Gg CO_2-eq, a 6.0 percent increase from the previous year. The increase is largely attributable to transport followed by manufacturing and construction and the commercial and residential sector. As for GHG emissions from fuel combustion in 2006 by source, energy industries accounted for 64 percent, manufacturing & construction 3 percent, the commercial and residential 12 percent, transport 19 percent and others 2 percent (Figure 3.3).

The fugitive emissions from coal mining in 2006 totaled 150 Gg CO_2-eq, a 7.1 percent increase from the previous year, caused by the increase of coal mining activities.

In 2006, the total emissions of GHG from the energy sector were estimated at 10,220 Gg CO_2-eq, of which the CO_2, CH_4 and N_2O emissions accounted for 96.2 percent, 3.2 percent, and 0.6 percent respectively. This shows that the value of the methane and the nitrous oxide emissions are very low and that the predominant emissions are carbon dioxide emissions in the energy sector. In addition to the main GHGs mentioned above, many energy-related activities generate emissions of indirect GHGs. In 2006, about 44 Gg of NO_x, 226.58 Gg of CO, and 34.74 Gg of MNVOC were emitted from fuel combustion activities.

3.1.2 Industrial processes

The GHG emissions from industrial processes totaled 892 Gg CO_2-eq in 2006, a 3.5 percent increase from the previous year. The growth rate indicates an increase in potential consumption of HFCs in refrigeration and air conditioning. Figure 3.4 shows GHG emissions from Industrial Processes by Source in 2006.

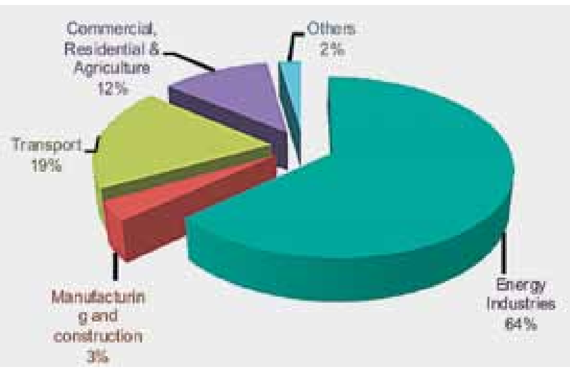


Figure 3. 3. Greenhouse gas emissions from fuel combustion by sector in 2006

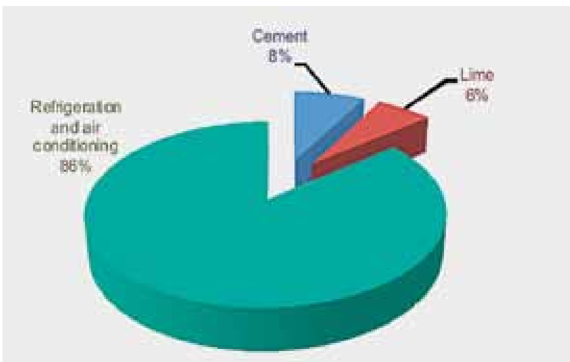


Figure 3. 4. Greenhouse gas emissions from industrial processes by source in 2006

3.1.3 Agriculture

The agriculture sector produced 6,462 Gg CO_2-eq of GHG, a 10.3% increase from the previous year, in line with the increase in the livestock population. Enteric fermentation and manure management from livestock emitted 288.9 Gg of methane, a 12.4 percent increase from the previous year. The amount of nitrous oxide from agriculture was very little and amounted to 394 Gg CO_2-eq. Figure 3.5 shows GHG emissions from agriculture by source in 2006.

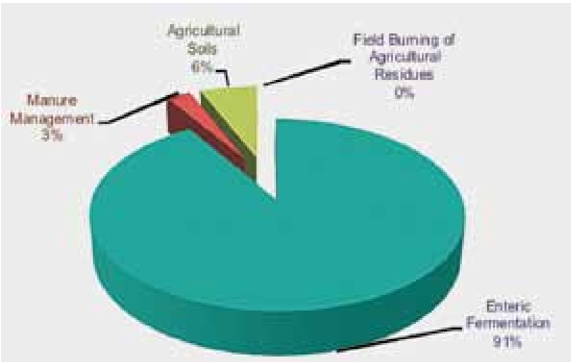


Figure 3. 5. Greenhouse gas emissions from agriculture by source in 2006

3.1.4 Land-use change and forestry

Carbon dioxide emissions from changes in forest and other woody biomass stocks and forest and grassland conversion were 964 Gg and 193 Gg respectively in 2006. The total removals from the abandonment of managed land were 3240 Gg. Finally, it shows that 2,083 Gg of carbon dioxide has been absorbed in land use and the forestry sector. The net removals from the land-use change and forestry increased by about 5.9 percent from the previous year.

3.1.5 Waste management

The waste sector produced 6.55 Gg of methane, a 2.7 percent increase from the previous year, caused by an increase of municipal solid waste in disposal sites and domestic, commercial and industrial waste water. Also, in 2006, methane from landfills accounted for 2.43 Gg, methane and nitrous oxide from domestic and commercial sewage for 1.18 Gg, and methane from industrial wastewater 2.28 Gg. Figure 3.6 shows the share of GHG emissions from agriculture by source in 2006.

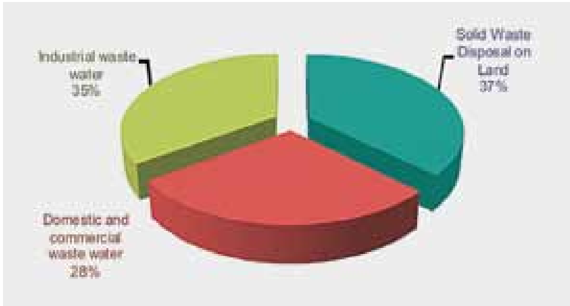


Figure 3. 6. Greenhouse gas emissions from waste by source in 2006

3.2 Trends of greenhouse gas emissions (1990-2006)

The total (source) and net (source and sink) GHG emissions in CO_2-eq in Mongolia for the period between 1990-2006 are presented in Figure 3.7.

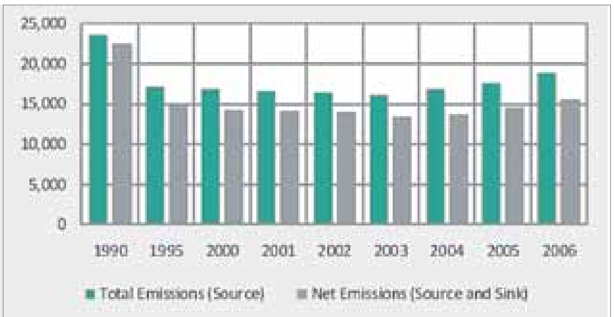


Figure 3. 7. Trends of greenhouse gas emissions (1990-2006) in Gg CO_2-eq

The trend of net GHG emissions between 1990-2006 indicates an average annual reduction of 2.3

percent from 22535 Gg CO_2-eq in 1990 to 15,628 Gg CO_2-eq in 2006 with per capita emissions reducing by 3.6 percent every year since 1990, recording 6.02 ton CO_2-eq in 2006. The reduction of net GHG emissions is mostly due to the socio-economic slowdown during the transition period from a centrally planned to a free market economy. However, starting from 1995, the net GHG emissions stabilized and from 2000 to 2006 the net GHG emissions increased with an average annual increase of 1.6 percent (Table 3.2 and Table 3.3)

While the total amount of GHG emissions in Mongolia is comparatively low, the per capita rate of GHG emissions is relatively high compared to

Table 3. 2. Major indicators of total greenhouse gas emissions (1990-2006)

Characteristic	1990	1995	2000	2001	2002	2003	2004	2005	2006
Net emissions (source and sink), Gg CO_2-eq	22,535	15,044	14,247	14,155	13,944	13,332	13,755	14,519	15,628
Population, thousand persons	2103	2249	2407	2446	2475	2504	2533	2562	2595
Per capita GHG emissions, tons CO_2-eq/person	10.72	6.69	5.92	5.79	5.63	5.32	5.43	5.67	6.02
GDP*, billion 2000 US$ using exchange rate	1.1	1.0	1.0	1	1.0	1.1	1.4	1.5	1.6
Per GDP CO_2 emissions, kg CO_2-eq/US$	20.49	15.04	14.25	14.16	13.94	12.12	9.83	9.68	9.77

** IEA Statistics. CO_2 emissions from fuel combustion, 2009*

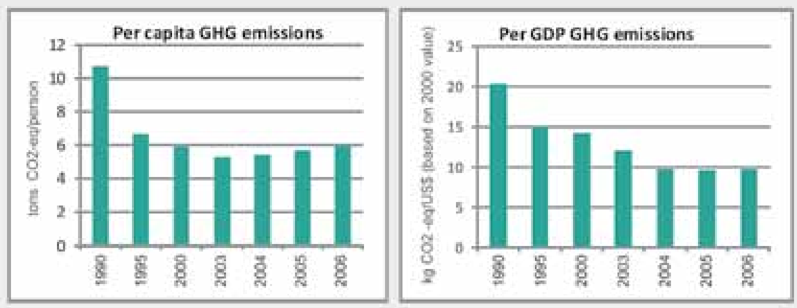


Figure 3. 8. Major indicators of Total greenhouse gas emissions (1990-2006)

Table 3. 3. Greenhouse gas emissions by source (1990-2006), Gg CO_2-eq

Sector	1990	1995	2000	2002	2004	2005	2006	Average annual growth rate, %		
								1990-2000	2000-2006	1990-2006
Total emissions (source)	23,645	17,205	16,896	16,405	16,910	17,582	18,868	-3.3	1.9	-1.4
Energy	12,529	8,710	8,865	9,418	9,247	9,635	10,220	-3.4	2.4	-1.3
Industrial processes	326	166	276	451	972	862	892	-1.7	21.6	6.5
Agriculture	7,695	6,964	6,748	5,338	5,518	5,854	6,462	-1.3	-0.8	-1.1
Land-use change and forestry	1,887	-906	-1,762	-1,386	-2,112	-1,966	-2,083	-	2.8	-
Waste	96	110	120	124	131	134	138	2.3	2.4	2.3
Net emissions (source and sink)	22,535	15,044	14,247	13,944	13,755	14,519	15,628	-4.5	1.6	-2.3

other developing countries, because of the cold continental climate and the long heating season, the use of fossil fuels for energy and the low efficiency of fuel and energy. The estimated amount of net national GHG emissions in 2006 is 15.6 million tons. (Table 3.2).

3.2.1 Trend of greenhouse gas emissions by sources (1990-2006)

Greenhouse gas emissions by sources are shown in Table 3.3.

Energy

GHG emissions reduced by 1.3 percent per year from 12,529 Gg CO_2-eq in 1990 to 10,220 Gg CO_2-eq in 2006 from fuel combustion and fugitive emissions in the energy sector. However, the significant reduction of emissions was only up to 2000, with an annual decrease of 3.4 percent. The emissions increased by 2.4 percent per year from 2000 to 2006 (Table 3.3). Over the period of 1990-1995, carbon dioxide emissions from energy transformation reduced by an annual 3.2 percent.

CO_2 emissions from the combustion of solid, liquid and biomass fuels for the period 1990–2006 are presented in Figure 3.9. The figure shows that most of the solid fuel or coal (60–80 percent) was used in the energy industry for the generation of electricity and heat in power plants and for heating boilers during the period 1990–2006.

CO_2 emissions from liquid fuels mainly originate from the combustion of imported gasoline, diesel oil, residual fuel oil, jet kerosene, and LPG. In 1990, CO_2 emissions from liquid fuels were 2,542 Gg and reduced by 16.7 percent per year to 1020 Gg in 1995 and after that started to increase by 5.9 percent per year to 1918 Gg in 2006.

The sharp decrease in CO_2 emissions from fuel combustion observed between 1990 and 1995 was mostly due to the socio-economic slowdown during the period of economic transition.

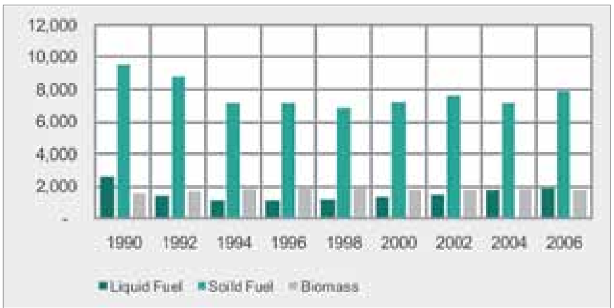


Figure 3. 9. Trend of CO_2 emissions in energy sector by fuel type, Gg CO_2-eq

The sources of methane emissions in the energy sector are fuel combustion activities and fugitive emissions from coal mining. The main sources of N_2O emissions are fuel combustion activities in the energy industry and the residential sector. The values of CH_4 and N_2O emissions from the energy sector are relatively low. In 1990, CH_4 emissions from the energy sector were 18.38 Gg and decreased to 11.64 Gg in 1995. Since 1996, CH_4 emissions have been increasing and reached 15.39 Gg in 2006. Fugitive emissions from coal mining accounted for 50 percent in 1990, 42 percent in 2000, and 46 percent in 2006 of CH_4 emissions from the energy sector. The N_2O emissions from the energy sector are very low and were about 0.19 Gg during the period 1995–2006.

Greenhouse gas emissions from the energy sector were 12,529 Gg in 1990, reducing to 8,710 Gg in 1995 and then increased to 10,220 Gg in 2006. This indicates that the emissions in 1995 decreased by 30 percent compared to the figure in 1990 and the emissions in 2006 increased by 14.7 percent compared to the figure in 1995. The carbon dioxide emissions are predominant in the total greenhouse gas emissions in the energy sector during the period 1990-2006 (Figure 3.10).

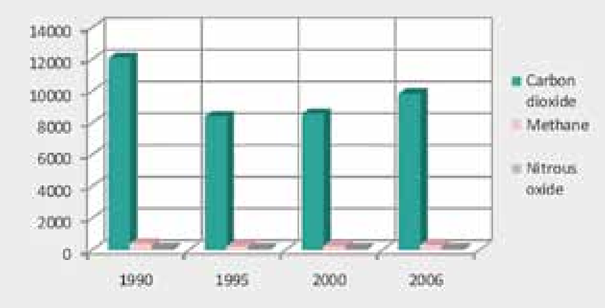


Figure 3. 10. Trend of greenhouse gas emissions in energy sector by gases (1990-2006), Gg CO_2-eq

In addition to the main GHG, many energy-related activities generate emissions of indirect GHG. The trends of emissions of NO_x, CO, and non-methane volatile organic compounds (NMVOC) from energy-related activities from 1990 to 2006 are presented in Figure 3.11.

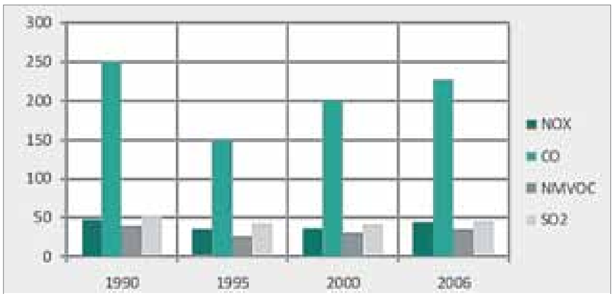


Figure 3. 11. Trend of NO_X, CO, NMVOC and SO_2 emissions from energy sector, Gg CO_2-eq

Industrial processes

GHG emissions from industrial processes include CO_2 and SO_2 emissions from cement manufacturing, CO_2 emissions from lime manufacturing, emissions produced by consumption of HFCs, PFCs and SF6 and NMVOC emissions from food and drink production. Other industries such as iron and steel are too small to calculate greenhouse gas emissions.

Emissions from industrial processes have increased since 1990 with an average annual growth of 6.5 percent due to the increased consumption of HFCs (Table 3.3). However, the CO_2 emissions from cement production have been reduced by 3 times from 220 Gg in 1990 to 70 Gg in 2006 with an annual average of 6.9 percent. The lime production is reduced by an average annual of 3.7 percent from 94 Gg in 1990 to 51 Gg in 2006.

In the case of Mongolia, potential product halocarbon emissions (HFCs) contained in various imported products such as refrigeration and air conditioning was calculated using Tier 1b methodology. The results of potential product halocarbon emissions contained in refrigeration and air conditioning show that most potential product halocarbon emissions are in stationary refrigeration. But statistical information about stationary refrigeration is not available for the period of 1990-1998. In 2000, the potential product halocarbon emissions from stationary refrigeration were 82.8 tons and increased by 37.5 percent per year to 561 tons in 2006.

Non-methane volatile organic compounds (NMVOCs) are produced during the production of alcoholic beverages, bread making and other food products. The NMVOC emissions from food and drink production in 1990 were 1205 Gg and reduced up to 806.5 Gg in 2006.

Agriculture

Methane and nitrous oxide emissions from agriculture are directly affected by the number of livestock and the cultivation of soils. Consequently, methane emissions from domestic livestock depend on the livestock type, its weight, productivity and the quality of forage. However, most Mongolian livestock are indigenous breeds that graze throughout the year on natural pastures with low productivity and are physically small compared to other breeds of animals in the world. In addition, the climate in Mongolia impacts the type of forage and the amount ingested by livestock annually and therefore emission factors for enteric fermentation have been developed for Mongolia-specific conditions using

Tier 2 by the Working Group on the GHG Inventory. Default emission factors are used for calculating methane emissions from manure management.

The number of livestock increased from 25.6 million heads in 1990 to 33.6 million heads in 1999 and then reduced again to 23.9 million heads in 2002 because of natural disasters such as zud and droughts. Then the number of livestock again increased to 34.8 million heads in 2006. As result, methane emissions from domestic livestock increased by 2.3 percent per year from 271 Gg from 1990 to 333 Gg in 1999 and then reduced to 289 Gg until 2006 (Figure 3.12).

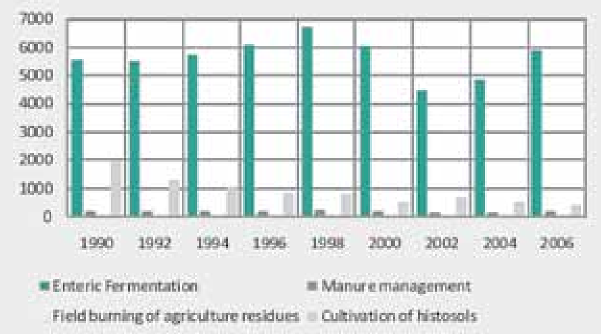


Figure 3. 12. Trend of methane emissions from agriculture, Gg CO_2-eq

Agriculture residues were calculated for wheat and potatoes as these are the most the common crops in Mongolia. However, greenhouse gas emissions from field burning of agriculture residues were very small compared to other emissions from agriculture. Emissions of N_2O from agricultural soils are primarily due to the microbial processes of nitrification and denitrification in soil. Areas of cultivated soils showed a reduction from 787 thousand hectares in 1990 to 162 thousand hectares in 2006. As result, the emissions of N_2O from the cultivation of soils were reduced by 9.5 percent per year from 6.23 Gg in 1990 to 1.27 Gg in 2006.

Total GHG emissions from the agriculture sector have reduced by 1.6 percent per year since 1990 to 6,462 Gg CO_2-eq in 2006 mostly due to the reduced land area cultivated.

Land-Use Change and Forestry

GHG emissions from land-use change and forestry include emissions from: a) changes in forest and other woody biomass stocks, b) forest and grassland conversion to cultivated land, and c) abandonment of managed lands.

The calculation of GHG emissions from changes in forestry and other woody biomass stocks shows that the annual removals of CO_2 from biomass increment and forest plantation are much less than the CO_2 emissions from annual biomass consumption from stocks. During the period of 1990 to 2000, the net emissions from change in forest and other woody biomass stocks reduced along with the reduction of the annual biomass consumption from stocks. However, the biomass increment and forest plantation also reduced for this period. As a result, the CO_2 emissions from change in forest and other woody biomass stocks decreased by 4.7 percent per year from 2,072 Gg in 1990 to 964 Gg in 2006.

Emissions from forest and grassland conversion to cultivated land include CO_2 from grassland conversion and land use for industrial mining activities. The CO_2 emissions from grassland conversion to cultivated land were reduced by 9.3 percent per year from 926 Gg in 1990 to 193 Gg in 2006.

Massive areas of cultivated land were abandoned during the transition period from a centrally planned to a liberalized market economy and the abandoned lands have been reverting back to grasslands. As result, the CO_2 uptakes from abandoned of managed lands, were 1110.9 Gg in 1990 and increased to 3239.9 Gg in 2006. The total emissions from changes in land use and forestry were decreasing during the period from 1990 to 1993 and the balance became negative in 1994 due to the increase in abandoned lands. Total emissions were reduced rapidly from 1,887.4 Gg in 1990 to 74.42 Gg in 1993 and the removals dominated from 1994. Subsequently, the CO_2 removals increased from 538.8 Gg in 1994 to 2,082.6 Gg in 2006 due to an increase in the amount of abandoned lands and a reduction in the rate of conversion to cultivated land.

Waste management

GHG emissions from waste include methane emitted from solid waste disposal sites, from domestic and commercial wastewater handling and industrial waste water.

The total CH_4 emissions from waste were estimated at 4.59 Gg in 1990 and this amount increased by 2.3 percent per year to 6.55 Gg in 2006. During the period of estimation, about 38 percent of CH_4 emissions were released from solid waste disposal sites and 62 percent from waste water treatment. In 2006, about 2.43 Gg of CH_4 were emitted from solid waste disposal sites and 4.12 Gg of CH_4 from waste water treatment. About 55 percent of wastewater emissions were produced by industrial waste water treatment facilities. The trend for emissions shows that the annual emissions of CH_4 from solid waste disposal sites and waste water treatment increased continuously year by year (Figure 3.13).

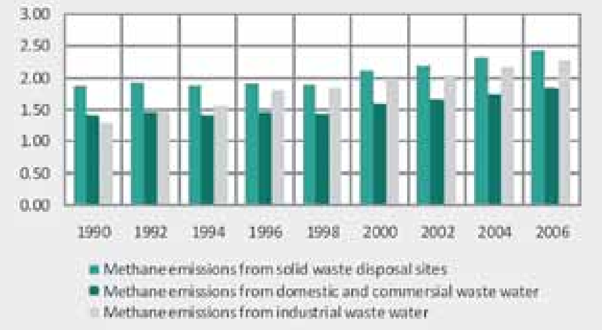


Figure 3. 13. Trend of methane emissions from waste, Gg

GHG emissions from forest fires

Mongolia is one of the most steppe and forest fire prone countries in Asia, due to its low humidity, dry climate and strong winds in the driest seasons. The probability of forest and steppe fires drastically rises in the dry spring (from March to May) and autumn (from September to November) periods. The GHG emissions from forest fires are calculated and shown in Table 3.4.

The highest numbers of wild fires were in 1996 and 1997. In 1996, 417 fires were registered, af-

Table 3. 4. GHG emissions from forest fires

Year	Burned forest area, thousand, ha	GHG emissions, Gg				
		CO_2	CH_4	CO	N_2O	NO
1994	180.00	3,033.00	48.60	424.80	0.34	11.00
1995	10.00	168.50	2.70	23.60	0.02	0.70
1996	2,400.00	40,440.00	648.00	5,664.00	4.30	158.40
1997	2,700.00	45,495.00	729.00	6,372.00	4.86	178.20
1998	700.00	11,795.00	189.00	1,652.00	1.25	42.60
1999	125.00	2,106.00	33.70	295.00	0.22	8.20
2000	700.00	11,795.00	189.00	152.00	1.26	42.60
2001	87.00	1,465.90	23.50	205.30	0.15	5.70
2002	582.00	9,806.70	157.10	1,373.50	1.04	38.40
2003	100.00	1,685.00	27.00	236.00	0.18	6.60
2004	120.00	2,022.00	32.40	283.20	0.21	7.90
2005	31.00	5,223.50	83.70	731.60	0.55	20.40
2006	176.00	2,965.60	47.50	415.30	0.31	11.60

fecting a forest area of 2.4 million ha and CO_2 and CO emissions from these fires were calculated as 40,440.00 Gg and 5,664.00 Gg respectively.

In 1997, 239 fires occurred in the territories of 14 aimags, which affected a forest area of 2.71 million ha. CO_2, CO emissions from these fires were calculated as 45,495.00 Gg and 6,372.00 Gg respectively.

The GHG emissions from forest fires are presented for information purposes only and are not included in the total emissions inventory.

3.2.2 Trend of greenhouse gas emissions by gases (1990-2006)

The net GHG emissions by gases in Mongolia for the period 1990 to 2006 are presented in Figure 3.14. The calculation shows that Mongolia's net GHG emissions were 22,535 Gg of CO_2-eq in 1990, while the net GHG emissions were reduced to 15,044 Gg of CO_2-eq in 1995. As noted above, the reduction of net GHG emissions is mostly due to the socio-economic downturn during the transition period from a centralized to a market economy.

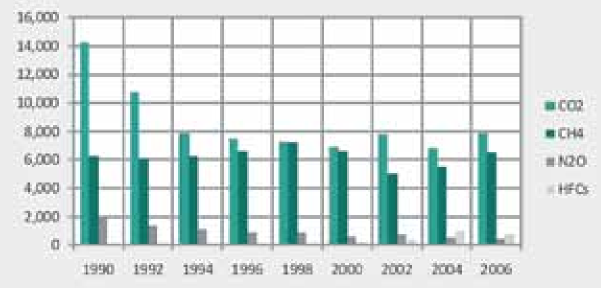


Figure 3. 14. Trend of net greenhouse gas emissions by gases, Gg CO_2-eq

Carbon Dioxide

The total carbon dioxide emissions reduced by 4.7 percent per year from 15,384 Gg in 1990 to 9,527 Gg in 2000 because of the economic decline during the transition period. However, the total carbon dioxide emissions have increased since 2000 by an annual 2.6 percent to 11,114 Gg in 2006.

CO_2 emissions from fuel combustion accounted for 88.5 percent of the total carbon dioxide emissions in 2006. Its annual growth rate was 2.3 percent accounting for 8,561 Gg and 9,831 Gg in 2000 and 2006, respectively. Carbon dioxide emissions from fuel combustion in power and heat generation and the transportation sectors are relatively higher than other sectors. The high emissions of carbon dioxide from power generation are largely attributable to the coal-fired power and heat generating facilities. Power and heat generation accounted for about 65 percent of the carbon dioxide emissions from fuel combustion in 2006, whereas transportation accounted for 19 percent, industrial processes 4 percent, residential, commercial and agriculture 10 percent and others, including public use contributing to the rest (Figure 3.15).

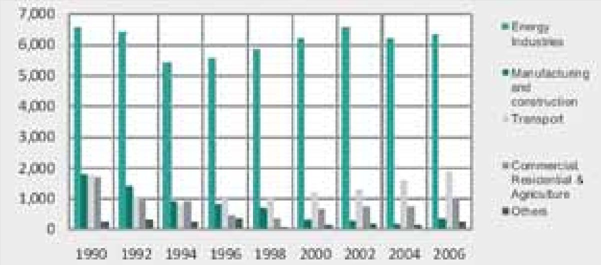


Figure 3. 15. Trend of carbon dioxide emissions from fuel combustion by source, Gg

Meanwhile, the net removals of carbon dioxide by land-use change and forestry rose by an annual 6.9 percent from 1,111 Gg in 1990 to 3,240 Gg in 2006, due to an increase in the amount of abandoned lands and a reduction in the rate of conversion to cultivated land.

Methane

The main source of methane emissions is agriculture, namely the livestock sector. Agriculture accounted for about 93 percent of the total methane emissions in 2006, whereas energy accounted for 5 percent and waste 2 percent. The trend of methane emissions shows that the total methane emissions increased by 1.8 percent per year from 297.35 Gg in 1990 to 347.83 Gg in 1999, due to the increase in the number of livestock mostly as result of livestock privatization. However, the total methane emissions have been reduced since 1999 to 239.65 Gg in 2002 due to the decrease in the number of livestock because of natural disasters (zud).

Subsequently, methane emissions have increased again by 6.7 percent per year since 2002 to 310.90 Gg in 2006 (Figure 3.16).

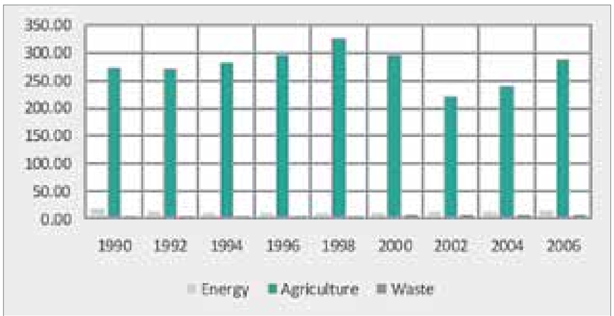


Figure 3. 16. Trend of methane emissions, Gg

Nitrous Oxide

The main source of the Nitrous Oxide emissions is agriculture, namely the cultivation of soils. Agriculture accounted for about 86 percent of the total Nitrous Oxide emissions in 2006, while energy accounted for 14 percent. The trend of total emissions of nitrous oxide shows that the Nitrous Oxide emissions reduced by 8.8 percent per year from 6.47 Gg in 1990 to 1.48 Gg in 2006 due to a reduction in areas of cultivated land (Figure 3.17).

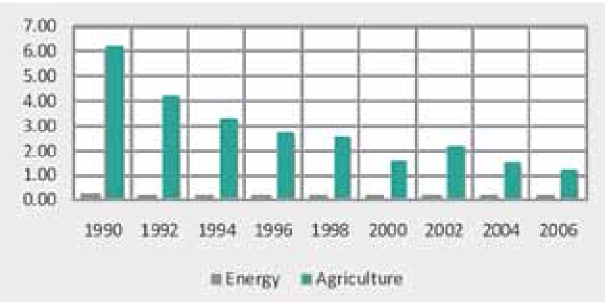


Figure 3. 17. Trend of nitrous oxide emissions, Gg

HFCs, PFCs, SFs greenhouse gases

In general, the potential product halocarbon emissions (HFCs) were calculated for various imported products such as refrigeration and air conditioning. According to the results, stationary refrigerations are the main source of potential product halocarbon emissions (HFCs). However, statistical information about stationary refrigeration during the period of 1990-1998 has been unavailable. The trend of potential product halocarbon emissions shows that the HFCs emissions increased by 25.6 percent per year from 0.15 Gg in 2000 to 0.59 Gg in 2006 due to refrigerators and vehicles with air conditioning (Figure 3.18).

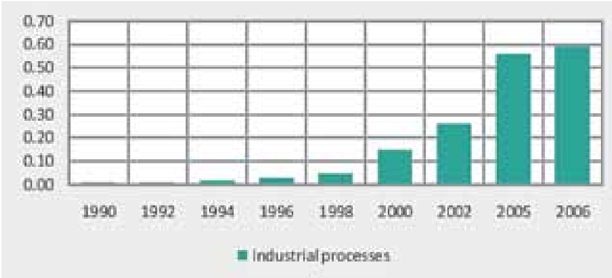


Figure 3. 18. Trend of potential product halocarbon emissions, Gg

3.2.3 Summary of greenhouse gas inventories for 1990-2006

Detailed GHG inventories for the period of 1990 to 2006 are presented in Table 3.5.

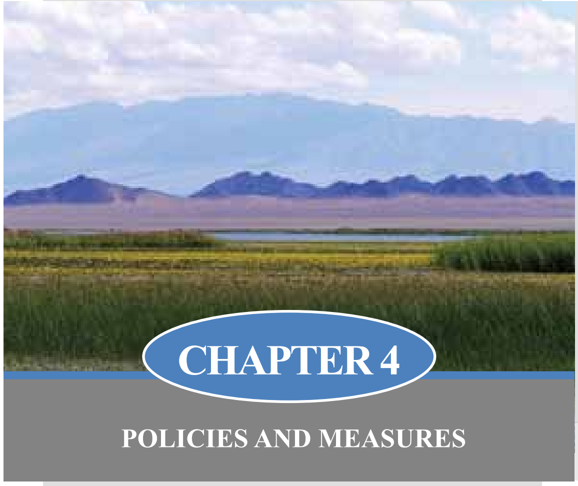
During the period the total emissions (source) and net emissions (source and sink) reduced respectively by 20.2 percent and 30.0 percent. The energy sector is the main source of GHG emissions. The share of GHG emissions from the energy sector in the total emissions was 53.1 percent in 1990 and increased to 54.2 percent in 2006. The second largest sector is the agriculture sector with a 32.6 percent share in the total emissions in 1990 and 34.3 percent in 2006.

