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Egyptian Environmental Affairs Agency

Ministry of State
for Environmental Affairs
Egyptian Environmental
Affairs Agency

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United Nations
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EGYPT THIRD NATIONAL COMMUNICATION

MARCH 2016

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UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

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Under the United Nations Framework Convention on Climate Change

This report is submitted to
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FOREWORD

Climate change is now considered as one of the greatest challenges not only to the national and regional governments but also to the global community. The international scientific community has proven that global warming of the climatic system is unequivocal. As a result of global climatic disorder the sufferings of humankind have already increased remarkably especially in Least Developed Countries.

All Parties to the United Nations Framework Convention on Climate Change (UNFCCC), taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, need to periodically report to the Convention a National Communication as per Article 4.1 and 12.1 of the UNFCCC.

Towards fulfillment of obligation under the Convention, Egypt submitted its Initial National Communication (INC) and Second National Communication (SNC) to the UNFCCC Secretariat in 1999 and 2010, respectively. This Third National Communication to the Conference of the Parties reflects the firm commitment of the Government of Egypt to the Convention, its ultimate objective and principles.

I am pleased to note that the publication of Egypt Third National Communication will provide an overview on the climate change issues and status to the key stakeholders at local, national, regional and global arena. This document contains National Circumstances, Greenhouse Gas (GHG) Inventory, Programmes containing measures to mitigate climate change, Vulnerability and Adaptation and the lines of research, education and systematic observation specific to the topic.

Egypt's Third National Communication Project, funded by the Global Environment Facility (GEF) through the UNDP Egypt, has been able to create a solid foundation for further work on scientific and policy issues. It has also been able to clearly define the concerns relevant within the national context and has identified potential areas for further action.

The project has alerted policy makers to the need to mainstream climate change issues in the national policy and legal framework. It has helped to enhance the capacity of the scientific and research communities of Egypt in properly formulating and planning mitigation and adaptation policies and options. The project has further highlighted the need for stronger efforts to spread awareness among stakeholder groups and decision-makers.

I would like to take this opportunity to express my gratitude to the officials and experts of the Ministry of Environment and Climate Change Central Department, other related government and non-government organizations, the consultant team and individuals for their dedication and commitment in the preparation of the document through a participatory process, which included a series of workshops, seminars and meetings involving all key stakeholders.

Dr.Khaled Fahmy

The Minister of Environment

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ABBREVIATIONS

AHR	Atmospheric Heating Rate
AOD	Aerosol Optical Depth
ARC	Agricultural Research Center
ARE	Arab Republic of Egypt
ASI	Avoid, shift and improve strategy
ARI	Acute respiratory infection
BAMS	Bulletin of the American Meteorological Society
BAU	Business as Usual
BOA	Bottom of Atmosphere
BOD	Biological Oxygen Demand
CAPMAS	Central Agency for Public Mobilization and Statistics
CCI/CLIVAR	Expert Team on Climate Change Detection
CCS	Carbon Capture and Storage
CDC	Communicable Disease Control Center
CDM	Clean Development Mechanism
CH_4	Methane
CITES	Convention on International Trade in Endangered Species
CLAC	Central Laboratory for Agriculture Climate
CNG	Compressed Natural Gas
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2e	Equivalent carbon dioxide
COP	Conference of Parties
CoRI	Coastal Research Institute
CPS	Concentrated solar power
CRUTEM3	Dataset at Hadley Centre of the UK Met Office
DEM	Digital Elevation Model
DDT	Dichlorodiphenyltrichloroethane
DSM	Demand Side Management
ECHAM4	Climate model has been developed from the ECMWF atmospheric model
EDHS	Egyptian Demographic and Health Survey
EEAA	Egyptian Environmental Affairs Agency
EEHC	Egyptian Electricity Holding Company
EF	Enteric Fermentation
EGAS	Egyptian Gas Holding Company
EGP	Egyptian Pound
EGPC	Egyptian General Petroleum Corporation
EHMC	Environmental Hazards and Mitigation Center, Cairo University
EM	Eastern Mediterranean
EMA	Egyptian Meteorological Authority
ENR	Egyptian National Railway

EOR	Enhanced Oil Recovery
EPF	Environmental Protection Fund
ETCCDMI	Expert Team for Climate Change Detection Monitoring and Indices
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FEI	Federation of the Egyptian Industry
GAP	Global Hydrology Mode
GCM	Global Circulation Models
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFDL	Geophysical Fluid Dynamic Laboratory
GHG	Greenhouse Gases
GISS	Goddard Institute for Space Studies
GNP	Gross National Product
GWP	Global Warming Potential
GWR	Ground Water Resources
H5N1	Avian influenza A virus
HadEX	Hadley EXtrem indices (Hadley Centre climate model data)
HC1	(HelioClim-1 model
HDI	Human Development Index
hPa	hector-Pascal, unit pressure = 100 Pascal
HY	HYdrostatic model (HY) and modified version non-hydrostatic (NH) models.
IAEA	International Atomic Energy Agency
ICE	Internal Combustion Engine
ICZM	Integrated Coastal Zone Management
IDA	Industrial Development Authority
IFAD	International Fund for Agricultural Development
IGSR	Institute for Graduate Studies and Research, Alexandria University
INC	Initial National Communication
IPCC	Inter-governmental Panel on Climate Change
ITCZ	Inter Tropical Convergence Zone
IWMI	International Water Management Institute
Kt	Thousand tons
kWe	Kilo-Watt electrical
kWh	Kilo-Watt hour
LE	Egyptian pound
LPG	Liquefied petroleum gas
MALR	Ministry of Agriculture and Land Reclamation
Mbbl	Million barrels
MBOE	Million Barrels of Oil Equivalent
MJ	Mega Joules
MSW	Municipal Solid Waste
Mt	Million tons
MTOE	Million Ton of Oil Equivalent

MoP	Ministry of Petroleum
MoT	Ministry of Transport
MW	Megawatt
MWe	Megawatt electrical
MWRI	Ministry of Water Resources and Irrigation
N_2O	Nitrous oxide
NARSS	National Authority of Remote Sensing and Space Sciences
NAMAs	Nationally Appropriate Mitigation Actions
NASA	National Aeronautics and Space Administration
NAMRU-3	Naval Medical Research Unit Three
NCCM	National Council for Childhood and Motherhood
NEAP	National Environmental Action Plan
NG	Natural Gas
NGOs	Non-Governmental Organizations
NH	Non- Hydrostatic model
NH_3	Ammonia
NIOF	National Institute of Oceanography and Fisheries
NIS	Non-indigenous species
NMVO	Non-methane volatile organics
NOAA	National Oceanic and Atmospheric Administration
NOx	Nitrogen oxides
OECD	Organization for Economic Cooperation and Development
OEP	Organization of Energy Planning
Oile	Oil equivalent, hypothetical fuel with high heating value of 10,000 kilo-Calories per kilogram
ORS	Oral rehydration solution
PFC's	Perfluorocarbons
PPP	Private-Public Partnership
PV	Photovoltaic
R&D	Research & Development
RD&D	Research, Development and Deployment
RDF	Refuse Derived Fuel
RE	Renewable Energy
RF	Radiative Forcing
SADS	Sustainable Agricultural Development Strategy
SBSTA	Subsidiary Body for Scientific and Technological Advice
SeaWif	Sea-viewing wide field-of-view sensor
SFD	Social Fund for Development
SI	Sensitivity Index
SLR	Sea level rise
SNAP	Support for National Action Plan
SPA	Shore Protection Authority
SPOT	Satellite Pour l'Observation de la Terre
SRES	Special Report on Emissions Scenarios
STT	Satellite communication Transportable Terminal

S&T	Science and Technology
SWDS	Solid Waste Disposal Sites
TB	Tuberculosis
TCF	Trillion Cubic Feet
Tg	Teragrams (10^{12} grams, equivalent to mega tonne)
TSP	Total Suspended Particles
UKMO	United Kingdom Meteorological Office
UNDP	United Nations Development Program
UNICEF	United Nations International Children Emergency Fund
US$	United States dollars
USA	Unites States of America
VACSERA	Egyptian Company for Production of Vaccines, Sera and Drugs
VI	Vulnerability Index
VOC	Volatile Organic Compound
WHO	World Health Organization
WMO	World Meteorological Organization
WRF-ARW	Advanced Weather Research and Forecast
WW	Wastewater
WWTP	Centralized Wastewater Treatment Plant

EXECUTIVE SUMMARY

Egypt lies between Latitude 22° and 32°, and the country's maximum distances are 1,024 km from north to south, and 1,240 km from east to west. Egypt is boarded by the Mediterranean Sea to the north, by Sudan to the south, by the Red Sea, Palestine and Israel to the east, and by Libya to the west. The total area of Egypt is 1,001,450 km^2, with a land area of 995,450 km^2 and a coastline of 3,500 km on the Mediterranean and the Red Sea. The surface level extremes range from 133 m below sea level in the Western Desert to 2,629 m above sea level in Sinai Peninsula.

The general climate of Egypt is dry, hot, and desertic, with a mild winter season with rain over the coastal areas, and a hot and dry summer season. The only differences between the seasons are variations in daytime temperatures and changes in prevailing winds. In the coastal regions, temperatures range between an average minimum of 14° C in winter and an average maximum of 30° C in summer. Egypt receives fewer than eighty millimeters of precipitation annually in most areas. Most rain falls along the coast, but even the wettest area, around Alexandria, receives only about 200 millimeters of precipitation per year.

According to the official figures released by the Central Agency for Public Mobilization and Statistics (CAPMAS) in 2012, Egypt's population has reached 82 million living on just 5.3% of the country's area. The Egyptian gross national product (GDP) was 107.43 billion US$ dollars in 2006, reached 271.97 billion US$ in 2014, GDP real growth rate is 1.8% and GDP-per capita is 6.600$ on 2013.The GDP composition by end use is 78.6% household consumption, 11.8% government consumption, 14.3% investment in fixed capital, 0.4% investment in inventories, 18% exports of goods and services and -23.2% imports of goods and services. GDP composition by sector of origin in 2013 shows 14.5% agriculture, 37.5 % industry, and 48% services. The labor force on 2013 is 27.69 millions, 29% in agriculture, 24% in industry and 47% on services. The unemployment rate reached 13.4% on 2013 and inflation rate 9%.

Egypt is one of the most populous countries in the world; population density reached 1,850 people per square kilometer. Informal growth trend had continued over the urban border of Egyptian cities. In 2011, the total number of population in new cities came to 5 million and is expected to reach 17 million when the cities are completely grown.The new cities provided 511 thousand job opportunities and the number of under construction factories came to 2,967 providing 97 thousand job opportunities.[1]

The main source of water in Egypt is the Nile River. Egypt is unique among other countries in its dependence on water from one deterministic source. The Nile water agreement with Sudan, allocates 55.5 BCM/year to Egypt. Rainfall in Egypt occurs only in winter in the form of scattered showers. The average annual amount of effectively utilized rainfall water is estimated to be 1.3 BCM/year. This amount cannot be considered a reliable source of water due to high spatial and temporal variability. Groundwater exists in Western Desert and Sinai in aquifers that are mostly deep and non-renewable. The total groundwater volume has been estimated at about 40,000 BCM. However, current abstraction is estimated to be 2.0 BCM/year. The main obstacles in utilizing this huge resource are the great depths (up to 1500 m in some areas) of these aquifers and deteriorating water quality at the increasing depths. The main water-using sector in Egypt is agriculture, followed by municipal and industrial uses.

The coastal zones of Egypt extend for over 3,500 km in length along the Mediterranean and Red Sea coasts. The Mediterranean shoreline is most vulnerable to sea level rise due to its relative low elevation in

[1] New Urban Communities Authority, 2010

Egypt compared to the land around it. The Delta and its north coast are hosts to several main towns and cities such as Alexandria, Port Said, Damietta, and Rosetta, accommodating several millions of population, and large investments in industrial, touristic and agricultural activities as well as in the infra structure serving these activities. These are all vulnerable to sea level rise.

The energy sector was the largest contributor to greenhouse gas emissions in Egypt. This is mainly because Egypt is highly dependent on fossil fuels, namely oil and natural gas; thus carbon dioxide is the main greenhouse gas emitted. Since the early 1990s, large amounts of natural gas reserves have been discovered, and in consequence, there has been a trend for the substitution of petroleum products by natural gas as an alternative fuel. Emissions of CO_2e from the energy sector for the base year 2005/2006 are 147,324 Gg. Emissions of CO_2e from the Electricity Sector for the base year 2005/2006 are 54,845.6Gg. The percentage of GHGs emissions of the Electricity Sector relative to all energy consumption for CO2e for the base year 2005/2006 is 37.23%.

Industrial Production in Egypt increased 20.69% in November of 2014 over the same month in the previous year. Industrial production in Egypt averaged 4.45% from 2004 until 2014, reaching an all-time high of 34.77% in February of 2012 and a record low of -24.89 percent in February of 2011. The second highest contributor to GHG emissions is industrial production which accounts for 42,013 Gg. Carbon dioxide gas emitted from cement production is the main contributor with 16,717 Gg followed by ozone depleting substances (HFC's and PFC's) with 15,473 Gg. Nitric acid production responsible for nitrous oxide emissions contributes by 5,042 Gg. Other activities which contribute insignificantly to this sector are ammonia production, iron and steel as well as lime production all producing carbon dioxide emissions. Another minor contributor is aluminum production emitting PFCs.

Egyptian agricultural land can be classified into: "Old-land" comprising the lands of the Nile Valley and the Nile Delta which have been irrigated and intensively cultivated since ancient times, and which represent about 80% of the cultivated area; "New-land" entailing lands that have been reclaimed relatively recently or are in the process of being reclaimed now, representing about 20% of the cultivated area. The cultivated land base of Egypt is about 3.5 million hectares, with a total annual cropping area of about 6.2 million hectares, representing 176% of the total cultivated land area (SADS, 2010). Greenhouse gas emissions from the agriculture sector have a contribution of 39,446 Gg. Agricultural soil is the main source of GHGs emissions from agriculture sector by contribution of 50.75% in 2005. Enteric fermentation is the second important source by contribution of 22.8% in 2005 followed by rice cultivation by contribution of 11.73%. These are followed by manure management by contribution of 10.18% and finally, the field burning of agricultural residue by contribution of 4.43% in 2005.

Despite the national and local efforts to tackle the solid waste management crisis in Egypt, the improper waste handling, storage, collection, treatment and disposal practices still pose serious environmental and public health risks. The major challenges facing the sector are the inadequate planning and legislation, resource constraints, institutional deficiencies and the lack of stakeholders' participation. The waste category includes emissions from the treatment and disposal of wastes and amounts to 19,198 Gg.

Sources include solid waste disposal on land, wastewater treatment, and waste incineration. Emissions estimated are CH_4 emissions from solid waste disposal on land, CH_4 and N_2O emissions from wastewater treatment, and CO_2 emissions from waste incineration. The most important gas produced in this source category is methane (CH_4).

The key for Egypt to mitigation of climate change is to lay a sound foundation for further evolution to zero- and low-carbon energy supply technologies, with substantial reductions in energy intensity along with comprehensive mitigation efforts covering all major emitters and technology and financial transfers from industrialized countries to support decarbonization, Most policies that aim at a more sustainable development rest upon four main pillars: more efficient use of energy, especially at the point of end use; increased utilization of renewable energy as a substitute for non-renewable energy sources; accelerated development and deployment of new energy technologies – particularly next-generation fossil fuel technologies that produce near-zero harmful emissions and open up opportunities for CO_2 sequestration, in addition to the new generations of nuclear power; and bio sequestration of carbon in terrestrial ecosystems, including soils and biota.

GHGs emissions mitigation opportunities in energy intensive industries include introducing energy efficiency measures, applying energy management systems, capacity building and training, introducing renewable energy, encouraging switching to alternative fuels and waste materials and waste heat recovery. In the transport sector, achieving low carbon emissions is through the application of the Avoid-Shift-Improve (ASI) strategy; “Avoid”excessive increase in transport demand, “Shift” demand to energy-efficient / low-carbon modes, and “Improve” the efficiency of vehicles and the quality of fuels.

As for the agricultural sector, reduction of GHGs emissions can be achieved through mitigation of methane emissions from rice cultivation and from fertilizers, developing agricultural waste management aimed at reducing gas emissions and concentrating on bioenergy for gas and electricity production. Other opportunities include mitigation of GHG emissions in livestock and poultry production, resorting to low emission farming systems and smart agriculture as well as promoting practices for postharvest handling and food waste.

With regards to the waste sector, common mitigation opportunities for different solid waste types include improved sanitary landfilling., incineration with energy recovery (IER), gasification, anaerobic digestion, composting and co-firing in cement kilns.

In spite of the very low contribution of Egypt in the global GHG emissions, Egypt is considered as one of five highly vulnerable countries in the world to climate change. Egypt is largely dependent on Nile water which is used for: potable water supply, agriculture, industry, fish farming, power generation, inland river navigation, mining, oil and gas exploration, cooling of machinery and power plants in addition to the most important goal of protecting the environment from pollution. This wide range of water utilization for different purposes explains the reason of concern against negative impacts of climate change which might cause, as reported by many agencies, that the natural flow of the River Nile will be reduced due to the reduction of rainfall on the upper Nile Basins as well as the reduction of rainfall on the east Mediterranean coastal zone plus the effect of sea level rise on the quality of groundwater in the coastal aquifers.

The national and regional policies for adaptation for water resources management include water conservation measures in agriculture, industry and municipal supplies, upgrading water quality and sanitation to minimize pollution, construction of infrastructure for water collection in flash flood areas (e.g. Sinai, Red Sea and Upper and Middle Egypt), use of renewable energy (solar and wind) for water desalination, storage of drainage and fresh water in coastal lakes and public awareness campaign on water scarcity and water shortage.

As for institutional and research measures, they include encouraging meteorology departments in universities and otherwise to study impacts of climate variability and change, strengthening cooperation and exchange of information between research institutes and universities working on different aspects of water resources, improving adaptive capacity on climate variability and change, improving rain harvesting techniques, increasing abstraction of groundwater both fresh and brakish improving recycling techniques of treated sewage and industrial effluent, desalination and enhancing water conveyance.

Agriculture in Egypt is expected to be especially vulnerable because of hot climate. Further warming is consequently expected to reduce crop productivity. These effects are exacerbated by the fact that agriculture and agro-ecological systems are especially prominent in the economics of Egypt as one of the African countries. Adaptation is a key factor that will shape the future severity of climate change impacts on food production. Adaptation measures includes inexpensive ones such as shifting planting dates or switching to an existing crop variety and more costly measures including the development of new crop varieties and expansion of irrigation. These adaptations will require substantial investments by farmers, governments, scientists, and development organizations, all of whom face many other demands on their resources. Prioritization of investment needs, such as through the identification of “climate risk hot spots” is a critical issue.

The most vulnerable parts in Egypt will be the governorates on the coasts including Alexandria, Port Said, Beheera, Kafr el Sheikh as well as other parts such as the south Mediterranean coastal areas of Al-Burullus and Manzala. There are indications that the city of Damietta, Ras el-Barr, Gamasa, the areas around Al-Burullus Lake, Al-Manzala Lake and Bardaweel Lake will be inundated between 2040 and 2050. Due to the uneven topographical nature of the coastal area between Damietta and Rosetta, this area is predicted to become separate islands surrounded by water from all directions.It is estimated that a sea level rise of up to 100cm is expected until year 2100.

Adaptation measures to coastal zone venerability include structural and architectural interventions such as conventional and unconventional engineering protection works (maritime walls, submersible barriers, shore coating, soil fixation, and prevention methods for seawater intrusion into land including the implementation of covered and uncovered sanitary drainage projects), and the protection of coastal buildings and constructions and electricity, water, and sanitation grids. Other measures include artificial nourishment with sand to compensate for the erosion of the beach, which, if necessary, may be accompanied by the establishment of solid protection measures such as stone heads or submersible barriers, in order to increase the space, which will lead to the protection of the back shore from attacks by the sea, and address the rise of sea level. In addition, reinforcement of anti-flood protection structures and construction of new ones are civil constructions that would break flash floods or prevent them from reaching populated areas, and areas of economic infrastructure.

As for tourism, climate change and sea level rise will have direct impacts on the erosion and inundation of sandy beaches and the gradual regression of shorelines. Another impact is the possible recurrence of storms and hurricanes, which would have a negative impact on multiple sectors of the coastal zone. Other impacts include issues of sailing of ferries in the Nile, effects on coral reef growth and integrity, salt water intrusion and affects on buried monuments and socio economic losses due to all mentioned impacts. Preventive and precautionary measures to decrease the effects of these impacts include proclamation of marine and wildlife protectorates, implementation of integrated environmental management systems in touristic sites, assessing the degree of fragility and vulnerability to risk of touristic sites and sites of archaeological value, orienting tourism growth away from environmentally sensitive areas and areas that are most at risk to less sensitive and vulnerable ones, developing a monitoring system for the expected impacts of climate change in touristic sites, analyzing the effectiveness of the enforcement of environmental protection laws, and encouraging and supporting civil society organizations to participate in applying strategic operational policies.

Climate change can affect health directly in case of extreme weather events; in the form of storms, floods, and heat waves, or indirectly through changes in the ecological ranges and distribution of vectors-borne diseases, water-borne pathogens, air quality, water and food availability and quality. Major killers; such as diarrheal diseases, malnutrition, malaria and dengue fever, are high climate-sensitive health problem, and expected to be worst with the climate changes. Adaptation response to the national planning and policy include mapping of the areas at risk , mapping of vulnerable populations , mapping the effects of a given event attributed to climate change, decreasing of the urban heat islands can be reduced through proactive urban planning and environmental preservation, and controlling for the communicable (infectious) and non-communicable diseases.

As for biodiversity, climate change will probably affect marine species through ocean acidification, or ecosystem stratification, or increasing oceanic dead zones. Adaptation actions are undertaken either to avoid, or take advantage of, actual and projected climate change impacts either by decreasing a system‘s vulnerability or increasing its resilience. This may entail reprioritizing current efforts as well as identifying new goals and objectives to reduce overall ecosystem vulnerability to climate change.

As a result of the increased scientific evidence of the dangerous of Climate Change phenomenon and its impacts on Egypt, the National Committee on Climate Change has been established in 2007 (Prime Minister Decree #272). The committee includes representatives from the Ministries of Foreign Affairs, Water Resources & Irrigation, Agriculture & Land Reclamation, Electricity & Energy, Petroleum, Trade & Industry, Economic Development and Defense, besides experts from national and relevant agencies. The National Committee is concerned with developing mitigation and adaptation strategies to address phenomenon of climate change and reviewing and activating the National Strategy for Climate Change with the preparation of plans and programs required in the short term and long term as well as integrating these into national action plans for development in Egypt.

A number of efforts have been undertaken by the Government of Egypt to achieve the objectives of the convention. They included Technology Cooperation Agreement Pilot Project (TCAPP), promotion of wind energy for electricity generation, fuel cell bus demonstration project, hybrid-electric bus technology, natural gas motorcycles, methane recovery from landfills, integrated solar thermal/natural gas power plant at Kuraymat, energy efficiency improvement and emissions reduction project as well as fuel switching. Other measures taken by Egypt included observations, networking, research and technology development, education, training and raising of public awareness.

CHAPTER I: NATIONAL CIRCUMSTANCES

I.1. INTRODUCTION

This report is an update on the second national communication (SNC) of Egypt issued in 2010 for which the cutoff date was 2007. During this period Egypt has passed through historic revolutions, which reflects a tremendous and significant change in Egypt's national circumstances relevant to the climate change andthe classification of Egypt as a developing country in the UNFCCC.

I.2. GEOGRAPHIC SITUATION

Egypt lies between latitude 22° and 32°, and the country's maximum distances are 1,024 km from north to south and 1,240 km from east to west. Egypt is bordered by the Mediterranean Sea to the north, by Sudan to the South, by the Red Sea, Palestine and Israel to the east and by Libya to the west. The total area of Egypt is 1,001,450km^2,with a land area of 995,450 km^2 and a coastline of 3500 km on the Mediterranean and Red Sea. The surface level extremes range from 133 m below sea level in the Western Desert to 2,6269m above sea level in Sinai Peninsula.Figure (I.1) is a map of Egypt.

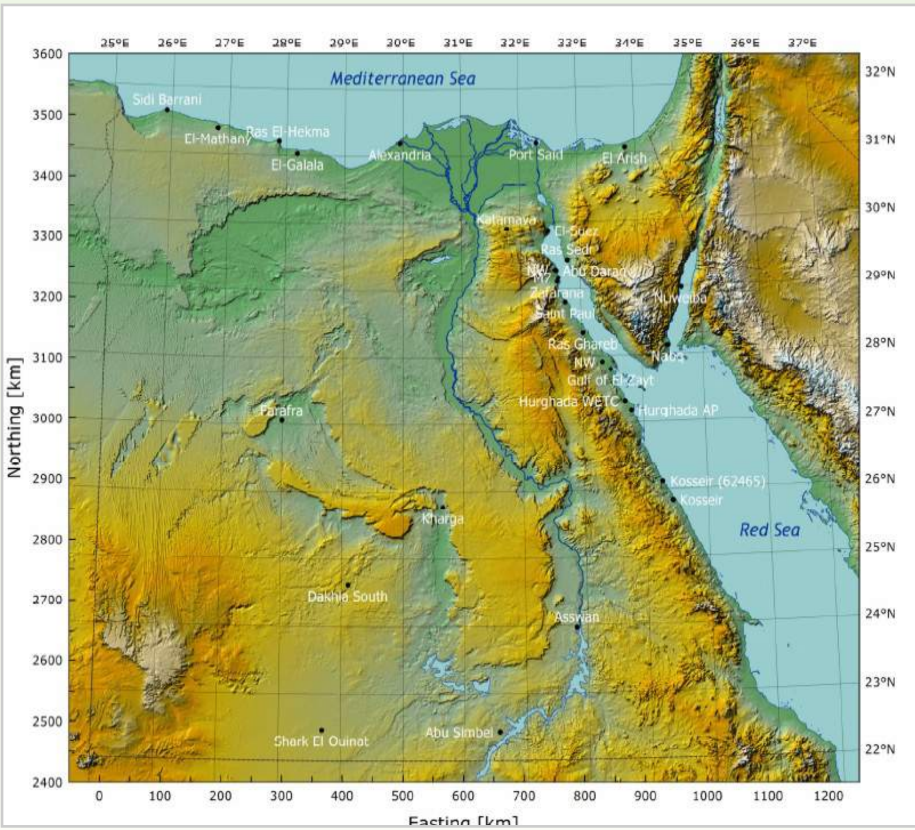

Figure (I.1): Map of Egypt

I.3. CLIMATE PROFILE

Throughout Egypt, days are commonly warm or hot, and nights are cool. Egypt has only two seasons: a mild winter from November to April and a hot summer from May to October. The only differences between the seasons are variations in daytime temperatures and changes in prevailing winds. In the coastal regions, temperatures range between an average minimum of 14°C in winter and an average maximum of 30°C in summer.

Temperatures vary widely in the inland desert areas, especially in summer, when they may range from 7°C at night to 43°C during the day. During winter, temperatures in the desert fluctuate less dramatically, but they can be as low as 0°C at night and as high as 18°C during the day. Figure I.2, presents the annual mean air temperature (0°C).

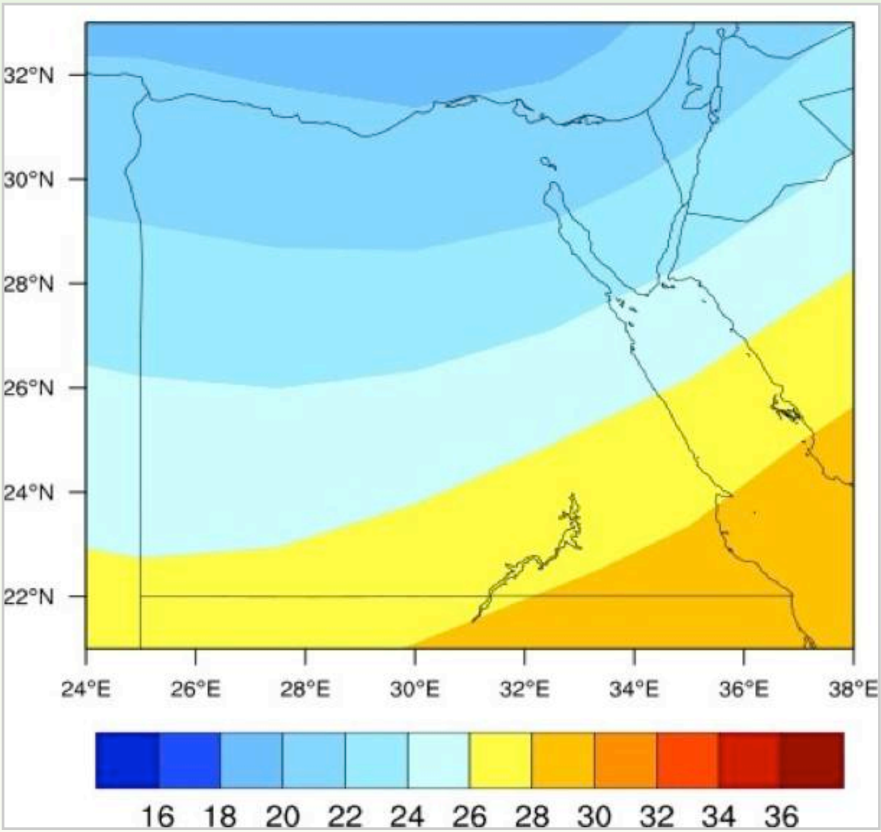

Figure (I.2): Annual mean air temperature (°C)

Egypt receives fewer than eighty millimeters of precipitation annually in most areas. Most rain falls along the coast, but even the wettest area, around Alexandria, receives only about 200 millimeters of precipitation per year. Alexandria has relatively high humidity, but sea breezes help keep the moisture down to a comfortable level. Moving southward, the amount of precipitation decreases as Cairo receives a little more than one centimeter of precipitation each year. The city, however, reports humidity as high as 77% during the summer. But during the rest of the year, humidity is low. The areas south of Cairo receive only traces of rainfall. Some areas will go years without rain and then experience sudden downpours that result in flash floods. Sinai receives somewhat more rainfall (about twelve centimeters annually in the north) than the other desert areas, and the region is dotted by numerous wells and oases, which support small population centers that formerly were focal points on trade routes. Water drainage toward the Mediterranean Sea from the main plateau supplies sufficient moisture to permit some agriculture in the coastal area, particularly near Al Arish. Figure I.3, presents the annual mean relative humidity (%) while Figure I.4, presents the annual mean precipitation (mm).

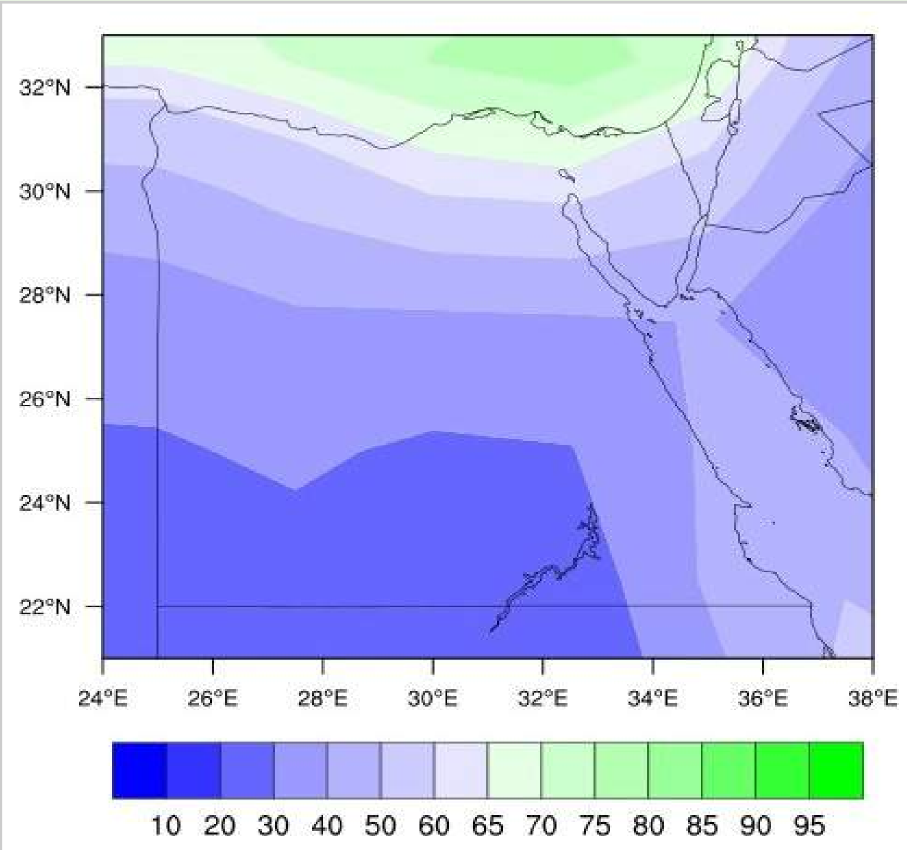

Figure (I.3): Annual mean relative humidity (%)

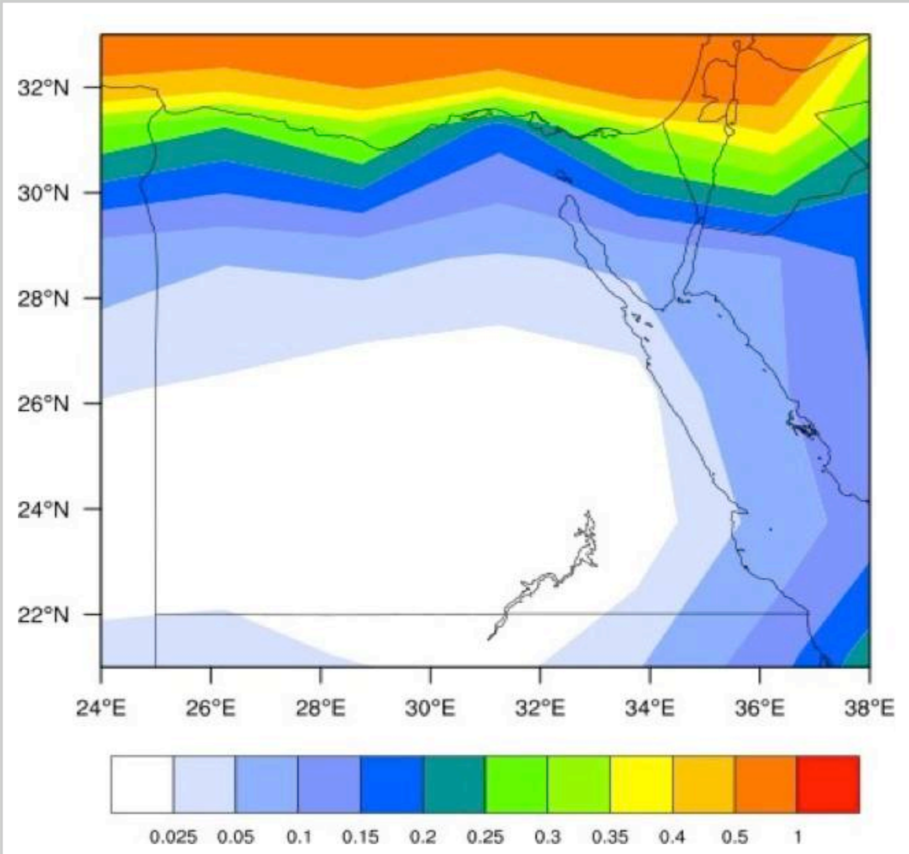

Figure (I.4): Annual mean precipitation (mm)

Most of Egypt's rain falls in the winter months. South of Cairo, rainfall averages only around 2 to 5 mm (0.1 to 0.2 in) per year and at intervals of many years. On a very thin strip of the northern coast the rainfall can be as high as 410 mm (16.1 in),] mostly between October and March. Snow falls on Sinai's mountains and some of the north coastal cities such as Damietta, Baltim, SidiBarrany, etc. and rarely in Alexandria. A very small amount of snow fell on Cairo on 13 December 2013, the first time Cairo received snowfall in many decades. Frost is also known in mid-Sinai and mid-Egypt. Egypt is the driest and the sunniest country in the world, and most of his land surface is desert.

A phenomenon of Egypt' climate is the hot spring wind that blows across the country. The winds, known to Egyptians as the khamsin, usually arrive in April but occasionally occur in March and May. The winds form in small but vigorous low-pressure areas in the Isthmus of Suez and sweep across the northern coast of Africa. Unobstructed by geographical features, the winds reach high velocities and carry great quantities of sand and dust from the deserts. These sandstorms, often accompanied by winds of up to 140 kilometers per hour, can cause temperatures to rise as much as 20°C in two hours. The winds blow intermittently and may continue for days, cause illness in people and animals, harm crops, and occasionally damage houses and infrastructure. Figure I.5, presents the annual mean surface wind in meter/sec. over Egypt.

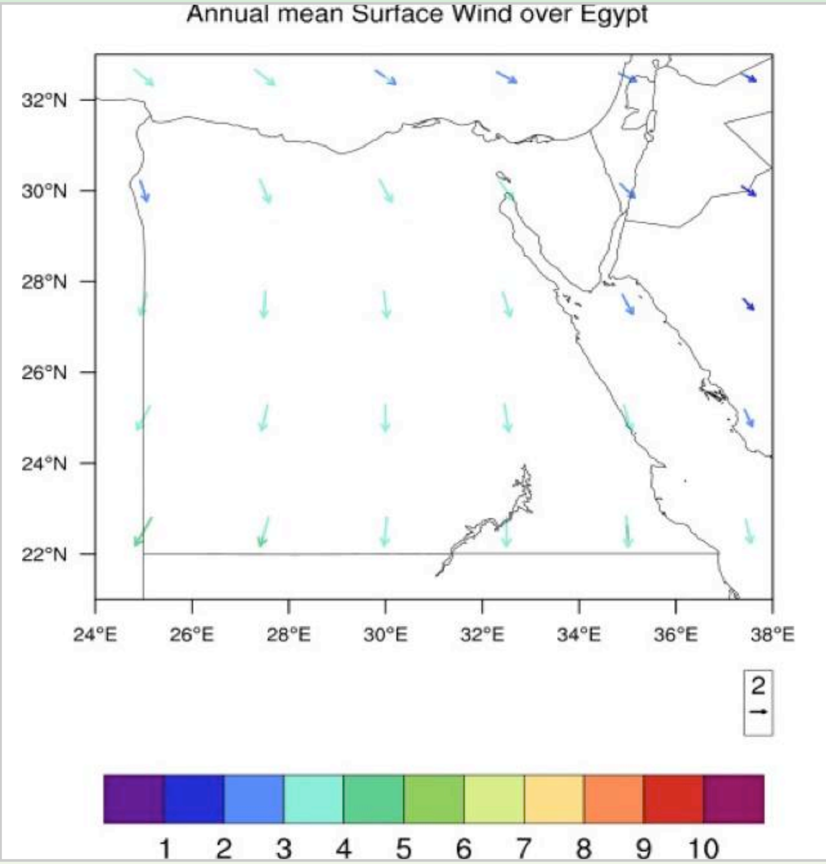

Figure (I.5): Annual mean wind velocity (m/sec.)

I.4. POPULATION

Population of Egypt showed a remarkable increase since the SNC where the census of 2006 showed a population of 72.6 million living inside Egypt and 3.9 millions living abroad. The average population growth rate was 2.3% and rather stable for the previous 10 years.

The recent population released by CAPMASon 2013 reported 83.452million inside Egypt while the expatriates abroad reached 7.8 million as reported by the Ministry of Foreign Affairs. The population total rate of natural increase reached 2.5% in 2013 due to the slowdown of the family planning programs. On the SNC it was projected that this population increase with its straining effects on the environment as well as the economy, given the limited available natural resources reflected by:

- Further encroachment on the limited agricultural land by more inhabitants and more population density pressuring the environmental as well as health integrity.

- Further regression of the per capita annual share of water and considering the fixed share of Nile water and the present conflict of the new dam project at Ethiopia.

- Following the two revolutions on 2011 and 2012 resulting in a slowed down economy and serious budget deficit necessary for basic population needs such as energy, transportation, housing and job creation.

- More difficulty to ensure satisfactory basic food supply and implementation of poverty alleviation and social support programs.

I.5. GOVERNMENT STRUCTURE

Egypt is a republic having 27 governorates. It had several previous amendments, the latest approved by a Constitutional Committee in December 2013 and approved by the referendum held on 14-15 January 2014 and ratified by the Interim President on 19 January 2014. Egypt has a mixed legal system based on Napoleonic Civil and Penal Law, Islamic religious law,and vestige of colonial era laws. Judicial review of the continuality of the laws is done by the Supreme Constitutional Court.

Egypt is a multiparty system. The executive branch is composed ofThe President as the chief of state and the Prime Ministeras the head of government and the Cabinet.The legislative branch at the time of SNC was a bicameral parliament consisting of the ShuraCouncil(at least 150 seats) and the House of Representatives (at least 350 seats).This legislature was dissolved and under the 2014 constitution was changed to the unicameral House of Representatives (minimum of450 seats with up to 5% appointed by the president). The Judicial branchconsists of theHighest courts which are the Court of Cassation (consists of the court president and 550 judges organized in circuits with cases heard by panels of 5 judges) and the Supreme Administrative Court, the highest court of the State Council(consists of the court president and organized in circuits with cases heard by panels of 5 judges).

I.6. EGYPTIAN ECONOMY

Egyptian economy is still suffering from a severe downturn following the 2011 revolution and the government faces numerous challenges as to how to restore growth, market and investor confidence. Political and institutional uncertainty, a perception of rising insecurity and sporadic unrest continue to negatively affect economic growth.Egyptian government backtracked on economic reforms, markedly increasing social spending to address public dissatisfaction. Tourism, manufacturing and construction were the most affected sectors. Revenues from tourism have fallen 54% on 2014 compared to 2008. Egypt's summary of budget financing from 2002 to 2013 is shown in Table I.1

Table (I.1): Egypt's summary of budget financing 2002–2013
(Million of Egyptian Pounds and Fiscal years)

Item	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Revenues	78,318.3	89,146.0	101,878.7	110,864.0	151,266.0	172,153.0	184,729.0	275,700.0	224,986.0	303,622.0	393,476.0	497,145.0
Taxes	50,801.3	55,736.4	67,157.6	75,759.0	97,779.0	108,609.0	120,075.0	166,500.0	145,544.0	207,410.0	266,905.0	356,925.0
Grants	4,264.9	3,289.6	5049.6	2,853.0	2,379.0	3,657.0	3,166.0	4,600.0	7,700.0	10,104.0	9,021.0	2,358.0
Other resources										86,108.0	117,549.0	137,863.0
Expenditures	115,541.9	127,319.6	145,987.9	161,611.0	207,811.0	212,104.0	241,552.0	340,370.4	319,137.0	470,992.0	583,789.0	692,421.0
Wages and Compensations	30,515.7	33,816.1	37,265.7	41,546.0	46,719.0	51,270.0	59,574.0	82,000.0	86,100.0	122,818.0	142,629.0	172,159.0
Interest	21,751.7	25,851.2	30,703.9	32,780.0	36,815.0	50,448.0	51,979.0	52,900.0	71,066.0	104,441.0	138,612.0	182,046.0
Subsidies and Social Benefits	18,050.9	20,649.2	24,751.7	29,706.0	68,897.0	51,844.0	64,465.0	133,600.0	73,400.0	150,193.0	182,383.0	205,540.0
Cash Deficit	-37,223.6	-38,173.6	-44,109.2	-50,747.0	-56,545.0	-39,951.0	-56,823.0	-64,670.4	-94,151.0	167,370.0	190,309.0	195,276.0
Net Acquisition of Financial Assets	-1,261.9	-5,586.3	-1,951.2	-896.0	6,160.0	-9,209.0	-1,946.0	-2,674.0	730.0	665.0	5,314.0	2,218.0
Overall Deficit	-38,485.5	-43,759.9	-46,060.4	-51,643.0	-50,385.0	-49,160.0	-58,769.0	-67,344.0	-93,421.0	-166,705.0	-184,995.0	-197,494.0
Net Borrowing	38,066.7	43,720.7	46,043.4	50,631.0	50,259.0	48,660.0	57,769.0	66,792.0	94,880.0	166,705.0	184,705	197,244
Proceeds from Privatization	418.8	39.2	17	1012	126.0	500	1000	10,000		500	500	
Deficit as % of GDP	-10.2%	-10.5%	-9.5%	-9.6%	-8.2%	-6.7%	-6.9%	-6.4%	-7.97%	-10.6%	-10.7%	-9.6%

Treasury bonds and notes issued to the Central Bank of Egypt constitute the bulk of the government domestic debt. Since FY2001, net government domestic debt (i.e. after excluding budget sector deposits) has been rising at a fluctuating but decreasing rate. In 2007, it reached 65.4% up from 54.3% of GDP in 2001. The national domestic government debt from 2001 to 2012 is shown in Table I.2.

Table (I.2):Egypt's summary of Domestic Government Debt 2001–2012 (Billion of EGP and Fiscal years)

Item	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Government domestic debt (EGP bn)	194.6	221.2	252.1	292.7	349.1	387.7	478.2	562.3	663.8	808.1	990.5	1,113.1
(% GDP)	54.3	58.4	60.4	60.3	64.8	62.8	65.4	54.1	55.0	58.9	64.1	63.7

The Egyptian gross national product (GDP) was 107.43 billion US$ dollars in 2006, reached 271.97 billionUS$ in 2014, GDP real growth rate is 1.8% and GDP-per capita is 6.600$ on 2013.

The GDP composition by end use is 78.6%household consumption, 11.8% government consumption, 14.3%investment in fixed capital, 0.4%investment in inventories, 18% exports of goods and services and -23.2% imports of goods and services.GDP composition by sector of origin in 2013 shows 14.5% agriculture, 37.5 % industry, and 48% services. The main agriculture-products are cotton, rice, corn, wheat, beans, fruits, vegetables, cattle, water buffalo, sheep and goats. The main industries are textiles, food processing, tourism, chemicals, pharmaceuticals, hydrocarbons, construction, cement, metals and light manufactures. Industrial production growth rate on 2013 was 1.4%. The labor force on 2013 is 27.69 millions, 29% in agriculture, 24% in industry and 47% on services. The unemployment rate reached 13.4% on 2013 and inflation rate 9%. Figure I.6, presents the Egypt's GDP from 2006 to 2014 (in Billion US$). Population below poverty line is estimated as 26.5%.

Figure (I.6): Egypt's GDP from 2006 to 2014 (in Billion US$)

I.7. EGYPT NATURAL RESOURCES

I.7.1. Land

Egypt is one of the most populous countries in the world;population density reached 1,850 people per square kilometer.

Informal growth trend hadcontinued over the urban border of Egyptian cities, yet, the 750 feddan(each feddan is 4200 square meters)total area of the newcities would have been deducted from the cultivated areas in the Valley and Delta for urbanexpansion, in case the cities were not built.The new cities provided 511 thousand job opportunities andthe number of under construction factories came to 2,967 providing 97 thousandjob opportunities. [1]

New cities also provided housing. In 2011, the total number of population in new cities came to 5 million and is expected to reach 17 million when the cities are completely grown. Currently,implementation of the Social Housing Program is underway and expected to implement 100thousand housing units for the limited income category in the new cities. 155 thousandresidential land plots had been allocated including 86 thousand for low and middle levelscoring 62%, and 59 thousand plots for upper middle forming 38% (New Urban CommunitiesAuthority 2011).

Sixteen years after constructing the new cities, 15th of May continued achievingthe targeted population by 100%, Salhia by 90%, however, the percentage was 60% in 10th ofRamadan and Sadat, 44% in 6th of October, and only 14% in Borg el Arab. It is observed that6th of October is the most attractive city for residents whereby it scored a growth rate of15.86% in 1966-2006 due to population settlement and natural increase. It should be noted, though that the existing industries in the 6th of October are less in size than those in the 10th of Ramadan which scored a growth rate of 10.16% during the same timeframe. In this

1 New Urban Communities Authority, 2010

regard, population size in the 6th of October reached 35 thousand in 1996 which rose to 155 thousand in 2006. In other words, it grew by five fold in ten years which entailed increasing the targeted population by 2017 from half a million to million and to 2.5 million for the same year coupled with changing 6th of October from a city to a governorate. As for 15th of May, it attained the lowest growth during this timeframe whereby it attained 3.3% growth rate, Salhia 8.2%, Sadat 10.08% and Borg el Arab 10.65%.Figure I.7, presents the map of Egypt and its governorates.

Figure (1.7): Map of Egypt and its Governorates

Experience with new cities seems an insufficient way of development as 98.2 % of the population still lives on the Nile valley and delta and only 1.8% lives outside it. The new system is acquiring simultaneous regional giant development projects like Suez Canal, West Coast, and Tushka, planning to accommodate the projected population increase of 60 million over the coming 40 years, with a sustainable development mode to preserve the natural resources for the coming generations.

I.7.2. Water Resources

By the year 2020, water requirements will most likely increase by 20% (15 BCM/yr). Water quantity and water quality are inseparable. Since all water uses require that water quality falls within a range specific to that use. Thus the present rate of deterioration of quality will certainly increase the severity of the water scarcity problem or add to the cost (i.e., treatment requirements) of using water at the levels expected in 2020.

It has been forecasted that in 2025 the population of Egypt will increase to about 95 million from about 75 million in 2008, leading to a decrease in per capita water availability from 800 to 600 m3 per year assuming that total water availability remains constant. Developments in Sudan, Ethiopia or other riparian countries could reduce water availability to Egypt, for example through increased abstractions for irrigation. However, they could also increase water availability, for example through the draining of swamps such as the Sudan where large amounts of water currently evaporate.

Furthermore, climate change is likely to affect water availability to Egypt, although the direction of change is uncertain. According to National Water Research Centre (NWRC) “Some experts say that there will be water increase with more rainfall from the Ethiopian plateau, and some say there will be a decrease because of water evaporation.”. Some studies foresee a decline of up to 70 percent in Nile water availability, while other studies project an increase in Nile water levels by 25 percent. Seawater desalination, which already is used in some resorts on the Red Sea, is also likely to become an increasingly important source for municipal water supply in coastal areas of Egypt. For example, in October 2009 the West Delta Electricity Production Company awarded a contract for a power plant with a 10,000 m3/day seawater desalination plant near Alexandria. Brackish water desalination for irrigation may also become more important.

As for the vulnerability of the Nile delta to increases in sea level varies, one study estimates that 30% of the Delta and Alexandria coast is vulnerable, 55% is “invulnerable” and 15% was artificially protected in 2003. High-risk areas in and near the Delta include parts of Alexandria, Behaira, Damietta and Port Said governorates.

The main water-using sector in Egypt is agriculture, followed by municipal and industrial uses. Total water withdrawal in 2000 was estimated at 68.3 km3 and on 2010 it was estimated to be 69.25km3.

Data on agricultural water use in Egypt are not precise and often contradictory. The total area equipped for irrigation was 3.4 million hectares in 2002; 85 percent of this area is in the Nile Valley and Delta. Agriculture used about 59 km3 of freshwater in 2000 (86 % of total use). All drainage water in Upper Egypt, south of Cairo, flows back into the Nile and the irrigation canals; this amount is estimated at 4 km3/yr. Drainage water in the Nile Delta is estimated as 14 km3/yr. Reuse of drainage water occurs in three different ways:

- Official reuse through public pumping stations that pump water from drains to irrigation canals. This accounts for about 4.5 BCM/year in the Delta and 0.9 BCM/year in Upper Egypt and Faiyoum.
- Unofficial reuse done by farmers themselves when they are short of canal water. In the Delta alone this has been estimated to be around 2.8 BCM/year.
- Indirect reuse from drains in Upper Egypt that discharge into the Nile, amounting to about 4 BCM/year.

As for municipal and industrial use of water, it accounts for 5.3 km3 (8 %) and 4.0 km3 (6 %) respectively. It has been estimated that about 3.5 BCM/year of municipal waste water was being discharged into the Nile and the sea in 2002, out of which only 1.6 BCM/year (about 45%) were treated. Industrial effluents contribute to about 1.3 BCM/yr of waste water being discharged to surface waters, only some of which is being treated.

An important use of water in Egypt is for the production of hydropower. This use is non-consumptive and is thus available for other uses further downstream. Hydropower plants exist at the Aswan High Dam (2100 MW), the old Aswan Dam (270 MW)and power plants at Esnaweir (90 MW) and Naga Hammadi weir (64 MW). Together these plants accounted for 16% of installed electricity generation capacity in 2004. The share of hydropower in power generation declines since the hydropower potential is largely exploited and power demand increases rapidly.

The Nile is also important for navigation, especially for tourism, which makes it necessary to maintain a minimum flow of the Nile year-round. Last but not least the Nile River also has ecological functions that require minimum flows to be maintained, especially for the brackish lakes in the Delta

Water quality in the Nile deteriorates along the course of the river. Lake Nasser has good water quality with only small organic substance concentrations, which makes its water a reference point for water quality along the river and its branches. According to reports by the Egyptian Environmental Affairs Agency, in 2007 average organic loads in 11 governorates along the Nile remained below the allowed limit of 6 mg/liter of biological oxygen demand (BOD). This is due to the high self-assimilation capacity of the Nile. However, in the same year chemical oxygen demand was above the allowed limit of 10 mg/liter in 7 of 11 governorates. The report does not include data for some governorates on the Nile such as Monufia and Sharqia. The average level of dissolved oxygen was slightly higher than the allowed minimum of 5 mg/liter in all governorates. The report by the Environmental Authority only shows averages and does not indicate the frequency of standards violations.

Nitrogen fertilizers whose consumption has doubled between 1980 and 1993 present another source of pollution. Water hyacinth flourishing at the downstream of water ways due to increased nutrients lead to clogging of canals. It is combated with mechanical and biological technologies.

Salinity is another important water quality issue. Drainage return flows to the Nile result in an increase in salinity of the water from 250 ppm (mg/l) at Aswan to 2,700 ppm at the Delta barrages. However, more salts are being discharged into the Mediterranean Sea than are entering at Aswan so that in the long run the salinity of the water at the Delta barrages could decrease. However, saline groundwater of marine origin enters the Delta through pumping of brackish water and upwelling in lakes and drains, thus counter-balancing this effect.

Nile water originates from three different sources namely the Equatorial Lakes Plateau, Bahr El Ghazal sub basin and the Ethiopian High Lands. The three sub basins are climatically independent and, therefore, the effect of climate change has to be investigated on each sub basin separately. A conference was held in Cairo on 24-25 February, 2013 on "Climate Change Impact on the Nile Basin, Exchange of Experiences within the Basin". In this conference, a number of country reports were presented. TheCountry Report of Egypt gave the results of a statistically down scaled model from the UK MO Regional Circulation Model. The conclusion of the report was that changes in rainfall, temperature and potential evapo-transpiration were all smaller than previous studies. Following are the ranges of change in flow:

- Blue Nile (Diem): (-19%) to (+29%)
- White Nile (Malakal): (-8%) to (+10%)
- Main Nile (Dongola): (-13%) to (+36%)

The report also states that the results confirm uncertainty regarding the direction of change for rainfall and flow. The Regional Circulation Model reduced uncertainty in bandwidth but "care must be taken that not all sources are included".

The Research Report (2) published by the International Water Management Institute and the Utah State University on "Climate Change Impacts on Hydrology and Water Resources of the Upper Blue Nile River Basin, Ethiopia revealed the following:

- Climate in most Upper Blue Nile River Basin is likely to become wetter and warmer in the 2050's (2040 – 2069).
- Low flows may become higher and severe mid-to long- term droughts are likely to become less frequent throughout the entire basin.
- Potential future dam operators are unlikely to significantly affect water availability to Egypt and Sudan based on predicted outflows from six GCM's and many dam operation scenarios.

The results however uncertain with existing accuracy of climate models, suggest that the region is likely to have the future potential to produce hydropower, increase flow duration and increase water storage capacity without affecting outflows to the riparian countries in the 2050's. Potential impacts of climate change on the hydrology and water resources of the River Nile Basin downscaled from runs of 11 GCM's and 2 global emission scenario's (A2 & B1) show the following results:

- The Nile Basin will experience increase in precipitation early in the century (Period I, 2010-2039), followed by decreases later in the century (Period II, 2040-2069 and Period III, 2070-2099) with the exception of the eastern-most Ethiopian highlands which is expected to experience increases in summer precipitation by 2080-2100.
- Summarized as spatial average over the entire Nile Basin, multi model – average Nile Basin precipitation changes as percentage of the period (1950-1999) are 115 (117), 98 (104) and 93 (96) while temperature changes are 1.5 (1.3), 3.2(2.8), 4.4 (3.6). the given figures are for A2 scenarios and B1 figures between brackets.
- These changes in precipitation and temperatures resulted in stream flow at High Aswan Dam that are

111 (114), 92 (93) and 84 (87) percent of historical simulated stream flow (1950-1999).

- Hydropower production at High Aswan Dam will increase early in the century to 112, (118) % but then decrease to 92(97) % and 87 (91)% (A2 &B1 : Global Emission Scenarios.

I.7.3. COASTAL ZONES

The entire coastline of Egypt, comprising some 3500 km of tide affected coast. Of this total length, 1000 km is primary wave-affected Mediterranean coast, 1500 km is primary Red Sea coast (including Gulf of Suez and Gulf of Aqaba), 550 km is secondary Mediterranean coast (shorelines of coastal lagoons), and 450 km is Suez Canal area 'coast', including the adjacent lakes' shorelines. There is a very wide variation in coastal characteristics and types and extent of coast-related activities.

The impacts from the predicted climate change in terms of significant rises in thelevels and temperatures of the sea water constitutes another long-term threat tothe present state of the coastal ecosystems. The rising water and temperatureswill accelerate the present erosion of the Mediterranean coast and destroy partsof the coral reefs in the Red Sea.Large investment will be required to reinforce the present coastal structures protectingthe promontories of the River Nile Branches at Rosetta and Damietta and protect the located cities around the river mouths.The extensive aquaculture activities found along the Delta Coast will have to adapt to the new water levels in the Mediterranean Sea.

The use of the coastal land is under an extreme pressure from various stakeholders including agriculture, aquaculture, ports and an increased number of national and international recreational users. This pressure poses a devastating threat to the ecosystem of all Egyptian shores.Until recently, the overall planning for the coastal areas has been undertaken bythe line ministries and the Governorates.Lack of coordination resulted in unsustainabledevelopment, i.e. massive settlements of beach resorts, vacation housesand apartment blocks; combined with severe coastal erosion lead to the environment beingcompromised and the ecosystems put at high risk.

The national economy including tourism and agriculture and the environmentaltreasures in terms of irreplaceable coastal landscapes and habitats of regional, nationaland international importance are at stake, and are calling for Integrated CoastalZone Management (ICZM). To support the implementation of the ICZM among the Mediterranean riparianstates a "Protocol on the integrated management of the Mediterranean coastalzones" was issued for signatures beginning of 2008. The Protocol was elaborated under the auspices of the Barcelona Conventionfor the Protection of the Mediterranean Sea against Pollution signed byEgypt in 1976. This purpose of the protocol is to establish a common frameworkfor the integrated management of the Mediterranean coastal zone and to strengthenregional cooperation for this purpose (EEAA Strategy for Implementing ICZM Process in Egypt.2008).

According to institutional and legal framework analysis, the following has been identified as problems facing the coastal zone:

- Physical alteration of the shoreline
- Infrastructure for shoreline protection work

- Development that don't respect the dynamic characteristics of the coastal zone.
- Pollution.
- Habitat destruction which may lead to loss of biodiversity, destruction of spawning and nursery grounds and depletion of fisheries resources due to over fishing.
- Constrains and threats to the Coastal Zone Management under the threat of the sea level rise (SLR).
- Insufficient data and lack of information exchange mechanism.
- Inadequacy and conflict of laws/regulations/mandates as well as inadequate coordination among coastal resources managers.
- Shoreline erosion specially those due to infrastructure and shoreline protection projects leading to loss of properties.
- Habitat destruction as a result from development that exceed the carrying capacity of a region and loss of biodiversity and deterioration of fish stock.

I.8. PROFILE OF THE KEY SECTORS

The main key sectors producing GHG emissions and climate change represent a potential threat to them are energy, transportation, industry, agriculture and waste.

I.8.1. Energy

According to the Oil & Gas Journal's (OGJ) January 1, 2013 estimate, Egypt's proven crude oil reserves are 4.4 billion barrels, an increase from the 2010 reserve estimate of 3.7 billion barrels, with new oil discoveries boosting oil reserves in recent years. According to the Arab Oil and Gas Journal, several new oil discoveries have been made every year since 2008, with 16 in 2011, 16 in 2010, 11 in 2009, and 17 in 2008. Many of these oil discoveries were the result of exploration conducted by the U.S.-based Apache in Egypt's Western Desert. Egypt's oil production comes from the Gulf of Suez, Nile Delta, Western Desert, Eastern Desert, Sinai, and the Mediterranean Sea. Most of Egypt's production is derived from relatively small fields that are connected to larger regional production systems. Overall production is in decline, particularly from the older fields in the Gulf of Suez and Nile Delta. However, declines have been partially offset by small new finds, particularly in the Western Desert and offshore area. In addition, the use of enhanced oil recovery (EOR) techniques at mature fields has eased production declines.

After Egypt's production peak of more than 900,000 bbl/d (Barrels per Day "bbl/d or bpd") in the mid-1990s, output began to decline as oil fields matured. However, natural gas liquids (NGL) output has increased over the past decade as a result of expanding natural gas production and has offset some of the declines in other liquids production, such as crude oil. In 2012, Egypt's total oil production averaged around 720,000 bbl/d, of which approximately 555,000 bbl/d was crude oil including lease condensate, almost 170,000 bbl/d was NGL, with refinery processing loss accounting for the difference.

One of Egypt's challenges is to satisfy increasing domestic demand for oil amid falling domestic production. Total oil consumption grew by an annual average of 3 percent over that past decade to 755,000 bbl/d in

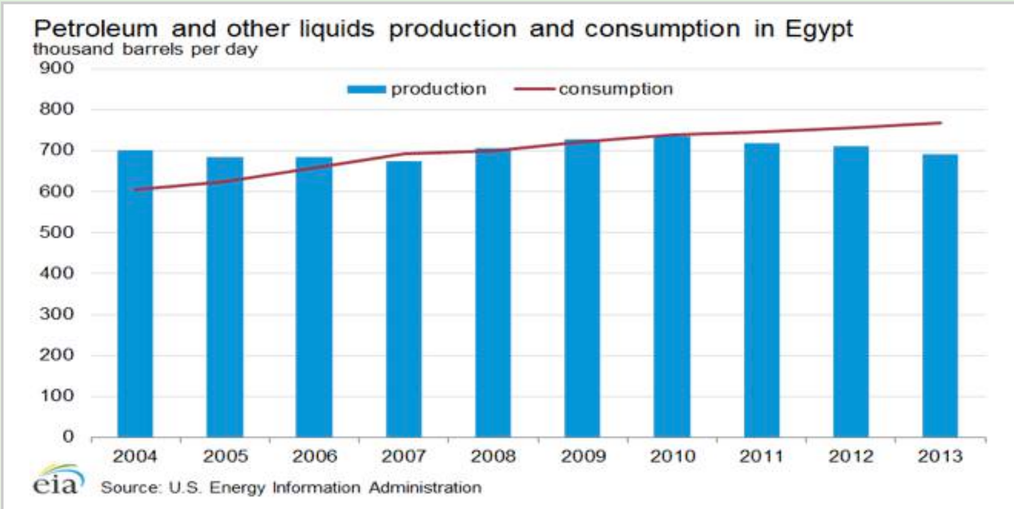

Figure (I.8): Petroleum and other liquids production and consumption
(Thousand barrels per day)

2012. Egypt's oil consumption has outpaced production since 2010. Figure I.8, presents the petroleum and other liquids production and consumption (thousand barrels per day).

According to OGJ estimates as of January 1, 2013, Egypt's proven natural gas reserves registered at around 77 Trillion Cubic Feet (Tcf), an increase from the 2010 estimate of 58.5 Tcf and the third highest in Africa, after Nigeria and Algeria. New discoveries in the deepwater Mediterranean Sea and Nile Delta, along with some finds in the Western Desert, have led to the increase in proven reserves. There were 16 natural gas discoveries in 2009, 10 in 2010, and 7 in 2011, according to the Arab Oil and Gas Journal. The majority of Egypt's natural gas reserves and production is located in the Mediterranean Sea and Nile Delta.