Table 3. 5. Mongolia's greenhouse gas inventory (1990-2006), Gg CO_2-eq

Sector	1990	1995	2000	2001	2002	2003	2004	2005	2006
Total emissions (source)	23,645	17,205	16,896	16,607	16,405	16,137	16,910	17,582	18,868
Net emissions (source and sink)	22,535	15,044	14,247	14,155	13,944	13,332	13,755	14,519	15,628
1. Energy	**12,529**	**8,710**	**8,865**	**9,063**	**9,418**	**9,023**	**9,247**	**9,635**	**10,220**
A. Fuel combustion (sectoral)	12,334	8,611	8,768	8,966	9,313	8,916	9,118	9,495	10,069
• Energy industries	6,585	5,600	6,231	6,093	6,583	6,127	6,247	6,421	6,399
• Manufacturing and construction	1,809	1,017	334	309	283	282	198	220	356
• Transport	1,786	905	1,214	1,341	1,334	1,321	1,591	1,643	1,887
• Commercial, residential & agriculture	1,895	775	852	765	934	963	943	1,059	1,181
• Others	259	314	136	456	180	223	139	151	244
B. Fugitive emissions from fuels	195	99	98	97	105	107	128	140	150
• Coal	195	99	98	97	105	107	128	140	150
• Oil and natural gas	0	0	0	0	0	0	0	0	0
2. Industrial processes	**326**	**166**	**276**	**275**	**451**	**729**	**972**	**862**	**892**
A. Mineral products	313	101	79	61	112	119	58	130	125
B. Chemical industry	0	0	0	0	0	0	0	0	0
C. Metal production	0	0	0	0	0	0	0	0	0
D. Other production	0	0	0	0	0	0	0	0	0
E. Production of HFCs, PFCs, SF_6	0	0	0	0	0	0	0	0	0
F. Consumption of HFCs, PFCs, SF_6	13	67	197	214	338	610	914	732	767
3. Solvent and other product use									**0**
4. Agriculture	**7,695**	**6,964**	**6,748**	**6,040**	**5,338**	**5,240**	**5,518**	**5,854**	**6462**
A. Enteric fermentation	5,576	5,857	6,044	5,354	4,500	4,547	4,879	5,234	5895
B. Manure management	183	196	192	153	139	140	148	156	172
C. Rice cultivation	0	0	0	0	0	0	0	0	0
D. Agricultural soils	1,932	909	511	531	697	552	490	463	393.7
E. Field burning of agriculture residues	1	2	1	1	1	1	1	1	0.84
5. Land-use change and forestry	**1,887**	**-906**	**-1,762**	**-1,348**	**-1,386**	**-1,788**	**-2,112**	**-1,966**	**-2083**
A. Changes in forest and other woody biomass sticks	2,072	907	620	766	721	754	807	872	964
B. Forest and grassland conversion	926	347	267	339	354	263	236	225	193
C. Abandonment of managed land	-1,111	-2,160	-2,649	-2,453	-2,461	-2,806	-3,155	-3,063	-3240
D. CO_2 emissions & removals from soil	0	0	0	0	0	0	0	0	0
E. Others	0	0	0	0	0	0	0	0	0
6. Waste	**96**	**110**	**120**	**124**	**124**	**127**	**131**	**134**	**138**
A. Solid waste disposal on land	39	40	45	45	46	47	48	50	51
B. Wastewater handling	57	69	75	79	78	80	82	84	87
C. Waste incineration	0	0	0	0	0	0	0	0	0
D. Others	0	0	0	0	0	0	0	0	0

CHAPTER 4

POLICIES AND MEASURES



4.1 Institutional framework for implementation of international environmental legal instruments including UNFCCC

The Government of Mongolia has prioritized the establishment of a safe and healthy environment for its people while sustaining a long term, comprehensive policy on socio- economic development, with an emphasis on protecting the environment and natural resources inherited from our ancestors, as a result of their attention, over thousands of years, to maintaining the ecological balance. The historical background of this concern led to the establishment of the Ministry of Nature and Environment in 1987. Since that time, the Government of Mongolia has been taking continuous steps to deal with environmental and natural resource issues.

The Millennium Development Goals-based Comprehensive National Development Strategy (MDG-based CNDS) of Mongolia identifies the need “to create a sustainable environment for development by promoting capacities and measures on adaptation to climate change, halting imbalances in the country’s ecosystems and protecting them”. In addition, the MDG-based CNDS includes a Strategic Objective to promote capacity to adapt to climate change and desertification, and to reduce their negative impacts.

At the international level, Mongolia has joined 14 environment-related UN Conventions and Treaties, such as the UN Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD) and the Convention to Combat Desertification (CCD). The UN implementing and specialized agencies like UNDP, World Bank and UNEP support capacity strengthening of concerned national and local institutions to fulfill their commitments and provisions received under these conventions, to implement and monitor related policies, and to enhance coordination among them. The international organizations and partner countries also cooperate with local governments, civil society organizations, research organizations and the media for a wider outreach of environmental awareness campaigns.

The Parliament of Mongolia has passed several laws directed toward environmental protection including the State Policy on the Environment (1997), which forms the legal basis for the protection of the environment and Mongolia’s natural resources. In 1995, the Mongolian Environmental Action Plan was presented. The plan of action outlines the country’s priorities for environment and resource management. The Mongolian Action Programme for the 21st Century (MAP21), the National Action Plan to Combat Desertification, National Water Programme, the National Biodiversity Action Plan, the Action Programme to Protect Air, and the National Action Programme to Protect the Ozone Layer were developed. In particular, the MAP 21 includes concrete considerations and recommendations related to adaptation to climate change and the mitigation of GHGs emissions. The Law on Air (1995 and 2010) and the Law on Environmental Protection (1995, 2007) are the main legal instruments for the protection of air and environment.

In order to comply with the obligations and commitments under the UNFCCC as well as to address challenges relevant to climate change, Mongolia has developed its National Action Programme on

Climate Change and the programme was approved by the Government in 2000 and updated in 2010. The action programme includes the national policy and strategy to tackle the adverse impacts of climate change and to mitigate greenhouse gas emissions.

The Mongolia National Action Programme on Climate Change (NAPCC) approved in 2000 is aimed not only at meeting the UNFCCC obligations, but also at setting priorities for action and to integrate climate change concerns into other national and sectoral development plans and programmes. The NAPCC is based on the pre-feasibility studies on climate change impact and adaptation assessment, GHG inventories, and GHG mitigation analysis. This Action Programme includes a set of measures, actions and strategies that enable vulnerable sectors to adapt to potential climate change and to mitigate GHGs emissions. The starting point was that these measures should not adversely affect sustainable socio-economic development. Recently, the NAPCC has been updated, taking into account the latest global and national developments of policies, research and information on climate change.

The Government has established an inter-disciplinary and inter-sectoral National Climate Committee (NCC) led by the Minister for Nature, Environment and Tourism, to coordinate and guide national activities and measures aimed at adapting to climate change and mitigating GHG emissions. High level officials such as Deputy Ministers, State Secretaries and Director-Generals of the main Departments of all related ministries, agencies and other key officials are members of the NCC. The NCC approves the country's climate policies and programmes, evaluates projects and contributes to the guidance to these activities. The Climate Change Coordination Office (CCCO), under the supervision of the Chairman of the NCC, has been established by the Government, in order to carry out day to day activities related to the implementation of commitments and duties under the UNFCCC and Kyoto Protocol, to manage the nationwide activities, and to bring into action the integration of climate change related problems in various sectors.

4.2 Policies and measures on mitigation of GHG emissions

Mongolia has been developing and vigorously promoting various policies and measures to alleviate global warming at all levels of the economy. In particular, the strategies for sustainable development and reduction of greenhouse gases in the energy sector are focused on renewable and other clean energy use, energy supply efficiency improvement, clean coal technologies, and energy efficiency improvement in buildings and industry. In the transportation sector, greenhouse gas reducing strategies are to improve traffic conditions, to use more fuel efficient vehicles and to implement shifts from individual road vehicles to rail and public transport systems.

Greenhouse gas reduction strategies in agriculture are to improve animal husbandry management and technology to increase the productivity of each type of animals. As for the waste sector, policies and measures to establish a foundation to minimize waste, increase recycling and expand waste management processes should be implemented. Policies to increase removals and decrease emissions are also being implemented in the forestry sector through efficient management and maintenance of forests and afforestation.

The above strategies for each sector and policies and measures are summarized in Table 4.1.

4.2.1 Energy

The reduction of GHG emissions in the energy sector is being promoted by implementing measures and projects in energy supply and demand sectors.

Table 4. 1. Greenhouse gas mitigation policies and measures by sector

Sector/ subsector	Strategy	Policies and measures
Energy supply	Increase of renewable and other clean energy use	National renewable energy programme
		Renewable energy law
		100000 solar ger programme
		Electricity supply of remote soum centers by solar, wind and diesel hybrid systems
		National programme of LPG use
	Energy supply efficiency improvement	Reduction of energy losses in transmission and distribution systems
		Efficiency improvement of CHP
		Efficiency improvement of HOB
		Heat efficiency Improvement in ger district area
	Promotion of clean coal technology	Coal program
	Study of nuclear power development	Nuclear energy law
Energy demand	Demand side energy conservation policy	Issue of energy conservation law
		Promotion of energy efficiency in industry and ESCO activities
	Building energy efficiency improvement	Implement improvements of district heating system and installation of heat meters in buildings
		Insulation improvements for existing buildings and implement new energy efficient standards for new buildings
	Improvement of energy efficiency in Industry	Equipment efficiency improvements and good housekeeping
		Technology changes
Transport	Efficient management of transportation	Enhancement of national transportation system (railway enhancement and electrification; setting up transit logistics centers)
		Eco-transport strategy (efficient traffic management; expansion of public transportation; promotion of fuel efficient car)
Agriculture	Sustainable development of agriculture sector	Limitation of the number of livestock by increasing the productivity of animals, especially cattle.
Land use change and forestry	Land use management	Land degradation and desertification
	Forest conservation and afforestation	Protection of forest from fire
		Measures to taking toward combating forest harmful insects and disease
		Afforestation and measures to support natural regeneration
Waste	Waste management	Improvement of waste management
		Waste recycling

A. Increase of renewable and other clean energy use

National Renewable energy programme. In June 2005, the Parliament of Mongolia approved the National renewable energy programme (2005-2020) to promote the use of renewable energy in Mongolia. The goal envisaged in the programme is to increase the percentage of the renewable energy share in the total generation from 3 percent to 5 percent by 2010 and 20 percent to 25 percent by 2020.

In the first phase (2005-2010) of the framework of the National renewable energy programme, financial support of 131 million US$ was invested in renewable energy compounds and construction. Nowadays, renewable energy comprises 4.34 percent of national energy installed capacity of the country (Table 4.2).

Table 4. 2. The percentage of the renewable energy share in the total installed power generation capacity

Capaccity unit	Thermal power plant	Power generation from renewable energy			
		Total	Hydro	Solar	Wind
MW	827.4	37.5	28.3	5.32	3.8
%	95.66	4.34	3.28	0.62	0.44

Source: Proceedings of national forum of renewable energy. Ulaanbaatar, 2009

Renewable energy law. The Renewable energy law was passed by the Parliament in January 2007. The purpose of the law is to regulate relations concerning the generation of power using renewable energy sources and its delivery.

The primary stipulation of this law provides a feed-in tariff for the grid and the independent power generation from renewable energy, as shown in Table 4.3. Any price difference of electricity generated by a renewable energy power source, which is connected to a transmission network, shall be absorbed into the selling price from other power plants connected to the transmission network. The renewable energy fund shall be maintained by the following:

- State budget for renewable energy development
- Grants from donor and other countries and foreign and local organizations.
- Fifty percent of the proceeds assigned to the state and local property entities and institutions from the sale of the Certified Emission Reductions (CER) to other countries in compliance with the Kyoto protocol.
- Other sources

The renewable energy fund shall be disbursed for the following purposes:

- to compensate for price differences of energy produced by an independent renewable energy power sources as specified in Table 4.3.
- to prepare trained professional staff in the field of renewable energy.
- to conduct research aimed at introducing new techniques and technologies in renewable energy generation and use.

Table 4. 3. Feed-in tariffs, US$/kWh

Type of renewable energy generation	Capacity	Connected to electricity grid	Independent power generation
Wind power source	-	0.08-0.095	0.1-0.15
Hydropower station	Up to 5,000 kW	0.045-0.060	-
	Up to 500 kW	-	0.08—0.10
	501-2,000 kW	-	0.05-0.06
	2,001-5,000 kW	-	0.045-0.05
Solar power source	-	0.15-0.18	0.20-0.30

Source: Renewable energy law of Mongolia, January 11, 2007

- to assess renewable energy resources.

The Renewable energy law motivates potential foreign and domestic companies to carry out and invest renewable energy projects in Mongolia. For example, Newcom LLC, a Mongolian company, plans to construct a wind park in the area of Salkhit Uul, about 70 km southeast of Ulaanbaatar. The projectis expected to have a capacity of about 50 MW and generate 116 GWh of electricity per year. As the first wind farm in Mongolia the project will greatly assist the country in stimulating the commercialisation of grid-connected renewable energy technologies and markets. The project will, therefore, help reduce GHG emissions in contrast to the coal burning power plants. Furthermore, the project will improve air quality and local livelihoods and promote sustainable renewable energy industry development.

The 100,000 solar ger (traditional house) programme. The Mongolian government implements "The 100,000 Solar Ger" Project to provide portable solar power systems (Solar Home System -SHS) to satisfy the basic energy needs of nomadic herders' families. Within this national project, 32,000 SHS sets have been introduced to nomadic families since 2000. On the other hand, the actual conditions of SHS use is less understood in Mongolia than in other countries. The Government of Mongolia adopted Resolution No.158 in 1999 to implement "The 100,000 Solar Ger" Project and 1032 SHS sets introduced to nomadic families from 2001-2002. During the period 2003-2005, 31,790 SHS sets funded by Japanese and Chinese aid were delivered to nomadic households with a 50 percent discount. During 2007-2008, 40,400 SHS sets with a capacity of 50 W each were delivered to nomadic households, at a 50 percent discount from the State Budget. The Implementation status of 100,000 solar home national programme is shown in Table 4.4.

Table 4. 4. Implementation status of 100,000 solar home national programme

Implementation period	2001-2002	2003-2005	2007-208	2009-2011	Total
Number of households supplied by solar home system	1,032	31,790	40,400	26,778	100,000
Percentage	1.0%	31.8%	40.4%	26.8%	100%
Cumulative Percentage	1.0%	32.8%	73.2%	100%	100%

Source: Energy Department, Ministry of Mineral resources and Energy

Electricity supply of remote soum centers by solar, wind and diesel hybrid systems. The government of Mongolia intends to improve the supply of power to off-grid soums by introducing sustainable and independent renewable energy with a focus on solar power, in order to improve telecommunication and social services such as health care and education. The Solar PV system with a capacity of 60-200 kW is one of the best technology options for electricity supply to remote soum centers and low-demand consumers.

National programme of Liquid Petroleum Gas The use of LPG is increasing rapidly, and the Government of Mongolia (GoM) gives importance to the development of LPG use as a new fuel mix, as a relatively "clean" fuel compared to fossil fuel. The LPG Programme was adopted by the government in 2006 and is aimed at promoting the usage of LPG in the household and transportation sectors and to introduce necessary safety standards and regulations. In the transportation sector the goal is to get a 90 percent usage of LPG by taxis and 20 percent for private cars. For households and catering, the aim is to increase the level of use of LPG to 40 per cent and 80 percent respectively. Measures have been taken in the form of import duty and VAT exemptions on LPG equipment. The usage of LPG depends on the availability of other fuels, as well as the domestic production of LPG.

B. Energy supply efficiency improvement

Reduction of energy losses in transmission and distribution systems. With financial support from World Bank, the Government of Mongolia implemented the Energy Project during the period 2003-2010 to improve the financial sustainability of the energy sector through reducing losses and improving revenue collection in Ulaanbaatar and 9 other provinces in Mongolia. As of 2009, the cumulative reduction in total distribution network losses resulted in increased revenues of around US$17 million. The energy project has helped to reduce technical and non-technical losses from 30.67 percent in 2004 to 22.7 percent in 2009 in Ulaanbaatar. For 9 other provinces, technical and non-technical losses has been reduced from between 7.6 to 30 percent. The Power transmission and distribution losses of the Central Energy System are shown in Table 4.5.

Efficiency improvement of combined heat power plants. At present, 6 CHP are operating in Mongolia with a total installed electrical capacity of 824 MW, a steam production capacity of 7,100 tons/h and an annual load factor of 71.4 percent. To increase the efficiency and realibility of existing Combined Heat and Power Plants (CHP), the Government of Mongolia promotes projects from foreign countries, international Banks and financial organizations. During the period 1990-2008, 67 projects have been implemented in the Energy sector with a total investment cost of US$ 575 million as foreign loans or technical assistance[1] . From this amount, 53.4 percent of investment has been used for rehabilitation and improvement of CHP. The results were positive and the reliable operation and efficiency of energy production was improved. The station's own use of CHPs reduced from 22 percent in 2000 to 15.9 percent in 2009. The specific energy use for electricity generation reduced from 414.3 to 33.6, for heat generation from 185.4 to 178.1 respectively (Table 4.6).

Efficiency improvement of heating Boilers. The severe climate and long winter season make heating

Table 4. 5. Power transmission and distribution losses of central energy system

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Power T&D losses, %	23.0	23.6	23.0	21.9	20.3	19.8	18.4	17.4	16.8	17.7

Source: Energy Statistics-2009.ERA, Ulaanbaatar, 2010

Table 4. 6. Station own use and specific energy consumptions of CHPs

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Station's own use, %	22.0	22.0	21.0	19.8	19.1	18.1	17.5	16.5	16.1	15.9
Specific energy use for electricity generation, gram/kWh	414.3	408.6	414.3	395.5	389.5	378.3	366.7	347.9	336.8	332.6
Specific energy use for heat generation, gram/Gkal	185.4	184.6	185.7	184.8	183.5	183.3	180.8	178.5	178.6	178.1

Source: Energy Statistics-2009.ERA, Ulaanbaatar, 2010 an absolute requirement for sustaining life. Only 23 percent of the total amount of fuel consumed is used for electricity generation, while the remaining 77 percent is used for heat generation. Heat is provided to households, government buildings, schools, hospitals, and industries primarily by district heating, which is distributed from central heating plants in larger cities, and from small boiler houses in aimag and soum centers.

The total heat load is 800 MW in aimag and soum centers, which includes heating for residences, public offices, hospitals, and schools. About 80 percent of the boiler houses are located in soum centers. The individual heat output of boilers is between 0.8 MW and 2.1 MW, and coal is the main fuel. The condition of these boilers has deteriorated significantly since 1990s and the heat efficiency is only about 40 percent. As a result, the quality of heating services in soum centers is now extremely poor. Improving the existing heating systems in soum centers (through refurbishment and modernization) is a high priority to sustain life and livelihoods in these areas.

The existing heating plants are of a basic design and fail to meet any environmental and energy efficiency standards. The boilers have to be renewed approximately every five years. The state of heat generation and distribution systems has in many cases seriously deteriorated and urgently needs refurbishment and modernization. Improving the efficiency of heating systems in aimag centers will result in improving the quality of heating services during the winter. In addition, boiler efficiency is expected to increase from 40 percent to 70 percent, thereby decreasing coal consumption and CO_2 emissions. This results in both reduced boiler-related air pollution and savings in soum center government budgets.

Heat efficiency improvement in ger district areas. Household stoves in cities have low energy efficiency, pollute the environment and threaten human health due to inefficient fuel burning. One of the potential options to reduce environment pollution and greenhouse gas emissions is to replace the raw coal used in stoves with LPG and coal briquettes.

Since 1990, the Ministry of Nature, Environment and Tourism and the Administration of Ulaanbaatar City have undertaken several measures to increase the efficiency of furnaces and household stoves, but few results have been achieved. Therefore, the Parliament of Mongolia is focusing attention on the issue of air pollution in Ulaanbaatar City. The "New Development" programme was approved by the State Great Khural (Parliament) in April 2010. One of the main targets of the programme is to significantly reduce smoke, and consequently GHG emissions in the ger districts of Ulaanbaatar

The Millennium Challenge Account of Mongolia is implementing an Energy and Environment Project which is focused on this critical issue of air quality for Ulaanbaatar residents. Among other contributing factors, a significant factor in the deterioration of air quality is the heavy use of raw coal for heating and cooking by ger district residents, producing winter air pollution and emitting greenhouse gases. The objective of the project is a sustainable reduction of air pollution by increasing the adoption of energy efficient products in homes in the ger districts.

C. Promotion of Clean Coal Technology

Clean coal technology. Mongolia has substantial coal reserves. Coal continues to be the most important fuel for power and heat generation in the Central Energy System (CES) and for heat generation in provincial centers. There exists no provision for coal preparation at mine sites, and as a result there is no quality control in the supply system. The quality of the coal often does not meet the minimum standard requirements, and in many cases, the low quality of coal is the cause

[1] Ts. Batbaatar. Projects and programmes in energy sector. energy & engineering, #7(72) 2009

of emergency situations at the power stations.

Coal washing can be introduced at the biggest coal mines in Mongolia, such as *Baganuur, Shivee-Ovoo* and *Tavantolgoi* deposits. Although this option is technically feasible, there are some institutional barriers. This option is already included in the Mongolian Environmental Action Plan since coal is the main source of environmental pollution. The development of the technology for making coal briquettes could be an efficient way to mitigate GHG emissions and reduce air pollution. Some studies and investigations on conventional formed coal briquettes have been carried out by several Mongolian organizations. However, the quality of coal briquettes is the main concern.

According to an estimate by the Hashimoto Sangyo Company of Japan in Mongolia, the initial capital cost of a small scale (5-6 thousand metric tons per year) coal briquetting plant would be about 9.6 million US$. Compared to other technologies (e.g. liquefying and gasification) designed to produce clean fuel from coal, the technology of coal briquetting has advantages, such as less investment and lower life cycle cost.

D. Nuclear energy development

Nuclear energy law. The Parliament of Mongolia passed the Nuclear energy law in July 2009. The Nuclear energy law aims to regulate all aspects of dealing with nuclear materials, from uranium exploration and mining to the running of nuclear reactors. The Nuclear energy authority is the government regulatory agency which oversees the nuclear sector. It reports directly to the Prime Minister and under the Nuclear energy law the agency has been tasked with regulating the nuclear energy sector in Mongolia, including licensing, inspecting, and monitoring.

E. Demand side energy conservation policy

Issue of energy conservation law. The inefficient use of energy affects economic performance. The expenditure composition of the gross industrial product shows that the percentage share of the energy cost in total production cost increased almost 2 times for last 10 years. Technology development and the introduction of modern technology in Mongolia is the driving force for energy conservation. For this reason, it must form an integral part of the mainstream of energy conservation in Mongolia. Since 2000, energy responsible ministries have worked on the issue of an energy conservation law. However, there is still no law for promotion of activities on energy efficiency and conservation. Hopefully, the Ministry of Mineral Resource and Energy is going to issue the energy conservation law.

Promotion of energy efficiency in industry and ESCO activities. Since 2000, the Netherlands-Mongolia project “ESCO development in Mongolia” has been introducing ESCOs in Mongolia. The general objective of this project is to overcome the barriers for implementation of energy efficiency projects in Mongolia, by creating a conceptual framework for the development of ESCOs. Recently, there have been about 10 potential ESCOs in Mongolia. Since 2005 the Green Credit Guarantee Fund Scheme serves as a part of the environmental related business sector of Mongolia, providing financial support for its targeted clients. The purpose of the Green Credit Guarantee Scheme is to help energy saving companies in their financing activities by providing guarantees for loans they have borrowed.

F. Building energy efficiency improvement

Implement improvements of district heating systems and Installation of heat meters in buildings. Since 2000, industry and service entities in all of the major cities and towns have been using heat meters and are motivated to save heat energy. Nowadays, 30 percent of heat consumers have been supplied with heat meters. As a result of installing heat meters, heat consumption has decreased by 20 percent. In Mongolia, about 30 percent of the country's population lives in public apartments connected to the central heat supply network. None of these apartments have heat meters and the heating prices and fees are based on a fixed tariff. Also, since the apartments are not installed with the technical instruments to adjust their own heat consumption, the owners open windows when the indoor air temperature is high and release warm air.

Insulation improvements for existing buildings and implementation of new energy efficient standards for new buildings. Thermal energy is used for heating private and public buildings, the production of goods and services and in the preparation of household hot water. It is a peculiarity of Mongolia that 90 percent of the overall energy consumed is used for building heating purposes. Therefore, the introduction of technologies aimed at improving building insulation is critical to achieving increased energy efficiency. The loss of heat in buildings is high and residential consumers have no means of regulating the temperature inside their homes. There is big potential to save energy and reduce greenhouse gas emissions in building insulation options.

Since 1995, the Government has been encouraging the citizens' interest in owning their own homes and has adopted state policies and national programmes in this area, as a result of which an optimum condition is created. For example: (1) the recently adopted Law on Land provides all the people of Mongolia with the opportunity to possess and own land; (2) The free flow of all types of construction materials in the market; and (3) financial institutions have begun to provide long term loans with lower interest rates for the building of houses.

The Ministry of Road, Transport, Construction and Urban Development (MRTCUD) and the UNDP in Mongolia have been implementing the Building Energy Efficiency Project (BEEP) that is aimed at reducing the annual growth rate of greenhouse gas emissions from the building sector. BEEP will contribute to it through transforming the Mongolian buildings market towards more energy-efficient building technologies and services, sustainable private house insulation and energy efficiency financing mechanisms. The project objective is the improvement of the energy utilization efficiency in Mongolian buildings by refining the energy efficiency levels of new construction sector buildings and improving the energy efficiency of new and existing gers and private houses in urban areas.

The government policies for reduction of energy losses in buildings are focused on:

- Standards for new buildings
- Insulation of old buildings

By insulating currently used buildings to the standard level, heat losses could be reduced by 40 percent.

The results of the UNDP financed project "Commercialization of Super-Insulated Buildings in Mongolia: Conducting Energy Efficiency and Material Research" show that the heat conductivity rate of the investigated houses is relatively lower than the standard rate (construction heat technique Building Norm and Rules (BNaR) 2.0.03-93). The average thermal resistance of walls is 1.36 m^2 ^{0}C/W, of floors is 0.86 1.36 m^2 ^{0}C/W, and of ceilings is 1.36 m^2 0C/W. When these indexes are compared to current standards, they are seen to be lower by 2-3 times, which indicates that the majority of the houses have a higher rate of heat loss.

G. Improvement of energy efficiency in industry

Equipment efficiency improvements and good housekeeping. *Motor efficiency improvement:* Motor systems use about 70 percent of industrial electricity in Mongolia. These motor systems are often less efficient than the ones in industrialized countries. Motor efficiency improvement technology includes using energy-efficient motors and variable speed drives; improving operation and maintenance; correcting previous over-sizing; and improving mechanical power transmission and efficiency of equipment that is driven. It is estimated that the electricity savings potential is 20 percent of the electricity currently used by industrial motors.

Steam saving technology (steam traps, heat recovery, pipe insulation, etc.): This technology includes the rehabilitation of steam systems, including the repair of steam traps, insulation and valves and their return rate of condensation. It is assumed that 30 percent of all industrial heat demand is steam consumption. The steam saving potential of industry is estimated to be 25 percent.

Good housekeeping practices and energy management: Mongolian industry has a significant potential for saving energy through the improvement of energy use and management. The energy savings potential by "easy" savings (good housekeeping practices that minimize the use of heat and electricity and energy management) is 15-25 percent with a cost recuperation period of less than 1 year.

Technology changes. Introducing dry-processing in the cement industry: Changing the wet-processing of cement to dry-processing saves a large amount of energy. This has been proven by the feasibility study, which was conducted within the framework of the Clean Development Mechanism project to reduce GHG emissions. It is estimated that 25 percent of all industrial coal is used for cement production. Wet-processing of cement requires 1,500 to 1,700 kcal/kg-cl of heating whereas dry processing may require 1,000 to 1,200 kcal/kg-cl. This boils down to a savings potential of 40 percent of the coal consumption in the cement industry.

4.2.2. Transport

The enhancement of national transportation system. The Government of Mongolia (GoM) has developed important strategies for the transport sector encompassing expected goals for the long term. The Millennium Road Programme was developed by GoM and approved by the Parliament in 2001. The purpose of the project is to connect Mongolia to neighboring countries and sea ports, in the shortest possible way. The highway will stretch across the country, together with five vertical arterial roads, and is supposed to be implemented within 11 years. The Ministry of Road, Transportation, Construction and Urban Development (MRTCUD) focuses its efforts on developing legal contexts, monitoring and coordinating systems and revenue generating mechanisms for regulating the transit freight forwarding, connecting Asia and Europe via the territory of Mongolia by inland truck transportation. Also the Ministry is planning to develop a modern service infrastructure and logistics centers along the horizontal arterial roads.

The "Transit Mongolia" programme was adopted by the Government in May 2008 and will be implemented by 2015. The programme defined several strategic directions such as the construction of a secondary railway line, railway electrification, intensification of transit transport through Mongolian territory and the construction of transport and trade logistics centers and cargo terminals.

The Eco-transport Strategy is part of the Government of Mongolia's development agenda to protect our environment and the health of the population and to further our economic prosperity. Under the strategy framework, the following objectives have been identified:

- To improve efficient management of traffic
- To expand public transportation services
- To promote fuel efficient cars and flexible/alternative fuel vehicles

MRTCUD implemented a project "Efficiency Improvement of Transportation" financed with a long term soft loan from the Government of the Republic of Korea. Within the project, 45 traffic lights, 26 remote control circuit cameras were installed in the traffic junctions and 2 information sign boards for drivers have been installed and operated by the Integrated Management Center.

In 2009, about 224 thousand vehicles were registered in Mongolia and the total number of vehicles has increased by approximately 2.2 times since 2000. This rapid growth of transportation has increased the negative impact on the health of the population and the environment. To reduce the adverse impact, it is necessary to ensure the safety of transportation and reduce the number of accidents and traffic crimes, which do not meet traffic safety requirements. Under the "Transport Development Project", 24 transport diagnostic centers with a nationwide integrated transport data base network have been opened.

4.2.3 Agriculture

As mentioned in the previous chapter, the main contributor to the total methane emissions is enteric fermentation from animals in the agricultural sector, contributing about 92-93 percent of the total methane emissions. Livestock husbandry is the main livelihood and source of wealth in Mongolia and the country's economy substantially depends on the production and development of this sector. The value added of the agriculture sector is about 20 percent of the GDP of Mongolia. Livestock production comprises 80 percent of the total agriculture production.

The livestock sector development strategy aims to build risk management capabilities to ensure reliable protection for the wealth and income of herders and to increase production to optimal levels, taking into consideration regional advantages in increasing productivity. Low efficiency leads to an increased number of livestock being vulnerable to natural disasters. The number of livestock has exceeded the estimated carrying capacity of Mongolia's pasture, causing land degradation and desertification.

The Mongolian Government has adopted and implemented several national programmes in the past such as: "Livestock health", "To improve livestock quality", "To support the development of intensive livestock", "Milk", "Livestock fodder" and "Food security". In addition, more than 20 projects have been implemented with the assistance of foreign countries and donor organizations. Unfortunately these programmes have not realized their full potential because of an unconsolidated policy, weak monitoring and coordination and insufficient funding. Recently, the National Mongolian Livestock Programme has been approved by the Parliament of Mongolia. The objective of the Programme is to ensure the sustainable development of the livestock sector and create a legal environment that would promote economic development. According to the programme, the number of livestock is expected to reduce from 44 millions in 2008 to about 36 millions in 2021 as a result of improving animal breeding services based on social needs and increasing the productivity and quality of livestock products to increase the competitiveness of the sector.

4.2.4 Land use change and forestry

Land degradation, damage to the land and desertification. The 1991-2008 saw a steady decrease in both the area of cultivated land and the crop yields per hectare, due to economic difficulties and the reorganization of farms. Additionally, soil protection programmes were not in existence, and soil quality was seriously degraded as a result of poor agricultural practices. Gold mining and other mining activities, particularly the method of exploitation which involves the heavy use of extremely poisonous chemicals such as mercury, have cast a dark shadow on the environment, causing soil erosion and withered rivers and streams. In particular, the number of projects being implemented in the mineral exploration and exploitation sector, has increased mining activities, which are always accompanied by environmental risks and adversely affect the natural surroundings, causing air, water, soil and underground pollution. According to the 2007 report on land damage, 14,077 thousand ha of land was partially damaged, which shows an increase of 2,998 thousand ha compared to 2006. At the national level, 350.1 thousand ha of cultivated land was damaged, out of which 78,642 ha showed degraded productivity, and 82,020 ha was damaged by wind erosion. Researchers have concluded that 77.2 percent of the total territory of Mongolia was affected by desertification at low, medium and high levels. In 2010, the Government of Mongolia has approved the National Action Programme to Combat Desertification and the Action plan for the first stage of the programme.

Forest Conservation and afforestation. Mongolian forests provide a multitude of services in regard to climate change and other environmental challenges, including serving as carbon sinks, sources of renewable energy, watershed protection and soil erosion protection. Many of these services have been lost, or will be lost, due to the extreme pressure exerted on Mongolia's forest resources.

Transition to the market economy brought new challenges to the forestry sector. New problems in logging and wood processing have yet to be solved. Forest fires, insects, various types of diseases and Illegal logging have affected Mongolia's forested areas.

Protection of forest from fire. Protecting forest ecosystems and forest resources by preventing forest fires also supports the reduction of GHG emissions and preserves valuable carbon sinks. According to the forest census, the forest reserve areas have been increased national wide. However, in the past few years, large forests in certain areas has been affected by wildfire because of negligent human activities. Occurrences of forest fire in 2006-2007 are shown in Table 4.7.

Measures to taking toward combating harmful forest insects and diseases. In the last few years, the number of forest insects has been increasing because of the natural breeding cycles, and negative impact of climate change, dryness, wild fire, and human negligence. Some years, harmful forest insects cause damage that is equal to or greater than any other natural disasters. During the period 2006-2007, with the participation of local communities and financial support from the Government and UN organizations, activities have been organized, (as shown in Table 4.8) with the aim of restraining the spread of harmful forest insects in forest areas and developing new methodologies of combating harmful insects.

Afforestation and measures to support natural regeneration. In order to improve the coordination between policies and activities concerning forests, the Parliament of Mongolia made amendments to the Law on Forest in 2007. Numerous issues have been addressed within the provisions of this new law, including the proper utilization of forest, afforestation, improvement of the institutional framework and the structure of the afforestration organizations, the establishment of a legal framework for possess-

Table 4. 7. Forest fire occurrences in 2006-2009

Year	Number of fire incidents	Total area, mln. ha	Out of which: forest, ha	Total damage, million tugrug
2006	164	5.6	391.7	1,662.9
2007	216	1.1	514.2	193,128.3

Source: Report on the state of the environment of Mongolia. Ulaanbaatar 2008

Table 4. 8. Actions against forest harmful insects and diseases, implemented in 2005-2007

Actions	2005	2006	2007
Research of forest harmful insects, 1000 ha	600.0	240.0	897.6
Activities against forest harmful insects, 1000 ha	49.1	17.3	27.4

Source: Report on the state of the environment of Mongolia. Ulaanbaatar 2008 ing and utilizing forest reserves, and the increase of local community and user group's participation in forest conservation activities. Table 4.9 shows that the number of afforested areas was increased from 2005 to 2007. However, there are many incidents of illegal logging of forests. Intense logging of trees has a destructive effect, particularly on the natural regeneration of the forest. Moreover, the forest structure has deteriorated. Because of these factors, it is prohibited to cut birch trees for general use, for a two year period.

Table 4. 9. Afforested area

Forest area	2005	2006	2007
Afforested area, ha	4552	4596	6281
Greenbelt establishment, ha	307	430	260

Source: Report on the state of the environment of Mongolia. Ulaanbaatar 2008

4.2.5 Waste

Improvement of waste storage and collection system. Waste disposal is a mounting problem in Mongolia, not only in terms of GHG emissions, but also in terms of land use and sanitation, especially in Ulaanbaatar (UB). Almost half of Mongolia's population lives in the capital city. At present, the total amount of waste generated in UB is estimated to be 552.8 tons per day. Of this waste, 321.6 tons or only 58.2 percent of the total amount is officially transported to final disposal sites[2].

Waste recycling. The recycling rate is very low. More than half of the waste which is recycled is collected and reused by waste pickers either on the streets or at the disposal sites. All collected waste in the city of Ulaanbaatar is disposed in three landfills (Dari-Ekhiin Ovoo, Ulaan Chuluut and Moringiin Davaa) without any further processing. A plant is planned to be built by 2011 to sort various kinds of household and recyclable waste and scrap, and to produce perfect combustion fuel with sorted waste. The investment for the construction of the plant is estimated at about US$ 3.5 million.

4.3 Nationally appropriate mitigation actions

Mongolia has become a signatory of the Copenhagen Accord and submitted list of nationally appropriate mitigation actions (NAMA) to the UNFCCC Secretariat in January 2010. The main contents of the NAMA presented by Mongolia are listed in Table 4.10. The NAMA include a general outline of the above mentioned GHG mitigation measures, which will be implemented with support from the international mechanisms to strengthen national capacities, to transfer advanced technologies; and to provide financial resources to developing countries and parties.

4.4 Policies and measures on adaptation to climate change

In the new Millennium and in the era of globalization and climate change, the new technology needs to be introduced into the most vulnerable environmental components and economic sectors to make them independent of the environment and the weather hazards, through renovation and improvement of conventional methods and approaches. Today, all states acknowledge that it is impossible to provide sustainable development without providing a correlation of economic acceleration, human growth and

[2] The project implemented by the Japan International Cooperation Agency (JICA).

Table 4. 10. Nationally appropriate mitigation actions

Areas	Actions
Energy supply	**Improve coal quality** *a. Coal beneficiation* Coal washing plants can be implemented at the major coal mines in Mongolia. This option is technically feasible; there are low institutional barriers. This option is already included in the Mongolian Environmental Action Plan. *b. Coal briquetting* Introduction of coal briquetting technology could be an efficient way to mitigate GHG emissions and reduce air pollution. A feasibility study on production of conventional coal briquettes, carried out by the Mining Institute of Mongolia with support of UNDP, shows a production cost estimated at 14000 tugrug/ton (13.5 US$/ton).
	Improve efficiency of heating boilers ***a. Improve efficiency of existing HOBs and Install boilers with new design and high efficiency*** Building of 12 efficient boilers with capacity of 25 MW would give 91000 tons/year of CO_2 emission reduction. Installation of 260 new boilers with capacity of 1MW would reduce CO_2 emissions by 340000 tons/year. ***b. Convert hot water boilers to small capacity thermal power plants*** This option would convert hot water boilers to thermal power plants with a capacity of 5-10 MW. This would allow heating and power supply for the provincial centers and nearby provincial units. Converting of steam boilers to small capacity thermal power plants (5 x 10MW) would reduce CO_2 emissions by 190000 tons/year.
	Improve CHP plants ***Improve efficiency and Reduce internal use*** At present, 6 CHP are operating in Mongolia, with a total installed electrical capacity of 824 MW. Consequently, CHPs contribute an important part to total national GHG emissions. In particular, efficiency improvement including reduction of in-site use should be seriously considered for greenhouse gas mitigation. Implementation of this option would give 185,000 tons of CO_2 reductions per year.
	Increase renewable options ***a. PV and solar heating*** The installation of large scale PV systems in the Gobi region of Mongolia, may contribute to both reducing air pollution and supporting regional development. It is necessary to implement pilot research projects in the areas along the railways and consider PVs in the Mongolian Gobi desert and steppe areas in the future. ***b. Wind power generators and Wind farms*** Turbine generators (100-150 kW) could be placed in provincial centers in the southern part of Mongolia. The most promising sites should be prioritized according to the technical and economic feasibility of operating 100-150 kW wind turbine generators in parallel with existing diesel generators. Also, large scale wind farm projects can be implemented in Mongolia due to the fact that the country has experience in establishing a wind farm with a total capacity of 50 MW. ***c. Hydropower plants*** More than 20 promising hydropower sites have been identified in Mongolia, with capacities ranging from 5 MW to 110 MW. GoM encourages small and medium sized hydropower developments. The emission reduction potential of this option is high, and its local benefits are expected to outweigh potential negative impacts. Taishir and Durgun HPPs were registered as CDM projects with CER of 29,600 tons CO_2 and 30000 tons CO_2 per year respectively. The 220 MW Egiingol Hydroelectric power generation project with a potential CER of 192,500 tons CO_2 per year is in the project development stage and it has the potential to be initiated in the near future.
	Improve household stoves and furnaces ***a. Change fuels for household stoves and furnaces*** One of the potential options to reduce environment pollution and greenhouse gas emission is to replace the raw coal used in stoves with LPG and coal briquettes. ***b. Modernize existing and Implement the new design for household stoves and furnaces*** The modernization of 250,000 stoves and furnaces would reduce CO emissions by 920,000 tons/year.

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Building	**Building energy efficiency improvement** ***a. Improve district heating system in buildings*** Urgent actions are required to reduce the heat loss such as minimizing leakage and replacement of valves and compensators. Also, residential consumers need to save energy by regulating room temperatures. ***b. Install heat and hot water meters in apartments*** Many apartments do not have heat meters and their heating fees and prices are calculated based on a fixed tariff that does not reflect the actual amount of heat used. ***c. Make insulation improvements for existing buildings and implement new energy efficient standards for new buildings*** The study on heat losses concluded that nearly 40 percent of the heat supplied to houses and buildings is lost. When these parameters are compared with current standards, they are found to be 2-3 times lower than the standards, which shows that most housing has a higher rate of heat loss. ***d. Improve lighting efficiency in buildings*** This demand-side management option concerns the use of energy-efficient compact fluorescent lamps (CFL) to replace inefficient incandescent light bulbs (ILB). Lighting demand of households and service sectors accounted for 380 GWh and is expected to increase in future.
Energy supply	**Increase use of electricity for local heating in cities** ***Use of electricity from grid for individual households in cities*** The main purpose of this option is to reduce air pollution and GHG emissions in Ulaanbaatar city. The government of Mongolia is focusing its attention on reducing air pollution in Ulaanbaatar and investigating many alternative options including the use of electricity for heating in “Ger” districts. But no detailed research or projects have been carried out yet.

Industry	**Energy efficiency improvement in industry** ***a. Improve housekeeping practices*** The energy saving potential in industries can be divided into "easy" (no-cost and low-cost) sa-vings, medium-cost savings and long-term possibilities. The energy saving potential by "easy" savings (good housekeeping and energy management) is 15-25 percent with a pay- back period of less than 1 year. Implementation of this option could give about 300,000 tons of CO_2 reductions per year. ***b. Implement motor efficiency improvements*** The electricity saving potential of motor efficiency improvement technology is estimated to equal 20 percent of electricity consumption by industrial motors. Implementation of this option could give about 240,000 tons of CO_2 reductions per year. ***c. Introducing dry-processing in cement industry*** Changing the wet-processing of cement to dry-processing saves a large amount of energy. This shows that the saving potential of coal consumption in the cement sector is about 40 percent. The reduction of CO_2 emissions from implementation of this option would be about 147,000 tons per year.
Transport	***Use more fuel efficient vehicles and efficient traffic and transportation system*** • To promote the importing of fuel efficient vehicles, economic measures such as the implementation of used vehicle import standards and vehicle registration tax can be used to improve the overall fuel efficiency of vehicles. • Flexible/alternative fuel vehicles would help to reduce GHG emission and air pollution in cities. • Expansion of public transportation services • Efficient management of road and transport
Agri-culture including animal husbandry	***a. Improvement of agro-technology and increasing agricultural production*** To alleviate the negative impacts on crop production and to adapt to climate change, there could be adaptation measures such as changing wheat planting time, selection of appropriate varieties, and application of fertilizers etc. ***b. Improved livestock management and intensification of animal husbandry.*** Direct regulation of animal numbers might have a sensitive impact on herders' livelihoods. Therefore, limiting numbers of livestock could be implemented through intensification of animal husbandry with improved productivity per livestock and reduced expenses per head.
Forestry	***a. Improve forest management*** The following major mitigation options have been identified for the forestry sector: 1) Natural regeneration; 2) Plantation forestry; 3) Agro-forestry; 4) Shelter belts; and 5) Bioelectricity ***b. Reduce emissions from deforestation and forest degradation, improve sustainable management of forests and enhance forest carbon stocks in Mongolian forest sector*** There are a certain amount of potential for the reduction of GHG emissions from deforestation and forest degradation in Mongolia. Therefore, it is possible to initiate and implement a REDD project in Mongolia through reforestation activities by community based forest management improvement and sustainable use of forest resources.

natural resource utility. Mongolia has formulated and implemented a sustainable development policy as the milestone of the state development strategies.

Clearly, for a country which is vulnerable to climate change, the formulation and implementation of a policy on adaptation to climate change is vital for the sustainable development of the country, as well as for the fulfillment of its obligations under the UN Framework Conventions. The measures to reduce the adverse affects caused by climate change are based on impact and vulnerability assessment of climate change on the environmental and economic sectors. Also, new developments and amendments of policies and legal documents are required in order align them with recent climate change and the latest socio-economic development updates.

4.4.1 Adaptation policies and measures

High priority adaptation options and measures in different sectors vulnerable to climate change are summarized in Table 4.11.

Land degradation, desertification and decrease of land fertility. Due to the arid and semi-arid climate and its effect on the country, desertification and land degradation have become real challenges in Mongolia. Theoretically, land degradation is defined as a decline in soil fertility and land desertification as increasing vegetation scarcity, biomass and sand of grassland. A survey has identified the fact that desertification has become a disastrous problem for Mongolia. Action taken to adapt to climate change can be carried out through improving the management of land utility.

Strategies and measures to combat land and pasture degradation and desertification are identified in the National programme to combat desertification

Table 4. 11. Adaptation strategies and policies by sectors

Sector	Strategy	Policies and Measures
Animal husbandry	Reducing land degradation and desertification	Improving of legislation on pasture leasing, utilization and ownership
		Conservation of natural grassland through proper management
		Cultivation of forage plants and introduction of irrigation technologies
		Introduction of new varieties of plants resistant to droughts and pests
	Improved livestock quality and livestock management	Development of legal and economic leverages in order to control number of livestock and herd structure according to pasture capacity and resources
		Improving the quality of biological capacity of livestock
		Improving risk management of pastoral livestock and strengthen livestock insurance system
		Expanding research and experiment on livestock production and efficiency
		Enhancing artificial insemination techniques and veterinary services
		Supplementary feeding of animals
		Planting of forage and pasture production improvement
	Improved herders' livelihood	Capacity building of agricultural managers and herders
		Promoting household and community group-based enterprises to process livestock products
		Supply herdsmen with portable and renewable energy sources
		Promoting value added chains of livestock products and improving market competitiveness
		Improving communication system in rural areas
	Increased urban food supply	Promoting food processing enterprises
		Increasing export of meat and meat products
		Expanding farms of milk and meat (cattle, pig, chicken and etc) production in suburban areas
Arable farming	Improved agricultural technologies	Changing sowing period
		Introducing new varieties of crop
		Expanding application of fertilizers
		Extension of irrigated croplands
	Increased agriculture production	Implementing Agriculture campaign- 'ATAR3' in order to meet wheat and vegetables demand of the country
		Recovering and vegetating abandoned crop fields unused since 1990
		Developing infrastructure using market economy leverages
		Strengthening agricultural research institution focused on upgrading grain variety, agro chemistry, sowing, technology, agricultural equipments, marketing, pests and diseases etc

		Improving the structure of information exchange between local and international agricultural institutions and farmers
Water resource	Improved water resource management	Developing and implementing Integrated River Basin Management policy and plans in the river basins and at national level, coping with desertification
		Reinforcing national policy on covering the upper part of runoff formation zones by the Protected area network and protect it's ecosystems
		Construct water reservoirs harvesting glacier melting water, lakes and rivers for multipurpose, such as regulation of water flows, hydropower generation, drinking and industrial water supply, pasture watering and etc
		Reinforcing water storage policy in the upper river basins
	Increased urban water supply	Encouraging efficient and economic use of water resources through water saving technologies, water metering systems, and reuse of water at household and industrial levels
		Maintaining promotional activities on water saving and protection
		Imposing an appropriate and modernized tariff system on water
	Increased pastureland and agriculture water supply	Building up an oasis network based on the balance of pasture land and heads of livestock
		Maintaining, equipping and restoring old wells through proper solution of issues pertaining to ownership of wells
		Improving efficiency of irrigation systems and introducing water saving technologies such as low-flow showers, drip irrigation and night irrigation
		Improving the effectiveness of ground water utility
	Improved water quality	Advancing the level of water purification and sewage water treatment plants in urban areas
		Intensification of water substances and sanitation monitoring
	Changed behavior of population to use water efficiently	Educating the public and changing their attitude towards water resources, usage and protection
		Implementing the policy on providing equality on water use
Human health	Reduced risks to human health caused by natural disasters, communicable diseases and climate change	Implementing 'Healthy Mongolian' programme in order to change public behavior to prevent health risks and threats
		Setting up early warning system of human health risks and improve response capacity
		Improving the capacity to research the impact of climate change on public health
Forestry	Ensured sustainability of forest resources	Strengthening forest resource protection and conservation management
		Expanding green areas and trees in urban areas
		Supporting individual and organizations initiatives in planting trees and introduction of advanced technologies
		Increased resource of shrubs and bushes in the Gobi desert area through appropriate solutions of fuel for household fires

and the National action plan on climate change. The good management and coordination of activities included in these programmes are essential to reduce the desertification.

Natural disasters and communicable diseases

Mongolia is one of Asia's counties most prone to natural disasters, due to the increasing number of the population affected by natural calamities. Due to climate change, the frequency and magnitude of natural disasters in Mongolia is tending to increase. For instance, the occurrence of forest and steppe fires and their recurrence have increased tremendously because of the decline in spring precipitation by 17 percent in the last 60 years. The damage from fires is estimated to be billions of Tugrugs, excluding the environmental and human losses. There is a likelihood that the occurrence of steppe fires is dependent on the intensification of El Nino or Southern oscillation. So, it is vital to improve the management capacity of the Government, its institutions and the public towards hazards and early warning systems of natural disasters such as drought, zud (severe winter), snow storms and floods. Also, scientific approaches and models need to be used in developing forecasting methods and appropriate computing capacities to predict and estimate future climate change in Mongolia.

Animal Husbandry

Pastoral animal husbandry has adapted to climate and its risks for centuries in Mongolia. However, current climate change has been accelerating, so actions to adapt to climate change are necessary in livestock sector management.

The Government of Mongolia has approved 'The Livestock Programme' which includes the following five directions:

- ensuring sustainable development and creating a good governance at animal husbandry's sector by arranging a good economic environment and infrastructure for the sector;
- making products and raw materials of biological high quality and improving market competitiveness by refinements in livestock breeding and service in accordance with social needs;
- ensuring health of Mongolian livestock and protecting the social health by bringing the level veterinary service and practices into accordance with international standards;
- creating a network of meat procurement and sale by developing a goal-directed market for livestock, livestock raw materials and products, and accelerating the economic circulation.

Climate change adaptation strategy in animal husbandry stimulates the implementation of the above directions of the programme. The adaptation measures will decrease the adverse impact of climate change on animal weight and production and pasture production. This approach should be consistent with the government policy that promotes community and herders' ownership. The basis of state policy on pasture land management is to establish a network of pasture land management.

Arable farming

The impact of climate change causes a noticeable reduction in the crop yield of the central region. So, adaptation to climate change and prevention measures must be taken at the level of the agricultural sector as well as at the national level, with an immediate start.

Training and educating the general public and the people in the agricultural sector on climate change adaptation measures is essential. Research on agriculture and animal husbandry should focus on the development of new varieties of crops, resistant to climate change. Possible counter actions to overcome the negative impacts of climate change should be the priority adaptation methods. Agricultural adaptation methods are mainly addressed to state and private farming entities.

Water Resources

Water is not only a component of nature, but also plays a leading role in the restoration, protection and upgrading of the ecosystem. Land utility and other human activities are all regulated by water management. So, the most appropriate method to adapt to climate change in the water sector is the formulation and stabilization of a water resource management policy.

As suggested in various researches, land surface water resources tend to be enhanced during the first stage of climate change. However, there is no sign whatsoever of enhancement as yet during these years. This means that people still face the problems of water scarcity. Building structures which regulate the flow of rivers and lakes are not only the means of adaptation to climate change but also the solution to the problems pertaining to water shortage, overcoming water scarcity, prevention of floods and so on.

Considering the current water situation and the anticipated impacts of climate change on water, it is necessary to implement the following activities:

- Protection of water resources:
- Improvement of urban water supplies
- Increasing pasture water supplies
- Introduction of modernized water saving technologies and irrigation systems
- Improving water quality and water sanitation
- Educating public on proper water usage

4.4.2. Implementation strategy of adaptation measures

The current priority issue is not whether it is necessary to adapt to climate change, but how to adapt to it. The major part of adaptation is targeted on studies and assessments of climate change impact, including evaluation of the impact of climate change, its dangers and risks and the formulation of methods and measures to mitigate it. Efficient methods and strategies are needed in the first place in order to implement an adaptation policy on climate change. Implementation strategies must include factors related to legislation, structure, finance, human resources, science and media, and coherence with other policies and strategies. Also, it is vital to assess the subjective and objective impediments to the implementation of strategy and to take into the consideration how it is correlated with other socio-economic demands, while formulating a methodology to overcome or facilitate the removal of these impediments.

The sustainable development of Mongolia is largely dependent on the beneficent cooperation of the environment and the economy, while the economy is closely related with natural resources such as pastureland, animal husbandry, agriculture and natural resource utility. Adaptation technology usually requires a considerable amount of investment at the outset. On the other hand, the efficiency of adaptation measurements is not easily recognized in the short term and it takes a tremendous amount of effort and time before visible result are achieved.

Hence the priority concerns are as follows:

1. Organizing broad activities on climate change such as public awareness campaign and many other kinds of trainings among decision making authorities, farmers, the people working in the agricultural sector and the entire nation;
2. Providing herders and farmers with information and new technology;
3. Inventing technology and conducting surveys and studies oriented towards resolving the issues efficiently and to provide sustainable agricultural development;
4. Taking management actions targeted on providing coherence between surveys, monitoring and information

Apart from funding, the major factors in the successful implementation of adaptation procedures are ability, willingness and the concern of the people involved with the realization process. A successful completion is guaranteed only when there is provision for public participation in the action. The herders, farmers and local communities are the first sectors to benefit from a policy of adaptation. Also, it is crucial to have the participation and assistance of experts and specialists in training, fertilization, selection and invention of new breeds and irrigation construction. Currently the importance of taking action to increase public awareness of climate change is obvious, as well as the need to increase government willingness to cooperate with NGO-s and the public, to be supported by them and provide them with adequate information.

BOX

MESSAGE FROM OF THE GOBI DESERT BY THE GOVERNMENT OF MONGOLIA ON CLIMATE CHANGE

Gashuuny Khooloi, Bayandalai soum, Omnogobi province, Mongolia ***August 27, 2010***

On 27 August 2010 the Government of Mongolia held its special meeting at Gashuuny Khooloi, Bayandalai soum, Umnugobi province, where the effects of rapid desertification are being accelerated by climate change, decided to issue the following message addressed to the world community.

The Government of Mongolia,

Expressing the genuine aspirations of the Mongolian people to undertake urgent actions to tackle the challenges of climate change;

Referring to the ultimate objective and principles of the United Nations Framework Convention on Climate Change;

Welcoming the United Nations Decade for Deserts and the Fight against Desertification (2010-2020) launched on 16 August 2010 at the initiative of the Secretary-General of the United Nations;

Expressing the appreciation for the efforts and initiatives of the nations to mitigate climate change and strengthen capacity for climate change adaptation;

Underlining the adverse impacts of climate change on the socio-economic development of developing countries;

Concerned of the fact that any delay in the negotiating process of establishing new agreements on climate change may result in unpredictable consequences;

Expressing our intention to elaborate and implement national and sectoral policy, strategy and programs aimed at climate change adaptation and greenhouse gas emissions reduction;

Taking into account the evidence of recent research works and studies revealing the increasing impacts of climate change on ecosystems, societies and economies;

Underscoring the facts that:

- annual mean temperature has increased by 2.1^{0}C in Mongolia since 1940;
- seven out of the 10 most disastrous droughts and dzuds recorded since 1940 have occured after 2000;
- over 20 percent of its livestock animals were perished by the dzud that occurred in the 2009/2010 winter and resulted in the loss of livelihoods of thousands of herders;
- in less than 20 years more than 70 percent of its territory has been affected by desertification and pasturelands are subjected to degradation;
- yellow dust is on the increase and spreads throughout the Northeast Asian region and;
- hundreds of rivers, springs, streams, ponds and lakes have dried up, causing water shortage and biodiversity losses in some areas.
- Drawing the attention of the world community to the fact that Mongolia's traditional nomadic civilization based on pastoral animal husbandry is likely to be at risk by mid of 21st century;

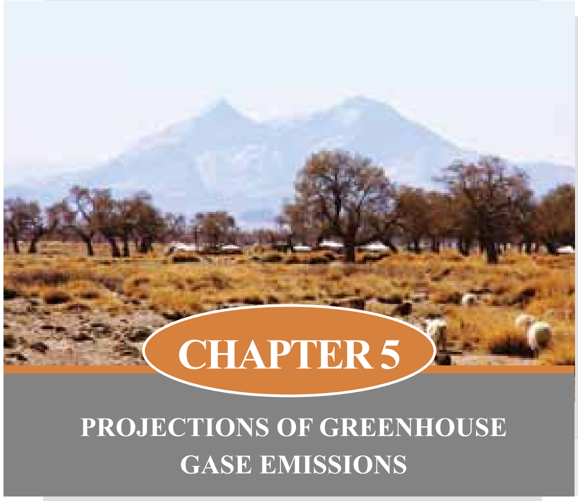
We, members of the Government of Mongolia,

1. *call* upon the world community, especially developed countries, to adopt a decision at a Conference of the Parties to the United Nations Framework Convention on Climate Change which takes account into the specific circumstances of developing countries that are landlocked, vulnerable and affected by rapid desertification.
2. *request* developed countries to establish a flexible mechanism that enables developing countries, in particular those with landlocked location and fragile ecosystem, to strengthen their capacity for countering climate change, introduce climate-friendly technologies, and provide financial resources in order to take appropriate response measures for climate change adaptation and greenhouse gas emissions reduction.
3. *reconfirm* our position that the role and responsibility of developed countries continue to be high to combat climate change and underline the importance of engagement of emerging economies in the fight against climate change.
4. *express,* by virtue of this message, our strong determination and support for the efforts of the international community, including regional organizations and nations towards protecting the global ecosystem for future generations, recognizing that there is no country or region immune from the impacts of climate change.

THE GOVERNMENT OF MONGOLIA

CHAPTER 5

PROJECTIONS OF GREENHOUSE GASE EMISSIONS



This chapter shows projections of GHG emissions between 2006 and 2030 in Mongolia. For the forecasting emissions from fuel combustion which accounts for most of the GHG emissions, calculation results from LEAP modeling of Mongolian Long term Energy planning are used. Emissions from agriculture, land-use change and forestry, and waste sectors were calculated on the basis of previous trends, taking into account social and economic changes and currently implemented or adopted policies and measures.

5.1 Projected emissions and removals by sectors

5.1.1 Energy

GHG emissions from energy demand

The projection of GHG emissions from energy demand by sectors and by fuels are shown in Figure 5.1 and Figure 5.2. Apparently, the energy consumption in the household sector depends on the growth rates of the population, the number of households and income level. GHG emissions from the residential sector are projected to increase, largely due to the increase of population with a growth rate of 3 percent. Energy consumption in the household sector will increase 1.84 times in 2020 and 2.55 times in 2030 from the base year of 2006. The energy consumption in the industrial sector is rapidly increasing due to the development of the mining and quarrying industry in mining projects such as Oyu tolgoi, Tavan tolgoi and other mining projects, especially from 2014 to 2020. GHG emissions from fuel combustion in the industrial sector are projected to increase 4.3 times in 2020 and 7.0 times in 2030 from the base year 2006 (Figure 5.3).

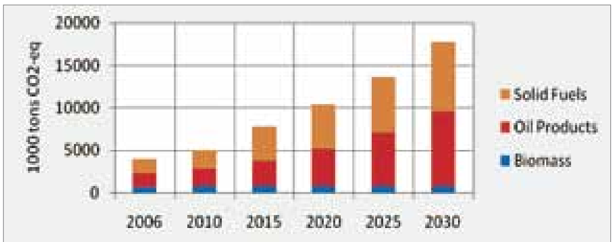


Figure 5. 2. GHG emissions from energy demand by fuels

The transportation sector is projected also to have a high growth rate of GHG emissions among the energy sector due to the relatively high increase of the number of vehicles and the demand for freight transport. GHG emissions from fuel combustion in the transport sector are projected to increase 2.5 times in 2020 and 4.9 times in 2030 from the base year of 2006. GHG emissions from the commercial

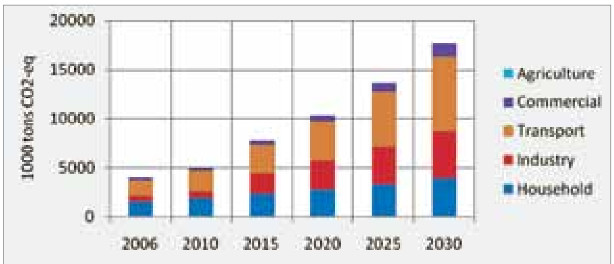


Figure 5.1. GHG emissions from energy demand by sectors

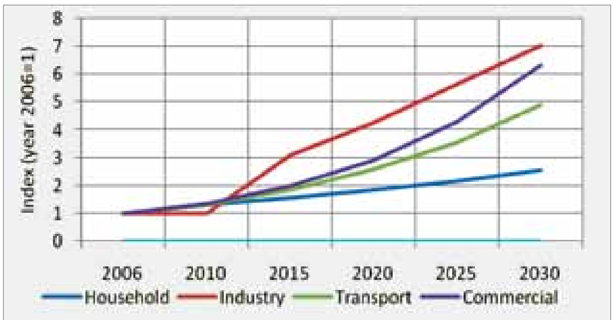


Figure 5. 3. Projected GHG emission trend index

sector are projected to increase 2.9 times in 2020 against 2006.

According to this projection the GHG emissions from energy demand, including emissions from biomass, will be increased from 4,000 Gg of CO_2-eq in 2006 to 10,400 Gg of CO_2-eq, or by 2.6 times, in 2020 and by 4.4 times in 2030.

GHG emissions from energy generation

In order to meet the growing energy demand, new energy sources such as the combined heat and power plant (CHP) in Ulaanbaatar with a capacity of 300MW, the wind farm in Salhit Uul near UB with a capacity of 50MW, the Mogoin gol thermal power plant with a capacity of 60 MW, the Hushuut thermal power plant of 36 MW and Tavan Tolgoi thermal power plant of 300-600 MW are expected to be established, according to the Government's infrastructure development programme for the next few years. It is also assumed that existing power plants will be rehabilitated and their capacity increased. The projections of GHG emissions from electricity and heat generation by energy sources are shown in Figure 5.4.

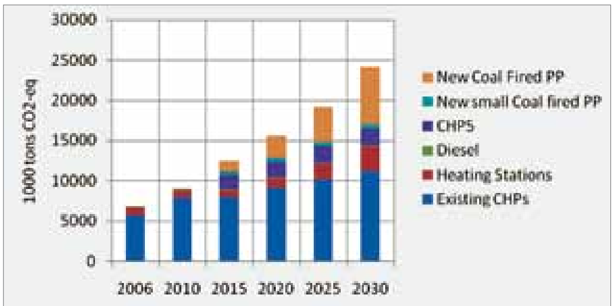


Figure 5. 4. GHG emissions from electricity and heat generation, Gg CO_2-eq

GHG emissions in the energy generation sector accounted for 6,850 thousand tons of CO_2-eq in 2006, and are projected to account for 15,560 Gg of CO_2-eq in 2020 and 24,130 Gg of CO_2-eq in 2030. Projections of GHG emissions in the transformation, with the exception of fugitive emissions, indicate carbon dioxide comprising 99.8 percent of total emissions from fuel combustion, whereas very little amounts of methane and nitrous oxide are emitted during the process of fuel combustion.

GHG emissions from energy transformation are estimated to rise by 2.27 times above the 2006 level by 2020 and 3.52 times by 2030. However, in the long-run, GHG intensity (GHG/energy) is projected to increase by 1.2 times in 2020 and 1.28 times in 2030 from the 2006 level (Figure 5.5).

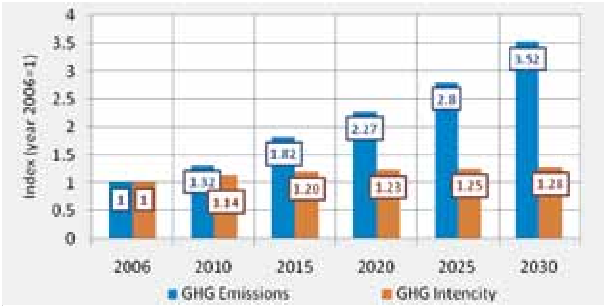


Figure 5. 5. Projections of major GHG index (base of 2006=1) in energy generation

Projection of total GHG emissions from energy sector

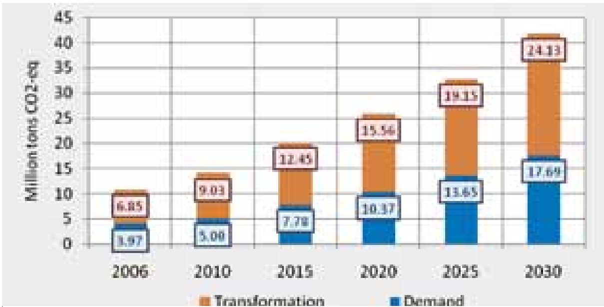


Figure 5. 6. GHG emissions from energy generation and energy demand

` The total GHG emissions from the energy sector are shown in Figure 5.6. The proportion of GHG emissions generated by the demand sector to the total GHG emissions from energy use is projected to increase to 42.3 percent in 2030 from 36.5 percent in 2006, as a consequence of an increase of energy-intensive industries and the intensive increase of the transport and commercial sectors. It is shown that the share of coal consumption in the total fuel consumption by energy sector is not reduced and is projected to be at about same level in 2030 as in 2006. (Figure 5.7).