Egypt's natural gas production is used to satisfy rising domestic demand, exports through the Arab Gas Pipeline, and LNG exports. In 2011, Egypt produced roughly 2.2 Tcf of dry natural gas, of which 1.8 Tcf was domestically consumed and 0.4 Tcf was exported. Egypt supplies natural gas mostly to European and Asian markets, although exports are competing with rising domestic demand, particularly in Egypt's power generation sector. Egypt's natural gas consumption has increased by an annual average of 11 percent from 2001 to 2011. Natural gas production rapidly increased for most of that time period as well, but after 2009 natural gas production began to fall because of a decline in output from offshore gas fields. Egypt's natural gas exports have also fallen. The government may start to import natural gas for the first time, to satisfy rising domestic demand and continue to export natural gas to global markets. Much of the natural gas consumed in Egypt is used to fuel electric power plants. The government is encouraging households, businesses, and the industrial sector to consider natural gas as a substitute for petroleum and coal. In

January 2008, the World Bank approved loans for the Natural Gas Connections Project, which aims to switch consumption of liquefied petroleum gas (LPG) to natural gas through investment in new connections and to further expand natural gas use in densely populated, low income areas.The share of natural gas

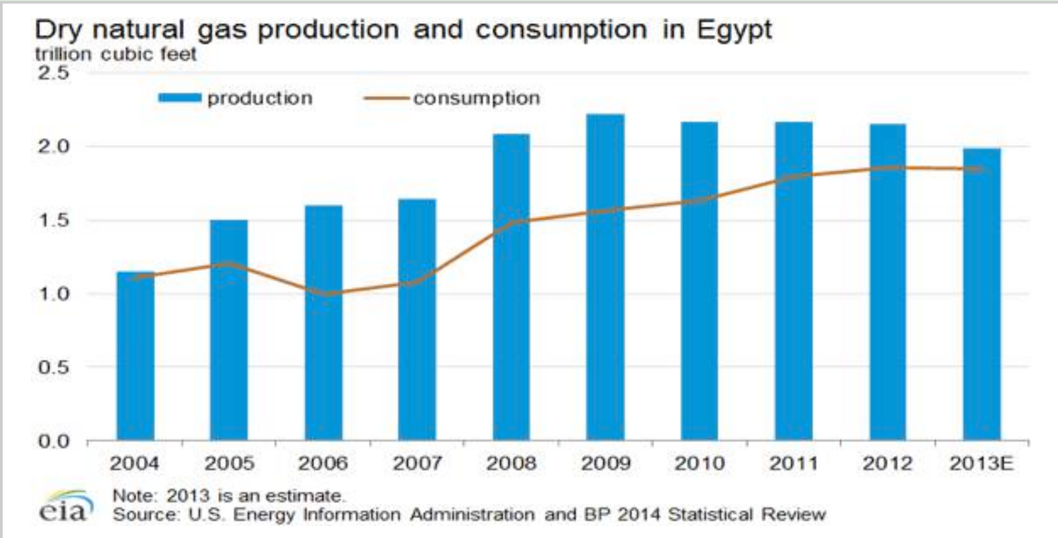

Figure (I.9): Natural gas production and consumption (trillion cubic feet)

consumed in the transportation sector also has been rising since the development of compressed natural gas (CNG) infrastructure and vehicles. Figure I.9, presents the natural gas production and consumption (trillion cubic feet).

As a result of Egypt's growing domestic energy demand, the government plans to increase the amount of power generated from renewable sources, particularly wind and solar, and is fostering nuclear power development.The Egyptian household electrification rate in 2009 was approximately 99.6 percent, according to the latest estimates from the International Energy Agency (IEA). Although the country has one of the highest electrification rates in Africa, approximately 300,000 people still lack access to electricity, mainly in rural areas.

total electricity net generation was around 138.7 billion KWh in 2010: 124.3 billion KWh (90 percent) of which was from fossil-fueled electric, 12.9 billion KWh from hydro, and 1.5 billion KWh from wind. Electricity consumption has grown by an average of 7 percent annually between 2000 and 2010. Most of Egypt's power demand growth comes from the industrial sector. Ageing infrastructure and rising demand have led to intermittent blackouts.

Egyptian electricity consumption is increasing much faster than capacity expansions, and the government is planning to invest heavily in the power sector over the next decade, while also seeking financing from external sources. The private sector, international organizations, and renewable energy funds such as the World Bank's Clean Technology Fund have all provided investment in the sector. Under existing plans, Egypt hopes to produce 12-20 percent of its electricity from renewable energy by 2020 while also developing a nuclear power industry, according to (IHS CERA)1. Wind energy represents a good alternative

1 IHS Cambridge Energy Research Associates®, Inc. (IHS CERA®) is a leading advisor to international energy companies,

for producing energy in West of Suez Gulf and on Red Sea coast between RaasGhareb and Safaga as well as East of El Owaynat in the Western Desert, as these areas are characterized by relatively steady wind activity in the West of Suez Gulf , El Alamain and MarsaMatrouh in the North Coast as the wind speed reaches 10m/second. Egypt is considered one of 30 countries over the world in which the Wind Atlas is issued. Moreover, Solar energy is considered as a promising alternative in Egypt as the number of sun rising hours in the remote areas varies between 2300 to 4000 hours per year. Table I.3 shows the electricity

Table (I.3): Solar Energy Power Stations

Energy in Egypt						
	Capita	Prim. energy	Production	Export	Electricity	CO_2-emission
	Million	TWh	TWh	TWh	TWh	Mt
2004	72.64	662	752	71	88	141
2007	75.47	782	957	153	111	169
2008	81.51	822	1,018	180	116	174
2009	83.00	837	1,026	174	123	175
2012	82.54				138	188
Change 2004-09	14.3 %	27 %	36 %	145 %	40 %	25 %
Mtoe = 11.63 TWh, Prim. energy includes energy losses						

generating stations from solar energy.

I.8.2. Industry

Industry; value added (% of GDP) in Egypt was last measured at 39.22 in 2012, according to the World Bank. Industry corresponds to ISIC divisions 10-45 and includes manufacturing (ISIC divisions 15-37). It comprises value added in mining, manufacturing (also reported as a separate subgroup), construction, electricity, water, and gas. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3,Industrial Production in Egypt increased 20.69% in November of 2014 over the same month in the previous year. Industrial production in Egypt averaged 4.45% from 2004 until 2014, reaching an all-time high of 34.77 percent in February of 2012 and a record low of -24.89 percent in February of 2011. Industrial production in Egypt is reported by the Ministry of Planning, Egypt.

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governments, financial institutions, and technology providers. IHS CERA delivers critical knowledge and independent analysis on energy markets, geopolitics, industry trends, and strategy.

Growing rapidly in developing countries, the cement industry accounts for 25% of the energy consumed by the manufacturing sector worldwide. Cement production is one of Egypt's most important industries, and by far the largest. This energy-intensive process is a significant source of GHG emissions, responsible for 65% of all emissions in the industrial sector. The industry's size and importance in Egypt mean that it has tremendous potential for reducing GHG emissions, which could be achieved by improving efficiency and shifting to alternative fuels. Equally importantly, an analysis of the cement industry's profitability, liquidity and debt ratios, shows that it is most attractive sector for undertaking mitigation actions without impacting upon competitiveness due to its very high profitability, good liquidity and relatively low debt ratio,The production of fertilizer for agriculture consumes 1.2% of total worldwide energy. In Egypt specifically, although it is the smallest contributor of GHGs of the three industrial sectors analyzed, it is by far the greatest energy consumer, and of the amount of energy consumed in the sector, approximately 90% is used for producing ammonia. (See the chart on energy types.) Therefore, the sub-sector of ammonia production has the most potential for reducing energy consumption within the fertilizer sector. Although energy consumption in ammonia plants is down to half of what is was in 1960, further efficiency can be gained by using more efficient, modern equipment and new technology.

Iron and Steel industry has seen steady growth worldwide since the 1970s, due particularly to its rapid expansion in China. The bulk of this growth has involved the use of inefficient processes and outdated technology only viable when energy costs are low. Fortunately, more efficient practices continue to emerge, including the use of less wasteful input materials, as well as the use of blast furnaces and coke for power, rather than gas. In Egypt, the most important steps identified for further GHG reductions in this sector include switching to these best-available technologies used worldwide, such as cleaner input materials, upgraded production facilities, implementation of CO2 capture and storage and improved materials management. However, the iron and steel sector was found to be the least financially sound sector of the three in Egypt, due to low profitability, low liquidity and very high debt ratio).

1.8.3. Agriculture

An estimated 55% of the labor force in Egypt is engaged in agricultural activities, a sector which consumes about 80% of the fresh water resources and contributes about 13.5 % to the GDP, in 2012/2013.

Egyptian agricultural land can be classified into: "Old-land" comprising the lands of the Nile Valley and the Nile Delta which have been irrigated and intensively cultivated since ancient times, and which represent about 80% of the cultivated area; "New-land" entailing lands that have been reclaimed relatively recently or are in the process of being reclaimed now, representing about 20% of the cultivated area. The cultivated land base of Egypt is about 3.5 million hectares, with a total annual cropping area of about 6.2 million hectares, representing 176% of the total cultivated land area (SADS, 2010).

Cultivation and modern irrigation in new lands can be classified as medium to high level. Due to the different conditions of soil, availability and quality of water and climatic conditions, there are two main cropping seasons a year, namely, winter and summer cultivation seasons. In some cases, farmers tend to cultivate a third crop during the period between summer and winter, termed "Nili" season, which may extend for about two months. At the same time, fruit trees are the most important perennial crops. Field crops cultivated in Egypt include maize, rice, cotton and sugarcane as main summer crops, while alfalfa, wheat, barley, green bean, clover, and sugar beet are the main winter field crops. Field crops in Egypt have a superior productivity, which has been improved through the last two decades as a result of switching to new cultivars, applying modern technologies and improving management programs (SADS, 2010).

1.8.4. Waste

Despite the national and local efforts to tackle the solid waste management crisis in Egypt, the improper waste handling, storage, collection, treatment and disposal practices still pose serious environmental and public health risks. The major challenges facing the sector are the inadequate planning and legislation, resource constraints, institutional deficiencies and the lack of stakeholders' participation. Recently, the "Annual Report for Solid Waste Management in Egypt, 2013" studies factors contributing to the SWM systems' failure and recommendations for future perspectives as commissioned by GIZ and the newly established National Solid Waste Management Programme (NSWMP) . In 2012, Egypt generated 89.03 million tons of solid waste, including:

- Municipal solid waste, 21 million tons;
- Agricultural waste, 30 million tons;
- Industrial waste, 6 million tons;
- Hazardous medical waste, 28,300 tons;
- Construction and demolition waste, 4 million tons;
- Waterway cleansing waste, 25 million tons;
- Sludge, 3 million tons.

A major challenge with regards to the management of municipal solid waste is the lack of adequate collection equipment. According to the Ministry of Environment, this is a result of both the poor maintenance and the lack of resources to increase and modernize collection and treatment equipment. Building capacities to better under-stand the functioning of equipment as well as to develop technical guidelines will need to go hand in hand with securing sufficient funds to manage municipal solid waste in an adequate manner. Integration of the informal sector in the formal public and private waste management sector, putting in place economic instruments, such as public-private partnerships, and strengthening human resources will be fundamental in the more effective implementation and enforcement of the existing policies. Improving the coordination among governmental entities responsible for regulating and operating MSW management is also required. Raising awareness in the population about the benefits of at-source waste separation will have a crucial role in complementing the efforts undertaken at governmental and company level. The waste sector produces greenhouse gas emissions from solid waste disposal sites (SWDS), wastewater handling and waste incineration.

The treatment of urban wastewater and the resulting wastewater sludge is accomplished using aerobic and/or anaerobic processes.The domestic wastewater handling in Egypt falls under the responsibility of two entities: the Holding Company of Water and Wastewater and the National Institution for Water and

Wastewater. The number of wastewater treatment plants (WWTP) has increased over the years. The total population is estimated at 2005 to be 70.1 million while only 26 millions are served in wastewater treatment plants.

I.9. INSTITUTIONAL FRAMEWORK FOR CLIMATE CHANGE

In June 1997, the responsibility of Egypt's first full time Minister of State for Environmental Affairs was assigned as stated in the Presidential Decree no.275/1997. From thereon, the new ministry has focused, in close collaboration with the national and international development partners, on defining environmental policies, setting priorities and implementing initiatives within a context of sustainable development. According to the Law 4/1994 for the Protection of the Environment, the Egyptian Environmental Affairs Agency (EEAA) was restructured with the new mandate to substitute the institution initially established in 1982. At the central level, EEAA represents the executive arm of the Ministry.

The principal functions of the environmental agency include:

- Formulating environmental policies
- Preparing plans for environmental protection and environmental development projects and following up their implementation and undertaking pilot projects
- The Agency is the national authority in charge of promoting environmental relations between Egypt and other countries as well as regional and international organizations.

An Environmental Protection Fund (EPF) will in accordance with the "Environment Act of 1994" be set up at the Agency. The Fund will receive the amount specifically allocated to it in the General State Budget by way of support, donations and grants presented by national and foreign organizations concerned with environmental protection, fines and compensation awarded by courts of law or via out-of-court settlements for damage caused to the environment, as well as revenues from the protectorates fund. The EPF shall have a juridical personality and shall be affiliated to the competent Minister for Environmental Affairs. The financial resources of the Fund shall be exclusively used for the purpose of realizing its objectives. The Agency will offer incentives to institutions and individuals engaged in activities and projects directed to environmental protection purposes.

I.10. ESTABLISHMENT OF THE NATIONAL COMMITTEE ON CLIMATE CHANGE

As a result of the increased scientific evidence of the dangerous of Climate Change phenomenon and its impacts on Egypt, the National Committee on Climate Change has been established in 2007 (Prime Minister Decree #272).

The committee includes representatives from the Ministries of Foreign Affairs, Water Resources & Irrigation, Agriculture & Land Reclamation, Electricity & Energy, Petroleum, Trade & Industry, Economic Development and Defense, besides experts from national and relevant agencies.

The National Committee is concerned with developing mitigation and adaptation strategies to address phenomenon of climate change. Reviewing and activating the National Strategy for Climate Change with the preparation of plans and programs required in the near term and long term and integrated into national action plans for development in Egypt.

CHAPTER II: NATIONAL GREENHOUSE GAS INVENTORY

II. 1. INTRODUCTION

The core elements of the national communications for both Annex I and non- Annex I Parties encompass information on emissions and reductions of greenhouse gases (GHGs), as well as details of the activities undertaken to implement the Convention. The data and procedures need to be consistent, transparent and well documented to the most possible extent.

In the inception report data sources were identified. They entailed Egyptian governmental institutions as well as reputable international data sources. The identified Egyptian institutions are ones responsible for with primary data collection and archiving, such as CAPMAS, information centers and information banks, as well as governmental institutions issuing licenses to targeted entities relevant to the GHG inventory. These licenses include essential technical information about capacity, technology, raw materials and fuel consumptions. Data used in this chapter pertain to activities of the year 2005, unless otherwise indicated. In the methodology for the current GHG inventory, the data received from the sources are reliable with minimum uncertainty. Processing is based on the considered IPCC default methodologies and default emission factors (IPCC, 1996; IPCC, 2000). In consequence, information in this chapter can be classified as falling within the Tier 1 level.

Estimating the GHG emissions in all sections of this chapter is carried out following the default methodology of the “Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories” (IPCC, 1996) and the “Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories” (IPCC, 2000). GHG emissions due to energy used in any sector including industry are calculated in the energy sector. GHG emissions in the industry sector are only emissions due to industrial processes. All calculations in the present report use the Global Warming Potential (GWP) of GHGs for 100 years, of table 2.9 of the ”IPCC Second Assessment Report”, following the incorporation of the provisions of decision 14/CP.11 for updated UNFCCC reporting guidelines on annual inventories, FCCC/SBSTA/2006/9 18 August 2006.

In cases where data are available, specific site calculations are considered, and the methodologies followed strictly adhere to the well-established scientific and technical rules. Comparison and verification between specific site calculations and the default emission factors defined by the IPCCC is shown. For these cases, the work can be considered as higher than Tier 1. Estimates have been made for the base year 2005. For cases where data are available for the sector and the source category, estimates are carried-out for the time series 1999-2012.

In accordance with paragraph 23 of Decision 17/CP.8, details of the GHG inventory studies are delivered as references, in both electronic and hard copy formats, with the present report of Egypt’s Second National Communication to the COP secretariat. Sectors, as sources of GHG emissions, are categorized according to their percentage share in the national GHG inventory. The outline of Egypt’s total GHG inventory in the year 2000 is presented by GHG type and also by sector. The national sources of GHGs are presented in successive ordering according to their categories. Data sources for each sector are defined, followed by a summary for the whole country. Whenever data are available, yearly GHG emission series are presented.

II. 2. ELEMENTS OF EGYPT'S GHG INVENTORY

II. 2.1 Egypt's GHG emissions by gas type for the year 2005

Table (II.1) and figure (II.1) present Egypt's total GHG emissions by gas type, for the year 2005.Emissions for the year 2000 are also shown in table (II.1). The total GHG emissions of Egypt in 2005 are 247.98 Mt CO_2e.

Table (II.1): Egypt's GHG emissions by gas type for the years of 2000 and 2005.

Gas	Emission (Mt CO_2e)	Emissions (%)	Emission (Mt CO_2e)	Emissions (%)
	2000		2005	
CO_2	128.2	66.3	167.6	67.58
CH_4	39.4	20.4	35	14.11
N_2O	24.4	12.6	28.74	11.59
PFC	1.1	0.6	1.07	0.43
SF_6	0.1	0.05	0.1	0.04
HFC's blend	0.1	0.05	15.46	6.24
TOTAL	**193.3**	**100**	**247.97**	100

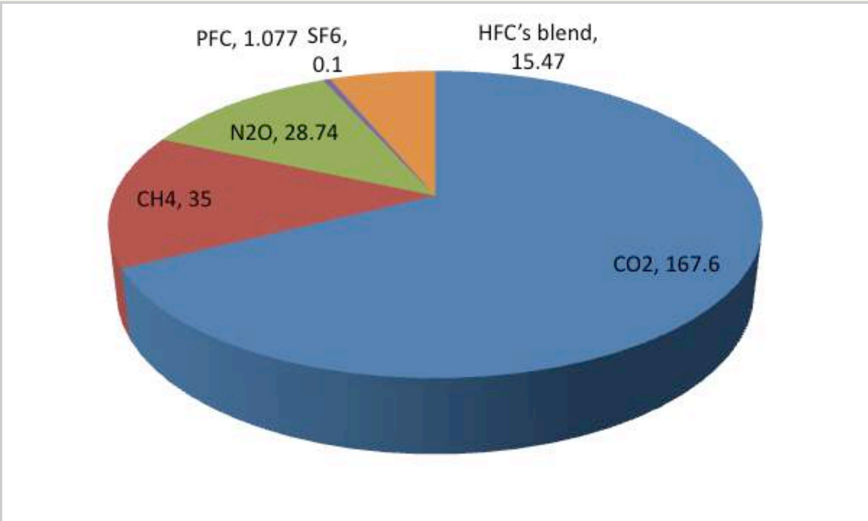


Figure (II.1): Egypt's GHG emissions by gas type for 2005 in Mt CO2e

II. 2.2 Egypt's GHG emissions by sector for the year 2005.

Table (II.2) presents Egypt's total GHG emissions by sector for the year 2005 in comparison with last inventory of 2000. Figure II.2 shows GHG emissions by sector for the year 2005.

Table (II.2): Egypt's GHG emissions by sector for the years of 2000 and 2005

Sector	Emission (Mt CO_2e)	Emissions (%)	Emission (Mt CO_2e)	Emissions (%)
	2000		2005	
Fuel Combustion	105.5	55	-	-
Fugitive Fuel Emissions	10.8	6	-	-
All Energy (Combustion and Fugitive emissions)	116.3	61	147.32	59.4
Agriculture	31.7	16	39.45	16
Industrial Processes	27.8	14	42.01	17
Waste	17.5	9	19.19	7.6
TOTAL	**193.3**	**100**	**247.97**	**100**

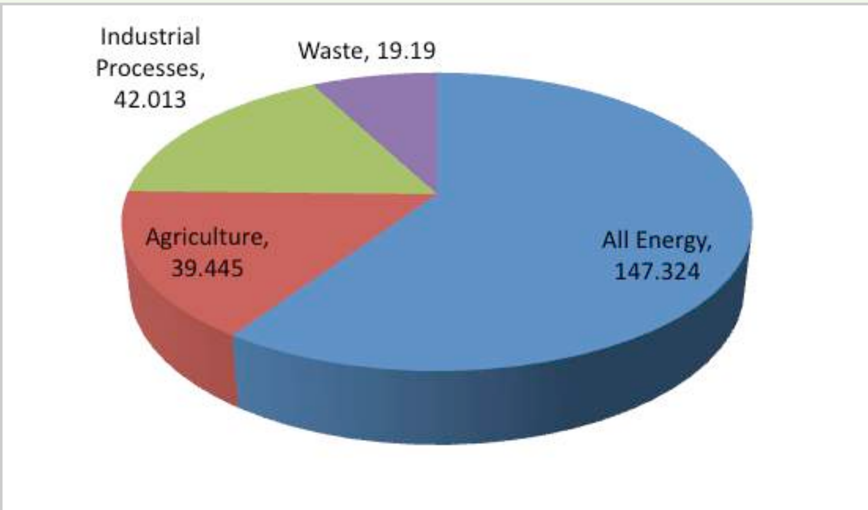


Figure (II.2):Egypt's GHG emissions by sector for 2005 in Mt CO2e

Table (II.3) show the change of sectors' contribution to Egypt's total inventory. It is clear that the total GHG emissions of Egypt increased in 2005 to be 213% of that in 1990 and 128% of that in 2000. During this period from 1990 to 2000, Egypt's population increased by 123% and 136% for period of 1990 to 2005 (Table (II.4)).

Table (II.3): Changes in contributions to the GHG inventory of different sectors

Sector	Emissions (Mt CO_2e/year) & (% of total)						Emissions of 2005 relative to	
	1990		2000		2005		1990%	2000%
All Energy (Combustion and Fugitive emissions)	82.7	71	116.3	61	147.32	59.4	178	126
Agriculture	10.3	9	27.8	14	39.45	16	408	151
Industrial processes	17.9	15	31.7	16	42.01	17	220	124
Waste	5.7	5	17.5	9	19.19	7.6	337	110
TOTAL	**116.6**	**100**	**193.3**	**100**	**247.97**	**100**	**213**	**128**

Table (II.4) gives the change of the GHG indicators for the year 2005 compare with 2000 and those of 1990. Total emissions per capita increased from 2.2 to 3.1 to 3.5tons CO_2e, for 1990, 2000 and 2005, respectively, and the total emissions per thousand US$ of the GDP at market prices decreased from 3.3 tons (1990) to 1.9 tons (2000) and then increase again in 2005 to 2.7tons CO_2e/1000 US$.

Table (II.4): Changes in the total GHG indicators

Year	Population (million)	GDP market price (billion US$)	Emissions (Mt CO2e)	Emissions (ton CO2e/ capita)	Emissions per capita; ratio for 2005/2000/1990 (%)	Emission (ton CO2e/ 1000 US$)	Specific emission; ratio for 2000/1990 (%)	Specific emission; ratio for 2005/2000 (%)
1990	52.6	35.16	116.6	2.2	--	3.3	--	--
2000	63.3	99.74	193.3	3.1	137	1.9	58	
2005	71.78	89.69	245.2	3.5	111	2.76	--	79

II. 3. GHG INVENTORY BY SECTOR

II. 3. 1. The Energy Sector

Energy systems in Egypt are largely driven by the combustion of fossil fuels. During combustion, the carbon and hydrogen of the fossil fuels are converted mainly into carbon dioxide (CO_2) and water (H_2O), releasing the chemical energy in the fuel as heat. This heat is generally either used directly or used (with some conversion losses) to produce mechanical energy, often to generate electricity oris used for transportation. The energy sector is usually the most important sector in greenhouse gas emission inventories. CO_2 accounts typically for more than 95 percent of energy sector emissions with methane and nitrous oxide responsible for the balance. Stationary combustion is usually responsible for about 70 percent of the greenhouse gas emissions from the energy sector. About half of these emissions are associated with combustion in energy industries mainly power plants and refineries. Mobile combustion (road and other traffic) causes about one quarter of the emissions in the energy sector. The energy sector mainly comprises:

- Exploration and exploitation of primary energy sources;
- Conversion of primary energy sources into more useable energy forms in refineries and power plants;
- Transmission and distribution of fuels; and
- Use of fuels in stationary and mobile applications.

II. 3. 1. A. METHODOLOGICAL APPROACH AND DATA SOURCES

Emissions arise from these activities by combustion and as fugitive emissions, or escape without combustion. For inventory purpose, GHGs emissions are calculated according to the following methodology. The approach used in this emissions inventory is based on the following:

1. All sources and sinks, as well as all gases as mandated by 17/CP8, have been covered.
2. Estimates have covered three of the direct GHGs, namely: CO_2, CH_4 and N_2O for both the all energy consumption and the electricity generation for years 1991/1992-2005/2006. Also, indirect GHGs gas of NOx has been covered for the electricity sector only.
3. Used methodologies, assumptions and data were dependent on IPCC 1996 and 2006 guidelines, as appropriate.
4. Source categories are identified for level analysis.
5. Activity Data:

   5.1 Fuel Definitions: The definitions used are the same as the definitions provided by the 2006 IPCC guidelines.

5.2 Fuel Units: For energy statistics and other energy data compilations, production and consumption of solid, liquid and gaseous fuels are specified in physical units, e.g. in tonnes or cubic meters. To convert this data to common energy units, e.g. Joules, net calorific values have been used expressed in SI units, as per 2006 IPCC guidelines for national greenhouse gas inventories.

6. Reliable activity data for the Energy Sector were used. Reliance has been put on sector data as given in the national sectoral reports, i.e. reports of the Egyptian General Petroleum Corporation (EGPC), the Egyptian Gas Holding Company (EGAS) and the Egyptian Electricity Holding Company (EEHC).
7. Emission factors that have been used in estimating emissions inventory relied on the IPCC good practice guidance issued in the years 1996 and 2006.
8. Uncertainty analyses were conducted for the energy inventory. These uncertainty estimates were conducted as given in the "IPCC Good Practice Guidance". Tier 1 uncertainty analysis was conducted.
9. Emissions released from bunker fuels were not estimated.
10. Estimates have been made for the base year 2005/2006. Also, estimates were carried out for All Energy Consumption for the time series 1991/1992-2005/2006 and for Electricity Generation for the time series of the same period in order to provide a clear view of the emissions trend.
11. The Energy Inventory of GHGs emissions and sinks for Egypt has been compiled for the fiscal years 1991/1992 through 2005/2006 (Fiscal year starts 1stJuly of a specified year and ends 30th of June the next year). The base year was 2005/2006. The five years period was selected for trend illustration.

The GHGs emissions from all energy consumption were calculated based on the following:

1. The Tier I method presented in the 2006 IPCC guidelines for estimating emissions from fossil fuel combustion has been used.
2. The Tier II method requirements, presented in the 2006 IPCC guidelines, have been almost met for the energy sector.
3. Emissions from all sources of combustion have been estimated on the basis of the quantities of fuel combusted (basically from national energy statistics) and using average emission factors.
4. Emission factors for CO_2 depend on the carbon content of the fuel, combustion conditions are relatively of a minor importance.
5. Local consumption has been estimated for Production ***plus*** Imports ***minus*** Exports ***plus or minus*** Stock Change.

   Simple equation has been used as follows:

   Local Consumption = Production + Imports – Exports + Stock Change
6. Other petroleum products such as wax, lubricating oils, bitumen …etc. have been considered as non-

energy use, hence, they were not considered in CO_2, CH_4, N_2O and NO_x, emissions calculations.

7. Natural gas utilized in fertilizer industry is considered as raw materials; hence it is not considered is calculating CO_2 emissions.
8. CH_4 default emission factor described in Vol. 1.2 under the title: “Energy”, Table 2.2 (energy industries) has been used.
9. N_2O default emission factor described in Vol. 1.2 under the title: “Energy”, Table 2.2 (energy industries) has been used

As for annual GHGs emissions from electric power generation, it based on the following:

- Emissions have been designed according to the IPCC 1996 and 2006 guidelines.
- Default factors of emissions for each GHGs emission category have been used as per the IPCC guidelines.

Global Warming Potential (GWP) Calculation Method based on the Annual Statistical Reports of the Egyptian Electricity Holding Company (EEHC) and the National Dispatch Center for checking and discussing data , was used. The following steps have been undertaken for calculating the GHGs emissions from electricity generation:

- Annual fossil fuel consumption of each single power plant has been identified for each type of fossil fuel, i.e. natural gas, mazout (fuel oil no. 6), gas oil/diesel (fuel oil no. 2), and special gas oil/diesel (imported fuel oil no. 2).
- Tables for calculating GHGs of the specified GHGs have been used as per the IPCC Third Report, 2001.
- All specified steps provided by the IPCC guidelines for calculating GHGs emissions have been precisely followed.

All relevant data have been collected from its respective sources, i.e. Egyptian General Petroleum Corporation (EGPC), Egyptian Natural Gas Holding Company (EGAS), Egyptian Electricity Holding Company (EEHC), New and Renewable Energy Authority (NREA), Ministry of Planning, Ministry of Transport, etc. In addition, interviews with key persons and visits to the concerned authorities/ institutions for consultation on methodology, in addition to analysis and review of the above mentioned reports and provision of specific information on energy per each fuel cycle, i.e. from exploration to end use, have been accomplished. Concerned consulted authorities / institutions include the following:

- Ministry of Petroleum.
- Ministry of Electricity & Energy.
- Egyptian General Petroleum Corporation (EGPC).
- Egyptian Natural Gas Holding Company (EGAS).

- Egyptian Electricity Holding Company (EEHC).
- National Electricity Dispatch Center (NDC).

II.3.1.B. EMISSIONS FROM THE FUEL COMBUSTION AND ELECTRICITY

Emissions of CO2e from the energy sector for the base year 2005/2006 are 147,324 Gg. Emissions of CO2e from the Electricity Sector for the base year 2005/2006 are 54,845 Gg. - The percentage of GHGs emissions of the Electricity Sector relative to all energy consumption for CO2e for the base year 2005/2006 is 37.23%.

GHGs Emissions from All Energy Consumption for the Base Year 2005/2006 are:

- GHGs Emissions from All Energy Consumption by GHGs Gases.
- GHGs Emissions from All Energy Consumption by Energy Types/ Products.
- GHGs Emissions from All Energy Consumption by Source Categories/Sectors.
- Fugitive Emissions.

Table (II.5)and figure (II.3) present details of emissions by type of gas for the base year 2005/2006 resulting from fuel combustion. It is clear that carbon dioxide emissions represent more than 99% of the total CO_2e of the total GHG emissions. The combustion of petroleum fuel represent 53% of the total GHG emissions of the energy sector while the natural gas account for about 47% as shown in figure (II.4).

Table (II.5):.GHGs emissions from all energy consumption by gas Type, 2005/2006 in million tons/year

GHGs	Petroleum	Natural Gas	Total	Total CO_2e	Share of Total (%)
CO_2	78.175	69.003	147.178	147.178	99.90%
CH_4	0.00289	0.00123	0.00412	0.095	0.06%
N_2O	0.00012	0.00006	0.00018	0.052	0.04%
CO_2e*	**78.275**	**69.050**	**147.324**	**147.324**	**100.00%**
Total (%)	**53.13%**	**46.87%**	**100.00%**		

* CO_2e = CO_2 Equivalent according to the IPCC's third report, 2001.

* GWP (Global Warming Potential): CO_2 = 1 &CH_4=23& N_2O = 296

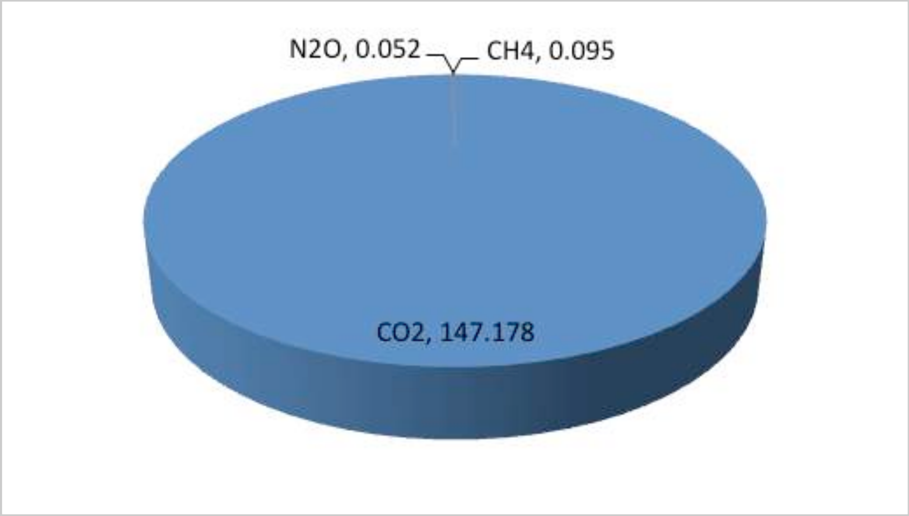


Figure (II.3): GHG emissions from energy consumption by gas type in Mt CO2e, 2005/2006

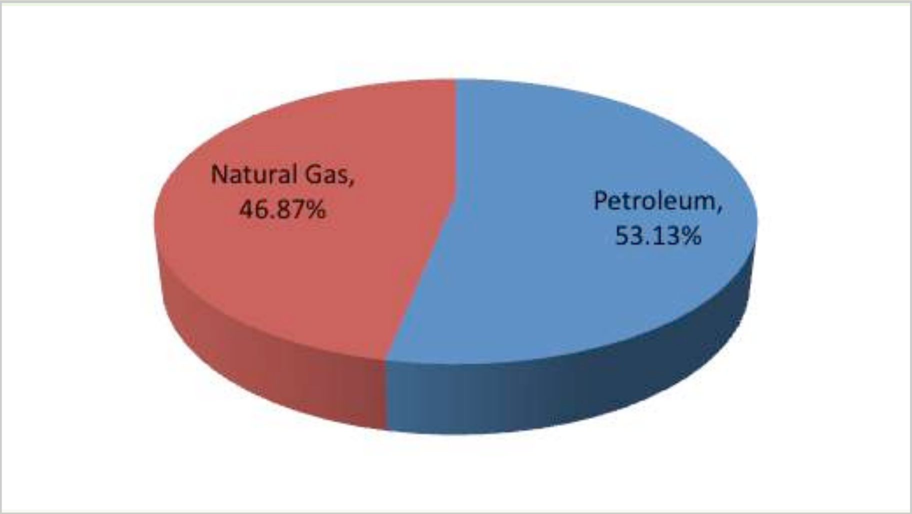


Figure (II.4): GHG emissions from petroleum fuels and natural gas, 2005/2006

Table (II.6) and figure (II.5) represent GHG emissions by fuel type for the energy sector.

Table (II.6): GHGs emissions from all energy consumption by fuel type in thousand tons/ year, 2005/2006

GHGs	LPG	Gasoline	Kerosene/ Turbine	Gasoil/ Diesel	Fuel Oil	Total Petroleum	Natural Gas	Grand Total
CO_2	10575	9063	2434	31031	25072	78175	69003	147178
CH_4	0.167	0.393	0.101	1.256	0.970	2.287	1.230	4.117
N_2O	0.018	0.014	0.004	0.044	0.034	0.114	0.062	0.175
CO_2e*	10583	9075	2437	31073	25104	78274	69049	147324

* CO_2e = CO_2 Equivalent according to the IPCC's third report, 2001.

* GWP (Global Warming Potential) : CO_2 = 1 & CH4=23 & N_2O=296.

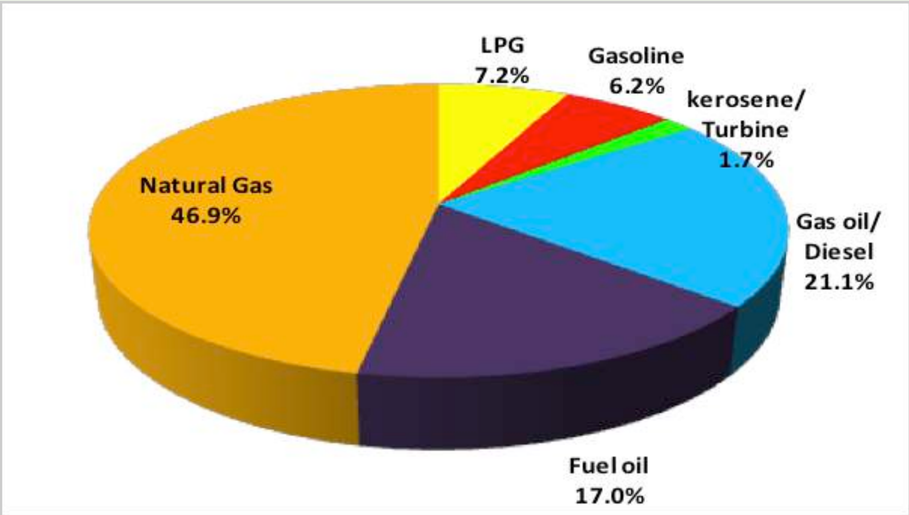


Figure (II.5):GHGs emissions from all energy consumption by fuel type in thousand tons/year, 2005/2006

Table (II.7) and figure (II.6) present GHG emissions by sector for different fuel types. As shown the electricity sector accounts for the highest percentage which is 37.2 % followed by the industry sector with 23.4% and the transportation sector by 22.5%.

Table (II.7): Sectoral GHG emissions in thousand tons/year, 2005/2006

Source Category / Sector	Consumption / GHGs Gases	Energy Consumption by Energy Type/ Products units and Relevant Emission Levels							Total Emissions CO_2e	Share (%)
		LPG	Gasoline	kerosene Turbine	Gas oil/ Diesel	Fuel oil	Total Petroleum	Natural Gas		
Industry	Consumption ('000 tons)	8372	0	3767	66349	140350	218838	319344	538182	
	CO_2 emissions	528.28	0	270.833	4916.461	10863.06	16578.632	17915.19	34493.83	
	CH_4 emissions	0.008	0	0.011	0.199	0.42	0.639	0.319	0.958	
	N_2O emissions	0.001	0	0	0.007	0.015	0.023	0	0.023	
	CO_2 e (Thousand tons)	528.7	0	271.2	4923.1	10877.1	16600.2	17922.5	34522.7	23.43%
Transport-ation	Consumption ('000 tons)	0	130774	20367	277350	17412	445903	10992	456895	
	CO_2 emissions	0	9062.6	1464.387	20551.635	1347.72	32426.353	616.651	33043.004	
	CH_4 emissions	0	0.393	0.061	0.832	0.052	1.338	0.011	1.349	
	N_2O emissions	0	0.014	0.002	0.029	0.002	0.047	0.018	0.065	
	CO_2 e (Thousand tons)	0	9075.7	1466.426	20579.45	1349.464	32471.073	622.207	33093.279	22.46%
Agriculture	Consumption ('000 tons)	0	0	920	33970	0	34890	0	34890	
	CO_2 emissions	0	0	66.134	2517.177	0	2583.311	0	2583.311	
	CH_4 emissions	0	0	0.003	0.102	0	0.105	0	0.105	
	N_2O emissions	0	0	0	0.004	0	0.004	0.001	0.004	
	CO_2 e (Thousand tons)	0	0	66.226	2520.584	0	2586.81	0.183	2586.992	1.76%
Res.& Comm.	Consumption ('000 tons)	159212	0	8804	18490	0	186506	22608	209114	
	CO_2 emissions	10046.3	0	632.993	1370.109	0	12049.367	1268.309	13317.676	

Source Category / Sector	Consumption / GHGs Gases	Energy Consumption by Energy Type/ Products units and Relevant Emission Levels							Total Emissions CO_2e	Share (%)
		LPG	Gasoline	kerosene Turbine	Gas oil/ Diesel	Fuel oil	Total Petroleum	Natural Gas		
	CH_4 emissions	0.158	0	0.026	0.055	0	0.24	0.023	0.263	
	N_2O emissions	0.017	0	0.001	0.002	0	0.02	0	0.02	
	CO_2 e (Thousand tons)	10054.885	0	633.874	1371.963	0	12060.723	1268.829	13329.551	9.05 %
Electricity	consumption('000 tons)	0	0	0	3913	160913	164826	749856	914682	
	CO_2 emissions	0	0	0	289.953	12454.68	12744.6	42066.9	54811.557	
	CH_4 emissions	0	0	0	0.012	0.482	0.494	0.75	1.244	
	N_2O emissions	0	0	0	0	0.017	0.017	0.001	0.019	
	CO_2e (Thousand tons)	0	0	0	290.3	12470.8	12761.1	42084.5	54845.6	37.23%
Petroleum	Consumption ('000(tons)	0	0	0	18705	5252	23957	127200	151157	
	CO_2 emissions	0	0	0	1386.041	406.505	1792.545	7135.9	8928.465	
	CH_4 emissions	0	0	0	0.056	0.016	0.072	0.127	0.199	
	N_2O emissions	0	0	0	0.002	0.001	0.003	0.042	0.045	
	CO_2 e (Thousand tons)	0	0	0	1387.9	407.0	1794.9	7151.3	8946.2	6.07 %
Total	Consumption ('000 tons)	167584	130774	33857	418777	323927	1074919	1230000	2304919	
	CO_2 emissions	10574.544	9062.6	2434.4	31031.4	25071.9	78174.843	69003	147177.843	
	CH_4 emissions	0.167	0.393	0.101	1.256	0.97	2.887	1.23	4.117	
	N_2O emissions	0.018	0.014	0.004	0.044	0.034	0.114	0.062	0.175	
	CO_2e (Thousand tons)	10583.618	9075.733	2437.735	31073.375	25104.415	78274.875	69049.603	147324.478	100.00%

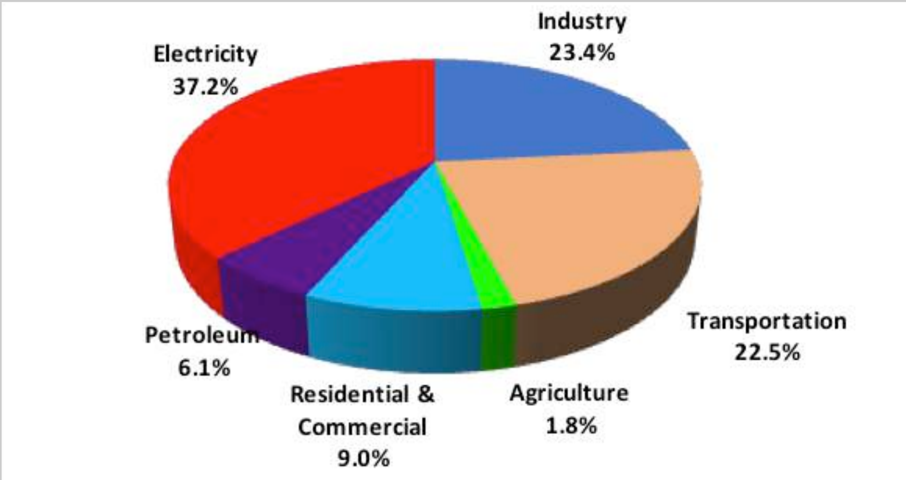


Figure (II.6): Sectoral GHGs emissions (CO2e), 2005/2006

Tables (II.8) and figures (II.7) to (II.10) show the trends in CO_2e, CO_2, CH_4 and N_2O emissions for All Energy consumption from 1991/1992 to 2005/2006.

Table (II.8): GHGs emissions trend for all energy consumption

Year	CO_2 Emissions (000'tons)	CH_4 Emissions (000'tons)	N_2O Emissions (000'tons)	CO_2 Equivalent (Million tons)	Evolution Ratio (%)
1991/1992	72346	2.5	0.47	72.54	
1992/1993	70807	2.4	0.44	70.99	-2.14
1993/1994	70216	2.3	0.41	70.39	-0.85
1994/1995	73515	2.4	0.43	73.70	4.7
1995/1996	79407	2.6	0.47	79.61	8.02
1996/1997	82050	2.7	0.48	82.25	3.32
1997/1998	90132	2.9	0.53	90.36	9.86
1998/1999	93756	3	0.55	93.99	4.02
1999/2000	98047	3.1	0.55	98.28	4.56
2000/2001	105151	3.3	0.56	105.39	7.23
2001/2002	108703	3.17	0.54	108.94	3.37
2002/2003	116927	3.36	0.57	117.17	7.55
2003/2004	120996	3.4	0.57	121.24	3.47
2004/2005	134065	3.9	0.66	134.35	10.81
2005/2006	147178	4.117	0.68	147.32	9.77

* CO_2e = CO_2 Equivalent according to the IPCC's third report, 2001.

* GWP (Global Warming Potential):CO_2 = 1& CH_4=23 & N_2O=296.

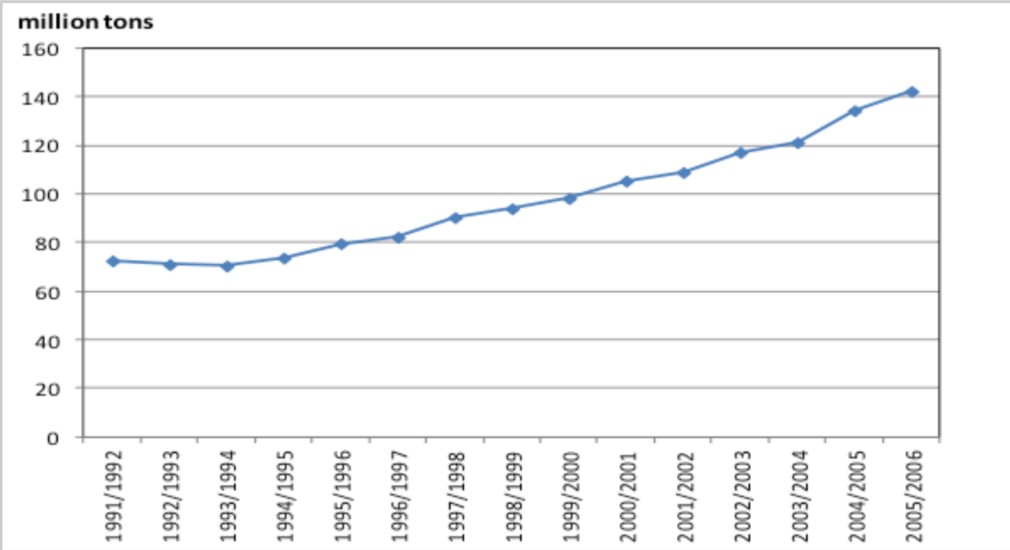


Figure (II.7) : Total CO2e emissions trend for all energy consumption (Average annual increase = 4.91%)

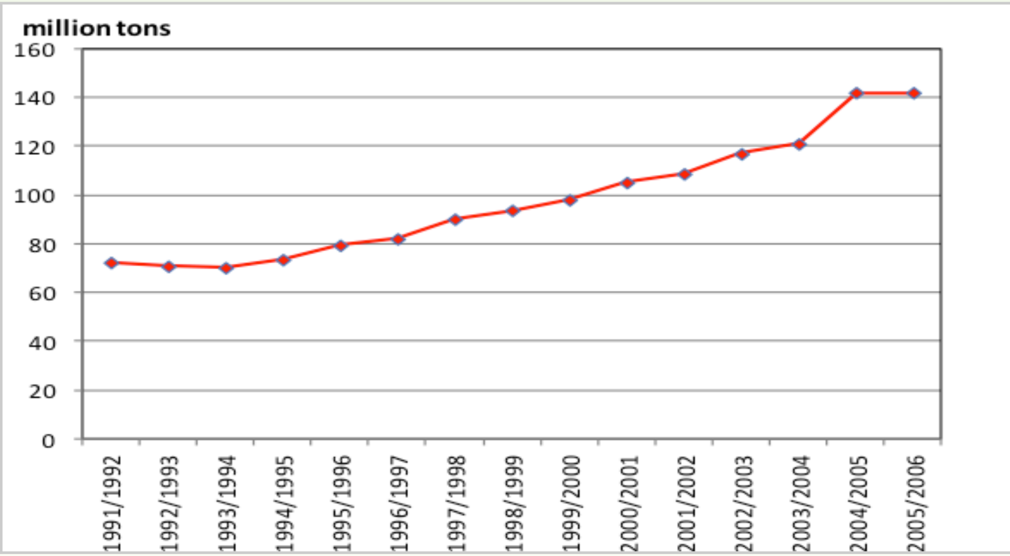


Figure (II.8): Total CO2emissions trend for all energy consumption (Average annual increase = 5.29%)

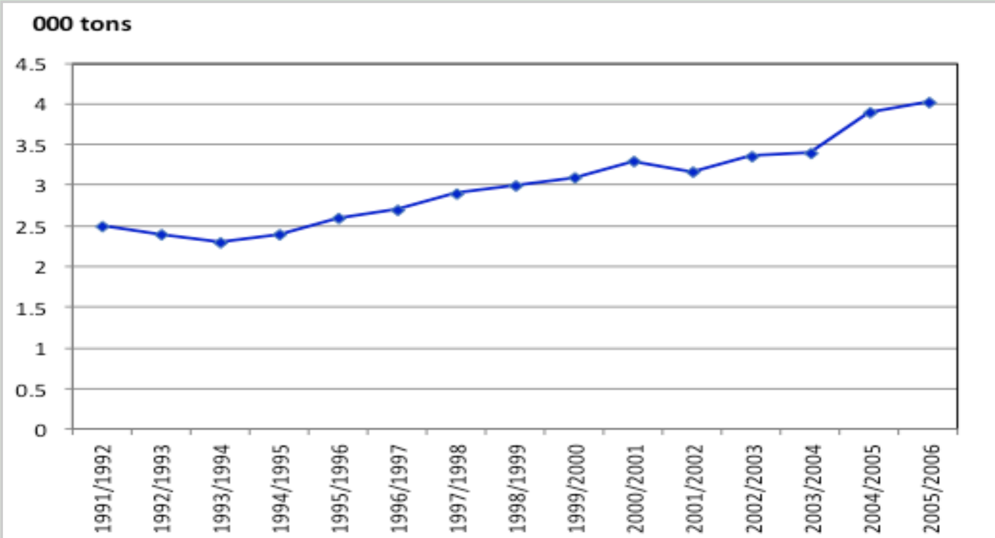


Figure (II.9): Total CH4 emissions trend for all energy consumption (Average annual increase = 3.49%)

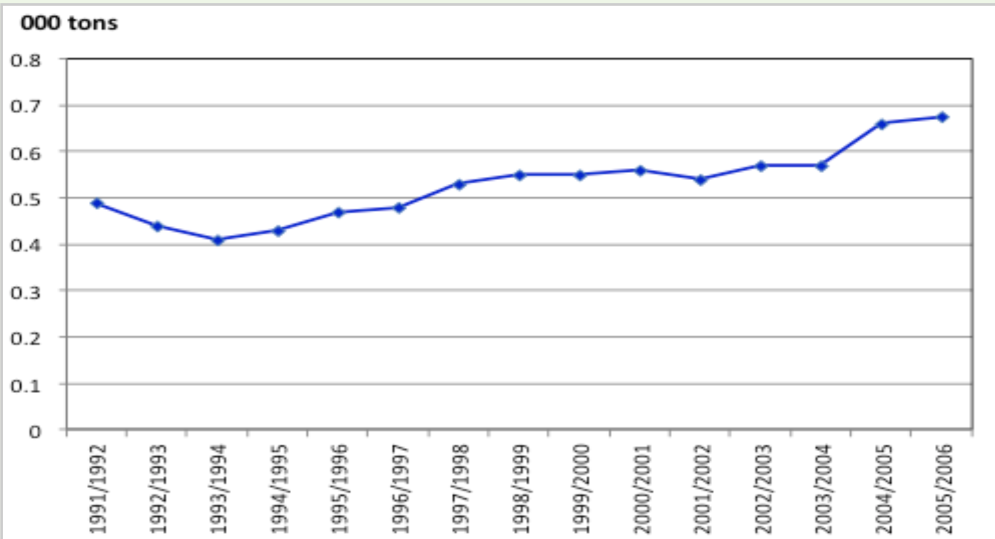


Figure (II.10): Total N2O emissions trend for all energy consumption (Average annual increase = 2.90%)

Considering the trends in GHG emissions resulting only from electricity generation from 1991/1992 to 2005/2006, these are presented in table (II.9) and figures (II.11) to (II.14).

Table (II.9): GHGs emissions trend for the period for electricity generation for 1991/1992 – 2005/2006

Year	CO_2 Emissions (10^3 kg)	CH_4 Emissions (10^3 kg)	N_2O Emissions (10^3 kg)	CO_2 Equivalent (10^3 kg)	Evolution Ratio (%)
1991/1992	24810800.0	14867.821	37507.640	24863175.461	
1992/1993	22943400.0	14316.350	29028.424	22986744.774	-7.52
1993/1994	21792700.0	14128.072	23784.192	21830612.264	-5.05
1994/1995	22898400.0	13539.456	24956.352	22936895.808	5.08
1995/1996	24498800.0	17050.153	28473.720	24544323.873	6.97
1996/1997	26085300.0	18761.238	30247.352	26134308.590	6.48
1997/1998	29595400.0	20643.972	39555.960	29655599.932	13.51
1998/1999	31614400.0	20081.645	42412.656	31676894.301	6.81
1999/2000	33514300.0	20634.841	37300.144	33572234.985	5.97
2000/2001	34939148.5	21507.990	31036.784	34991693.274	4.23
2001/2002	35897456.0	19234.663	27563.135	35944253.798	2.74
2002/2003	40572819.0	21815.824	30689.280	40625324.104	13.02
2003/2004	43157328.4	23946.379	30483.826	43211758.605	6.35
2004/2005	50061821.6	27259.798	49171.609	50138253.007	16.04
2005/2006	49070687.3	35791.938	41545.126	49148024.405	-1.98

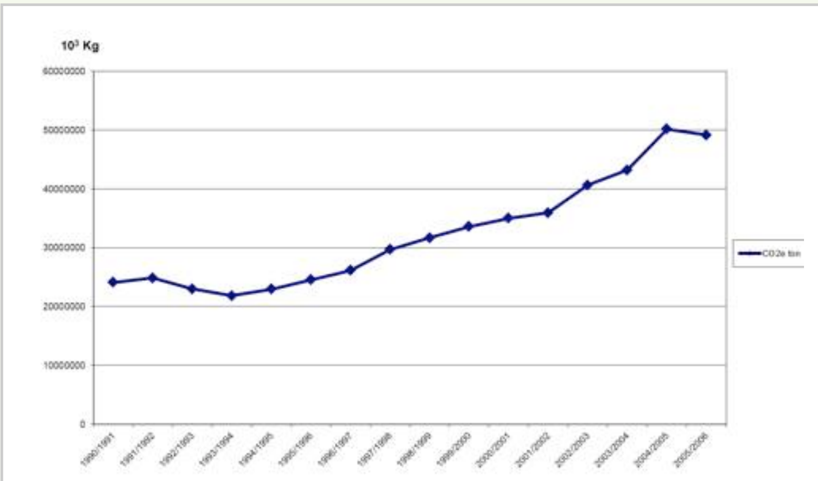
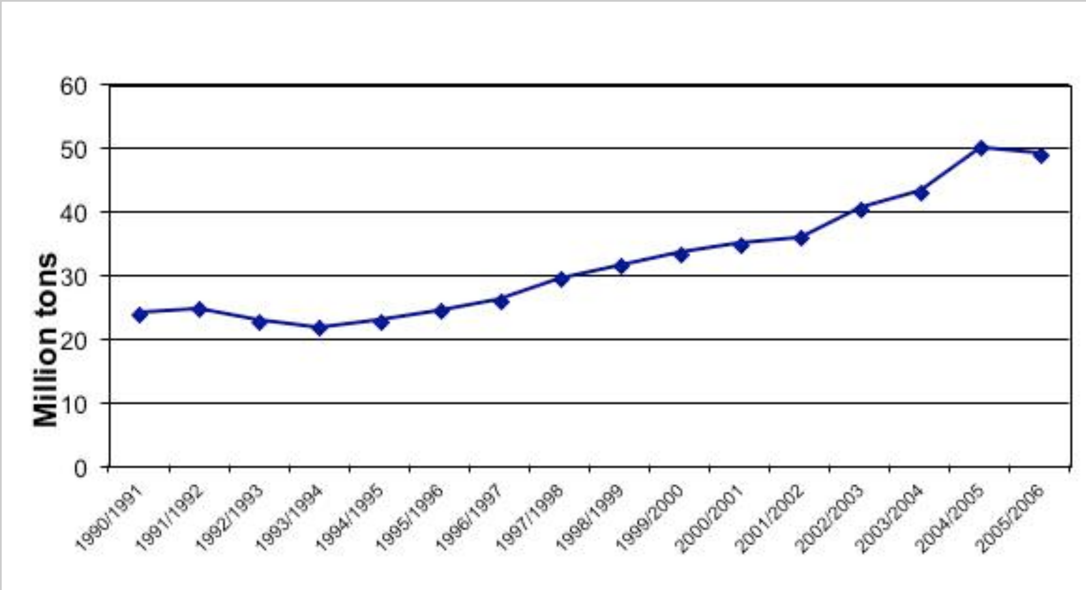


Figure (II.11) : Total CO_2e emissions trend for electricity generation (average annual increase = 4.84%)



Figure(II.12): Total CO2emissions trend for electricity generation (average annual increase = 5.36%)

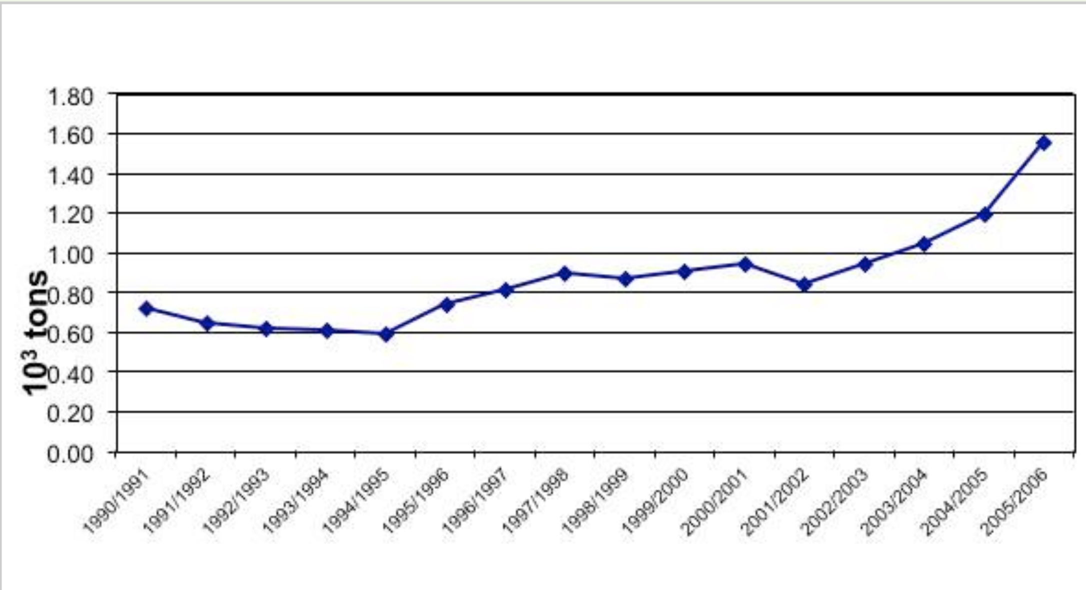


Figure (II.13): Total CH4emissions trend for electricity generation (average annual increase = 6.65%)

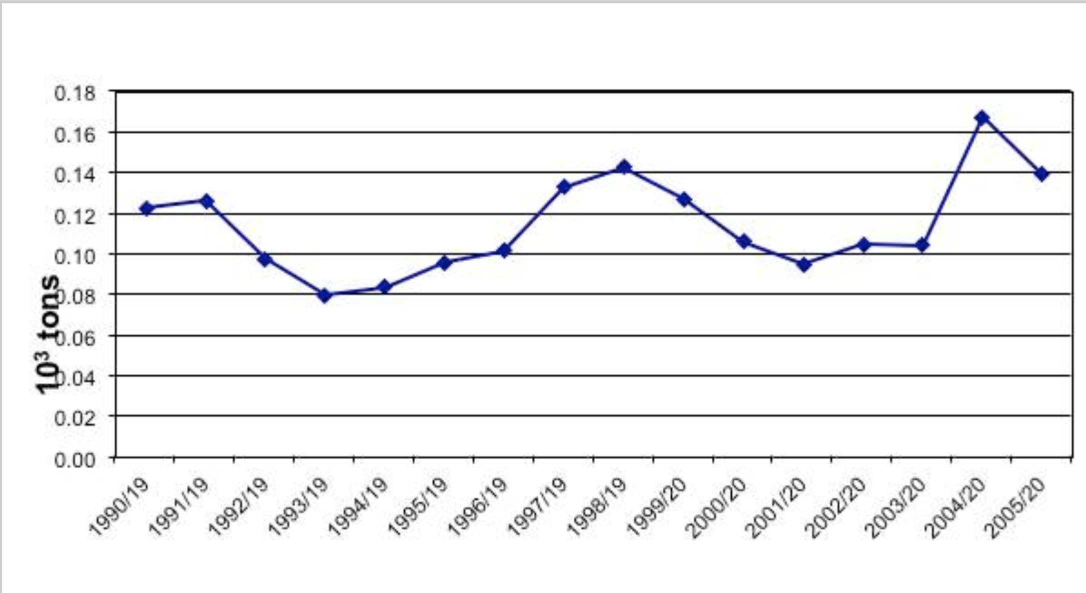


Figure (II.14): Total N2O emissions trend for electricity generation (average annual increase = 2.76%)

1.3.1.c. Fugitive Emissions

Fugitive GHG emissions from fuel combustion in All Energy Consumption are included in table (II.10).

Table (II.10):.Fugitive emissions from all energy consumption, 2005/2006

Products	Units	2005/2006
Emissions from oil production (fugitive, venting and flaring):		
Total CO_2 emission	000' ton CO_2	1,580.917
Total CH_4 emission	000' ton CH_4	382.224
Total N_2O emission	000' ton N_2O	0.022
Emissions from gas production and gas processing (fugitive, venting and flaring):		
Total CO_2 emission	000' ton CO_2	63.838
Total CH_4 emission	000' ton CH_4	0.040
Total N_2O emission	000' ton N_2O	0.001
Total GHGs Fugitive emissions from oil & gas	000' ton CO_2	1,644.756
	000' ton CH_4	382.264
	000' ton N_2O	0.023
Total CO_2e Fugitive emissions from oil & gas	000' ton CO_2e	1,644.756
	000' ton CO_2e	8,792.072
	000' ton CO_2e	1,927.552
Grand Total CO_2e	**000' ton CO_2e**	**12,364.38**
	Million ton CO_2e	**12.364**

II. 3.2. Transportation Sector

The transport sector is a major consumer of fossil fuels and therefore contributes a significant share of greenhouse gases (GHGs). The most common GHG emitted from the mobile sources in Egypt are carbon dioxide (CO_2). Its share ranges between 25-30% of total country GHG emissions. Other minor GHGs species such as nitrous oxide (N_2O) and methane (CH_4) are also emitted from transport. Moreover transport is the main source of important air pollutants, such as nitrogen oxides (NOx) carbon monoxide (CO), sulphur oxides (SOx), and non-methane hydrocarbons (NMHC). These pollutants can influence the concentration of the GHG through atmospheric chemistry.

II. 3.2.a. Methodological Approach and Data Sources

The IPCC Revised 1996 Guidelines and Good Practice Guidance references and standards are used for performing inventory estimate. For fleets sizes and composition, data are taken from the Ministry of Interior (MOI), the Egyptian National Railways (ENR) and the Ministry of Transport (MOT). Fuel consumption data sources are the Ministry of petroleum (MOP) and the Organization of Energy Planning (OEP). Other sources which assisted in filling data gaps included CAPMAS and the State Information Service (SIS).

There is deficiency in reliable local emission factors data and hence the present calculations relied mainly on data from reliable international sources that takes into account variation in local operating conditions. Suitable data were taken from the following sources:

1. IPCC Revised 1996 Guidelines and Good Practice Guidance
2. Joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook, Third Edition. Copenhagen: European Environment Agency, 2001
3. EDGAR v.2 Data Base, 1995
4. The EDGAR 3.2 Fast Track 2000 dataset (32FT2000)

II. 3.2.b. Road Transport

The road fleet in Egypt consists of various types of vehicles such as cars, taxis, buses and minibuses, trucks, motorcycles, tractors and special purpose vehicles. The number of vehicles registered in Egypt is continuously increasing at a rate much higher the rate of increase of the roads and this causes a sever traffic problems and increased fuel consumption and consequently increased GHG emissions. In recent years (after 2005)the total number of vehicles began to increase at a very high rate (11.8% annual increase rate in the period 2005/2010 compared to 2.2% in the period 2000/2005). This results from high increase rate of private cars and motorcycles. The annual increase rate of private cars jumped from 6.1% in the period 2000/2005 to 12.6% in the period 2005/2010 while the rate of increase of motor cycles jumped from 3.8% to 24.1% for the same periods.

Increase of the number of private cars reduces traffic speeds and increases specific fuel consumption. Low price of Chinese motorcycles and facilitation in terms of payment encouraged workers, technicians and students to buy them instead of using the crowded public transport. Moreover, bicycles which are considered an important non-motorized means of transport with nearly zero GHG emissions were also replaced.