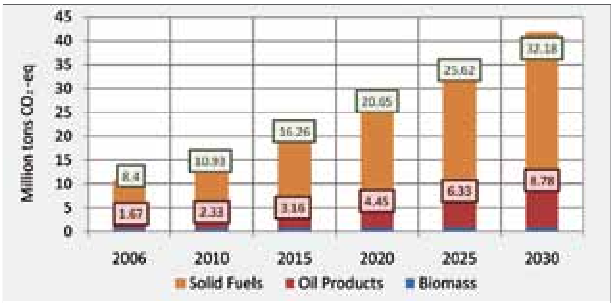


Figure 5. 7. GHG emissions from energy sector by fuels

5.1.2 Industrial processes

Energy consumption in the industrial sector is rapidly increasing, due to the development of mining and quarrying and other industries. The projection of GHG emissions from these industries is included in the energy sector above. Therefore, in this sector only cement and lime production and potential emissions from consumption of HFCs are presented. Cement production is expected to increase 4.1 times in 2020 and 6 times in 2030 from the 2006 level, due to an increase in building construction, and urban and industrial development.

The production of lime is projected to increase 2 times in 2020 and 3 times in 2030 from the 2006 level. It is assumed that the potential emissions from the consumption of HFCs will be increased 2.3 times in 2030 from the base year 2006, due to an increase of different kinds of refrigerators and cooling systems. The projection GHG emission from industrial processes is shown in Figure 5.8.

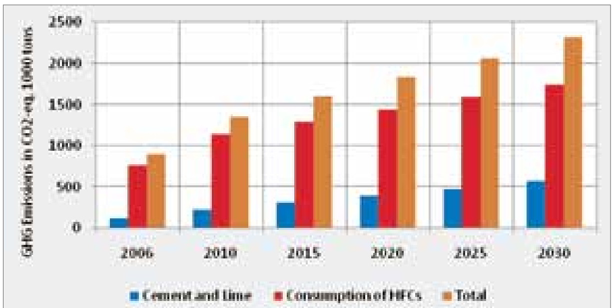


Figure 5. 8. GHG emissions from industry

5.1.3 Agriculture

Most GHGs emitted from agriculture are methane. Enteric fermentation and manure management are major sources of methane. The projection of methane emissions from agriculture sector depends on changes in the livestock population. According to the Mongolia National Livestock Programme, the livestock population is intended to be decreased from 44 millions in 2008 down to 36 millions in 2021, in order to comply with the actual pasture carrying capacity and to prevent desertification. The projection of methane emissions from animal husbandry shows that the methane emissions from enteric fermentation and manure management increased from 2006 to 2008 because of the increased animal population. It is expected to be reduced by the end of 2010 because of the extreme winter - zud in the 2009-2010 winter season (Figure 5.9).

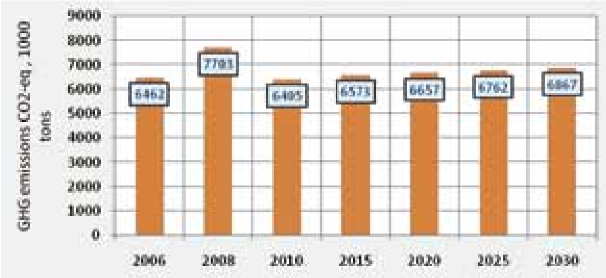


Figure 5. 9. Projections of GHG emissions from agriculture sector

As mentioned above, a reduction of animal population is expected in the future. However, the methane emissions have slightly increased because of the increased proportion of dairy cattle share in the total number of animals.

5.1.4 Land-use change and forestry

Crop cultivation plays an important role in sustaining self-sufficiency in foodstuffs. After the privatization of the large state-controlled farms in the 1990s, crop production fell sharply, a decline blamed on a lack of management skills, funds, and technologies. However, as result of the "Third Agriculture Campaign" launched by the Government of Mongolia, the production of cereals, potatoes and vegetables has been rapidly increasing since 2008. In 2009, Mongolia produced 255 thousand metric tons of cereals, in comparison to cereal production of 138.6 thousand metric tons in 2006.

It is projected that cultivated land for crops would increase up to 400,000 ha in 2020 and from 162,040 ha in 2006. However, the total cultivated area including crop rotation areas would not exceed 650,000 ha in 2020. It is assumed that the lands used for industrial mining would be increased by 12 percent annually. Also, forest plantation between 2006 and 2020 is proposed to increase by 10 percent per year while the annual biomass consumption from stocks would be reduced by 4 percent annually.

The removals from land-use change and the forestry sector between 2000 and 2030 are estimated to be reduced by 9.3 percent annually. The CO_2 emissions are estimated to be reduced by 10.8 percent (Figure 5.10) by 2030.

Figure 5.10 CO_2 emissions and removals from land use change and forestry sector

5.1.5 Waste

GHG emissions from solid waste and domestic and commercial waste water are expected to increase by 3 percent annually between 2000 and 2030. Population, lifestyle, the level of water consumption etc. would directly affect the amount of GHGs emitted from domestic sewage. However, future changes in lifestyle and an increase in the urban population are projected to result in a growth rate of methane emissions from domestic sewage. GHG emissions from industrial wastewater, which is influenced by the amount of industrial water converted into wastewater, are also estimated to grow at a rate of 5 percent annually. The methane emissions from the waste sector are shown in Figure 5.11.

Figure 5. 11. Metane emissions from waste sector

5.2 Aggregated projections of GHG emissions

The total GHG emissions during the projection period are expected to gradually increase due mostly to the increase in the energy industry and energy consumption by economic sectors. The total GHG emissions are expected to increase by 7.95 percent annually from 2006 to 2015 and 4.78 percent from 2015 to 2020. The average annual growth rate of the total GHG emissions from 2006 to 2030 is expected to be 9.33 percent. The aggregated projections of GHG emissions by sector are shown in Table 5.1.

The projections indicate that Mongolia's GHG emissions will rise above 2006 levels by about 2.1 times in 2020 and 3.2 times in 2030 (Figure 5.12).

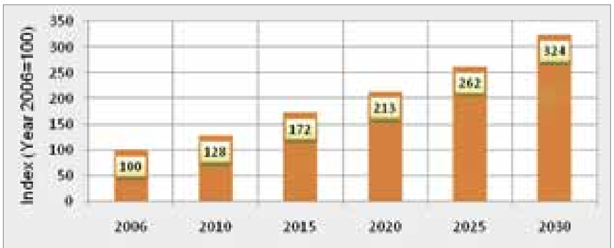


Figure 5. 12. Projected GHG emissions trend

Table 5. 1. Aggregated projections of GHG emissions by sector

Sectors	GHG emissions in Gg CO_2 -eq						Average annual growth rate , %			
	2006	2010	2015	2020	2025	2030	2006-2015	2015-2020	2020-2030	2006-2030
Energy	10,220	14,033	20,233	25,930	32,796	41,815	10.89	5.63	6.13	12.88
Industry	891	1,354	1,602	1,836	2,065	2,318	8.87	2.92	2.63	6.67
Agriculture	6,462	6,405	6,573	6,657	6,762	6,867	0.19	0.26	0.32	0.26
Land use change and forestry	-2,083	-1,932	-1,785	-1,420	-1,000	-680	-1.59	-4.09	-5.21	-2.81
Waste	138	158	183	209	254	294	3.62	2.84	4.07	4.71
TOTAL	15,628	20,018	26,806	33,212	40,877	50,614	7.95	4.78	5.24	9.33

During the same period, emissions from the energy sector are expected to increase by 4 times while those from the agriculture sector will increase by only 6 percent and emissions from waste by 3.6 percent annually. At the same time, removals from land-use change and forestry are projected to decrease 3 times (Figure 5.13).

According to projections by gases, carbon dioxide, the main gas from energy related GHG, would experience a relatively modest increase from 2006 by 2.2 times to 2020 and by 3.5 times to 2030. Methane emissions will be increased by only 1.15 times from 2006 to 2030 (Figure 5.14).

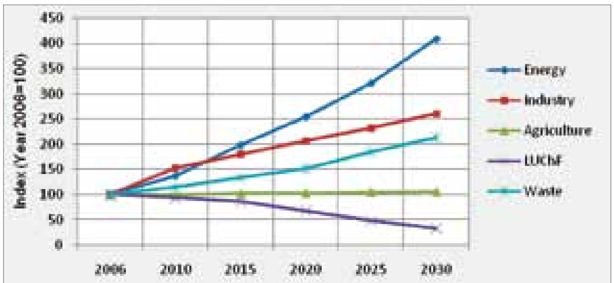


Figure 5. 13. Projected GHG emissions and removals by sources/sinks

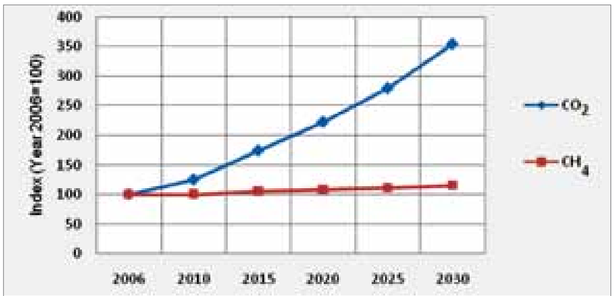
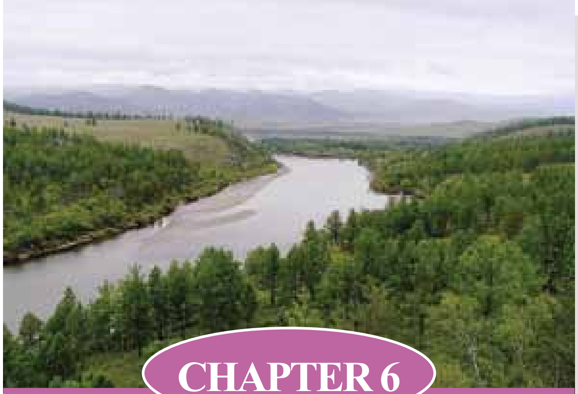


Figure 5. 14. Projected GHG emissions by gases

CHAPTER 6

CLIMATE CHANGE, IMPACT ASSESSMENT, ADAPTION OPTIONS



CHAPTER 6

CLIMATE CHANGE, IMPACT ASSESSMENT, ADAPTION OPTIONS

6.1 Current climate change in Mongolia

According to meteorological observation data since the 1940s, the mean air temperature has increased and precipitation has decreased in most areas of Mongolia. Climate model results and dendrochronology analysis for 2000 years confirm significant changes in the country's climate over the past 40 years.

In the coming century, climate change will probably radically change the traditional way of life that has been established in Mongolia for thousands of years. The effects of climate change will cause considerable damage not only to the ecosystem and natural resources but also to the economic and social sectors of the country. Current and future climate changes and their effects are comprehensively described below.

6.1.1 Air temperature changes

According to observation records for the period 1940 to 2008 at 48 meteorological stations, distributed evenly over the territory of Mongolia, the annual mean air temperature of Mongolia has increased by 2.14^{0}C (Figure 6.1). In the high mountain areas higher temperatures increase have been observed than in the Gobi and the steppe regions. In the last 69 years, out of the 10 warmest years, 9 have occurred since 1990. The warmest year was 2007, the second was 1989, while the third was 2004.

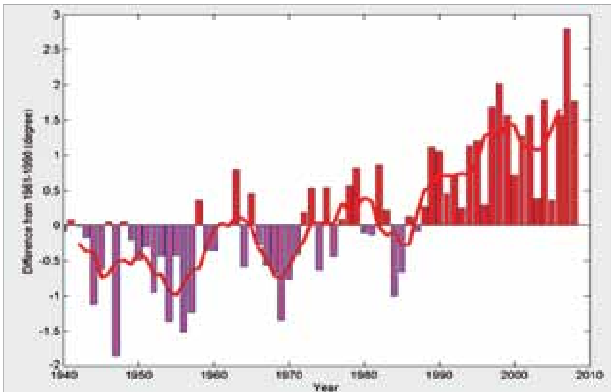


Figure 6. 1. Average air temperature trend (anomaly from the average for the period 1961-1990)

Air temperature increases were slight in all seasons except summer during the 2000s. However, the average summer temperature has been increasing noticeably since 1940 (Figure 6.2).

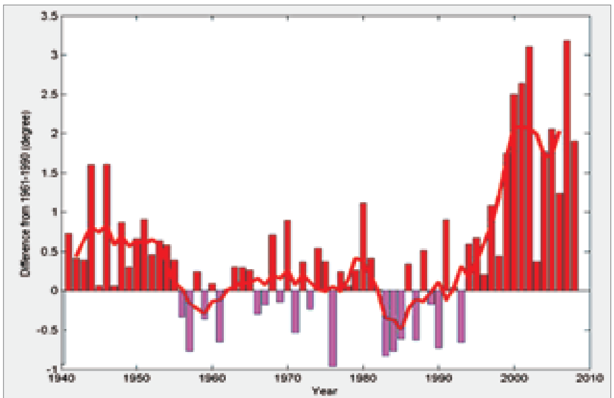


Figure 6. 2. Average summer temperature trend (anomaly from the average for the period 1961-1990)

Due to global warming, the frequency of extreme high temperatures has increased, whereas the incidence of extreme low temperatures has decreased. According to the classification of extreme climate indices, the number of hot days with a maximum air temperature above 26^{0}C (su26) increased by 16-25 days, the number of cold days with minimum air temperature below -5^{0}C (fd-5) decreased by 13-14 days, and the vegetation growing period (gsl) increased by 14-19 days. Moreover, the duration of the warm season (Wsdi) increased by 8-13 days, while the duration of the cold season (Csdi) decreased by 7-11 days due to the warmer climate,.

6.1.2 Precipitation changes

In terms of precipitation, there is an increasing trend of winter precipitation and a decreasing incidence of summer rainfall. Figure 6.3 shows the anomaly trend of annual precipitation from the mean for the period of 1961-1990.

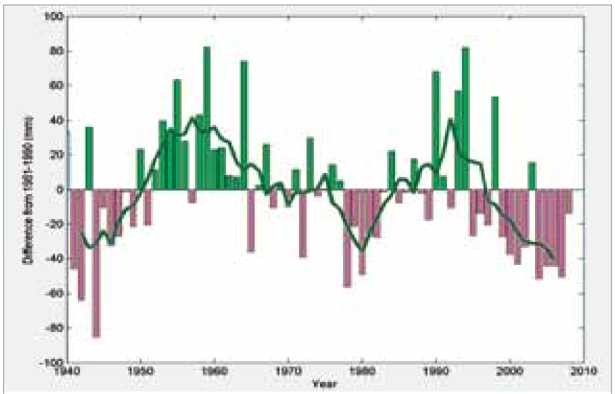


Figure 6. 3. Annual precipitation anomaly from the mean 1961-1990

Precipitation changes in Mongolia since 1961 can be classified by stations: in the Altai mountain region, the Gobi and the eastern part of the country it has increased, and in all other regions it has decreased by 0.1-2.0 mm/year (Figure 6.4).

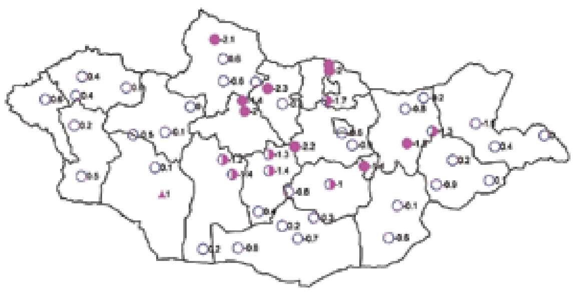


Figure 6. 4. Coefficient of linear trend equation of warm season precipitation change
Note: colored circles indicate more than 95%- reliable, half-colored 90% reliable, non-colored circles indicate precipitation decrease and triangles indicate increase

The central region of Mongolia, where a 95 percent reliable precipitation decrease was observed, had the highest decrease in precipitation. In the Gobi Altai mountains, precipitation increased by 95 percent reliability. In parallel, rainfall has dropped by 50 to 200 hours in all regions except the Altai mountains and the desert in the last 30 years. Another change that has been observed is that the proportion of storm rain in the total precipitation has increased by about 20 percent during the vegetation growing season.

6.1.3 Climate extreme indices changes

Hot temperature. According to recorded data for 1975 -2007, the number of hot days that exceeded 30^0C increased by 5 to 8 days in the eastern part of the country and the Great lakes depression. But, the rate of change is lower in the Altai and the Khangai mountains.

The increasing number of hot days is more than 95 percent, which is statistically reliable in most of the regions except stations located in the high mountain areas (Figure 6.5), while in most areas of the steppe and the Gobi-desert zone it is 99 percent reliable.

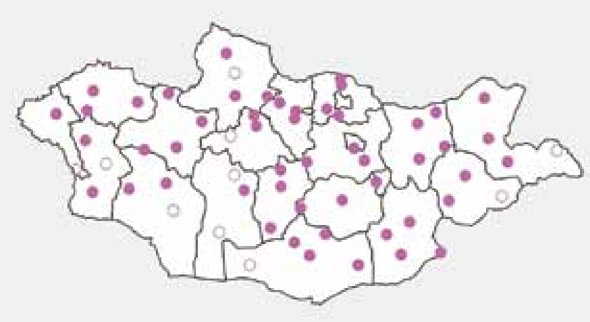


Figure 6. 5. Statistics persuasive of coefficient equation of number of hot days with temperatures higher than 30^0C
Note: in bright color if more than 95%- reliable

The highest temperature records between 1940s to1990s were broken in the last few years. According to the study, after 1991 the highest temperatures occured and were recorded in 58 out of 60 stations.

In the period 1975 to 2007, heat waves were recorded 13 times and 9 out of those observed since 1991 were in the capital city Ulaanbaatar.

Precipitation intensity. As mentioned above, the amount of rainfall in the warm season has tended to decrease in most areas of Mongolia, although the daily maximum precipitation has evidently increased since 1980s due to warming. In particular, the daily maximum precipitation was recorded at 28 stations during the 40 years before 1980, and at 36 stations in the period from 1981 to 2008.

As precipitation intensity increases, the extent of the damage it causes also increases. As a result of extreme events (atmospheric convection) such as thunderstorms, flashfloods, hail, etc., the damage has significantly increased during the past 20 years and caused human deaths and economic losses. The frequency of natural disasters has doubled (Figure 6.6.)

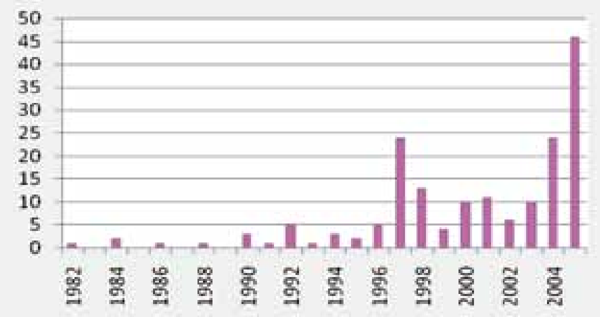


Figure 6. 6. Atmospheric convection related natural disasters numbers

Dust storms. In the past years, dust originating in the Gobi deserts of Mongolia and northern China passed over the north-eastern part of China, Korea and Japan having a negative influence on human health, the environment and industrial processes. The dust is known as 'yellow dust storm' or 'yellow sand'. The number of days with dust storms per year at 34 meteorological stations located throughout the country, are shown in Figure 6.7.

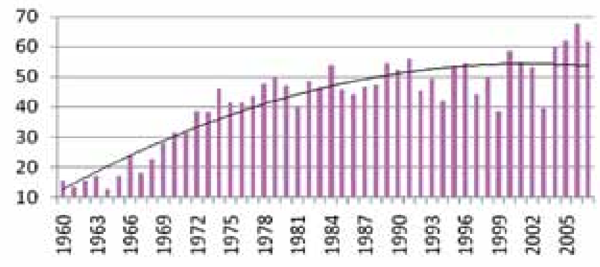


Figure 6. 7. The annual number of days with sand-dust storms

According to the figures, dust storms have been increasing significantly during recent decades. For instance dust storms were observed on 18.3 days during a year in the period 1960 to 1969, 40.9 days in 1970 to 1979, 47.4 days in 1980 to 1989, 48.5 days in 1990 to 1999 and 57.1 days in 2000 to 2007.

Atmospheric drought. Mongolia belongs to a drought risk area due to its location in arid and semi-arid areas. Atmospheric drought is defined by the indicator of Si - anomaly of normal air temperature in warm seasons from the normal precipitation amount. This characterizes arid regions, because drought is considered to be a climate anomaly phenomenon. Therefore, climate dryness is intensified in Mongolia within the pattern of global climate change. Figure 6.8 presents the drought index in multi years and confirms the intensified drought in the country.

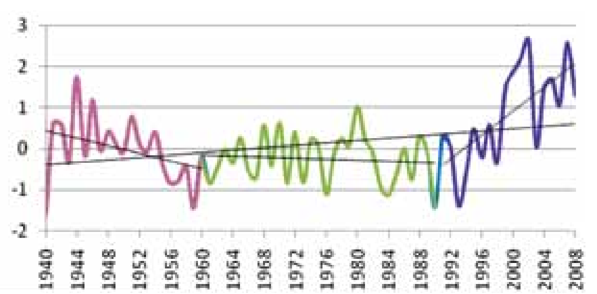


Figure 6. 8. Multi year drought index

Note: positive value represents dryness, negative value- wetness

Zud (severe winter). Nomadic livestock totally depends on nature and weather conditions and the zud causes hundreds of thousand to millions of animal deaths and huge damage to the economy of the country. The zud index in multiple years is presented in Figure 6.9. In previous years, the extent of the zud was generally lighter during the period 1940 to 2000, but the zud index dramatically increased later due to the intesified drought index from the 1990s and the colder snowy winters in the 2000s. The harshest winter was in 1944-1945 as its index reached 3.34 and 31 percent of the total livestock of Mongolia was lost. Generally, the high zud index was caused by severe winter conditions before 2000 and in the following seasons after the summer drought conditions. When the zud index is high, the areas affected by the zud and animal losses are greater.

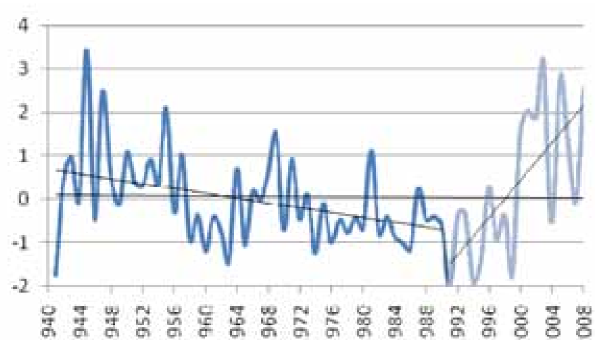


Figure 6. 9. Multi year average zud index in Mongolia

6.2 Climate change projections for the 21st century

Results of multi model ensemble

In the climate change projections, three GHG scenarios (A2, A1B and B1) have been used, based on 24 climate models developed by 17 World Centers as cited in the Fourth Assessment Report of IPCC.

Inter-annual winter precipitation increase is less than 50 percent and its value will increase by nearly 23 percent in 100 years, while summer precipitation is changing by less than 20 percent and its value will increase by only 3 percent. By comparison, winter precipitation will increase more than summer precipitation. Over time it will increase gradually until 2070 and will then stabilize.

Generally, based on overall climate change assessment the climate of Mongolia is expected to change so that winter will become milder and summer drier. Dryness, as expressed in percentage, will be more intensified due to high evapotranspiration and small increases in summer precipitation as compared to the normal climate.

With regard to temperature spatial distribution, eastern Mongolia will be warmer in the winter season compared to other regions, whereas the western part of the country will be warmer in the summer season.

According to the geographical pattern of precipitation change, the precipitation is expected to increase in the central and the eastern parts of Mongolia in winter as well as in the eastern and the south-eastern parts in summer. A decrease in precipitation is projected at 10 percent in western Mongolia.

Results of the HadCM3 model by HADLEY center

The assumption was that a model' with minimum error in calculation, of past climate conditions can project a future climate change scenario for Mongolia. Based on statistical interpretation of the global climate models outputs, the HadCM3 model of the HADLEY center was the most suitable for the specific conditions of Mongolia.

Results of the HadCM3 model are presented in Table 6.1.

Table 6.1 shows that the intensity of warming in the summer season is higher than winter and the

Table 6. 1. Results of HadCM3 model by HADLEY center

Period		Temperature change, ^{0}C			Precipitation change, %		
		2011-2030	2046-2065	2080-2099	2011-2030	2046-2065	2080-2099
Annual	A2	1.0	2.7	5.0	2	9	15
	A1B	0.9	3	4.6	0	7	16
	B1	0.8	2.1	3.1	3	6	11
Winter	A2	0.7	2.3	4.2	14	19	55
	A1B	0.2	2.5	3.8	0	23	41
	B1	0.2	1.6	3.0	7	14	32
Summer	A2	1.1	3.1	6.3	-2	4	7
	A1B	1.4	3.6	5.6	-4	3	11
	B1	1.2	2.7	3.7	2	0	8

amounts are 1.1-1.4 ^{0}C in 2011-2030, 2.7-3.6 ^{0}C in 2046-2065 and 3.7-6.3 ^{0}C in 2080-2099. Winter temperatures will have increased by 0.2-0.7 ^{0}C, 1.6-2.5 ^{0}C and 3.0-3.8 ^{0}C in the corresponding periods.

In general, the annual precipitation will have increased; however, there is a small decline in the summer season in 2011-2030 according to A2 and A1B GHG emission scenarios. Precipitation in the summer season will have increased by less than 10 percent, which is smaller than the winter precipitation rise compared to their normal climate. The summer precipitation will have decreased by 2-4 percent in 2011-2030, increased by 0-4 percent in 2046-2065 and 7-11 percent in 2080-2099. The winter precipitation is projected to increase by 0-14 percent, 14-23 percent and 32-55 percent, corresponding to the periods mentioned above.

Due to climate change, it is anticipated that winter will become milder with more snow, while summer will become hotter and drier even though there will be a slight increase in precipitation based on the overall climate change assessment.

The contradictory results of the multi model ensemble and HadCM3 model suggest that a further detailed study is required for future climate projection in Mongolia.

6.3 Impacts of climate change on bio-physical environment

6.3.1 Landscape (Ecosystems)

The geographic location of Mongolia occupies about 10° in latitude (from north to south). But within this territory, the geography changes greatly from the Central Asian Gobi desert to Siberian taiga. Its heterogenic surface has created a wide range of ecosystems. Consequently, climate change and human impact in the past decades has lead to changes in landscape and soil, and vegetation ecosystem shifts that have resulted in grassland degradation and impoverishment of species.

Current Landscape changes (by satellite information)

In general, ecosystem production depends on the landscape in direct and indirect ways. Consequently, remote sensing analysis from different satellites has become common practice throughout the world. Accordingly, in 1995, the Mongolian National Remote Sensing Center conducted an analysis using NDVI data for the years 1992-1993 from the NOAA satellite to evaluate the land surface of Mongolia. In 2006, the land surface was evaluated through utilizing MODIS satellite data which has a resolution that is16 times higher than the NOAA satellite data. The changes in land surface were based on a comparison between the different periods of measurement (Table 6.2).

A2 scenario shows that the rate of warming would be slow and as a result the process of forest-steppe turning into steppe would also be slow..

Table 6. 2. Land surface change, km^2

No	Classes	1992	2002	2006
1	Water	17,766	11,335	14,448
2	Barren	52,593	76,700	148,808
3	Grassland I	1,012,424	1,019,592	948,904
4	Grassland II	251,261	250,672	281,661
5	Forest	223,904	205,534	164,293
6	Grassland II + forest	475,165	456,206	445,953.6
	Total area	1,557,948	1,563,833	1,558,114

The comparison showed that water surface decreased by 38 percent from 1992 to 2002, but in 2006 the water area figures increased. Due to the higher quality satellite resolution, small lakes and ponds could be spotted in the 2006 data which were not observable before. Areas without grass (or that were barren) increased by 46 percent from 1992 to 2002. In 2006, this barren area almost tripled, while forest area decreased by more than 26 percent during the same period.

Future impact of climate change

Results of Century 4.0 model

Ecosystem shift is obviously a comprehensive process over many years and the net primary production (NPP) was estimated by the Century 4.0 model in order to assess the impact of climate change on the ecosystem in the periods 2010-2039, 2040- 2069 and 2070-2099.

According to the HadCM3 model, the taiga forest ($NPP>296^0Cg/m^2$) is expected to increase. This is especially noticeable in the years 2020 and 2050. However, it does not mean trees will grow naturally. There is the possibility of advantageous conditions for trees to grow if the biomass increases and there are no effects from human activity. In 2080, the forest-steppe is likely to turn into steppe. But the SRES

The steppe zone ($NPP=131\text{-}25^0Cg/m^2$) is likely to be encroached on by the semi desert zone from the south and will decrease significantly. Due to climate warming, the semi-desert zone will push the steppe zone to the north, especially by 2080. In 2080, forest-steppe and steppe areas will decrease; this will be caused by a decrease in rainfall and an increase in temperature in the growing season (June to September). Even, if the amount of precipitation increases by up to 1.6-2.7 mm, the temperature is likely to increase by 4-7^{0}C which will cause higher evapotranspiration and make the air dryer.

The percentage of desert zone ($NPP=6^0Cg/m^2$) tends to expand to the north. Although the amount of precipitation is expected to increase in the semi-desert and the desert zone, they are likely to expand. In other words, the increased amount of precipitation is still not enough for rapid evapotranspiration demand.

Aridity index. One of the criteria that define an ecosystem is the degree of aridity. There are many indices that describe dryness. In this research, the degree of aridity is represented by the ratio of total annual precipitation to annual potential evapotranspiration. Figure 6.10 presents the natural zones and aridity index geographical distribution in Mongolia.

Based on the above, natural zone and aridity index maps overlap in most areas. Consequently, the

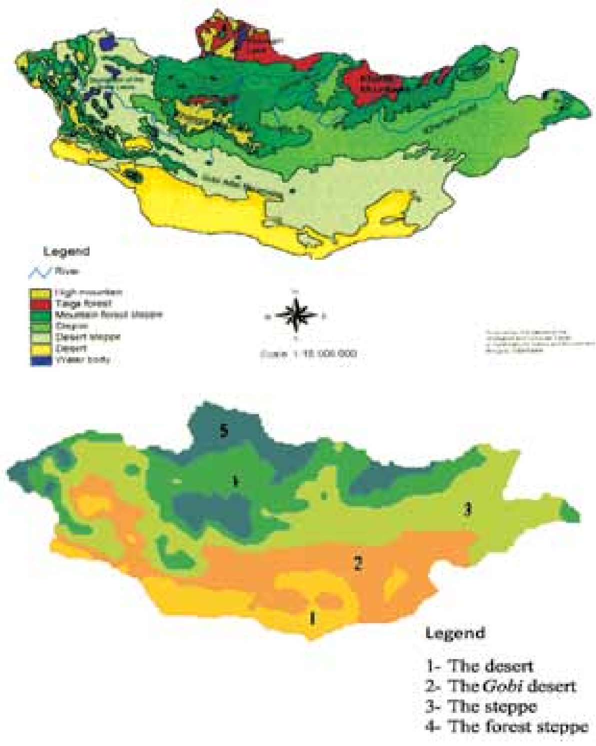


Figure 6. 10. Natural zones and aridity index distribution map

future dryness index can reflect possible vegetation and natural zone shifts in the future.

In the study, the future dryness index was estimated based on Had3CM model by the HADLEY center under A2, A1B, B1 emission scenarios (Table 6.3).

As the climate warms, generally the total amount of annual precipitation also increases, but as the semi-desert and the steppe zones move to the north and the degree of dryness tends to increase more. These changes will be observed to be more significant in 2070-2099.

Therefore, the northern part of the country is considered to be a vulnerable area. This does not mean that one zone would transform into another one immediately. The northern part of the country will tend to become a dryer steppe, but if permafrost melts rapidly, then moisture in the soil would increase. Consequently, the drying process is expected to occur over a long period of time and will affect plants while the moisture from the permafrost declines. However, the percentage of the desert zone will not increase extensively. The increase in the total amount of annual precipitation will reduce the aridity of the climate in this zone.

6.3.2 Rangeland

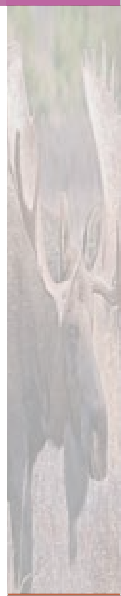
The main constituent of the Mongolian ecosystem is native grasslands. Apparently, its origin, history, composition, its variety of living organisms and development are unique because of the origin and development of the climate, the ground surface and its ecosystems.

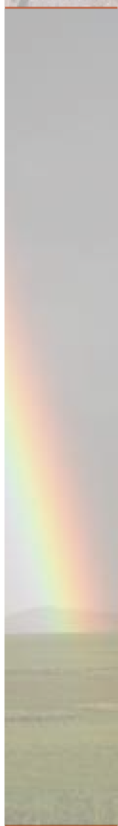
Current changes in pasture

In fact, assessment of the impact of climate change on rangeland in the future is quite a complicated task, because animals and herbivors and climate change jointly have an influence on the grassland. However, the degradation of pasture is largely due to the fact that the number of livestock has almost doubled in the past 20 years, and there have been radical modifications to the composition of herds and changes to the traditional methods and technology for the use of pasture, in the nomadic lifestyle of herders (Table 6.4).