The overall fleet composition is continuously changing. The percentage of private cars increase from 44.5% in 2000 to 49.1% in 2010 while that of motor cycles increased from 16 to 24.3% in the same period. The percentages of the other types of vehicles such as buses and trucks remain constant or slightly decrease. Despite the large number of motor cycles, it has little effect on overall fuel consumption because of their small engines and shorter distances travelled. The main fuel consuming road vehicles are private cars, taxis, trucks and buses. The numbers of buses are increasing at a very small rate. This increase is due to increase in private, tour, tourism and school buses while public buses increase at very small rate (3.5% compared to 12.6%, 11.8%, and 12.1% for travel, tourism and school buses).

Road vehicles capacity and age are important indicators of fuel consumption and emissions. Capacity of cars is represented by engine displacement, for trucks by pay load and for buses by number of passengers. Vehicle age is represented by model year or km travelled. So the road fleet has been further analyzed according to age and capacity. Data from traffic departments for major governorates as well as published sales rates have been used in this analysis. In 2005 higher percentages of taxis, buses and truck are more than 15 years old. However, most of the old private cars and taxis are low efficiency Fait vehicles. The percentage of old private cars is being gradually reduced because of the high purchase rate of more efficient modern vehicles. For taxis, the scrapping rate is very low because of the traffic regulations that restricted registration of new taxis in greater Cairo area but now a scrapping program is applied and supported by the Ministry of Environment to replace old taxis with by-fuel (gasoline and natural gas) new vehicle. In the first phase about 35000 taxis have been replaced. It should be noted here that the number of taxis includes shared taxis which are minibuses of 8 passengers operated by individuals and private sector. These represent problem as a considerable percentage of them are old, poorly maintained and of high fuel consumption. Their number is expected to increase to fill the gap between growing passenger trip demand and limited public transport supply.

II. 3.2.c Rail Transport

Egypt was the first country in the region to use a railway transport system. The Egyptian railway system witnessed a slow rate of growth of the route but the track length increased sharply in the nineties due to using double track in Cairo Aswan line. The number of working locomotives increased in the period 1990-2000 and started to decrease again and this may be due to lack of maintenance and availability of spare parts replacement funds. The number of working freight wagons shows similar trends but the number of passenger coaches slightly increased. A study made by the World Bank and Egyptian government for restructuring Egyptian's railways showed that the motive power and rolling stock fleet is aging. In locomotives, only 146 are less than 20 years old. Availability of locomotive is below standard (about 70–73 percent against a target of 85 percent). Similarly, part of the passenger coach fleet has reached the end of its economic life while freight wagons are older. Some rolling stock maintenance facilities are old and lack adequate equipment. Only 180–200 kilometers of track is renewed annually, an amount that might be insufficient on a heavily used network. The rail transport comes directly after road in passenger transport but its importance as a means of freight transport is diminishing.

II. 3.2.c. Water Transport

The water transport in Egypt is an important sector as it constitutes a large number of vessels working between large number of ports either on sea shores or on river banks. Table 11 shows the number of both sea ports and river ports in Egypt as well as the total berths length and land and water areas of commercial ports. The sea port handled a large number of different ships of different types and different nationalities. The number of vessels registered in the Egyptian ports in 2006 is about 19416 with 13306vessels registered in the territorial waters and 6110 registered in the international waters. These vessels vary in capacity.

This activity involves development of international trade volume through Egyptian ports as well as the share of the national sea commercial fleet. The increasing activity volume in Egyptian ports has an impact on Egypt ‘share in the international marine bunker fuel market. Egyptian ports achieved positive growth to the volume of cargo throughput during 2006-2010. In 2010 Egyptian ports handled about 135.4 million tons compared to 106.6 million tons in 2006 representing a growth rate up to 27%: As for containers handling Egyptian ports, it achieved positive growth rates as related to the number of TEUs handled in 2006- 2010. In 2010 Egyptian ports handled about 6.7 million TEUs compared to 4.6 million TEUs in 2006 recording a growth rate up to 46.6%.

II. 3.2.d. Civil Aviation Fleet

The Egyptian civil aviation fleet belongs mostly to the national public company, Egypt Air. Egypt Air fleet in 2005 consisted of 38 planes of different seating capacities in addition to three cargo planes. The company offers more than 400 flights a week to more than 60 international and national destinations. Also, there are 9 private companies with a total of 19 different types of planes. Egypt Air was responsible in 2004 for 19 per cent of total international schedule and non-scheduled passenger traffic through Cairo and the main Egyptian international airports, and for approximately 61 per cent of total domestic (scheduled and non-scheduled) passenger traffic. Egypt Air fleet can be considered as medium age fleet.

However, the composition of Egypt Air fleet is continuously changing in number and type of planes. In 2003, the number increased to 62 with an average age of 9.5 years. The fleet composition also changed where the number of Boeing 737 increased from 6 in 2005 to 24 in 2014 used mostly in domestic flights while the number of Boeing 777 increased from 5 to 9 in the same period and they are mostly used in international flights. The number of air ports increased from 15 airports in 1995 to 70 in 2005 paved air ports in addition to a number of 17 non-paved and heliports. There are nine airports of these through which most air traffic takes place.

Although Egypt has more than 70 airports with paved runways almost all passengers are carried through 20 airports. Eight of these deal with about 95% of the total traffic while the remaining airports deal with about 5% of the total traffic, see However, because most aircraft landing in small airports are small aircrafts, the corresponding number of flights to small airports represents about 10% of the total number of flights.

II. 3.2.e. Fuel Consumption and GHG Emissions from Transport Sector

Transport sector consumes different types of fuels such as gasoline, jet fuel, gasoil, heavy fuel oil and natural gas in addition to other types of petroleum products such as lubrication oils etc. Data from the Organization of Energy Planning (OEP) and the Egyptian General Petroleum Corporation (EGPC) shows fuel consumption is continuously increasing as shown in table (II.11)and figure(II.15). During the period 1990/2000 the average annual rate of increase of the fuel consumption of the transport sector was 4.4% and dropped to 3.1% in the period 2000/2004 but started to increase again to reach 7.2 in 2004/2006. This could be attributed to the increase in gasoline affected by increase in the number of cars motor cycles and three-wheelers. Figure II.16 shows the development of transport sector of different types of fuel and it is clear the gas oil/diesel fuel and gas oil represent the large share in the total transport fuel.

Table (II.11): Development of fuel consumption in transport sector, thousands tons

Year	Fuel Consumption Thousand tons						
	Gas oil/ Diesel Fuel	Gasoline	Jet Kerosene	Natural Gas	Residual Fuel Oil	Total Fuel (toe)	Lubricant
1990	2896	2139	452	0	153	6085.34	79
1997	3731	2024	416	0	705	7346.75	246
1998	4074	2155	408	0	847	7986.22	268
1999	4917	2205	418	0	738	8844.92	297
2000	5375	2200	457	80	646	9369.44	311
2001	5454	2226	420	100	787	9601.43	319
2002	5664	2266	403	150	800	9919.13	327
2003	5769	2348	422	189	820	10204.91	465
2004	5874	2516	451	198	846	10568.91	347
2005	6139	2739	456	208	1278	11533.81	380
2006	6403	3043	422	228	1287	12144.59	400

Source: OEP and EGPC

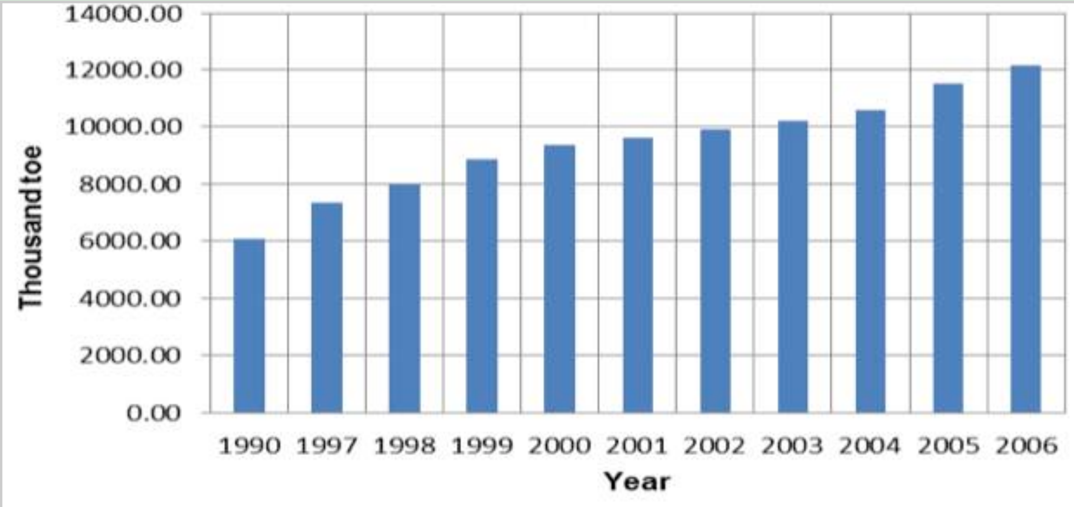


Figure (II.15): Development of transport fuel consumption in toe

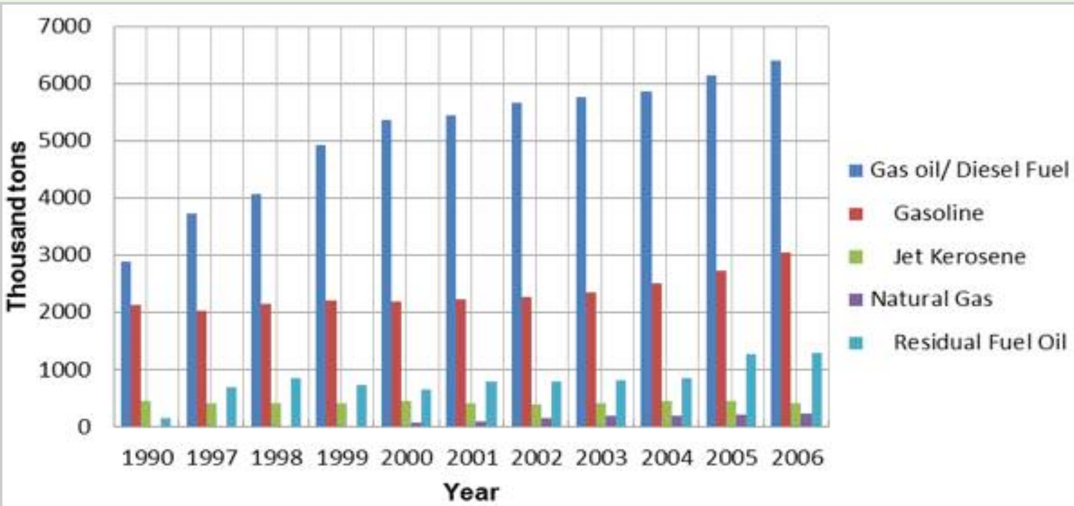


Figure (II.16): Development of transport consumption of different types of fuels

The distribution of fuel consumption among different transport modes shows that Road transport consumes the largest share of total fuel in this sector as shown in table (II.12). It should be mentioned here that this fuel consumption includes fuel consumed by national ships and planes engaged in international trips. This will be taken into consideration in the present calculations. It should be noted also that non-road transport consumes a considerable amount of fuel.

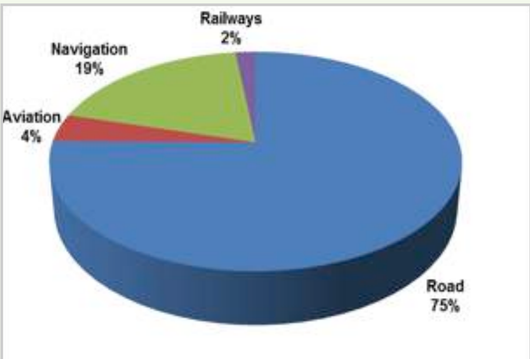
Table (II.12): Fuel consumption in transport sector (thousand tons), 2005/2006

Fuel type	Road Transport	Railways	Aviation	Navigation	Agricultural Tractors and Machinery [1]	Non-road
Gasoline	2740					
Gasoil/diesel	5125.7	193		819.7	889	2240
Kerosene		4.6	422			
Heavy fuel oil				1278		
Other products[2]	323	20		20	28	12

(1) Includes construction and other non-road machinery

(2) Include lubricating oils, greases and asphalts

Source: The Egyptian General Petroleum Corporation



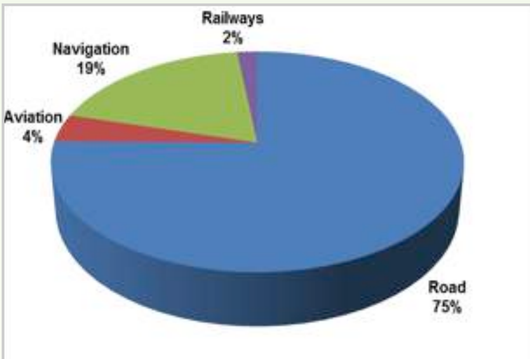


Figure (II.17): Fuel consumption of different transport modes in 2005;(a) without tractors and non-road, (b) with tractors and non- road.

The calculated CO_2 emissions using reference approach method for transport and bunker fuels is shown in figure (II.18). It follows the same trends of total fuel consumption discussed above. Table (II.13) shows the annual GHG emissions from the transport sector from 2000 to 2006.

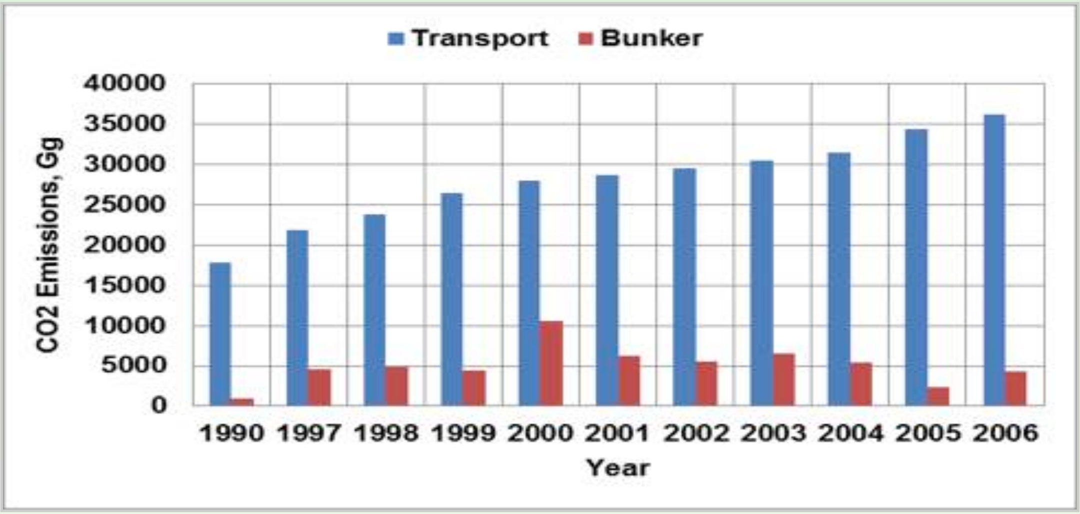


Figure (II.18) Development of CO2 emissions from transport and bunker fuel combustion using reference approach

Table (II.13): Annual GHG emissions from transport sector, Gg

Year	CO_2	CH_4	N_2O
2000	26532.14	3.455	0.229
2001	27086.57	3.571	0.232
2002	28037.98	3.771	0.239
2003	28826.13	3.962	0.245
2004	29880.89	4.162	0.254
2005	32335.24	4.5296	0.278
2006	34216.4	4.906	0.290

The emissions of non CO_2 GHG from transport have negligible value even if the equivalent CO_2 greenhouse effect for CH_4(21) and N_2O(310) are considered. The contribution for both gases is less than 0.3%.

Considering the transport mode, the calculations shows that road transport is the main emitter of GHG as shown in Figure (II.19).

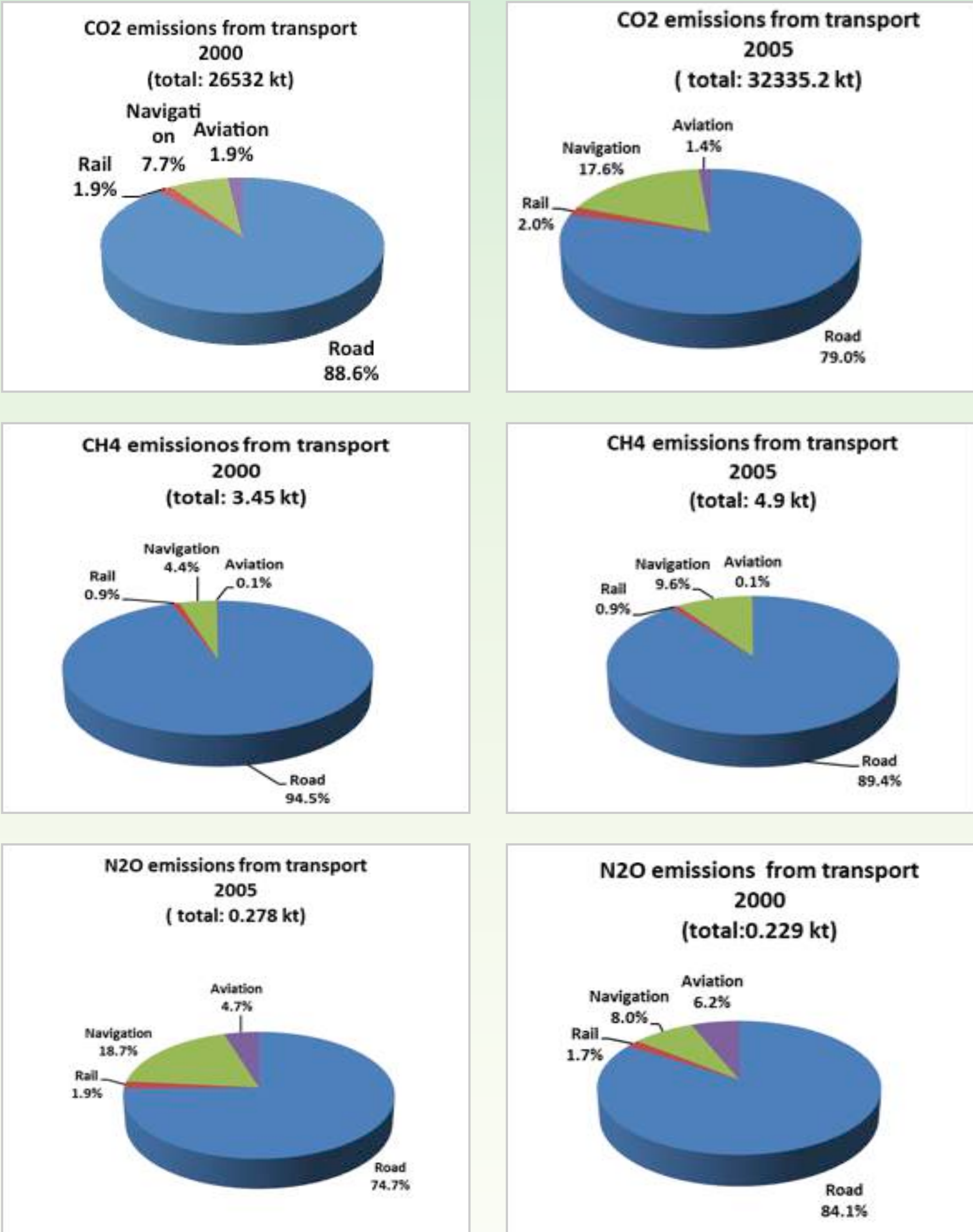


Figure (II.19): GHG emissions from different modes of transport in years 2000 & 2005

The transport sector is responsible for large portion of gaseous pollutants emissions such as nitrogen oxides (NOx), carbon monoxide (CO) non methane organic compounds (NMOC) and sulphur dioxide (SO_2) as shown in table (II.14) and figure (II.20).

Table (II.14): Pollutants emissions from transport sector, Gg

Year	CO	NOx	NMOC	SO_2
2000	1049.48	294.32	199.97	86.72
2001	1068.40	313.51	203.52	99.30
2002	1093.27	325.14	208.15	101.79
2003	1128.97	330.47	214.78	103.71
2004	1194.65	338.00	227.16	106.26
2005	1304.01	399.42	248.00	146.45
2006	1424.74	414.72	270.68	147.54

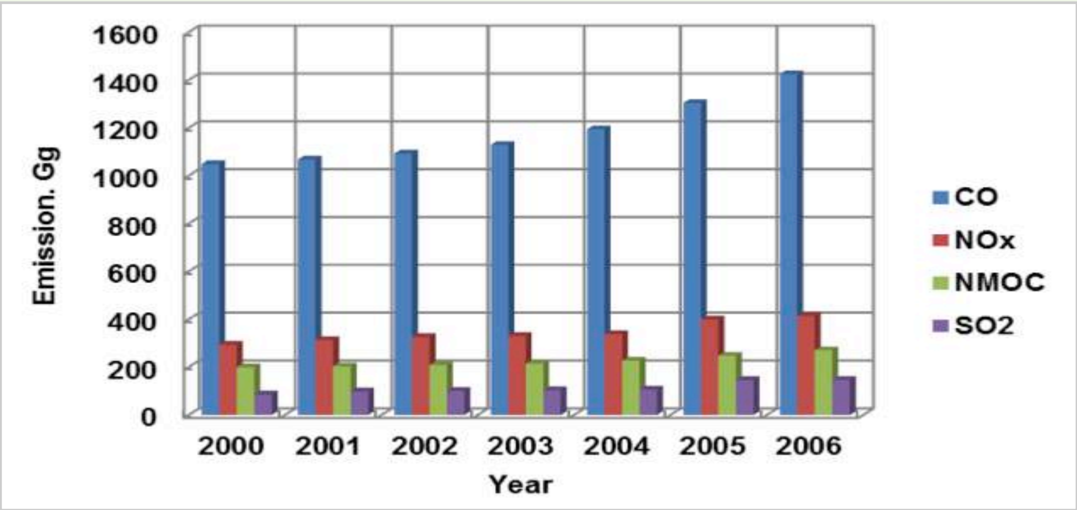
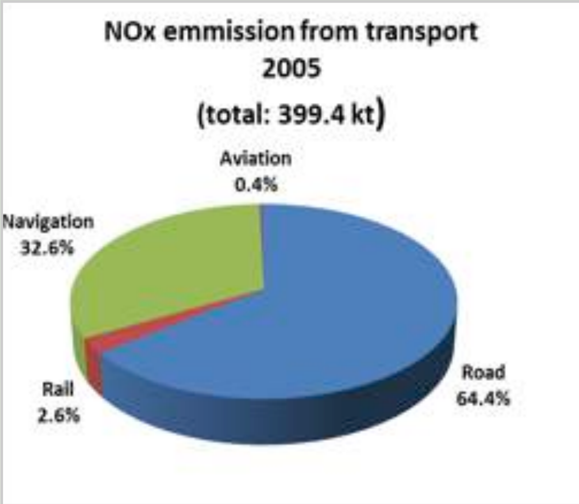
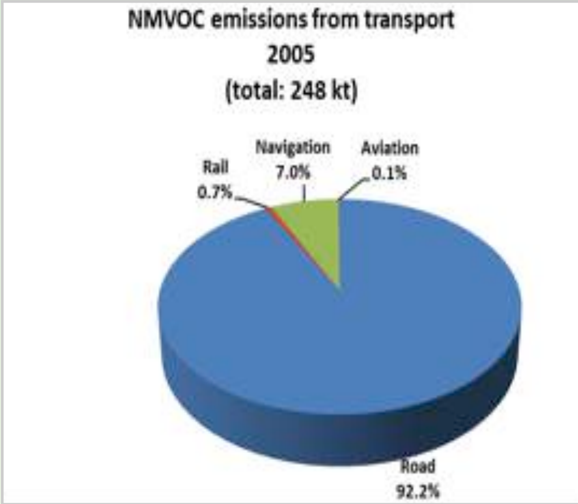


Figure (II.20): Development of pollutants emissions from transport sector

Considering different transport modes road transport emits most CO and NMOC and large portion of NOx. Navigation emits considerable amount of NOx (15-30%) depending its share in total fuel consumption that vary from one year to another.





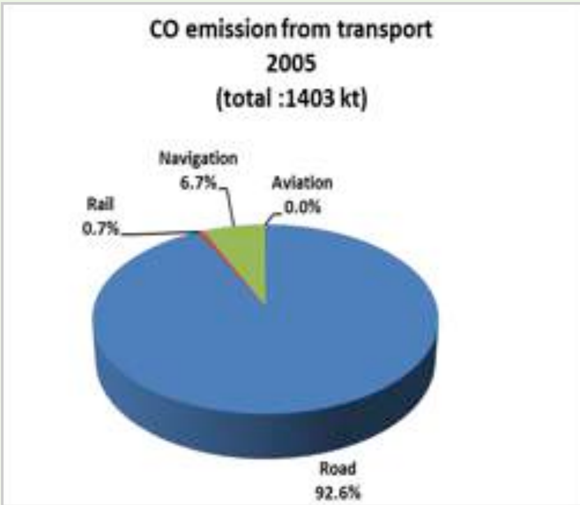


Figure (II.21): Emission of gaseous pollutants from different transport modes in 2005

SO_2 emissions depend totally on the sulphur content of fuel. Natural gas and light petroleum products such as gasoline and kerosene have low sulphur content while heavy fuel such as residual fuels have high sulphur content.As a result navigation that uses heavy fuel is responsible of most SO_2 emissions, see Figure (II.22).

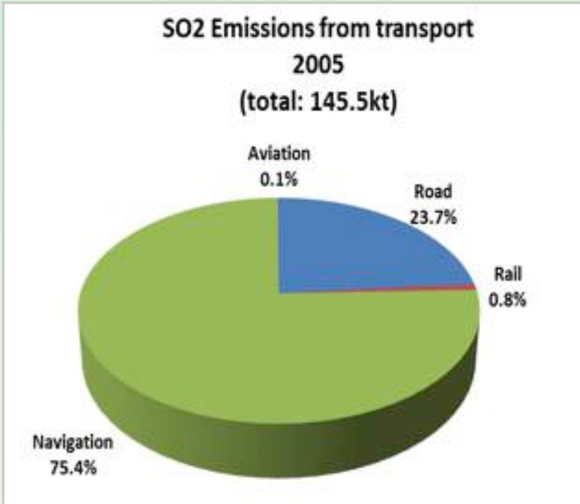


Figure (II.22): SO2 emissions from different modes in 2005

For aviation, figure (II.23) show that GHG emissions of aviation transport is mostly CO_2 with negligible amount of CH_4 and N_2O. The result show no general trend as this type of transport is very sensitive to global economic crises and also local stability of the country, especially for countries where aviation transport is used mainly by tourists.

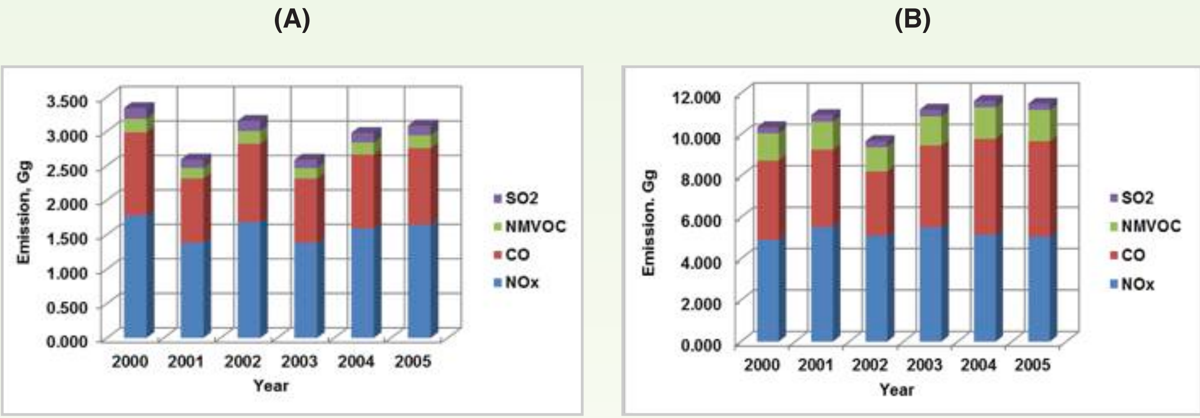


Figure (II.23): Development of pollutants emissions from aviation transport (2000-2005)
(a) Domestic Aviation and (b) International Aviation

The air pollutants emitted by aviation transport are mainly carbon monoxide and nitrogen oxides with small amounts of non-methane hydrocarbons and sulphur oxides. Emissions are mainly during take-off where the engine works at full power and at higher fuel to air ratio.

II. 3. 3. The Industry Sector

Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines) is the main source of methodology for the present work. The 1996 IPCC Guidelines and the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (GPG2000) are also considered. Good practice guidance is provided for major emissions source categories – including: Cement production, lime production, iron and steel industry, adipic acid and nitric acid production, aluminum production, magnesium production, sulfur hexafluoride (SF6) emissions from electrical equipment, and from other sources, per fluorocarbons (PFC), hydro fluorocarbons (HFC) and SF6 emissions from semiconductor manufacturing, emissions of substitutes for ozone depleting substances (ODS substitutes) including seven sub-source categories, and HCFC-22 manufacture.

The "2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3, Industrial Processes, and Product Use" will be considered. The improvements are depicted in the Annex 3: Improvements since 1996 of the 2006 IPCC, which will be highly considered.

All the IPCC Guidelines for GHG inventory emitted from the Industrial processes require data related to production, technology and raw materials introduced into the process. According to the available quality of data processed, accuracy and uncertainty, they are divided into Tier1, Tier2 and Tier3. Tier 1 methodologies employ IPCC default GHG Emission Factors. Higher Tier methods as Tier 2 and Tier 3 are considered whenever the required information is available.

II. 3. 3. a. Methodological Approach and Data Sources

The "Industrial Development Authority (IDA)" was depended onto for supplying the factory license data including the production capacity, raw material and date of license issuance. The "Ozone Layer Protection Unit/EEAA" is the main information source for the concerned ODS substitutes in Egypt. Moreover, by analyzing data obtained from the "Industrial Development Authority (IDA)" and the "Ozone Layer Protection Unit/EEAA", data gaps were identified leading to the next step.

The actual data sources are the Holding Companies and the Companies working in the targeted industries. But, to get correct information for the GHG inventory, specific awareness about the required specific information need to be developed. This was accomplished through two steps:

First, well design of log sheets for the specific companies containing specific questionnaire.

Second, by identification of data gaps, actual visits were held for specified companies for specific jobs to fulfill the gaps.

According to the "1996 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories", Chapter 3, "Industrial Processes", the Main sources of GHG emissions in the industrial processes are:

- Cement industry
- Limestone and Dolomite production and use
- Iron and steel industry

- Nitrous Oxide (N2O) production for nitric acid and fertilizers production
- Carbon Fluorides from Aluminum smelting
- Sulfur Fluorides due to Magnesium production
- Emissions Related to Consumption of Halocarbons (HFCs , PFCs) and Sulfur Hexafluoride (SF 6) as alternative of Ozone depletion materials

II. 3. 2. b. Industrial GHG Emissions by Gas Type and Sources

Tables (II.15) to (II.18) depict the emissions by gas, while the concerned industry is considered.

Table (II.15): Emissions of carbon dioxide (CO2) from Industry, 2005

Item	Industrial Source	Carbon Dioxide, tons/year	CO_2 Equivalent, tons/year
1	Cement production	16,716,754	16,716,754
2	Lime production	202,844	202,844
3	Iron and steel industry	1,576,175	1,576,175
4	Ammonia not used in Urea	1,924,848	1,924,848
Total CO_2 from Industry		**20,420,621**	**20,420,621**

Table (II.16): Emissions of nitrous oxide (N2O) from Industry, 2005

Item	Industrial Source	Nitrous Oxide, tons/year	CO_2 Equivalent, tons/year
1	Nitric acid production	16,266	5,042,460
Total N_2O emissions from Industry =		16,266	
Total CO_2 equivalent =			**5,042,460**

Table (II.17): PFC's Emissions from aluminum production, 2005

Item	Industrial Source	Type of Emissions	Emissions, ton/year	100 years GWP	CO_2e, tons
1	Aluminum production	CF_4	145	6500	942,500
		C_2F_6	15	9200	138,000
Total CO_2 equivalent emissions in tons/year					1,080,500

Table (II.18):Emissions due to Ozone Depleting Substances (ODS Substitutes) not including refrigeration and air conditioning applications, 2005

Type of Emission	Emissions, ton/year	100 years GWP	CO_2 Equivalent, tons/year
Halons, (almost Halon-1301)	22.31	7140.0	159293.4
Halon-1211			
Halon-1301			
Halon-2402			
Carbon tetrachloride CTC	5	1400.0	7,000
Methyl chloroform	150.00	146.0	21,900
Methyl bromide	314.00	5.0	1,570
CFC's Chloroflourocarbons (almost R12)	821.20	10900	8,951,080
HCFC's Hydrochloroflourocarbons (almost R22)	3470.00	1810	6,280,700
Total, tons =	4783		
Total CO_2e, tons =			15,421,543

Table (II.19):Emissions due to Ozone Depleting Substances (ODS Substitutes) for Refrigeration and Air Conditioning applications, 2005

Item	Species	Chemical Formula	Imported amount, ton/ year	GWP	CO_2 Equivalent, tons/year
1	R-23	HFC-23	0.145	11,700	1,697
2	R-32	HFC-32	4.02	650	2,613
3	R-134a	HFC-143a	0.572	3,800	2,174
4	R-407	Blend of R 32, R125 and R 134a	3.39	1,526	5,171
5	R-408	Blend of R22 and R125, R 134a	0.817	794	649
6	R-410	Blend of R32, R125	18.935	2,050	38,817
Total CO_2 Equivalent Emissions, tons/year =					**51,120**

As for the total amount of GHG emissions from all surveyed industrial sectors emissions in 2005, they are shown in table (II.20). They are also presented by gas type and sector in tables (II.21) and (II.22) respectively and figures (II.24) and (II.25).

Table (II.20): GHG emissions from surveyed industrial sectors emissions, 2005

Sector, (GHG Gas)	CO_2 Equivalent, thousand tons/year
Cement, (CO_2)	16,717
Ozone Depleting Susbstances, (ODS Substitutes, HFC's & PFC's)	15,473
Nitric Acid Production, (N_2O)	5,042
Ammonia not used in Urea, (CO_2)	1,925
Iron and steel, (CO_2)	1,576
Aluminum Production, (PFC's)	1,077
Lime, (CO_2)	203
Semi-Conductors Production, (SF_6)	0.00
Magnesium Production, (SF_6)	0.00
CH_4, No reported Industry	0.00
TotalCO$_2$ Equivalent, thousand tons/year	**42,013**

Table (II.21): GHG emissions by gas due to industrial processes in Egypt, 2005

GHG Gas type	CO_2 Equivalent, thousand tons/year
CO_2, (Cement, Ammonia not used in Urea, Iron and steel, Lime)	20,421
ODS Substitutes, HFC's & PFC's, (Ozone Depleting Susbstances)	15,473
N_2O, (Nitric Acid Production)	5,042
PFC's, (Aluminum Production)	1,077
SF_6, (Semi-Conductors Production, Magnesium Production)	0
CH_4, No reported Industry	0
Total CO_2 Equivalent, thousand tons/year	**42,013**

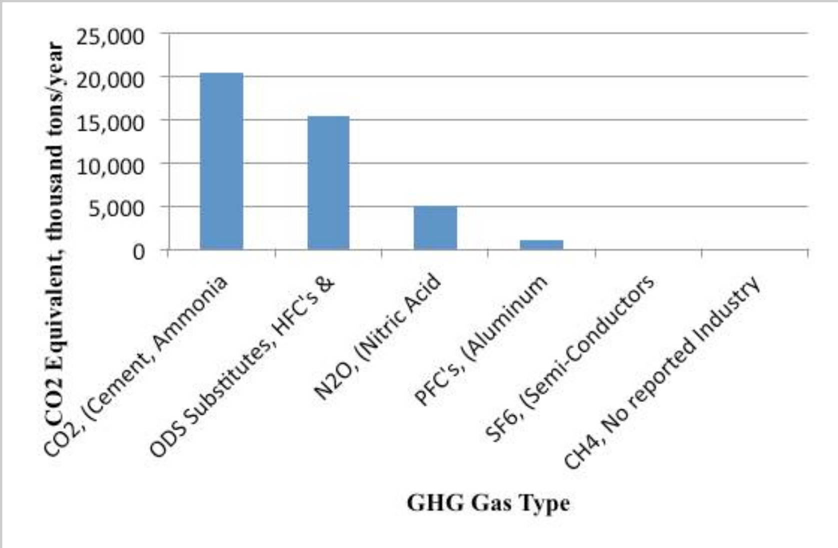


Figure (II.24): GHG emissions by gas from industrial sector, 2005

Table (II.22): GHG emissions by sector in descending order of industrial sectors emissions, 2005

Sector	CO_2 Equivalent, thousand tons/year
Cement (CO_2)	16,717
Ozone Depleting Susbstances (ODS Substitutes, HFC's & PFC's)	15,473
Nitric Acid Production (N_2O)	5,042
Ammonia not used in Urea (CO_2)	1,925
Iron and steel (CO_2)	1,576
Aluminum Production (PFC's)	1,077
Lime (CO_2)	203
Semi-Conductors Production (SF_6)	0
Magnesium Production (SF_6)	0
CH_4, No reported Industry	0
Total CO_2 Equivalent, thousand tons/year	**42,013**

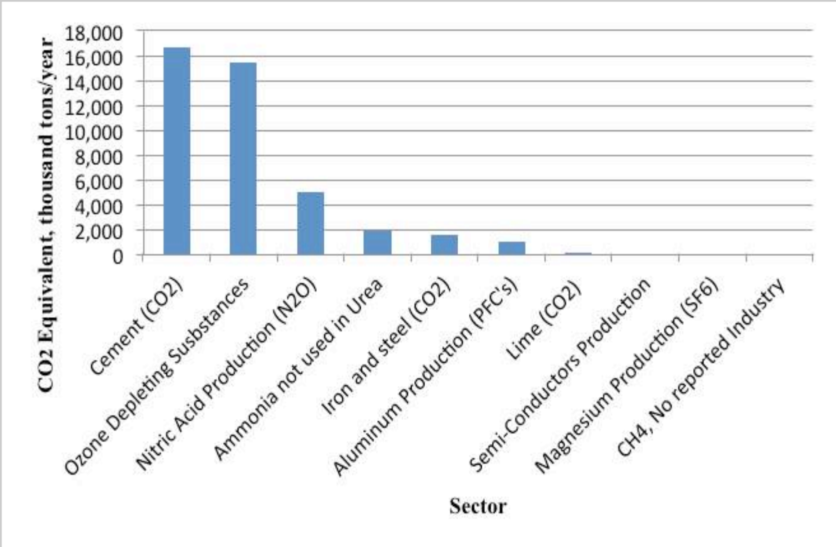


Figure (II.25): GHG emissions by sector in descending order of industrial sectors emissions, 2005

II.3.4. Agriculture Sector

In Egypt, agricultural activities contribute directly to the emissions of greenhouse gases through various processes. The following sources have been identified to make a more complete breakdown in the emission calculation:

1. Enteric fermentation of livestock;
2. Manure management;
3. Rice cultivation;
4. Agricultural soils; and
5. Field burning of agricultural residue.

The processes and activities of the agriculture are the main sources of CH_4 and N_2O. However, the field burning of agricultural residues is the source of CH_4, N_2O, CO and NO_X. There are no ecosystems in Egypt that could be considered as natural savannas; consequently, no greenhouse gas emissions exist for this subcategory. In the last submissions of Egypt of Initial National Communication (INC 1999), and Second National Communication (SNC 2010) the most important GHG in the agriculture sector was methane (CH_4) followed by nitrous oxide (N_2O) in the INC. However, in the SNC, the most important GHG was nitrous oxide (N_2O). For the current submission (Third National Communication, TNC) the base year is 2005 and the period of 1999-2012 is the estimated period of the GHG emission from agriculture sector.

II.3.4.a Methodological Approach and Data Sources

The default methodology of IPCC revised guidelines of 1996 and IPCC good practice guidance of year 2000 has been used to calculate the methane emission from ***enteric fermentation***. Tier 1 (simplified method) has been used as well as default EF specific for the animal type, the climate zone (warm), geographic region (Africa and Middle East) and the degree of the region development (Developing Countries). Tier 2 method was not applied because accurate activity data was not available.

IPCC methodology of IPCC revised guidelines of 1996 and IPCC good practice guidance 2000 has been used to calculate the CH_4 and N_2O emissions from ***manure management***. Default EFs specific for the animal type, the climate zone (warm), geographic region (Middle East) and the degree of the region development (Developing Countries) were applied to estimate CH_4 emissions. As well as default IPCC values of nitrogen excretion per head of animal (Nex_T) [kg/animal/yr] for near east & Mediterranean, and IPCC default N_2O EFs from animal waste management systems (AWMS) were applied to estimate N_2O emissions. Percentages of AWMS in Egypt were estimated according to experts' judgment, for dairy and non-dairy cattle, buffalos, sheep, and goats groups. According to experts, solid storage and drylot, pasture range and paddock (grazing), burning as fuel were the main manure management systems applied under Egyptian conditions. Solid storage and drylot system represent 67% of total manure management systems of cattle and buffalo categories. N_2O from solid storage and drylot was reported under manure management, whereas, pasture range and paddock and manure used for fuel were excluded from manure management calculations. Pasture range and paddock were reported under direct soil emissions of N_2O from animal production, and the used manure for fuel was reported in Energy section (IPCC, 1996).

Default methodology of IPCC revised guidelines of 1996 and IPCC good practice guidance of 2000 has been used to calculate the CH_4 emissions from ***rice cultivation***. According to the available data that published in Sass et al, 1993 the climatic conditions of rice cultivated area in Egypt is more or less similar to the presented in Texas. In addition to both soils are clayey in texture. Therefore, default IPCC average EF specific for USA (Texas) of fully irrigated rice and continuously flooded rice (25 g CH_4/ m^2 season) was applied to estimate CH_4 emissions. Regarding to cultivation period, IPCC EF was calculated to monthly values to estimate the EF of the early cultivars.

As for ***agricultural soil*** and based on the IPCC methodology, three sources of N_2O emissions are distinguished in GHGs inventory. They entail direct emissions of N_2O from agricultural soils, direct emissions of N_2O from animal production, and indirect emissions of N_2O from agricultural activities. Direct emissions of N_2O from agricultural soils include total amounts of nitrogen added to soils through cropping practices such as the application of synthetic fertilizer, nitrogen from animal waste, production of nitrogen–fixing crops, and nitrogen from crop residue mineralization. Total nitrogen excretion from manure management was used to calculate manure nitrogen used as fertilizer. Calculation of N_2O emissions from soil nitrogen mineralization due to cultivation of histosols (soil with very high organic matter and having special emission factors) is not considered here, as it does not exist in Egypt. Estimates of N_2O emissions from animals were based on animal waste deposited directly on soils by animals in pasture, range and paddock. Calculations of indirect N_2O emissions from agricultural soil are based on the volatilization and subsequent atmospheric deposition of NH_3 and NOx originating from the application of fertilizers and animal manure, as well as leaching and runoff of the nitrogen that is applied to or deposited on soils.

Default methodology of IPCC revised guidelines of 1996 has been used to calculate emissions from ***field residuals burning***. Country specific crops data on ratios of residue to crop production, fraction of residue burned, dry matter content of residue and carbon and nitrogen contents of residue were used.

II.3.4.b Total GHG Emission for Agriculture Sector

Figure (II.26) presents the total emissions (in CO_2 equivalent) of the five sources of GHGs in agriculture sector. Agricultural soil is the main source of GHGs emissions from agriculture sector by contribution of 50.75% in 2005 and 49.36% for average period of 1999-2012. However, in the last submission (SNC) it was 32.24% of total agricultural emissions. Manure management was the second important source by contribution of 10% in 2005 and 19.46 for the average period of 1999-2012 which are lower than the SNC which was 28.99%. This was followed by enteric fermentation by a contribution of 22.8% in 2005 and 19.89%, for the average period of 1999-2012, as compared to the SNC which was 25.48%. Then, rice cultivation by contribution of 11.73% in 2005 and 9.46%, for the average period of 1999-2012. However, in the last submission (SNC) it was 7.82%. Then finally, the field burning of agricultural residue contributed by 4.43% in 2005 and 3.49 for the average period of 1999-2012 as compare to 5.47%. The same results are illustrated in Table (II.23) for year 2005 and Table (II.24) for the average period of 1999-2012.

In the current submission of year 2005, the most important GHG in the agriculture sector is nitrous oxide (N_2O) contributing by 65.32% of the sector expressed in CO_2 equivalent, followed by CH_4. However, in last submission of the SNC it was accounting to 75.4 %, of the sector, that is because of increasing consumption amount of N fertilizers. Total GHG emissions from the Sector in 2005 amounted to 39,446.39 Gg CO_2 equivalent.

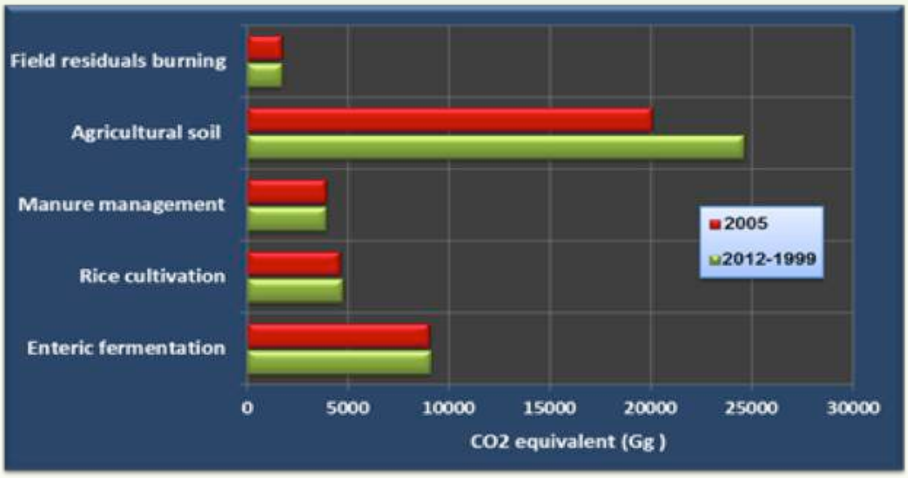


Figure (II.26): Total GHGs emissions of the five key sources of GHGs in agricultural sector for the average period of 1999-2012 and year 2005

Table (II.23): Total GHGs emissions from agricultural sector in Egypt, 2005

GHG source and sink categories	CO_2	CH_4	N_2O	Total
	CO_2 equivalent (Gg)			
Total Agriculture	-	15,797.99	23,648.4	39,446.39
Enteric Fermentation	-	9,063.29	-	9,063.29
Manure Management	-	639.72	3333.75	3,973.48
Rice Cultivation	-	4,636.55	-	4,636.55
Agricultural Soils	-	NE	20,021.96	20,021.96
Field Burning of Agricultural Residues	-	1,458.43	292.69	1,751.12

Table (II.24): Total GHGs emissions from agricultural sector in Egypt for the average periods of 1999-2012

GHG source and sink categories	CO_2	CH_4	N_2O	Total
	CO_2 equivalent (Gg)			
Agriculture	-	15,850.1	34,003.9	49,854.00
Enteric Fermentation	-	9,088.74	-	9,088.74
Manure Management	-	615.55	3,304.91	3,792.047
Rice Cultivation	-	4,714.84	-	4,714.84
Agricultural Soils	-	NE	24,608.66	24,608.66
Agricultural Residues	-	1,458.43	308.52	1,739.51

II.3.4.c GHG Emissions from Enteric Fermentation

Methane is a direct product of animal metabolism generated during the digestion process. The greatest producers of methane are ruminants (cattle, buffalo and sheep). The amount of the produced and excreted methane depends on the animal digestive system and the amount and type of the animal feed. The estimations in this inventory include only emissions in farm animals.

Thirteen years average livestock population data for all livestock types were obtained from agricultural statistics of livestock reports of Economic Affairs Sector, Ministry of Agriculture and Land Reclamation, Egypt (MALR, 1999- 2012).

Figure (II.27) presents the average distribution population trend of livestock categories in Egypt from year 1999 to year 2012. Cattle population is categorized to dairy cattle group and non-dairy cattle group.

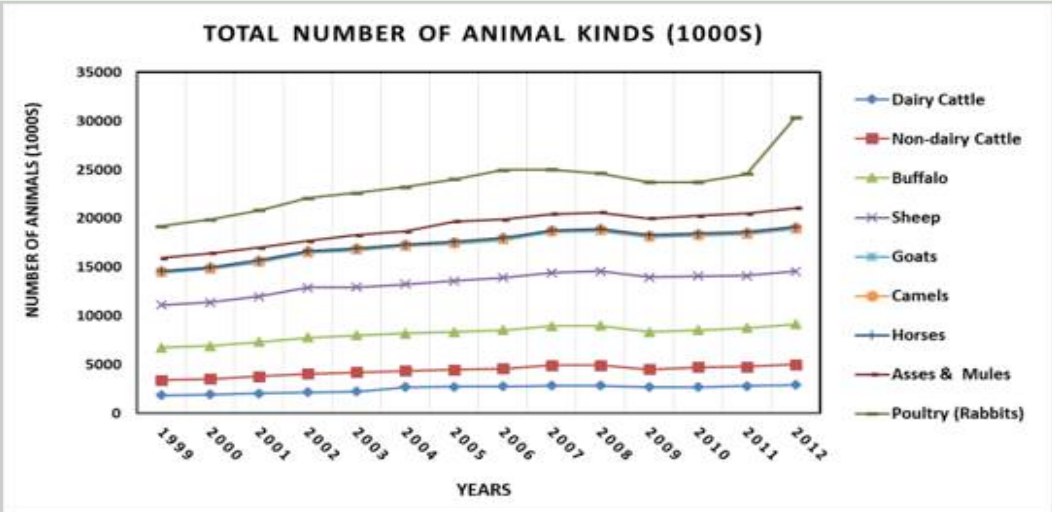


Figure (II.27): Livestock categories population from year 1999 to year 2012

Total emissions of methane from enteric fermentation revealed an increase from 323.4 Gg in year 1990 to 384.8 Gg in year 2000 (15.95 % increase), while it increased to be 394 Gg for year 2005 (22 % increase than 1990). This increase is mainly attributed to the increase in livestock population. Buffalo group was the key source of CH_4 emission from enteric fermentation, by total emission of 213.68 Gg, accounting 48% whereas cattle group was the second key source by total emission of 154.44 Gg. While for average period of 1999-2012, Buffalo group was 209.40 Gg, and for cattle group it is 150.53 Gg. Figure (II.28) illustrates total CH_4 emissions from livestock due to enteric fermentation the period of 1999-2012. Meanwhile, Figure (II.29) shows the total CH_4 emissions from livestock categories due to enteric fermentation for 2005 year.

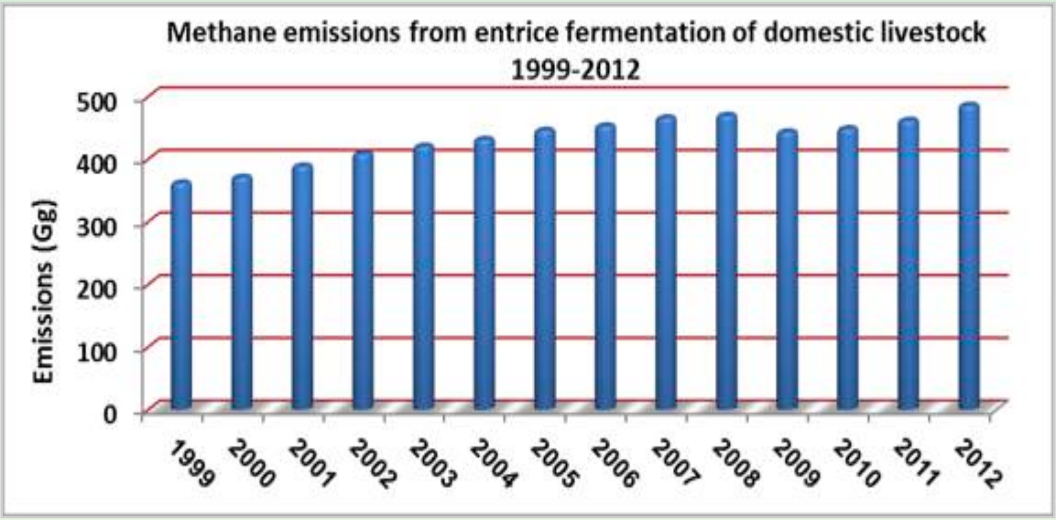


Figure (II.28): Trend in CH4 emissions (Gg) from enteric fermentation, 1999-2012

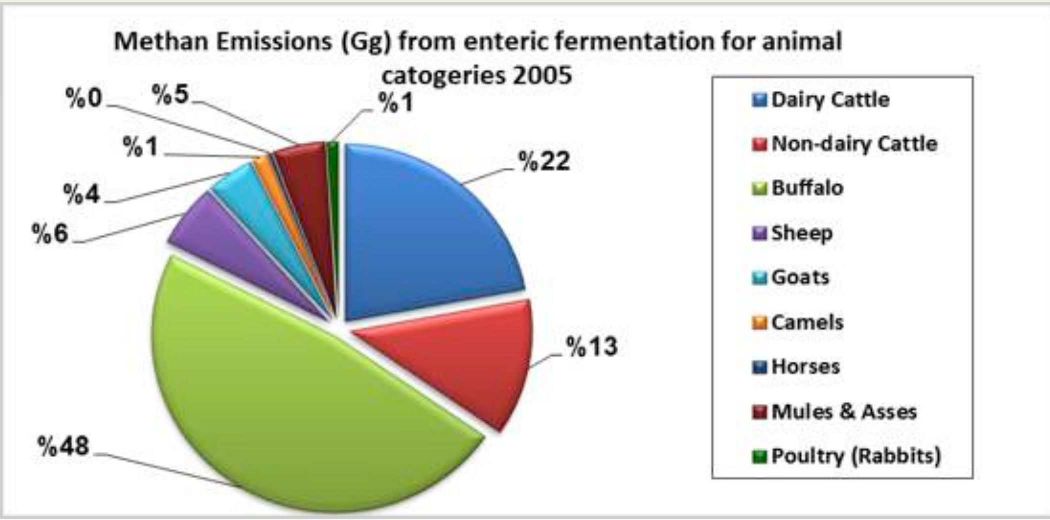


Figure (II.29): Total CH4 emissions (Gg) from livestock categories due to enteric fermentation

II.3.4.d Manure Management

The management of livestock manure produces both methane (CH4) and nitrous oxide (N2O) emissions. In 1999 Egyptian submission, CH4 emissions from manure management were estimated, whereas N2O emissions from the same source were not included. In 2010 submission and the current submission (TNC), both CH4 and N2O emissions from manure management are estimated.

The livestock population data were identical to the data used in estimating emissions from enteric fermentation. Livestock categories of camels, horses, swine, and mules and asses are not included in N2O estimation, because the required accurate activity data was not available.

Total CH4 emissions from manure management increased from 23.23 Gg in 1990 to 27.78 Gg in 2000 submission, by increment percentage of 16.38%, while it increased to be 30.46 Gg for year 2005 (23.74 % increase than 1990). This increase is mainly contributing to the increase in livestock population. Buffalo group was the key source of CH4 emission from manure management, by total emission of 19.43 Gg. While for average period of 1999-2012, buffalo group was 19.03 Gg, and for cattle group it is 7.22 Gg in 2005 and 6.91 Gg for average period of 1999-2012. Figure (II.30) illustrates total CH4 emissions from livestock due to manure management the period of 1999-2012. Figure (II.31) shows the total CH4 emissions from livestock categories due to manure management for 2005 year.

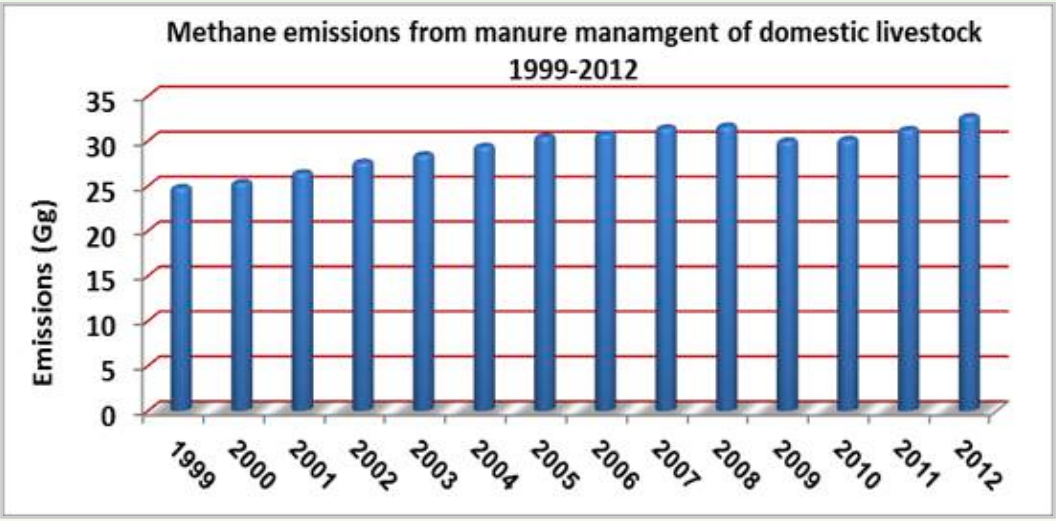


Figure (II.30): Trend in CH4 emissions from domestic livestock 1999-2012

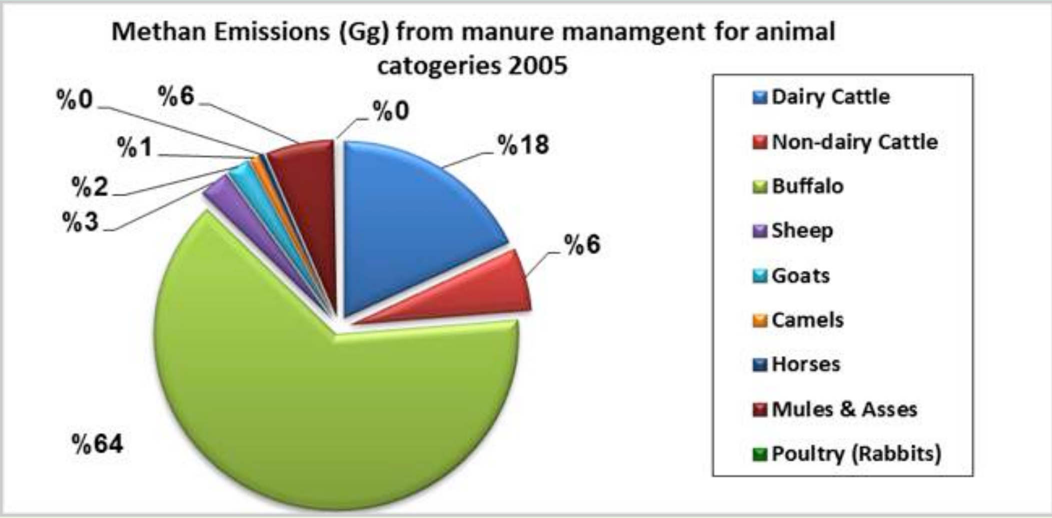


Figure (II.31): Total CH4 emissions from livestock categories due to manure management

II.3.4.d Rice cultivation

Anaerobic decomposition of organic material in flooded rice fields produces methane, which escapes to the atmosphere primarily by transport through the rice plants (IPCC, 1996). However, not all of the methane that is produced is released into the atmosphere. As much as 60 to 80 per cent of the methane produced is oxidized by aerobic methanotrophic bacteria in the soils (Holzapfel-Pschorn et al., 1985; Sass et al., 1990). Some of the methane is also leached to ground water as dissolved methane, and some methane also escapes from the soil via diffusion and bubbling through the floodwaters. The amount emitted CH4 from rice field is influenced according to rice cultivars, growing season length, soil type, air and soil temperature, irrigation management, fertilization program, farm management practices, and drainage practices (IPCC, 1996).

Thirteen years average of rice cultivated area data were obtained from FAOSTAT I © FAO Statistics Division 2014 I. Figure (II.32) shows the change in rice cultivated area from year 1999 to year 2012. In Egypt all rice fields are irrigated by continuous flooding. Moreover, two main types of rice cultivars are cultivated now under Egyptian conditions. The first type is conventional cultivars that stay in field for 3 months. Whereas, early cultivars is the second type that stay in field for 2 months. Switching cultivars was strongly taken place in rice cultivation since 1995.

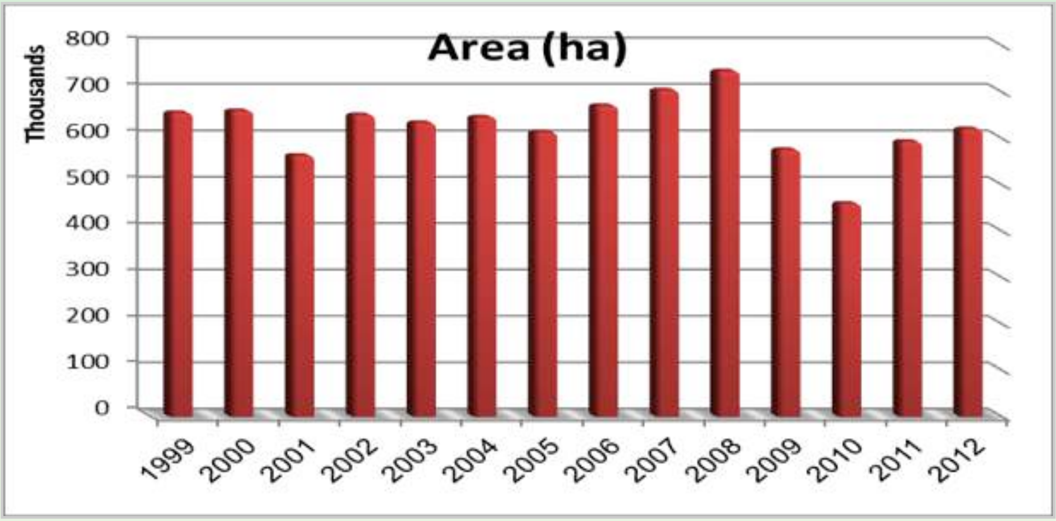


Figure (II.32): Rice cultivated area from year 1999 to year 2012. (FAOSTAT 2014)

Total CH4 emission from rice cultivation is decreased from 235.87 Gg in 1999 to 220.78 Gg in 2005 submission, by a reduction of 6.4%. Meanwhile, it steady decreased to be 223.30 Gg for year 2012 (5.2 % decrease than 1999).This reduction is mainly attributed to the rapid switching of long duration traditional cultivars to early-maturing short-duration cultivars. The conventional cultivars stay about four months under flooding, while the early maturing ones stay only about three months under flooding. Also, because decrease cultivation area of rice during last decade in Egypt.

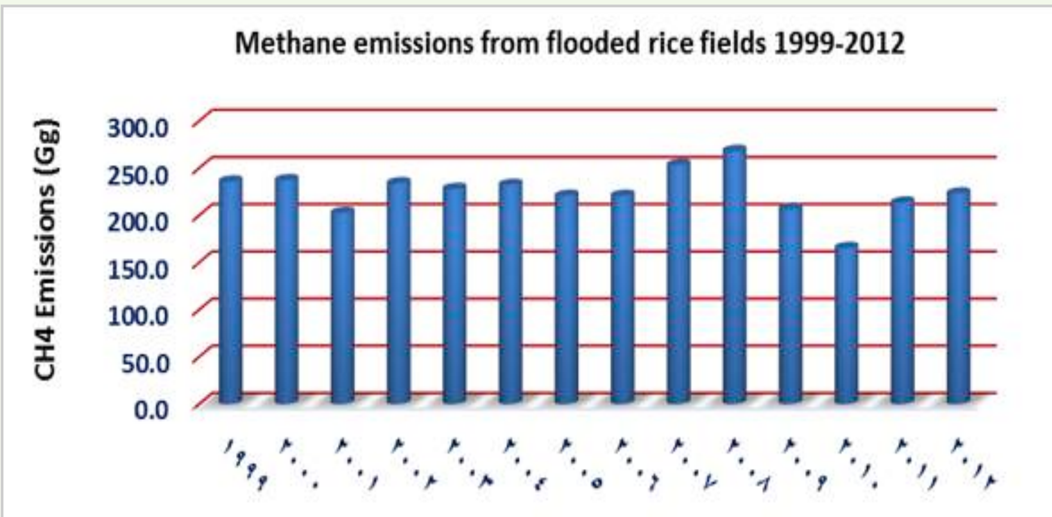


Figure (II.33): Total CH4 emissions from flooded paddy rice

II.3.4.e Agriculture Soil

A number of agricultural activities add nitrogen to soils, thereby increasing the amount of nitrogen available for nitrification and denitrification, and ultimately the amount of N2O emitted. Three sources of N2O emissions are distinguished in methodology:

- Direct emissions of N2O from agricultural soils
- Direct soil emissions of N2O from animal production
- Indirect emissions of N2O conditioned by agricultural activities

Direct emissions N2O from agricultural soils include total amount of nitrogen to soils through cropping practices. These practices include application of synthetic fertilizer, nitrogen from animal waste, production of nitrogen – fixing crops, nitrogen from crop residue mineralization and soil nitrogen mineralization due to cultivation of histosols.