Data analysis of pasture observation confirms that the pasture biomass edible for livestock has decreased. For example, the pasture biomass has dropped by approximately 20-30 percent in the last 40 years. Pasture monitoring data from the National Agency for Meteorology, Hydrology and Environmental Monitoring (NAMHEM) for 1960s to 2007 was used to analyse changes in pasture biomass in different natural zones (Table 6.5). The study showed that in most areas the biomass tended to decrease.

In a linear trend analysis of the Normalized Difference Vegetation Index (NDVI) of satellite data, the NDVI had either decreased or had not changed





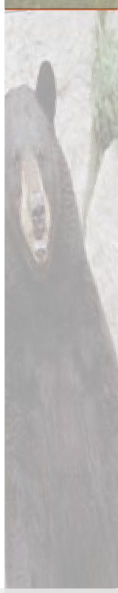


Table 6. 3. Natural zones area changes in Mongolia in 21st century (%)

Natural zones	Aridity index	Area by Ulziikhutag, %	Area by aridity index, %	Area changes, %		
				2011-2039	2040-2069	2070-2099
A2 scenario						
1.The desert	0.03-0.14	15.3	12	12	16	30
2.The Gobi desert	0.15-0.26	21.9	23.7	16	23	37
3.The steppe	0.27-0.50	25.9	31.2	27	36	38
4.The forest steppe	0.51-.070	23.3	20.2	-22	-41	-62
5.The high mountains	0.71<	8.4	12.9	-71	-80	-90
A1B scenario						
1.The desert	0.03-0.14	15.3	12	-17	-1	-17
2.The Gobi desert	0.15-0.26	21.9	23.7	31	25	47
3.The steppe	0.27-0.50	25.9	31.2	32	37	33
4.The forest steppe	0.51-.070	23.3	20.2	-28	-36	-45
5.The high mountains	0.71<	8.4	12.9	-75	-79	-80
B1 scenario						
1.The desert	0.03-0.14	15.3	12	-32	-35	-26
2.The Gobi desert	0.15-0.26	21.9	23.7	32	40	35
3.The steppe	0.27-0.50	25.9	31.2	20	24	23
4.The forest steppe	0.51-.070	23.3	20.2	-9	-18	-16
5.The high mountains	0.71<	8.4	12.9	-63	-70	-68

Table 6. 4. Number of livestock, thousand heads

Animal type	1960	1990	2008	2009
Camel	859.1	537.5	261.8	277.1
Horse	2,502.7	2,262.0	2,122.4	2,221.3
Cattle	1,905.5	2,848.7	2,448.3	2,599.3
Sheep	12,101.9	15,083.0	17,898.0	19,274.7
Goat	5,631.3	5,125.7	19,465.4	19,651.5
Total	**23,000.5**	**25,856.9**	**42,195.8**	**44.023.9**

Source: National statistical yearbook, 2009

Table 6. 5. Linear trend coefficient of pasture biomass changes (100kg/year) on fenced plot from 1965 to 2007

Natural zones	Number of sites	Time series	Month and day			
			24 Jun	24 Jul	24 Aug	04 Sep
The high mountains	10	33-42	-0.01	-0.01	0.00	-0.02
The forest steppe	16	21-41	0.02	-0.02	-0.03	-0.03
The steppe	17	27-41	-0.02	-0.02	-0.02	-0.03
The desert steppe	10	24-40	-0.05	-0.02	-0.05	-0.05
The desert	3	35-41	-0.06	-0.14	-0.10	-0.01

Source: B.Erdenetsetseg 2008

in 69 percent of the total area, and most of the changes occurred in the forest steppe and the steppe.

Thus, the ground observation and satellite monitoring both confirm pasture degradation in Mongolia. According to studies by botanists, pasture species have been impoverished in recent years.

Rangeland future changes

It is a challenge to estimate the future of grassland ecosystems in the long term., for, this depends on the following factors:

- Changes in pasture land use
- Future climate change and extreme conditions such as droughts and hot temperatures
- Anthropogenic and technology pressures such as population growth, air pollution, use of chemicals to destroy weeds, insects and rodents, and other socio economic issues
- Ecosystem changes.

In the study of grassland changes, some factors such as grazing intensity, soil erosion and fires were not considered.

Consequently, the Century 4.0 model that was developed to analyze the dynamics of soil organic matter in North America was used in the research. Pasture biomass at 37 representative sites of Mongolia was evaluated using the Century model within incremental scenarios of temperature increases of 1,2,3,4 and 5^{0}C and precipitation changes of -30, -20, -10, 10, 20 and 30 percent.

With respect to biomass changes, the negative effects of a high increase in temperature by more than 3^{0}C cannot be balanced even by increased precipitation of 20 percent in the forest steppe and the steppe. However, a precipitation increase of 20 percent would be favorable for pasture in the Altai Mountains and the desert steppe in Mongolia.

Pasture biomass changes during the periods 2011-2030, 2046-2065 and 2080-2099 from the base period 1961-2008 were estimated under HadCM3 climate scenario of HADLEY center and A1B emission scenario (Table 6.6).

Table 6. 6. Pasture biomass change in future

Vegetation zones	Aboveground biomass, g/m^2	Aboveground biomass changes in %	
	1961-2008	2011-2030	2046-2065
The high mountains	13.89	-17.43	-22.46
The forest steppe	68.22	-28.41	-37.45
The steppe	38.52	-22.40	-31.46
The desert steppe	8.93	-4.30	-7.36

As can be seen in the table, pasture biomass would decrease in almost all areas especially in the forest steppe and the steppe. Geographical distribution of pasture biomass changes are shown in Figure 6.11.

Figure 6. 11. Pasture biomass changes from the base period 1961-2008

6.3.3 Spread of pasture insects and rodents

In the past decade, the incidence of some insects and rodents has increased due to climate change, drought and extreme weather events. In particular, rodents and grasshoppers became widespread in the drought years of 2000 to 2002 and caused extensive damage to pasture. Furthermore, the increase in pests in crop lands led to a significant decrease in the harvest.

According to information from research, 28 out of the 75 most harmful kinds of crop diseases and 30 types of insects out of 92 are in the crop and pastureland of Mongolia. They cause damage to 15-20 percent of the total yields every year in the country. Researchers estimated that if proper soil tillage measures are not taken against insects and rodents, grain harvest drops by 30-40 percent and potato and vegetable harvest decreases by 60-80 percent.

There was no systematic observation and monitoring system in Mongolia and so the spread and increase of harmful insects and rodents were difficult to study in relation to weather and climate conditions. Since 2002 the NAMHEM has started systematic observation of harmful pasture and crop insects and rodents. The observation will help to estimate the location of the habitats of rodents, the range and density of their increase and the extent of damage to biomass and harvest.

Steppe vole (Laciopodomus brandti): The research indicates that the area of steppe vole distribution has extended because of pasture degradation and the increase in livestock due to climate warming. Observation data from the period 2002-2008 confirms that the extent of the steppe vole population and the number per hole was higher in 2002 and 2007 when droughts were widespread.

According to the observation data, the density of the steppe vole has been recorded as 50-80 in Tsetsen-Uul soum, Zavkhan every year since 2003, 30-120 in Tsengel soum of Bayan-Ulgii, Bayanbulag, and Jargalant soums of Bayankhongor, Dashinchilen soum of Bulgan, Tudevtei of Zavkhan and Kherlenebayan-Ulaan of Khentii aimag in 3-5 consecutive years. In the recent years, voles have spread extensively in most areas of Selenge aimag, the eastern south part of Bulgan, the western north parts of Bayan-Ulgii and Uvs and the north of Dornod aimag compared to the distribution map of voles done by Dr. Avirmed in 2000.

Grasshopper (Eclipophleps tarbinskii Orytsh): There is some indication of grasshopper outbreaks in the Mongol Altai Mountains in 20 soums of Khovd and Bayan-Ulgii aimags. However, exact data are not available of distribution areas, density and dynamics.

Grasshopper Eclipophleps tarbinskii requires a sum temperature of 159.4^{0}C for its full growth stages from diapauses, and a mature grasshopper lives for 30-60 days. The minimum temperature for grasshopper development is 10^{0}C. Given the minimum threshold for grasshopper growth as 10^{0}C and the total sum temperature required for one generation, the lifespan of the grasshopper and the number of population of grasshoppers were estimated for the periods of 1961-1990, 2010-2039, 2040-2069 and 2070-2099 as shown in Table 6.7.

Table 6. 7. Average date of grasshopper emergence, decease and number of generations per year

Period	Eclosion date	Decease date	Duration, days	K1	B
1961-1990	23 May	18 Sep	118	599	4
2010-2039	16 May	19 Sep	126	818	5
2040-2069	11 May	24 Sep	136	1004	6
2070-2099	03 May	01 Oct	151	1390	9

According to the table, grasshoppers live for 118 days from 23 May to 18 September and 4 generations are created in a season. In future, grasshoppers will appear earlier until late autumn and 5 generations will be developed in 2010-2029, 6 in 2040-2069 and 9 in 2070- 2099.

6.3.4 Desertification

Mongolia is located in the most arid and semi-arid region in the northern hemisphere where, according to weather stations' data the ratio of precipitation and potential evapotranspiration varies from 0.04 to 0.78. Only in the taiga and the high mountains does the value reach higher than 0.65, and so the country is the most vulnerable to desertification. Nevertheless, the traditional nomadic lifestyle fully depends on the weather, climate and natural grassland.

Due to the dry climate and the changes that are taking place in Mongolia,, desertification and land degradation have become a real challenge for the country. Theoretically, land degradation is defined as a decline in soil fertility, and land desertification as the increasing scarcity of vegetation biomass, and of sand in the grassland. The least amount of precipitation in a year occurs in April and May with 15-20 percent in the daytime in the semi desert steppe zone. In the semi desert and the Gobi desert areas, winds of 15 m/s and above occur 30-70 days in a year, of which 30-60 percent occur in March and 18.5 percent in autumn. Because of this factor, land surface stays as bare soil without any plant cover around the year. The interval between the ground thawing and the emergence of vegetation is long; hence, bare soil is being blown by the wind for a longer period. This is aggravated if the land has either thin or no snow covering it, when it is arid, and exposed to strong winds. All these factors contribute to the intensification of land degradation. The actions on adaptation to climate change can be carried out through good management of the improvement of land utility.

The first step towards the restoration of soil fertility is improvement of the vegetation coverage on the surface of the soil. Furthermore, it's necessary to increase the amount of humus in it by accumulating organic substances. In different parts of the world, the only way that is used to restore soil fertility is the enhancement of organic substances in the soil. The method of enhancing organic substances varies depending on environmental features and climate. According to the survey conducted by the Institute of Botany and Agriculture (by E. Otgonbaatar, 1991-1994), in the central agricultural zone, the priority is to have a major incentive to increase the level of organic substance residues in the soil. Leguminous plants, in particular, are remarkably useful because of their rich green mass and capacity to increase nitrogen in the soil by bulb bacteria multiplication. They play a role in producing both nitrogen and organic fertilizer in brown soil. For example, the level of nitrogen and humus in the soil has increased after planting Lucerne for three years on the arable land of Boroo, in Zuunkharaa, which was considered infertile and useless. (Dorj,1999)

Research into the desertification dynamics of Mongolia, conducted by using land and satellite monitoring, concluded that 78.2 percent of the territory of Mongolia has been affected by medium and intensive desertification (Figure 6.12).

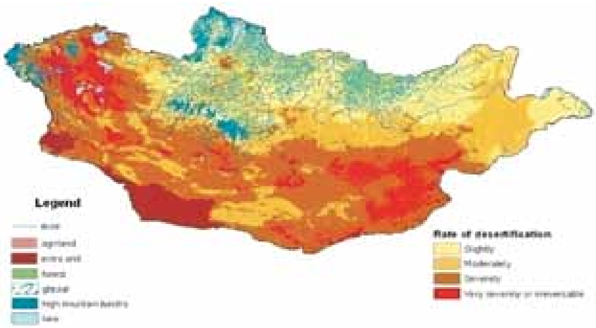


Figure 6. 12. Desertification map of Mongolia
(Source: Mandakh N., Dash D and Khaulenbek A., 2007)

Thus, there are many factors that intensify both the current and the future desertification process. In particular, future temperature increases during the growing season, the potential increase of evapotranspiration, the decrease in precipitation in most areas or lack of precipitation increase to counter higher evapotranspiration demands, hot spells that cause crop stress, intensified heavy rainfall (20 percent), a drop in the duration of total rainfall, early melting of snow cover, longer periods when soil is bare between snow cover until vegetation appears and the growing number of dust storms are leading factors that lead to desertification.

6.3.5 Water Resources

Current changes

Annual water use in the country ranges from 0.5-0.7 km^3/year. However, a surface water inventory conducted in 2003 estimated that there are 5565 rivers and streams, 683 of which are dried-up, 9,600 springs of which 1,484 are dried-up, 374 mineral waters, 10 of which are dried-up, 4,193 lakes and ponds, of which 760 dried-up in the past few years. The surface water inventory conducted in 2007 shows that the number of dry streams, lakes and springs has increased by 30 percent.

The total river flow in the country increased from the end of 1970s till the beginning of 1990s. A long lasting, very low flow period has continued since 1994 till the present (Figure 6.13).

Figure 6. 13. Dynamics of total river flow in Mongolia

Current changes in annual and seasonal runoff of rivers in Mongolia can be divided into 4 groups: 1) Rivers in which annual and seasonal flows show an increasing trend, 2) Rivers in which annual and warm season's flows have a decreasing trend, but show a slight increase in autumn and winter, 3) Rivers where annual and seasonal flows show a decreasing trend, but a slight increase in winter, and 4) Rivers in which the annual and seasonal flows show a decreasing trend. Rivers draining from the glaciers of the Altai mountain range, rivers in the continuous permafrost catchment of the Khuvsgul mountain and Bogd river coming from the Otgontenger glacier in the Khangai mountain compose the first group. Rivers flowing from the continous and discontinous permafrost catchment of the Northern slope of the Khangai mountain range and Khentii mountain ranges compose the second group. The downstream reaches of bigger rivers compose the third group. Rivers draining from the Southern slope of the Altai and Khangai mountain range and streams draining from the Gobi Altai and Gobi and steppe regions compose the fourth group.

The annual average water discharge of rivers flowing from the Altai and Khuvsgul mountain has been increasing by 15-35 percent of their longterm average; and decreasing by 30-40 percent over the past 30-70n years in the rivers coming from the Khangai, Khentii and Ikh Khyangan mountain ranges.

Ice phenomena. Statistically significant changes occur in the beginning and ending dates of the occurrence of ice phenomena and ice cover in autumn and spring, their duration and ice depth. A slight increasing trend in annual and seasonal flows is observable in small and medium size rivers, draining from the northern slopes of the Altai Mountains, and also a slight increase in the autumn and winter flow of Selenge and Onon rivers. The maximum ice depth has decreased by 35 cm, while the date by which it can be observed has moved forward by half a month and the duration of the period of ice cover has been shortened by 5-44 days, 20 days on average; the ice phenomena period has shortened by 15 days in river basins of non-continuous permafrost and steppe zones, where water temperature has been increasing. However, permafrost and glacier fed rivers have opposite trends with respect to ice depth and the duration of period and with ice phenomena and cover.

Spring flood. Hydrological research results show that certain changes occurred during the regime of spring floods. Spring floods are starting 20 days earlier in rivers draining from the Southern slopes of the Mongolian Altai and Khangai Mountains, 5-10 days earlier in rivers flowing from the Northern slopes of the Khangai Mountains and Khuvsgul Mountains and 5 days earlier in rivers flowing from the Khentii Mountains. For instance, a hydrological record over 60 years shows that the spring flood in the Tuul river starts earlier by 20 days compared with the starting date at the beginning of the observation.

Rainfall flood. 60-80 percent of annual precipitation falls in summer. Therefore, annual maximum flows occur in July-August and form 40-70 percent of the annual flow. Some changes have been observed in the pattern of rainfall flood. Its starting date tends to be observed earlier by 2-3 days in rivers originating from the western slopes of the Khentii Mountains, by 10 days in rivers flowing from the southern slopes of the Khentii mountain, by 2-7 days in rivers originating in the Khangai, Khuvsgul, and Khan Khukhii Mountains. However, the date tends to get later by nearly one month in the Khalkh River, flowing from the Ikh Khyangan Mountains. The duration of rainfall flood tends to be shortened by 5-10 days in rivers coming from the Khangai, Khuvsgul, and Khan Khukhii Mountains. Therefore, its peak flow tends to increase along with its potential causes. Rainfall flood peak flow increased by 30-50 m^3/s in rivers draining from the Khangai, Khuvsgul, and Khan Khukhii Mountains by almost 100 m^3/s in rivers draining from the southern slopes of the Khentii and decreased by 50-150 m^3/s in rivers draining from the western and northern slopes of the Khangai Mountains and the western slopes of the Khentii Mountains.

Hydrological changes driven by the impact of climate change and anthropogenic influences are very complex and also reflect the effects of glacier and permafrost melting.

Impact of future climate change on water resources. According to the assessment of the effects of climate change on water resources, river runoff changes with changes in precipitation. For example, if it's assumed that the annual amount of precipitation decreases by 10 percent and that there is no change in the air temperature, then annual river flows in the Central Asian Internal Drainage basin, the Arctic Ocean and Pacific Ocean basins would decrease by 7.5, 12.5 and 20.3 percent, respectively. When the annual precipitation decreases by 20 percent, the reduction in river flow is approximately the same in all basins; namely, the river flow would decline by 20.2 percent in the Central Asian Internal Drainage Basin, by 22.3 percent in the Arctic Ocean Basin and by 29.3 percent in the Pacific Ocean Basin. The percentage of increase in river flow due to 20 percent of increase in precipitation is comparatively less than the decrease in volume of river flow when there is the same percentage decrease in precipitation. When there is no change in precipitation but the air temperature increases, then on average the river flow in the Arctic Ocean basin will drop by 4-20 percent, and decrease by 15-30 percent in the Pacific Ocean Basin. This fact is explained by an increase in potential evaporation. Thus, the surface water cannot be supported by soil moisture or underground water. However, in the Central Asian Internal Basin, the river flow would be increased by 6.7 percent with a one degree increase in the air temperature, and as the air temperature increases by 2^0C the river flow decreases by 3.4 percent, and with a 3^0C increase in air temperature, the river flow decreases by 0.2 percent. This fact shows that the initial temperature increase causes snow cover and glaciers melting, thereby increasing the river flow. However, as the temperature continues to rise, the

snow cover and glacier water resources could be exhausted; when the air temperature increases by 5^0C, the river flow will be decreasing. Approximately 40 percent of the Mongolian river water resources form in the Central Asian Internal Drainage Basin and in its Great Lakes Depression store another 20 percent of the total lake water resources in the country.

Current water balance elements in river basins were assessed using historical hydrological and meteorological data records and conventional methods. Their future projections of changes were assessed based on the Hadley center climate model (HadCM3) output results in accordance with GHG emission scenarios A2, A1B and B1 for the periods of 2020 (2011-2030), 2050 (2046-2065) and 2080 (2071-2099) in comparison with the average air temperature, humidity, wind speed and precipitation data for the period of 1980-1999 (Davaa G. 2009). It is projected that the annual potential evaporation or evaporation from the open surface of water will be increased by 2.5 times in mountainous areas, by 2 times in steppe zones and 1.5 times in the desert areas according to A1B GHG scenarios.

Water temperature is a key environmental factor of aquatic life. However, according to climate change A1B GHG scenarios, average water temperature for the warm period of the year, April-October, is projected to increase in the Arctic Ocean basin by 2.2^0C in 2020, 2.8^0C in 2050 and 3.5^0C in 2080, in the Pacific Ocean basin by 2.3^0C, 3.0^0C, 3.8^0C and in the Central Asian Internal drainage basin by 2.4^0C, 3.1^0C, 3.8^0C above its average in the period 1980-1999. It is obvious that these changes will lead to drastic changes in aquatic life in the future. Water temperature will increase even more than is described above, in accordance with A2 GHG scenarios and a lower increase is projected when using B1 GHG scenarios.

Study results show that from the A1B GHG scenarios, river runoff in the Arctic Ocean basin will increase by 4 mm by 2020, 8 mm by 2050 and 13 mm by 2050, by 5, 8, 9 mm in the Pacific Ocean basin and 2, 3, 4 mm in the Central Asian Internal drainage basin during these years. However, projected increases in evaporation from open surface water will exceed the increase in runoff by 138, 77, 48 times in the Arctic Ocean basin, 115, 75, 101 times in the Pacific Ocean basin and 144, 168, 111 times in the Central Asian Internal drainage basin, in these periods. This will lead to more dry conditions and to an imbalance between the inflow and outflow components of water bodies.

Area distribution of changes in river runoff shows that there will be a slight increase of 3-10 mm in the Mongolian Altai mountain. in the upper basin area of the Khovd river, in Orkhon, Chuluut rivers flowing from the eastern slopes of the Khangai mountain. and in the upper basin of the Tes and Shished rivers flowing from Khuvsgul mountain. However, river flow will decrease in the basins of the Khuvsgul lake, Eg, Uur, Zavkhan, Khungui, Ider rivers, Valley of lakes, Great Lakes Depression and in the steppe and Gobi regions (Figure 6.14).

6.3.6 Climate change impact on cryosphere

Snow cover. Snow cover plays an important role in the environmental and biophysical components. Namely, it provides prevention of deep soil freezing, acts as a water source for herdsmen, wild and domestic animals during the winter, and causes spring floods in the rivers and streams. However, if there is a heavy snowfall, a white zud occurs, which results in no food being available for the herds. Conversely, if no snow falls, a black zud occurs, resulting in a lack of drinking water for livestock.

The change in the average depth of snow cover over the last 30 years shows that the snow depth has decreased in the northern mountainous regions of Mongolia. However, it tends to increase in the eastern and southern steppes and the Gobi desert region. The date of the disappearance of stable snow cover has tended to shift to 1 month earlier (B. Erdenetsetseg, 2005).

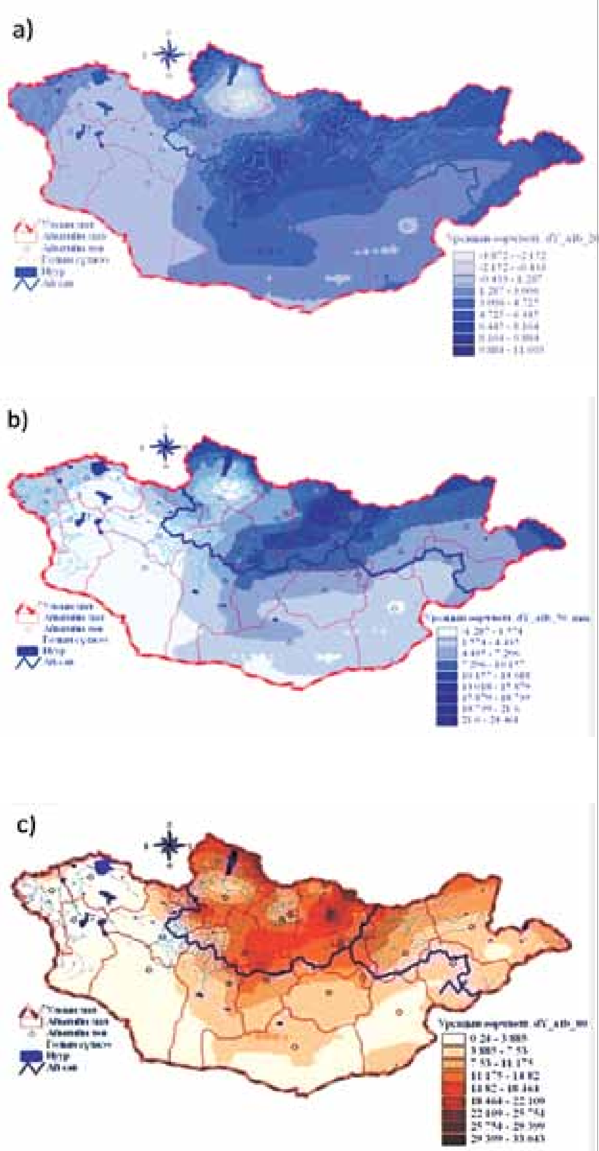


Figure 6. 14. Runoff and its future changes, mm/year, a) by 2020, b) by 2050 and c) by 2080 under A1B scenarios

A mapped isotherm of a zero value of annual radiation balance basically overlays on the isotherm of an annual average of air temperature of 0^0C. Thus, it allows an estimation of isotherms of stable snow cover lasting for more or less than 50 days in the country (Mijiddorj R., 2002).

The area of annual mean air temperature not exceeding 0^0C for the period 1961-1990 covers 62 percent of the country's territory. That area, projected by the SRES A2 and B2 GHG emissions scenarios and climate model HadCM3, will be reduced to 43-46 percent in 2020 (2010-2039), 31-35 percent in 2050 (2040-2069) and 27 percent in 2080 (2070-2099) (Table 6.8).

Permafrost. Currently, the permafrost extends to 63 percent of the country's territory. There are seven types of permafrost, namely continuous, discontinuous, common patchy, rare patchy, occasional, non-constant (permafrost that is formed once in a couple years) and seasonal (Figure 6.15).

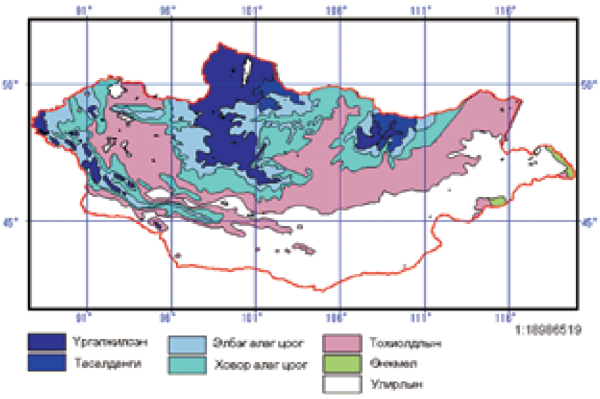


Figure 6. 15. Distribution of permafrost in Mongolia, 1968-1970

Table 6. 8. The area of below and above 0^0C by HadCM3, percent

GHG emissions scenarios	T⁰C	current	2011-2039	2040-2069	2070-2099
A2	< 0^0C	62	46	31	27
	0^0C <	38	53	68	73
B2	< 0^0C	62	43	35	27
	0^0C <	38	57	65	73

Permafrost area commonly extends and continuous permafrost prevails in the northern part of Mongolia. Over the past 30 years, a seasonal thawing in the active soil layer in the permafrost region has increased by 0.1-0.6 cm in the Khentii and Khangai Mountains, by 0.6-1.6 cm in the Khuvsgul Mountains. The seasonal depth of freezing in an active layer has been decreasing by 10-20 cm in the eastern part of Mongolia in the last 30 years.

No changes have occurred in the depth of permafrost of 13.4 m in Baganuur, 37 m in Nalaikh, 13.5 m in Argalant, 29.5 m in Artag (Khuvsgul) and 36 m in the valley of the Terkh River. However, the annual average temperature in active layers has increased by 0.05-0.15^{0}C in the Selenge river basin, by 0.05-0.10^{0}C in the Khentii Mountains region and by 0.10-0.15^{0}C in the Khuvsgul and Khangai Mountains.

Permafrost phenomenon such as thermocarst, solifluction, thermoerosion and icing has intensified over the last 50 years. As a result of thawing, the top of pingo concaves and ice in the body of pingos thaws, micro-thermocarst hollows and ponds are formed. This phenomenon has been observed in the Darkhad depression, the Chuluut River basin and around the Batsumber soum area. The thermocarst process advances by approximately 5-10 cm/year and, in some places reaches 20-40 cm/year.

Future projections of changes in permafrost extension were assessed, based on the ratio of the average air temperature from the coldest to the same temperature in the warmest months, SRES A2 and B2 GHG emission scenarios developed by the GCM as HadCM3, CSIRO, ECHAM for the periods 2010-2029, 2040-2069, 2070-2099 (Table 6.9).

Table 6. 9. Future projection of changes in permafrost extension, assessed based on ratio of average air temperature in the coldest and to the same temperature in warmest months, %

Permafrost zone	Ratio of average air temperature in the coldest and to the same temperature in warmest months	1961-1990	HadCM3, A2			HadCM3, B2		
			2011-2039	2040-2069	2070-2099	2011-2039	2040-2069	2070-2099
Continuous	<-2.3	14.0	4.4	0.5	0.0	3.1	0.6	0.0
Discontinuous, common patchy, rare patchy	-2.3 -1.4	26.18	23.94	17.92	6.49	22.29	19.58	15.33
Occasional	-1.4 -1.1	24.3	21.8	14.6	12.6	17.7	15.4	14.0
Seasonal	>-1.1	35.5	49.9	67.0	80.9	57.0	64.4	70.6

It is projected that permafrost will be retreating and shrink in mountainous areas, and its higher geographical classes will be replaced by lower classes of permafrost, decade by decade. In effect, it is projected that continuous permafrost areas will be changed into discontinuous, common patchy and rare patchy during the 2010-2039 period. The continuous permafrost extent in the Altai, Khangai and Khuvsgul Mountains will be changed into discontinuous, common patchy, rare patchy during the 2040-2099, 2070-2099 periods. That will lead to a reduction of one third in permafrost extension and non-permafrost areas will have doubled.

Glaciers. All glaciers are distributed in the Altai Mountains except for the Otgontenger glacier in the Khangai Mountains and the Munkhsaridag glacier in the Khuvsgul Mountains. 50-70 percent of annual flow is formed from snow and ice melting into the rivers flowing from the Altai Mountains. As glaciers are indicators of climate, glacier mass balance is primarily defined by the intensity of changes in climate.

The biggest glaciers among glaciers in Mongolia are valley glaciers such as Potanin and Aleksander (Figure 6.16). The terminious line shifts upwards,

Source G. Davaa, .2009

Figure 6. 16. Change in terminious line positions of the Potanin and Aleksander glaciers in the Tavanbogd mountain Mongolia

indicating a retreat of 550 m in the period 1945-1981 and 185 m in the period 1981-2001. The rate of retreat was 12 m/year in the first mentioned period and it increased to 15 m/year in the second.

Reasons for the reduction of evaporation from the water surface area of the lake could be the decrease in water temperature due to the increase in melted water flowing into the Uvs Lake primarily in the form of an underground flow. The retreat of the Kharkhiraa and Turgen glaciers has been drastically increasing since the 1940s. The Kharkhiraa, Turgen, Tsambagarav and Tavanbogd glaciers areas were 50.13, 43.02, 105.09 and 88.88 sq.km, estimated from a topographic map with a scale of 1:100 000 and compiled in 1940s (Kadota and Davaa, 2003). The areas of the Kharkhiraa, Turgen, Munkhhairkhan, Tsambagarav and Sair glaciers have decreased by 45.5, 33.7, 25.8, 21.4 and 42.5 percent from 1992 to 2002, respectively (Kadota and Davaa, 2003, Davaa et. al., 2005), (Table 6.10).

6.4 Vulnerability assessment of social and economic sectors to climate change

The Mongolian economy is very sensitive to climate change due to pastoral livestock, agriculture watered by rain, and the uneven distribution of surface water resources. Consequently, the vulnerability of the economy, of livelihoods and the traditional nomadic culture is potentially very high, as a result of future climate changes.

6.4.1 Agriculture and animal husbandry

Animal Husbandry

Climate change, through pasture alteration, indirectly influences the productivity and efficiency of animal husbandry. In addition, climate changes such as temperature, precipitation and variations in snow coverage could also have an effect on animal energy cycle and dynamics.

Table 6. 10. Changes in glacier areas, sq.km (Landsat ETM)

Glacier massif	25 June, 1992	10 Sep. 2000	8 Aug. 2002
Kharkhiraa	-	36.08	31.29
Turgen	-	34.74	33.83
Munhkhairkhan	36.96*	-	27.42
Tsambagarav	90.98	74.8	71.52
Sair	11.51	-	6.62

In theory, animal productivity would be highest under optimum nature and weather conditions. Normally, animals graze in winter pasture during high and low temperatures, storms, precipitation and snow coverage. When these weather factors exceed certain thresholds, the weather limits the grazing of animals.

Due to climate change, the increasing number of very hot summer days has a potential influence on the summer conditions of animal grazing. For instance, an average daily interruption of livestock grazing occurred in June-July by 0.8 hours (48 minutes) and this has increased by 0.2 hours (12 minutes) during the past ten years in comparison with the previous ten years. In addition, the number of days with more than three hours interruption of grazing time has increased by about seven days during the past 20 years. In particular, it has significantly increased since the beginning of summer in 1990.

Many interconnected factors have had an influence on the livestock and its main parameters, such as animal fat, live-weight change. These factors impact on growth, reproduction, productivity and vitality. Consequently, the investigation of trends in changes of weight has become a key issue and includes many concerns related to climate and ecological changes.