Calculations of indirect N2O emissions from nitrogen used in agriculture are based on two pathways. These are: volatilization and subsequent atmospheric deposition of NH3 and NOx (originating from the application of fertilizers and animal manure), and leaching and runoff of the N that is applied to, or deposited on soils. These two indirect emission pathways are treated separately, although the activity data of synthetic fertilizer and manure applied to soil used are identical.

Total emissions of N2O from agricultural soil revealed an increase from 21.1 Gg in year 1990 to 32.98 Gg in year 2000 (36.03 % increase). While it increased to be 64.59 Gg for year 2005 (196 % increase than 1990). Figures (II.34) and (II.35) show N2O emissions from animal waste management for year periods and animal categories. The average period of 1999-2012, the total emissions of N2O from agricultural soil is 79.38 Gg (Figure II.36). Total N2O direct emissions from agricultural soil were estimated by 31.20 Gg in 2005 submission. The N2O emissions from synthetic fertilizers presented about 87.9% of the total N2O direct emissions from agricultural soil which is attributed to huge amount of N consumption in crop cultivation in Egypt during last few years as shown in table II.25.

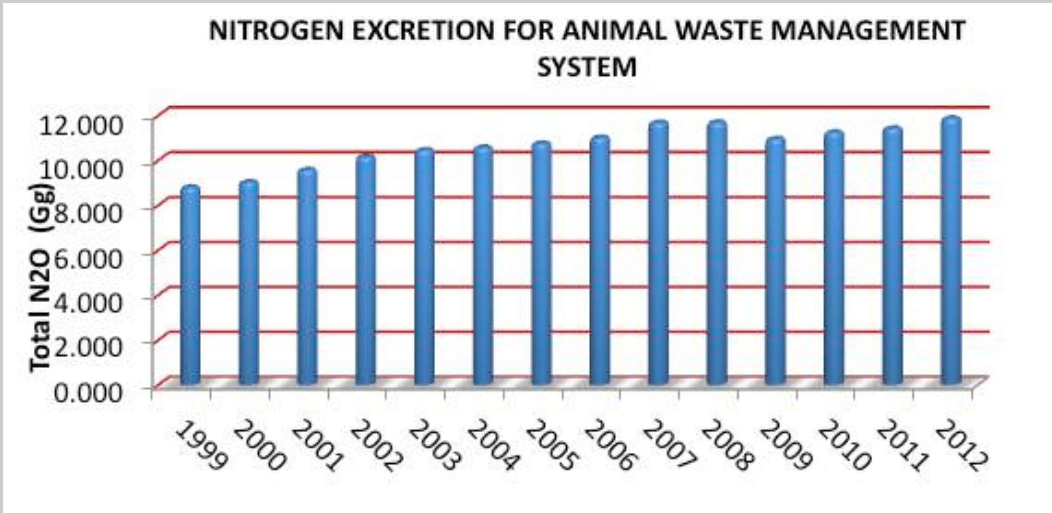


Figure (II.34): Total N_2O emissions from animal waste management for 1999-2012

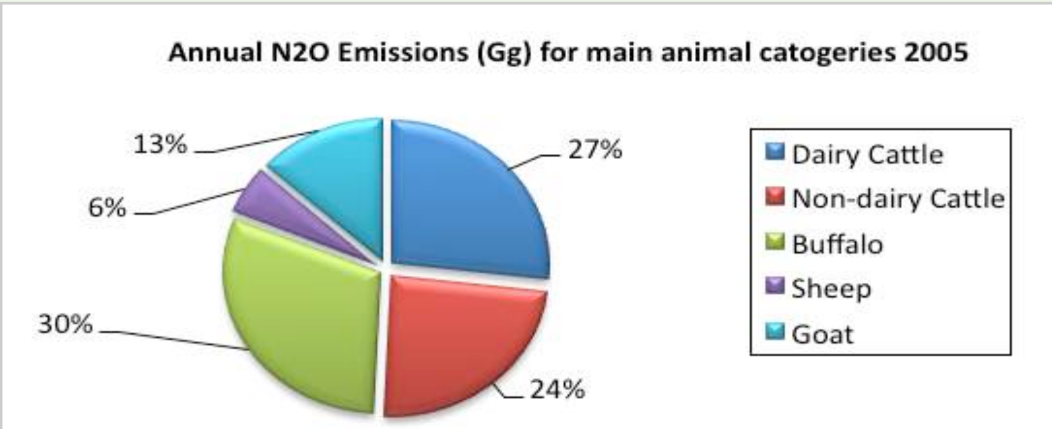


Figure (II.35): N_2O emissions from animal waste management categories, 2005

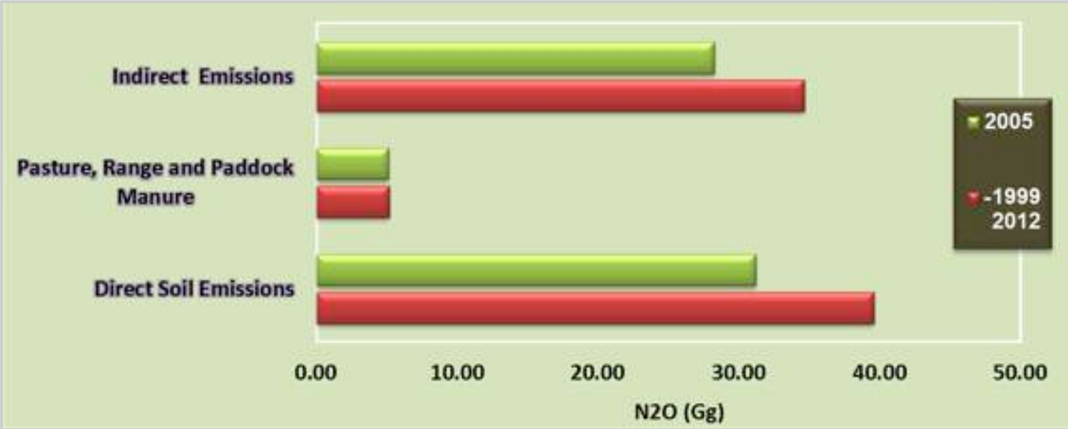


Figure (II.36): Indirect, direct and paddock manure N_2O emissions for the periods of 2005 and average of 1999-2012

Table (II.25): Total N_2O emissions from agricultural soil in year 2005

Type of N input to Soil		Direct Soil Emissions of N_2O (Gg)
Direct N_2O emissions from agricultural soil (Gg)	Synthetic fertilizer	27.44
	Animal waste	3.66
	N-fixing crops	0.06
	Crop residue	0.04
	Total	31.19
N_2O emissions from grazing animals (Gg)	Total	5.12
Indirect N_2O emissions from agricultural soils (Gg)	Total	28.27
Total N_2O emissions from agricultural soil		**64.59**

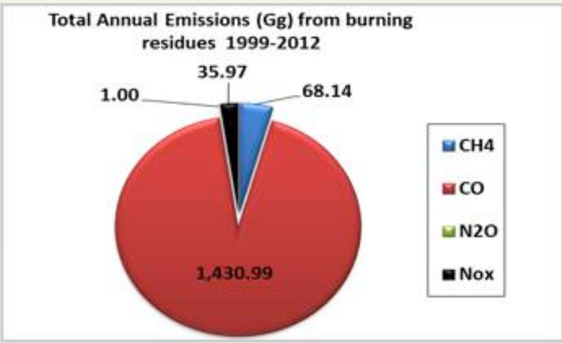
II.3.4.f Field Residuals burning

Large quantities of agricultural wastes are produced, from farming systems in the form of crop residue. Burning of crop residues is not thought to be a net source of carbon dioxide (CO_2) because the carbon released to the atmosphere during burning is reabsorbed during the next growing season. However, crop residue burning is a significant net source of CH_4, CO, NO_x, and N_2O.

The amount of agricultural wastes produced varies by country, crop, and management system. In Egypt, more than 25 million ton of crop residues are burned annually. Burning is the major disposal method for rice and sugar cane residues in Egyptian farming system.

Two separated years of annual production of the major field crops (wheat, broad been, maize, cotton, rice and sugar cane) depends on burning to disposal its residues, were obtained from FAO Statistics Division 2014 (FAOSTAT, 1999 and 2012).

Total emissions of CH_4 from field burning of agricultural residues increased from 64.67 Gg in year 1999 to 69.44 Gg in year 2005. Meanwhile, it increased in 2012 to be 70.31 Gg. Moreover, N_2O emissions from the same source increased from 0.94 Gg in 1999 to 1.01 Gg in 2005 and 1.03 Gg in 2012. Burning is the major disposal method for rice and sugar cane residues in Egyptian farming system. Therefore, rice and sugar cane were the main sources of emissions of field burning emissions. Figure (II.37) shows the comparison between the different gas emission from crop burning residues in year 2005 and average period of 1999-2012.



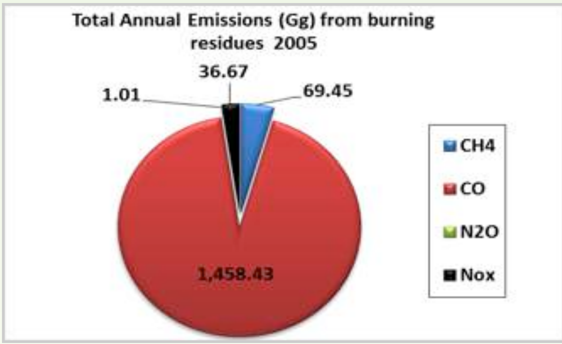


Figure (II.37): Total GHG emissions from crop residues burning

II. 3. 5. Waste Sector

The Waste category includes emissions from the treatment and disposal of wastes. Sources include solid waste disposal on land, wastewater treatment, and waste incineration. Emissions estimated are CH_4 emissions from solid waste disposal on land, CH_4 and N_2O emissions from wastewater treatment, and CO_2, CH_4, and N_2O emissions from waste incineration. The most important gas produced in this source category is methane (CH_4). Table (II.26) summarizes the Waste Sector and source categories contributions for inventory years between 2000 and 2005. Figure (II.38) shows the relative weight of different waste source categories for GHG emissions in 2005.

Table (II.26): Total CO2e emission from waste sector (Gg/y)

Source Category / Year	Solid waste	Wastewater	Incineration	Total
2000	9,330	5,936	5.86	15,272
2001	9,736	6,232	5.99	15,974
2002	10,172	6,557	6.13	16,735
2003	10,620	6,913	6.26	17,539
2004	11,068	7,281	6.4	18,355
2005	11,526	7,665	6.54	19,198

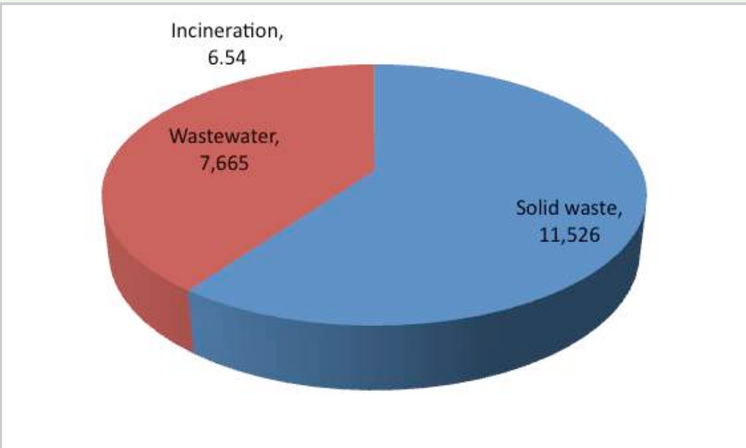


Figure (II.38): Relative weight of different waste source categories for GHG emissions, 2005

II.3.5.a. Methodological Approach and Data Sources

The Revised 1996 IPCC Guidelines provide two methodologies for estimating emissions from ***Solid Waste Disposal Sites*** (SWDS): theoretical gas yield methodology and first order kinetics methodology. The methodology of choice is the first order kinetics methodology, which is also the default methodology in the IPCC guidelines. However the equation used is from the according to the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (Equation 5.1) to count for the normalization factor 'A'.

Governorates, Giza, Kafr El Sheikh, Damietta, Aswan, Assiut, South Sinai and Port Said, failed to complete the questionnaire about the quantities of MSW generation and collection. For those, values of daily MSW generations are obtained from the Egypt Report on the Solid Waste Management (SWEEPNET, 2010). Governorates, Cairo, Alexandria, Qena, Sohag, Luxor, El Menia, showed inaccuracies in the obtained questionnaire as the MSW collected exceeded the quantity of MSW generated for the same year. For those governorates, value of MSW generation in year 2010 specific for each governorate is obtained from the Egypt Report on the Solid Waste Management (SWEEPNET, 2010). After that, a growth rate of 3.4% is used to extrapolate the MSW generation for the years 2000 to 2005.For the governorates for which the collected waste was higher than the generated amount from the data of the Ministry of Local development and from the Egypt Report on Solid Waste Management, it was assumed that generated waste for the year is equal to the collected waste for the same year. This assumption was applied to the governorates Wady El Gadeed, North Sinai, BaniSwaif and El Menia.

Methane production from ***wastewater handling*** (WWH) under anaerobic conditions is from two sources: industrial and domestic. Data regarding industrial wastewater is very limited. As a result, estimates of the quantities of industrial wastewater provided in the previous inventory were used and extrapolation was done for values beyond 2000. Default IPCC emission factors were used and assumption of treated versus untreated wastewater was modified to reflect reality.

The domestic wastewater handling in Egypt falls under the responsibility of two entities: the Holding Company of Water and Wastewater and the National Institution for Water and Wastewater. The number of wastewater treatment plants (WWTP) has increased over the years. The total population is estimated at 2005 to be 70.1 million while only 26 millions are served in wastewater treatment plants.

The domestic wastewater sources are categorized into 2 groups:

- **Group (i):** Population served by centralized wastewater treatment plants according to data from Holding Company of Water and Wastewater and the National Institution for Water and Wastewater. Country specific MCF is used (if treatment method known). It is assumed MCF = 0.3 (if treatment method unknown assuming overloaded centralized wastewater treatment plant)
- **Group (ii):** Population served by other treatment methods.MCF used is the PCC default.

Group (i) represents the population in the Governorates with available data concerning the number of people served by the centralized wastewater treatment plants as indicated in Appendix I. Group (ii) represents the total population in those Governorates as provided by CAPMAS Egypt minus the population in Group (i). Since the other treatment methods are unknown in Group (ii), the default values for the treatment pathways are used from the IPCC.

Wastewater treatment system/pathway usage differs for rural and urban residents, as well as between urban high-income and urban low-income residents. Handling of wastewater and sludge under anaerobic conditions results in CH_4 production. The extent of CH_4 production depends primarily on the following factors:

- Wastewater characteristics (i.e. BOD, COD, etc)
- Handling Systems (i.e. aerobic ponds, anaerobic lagoons, etc)
- Temperature (i.e. higher than 15°C)
- Other factors (i.e. retention time, degree of wastewater treatment, and other site specific characteristics)

For domestic wastewater, emissions are a function of the amount of organic waste generated and an emission factor that characterizes the extent to which this waste generates CH_4. The Tier 1 method was selected where it applies default values for the emission factor and activity parameters due to the unavailability of relevant data in Egypt. The same method and a constant national increase in industrial production per year are assumed for estimating CH_4 emissions from industrial wastewater for each year resulting in consistent time series. Country specific values have been applied for estimation when data is available. Comparison of country-specific data to IPCC default values as advised by the *Good Practice Guidance.*

The Revised 1996 IPCC and Good practice guidelines were used for estimating CH_4 emissions from the industrial wastewater. It is considered good practice for countries with limited data as Egypt. Sludge and wastewater calculations are not distinguished because of the lack of appropriate statistics that distinguish between them. Data were only available for food and beverage, textiles and pulp and paper industries with no specific data that distinguish the quantities of wastewater from the quantities of sludge.

The emissions of N_2O from human sewage are calculated as follows according to the 1996 IPCC guidelines: The method followed in the 1996 IPCC guidelines is based on protein intake per capita, as it is considered closely linked to the agricultural N cycle. The same method is used for estimating N_2O emissions from domestic wastewater for each year resulting in consistent time series.

As for clinical waste, .default values from IPCC 2006 guidelines for the fraction of carbon in clinical waste, fraction of fossil carbon and emissions factors were used.

According to the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, emissions from CH_4 are not likely to be significant because of the combustion conditions in incinerators e.g. high temperatures and long residence times.

Normally, emissions from CO_2 from waste incineration are significantly higher than NO_2 emissions. Nitrous oxide is emitted in combustion processes at relatively low combustion temperatures between 500 and 950 °C. As indicated in table (5.7) in Good Practice Guidance, it is not applicable to use the reported N2O emission factors for incinerating the clinical waste. Therefore, N_2O emissions from clinical waste incineration are not estimated.

II. 3. 5. b. Solid Waste Disposal on Land

In previous editions of the IPCC Guidelines (1995), solid waste disposal sites were characterized as "open dumps" or "sanitary landfills," however in the Revised 1996 IPCC Guidelines due to the unclarity of the distinction between landfills and open dumps, all sites at which solid waste is deposited to land are defined as "solid waste disposal sites" (SWDSs). In this sub-section, the emissions are estimated from two types of solid waste disposal methods on land:

- Solid Waste Disposal Sites (SWDS) – collected solid waste
- Managed SWDS
- Unmanaged SWDS
- Uncategorized: uncollected solid waste abandoned in unrecognized sites

SWDSs are categorized into two types according to management practices: managed and unmanaged sites. As to the uncategorized solid waste, it is the uncollected waste abandoned on unrecognized sites. The percentage of collected wastes in Egypt is nearly 69% from the total municipal waste generated (IPCC, 2006). This assumption was only used for governorates that failed to report the amount of collected MSW for each year.

The CH_4 emissions results from the decomposition of organic waste in SWDSs by bacterial action. Due to the heterogeneous nature of SWDSs, there are considerable differences in CH_4 emissions between different SWDSs due to mainly the following influencing factors:

- Waste disposal practices, i.e. degree of control of the placement of waste and management of the site.
- Waste composition, i.e. quantities of degradable organic matter.
- Physical factors, i.e. moisture content, temperature, pH, and nutrient availability.

In the recalculations, an evident discrepancy lies in the quantities reported by the governorates between the Second National Communication (SNC) and the Third National Communication (TNC). In the TNC, the governorates reported MSW generation quantities that are less from the SNC by around 40% in all years. The quantities reported were through the official questionnaire regarding the MSW generation per year that was sent out in 2012 through the Ministry of Local Development.

According to Egypt's Second National GHG Inventory (1900 – 2000), the net CO_2e from methane emissions from all Solid Waste Disposal (collected and uncategorized) were 10,102 Gg in year 2000. The recalculation for years 1990 - 2005 resulted in net CO_2e of 7,207 Gg. Thus, the recalculations for total emissions from Solid Waste Disposal resulted in about 30% decrease in total emissions in TNC from emissions reported in the 2000 inventory year submission due to lower quantities of MSW generated and collected from each governorate.

Table (II.27) and figure (II.39) show the trend in GHG emissions for solid waste disposal from 1990 to 2005.

Table (II.27): Total CO2e emission from solid waste disposal on land (Gg/y)

Source Category	1990	1995	2000	2001	2005
Managed SWDS	0	0	472	819	2363
Unmanaged SWDS	23	124	324	447	924
Uncategorized	6532	7640	8533	8469	8239
Total	**6554**	**7764**	**9330**	**9736**	**11526**

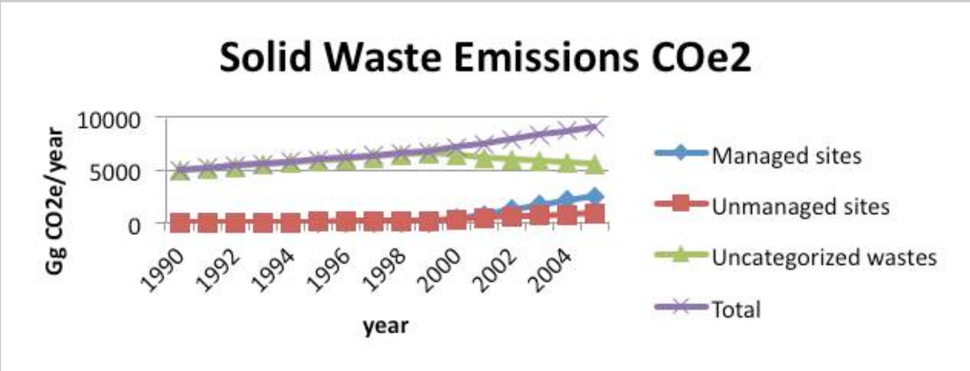


Figure (II.39): Total CO2e emission from solid waste disposal on land (Gg/y)

II. 3. 5. c. Wastewater Handling

The treatment of urban wastewater and the resulting wastewater sludge is accomplished using aerobic and/or anaerobic processes. During the treatment, the biological breakdown of Degradable Organic Compounds (DOC) as well as nitrogen compounds can lead to methane (CH_4) and nitrous oxide (N_2O) emissions, respectively. The discharge of effluents subsequently results in indirect N_2O emissions from surface waters due to the natural breakdown of residual nitrogen compounds. The source category also includes the CH_4 emissions from anaerobic industrial wastewater treatment plants (WWTP) and from septic tanks, but these are small compared to urban WWTP. Methane (CH_4) and nitrous oxide (N_2O) emissions from wastewater are considered under this source category.

According to Egypt's Second National GHG Inventory, the net methane emissions from Industrial Wastewater Handling for the year 2000 were estimated at 184.81 Gg. The recalculation for the same year resulted in net methane emissions of 194.43 Gg. The difference is due to the used value of the COD from textiles industry. A value of 0.09 kg COD/m^3 wastewater was used similar to the default value of Greece in 1996 guidelines. For the TNC, a value of 0.9 kg COD/m^3 wastewater as indicated in Good Practice Guidance is used.

Moreover, according to Egypt's Second National GHG Inventory, the net methane emissions from Domestic Wastewater Handling for the year 2000 were estimated at 90.67 Gg. The recalculation for years the same year resulted in net methane emissions of 88.09 Gg. The negative difference is attributed to the lack of data about the treatment pathways in the earlier submission, which was enhanced to be more realistic during this submission.

The source of Nitrous oxide (N_2O) emissions is from human sewage that is discharged into aquatic environments and is generated due to nitrification and de-nitrification processes. According to Egypt's Second National GHG Inventory, the N_2O emissions from Sewage Sludge for the year 200 were estimated at 0.00965 Gg. The recalculation for years the same year resulted in N_2O emissions of 0.00936 Gg. The difference is attributed to the enhancement done for the collected data to be more realistic during this submission.

Table (II.28) and figure (II.40) show the GHG emissions from wastewater handling for domestic wastewater, human sewage, industrial wastewater and the overall total from 1990 to 2005.

Table (II.28): Total CO2e emission from wastewater handling (Gg/y)

Source Category	1990	1995	2000	2005
Domestic wastewater	1,527	1,681	1,850	2,120
Human sewage	2	3	3	3
Industrial wastewater	2,216	3,008	4,083	5,542
Total	**3,746**	**4,692**	**5,936**	**7,665**

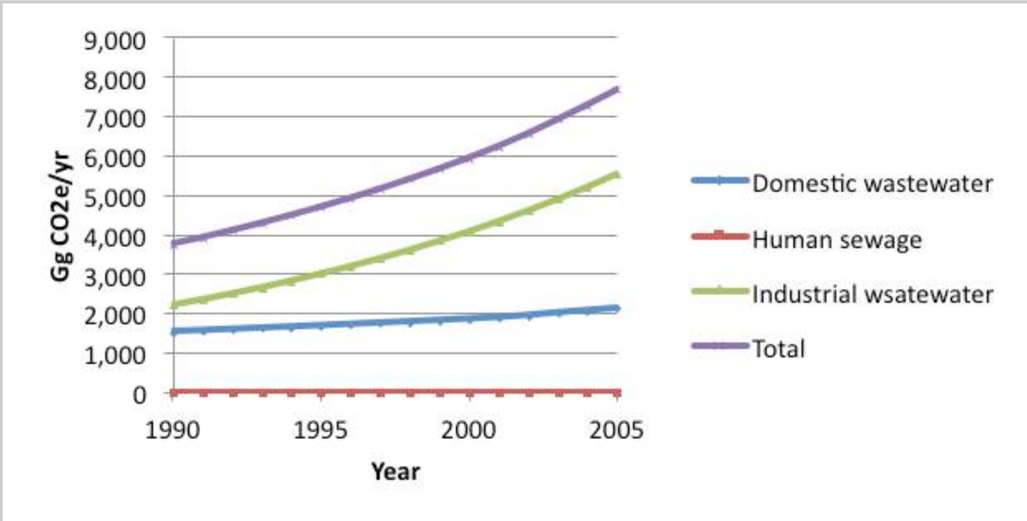


Figure (II.40): Total CO2e emission from wastewater handling (Gg/y)

II. 3. 5. d. Incineration

Waste incineration, like all combustion processes, can produce CO_2, CH_4, CO, NO_x, N_2O and NMVOCs. In Egypt, waste incineration is mostly done for clinical waste. Regarding GHG emissions, only CO_2 emissions resulting from oxidation of carbon in waste of fossil origin (e.g., plastics, certain textiles, rubber, liquid solvents, and waste oil) are considered net emissions and included in the national CO_2 emissions estimate. The CO_2 emissions from combustion of biomass materials (e.g., paper, food, and wood waste) contained in the waste are biogenic emissions and are not included in the estimates.

The total emissions from incineration for 2005 were 0.006 Mt CO_2e, representing 0.02% of the emissions of the waste sector. According to Egypt's Second National GHG Inventory 1999/2000, the CO_2 emissions from incinerating clinical waste were estimated at 3.08 Gg. The recalculation for years 1999/2000 resulted in CO_2 emissions of 5.86 Gg. The difference is attributed to the enhancement done for the collected activity data.

Table (II.29) and figure (II.41) show the total GHG emissions from incineration from 1990 to 2005.

Table (II.29): Total CO_2e emission from incineration (Gg/y)

Year	1990	1995	2000	2005
Incineration	4.50	5.18	5.86	6.54

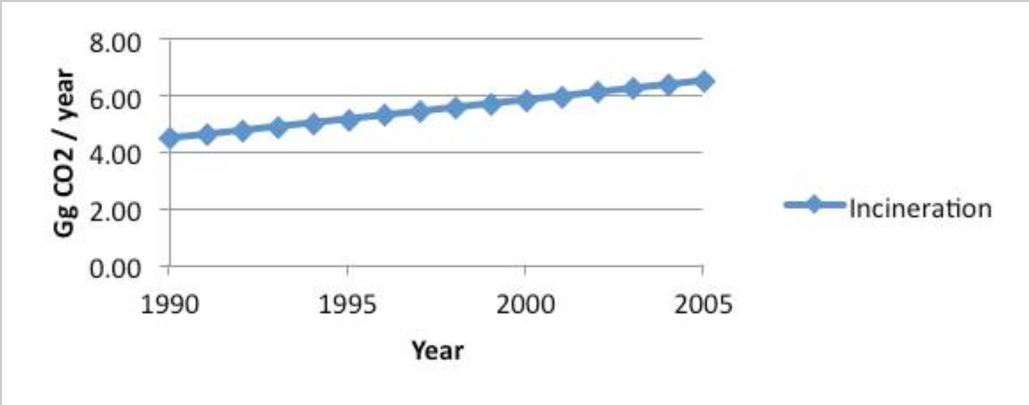


Figure (II.41): Total CO2e emission from incineration (Gg/y)

II. 3. 5. e. GHG for Waste Sector by Gas

As mentioned in the above section (II.3.5.d), all carbon dioxide (CO2) emissions generated from the waste sector are from the incineration and follow the trend in figure (II.41). Methane emissions from the different waste sectors from 1990 to 2005 are shown in table (II.30) and figure (II.42). As for nitrous oxide, it is mainly emitted from human sewage as shown in table (II.31) and figure (II.43).

Table (II.30): Total CH4 emissions (Gg/y)

Source Category	1990	1995	2000	2005
Solid waste	312	370	444	549
Wastewater	178	223	283	365
Incineration	0	0	0	0
Total	**490**	**593**	**727**	**914**

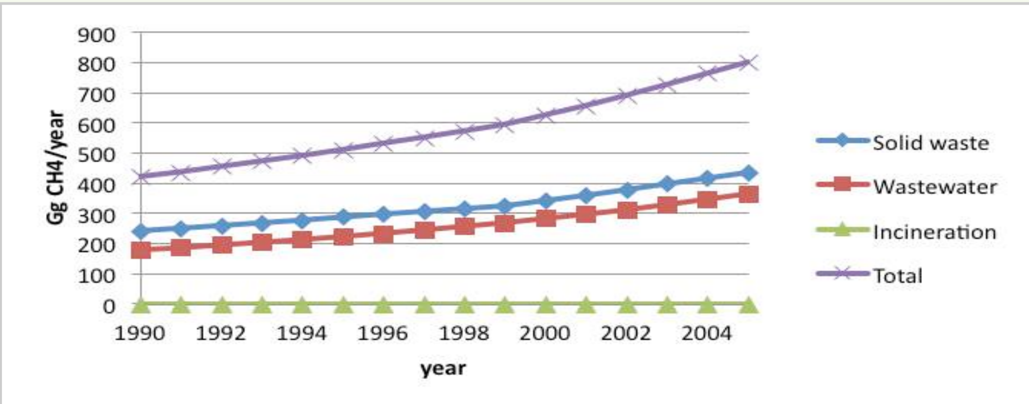


Figure (II.42): Methane emissions for waste sector from 1990 to 2005

Table (II.31): Total N_2O emissions (Gg/y)

Source Category	1990	1995	2000	2005
Human Sewage	0.0077	0.0085	0.0094	0.0103

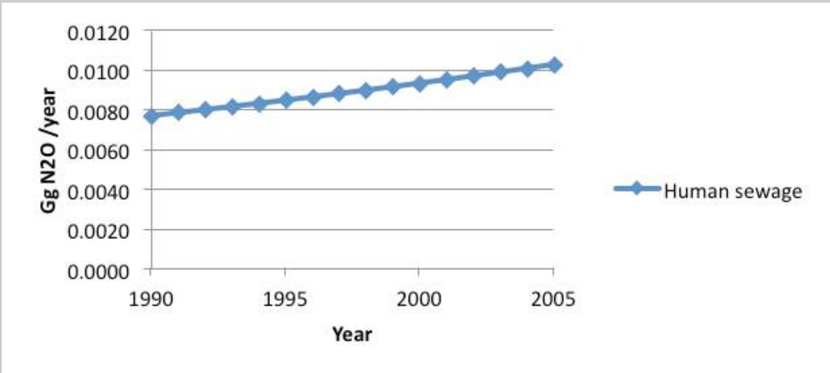


Figure (II.43): Nitrous oxide emissions from human sewage from 1990 to 2005

II.4. SUMMARY

Table (II.32) presents a summary of Egypt's inventory for the year 2005. Total greenhouse gas emissions for 2005 amounted to about **247.97 Mt CO2e.** This is the total of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), PFCs, HFCs, SF6 from the energy (combustion and fugitive emissions) , industry (industrial processes), agriculture and waste sectors.

The energy sector was the largest contributor to greenhouse gas emissions in Egypt. This is mainly because Egypt is highly dependent on fossil fuels, namely oil and natural gas; thus carbon dioxide is the main greenhouse gas emitted. Emissions have been estimated excluding CO_2 emissions from biomass burned for energy. Also, activity data for emissions of non-CO_2 gases from biomass burned for energy were not estimated, considering that using the potential of biomass resulting from agriculture residues and livestock are to be treated under agriculture or waste sector.

Emissions of CO_2e from the energy sector for the base year 2005/2006 are **147,324 Gg**. Methane emissions are 4.120Gg, and N_2O emissions are 0.180Gg. Emissions of CO_2e from the Electricity Sector for the base year 2005/2006 are 54,845.6 Gg. - The percentage of GHGs emissions of the Electricity Sector relative to all energy consumption for CO_2e for the base year 2005/2006 is 37.23%.

The second highest contributor to GHG emissions is industrial production which accounts for **42,013 Gg**. Carbon dioxide gas emitted from cement production is the main contributor with 16,717 Gg followed by ozone depleting substances (HFC's and PFC's) with 15,473 Gg. Nitric acid production responsible for nitrous oxide emissions contributes by 5,042 Gg. Other activities which contribute insignificantly to this sector is ammonia production, iron and steel as well as lime production all producing carbon dioxide emissions. Another minor contributor is aluminum production emitting PFCs.