The analysis of monthly ewe weight measurement for 21 years at the zoo meteorological station in Tsetserleg soum of Khuvsgul and Orkhon soum of Bulgan aimag demonstrated that sheep weight has decreased by 4 kg and goat weight - by 2 kg on average in the forest steppe regions. The rate of the decrease has been significant especially since 1990, as seen as in Figure 6.17. According to measurements, the weight of a matured cow has dropped by 13.8 kg from 1980 to 2001.

These negative changes in animal productivity and meat production will lead to biological and economic losses. The survival rate of animals during

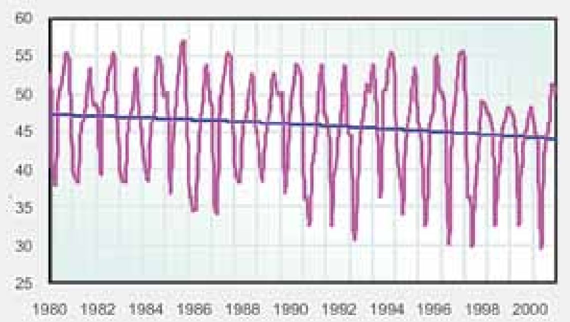


Figure 6. 17. Ewe weight dynamics trend

lean and severe winter and spring conditions would be reduced because of an insufficient accumulation of energy and weight of livestock in the summer-autumn period. Consequently, this leads to long term weight loss because of diminished ability to gain weight in the summer- autumn seasons. If the drop in each animal's weight is converted to nationwide livestock production, the loss in meat production could amount to thousands of kg of meat. Subsequently, the sources of herders' livelihood and economic benefits would be decreased. Not only weight reduction, but also other products have apparently decreased. Multi year measurements in the forest steppe sites also indicate that wool production of ewes dropped by 90 g or 4.3 g per year. As a result, the total wool production in the country could be reduced by 60 metric tons of wool. Therefore, goat cashmere and cattle hair productions are tending to decrease. In particular, cashmere production per goat decreased by 4.1 g or 0.2 g per year over the past 20 years. The total national production of cashmere is estimated as 2 tons assuming there are 11 million goats in the country. These results show that recent climate changes have a primarily negative affect on pastoral livestock, which leads to a reduction in livestock productivity and impacts on the economic efficiency of animal husbandry. Due to the climate changes, over the past 20 year period sheep, goat and cattle hair cutting times have shifted forward by about a week.

Future grazing conditions for sheep

The hot air temperatures during the summer-autumn period significantly impact on the sheep grazing, which ultimately affects livestock reproduction, fat and productivity. Animal stimulus lessens and the daily pasturage duration decreases due to the reduction in animals grazing on pastures under very hot temperatures.

When average air temperatures rise to 20-22 ^{0}C, then pasture grazing of Mongolian sheep is interrupted and their grass intake decreases. For instance, while the duration of normal grazing time in summer occupies 25 percent of total pasture time, it will decrease by almost twice as much in 2020. However, the present interruption time of gazing on pasture is 38 percent, which will be significantly increased to 53-58 percent in 2011-2030 (Table 6.11).

Similar results were obtained from calculations of ECHAM and CSIRO models. In contrast, sheep grazing interruption would be decreased in winter conditions if snow coverage is ignored.

Future ewe weight changes

In the future, Mongolian sheep live weight in the summer-autumn period will decrease in most areas because of warming in summer and dryness, as shown in Table 6.12.

The drop rate will be more from the south to the north west of the country. In other words, sheep weight gain will be less in the forest steppes than in the steppes and the Gobi desert areas.

Agriculture

In Mongolian agricultural areas, precipitation

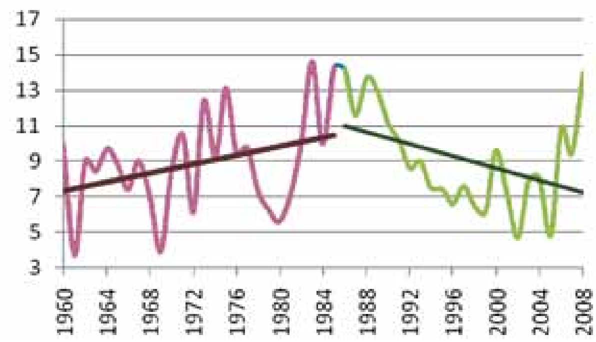


Figure 6. 18. Multiyear trend of spring wheat yield /national average/

Table 6. 11. Grazing condition of sheep in pasture by HadCM3 model, %

Grazing status	Current	HADCM3 SRESA2			HADCM3 SRESB2		
		2011-2039	2040-2069	2070-2099	2011-2039	2040-2069	2070-2099
Normal	25.139	15.13	5.67	1.56	12.24	6.90	1.56
Difficult	36.596	26.81	25.25	21.80	27.47	25.47	21.80
Interrupted	38.265	58.06	69.08	76.64	60.29	67.63	76.64

Table 6. 12. Sheep live-weight changes in summer-autumn period by HadCM3 model under SRES A2 emission scenario, (%)

Regions	2011-2039	2040-2069	2070-2099
The forest steppe	-10.68	-34.40	-57.75
The steppe	-12.85	-31.67	-39.50
The high mountains	-2.92	-3.05	-9.03
The Gobi desert	2.02	3.87	-0.18

variation is high during the growing season , which leads to big fluctuations in crop yields from year to year. Figure 6.18 shows the multiyear national average yield of spring wheat for Mongolia.

As presented in the above table, the wheat yield per hectare (ha) showed an increasing tendency and lower variation coefficient from 1960s to 1980s during the extensive cultivation in the country. However, in the last 20 years the trend has begun to decrease. Obviously there have been many factors that have affected this tendency. Firstly, soil fertility has been depleted after long term crop rotation of black fallow-wheat–black fallow. From the 1990s, a significant amount of agricultural land was abandoned due to a deficit of investment and financial resources. The frequency and magnitude of drought and aridity intensified in the late 1990s. Measurement of crop fields by the Agricultural Institute in Khongor soum, Darkhan-Uul aimag showed that the spring wheat yield has decreased by 0.28 centner /ha per year during the period of 1986 to 2007.

Another factor affecting yield decline is the rising number of hot spells during crop flowering and pollination stages. The study revealed a significant correlation between the number of days with temperatures higher than 26^{0}C and the critical period -July for wheat crops. This is also reflected in changes to the development stages. In theory, when temperatures rise, the crop development stage will be shortened. However, higher temperatures above certain thresholds will possibly delay the crop stages. Observation data confirmed that all wheat stages were shortened except the stage from tilling to heading.

In the study, the DSSAT 4.0 model was used to assess future trends of spring wheat yield. Spring wheat yields were estimated during temperature increases by 1^{0}C, 2^{0}C and 3^{0}C and precipitation changes of ±10% and ±20%. In addition, CO_2 concentration was taken in the years of the study of crop yield changes as current in the 2011 to 2030 period, 1.5 times higher in the period of 2056-2065 and double in 2080-2099 years. Due to faster crop growth under higher temperatures, the spring wheat growing period could be shortened by 3-5 days. The simulation by the model showed that when the average air temperature increases by 1-3^{0}C, the wheat yield will be increased by 1.7-3.8 percent above the current average. Spring wheat yield will be reduced by 2.5 and 4.4 percent, when there are no changes in temperature and precipitation is decreased by 10 and 20 percent . Rainfall increases by 10 to 20 percent could lead to a spring wheat yield rise by 5 to 10 percent. Also, a double CO_2 concentration could increase wheat yield by 4-9.5 percent.

Spring wheat yield changes in the future were estimated in an A1B scenario by the HadCM3 model. This showed that wheat yield would decline by 1-30 percent (on average 13 percent) in 2011-2030 from the current average yield. However, possible effects of warming, such as pest and disease occurrence, hot spells, changes in the nature of precipitation changes (more frequent heavy rains) etc were not included in the simulation.

Increased CO_2 concentration in the atmosphere would have positive effects alone, because the photosynthesis process is intensified and carbohydrates become higher. Research showed that, depending on the local heat and moisture regime, the rate of photosynthesis especially of C3 crops can increase by 10-50 percent in doubled CO_2 concentration (Parry, 1990). However, increased CO_2 concentration causes a decrease in transpiration of plant. Wheat is a C3 plant, and so a CO_2 concentration rise would generally be positive.

6.4.2 Forestry

Depending on factors such as climate change and harmful human activities, forest ecosystems are being changed through the deterioration of forest resources, epidemics of insects and diseases, and frequent forest fires, etc. However, these changes are not being recorded properly because a systematic monitoring system of forest stock does not exist in Mongolia.

In recent years, Lepidoptera such as Dendrolimussibiricus superans Tshetv, Lymentriadispar L /Gypsy moth/, Orgyiaantiqua L, Erannisjacobsoni diak etc out of 600 registered harmful insects have spread and created distribution epicenters in the forest areas.

Furthermore, the forest fire season starts earlier in spring and continues in summer due to the extended warm season and climate change. Forest and steppe fires occur every year and the extent of fire has increased in some areas. A data source states that burned forest land comprises 3.36 percent of the total forest stock in Mongolia.

Figure 6.19 shows the growing frequency of forest and steppe fires since 1960s.

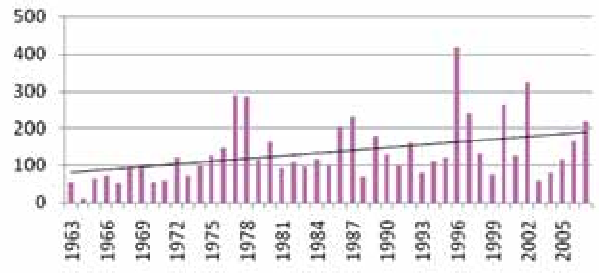


Figure 6. 19. Frequency of forest and steppe fire

Future trend of forest resources

However, the task of assessing the impact of climate change on forest resources is complicated. In Mongolia, there is permafrost underneath the forest areas, consequently warming causes permafrost deterioration. On the other hand, CO_2 enrichment in the air could have a positive effect on tree growth. In the study, the forest dynamic model – FOREST - was employed to estimate changes in forest tree composition and production at selected sites. The results showed that forest biomass would decrease in the northern Khentii mountain ranges.

6.4.3 Human health

Comprehensive research on public health in connection with climate change has not yet been done in Mongolia before and the unavailability of related statistics and medical information impedes the research. A particular study commenced in Mongolia in 2009 initiated by the Asian and Pacific Regional Organization of the WHO. It can be divided into the following aspects:

- Impact of climate changes on public health;
- Number of injured and casualties caused by the increase of natural disasters;
- Food borne diseases due to warming;
- Frequency of contagious (transmission infections) human diseases;
- Cardiovascular diseases caused by frequent hot spells;
- Inadequate personal hygiene due to insufficient clean water; contamination of water source by germs, viruses and parasites which leads to epidemic diseases like cholera, jaundice (hepatitis), salmonellae, cryptosporidium (ose), amoebae and pestiferous diarrhea;

Figure 6.20 presents the increase in the human death toll caused by natural disasters in the country.

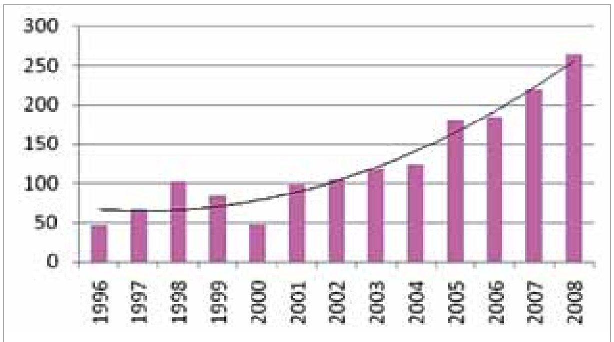


Figure 6. 20. Number of victims affected by natural calamities

The high cardiovascular disease rate in the last 30 years is connected with the increasing cardiologic, and particularly hypertension cases caused by global warming. (Figure 6.21)

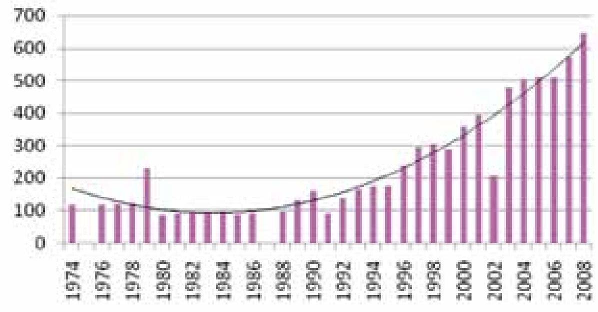


Figure 6. 21. Cardiovascular disease rate per 10,000 people, 1974-2008

During zud, herders at remote encampments are not able to get medical aid, which leads to augmentation. In addition, because of the loss of their sources for survival as a result of livestock death they become impoverished and consequently become malnourished.

It is common that food borne contagious diseases are likely to increase due to climate warming.

In addition to climate warming, the outbreak of some tropical diseases can possibly occur in the territory of Mongolia. For instance, the researchers have confirmed that virus of the Western Nile have been recorded in the territory of Khovd and Gobi-Altai aimags. Also, cholera occurred for the first time in Mongolia in 1996. Human deaths caused by forest acarus, which did not exist in our country before, have been recorded in the past few years.

6.4.4. Natural disaster

Mongolia is one of the disaster prone countries in Asia due to the increasing number of the population affected by natural calamities. Therefore, it is vital to improve the disaster management capacity of the Government and its institutions, to inform the public concerning hazards and to have early warning systems of natural disasters such as drought, zud (severe winter), snow storms and floods. Also, a scientific approach has to be used in developing forecasting methods and assessing preferred tools and computing capacities to predict and estimate climate change in Mongolia.

6.5 Adaptation measures, needs, challenges and opportunities

Various adaptation options and measures to reduce the adverse impacts of climate change were defined in the National Action Plan on climate change updated in 2010.

6.5.1 Adaptation of pastoral livestock

The main negative impact of climate change on animal husbandry is animal weight loss. Consequently, measures against weight loss are essential in traditional pastoral animal husbandry. In the study, different adaptation options were considered in future climate change scenarios in order to minimize negative influences on ewe weight using a sheep weight model.

There is no doubt that if the lands with pasture resources are made usable through irrigation, building stockyards and cattlepens on them and reserving fodder and forage, this would contribute to stabilizing the usefulness of pastureland. In the southern part of the country, where there is a scarcity of pastureland, pasturelands are located in the middle of the provincial borders and are not used at all or used only during the year when there is a snow mantle. So the exploration and development of pasture land resources should be focused on such areas.

This has formed the basis of a settled and part-settled farming system in Mongolia which requires that the nomadic animal husbandry be transformed into intensified animal husbandry.

Livestock raised through intensive husbandry and adapted to future climate and environmental changes and on farms near big settlements are vital. The government is implementing this strategy to a certain extent. Since 2008, 517 intensified farms have been registered in Mongolia, 412 of them for cattle milk production, 48 for cattle meat production and 57 for sheep wool production.

While 'intensifying animal husbandry' and "improving intensified animal husbandry" basically have the same implications, the two are differentiated in the means of their realization. Intensification of animal husbandry refers to an increase in income on account of the improvement in productivity per livestock, which alleviates the expenses per head. Whereas, improvement of intensified animal husbandry refers to the development of the more fertile and productive animals and conducting animal husbandry based on an intensified farming system independent of the environment. The farming system has already been introduced successfully into Mongolia, resulting in an improvement in the quality of livestock and the cultivation of new breeds with high productivity. Nevertheless, this type of system has been largely dependent on state subsidy and external market development. However, a highly subsidized system is no longer compatible with the free market economy. So it is important to make a coherent plan, with a realistic view of the intensive farming system that corresponds to current development trends.

In livestock breeding, we should use methods leading to short term efficiency. For instance, artificial insemination gives an opportunity to fertilize cattle and increase the number of heads of a high quality in the short term, thus improving the quality of cattle. This method is used widely throughout the world.

One of the ways to improve the adaptation capacity of pastureland to climate change is to cultivate new breeds of fodder plants resistant to drought, cold, pests and diseases, to restore degraded land and to create cultivated pastureland. The invention of new breeds of plant requires 12-15 years using conventional methods, but it could be shortened 2-3 times using bio-engineering methods. At present there are only a few new breeds. The action taken on the planting of drought resistant wild floras is clearly insufficient and the creation of a genetic fund and the issues concerning crop farming remain unresolved. There are around 2,000 breeds of gene samples of flora in the national genetic fund, which is unsatisfactory.

No action is being undertaken on the improvement of regional pasture land. Consequently, the old technologies currently being used so not meet the requirements of climate change. The urgent priorities currently being adopted by research and government institutions are the building of adaptation capacity through the invention and cultivation of new breeds of flora resistant to expected climate change, the creation of cultivated pastures and the introduction of new technology for the restoration of degraded lands.

Some selected adaptation options to reduce adverse impacts of climate change in animal husbandry are described below.

Increase of grazing time of animals: Summer-autumn season: Assuming that weight can be gained through an increase in the daily intake , early and late herding of flocks in a day on pastures were considered in the model simulation under HadCM3 scenarios to calculate sheep weight. According to the results, extending pasture time by several hours, compared to the current grazing time, would balance potential weight loss. In particular, the, extension of spring and summer grazing by 4 hours could stabilize weigh loss by 1.4 – 1.9 kg a sheep in 2011-2039. However, grazing time is limited by the potential day time. So if further weight decrease cannot be balanced by longer grazing time for extended periods, other options are required to reduce negative impacts.

Spring-winter season: If grazing time is extended by 3 hours, spring and winter weight loss of sheep could be kept at the current rate in 2011-2039. Sheep weight loss would be balanced by an extension of 3 hours grazing time in the Gobi desert and decreased by 0.09 to 0.35 kg in the forest steppes, the steppes and the high mountains within the period of 2040-2069. However, the potential day time is shorter and severe cold temperatures are frequent in the mornings and evenings during winter. So this measure is not very applicable in the winter and spring seasons. Therefore, supplementary feeding of animals would have better results than an extension of grazing time. Also, a combination of the two methods could be applied.

likely possibility, which means that the preparation of hay and supplements would be needed.

Sheep would require 1.2 kg of fodder or 3.0 kg of silage per day in 2011-2039 based on food requirement estimates in order to decrease animal weight loss in future (Table 6.13).

Table 6. 13. Fodder requirement to balance sheep wieght loss (kg/sheep)

Ecological zone	2011-2039	2040-2069	2070-2099
Fodder			
The forest steppe	1.2	1.6	2.1
The steppe	1.8	1.8	2.4
The high mountains	0.8	1.2	1.5
The Gobi desert	-	-	0.4
Silage			
The forest steppe	3.0	3.4	3.6
The steppe	3.3	4.2	4.6
The high mountains	1.9	2.3	2.8
The Gobi desert	-	-	2.1

Supplementary feeding of animals : Spring is the leanest period for pastoral livestock as pasture resources under public ownership become very sparse in this season. Pasture biomass decreases by 1.8 times more than in winter and animals suffer from food and protein deficiencies. This means that animals need to walk for long distances to find pasture and gain only 40 percent of their necessary food. Spring pasture production is essential for animals to recover weight loss in winter. But in the future, a decrease of spring pasture is most likely on account of future climate change. According to research, an increase of spring pasture production by 20 percent could decrease the weight loss of animals in 2011-2039, but even an increase of pasture production by 30 percent could not balance the weight loss in spring during 2040-2069 and 2070-2099. Improvement of spring pasture production is an un-

Furthermore, supplementary feeding would be required for livestock even in the summer and autumn periods. However, the amount of such fodder required would not be economically feasible and efficient.

Planting of forage or pasture production improvement: Apparently, the main factor that causes negative effects on animals would be changes in pasture production in the future. If pasture production is increased by 10, 20 and 30 percent, then for certain animal weight loss would be affected.

The study showed that an increase of pasture of only 20 percent or more of biomass would have positive results. In the future, dry conditions or drought would commonly occur due to climate change. Consequently, changes in current pasture and forage practices and more appropriate management of livestock are required in order to maintain sustainable pastoral livestock.

Another issue in the future is the increased frequency and magnitude of natural disasters such as zud and drought in Mongolia on account of climate change and the expected increased loss of animals. Specifically, the loss of animals is estimated as 12 percent during 2010-2039 period and 17.8 percent in 2040 to 2069, due to increased risks of droughts and zud. According to livestock experts, cattle losses of more than 5-6 percent (compared to 3.1 percent in 1940 to 2002) would lead to a destruction in the reproduction rate of herds. This means that pastoral animal husbandry would not be sufficient alone, because of future zud trends. As a result, the traditional nomadic way of life that has existed for centuries could be altered.

Recommended adaptation measures in animal husbandry

- Development of new model of combined practices of pastoral and modern intensified livestock farming
- Establishment of integrated livestock model farms in suburban areas or along rail and national road transportation lines.
- Improving animals tolerance abilities and rearing best local breeds
- Strengthening of risk management of pastoral livestock and the insurance system
- Diversifying livelihood sources for herders and support farming initiatives
- Building capacity of livestock managers and herders through various methods
- Introduction of the best technologies for the processing of livestock raw materials
- Supporting household and community based enterprise intitiatives
- Reinforcement of legal environment on the management of the structure of herds and animal numbers in accordance with pasture resource sustainability
- Defining regions or areas for pastoral and intesified animal husbandry
- Regulation of the number of animals through taxation policy and pasture carrying capacity
- Strengthening livestock insurance system
- Supporting investment sources for pasture improvement through a tax on pasture usage or charge, etc.
- Supplying herdsmen with portable and renewable energy sources
- Preventing pasture degradation through tax policy in a reasonable and feasible way.

6.5.2 Arable farming

To alleviate the negative impacts on crop production and adaptation to climate change, adaptation measures could be taken, such as changing the wheat planting time, the selection of appropriate varieties, and the application of fertilizers, etc.

Changing sowing period: The timing of the sowing period is determined by the favorable dates to plant seeds. Considering that precipitation in July is the major factor for the ripening of cultivated plants, specifically wheat grain in Mongolia, sowing should be done when the precipitation season and seed sprouting periods coincide. In agricultural regions of the country, the annual spring sowing of wheat and potato are usually done in the first 10 days of May. However, due to global warming, the season of sowing is likely to be altered and therefore research should be carried out and experimentation conducted on early sowing. As research results show, the most favorable time for sowing is 15-20 days ahead of the conventional sowing term. Hence, this should be done through calculation, taking into account air temperature and the precipitation period, which are leading factors for the sowing, growing and ripening process of seeds. In other words, the current sowing system of 1-2 years should be changed into 4-5 years. In the case of sowing wheat seed once in 2 years it is necessary to renew the seeds each time and fertilize the soil each year. As for potatoes, it is suitable to sow the potato once in 2 years. It helps to increase the forage chemicals in the soil and helps it to become more fertile.

Introducing new varieties of seeds: In order to improve the adaptability of seeds it is necessary to develop new varieties of seeds with adaptable characteristics such as early ripening and resistance to heat and diseases. Also, it is necessary to conduct a study on the possibility of planting winter wheat, to assess its efficiency and overall expenses, to prepare qualified specialists and to provide the required facilities.

Application of fertilizers: DSSAT 4.0 model results showed that currently the application of nitrogen fertilizers can increase wheat yields by 40-70 percent. In future, 50 percent of yield growth can be harvested if nitrogen fertilizers are applied at 40-60 kg/ha in the periods 2011-2030, 2046-2065 and 2080-2099 under double the CO_2 concentration.

Irrigated cropland: Obviously, rainfed agriculture has high risks in arid and semi arid areas. This condition could be worsened due to a projected decrease in precipitation and increased potential evapotranspitaion in the future. According to the DSSAT 4.0 model results, irrigation after planting can increase wheat yields by 40-60 percent. However, irrigation costs would be great due to the unavailability of water, the deepening of ground water and the scarcity of surface water.

In 2008, irrigated spring wheat yield was 2,230 kg/ha (higher by 700 kg/ha than the national multiyear average) on 20 thousand hectares of irrgated land.

Recommended adaptation measures in arable farming

- Development and introduction of drought and hot weather resistant local varieties of spring wheat
- Establishment of irrigation system on 30 percent of grains and 100 percent on land for vegetables in the coming 5 years and introduce water efficient irrigation measures
- Establishment of protection of tree strips around cropland
- Application of extended agricultural practices through strengthening of the capacity of research institutions to conduct studies on pests and diseases, tillage and planting technologies, chemical applications and crop varieties, etc.
- Extension of fertilizer production, processing and converting dung, manure wastes from swine and cow farms into organic fertilizer
- Coordination of cultivation of wild land and crop farming in remote areas through economic policies
- Supporting farmers, companies and farming groups to apply best soil tillage practices and technologies through taxation and economic policies, etc.
- Carrying out research on winter wheat planting
- Education of farmers and cultivators on climate change response actions

6.5.3 Water resources

As mentioned above, Mongolia is a country with scarce water resources. Taking an optimal combination of measures for the rational use, conservation and storage of water resources is essential for securing sustainable development in the country. Issues related to global warming and anthropogenically influenced environmental changes are not only global issues, but also local issues, such as the scale of a river basin and the influence on the wellbeing of people living in a river basin. In this period of intensive economic development, these changes are quite remarkable. It is becoming quite evident that the issue of water resources will be a high priority concern in this projected dry climate.

Due to the scarcity of ground water and the inconvenient location of wells, there are 10.7 million abandoned and unused hectares of pastureland. The highest percentage of them are in the Khalkh Gol, South Gobi, Bayankhongor and Gobi-Altai aimags and the southern part of Khovd aimag, inwards from the national border and located remotely from the municipal administration. As much as 50 percent of pastureland resources in Dornod aimag are not used and this relates to the water supply in a direct and indirect way. Because of the poor location of the wells which are distant from the pastureland that must be used, some pasturelands are crowded with cattle and people in the warm seasons and this impacts negatively on pastureland proficiency. In some places, where there is poor management , the oasis /water point/ itself turns out to be a reason for the pastureland degradation. After water points and wells have been enhanced, a negative consequence is that a concentration of cattle and people develops, which causes the grassland to become barren. Since herders are not able to repair and maintain the wells themselves due to lack of funds, it is necessary to provide herders with portable, compact, small-sized, electricity and fuel efficient, simple to assemble water generators. One way of encouraging contributions from herders and individuals towards the repair and maintenance of water points could be by letting them privatize water points by offering them affordable long-term preferential loans (Lkhagvadorj, 2002) Introducing the mechanism of expense-sharing into livestock water supply would be helpful in increasing the efficiency of the state budget expenditure and to encouraging herders to dig wells.

Recommended adaptation measures in the water sector

- Implementation of Integrated River Basin Management policy and plans at local and national level
- Introducing National policy on covering upper parts of runoff formation zones by means of the Protected area network and protecting its ecosystems. 70 percent of river water resources are formed in the runoff formation zones extending mountainious region of Altai, Khangai, Khentii, Khuvsugul and Ikh Khyangan Mountains, which totals 30 percent of the country's territory.
- Supporting individual and community initiatives to protect upstream basins of rivers, streams, and lakes
- Collecting melting water of glaciers. The ongoing intensive retreat and shrinkage of glaciers compels the storage of melting from glaciers in reservoirs, existing lakes, preferably those located as high as possible to minimize the evaporation loss. Reservoirs or water complexes will have multipurpose use, such as hydropower generation, drinking and industrial water supply, and pasture irrigation. The main concern is to regulate glacier melting water and the system acts as a natural glacier regime. To collect all of the glacier melt water, it will be necessary to construct water reservoirs with a volume comparable to 2 Uvs lakes. Reservoirs will possibly be constructed in the upper reaches of the Khovd, its tributaries, Kharkhiraa, Turgen, Zuil, Bulgan, Tsenkher and Bogd rivers. They will regulate the regime of the lakes in the Great Lakes basin. The outflow sites of lakes, fed by glacial waters, located in high mountain zones, are potential areas in which to store water.
- Reinforcement of water storage policy. Such a policy is required in the upper river basins of the Khangai, Khentii and Khuvsgul Mountains. to regulate a long-term river regime and to minimize water surface evaporation loss from reservoirs and irrigation systems. Closed water distribution and storing systems are appropriate for implementation in the steppe, semi desert and desert regions.
- Encouraging efficient and economic use of water resources is essential for saving water. Water saving technologies, water metering systems and recycling of water at household and industrial levels are highly recommended in industries, agriculture and other socio-economic sectors.
- Gathering rain water and using it for non-food consumption such as car washing, lawn irrigation and waste removal
- Reducing the loss of water from its distribution and water transmission systems

- Minimizing the pollution of sources of soil and water is the basis for the protection of water resources. Improving the level of water purification and sewage water treatment plants in all settlement areas is required.
- Increase in the frequency of the occurrence of droughts necessitates the application of irrigation systems for sustainable crop production. It is strongly recommended to replace irrigation technologies currently in use, with advanced efficient technologies such as low flow showers, drip-irrigation, night irrigation, etc.
- Intensification of environmental monitoring (extension and modernization of observational networks, modeling, remote sensing, data integration and regional cooperation etc.) is the basis for decision making and development of policy and action plans. Improving the control system of water hygiene and sanitation as well as the monitoring system of chemical and biological substances, would play a crucial role at household as well as industrial level.
- Implementation of projects geared towards the reduction of GHG emissions, the use of Clean Development mechanisms and economically efficient use of weather modification are important for reducing the negative impacts of climate changes.
- Public awareness and educational activities on water efficient usage and protection

6.5.4 Human health

Within the strategy for adaptation to climate in the health sector which aims to extend research into human health risks induced by climate change, and improve the quality of and access to medical care and insurance systems, the following measures are recommended:

- To conduct research on human health risks induced by climate change in the short and long term;
- To improve the capacity to diagnose cardiovascular diseases caused by heat waves, and strengthen first aid, particularly in the countryside;
- To expand the diagnosis, treatment and prevention systems in response to new infectious diseases arising from climate change;
- To strengthen the preventive system of food borne diseases and other threats to human health caused by air pollution, water and soil contamination;
- To improve the medical registration and information data base of health cases related to climate change;

6.5.5 Natural disaster

The following adaptation measures can be taken in order to prevent and to reduce the risk of natural disasters and outbreak of communicable diseases:

- o conduct an evaluation and analysis of studies of the impact of climate change on public and environmental health in Mongolia,
- To strengthen the early warning and response capacity of the NAMHEM and the National Emergency Management Agency (NEMA),
- To conduct comprehensive research into the risk of forest and steppe fires and their distribution while educating the public to prevent fires,
- To improve flood prevention, protection and forecasting systems,
- To expand the capacity of medical institutions in order to prevent human and animal communicable diseases

6.5.6 Supporting natural ecosystems adaptation

Conservation of the Mongolian ecosystems means protection of rangeland from degradation and the restoration of degraded land at the lowest possible cost. One of the best practices for the protection of ecosystems is to establish a network of protected areas including ecosystems of representative regions that have natural and economic significance. In 2008, 14 percent of the total territory, which is 61 areas of 21.9 million hectare were taken under state protection. The Millenium Development Goals aim to have 30 percent of the total land under protection in the future. Community protection of natural, historical or culturally significant areas has been a way of limiting negative human actions on those lands. In 2008, about 911 areas out of 16.3 million hectare were registered as local protected land. Protection of rangeland requires the following measures:

- An appropriate management system for the development of pasture
- Imposing legislation on pasture leasing, utilization and ownership. It is imperative to preserve pasture land through the investment made by herders themselves by increasing their awareness of the importance of pastureland, because pasture remains under state ownership, while the livestock is private. The investment by herders could be made in 2 ways: a) vegetation of pasture; and b) creation (cultivation) of pasture. The efficiency of both methods depends on how much the herders' sense of ownership of pasture is guaranteed. A promising future can be foreseen if the herders could cooperate in investing in pasture land.
- Comprehensive assessment and mapping of degraded lands at each provincial level
- Ensuring sustainable pasture utilization through improving pasture water availability, re-arrangement of administration units and coordination of otor – temporary pasture during emergencies, etc
- Biological management of insects and rodents inhabiting rangelend
- Strenthening the monitoring and information system of land use and its usage in application and operation.
- Conservation of rare and endangered plants for food and medicines and support for their planting
- Establishment of community ownership of areas in which wild animals are hunted and introduction of endangered species of animals
- Cultivation of forage plants and introduction of the best soil conservation management
- Setting up a pastureland irrigation system
- Introduction of new varieties of plants, resistant to droughts and pests

6.5.7 Adaptation measures in forestry

The main approach towards the protection of forest resources is to enhance the protected area network. Recently, the Parliament of Mongolia endorsed a new law banning mining activities in forest and water resource areas. The Millenium Development Goals based Comprehensive National Development Strategy stated the importance of sustanable utilization of forest resources through forest protection, restoration and maintaining ecological balances. The strategy can be implemented through the following measures:

- Organizing afforestation activities in at least 12 thousand ha areas in a year and implementation of the Government 'Green Belt' programme on land of at least 200 ha.
- Ensuring tree and bush seed production of at least 5 tons and plant 30 million seedlings per year
- Conducting a forest insects and diseases distribution survey in 1,200 thousand ha and implement actions against harmful forest insects and diseases in 68.5 thousand hectares of land in a year.
- Regulation of the limit of annual logging. Logging areas can be established as 20-30 thousand hectares per year in relation to tree types, their number and capacity.
- Strengthening forest fire prevention and fighting system
- Introduction of enhanced forestry management methods. Community ownership on 20 percent of the total forest fund by local communities and forestry groups should be established in order to

ensure forest protection, restoration and proper utilization of forest resources, etc.

6.5.8 Constraints and barriers of implementation of adaptation measures

It is necessary to take into consideration the possible impediments to implementation of adaptation methods. It is certain there will be specific difficulties and impediments while implementing the adaptation measurements depending on the geographical, geophysical and environmental features and the level of socio-economic growth of the country. The most likely impediments and ways of overcoming them are mentioned below:

At the organizational and structural level

The impediments to some sectors have been identified and actions to overcome them are being taken. Among the sectors which are susceptible and vulnerable to climate change, obscurity, misjudgment and lack of practice and full awareness of the dangers of the actual and anticipated risks of climate change still remain. There is a contradiction between ministries and government agencies due to the lack of interagency operational coherence and human resources. Uncertainty of their responsibilities for adaptation to climate change leads to the reduction and loss of management efficiency.

The implementation of adaptation measures requires cooperative and regulatory activities by various groups. Decision making and implementation responsibilities regarding climate change are allocated only to government agencies such as the ministries of agriculture, environment, power energy or municipal administrations and this results in the overall inefficiency of these actions. Climate change issues are not only the concerns of one sector or institution; these issues need integration and collaboration and a clear assessment of responsibilities and lines of duty. It is necessary to fund and maintain the activities with a high degree of efficiency, to formulate present and future measures of adaptation, to monitor outcomes and benefits, and to improve the coherence of the activities of government agencies and institutions, while implementing planned actions.

At the financial level

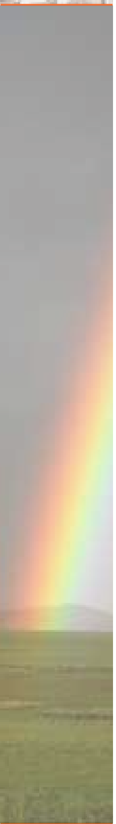
Insufficient funding is preventing realization of adaptation measures. Furthermore, there is a gap between the planning and realization processes of the policy. For instance, expensive ways of implementing adaptation measures would add financial burdens and negatively affect the realization process. Successful implementation is dependent on reliable sources of funding. Due to the weakness in the banking system in Mongolia there is not enough accumulation in the state budget. It might be more beneficial to attract foreign investment and aid to implement adaptation measures. To get financial, technical and technological assistance from the outside world, additional activities must be taken at national level aimed at broadening cooperation with international banks and organizations.

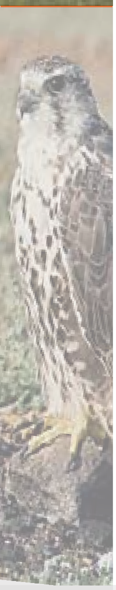
At the social level

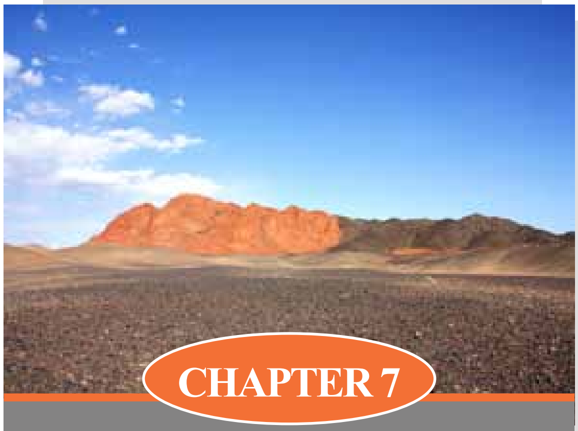
Lack of individual insight, coupled with conventional ways of thinking and attitudes and the scarcity of information available to the public are all considered to be impediments to the realization process and must be overcome. The majority of actions are taken by people in the agricultural sector including herders, so all measures must be in accordance with their traditional and ethical requirements and must be based on their practical experience. In this way, consumers would benefit from the policies and strategies implemented at the national level. It is better to involve the public in the process of formulating policy or strategy from the beginning and help them realize their role and responsibilities in it. All adaptation measures cannot be carried out at the same time. Overcoming impediments to certain implementation processes helps us to assess the most suitable means to overcome impediments to other processes, thus saving time, money and effort.

CHAPTER 7

FINANCIAL RESOURCES AND TECHNOLOGY TRANSFER







FINANCIAL RESOURCES AND TECHNOLOGY TRANSFER

7.1 Financial mechanism / resources

Commonly, implementation of measures and action for GHG mitigation and climate change adaptation require advanced techniques and technology, an adequate legal and institutional environment, sufficient human resources and sufficient investment. However, developing countries, including Mongolia, have limited capacities for such resources and assets. Under UNFCCC, developed countries are obliged to fully support measures and actions of developing countries to cope with the challenges of climate change. According to this principle, international agreements and documents on long term collaborations between countries that ensure the financial comprehensive mechanism are being developed within the UNFCCC framework. The financial mechanism is considered to ensure that new, additional, sufficient and predictable financial resources for developing countries.

Moreover, developing countries are obliged to align climate change issues with national development policies and strategies.

Financial resources for GHG mitigation and climate change adaptation measures and actions consist of the following sources:

1. Government funding
2. Private sectors investments
3. International financial mechanism

7.2 Technology needs

Advanced technologies play a vital role in the mitigation of GHG and adaptation to climate change. In particular, the replacement of inefficient, outdated and old equipment, improving the efficiency of energy production and consumption, the application of renewable energy, water saving and harvesting technologies, and the introduction of new crop varieties resistant to heat and drought etc. are required for the country to tackle the challenges of climate change.

In the last few years, the government has emphasized the importance of technology transfer and the following policy documentations have been developed.

1. Law on Technology Transfer,1998;
2. Sustainable Development Strategy of Mongolia in 21st century (MAP 21)
3. National Action Programme on Climate Change, 2000 and 2010
4. Law on Energy, 2005
5. Program on Renewable Energy of Mongolia, 2005
6. Law on Renewable Energy, 2007

In 2005 to 2006, a Climate Friendly Technology Needs Assessment (TNA) was conducted for the energy sector. In terms of technology, Mongolia is not positioned at a satisfactory level. When compared to the GDP, GHG emissions were 7.5 kg CO_2 eq/US$ in 2006, which is 10 times higher than the global average. Moreover, deterioration of the technology in the infrastructure, particularly in energy production, industry, transportation and construction sectors is the main reason for inefficiency and the negative impacts on the environment.

Based on the technology needs assessment, highly prioritized advanced technologies were identified and have been incorporated into the master plans and strategies of the sector. However, the country is facing economic, financial and human resource constraints in the introduction of advanced technologies. The implementation and introduction of these technologies require high investment and Mongolia is economically unable to implement them independently. Consequently, as a developing country, Mongolia considers that international financial and technology transfer mechanisms and the assistance of developed countries are the basic conditions for the introduction of environment friendly technologies. Mongolia's energy sector has a high potential of reducing GHG emissions. Almost the entire energy production or 98 percent is based on brown coal combustion. Therefore, the reduction of coal consumption is extremely important, not only to mitigate GHG emissions but also to support the country's sustainable development strategies. New advanced technologies enabling lower fuel consumption are greatly needed to fulfill the country's increasing demand for energy. Technologies enabling lower fuel consumption in electricity and heat production, renewable energy technology, construction technology to reduce heat loss of buildings, a regulation system for the heating of buildings, and the technology to reduce electricity and heat energy consumption are urgently required in the near future.

Various projects funded by investment, loans and aid from the UN system, international organizations and developed partner countries have been implemented in Mongolia in order to overcome economic and financial challenges. In particular, major projects have been implemented, aimed at improving the efficiency of energy production and reducing the GHG emissions. For example: a project aimed at rehabilitating the 4th Combined Heat and Power plant (CHP 4) has been implemented with the assistance of the government of Japan, in which fuel burning technology of steam boilers has been introduced. With funding from the German Technical Cooperation Agency (GTZ), a project renovating existing boilers and upgrading the control and monitoring system of power plants in Darkhan and Choibalsan has been implemented. The Asian Development Bank (ADP) has funded the Ulaanbaatar heat efficiency project and advanced technologies have been introduced in the city heat supply system. The ADB has also supported the rehabilitation of the CHP 3. The World Bank has supported an energy project aimed at reducing energy losses from the Ulaanbaatar electrical distribution system. Commonly, heat energy is used for heating of apartments and public buildings, industry and hot water for individual needs. However, about 90 percent of heat energy in Mongolia is consumed for heating because of the country context.

Recently, a research project aimed at improving the heating of old precast buildings was conducted by GTZ. Research results show that heating loss can be decreased by about 50 percent with standard insulation technologies.

In order to utilize the Clean Development Mechanism (CDM) under the Kyoto protocol in reform of technologies, the following initiatives have begun to be implemented:

1. CDM Designated National Authority (DNA) has been set up and conducted a capacity building project, funded by the ADB. Intensive training and workshops have been conducted for businessmen, researchers and environment assessment experts.
2. The CDM Projects Evaluation Committee has been established. Two hydropower plants, with a capacity of 12 MW each, operate as approved and registered CDM projects reducing GHG emissions and generating Certified Emission Reductions (CER).

Mongolia also highly emphasizes adaptation to climate change. Modern technologies are being implemented, with international financial support, through surface water and grassland conservation projects and projects to reduce natural risks to livestock, . Examples of such projects include the "Green Belt" programme funded by several governments, 'Green Gold'- project of pasture ecosystem management, funded by the Swiss Development Agency, 'Pasture Sustainable Management' by UNDP, 'Sustainable Livelihood-2' by the World Bank, and 'Gobi Pasture' reducing the natural risks to livestock, implemented by Mercy Corps.

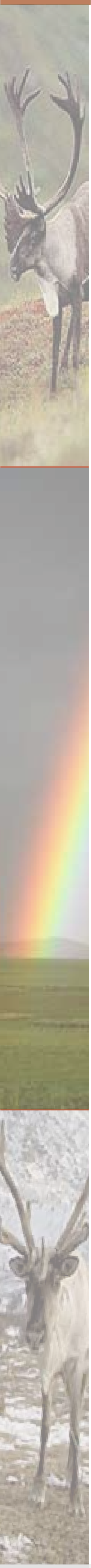
In the near future, while coal will remain the basis of energy production, the following technologies need to be introduced and implemented

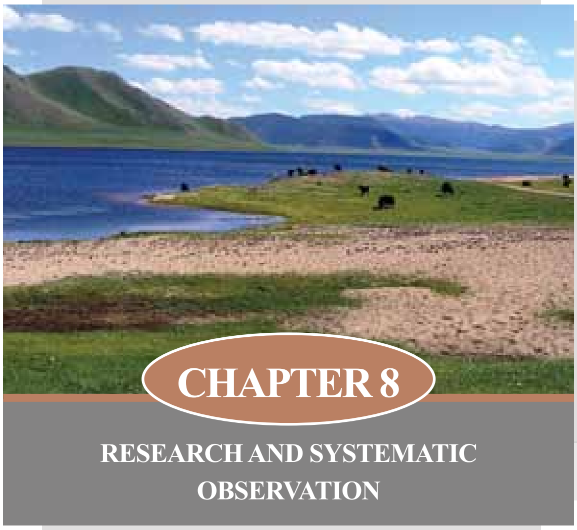
- clean coal technology and clean fuel production
- establishing a power plant with Integrated-coal gasification combined-cycle
- setting up a Carbon capture and Storage-CCS plant

Therefore, renewable energy and nuclear energy are considered to be major factors of the country's energy sector. Techniques and technologies which reduce energy consumption provide opportunities to utilize internal resources and potential.

CHAPTER 8

RESEARCH AND SYSTEMATIC OBSERVATION





8.1. The environment and climate monitoring network in Mongolia

The National Agency for Meteorology, Hydrology and Environment Monitoring (NAMHEM) of Mongolia was first founded in 1924 and commenced officially operating in 1936. NAMHEM is the government institution responsible for monitoring the environment and climate within the territory of Mongolia. The agency has been conducting surface water observation since 1942, upper air observation since 1941, solar radiation observation since 1965, observations of crop and plant phrenology, soil moisture and vegetation pests and diseases from the 1960s, environmental pollution observation since 1976, animal husbandry meteorological observations from 1976, greenhouse monitoring since 1992 and glaciers and permafrost observations since 2000.

Besides the ground water measurements which have been conducted by the Ministry of Geology since the late 1960s, forest inventories were conducted by the Ministry of Forestry Industry from the 1950s, permafrost observation was conducted by the Academy of Science of Mongolia from the 1950s, and land use and management monitoring by the Ministry of Agriculture in the 1970s. However, these observations and monitoring stopped and the data and information are now unavailable.

Since 1970, Mongolia has been receiving information and images from the Polar orbit satellites, which is an analogue system. Further, not only cloud image, but also the analysis of rapidly changing natural resources has been possible, due to a digital information station installed in 1987. Since 2007, Mongolia has been receiving satellite images of resolutions of 250 m from MODIS and geostationary FY2C satellites, which has significantly increased the quality of monitoring.

8.2 Observation network of hydrology, meteorology and the environment

Currently, 120 operational weather stations in Mongolia are functioning according to the World Meteorological Organization's (WMO) guidelines and procedures, monitoring and measuring, 8 times a day, the air pressure, atmosphere and soil temperatures, air humidity, rainfall, wind velocities, snowfall, depth (when snow) and other weather phenomena. (Figure 8.1).

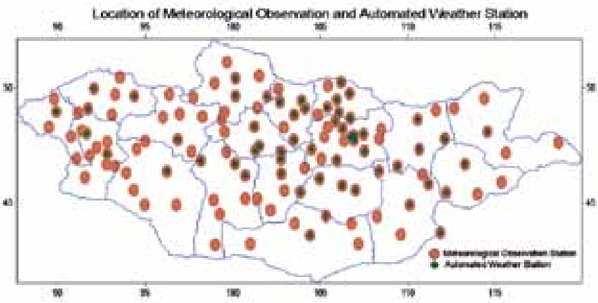
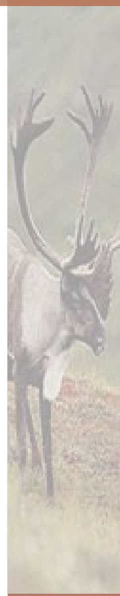
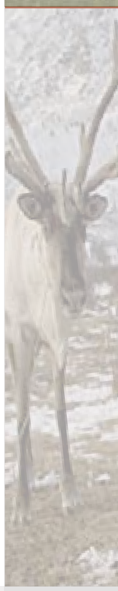


Figure 8. 1. Locations of meteorological stations

At meteorological stations, recording instruments continuously record air pressure, humidity and temperature. Around 40 stations monitor soil temperature in depths of 20 - 320 cm, 25 weather stations record the amount and intensity of precipitation. In addition, 32 weather stations used to estimate the duration of sunshine. However, many





automatic stations have now been introduced to replace these observations.

There are 40 weather stations of Mongolia that are included in the synoptic network base stations of WMO and 10 stations are included in the Climate Observation base stations network. More than 200 soum centers have weather sites which measure the temperature of the atmosphere and soil, moisture, wind, atmosphere occurrence 3 times a day at 00,06 and 12 GMT.

The solar radiation observation network in Mongolia was established in 1961. Since the 1970s until 2004-2005, Mongolia had 19 points to measure solar direct and indirect radiation, long and short wave radiation balance and apparatus to measure surface albedo. Currently, there are 5 operational stations in Mongolia which are included in WMO's actinometer network.

The upper air observations in Mongolia commenced in 1941. Initially, at 8 stations the Russian made radio-locators were used; later Finland Vaisala Dijicora 2 and Dijicora 3 equipment were installed in 1996 and 1999-2000 respectively. In 2003, Ulaanbaatar, Dalanzadgad and Arvaikheer stations were equipped by with the French system. Currently, there are 7 upper air observation stations. However, financial difficulties are resulting in partial observations being conducted only in the Ulaanbaatar, Murun and Ulaangom stations.

Mongolia established jointly with the National Oceanic and Atmospheric Administration (NOAA) of USA the first monitoring site in Central Asia, to measure the atmospheric greenhouse gas concentrations in Ulaan Uul, Dornogovi aimag in 1992. Based on the data, the atmospheric greenhouse gas concentrations are defined in the Climate Monitoring Diagnosis Laboratory (CMDL) in USA. The observation data are being archived in the world greenhouse gas database in Tokyo Centre, Japan.

The monitoring of surface water started in 1942 and at present, 126 observation sites are measuring the daily water level, water charge, ice occurrence, ice thickness, flow speed and water temperature. A number of observation points collect samples for further analysis. Observations are conducted on another 16 small and large lakes. In addition water plankton, benthos organisms and plants samples are collected at 64 observation points. and water chemistry research samples are collected at more than 140 points.

The weather stations and posts (consisting of 39 units) in the agricultural part of Mongolia observe phenology phases, heights, density, thickness, damage rates, causes and harvest of grains, potatoes and vegetables. In some areas, precipitation and other crop productivity (e.g. weight of 1000 seeds) are carefully being observed.

Since the 1960s, the observation and measurement of pasture lands has been done through the NAMHEM network of stations and posts at 317 points. Since 2001, pasture land observation is monitored using three types of observations: a). Pasture plant phenology; b) Major pasture insects that damage pasture lands, rodents; and c). Pasture degradation and desertification.

8.3 Overview of climate change studies in Mongolia

The study of climate change began in 1979, after the Second World Meteorological Conference. The first symposium on climate change issues in Mongolia was conducted by the Institute of Meteorology and Hydrology in June 1980.

There were some studies on climate change using tree-rings and crysphere data, but there was no systematic study covering the entire country. Some efforts have been made to reconstruct the historical climate data on the basis of tree-rings data analysis on the Solongot Mountain, which is part of the Khangai mountain range, located in the western part of Mongolia.

In 1994-1996, the "Country Studies Programme on Climate Change" project was implemented with technical assistance of the US Country Studies Programme. During the project, for the first time, Mongolian scientists and meteorologists estimated the future precipitation and temperature changes when CO2 is doubled in the atmosphere, using some General Circulation Models (GCM). Subsequently, the study was used in the preparation of the National Action Programme on Climate Change (NAPCC) and the 21st Century National Sustainable Development Programme.

The scenario of IS92a was used to examine the impacts of increased GHGs on the ecosystem and economic sectors of Mongolia. The scenarios selected for the study were the climate models developed by the Hadley Center (HadCM3) of the United Kingdom Meteorological Office, the Canadian Climate Center Model (CCCM), CCGM3 of Analyze Center, Australia (CSIROMK-2) model, the Max Plank Institute of Hydrology and Meteorology of Germany (ECHAM4) model, and the Geophysical Fluid Dynamics Laboratory (GFDL) model. Mongolia's future climate changes until 2100 were projected on the basis of the IS92a scenarios listed above and developed in the NAPCC, which was approved by the government in July 2000.

During the period 2002-2004, a project on "Climate change - Its Impacts and Adaptation on Livestock and Biosphere" supported by AIACC, UNEP and START was implemented in Mongolia. This was funded primarily by a grant from the Global Environment Fund (GEF). Mongolia's future climate changes until 2100 were determined on the basis of the A1, A2, B1GHG emission scenarios of the SRES 2000, using the results of the climate models mentioned above. In this way, strategies for livestock sector adaptation to climate change were developed.

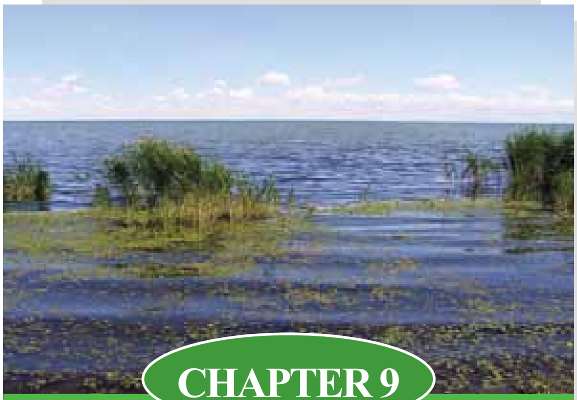
Within the projects implemented with the support of UNEP and GEF, the initial and the second national communications from Mongolia to the UNFCCC were developed in 2001 and 2010. A project on 'Climate Change impacts on Human Health' was implemented by the Ministry of Health with the assistance of WHO. Mongolia also participated in regional projects on climate change and GHG inventory preparation.

In addition, climate change, its impacts and vulnerabilty studies have been conducted under the fund of National Science and Technology Fund of Mongolia since 1994.

In recent years, researchers from the Mongolian National University and Agriculture University of Mongolia have been conducting research on the impact of climate change on pasture degradation and desertification and the adaptation of animal husbandry to climate change.

CHAPTER 9

EDUCATION, TRAINING AND PUBLIC AWARENESS



CHAPTER 9

EDUCATION, TRAINING AND PUBLIC AWARENESS

9.1 Education and training

There is no socio-economic sector which is unaffected by climate change. The main step towards adaptation and enhancement of the capacity to adapt to climate change is to strengthen and intensify the activities of research institutions in the agricultural and other sectors and build human resources capacity. It is essential not only to conduct a study on climate change, its impacts and further attitudes, but also to sustain it and to scrutinize each sector's overall goals and efforts.

It is apparent that the implementation of nature conservation, and climate change adaptation and mitigation measures requires the active participation of every citizen as well as civil society. The government of Mongolia endorsed a 'Programme of Ecological education for the Public' in 1997 and currently the second phase of this programme is being implemented.

The programme goal is to revive the traditional Mongolian culture which protects nature and the environment and to introduce the practice of adapting to future climate change. Consequently, the contents of public awareness material have been aligned with global concepts such as 'Global Sustainable Development Initiatives towards the 21st century', 'Education for Sustainable Development' of the UN and the Millennium Development Goals, in order to deepen education on nature, the environment and sustainable development.

Environment and natural protection and conservation have become part of the compulsory curriculum at primary and high school levels.

Moreover, about 500 -700 students are majoring in environment and natural conservation in degree courses at state and private colleges and universities. Also, the Citizen's Education Program has a section on environmental education. In addition, training and workshops on climate change and disaster management focus on the prevention of atmospheric disasters and good practices.

Researchers and experts on climate studies are trained by the National State University of Mongolia and Darkhan College of the Agriculture University of Mongolia. In addition, students of the University of Science and Technology study energy saving technologies, nature conservation, and impact assessment on nature and the environment.

Climate change related studies and research are conducted mainly by the Institute of Meteorology and Hydrology and are conducted by experts and specialists in the fields of agriculture, animal husbandry, biology, botany, geography and cryopedology. Such surveys and studies are usually being conducted within the framework of particular projects or programmes. Since there is no single sector which is not affected by climate change, intersectoral study should be conducted in the future.

There is an urgent need to prepare qualified specialists in each sector who can understand and adequately evaluate climate change as a systematic issue. To expand and intensify studies on climate change and climate change monitoring, it is necessary to take certain actions to prepare, train and specialize young researchers by getting them involved in local, international and occupational trainings and seminars, after the completion of their degrees.

9.2 Public awareness

In recent years, the issue of climate change has become a focus for the general public and the negative consequences for the environment and society are being explained as a result of climate change. Hundreds of NGOs initiated by individuals are working towards the protection and conservation of nature and the environment. However, there are very few organizations that focus on climate change issues, including adaptation and adaptation measures.

Many projects funded by foreign donors are being implemented in order to protect and restore nature and the environment, strengthen natural disaster prevention and management systems, reduce the impact of climate change and implement adaptation measures, and to improve energy efficiency. One of them is a project on Pasture Management Improvement implemented by the Ministry of Food and Agriculture. More than 80 projects on environmental protection have been implemented by the Ministry of Nature and the Environment and its institutions since 1992.

Apart from funding, the major factors in the successful implementation of adaptation and mitigation procedures are the ability, willingness and concern of the people involved in the realization process. Successful completion is guaranteed only when there is a provision for public participation in the activities. Residents of the city, the aimag centre or the soum, herders, farmers and local communities are the first stakeholders to benefit from adaptation policies. Also, it is crucial to have the participation and assistance of experts and specialists in training, fertilization, selection and invention of new breeds and irrigation construction. It is now obvious that it is of prime importance to take action in raising public awareness of climate change, in increasing government willingness to cooperate with NGO-s and the public, to be supported by them and to provide them with adequate information.

The government is working to increase public awareness on climate change and its impacts and is forming partnerships with industries and NGOs to enhance the effectiveness of measures for mitigation and adaptation to climate change. Moreover, the adverse effects of global warming are being publicized throughout the country to motivate the people to participate in adaptation and mitigation measures.

9.2.1. Media coverage

The media's role is essential in disseminating the government's strategy and policy on adaptation to climate change and the mitigation of GHG emissions in the context of national development goals. The media can introduce various adaptation and natural resources and energy-heat-fuel-saving methods and best practices. To enhance the effect of the educational programmes on climate change and global warming, such methods and practices are documented in audiovisual aids and exhibited during educational programmes and events held by various governm9ent agencies, groups and schools. Furthermore, a variety of information is available at related web-sites operated by the government and public organizations, including the outcome of related international conferences, active measures to adapt to climate change, the adverse effects and consequences of climate change, and how the public can help reduce greenhouse gas emissions.

9.2.2. Dissemination of information and advocacy materials

Booklets, brochures, information sheets and single volumes are being distributed, containing outputs and results of climate change research and studies in the fields of climate change, the efforts by the government and industries on adaptation to climate change and greenhouse gas reduction. Public awareness is raised through alternative means of advertisement, which conveys the importance of practicing adaptation in sectors vulnerable to climate change and of resource and energy conservation. These means include outdoor advertisements for maximum visual effect, various publications, advertisements on public buses and other means of transportation, and hand-outs.

9.2.3. Cooperation with NGOs

The participation and support of the people have contributed to forming the basis for consolidating the energy conservation campaign and lowering energy and resource consumption. To further motivate adaptation measures and energy conservation efforts by the general public, the government runs the campaign in close cooperation with civic groups and related organizations and distributes publications on climate change issues.

9.2.4. Local governments and gities initiatives

Initiatives and measures to resolve climate change challenges will be implemented at both local and city level. Consequently, local governments will play a crucial role in the implementation of government efforts. For instance, the Urban Greening Campaign represents the government's effort to reduce air pollution in cities and provide a cleaner atmosphere, through the removal of air pollutants by trees. Provincial activities to reduce the adverse impact of climate change in sectors which are vulnerable to climate change, such as animal husbandry and arable farming, will contribute to the government efforts.

9.2.5. Environment day events

The aim of Environment Days is to raise public awareness for the need for environmental protection. Various events celebrating Environment Day, including government ceremonies, take place each year. Under the themes of various emerging issues, for example climate change, information dissemination and public awareness campaigns and award ceremonies took place in the spring and autumn, and in campaign months for environmental protection.

ANNEXES

BRIEF DESCRIPTIONS OF POTENTIAL PROJECTS

ANNEX I

GHG mitigation projects proposals

Project 1. Feasibility study on very large scale photovoltaic power generation system in the gobi region of Mongolia

Project name	Feasibility study on very large scale photovoltaic power generation system in the gobi region of Mongolia
Starting year	2011
Implementation period	2 years
Rationale	• The world PV market and PV system application have been greatly extended in recent years. PV Industries in the USA, Europe and Japan recently launched their long-term vision in the PV market. • Very Large Scale Photovoltaic Power Generation (VLS-PV) systems are expected to be one of the main energy sources for the long term because of the potential reduction of PV system costs through further R&D, increasing market demand and sustainable solutions to global energy and environmental issues. • The National Renewable Energy Program (2005-2020) approved by the Mongolian Parliament in 2005, emphasizes implementation of VLS-PV projects especially in the Gobi region. • Some preliminary assessments and studies have been carried out in the region. Energy demand is expected to be greatly increased due to mining intensification at Oyu Tolgoi and Tavan Tolgoi mineral deposits.
Objectives	• To conduct a detailed feasibility study of construction of a VLS-PV system in the Gobi desert area of Mongolia through identifying the key factors, clarifying the effectiveness and benefits of the system's application in the neighboring regions and countries, and potential contribution to the environment protection
Implementation approach and strategy	• The project will be based on studies of the International Energy agency PVPS Program. • The project will be implemented through international bidding procedures.
Beneficiaries	Energy consumers in the Gobi region of Mongolia and neighboring countries and regions
Hosting organization	The Ministry of Mineral Resources and Energy, the Energy Authority, the National Renewable Energy center
Expected outcome	Feasibility study on Very Large Scale Photovoltaic Power Generation System in Gobi Desert area
Required investment, million US$	The Government 0.4 International donors 2.0 Total 2.4
Mitigation of GHGs emissions	The installed capacity of the VLS-PV system will be 100 MW. Mitigation of GHG emissions is estimated at 100,000 tons CO_2/year.
Target area	The Gobi region; particularly near Sainshand of Dornogobi aimag

Project 2. Orkhon hydro power plant

Project Name	Orkhon hydro power plant
Starting year	2012
Implementation period	4 years
Rationale	• The plan of construction of the Orkhon Hydro power plant (HPP) plant has been included in the Program of Energy integrated system and the National Program of Renewable Energy for 2005-2020 approved by the Parliament. • The feasibility study has been carried out by Japanese Chubu Electric Power and Japan External Trade Organization (JETRO) in 2001.

Objectives	To construct a Hydro Power plant at Orkhon River of Selenge aimag, and improve the sustainability of power supply to Central Energy system of Mongolia. The Orkhon HPP is expected to have an installed capacity of 100 MW and be connected to the Central Grid. The power will be supplied to the Central Grid through two 220 kW power connection lines.
Implementation approach and strategy	The project will be implemented through encouraging private investment in state and private enterprises partnerships according to Concession Law of Mongolia.
Beneficiaries	Energy consumers, local residents and investors
Hosting organization	The Ministry of Mineral Resources and Energy, the Energy Authority, the National renewable energy center, private investors
Expected outcome	• Improved operation condition of the Central Energy Grid • Reduced electricity import • Decreased coal consumption of CHPs • Mitigation of GHG and reduction of air pollution • Reduced negative impacts of Energy sector on the environment
Required investment, million US$	Private investment 160
Mitigation of GHGs emissions	Mitigation of GHG emission is estimated at 210,000 tons CO_2/year.
Target area	Orkhon River of Bulgan aimag near Erdenet city located 20 km from the Central Grid.

Project 3. Egiingol hydro power plant

Project name	Egiingol hydro power plant
Starting year	2014
Implementation period	4 years
Rationale	The feasibility study of the project was carried out in 1992 and final design and tender documents have been prepared. There are some challenges to start up the project.
Objectives	To establish a Hydro Power plant to regulate CHP regimes of the Central Energy System
Implementation approach and strategy	The project can be implemented through soft loans.
Beneficiaries	Electricity consumers and local residents
Hosting organization	The Ministry of Mineral Resources and Energy, the Energy Authority, the National Renewable Energy center
Expected outcome	• The installed capacity of the HPP is expected to be 220 MW. • Improved energy regime of the Central Grid during peak load • Reduced import of electricity • Decreased coal consumption in CHPs and mitigation of GHG • Reduced negative impacts of Energy sector on the environment
Required investment, million US$	Soft loan 300
Mitigation of GHGs emissions	The installed capacity of the HPP would be 220 kW and the annual energy production is expected to be 500 million kW. GHG emissions are expected to be reduced by 192,500 tons CO_2/year
Target area	Egiingol River of Selenge aimag located 300 km from Ulaanbaatar

Project 4. Chargait hydro power plant

Project name	Chargait hydro power plant
Starting year	2014
Implementation period	4 years
Rationale:	• Previous studies were conducted in 1990 and 1997. • The feasibility study was carried out by ESB International Dublin, Ireland and Fichtner Stuttgart, Germany companies and was funded by European Commission.
Objectives	To establish a hydro power plant to regulate CHP regimes of the Central Grid.
Implementation approach and strategy	The project can be implemented through CDM project and funded by soft loans
Beneficiaries	Electricity consumers and local residents
Hosting organization	The Ministry of mineral resources and energy, the energy authority, the national renewable nergy center
Expected outcome	• The installed capacity of the HPP is expected to be 15 MW. • The HPP will be connected to the Central Grid and supply energy during peak load. • Reduced import of electricity • Decreased coal consumption in CHPs and improve operation condition of CHPs • Mitigation of GHG
Required investment, million US$	Soft loan 59
Mitigation of GHGs emissions	GHG emissions are expected to be reduced by 41,000 – 55,000 tons CO_2/year.
Target area	Delgermurun River of Khuvsgul aimag located 50 km from Murun town.

Project 5. The taishir wind park

Project name	The taishir wind park
Starting year	2015
Implementation period	3 years
Rationale:	• Combined operation of Hydro Power Plant (HPP) at Taishir and proposed wind park would improve energy supply to the Altai Energy System. • Current Hydro Power of Taishir is not operating fully due to lack of water resource caused by consecutive droughts. Consequently, an additional energy source is required. • The proposed wind park is included in the Strategic Plan of the Government 2008-2012. Wind assessment is being conducted by the National Renewable Energy center.
Objectives	To establish the wind park to operate simultaneously with the Taishir HPP
Implementation approach and strategy	The project can be implemented through soft loans or Public Private Partnership Opportunities.
Beneficiaries	Energy consumers of the Altai region
Hosting organization	The Ministry of Mineral Resources and Energy, the Energy Authority
Expected outcome	• The installed capacity of the wind park is expected to be 5-10 MW. • Improved supply of electricity to the Taishir Grid for users of Gobi-Altai and Zavkhan aimags
Required investment, million US$	Soft loan or private investments 6-12 (depending on capacity)
Mitigation of GHGs emissions	GHG emissions are expected to be reduced by 10,000-15,000 tons CO_2/year.
Target area	Near Taishir Hydro Power Plant of Gobi-Altai aimag

Project 6. The sainshand wind park

Project name	The taishir wind park
Project name	The Sainshand wind park
Starting year	2014
Implementation period	4 years
Rationale	• Renewable energy power plants are planned to be established in the Gobi and the Eastern aimags according to the Government Strategy. • Energy demand of Sainshand is expected to be grown due to planned construction of the industrial park in the area. • Sainshand is one of the more windy areas in Mongolia. Wind assessment is being conducted by the National Renewable Energy center.
Objectives	To establish a wind park to operate concurrently with the CHP of Sainshand in order to meet increasing demand of energy in Sainshand.
Implementation approach and strategy	The project can be implemented by private investments supported by feed-in tariff as indicated in the Renewable Energy Law. The "Sainshand Wind Park" Co.,Ltd is working on preparation of documents for Clean Development Mechanism project opportunities.
Beneficiaries	Energy consumers in the Gobi region, local residents and investors
Hosting organization	The Ministry of Mineral Resources and Energy, the Energy Authority, private investors and "Sainshand Wind park" Co., Ltd
Expected outcome	• The wind park is proposed to have capacity of the 52 MW and produce 170 million kWh electricity per year. • The produced electricity will be supplied to the Central Grid. • Improved supply of electricity to users • Reduced coal combustion and GHG emissions • Reduced negative impacts to the environment
Required investment, million US$	Private investments 75
Mitigation of GHGs emissions	GHG emissions are expected to be reduced by 174,000 tons CO_2/year.
Target area	In the valley of Ulaantolgoi at a distance of 15 km from Sainshand of Dornogobi aimag.

Project 7. The Choir wind park

Project name	The Choir wind park
Starting year	2014
Implementation period	4 years
Rationale	• Renewable energy power plants are planned to be established in the Gobi and the Eastern aimags according to the Government Strategy for 2008-2012. • Energy demand of industry and mining sectors in the eastern and southern regions is expected grow due to planned industrial construction in the area and intensification of mining activities. • Choir is one of the more windy areas in Mongolia. The feasibility study was conducted by Ebara Corporation Japan.
Objectives	To establish the wind park to operate simultaneously with the CHP in order to meet increasing demand of energy
Implementation approach and strategy	The project can be implemented by private sector investments supported by feed-in tariff according to the Renewable Energy Law. Also the project can be implemented as a CDM project.
Beneficiaries	Energy consumers in the Gobi region, local residents and investors
Hosting organization	The Ministry of Mineral Resources and Energy, the Energy Authority, and private investors

Expected outcome	• The wind park is proposed to have capacity of 52 MW and produce 97.4 million kWh/year. • Improved supply of electricity to users • Reduced coal combustion in CHP • Reduced GHG emissions
Required investment, million US$	Private investments 58.2
Mitigation of GHGs emissions	GHG emissions are expected to be reduced by 121,000 tons CO_2/year.
Target area	Near Choir town of Gobisumber aimag

Project 8. Improved insulation of panel apartment buildings

Project name	Improved insulation of panel apartment buildings
Starting year	2012
Implementation period	8 years
Rationale	• Most of the energy produced is used for heating buildings for 8 months during the cold winter. • Most residential buildings were built with poor insulated concrete panels before the 1990s. So, heat loss of buildings is estimated at about 40 % of the total loss. • Research projects of building insulation were implemented and funded by GTZ and others. These projects determined that heat loss of buildings can be reduced by 50-60 % through additional insulation and rehabilitation of residential buildings.
Objectives	To carry out additional insulation of 420 existing apartment buildings in order to ensure thermal comfort of Ulaanbaatar residents who live in old residential buildings
Implementation approach and strategy	The financial mechanism to implement the project of thermal and technical rehabilitation should be defined. A heat consumption based tariff system in the housing sector is required to be implemented. Improving management and responsibilities of owner association/administration is crucial.
Beneficiaries	Residents of existing apartment buildings
Hosting organization	The Ministry of Transportation, Road and Urban Development, the Municipal Governor Administration Office, and residents
Expected outcome	• 743,500 MWh of energy or 561,700 tons of coal would saved. • Apartment comfort will be improved
Required investment, million US$	Investments 84
Mitigation of GHGs emissions	GHG emissions are expected to be reduced by 842,600 tons CO_2/year.
Target area	420 existing apartment buildings in Ulaanbaatar

Project 9. Replacement of incandescent light bulbs with energy efficient lamps

Project name	Replacement of inefficient incandescent light bulbs with energy efficient lighting
Starting year	2012
Implementation period	8 years
Rationale	Nowadays, incandescent bulbs are commonly used in Mongolia. Incandescent bulbs produce 10-15 lumen/W and last for 1,000-2,000 hours. Compact fluorescent lamps (CFLs) produce 50-60 lm/W and last for 10,000-15,000 hours. Moreover, Light-Emitting Diodes (LEDs) produce 100-130 lm/W and last for 35,000-50,000 hours. Usage of CFLs at household and service sectors levels is low due to its relatively high price.
Objectives	To promote usage of energy efficient lamps such as CFLs and LEDs

Implementation approach and strategy	The project can be implemented through promoting consumers to switch from ILs to more energy efficient lamps (CFLs and LEDs) by providing them with some incentives originated by the Certified Emission Reductions (CERs) revenue as a Clean Development Mechanism Project. The project will reduce greenhouse gas emissions by preventing CO_2 emissions from electricity generation by fossil fuel power plants that supply the Central Energy System of Mongolia. Most CERs revenue acquired by this project activity can be designed to be returned to CFLs buyers in the form of the incentive.
Beneficiaries	Consumers of energy efficient lamps and investors
Hosting organization	Government and non government organizations, commercial banks, residents and investors
Expected outcome	Currently, 30 % of household consumption electricity is being used for lighting. When the project is accomplished, 218 million kWh of energy will be saved per year.
Required investment, million US$	Investments 80
Mitigation of GHGs emissions	GHG emissions are expected to be reduced by about 200,000 tons CO_2/year.
Target sectors	Households and service sectors in Ulaanbaatar and other cities

Project 10. Improvement and reconstruction of heat only boilers

Project name	Efficiency improvement and reconstruction of heat only boilers
Starting year	2011
Implementation period	5 years
Rationale	• Most energy is used for heating buildings for 8 months during the cold winter. • A rapid increase in urban populations, fed by a large influx of migrants in recent years, has resulted in a proliferation of coal-fired heating stoves and heating boilers in Ulaanbaatar and other cities, leading to large GHG emissions and serious indoor and ambient air pollution. • In Mongolia big cities have centralized district heating systems supplied from Combined heat and power plants (CHPs). Coal-fired heat-only boilers (HOBs) represent boilers which provide space heating for multiple buildings – apartments, schools, hospitals, and other public and commercial buildings in areas surrounding the center city but not served by the district heating system. The HOBs use raw coal and the efficiency of most HOBs is very low (50-60percent).
Objectives	To undertake a detailed analysis of existing HOBs and replace inefficient boilers with new high efficiency boilers.
Implementation approach and strategy	The project activity could be implemented by private investors. The project activity could also encourage HOB owners to install more energy efficient boilers by providing them with some incentives originated by the Certified Emission Reductions (CERs) revenue as CDM Project. The project activity will reduce greenhouse gas emissions by saving coal in HOBs. CERs revenue acquired by this project activity can be designed to be returned to HOB owners.
Beneficiaries	Heat consumers from HOBs, HOB owners, private investors and residents
Hosting organization	The Municipal Governors Administration office, HOB owners and private investors
Expected outcome	About 60 percent of existing HOBs are required to be reconstructed. Improvement of these HOBs will provide an opportunity to save at least 10-20 thousand tons of coal per year.
Required investment, million US$	Investments 30
Mitigation of GHGs emissions	GHG emissions are expected to be reduced by about 30,000-40,000 tons CO_2/year.
Target area	Heat only boilers in Ulaanbaatar and other cities.

Project 11. Introduction of smokeless coal briquetting technology

Project name	Introduction of smokeless coal briquetting technology
Starting year	2011
Implementation period	6 years
Rationale	• The main cause of air pollution is the burning of raw coal. Introducing smokeless coal briquetting technology is an efficient way to reduce coal combustion and air pollution. • The MDG based NDCS accentuates establishment of small scale factories to produce smokeless coal briquettes. • Also, the 'New Development' program of the Government emphasizes smokeless fuel production through numerous actions such as supporting private investments, promoting through tax and financial policies.
Objectives	Supporting production of smokeless fuel of 600 thousand tons per year and reducing the use of raw coal for heating.
Implementation approach and strategy	The project can be implemented by private investors and the Government can support with taxation and tariff policies.
Beneficiaries	Urban residents and project investors
Hosting organization	The Ministry of Mineral Resources and Energy, the Municipal Governors Administration office and private investors
Expected outcome	Urban resident would be able to live in safe and clean environment. Coal consumption at household and service sectors levels would be reduced.
Required investment, million US$	Investments 25
Mitigation of GHGs emissions	GHG emissions are expected to be reduced by about 270,000 tons CO_2/year
Target area	Factories of smokeless coal briquettes will be established based on coal mines of Baganuur, Shivee-Ovoo, and Shariingol etc.

Project 12. Producing energy from waste and biomass

Project name	Producing energy from waste and biomass
Starting year	2010
Implementation period	5 years
Rationale	• Waste management is a key issue in urban areas. At present, the total amount of waste generated in Ulaanbaatar is estimated to be 552.8 tons per day. 58.2% of this waste is transported to final disposal sites, while 21.4% is dumped illegally in open spaces. All collected waste in the city of Ulaanbaatar is disposed in three landfills without any further processing. No processing such as sorting, disinfection, reusing and recycling of waste takes place. • The Government is giving priority to waste recycling and conversion waste to energy. • The Government of Mongolia is giving high priority to waste recycling and has approved a list of 26 major projects for implementation in the first stage of the Action Plan. The list includes a project to produce liquefied fuel from 250 tons of organic waste and biomass per day
Objectives	To produce liquefied fuel from 250 tons of organic waste and biomass per day
Implementation approach and strategy	The project can be implemented by private investments and soft loans.
Beneficiaries	Urban residents, investors and project implementers
Hosting organization	The Ministry of Nature, Environment and Tourism, the Municipal Governor's Administration offices
Expected outcome	• Improved air quality in urban areas • Reduced risks of contagious diseases caused by contamination • Reduced GHG emission • 250 tons of organic waste would be recycled per day.
Required investment, million US$	Investments 200
Mitigation of GHGs emissions	GHG emissions are expected to be reduced by about 20,000 tons CO_2/year
Target area	In Ulaanbaatar

ANNEX II

Adaptation project proposals

1. Livestock sector

Project 1. Increasing meat production and reducing pasture degradation

Project name	Production of lamb meat
Starting year	2011
Implementation period	5 years
Rationale	• Pasture has been critically degraded due to migration of herders from remote areas to central regions where infrastructure, market and other services have been developed. • There is a high demand for lamb meat with qualified standards in towns. • Controlling livestock number in winter and pasture management activities are required in areas where pasture has degraded as a result of human actions and climate change. • Production of lamb can increase herders' income and improve their livelihood. • The lamb production will support to control animal numbers and reduce the number of 1 year old sheep before winter
Objectives	To supply urban population with qualified meat; to reduce pasture pressures, to increase herders income and to increase exports of meat and meat produced by sophisticated technologies
Implementation strategy and approach	• Educating herders on early rearing of young animals and economic benefits • Rearing young animals would be carried out 15 days earlier and would be butchered in the nearest slaughterhouses in August. • Lamb meat would be supplied for food consumption, and exported after processed by modern technologies • Other products such as skin, intestine, head and etc would be used. • Export of animals would be extended.
Beneficiaries	Herders, processing factories, urban population
Hosting organization	The Ministry of Food, Agriculture and Light Industry, local governments and private enterprises
Expected outcomes	• Increased income of herders through selling lamb • Employment opportunities in meat processing factories • At least 60 % of 1 year male sheep would be slaughtered in 2015 and pasture capacity would be improved due to decreased animal numbers in winter
Required budget, million US$	The Government 0.6 Donors and NGOs 1.2 Individual and private enterprises 0.2 Total 2.0
Target areas	Areas located near (about 200 km) to meat processing factories

Project 2. Establishment of farmers cooperative

Project name	Establishment of farmers cooperative
Starting year	2011
Implementation period	5 years
Rationale	The livelihood of rural populations has been affected due to livestock loss caused by natural disasters such as drought, zud and climate change. Cattle numbers have decreased because of pasture degradation. Urban residents mostly consume imported milk products. Demand of qualified milk and milk products has increased in urban areas. Cattle breeds with high milk and meat productivity have decreased. Also other related sectors such as forage planting and preparation, veterinary and breeding are not yet developed to produce sufficient amounts of production.
Objectives	To increase milk production and to improve livelihood of poor herders families through supporting their collaboration
Implementation strategy and approach	• Identifying beneficiaries through selection criteria, establish herders groups of 4-5 households and providing these group with necessary equipments, such as cattle pens, milking machines and land; • Providing extensive training on cattle management and high breed; • Identifying the milk market and making sustainable contracts • Supporting families to have high breed of cattle under repayment conditions; • Establishment of a database of each cattle ID, origin and productivity; • Establishment of cooperatives of 8-10 herders groups considering local context, infrastructure and the local market • Each cooperative would have its own artificial breeding and veterinary facilities, forage preparation equipments, milk transportation and hay and mowing tools. • Extra forage can be sold to neighboring herders to overcome risks. • Different specialists on livestock management will be trained and work in the cooperative
Beneficiaries	Farmers, rural residents
Hosting organization	The Ministry of Food, Agriculture and Light Industry, the Ministry of Finance, the Ministry of Nature, Environment and Tourism, local governments of cities and aimags.
Expected outcomes	• To produce about 9 million liters of milk per year that would replace imported milk worth about 10 mln US$ • Direct beneficiaries would be 6200 people and indirect beneficiaries would be approximately 60 thousand people. • Establishment of at least 20-25 cooperatives of more than 1000 households
Required budget, million US$	• The government 3.4 • International donors and NGOs 15.0 • Individuals and private enterprises 0.6 Total 19.0
Target areas	Ulaanbaatar city and Tuv, Orkhon, Darkhan-Uul, Dornod and Khentii aimags

Project 3. Establishment of water harvesting reservoirs for livestock

Project name	Establishment of water harvesting reservoirs for livestock
Starting year	2011
Implementation period	3 years
Rationale	About 36 thousand wells were registered in 2009. 68 % out of the total are dug wells and the remainder are drilled wells. 18 thousand dug wells out of 25 thousand wells in pasture are and 4 thousand drilled wells are being used as water sources for 25 million livestock in winter and spring. The remaining animals drink snow and ice water during these seasons.

	In summer and autumn 70 % of drilled wells and 30% of dug wells are used to water about 30 million animals. The remaining animals use rivers, streams and rain water. A lot of pasture especially in the Gobi desert and the steppe is not being used due to lack of water sources.
Objective	Improved water supply to livestock
Implementation strategy and approach	To provide professional and technical support to community initiatives to establish water harvesting reservoirs: • Carrying out assessment on pastureland and identifying locations appropriate for water reservoirs; • Protection of upper river and stream basins and establishment of water reservoirs to supply water to animals; • Developing technology to build water reservoirs and training communities. • Establishing snow water harvesting reservoirs using the natural landscape and canals.
Beneficiaries	Herders
Hosting organization	The Ministry of Food, Agriculture and Light Industry, the Ministry of Finance, the Ministry of Nature, Environment and Tourism, Aimag and Municipal Governor Administration Offices
Expected outcomes	A water reservoir can supply water to up to 5000 animals in the vicinity. Vegetable gardening and forage planting at the household level can be extended.
Required budget, million US$	Each reservoir would cost 3.6 International donors 3.0 Individuals and private enterprises 0.6 Total 720.0 (for 100 reservoirs)
Target areas	The western, the northern and the northeast parts of the country

Project 4. Planting animal forage

Project name	Planting forage in winter camping places
Starting year	2011
Implementation period	5 years
Rationale	• Pasture has been degraded due to human actions, climate fluctuations and climate change • Animal numbers have increased significantly. • Production of forage and fodder for animals is insufficient especially during winter and spring.
Goal	• To prepare forage for animals at the least cost • To reduce risks through grazing in the nearest fields in severe winter weather
Implementation strategy and approach	• Conducting surveys among herders to plant forage • Providing training and technical and financial support to herders • Developing partnerships with related projects and programs implemented by International agencies • Strengthening research institutions to provide seeds and varieties of plants appropriate for animals
Beneficiaries	Herders and local communities
Hosting organization	The Ministry of Food, Agriculture and Light Industry, the Agency of Food, Agriculture and Small and Medium Enterprises, local governments
Expected outcomes	• By 2015, herders would produce at least 30 % of own animals forage demand. • Livestock resilience would be improved and death rate would be reduced.
Required budget, million US$	The Government 1.0 International agencies and organizations 4.0 Individuals and private enterprises 0.5 Total 5.5
Target areas	Selected areas with land and water resources

Project 5. Improvement of water monitoring network

Project name	Improvement of water monitoring network
Starting year	2011
Implementation period	2 years
Rationale	Research results on grassland condition show that the yield of grasslands has decreased by 20-30% in the last 40 years. Also, increased drought at the level of 95 percent in Mongolia has resulted in the decrease of palatable pasture plants and grass, and reduced availability of water and supplementary feed for animals. Warming, climate change, glacial melting, permafrost degradation, and lowering of the ground water table have occurred and will continue to have significant negative impacts on pasture water supply. The Mongolian livestock sector depends heavily on climate, pasture and its water supply availability. Nearly 80 percent of the total water demand is provided by groundwater sources, including pasture water supply. Shortages of pasture water supply leads to deterioration of pasture and intensification of desertification, limiting the use of pasture reserves and potential pasture lands. Unregulated ownership and privatization of water source infrastructure is leading to unsustainable pasture water systems. Environmental problems existing at present are damage to banks of streams and dugouts, siltation problems in spawning areas for fish, loss of riparian habitat and vegetation, loss of water storage in dugouts and streams, nutrient build-up in both the source and downstream water bodies, rapid growth of weeds and algae and deterioration in water quality.
Objective	• To develop an assessment on availability of surface and groundwater resources and optimization of locations of new water sources for pasture water supply • To determine the feasibility of designing pasture water supply systems and water accumulation dams • To establish a groundwater monitoring network in a pasture reserve area and to extend the surface water observation network • To demonstrate and test some water supply systems in the selected pasture area for further recommendations
Implementation strategy and approach	To provide professional and technical support to community initiatives to establish water harvesting reservoirs: • Carrying out an assessment on pastureland and identifying locations appropriate for water reservoirs; • Protection of rivers and streams and establishment of a water reservoir to supply water to animals; • Developing technology to build water reservoirs and train communities. • Establishing snow water harvesting reservoirs using the natural landscape and canals.
Beneficiaries	Herders and local communities
Hosting organization	The Ministry of Food, Agriculture and Light Industry, Aimag Governor Administration Offices, Institute of meteorology and hydrology, Hydrometeorological society of Mongolia
Expected outcomes	• Recommendations, handouts on field survey, water resources assessment, optimization of location of water sources, and feasibility design of water supply systems • Constructed demonstration water supply systems • Extended monitoring network for surface and groundwater • Improved preparedness and risk reduction of climate change in livelihoods through learned capacity and knowledge • New technology and skills adopted in pasture management
Required budget, thousand US$	International donors 940,000 Total 940,000
Target areas	Kherlenbayanulaan, Khentii aimag and Dundgobi aimag, Khovd river of Bayan-Ulgii aimag

Project 6. Early warning network of prevention and mitigation of risks related to climate change

Project name	Early warning network of prevention and mitigation of risks related to climate change
Starting year	2011
Implementation period	2 years
Rationale	• The frequency of climate related extreme events has increased and the magnitude and scope of the occurrence area of natural disasters has expanded, resulting in 10-12 billion tugrugs worth of damage every year to the government, society and people's property. Pastoral livestock is highly dependent on weather conditions and is extremely sensitive to climate change. • One of the major economic sectors of Mongolia is nomadic livestock husbandry, wich relies on pastureland. • Due to the lack of reliable and accurate real time information on the magnitude, location, speed and direction of disasters, herdsmen have not been provided with sufficient notice to respond to reduce the impact of extreme events. • To prevent loss of livestock and to protect livestock husbandry practices from natural disasters, it is crucial to find solutions to transmit a highly accurate, real time emergency messages about the location of disaster events. • The "Livestock and Agriculture Risk Study Center" NGO has piloted a study, based on experimental research design for establishment of an "Early Warning Point" in Dundgobi aimag.
Objective	To establish six "Early Warning Points" in the high risk regions of the Gobi and the steppe area and for the Network Monitoring Center to provide coordination and management for continuous operation of the "Early Warning Points".
Implementation strategy and approach	The project can be implemented under the financial support of the "Adaptation Fund". • Herders would be informed about unexpected disasters by the network of "Early Warning Points" in order to provide time to respond to mitigate the impact and minimize loss and damages. • Reduced risks will help to slow down the internal migration of the rural population of the Gobi and the steppe region to urban areas • Disaster warning complexes will be located at the most advantageous transmission point in the local area. • The project will be implemented in a cost- effective manner ensuring community participation though volunteers initiatives. • The project will increase the capacity of herders of the Gobi and the steppe region in mitigation and preparedness of the adverse impacts of hazards, establishment of effective early warning systems and lessons learnt.
Beneficiaries	Herders and local communities
Hosting organization	The Ministry of Nature, Environment and Tourism, Authority of the Mongolian Special Envoy for Climate Change
Expected outcomes	• Detecting the upcoming climate disaster events, through people centered rapid dissemination of emergency messages and transmission to the appropriate people at risk, will be achieved and will enable the affected people to respond as required to mitigate harmful effects of the disaster with actual participation of the local community. • Continuous operation of sites, established in framework of project implementation; • Herders families will have improved preparedness and reduced risk of climate change affecting livelihoods through learned capacity and knowledge; • Increased family income and improved living conditions for herders in target areas;
Required budget, thousand US$	International donors 997,800 Total 997,800
Target areas	Uvurkhangai, Dundgobi, Umnugobi, Gobi-sumber, Dornogobi, Sukhbaatar, Khentii and Dornod aimags, Ulaanbaatar

2. Agriculture sector

Project 7. Extension of irrigated cropland

Project name	Establishment of irrigation systems
Starting year	2011
Implementation period	4 years
Rationale	• 98 % of the total cropland is non- irrigated. When droughts and low precipitation occur, imports must be increased to meet food demand in the country. • Generally, farmers harvest yield is low for 3 years out of every 5 years. • Large scale (100 ha) irrigation systems are required to be supported by international funding.
Objective	• To ensure high productivity of crop, food security and sustainability of economy • Support to national and foreign investments • Providing monitoring and maintaining efficiency of irrigated croplands
Implementation strategy and approach	• To conduct survey of agriculture land and undertake an effective analysis to develop national and local policies and strategies in aimags and soums • Providing financial and technical supports • Attaining national and international donors interest through promotion of policies and strategies for large scale crop fields • To ensure partnership of private and foreign enterprises in construction of large irrigation system
Beneficiaries	Farmers, flour producers, users and the Government
Hosting organization	The Ministry of Food, Agriculture and Light Industry, the Ministry of Finance and the Ministry of Nature, Environment and Tourism
Expected outcomes	• Increased cropland by 1.5 times compared to 2009 • At least 20 % of cereals and legumes would be harvested from irrigated land • To ensure food security and farmers income
Required budget, million US$	The Government 51.7 International agencies and organizations 15.0 Individuals and private enterprises 40.8 Total 107.5
Target areas	To conduct surveys and to identify appropriate locations and fields (Selenge, Kherlen, Khovd and Buyant river basins, Khurkh, Onon and Balj rivers valleys etc.)

Project 8. Introduction of water efficient technology in agriculture

Project name	Introduction of water efficient technology in agriculture
Starting year	First phase 2011-2016
Implementation period	10 years
Rationale	• About 20 % of vegetable gardening fields have irrigation; however, irrigation efficiency is low leading to higher expenses and lower incomes for farmers. • Efficient irrigation technologies have been piloted by research institutions.
Objective	Increased farmers income and improved sustainability of crop production through reducing irrigation cost and increasing vegetable yield
Implementation strategy and approach	• Providing drop irrigation system through international projects and programs • Extension of imports of plastic cover materials that reduce evapotranspiration • Providing farmers and enterprises with technical and financial supports
Beneficiaries	Farmers, and users

Hosting organization	The Ministry of Food, Agriculture and Light Industry, farmers
Expected outcomes	• To provide plastic coverage to 1-1.5 thousand ha of vegetable fields • Drop irrigation systems will be provided to 90-100 ha of vegetable fields and 10-15 thousand ha of fruit planting fields • Water consumption in agriculture will be decreased by about 25 -30 % as a result of efficient technologies.
Required budget, million US$	Drop and root irrigation system of 115 ha 0.97 Plastic coverage for 15 thousand ha 2.25 Total 2.35 The Government 0.675 International agencies and organizations 0.450 Individuals and private enterprises 1.221
Target areas	Vegetable and crop fields and fruit plantations

3. Water sector

Project 9. Natural and artificial regulations of rivers flow

Project name	Natural and artificial regulation of river flow
Starting year	2011
Implementation period	6 years
Rationale	• Precipitation intensity has increased and river flood has grown due to climate change. Regulation of river flow is essential to prevent flood risks as well as to provide dry areas with drinking and irrigation water.
Objective	• Reduced flood risks and increased water accumulation • Increased use of accumulated water for livestock and vegetable gardening
Implementation strategy and approach	• Identifying sites for restoring natural regulations at Orkhon and Khovd rivers • Establishment of blocking walls through local community participation • Identifying artificial regulation sites • Establishing blocking through cascading technology
Beneficiaries	Local communities and local governments
Hosting organization	The Ministry of Nature, Environment and Tourism, the Ministry of Food, Agriculture and Light Industry, the Ministry of Finance
Expected outcomes	• River flow would be regulated • Reduced adverse impacts of climate change • Increased water availability and • Reduced flood risks
Required budget, million US$	The Government 6.0 International agencies and organizations 4.0 Individuals and private enterprises 1,0 Total 11.0
Target areas	Orkhon, Khovd and Kherlen river basins

Project 10. Equipping resident apartments in Ulaanbaatar with water counters

Project name	Equipping residents apartments in Ulaanbaatar with water counters/meters
Starting year	2011
Implementation period	6 years
Rationale	The main water source for the UB population is the Tuul river. In 2020, water consumption of Ulaanbaatar residents is expected to be double that of 2010 levels. Studies have shown that, water consumption in households with counters is less than half of that of households without counters.
Objective	Reduced water consumption of households through changing behavior and through equipping with water counters all apartments in 3 and 4 sub districts of Bayangol district, UB.
Implementation strategy and approach	• To increase the number of households with water counters through extensive public awareness raising on proper water consumption and practices • To provide support for low income families to have water counters • Supporting imports of water countering equipments through taxation policies
Beneficiaries	Apartment residents in relation to water usage
Hosting organization	• Residential buildings service companies
Expected outcomes	• Changed behavior of residents • Increased water availability as a result of water saving habits and efficient technologies • Decreased household expenditure for water consumption
Required budget, mln US$	The Government 1.0 International agencies and organizations 0.5 Individuals and private enterprises 1,0 Total 2.5
Target areas	Residents of 3,4 sub districts, Bayangol district, Ulaanbaatar

Project 11. Public awareness on water consumption practices

Project name:	Public awareness on water consumption practices
Starting year	2011
Implementation period	6 years until the end of 2016
Rationale	Integrated water management (IWM) is one of the adaptation measures available to protect water resources. Increased water consumption efficiency is an essential component of IWM. Proper water usage habits and practices among residents would contribute to water conservation.
Goal	Increased water availability through improved water consumption efficiency
Implementation strategy and approach	• Publish training handouts and guidelines for pre-school, school, high school college university students and the public. • Disseminate brochures, leaflets and posters for pre-school, school, high school college university students and the public • Facilitate an awareness campaign in partnership with the media • Support community and childrens activities, competitions, quizzes, etc.aimed at water saving practices
Beneficiaries	• Preschool children • School children • Students of colleges and universities • The public
Hosting organization	Residential building service companies Environment NGOs Schools, colleges, universities
Expected outcomes	• Improved habits and practices of youth and people • Improved water consumption efficiency • Reduced household expenditure on water consumption
Required budget, mln US$	The Government 0.5 International agencies and organizations 0.5 Individuals and private enterprises 1,0 Total 2.0
Target areas	Residents of building in UB, kindergarten, schools, colleges and universities

4. Health sector

Project 12. Comprehensive study of climate change and human health

Project name	Comprehensive study of climate change and human health
Starting year	2011
Implementation period	5 years
Rationale	• Climate change impacts on human health have not been studied well in Mongolia. • Climate change impacts are clearly and intensively seen in the country. • There is a lack of research capacity. • Factual studies and statistical confidences are required in studies to support decision making.
Goal	To strengthen the capacity of scientific research on climate change and human health
Implementation strategy and approach	To improve research capacity through experts training and provision of necessary facilities and techniques
Beneficiaries	• Medical experts and decision makers • Public • Other stakeholders
Hosting organization	The Ministry of Health, the Ministry of Education, Culture and Science and other related institutes
Expected outcomes	• Completion of a comprehensive research study on the direct and indirect impacts of climate change on human health and determination of prevention measures and methods for public and medical workers • Reports, guidelines and recommendations on scientific backgrounds, information and preventative actions will be published for public and decision makers.
Required budget, thousand US$	The Government 939.4 International agencies and organizations 402.6 Individuals and private enterprises Total 1,342.0
Target areas	Nationwide

Project 13. Adaptation of health service system to climate change

Project name	Adaptation of health service system to climate change
Starting year	2011
Implementation period	4 years
Rationale	• Climate change consequences are clearly and intensively revealed in the country • Health service systems are not sufficiently able to cope with unexpected situations related to human health caused by climate shock and change. • Unknown and unexpected disease outbreaks are likely to increase. • Lack of human and equipment capacities to deal with health issues related to climate variability and change.
Goal	Improved preventative and curative capacities of health systems regarding climate change and shock
Implementation strategy and approach	• To improve the legal environment • To improve health service systems • Introduction of advanced technology, equipments, facilities, standards and guidelines
Beneficiaries	• Health workers • Public who receive health services • Decision makers
Hosting organization	The Ministry of Health, and related ministries and stakeholders
Expected outcomes	• Improved capacity to prevent and respond to human health issues and risks caused by climate change and variability
Required budget, thousand US$	The Government 149.0 International agencies and organizations 638.6 Individuals and private enterprises Total 2,128.6
Target areas	Nationwide

5. Education and capacity building

Project 14. Capacity building for Climate Change Adaptation

Project name:	Capacity building for Climate Change Adaptation
Starting year	2011
Implementation period	2 years
Rationale	• In Mongolia, there is no appropriate environmental management mechanism established in the way of promoting climate change adaptation, reducing environmental degradation, mitigating changes in ecosystems caused by global warming in the context of sustainable development. • Participation of communities, NGOs, civil society and business entities is crucial in adaptation to climate change, reduction of greenhouse gase emissions, and mitigation of impacts. Therefore it is vital to set up the foundations for an education programme on environmental issues among the population in order to assist vulnerable communities to strengthen their resilience to current and projected climate change impacts and climate-related disasters through adaptive measures and better disaster preparedness and management.
Objectives	This project is aimed at increasing the knowledge and skills of adaptation capacity for climate change and mitigation measures through development of public education programmes on climate change and global warming related topics.
Implementation strategy and approach	• The project can be implemented with the financial support of the "Adaptation Fund". • To develop a training curriculum of public education on capacity building for adaptation for climate change and improving livelihood targeted to local residents. • To facilitate a series of training workshops in Ulaanbaatar city or in 21 rural aimags on climate change adaptation • Intensive outreach programmes will be conducted through various media agents. • Publications handbooks and booklets will be developed and delivered to target groups of the population.
Beneficiaries	Urban population, herders, local communities
Hosting organization	The Ministry of Nature, Environment and Tourism, Authority of the Mongolian Special Envoy for Climate Change
Expected outcomes	• A training curriculum of public education will be developed. • Improved knowledge and skills of communities about climate change, its impacts, adaptation and mitigation measures.
Required budget, thousand US$	International donors 976,075 Total 976,075