GHGs from the agriculture sector come next with a contribution of **39,446 Gg**. Agricultural soil is the main source of GHGs emissions from agriculture sector by contribution of 50.75% in 2005. Enteric fermentation is the second important source by contribution of 22.8% in 2005 followed by rice cultivation by contribution of 11.73%. These are followed by manure management by contribution of 10.18% and finally, the field burning of agricultural residue by contribution of 4.43% in 2005.

Finally, the waste category includes emissions from the treatment and disposal of wastes and amounts to **19,198 Gg**. Sources include solid waste disposal on land, wastewater treatment, and waste incineration. Emissions estimated are CH_4 emissions from solid waste disposal on land, CH_4 and N_2O emissions from wastewater treatment, and CO_2 emissions from waste incineration. The most important gas produced in this source category is methane (CH_4).

Table (II.32): Summary of GHG emissions for Egypt, 2005

GHG Source & Sink Categories	CO_2 (Kt)	CH_4 (Kt)	N_2O (Kt)	PFCs (Kt)	SF_6 (Kt)	ODs (HFCs& PFCs) (Kt)	Total (Mt CO_2e)
All Energy (Combustion and Fugitive emissions)	**147,178**	**4.12**	**0.18**				**147.324**
Petroleum	78,175	2.89	0.12				78.275
Natural Gas	69,003	1.23	0.06				69.050
Industrial Processes	**20,420**		**16.26**	**0.16**		**4.81**	**42.013**
Cement production	16,716						16.716
Lime production	202.84						0.203
Iron and steel industry	1,576						1.576
Ammonia not used in Urea	1,924						1.924
Nitric acid production			16.26				5.042
Aluminum production				0.16			1.077
Ozone Depleting Substances, (ODS Substitutes, HFC's & PFC's)						4.81	15.473
Agriculture		**686.8**	**79.89**				**39.446**
Enteric Fermentation		394	-				9.06
Manure Management		27.8	11.26				3.973
Rice Cultivation		201.58					4.63
Agricultural Soils							20.02
Field Burning of Agricultural Residues		63.41	0.99				1.75
Waste	**6.54**	**914**	**0.0103**				**19.19**
Solid Waste		549					11.52
Wastewater		365	0.0103				7.665
Incineration	6.54						0.006
Total GHG Emissions in Mt CO_2e	**167.604**	**34.990**	**28.744**	**1.077**		**15.473**	**247.97**

CHAPTER III: PROGRAMS CONTAINING MEASURES TO MITIGATE CLIMATE CHANGE

III.1. INTRODUCTION

The key for Egypt to mitigation options of climate change is to lay a sound foundation for further evolution to low carbon energy systems. Because the climate security objective isstrongly normative, future energy supply pathways suggest that all the energy sustainability targets can be reached, if appropriate policies are introduced and energy investments are scaled up properly.

Pathways to achieving high CO_2 mitigation levels comprise the following:

- Widespread diffusion of zero- and low-carbon energy supply technologies, with substantial reductions in energy intensity.
- Comprehensive mitigation efforts covering all major emitters.
- Technology and financial transfers from industrialized countries to support decarbonization.

During 1998, an Inter-Ministerial Committee on Climate Change was established in Egypt to formulate, implement and promote Comprehensive Action Plans for Combating Climate Change. TableIII.1presents some examples of policies and measures implemented, and plans announced, for mitigation options in Egypt.

Most policies that aim at a more sustainable development rest upon four main pillars: more efficient use of energy, especially at the point of end use; increased utilization of renewable energy as a substitute for non-renewable energy sources; accelerated development and deployment of new energy technologies – particularly next-generation fossil fuel technologies that produce near-zero harmful emissions and open up opportunities for CO_2 sequestration, in addition to the new generations of nuclear power; and bio sequestration of carbon in terrestrial ecosystems, including soils and biota.

As a means for potentially decoupling energy demand from economic growth, energy efficiency represents a central lever for policymakers to target. The degree to which efficiency improvements can limit energy demand growth is -by design- one of the main distinguishing characteristics of the pathways. It is possible to improve energy intensity radically through a combination of behavioral changes and the rapid introduction of stringent efficiency regulations, technology standards, and environmental externality pricing, which mitigates rebound effects.

Renewable energy (RE) technologies will play a very important role in reducing GHG emissions, but they alone would not suffice to keep climate change manageable. RE may provide a number of opportunities and cannot only address climate change mitigation but may also address sustainable and equitable economic development, energy access, secure energy supply and reduce local environmental and health impacts.

In addition, the emphasis in Egypt should be on replacing or upgrading obsolete infrastructure, e.g., via upgrading sites of old fossil fuel power plants with technologies offering additional capabilities and pursuing carbon capture and storage (CCS) retrofits. There are four key technology-related requirements essential for transforming the fossil energy landscape: (i) continued enhancement of energy conversion efficiencies, (ii) carbon capture and storage-CCS,(iii) co-utilization of fossil fuel and biomass in the same facilities, and (iv) coproduction of multiple energy carriers at the same facilities.

The availability of advanced generations of nuclear reactor types could be important for filling the gap between reducing dependence on fossil fuels and the deployment of renewable energy. They could also be an important contributor in the future energy mix for stabilizing CO2 levels as energy demand continues to grow in the Arab region.

New public policies are needed to facilitate in the near term industrial collaborations between companies that would produce simultaneously fuels and electricity. It would be desirable to identify policy instruments that specify performance rather than technology and maximize use of market forces in meeting performance goals.

Table (III.1): Examples of policies and measures implemented and plans announced formitigation options in Egypt

1.	Expand access to renewable energy resources to reach a contribution of 20% of the total electrical energy demand by 2020, of which 7200MW wind farms. Today, 547 MW wind farms are operating along the Suez Gulf, 140MW ISGCC is operating at Kureimat and two 100MW each of CSP are announced in Comombo, in addition to two PV 20MW each. Apply Feed-in-Tariff system to promote extensive use and dissemination of photovoltaic and wind as well as those of waste to energy. Switching to using natural gas in substitution to oil for power generation. Enhancing electricity and gas grid-interconnection across borders of neighboring states.
2.	Reinforcing energy efficiency standards, expanding energy efficiency labeling for household appliances, application of energy efficiency code for buildings and disseminating efficient lighting. Transport sector improvements using natural gas in commercial vehicles; extending the electrified underground transportation to new areas in Greater Cairo; electrification of Cairo-Alexandria Line by 2020; electrification of Cairo - Upper Egypt Line around 2030; intensifying the use of environmentally sound river transport; facilitating the replacement of old taxis; and vehicles utilizing fuel cells are to grow as their economics improve. Launching a program to build a number of nuclear power generating plants, initiating the necessary steps to have the first 1000MW plant operational by 2017.

Additional mitigation measures include the increase of the country's CO_2 absorptive capacity through afforestation, entailing planting and maintaining suitable types of trees along the sides and the middle-island of inter-city roads, irrigation and drainage canals, in addition to developing man-made forest-wood trees using treated sewage water for irrigation.

The implementation of the Support for National Action Plan (SNAP) as well asthe GEF, EU and UNDP building capacity and GHGs emission reduction projects, led to increasedconcerns about climate change within different institutions and ministries. This hasbeen reflected in having more than twenty projects concerned with GHG mitigationactions over the past decade.

III.2. CURRENT STRATEGIES, PROGRAMS AND POLICIES FOR MITIGATING GHGS EMISSIONS BY KEYSECTORS

III.2.1 Energy Sector

New technology is the cornerstone of any sensible energy policy. Today, Egypt is seriously looking for technology transfer on the front edge of world industrial progress. These new technologies can only be successfully brought to market if an appropriate and stable legal, regulatory, and fiscal environment is maintained over the long term. When it comes to energy, Egypt needs it all. But ultimately, such new technologies must stand on their own and meet the demanding tests of both consumers and the marketplace.

Working through international cooperation, Egypt can transform its energy problem into an energy opportunity –an opportunity to unleash the power to develop new supplies, invest and apply new technologies, and create good new jobs for Egypt. It can be an opportunity to pass on to a new era of energy efficiency and truly enhance Egypt's energy security.

The strategy that Egypt declared for future energy at the world summit for renewable energy, held in Abu-Dhabi during mid 2014, comprehensively integrates the main policies and measures that could meet the longer term challenges facing the national economy, particularly energy industry.

The strategy energy pillars in the Egyptian open horizon can be grouped under these four critical challenges, which incorporate specific measures for mitigating climate change:

- Promoting greater energy efficiency
- Increasing and diversifying Egypt's energy supplies
- Improving environmental protection
- Modernizing and protecting nation’s energy infrastructure

First: Egypt has opportunities in the sustainable and efficient use of energy resources as well as in energy production

Egypt didn't succeed yet to cut energy intensity in any ratio, but there are many areas that it can improve upon to ensure continued economic growth while using less energy. Egypt will foster policies that address the inherent disincentives that exist for electric utilities, homebuilders, and others to use less electricity. Existing infrastructure constitutes a significant portion of Egypt energy consumption, and new building codes that incorporate energy efficiency measures and standards are to be enforced. Egypt's vehicles are to become more efficient. However, Egypt must also increase efficiency throughout the energy delivery chain through the use of new technology and policies.

Egypt will explore innovative new regulatory models that reward efficiency, especially for utilities and, ultimately, their customers through energy savings programs and new approaches to the delivery of electricity. Moreover, utility regulatory policies that reward more efficient use of generated electricity and natural gas must be encouraged. Consumers should have the ability to moderate their own consumption through transparent real-time pricing and smart metering, and grid technologies should become the norm. Egypt's industries, too, should recognize the benefits of improving their efficiency, making themselves more productive and thus more competitive.

Second: Egypt is to seek proven sources of energy while diversifying energy mix

Nuclear power is currently the largest source of zero-emissions baseload electricity that must be significantly expanded. To do so, the government’s regional and international cooperation with leading nuclear community are being enhanced to accelerate this revival.

Egypt also plans to use imported world's vast coal supply in a clean and environmentally responsible manner. Clean coal technology has witnessed a significant advancement.

Renewable sources of energy are growing at a faster rate than traditional sources; however, they still only provide a fraction of generated electricity. There is a belief that the alternative and renewable feed-in-tariff provide a useful incentive to bring initially expensive technologies into the mainstream and allow these technologies to compete in the market.

Technology is the cornerstone of Egypt's energy future. Egypt strivesto mobilize the capital that will be needed to deploy these clean energy technologies into the marketplace.

Third: Egypt is to improve environmental and climate protection without sacrificing jobs and growth

Egypt is addressing the impact of growing energy consumption on the environment and climate. However, climate change should be addressed as part of an integrated agenda that enhances energy security, maintains economic prosperity, reduces pollution, and mitigates greenhouse gas emissions. Energy efficiency is central to this approach, and advanced technologies - for example, clean coal technology, advanced nuclear power, renewables, and smart grid -are already needed on a vast scale to eventually reduce emissions significantly.

Egypt is working with developed and developing countries alike to tackle the interrelated challenges of energy security, economic development, environmental quality, and climate change. Egypt is promoting an approach to climate change that allows it to find its own best path for meeting strong environmental and economic development goals, while ensuring that it is included in addressing global environmental challenges. Innovative clean energy technologies and processes, developed by the international market can be an indispensable part of Egypt's future environmental solutions.

Fourth: Egypt will work on modernizing, expanding, and securing energy infrastructure because no energy source -traditional or alternative- can reach the market without a modern and vibrant infrastructure

Significant portions of Egypt's energy and transportation infrastructure are inadequate and, in some cases, in decline. Whether it is a new wind farm or transmission lines that carry generated electricity to homes and businesses, investments are needed to modernize, protect, and upgrade these critical assets. Transitioning to smart grid technology will help improve the resiliency and efficiency of Egypt's power supply and are a priority for the next decade.

With expected increases in energy facility construction and operations through 2030 to meet projected energy demand, a highly skilled and technical workforce is necessary to ensure Egypt's successful attainment of its ambitious goals. New partnerships with community colleges and training programs, and incentives are implemented to attract young people to technical fields where they can develop and manage the energy systems of the future.

In accordance with the commitment of all parties to the UNFCCC to support climate change efforts at the National level, the EU-UNDP Climate Change Capacity Building Project has supported Egypt to strengthen national capacity to identify opportunities for Nationally Appropriate Mitigation Actions (NAMAs). The process has resulted in Nationally Appropriate Mitigation Options in eight key sectors of the national economy, namely: energy sector; industrial sector; transport sector; agriculture sector, housing sector, water resources sector, tourism sector, and waste sector. NAMAs Prepared list of mitigation opportunities in each sector provides with a diversified portfolio of Potential Mitigation Projects, which enable Egypt to significantly contribute to the international endeavor towards reducing GHG emissions and combating climate change.

Egypt's "NAMAs Mapping for Sectoral Mitigation Opportunities" is prepared to help "Mapping of Mitigation Measures" most appropriate to the Egyptian Economy in different key sectors. Prepared List of NAMAs options include the following sectoral mitigation projects.

a. Oil and Gas Sub-Sector

Tables III.2 and III.3 present a list of GHGs mitigation opportunities in the oil and gas sub-sectors classified according to the main hierarchy of petroleum and gas activities.

Table (III.2):GHGs emissions mitigation opportunities in the Egyptian natural gas sub-sector

Sub-Sector	Activity	Mitigation Opportunities
Upstream	Gas production	- Minimize gas venting and flaring (flare gas recovery) - CO_2 capture and storage (CCS)
Transportation	Gas transportation	- Electricity generation from turbo-expanders through natural gas pressure reduction at Pressure Reduction stations (PRS) - Minimize natural gas transportation losses
Mid stream	Natural gas processing	- Electricity generation from turbo-expanders through natural gas pressure reduction - Increase efficiency of natural gas processing plants
Transportation	Natural gas transportation	- Minimize natural gas transportation and distribution losses

Sub-Sector	Activity	Mitigation Opportunities
End Use		- Electricity generation from turbo-expanders through natural gas pressure reduction at PRS - Fuel switching - Natural gas utilization as a fuel for vehicle - Improve natural gas utilization efficiency - Price increase and subsidiary removal (gas pricing policy)

Table (III.3): GHGs emissions mitigation opportunities in theEgyptian oil sub-sector

Sub-Sector	Activity	Mitigation Opportunities
Upstream	Oil Production	Minimizing gas flaring CO_2 Capture and Storage (CCS) Minimize oil production losses Utilization of renewable energy (wind &solr) for application and possibly oil production
	Oil transportation	Minimize crude oil and oil products transportation losses

Sub-Sector	Activity	Mitigation Opportunities
Mid-stream	Oil Refining	Improve oil refineries efficiency through: Fuel combustion efficiency improvements and control (analysis of combustion gases, use of efficient burners, maintaining fuel temperature at a value sufficient for obtaining good viscosity thus good pulverization, etc) Fuel switching Improve steam system efficiency (minimizing steam leaks, steam pipes insulation, use of efficient and effective steam trapping systems through the replacement o faulty steam traps in addition to facilitate condensate removal, etc.) Reflux control (important to maintain the reflux of the fractionating column at an optimal value in order to minimize the discharge of gasses to the flare Thermal losses reduction from boilers, furnaces, piping, tanks, heat exchangers and other heat transfer equipment Reduction of electricity consumption and costs through the use of high efficient motors and adjusting motor seed, high efficiency umps, compressors etc. Waste Heat Recovery (WHR) from hot flue gases of boilers and furnaces to improve efficiency Reduce blow down losses to improve cooling towers and boiler system performances Recovery of hot condensate through the implementation of condensate recovery system Renewable energy utilization for electricity generation, process heat and boilers feed water heating
Transportation	Oil Products transportation	Minimize oil products transportation losses
Storage	Crude oil and oil storage	Minimize crude oil and oil products losses
End Use		Oil products price increase and subsidiary removal

b. Electricity Sub-Sector

There are many actions that can be taken to reduce GHGs emissions in the electricity sector, particularly power generation activities, through improved efficiency in generation, transmission, distribution and end-use of electricity. Other actions include:

I. Use of lower (or non) carbon fuels;

II. Controlling the emissions of GHGs emitted at various sources;

III. Creating offsets through investment in GHGs emission sinks; or

IV. Use of the market-based economic instruments to facilitate cost-effective compliance.

TableIII-4 provides a synopsis of the prioritized NAMAs to facilitate comparison of the alternative climate change actions and estimate of possible annual emission reduction of CO_2e and associated cost.

The first column indicates the level of experience associated with deploying the climate change action (low-to-high). The second column relates the commercial benefit of the action-i.e., an action labeled "high" indicates that it makes commercial sense independent of any GHG benefit, while an action marked "low" requires GHG mitigation benefits to make commercial sense. The third column identifies the type of CO_2 mitigation action: avoid, offset or reduce. The next column provides an assessment of the degree of mitigation: high-to-low. When available, the last column indicates the CO_2 cost-effectiveness of the action.

Table (III.4): Climate change mitigation matrix for the electricity sub-sector

Climate Change Action Areas	Level of Experience With Deployment	Commercial Benefit	Type of CO_2 Mitigation	Level of CO_2 Mitigation	CO_2 Cost-Effectiveness
1. Utilizing Cleaner Fossil Fuel Systems (Cffs)					
1.1 Understanding, Qualifying And Controlling Ghg Emissions From Utility Operations	H	L	A	L	N/A
1.2 Improving Environmental Pollution Control	H	M/H	A	L	N/A
1.3 Utilizing Clean Coal Technology-Super Critical & Ultra Super Critical	L	M/H	A	L	N/A
1.4 Recycling Of Coal-Combustion Byproducts	L	L/M	A	M	N/A

Climate Change Action Areas	Level of Experience With Deployment	Commercial Benefit	Type of CO_2 Mitigation	Level of CO_2 Mitigation	CO_2 Cost-Effectiveness
2. Utilizing Nuclear Power Generation					
2.1 Utilizing Nuclear Power For Electricity Generation	L	H	A	H	H
3. Renewable Energy Actions					
3.1 Fuel Switching From Carbon To Noncarbon Based Fuels	M	L/M	A	M	M
3.2 Photovoltaics (Pv)	M	L	A	L/M	M/H
3.3 Solar Thermal	L	M	A	L/M	M
3.4 Wind Power	M	M	A	M/H	M/H
4. Fuel System Actions					
4.1 Coal Pretreatment And Beneficiation (When Coal Is Introduced To The National Power Generating System)	L	H	R	L	H
4.2 Use Of Non-Petroleum Vehicles By Utilities	L	L	A	L	L
4.3 Fuel Quality Testing, Assessment And Assurance	L	H	R	L	H
5. Conventional Power Generation System Actions					
5.1 Firing Equipment	M	M/H	A/R	L/M	M
5.2 Boiler Improvements	M	M/H	R	L/M	N/A
5.3 Turbine Cycle Improvements	M	M/H	R	L	N/A

Climate Change Action Areas	Level of Experience With Deployment	Commercial Benefit	Type of CO_2 Mitigation	Level of CO_2 Mitigation	CO_2 Cost-Effectiveness
5.4 Reducing Parasitic Loads From Auxiliary Equipment	L	M/H	A	L	N/A
5.5 Plant Instrumentation & Controls	L	H	R	L	N/A
5.6 Waste Heat Recovery Systems	L	M/H	A/R	L/M	N/A
5.7 Increase Capacity Availability By Reducing Planned Outages For Maintenance And Repairs	L	H	A	L	M/H
5.8 Increase Capacity Availability By Reducing Unplanned Outages	L	H	A	L	H
5.9 Energy Management Systems	L	H	A	L	M/H
6. Transmission System Actions					
6.1 High Voltage Direct Current	L	L/M	A	L	N/A
6.2 Improving Line Flow Control	L	H	A	L	N/A
6.3 Conductor Loss Reduction And Phase 6.4 Current Optimization	L	M	A	L	N/A
6.5 Installing More Efficient Transformers	M	L/M	A	L	N/A
6.6 Increasing And Stabilizing Line Voltage	M	L/M	A	L	N/A
6.7 Installing New, More Efficient Transmission Lines	M	L	A	L	L
6.8 Computer Software Systems And Models	L	H	A	L	N/A

Climate Change Action Areas	Level of Experience With Deployment	Commercial Benefit	Type of CO_2 Mitigation	Level of CO_2 Mitigation	CO_2 Cost-Effectiveness
7. Distribution System Actions					
7.1 Reduction In Reactive Power Losses	M	M	A	L	N/A
7.2 Upgrading And Automation Of Distribution Instrumentation And Controls	L	M	A	L	L
7.3 Reducing Conductor Losses	L	M	A	L	N/A
7.4 Installing More Efficient Transformers	M	M	A	L	N/A
7.5 Reducing Forced Outages And Stabilizing Line Voltage	L	M	A	L	N/A
7.6 Improving Customer Service	L	H	A	L	N/A
7.7 Computer Software Systems And Models	L	M	A	L	N/A
8. End-Use Energy Efficiency And Demand Side Management (Dsm) Actions					
8.1 Promote Residential Demand-Side Management (Dsm) Programs	L/M	H	R	L/M	M/H
8.2 Promote Commercial Demand-Side Management (Dsm) Programs	L/M	H	R	L/M	M/H
8.3 Promote Industrial Demand-Side Management (Dsm) Programs	L/M	H	R	L/M	M/H

Climate Change Action Areas	Level of Experience With Deployment	Commercial Benefit	Type of CO_2 Mitigation	Level of CO_2 Mitigation	CO_2 Cost-Effectiveness
8.4 Improving Billing & Collection Systems To Reduce Demand	L	H	R	L/M	M/H
8.5 Charging Economic Tariffs To Reduce Demand	L/M	H	A	L/M	M/H
8.6 Promoting New, Energy-Efficient Electro-Technologies	L	M	A	L/M	N/A
8.7 Instituting Customer-Focused Educational And Informational Programs	L/M	H	A	L/M	M/H
9. Offset And Emission Trading Actions					
Financing Mechanisms For Renewable Energy Projects	M	M	O	M	L/H
10. Data, Research And Monitoring Actions					
10.1 Inventory/ Quantification Of Ghg Emissions	N/A	L	A	N/A	N/A
10.2 Calculating Costs And Benefits Of Offsets	N/A	L	A	N/A	N/A
11. Energy Sector Institutional Reform And Restructuring Actions					
11.1 Increasing The Role Of Independent Power Producers In The Generation Sector	L	H	A/R	L/M	N/A
12. Regulatory Reform Actions					

Climate Change Action Areas	Level of Experience With Deployment	Commercial Benefit	Type of CO_2 Mitigation	Level of CO_2 Mitigation	CO_2 Cost-Effectiveness
12.1 Demand-Side Management (Dsm) Regulations And Incentives	L	M	R	L/M	L/M
12.2 Energy Efficiency Regulation And Incentives	L	M	R	L/M	L/M
12.3 Energy Conservation Regulation And Incentives	L	M	A	L/M	L/M

LEGEND:

Level of Experience with Deployment of Action: H – high M – moderate L – low Commercial Benefit: H- high (action makes commercial sense independent of any GHG benefit); M- moderate (action is marginally cost-effective, but a benefit from GHG Mitigation improves economics) L- low (action requires GHG mitigation benefit to make commercial sense)	Degree of Mitigation (number of MtC avoided/offset/reduced): H – high M – moderate L – low Type of CO_2 Mitigation Achieved: A- avoided O – offset R – reduced CO_2 Cost-Effectiveness: L- low cost per ton/C avoided/offset/reduced M moderate cost per ton/C avoided/offset/reduced H- high cost per ton/C avoided/offset/reduced

III.2.2 Industrial Sector

- Candidate industries identified for major mitigation measures include:
- Cement industry
- Steel industry
- Marble, granite and limestone Industry
- Mud bricks and sandstone industry
- Glass industry
- Ceramic and porcelain Industry
- Packaging and processing of fruits and vegetables Industry
- Extraction and preparation of Soda Ash, caustic soda, chlorine & sodium industry
- Refining and purification and bottling of salt Calcium carbonate industry
- Paints Industry
- Fertilizers industry and phosphate fertilizers
- Preparation and processing of minerals
- Gold extraction industry
- Goldsmiths craft workshops and handicrafts
- Handicrafts and environmental industries

GHGs emissions mitigation opportunities in all above industries are listed-up in TableIII.5.

Table (III.5): Industrial GHGs emissions mitigation opportunities

	Climate Change Action Areas
1.	EE measures/ Conduct Industrial Energy audit in all Industrial facilities.
2.	EE measures/Create baseline for energy consumption and benchmarking for GHG emissions.
3.	EE measures/Apply Energy management systems.
4.	EE measures/Apply lighting audit and Lighting efficiency in industrial facilities.
5.	EE measures/Apply Energy efficiency standards and labels programs for industrial equipment e.g. Motor efficiency.
6.	Reduce emissions resulting from facilities vehicles.
7.	Applying Capacity building programs, training and awareness campaigns.

8.	Encourage Waste management and recycling.
9.	Renewable energy/Biomass
10.	Renewable energy /Solar thermal systems
11.	Renewable energy / Heat pumps
12.	Encourage Fuel switching to alternative fuels and waste materials.
13.	Waste heat recovery.

III.2.3 Transport Sector

The question on "how" to reduce GHGs emissions from transport is best described by the Avoid-Shift-Improve (ASI) strategy. The ASI approach describes the three basic ways to achieve low-carbon transport:

A: Avoid an excessive increase in transport demand or reduce existing demand: Passenger transport demand is closely correlated to land-use and urban design. Dense urban structures with mixed use of areas avoid unnecessary traffic and reduce travel distances without limiting the access to goods and services. Likewise, demand for freight transport can be managed through intelligent organization of freight transport activities and the design of production and distribution procedures.

S: Shift demand to energy-efficient / low-carbon modes. Private motorized road transport (both passenger and freight) typically has the highest GHG emissions (per passenger or tonnekilometre) in land transport. For passenger transport, a shift from private cars to public transport and non-motorized modes can yield considerable GHG emission reductions. In terms of freight transport a shift to more efficient modes, including shipping and rail transport, results in several times less emission than road freight transport.

I: Improve the efficiency of vehicles and the quality of fuels: Technological and design improvements, as well as an efficient driving style and energy-saving devices can increase the fuel-economy of vehicles. Furthermore, carbon emissions can be reduced by switching to alternative fuels with lower lifecycle GHG emissions, such as natural gas.

In general, Table III.6 shows GHGs mitigation measures in road transport and maritime sub-sectors categorized by key mitigation strategies. TableIII.7 shows GHGs general mitigation opportunities in Civil Aviation sub-Sector.

Table (III.6): Road transport and maritime sub-sectors GHGs emissions mitigation opportunities

No.	Region	Project
1.	ITC (Intermodal Transport Corridor)	Double Tracking of Bypass Line for Cairo - New Alexandria
2.		Railway Link for 6th of October City
3.		Railway Link between Robeki to Helwan
4.		Improvement of Station Facilities for Freight services (2 stations) (good intermodal connection & facilities, railway layout/arrangement, warehouse and station office
5.		Railway Link between Sokhna Port to Helwan
6.		Inland Water Transport (IWT) port for Intermodal Transport Corridor (ITC)
7.		High Speed Railway for Cairo - Alexandria
8.		Waterway Improvement on Cairo - Alexandria
9.		Establishment of a Multi Purpose Terminal (Containers and General Cargo) at Alexandria Port
10.		Development of management and Operation for Multi Purpose Terminal in El Dekheila Port
11.		Dekheila Port: New Container Terminal
12.	Cairo – Alexandria	High Speed Railway for Cairo - Alexandria via Tanta
13.		Improvement of Tracks: Cairo - Tanta - Alexandria
14.	Inland Delta	Single Tracking for Basion City
15.		Double Tracking for Qalyoub - El Qnater
16.		Triple Tracking for Qalyoub - Benha
17.		Improvement of Track Arrangement for Cairo - Qalyub
18.	Cairo – Damietta - Port Said	Double Tracking to 10th of Ramadhan City
19.		Single Tracking for Kafr El-Batikh - New Damietta City
20.		Double Tracking for Mansoura – Damietta
21.		Improvement of Signaling System for Increase of Freight Trains for Tanta - Mansoura – Damietta
22.		Improvement of Tracks: Damietta - Port Said Line
23.		Waterway Improvement on Cairo – Damietta
24.		Damietta Port: Study on Sedimentation
25.		Port Said East: Logistic Center
26.	Cairo - Suez	Double Tracking for Ain Shams – Robeki
27.	Mediterranean	Single Tracking for Bir El Abd – Rafah
28.		Rehabilitation of Tracks for El-Kab - Bir El Abd

No.	Region	Project
29.	Upper Egypt	(High) Speed Railway for Cairo - Aswan [Electrificated]
30.		Development of Railway Bridge for Lemon - Abbasiya – Tora
31.		Improvement of Tracks: 1) Track renewal, 2) New track maintenance machines on Cairo – Aswan
32.		Improvement of Station Facilities for Freight Services (6 stations) (good intermodal connection & facilities, railway layout/arrangement, warehouse and station office)
33.		IWT port improvement for Upper Egypt
34.		Lock Expansion with Comprehensive Lock Operation Improvement
35.		Waterway improvement on Cairo –Assyuit
36.	East-West	Single Tracking for Luxor – Hurghada [Electrificated]
37.		Rehabilitation of Tracks for Qena – Safaga
38.		Rehabilitation of Tracks for Qena – Kharga
39.	Greater Cairo	Improvement of underground line 1 and 2 (Energy efficiency and Renewable energy)
40.	Egypt	High Efficiency electric motorcycle
41.	Alexandria	Double Tracking for Elmanashy/Elithad/Elqabari
42.	Cairo	Single Tracking for Elrobiki / 10th of Ramadan
43.	Alauxor/Hurgada	Single Tracking for Alauxour/Hurgada
44.	Suez canal	Under Suez canal tunnel, south Port saeed
45.	Elnobaria	Waterway Improvement on ElraiahElbhari/Elnobaria
46.	Cairo/Aswan	Waterway Improvement on Cairo/Aswan

Table (III.7): Civil aviation sub-sector GHGs emissions mitigation opportunities

	Project name	Brief description
1.	Fuel efficiency gap analysis	This project is a cooperation between Egyptair and IATA green team starts from 2009 to analyze all the (operational, technical and ground handles tasks and put in consideration basket of measures to improve the fuel consumption

2.	Plane weight reduction	Replacement of catering trolleys efficient catering trolleys. According to lata guidance material for best practices Cost of Weight) COW factor is from 2.5% :5%, In Egypt Air cow factor is 3% total COW= weight change * weight factor * flight hours
3.	Using Electric Lithium batteries in Ground Support Equipment (GSE)	Using Electric Ground Support Equipment Advanced Battery Technology Project in Egypt Air,
4.	Renewable fuel	Using renewable fuel to replace jet fuel
5.	Traffic programme	To optimize plane traffic to reduce fuel consumption
6.	High Efficiency Lighting	Replacement of existing lighting system with more energy efficiency lighting system
7.	High Efficiency Chillers	Replacement of existing chiller with more efficient ones
8.	Energy Management System (EMS)	Install modem EMS to control and operate the heating, ventilation and air conditioning system

III.2.4 Agriculture Sector

Agriculture is a major source of GHGs emissions (the contribution estimated as 16%). Agriculture represents a primary source of livelihood for more than one third of the Egyptian total workforce and the economic health is linked to the prosperity of farming communities.Agriculture provides with 60% of food needs (40% imported) and the gap of food security increases with time, especially with increases population (2.8 % / year) and this requires more agriculture production.

In the foreseeable future, the increased demand for food and feed will continue to be met through conversion production and wetlands into agricultural lands as well as use of post-green revolution conventional forms of agricultural intensification that usually base on much higher inputs of fossil fuels, fertilizers, pesticides and irrigation infrastructure and are associated with increased emissions of GHGs. The agricultural practices that farmers in Egypt are using are inappropriate, unsustainable, deplete the natural resources, and emit GHGs. FAO recommends that emissions reductionmay be measured in terms of improvements in efficiency rather than absolute reduction in GHGs emissions.

Key Challenges for mitigation in the agricultural sector is to achieve sustainable agriculture growth while reducing GHGs emissions or decoupling GHGs emissions from growth as shown in table III.8.

Table (III.8): GHGs emissions mitigation opportunities for agriculture sector

No.	Agriculture Sector Activity Opportunities
1.	Mitigation of Methane Emissions from Paddy Rice: • Reduction of cultivated rice area • Short duration varieties • Intermittent irrigation • Development of drought tolerant varieties • Aerobic rice production, • Develop high yielding varieties to suit different rice environments, • Water saving technologies, • Optimize water use efficiency, • Dry rotation and dry seeding, • Improved irrigation techniques • Reduce water loss and wastage.
2.	**Mitigation of GHG emission from Fertilizer**
3.	• **Develop agricultural wastes management for reducing gas emission** • Utilization of vermicompost technique as entrance to mitigate the greenhouse gases (GHG) emissions
4.	**1) Wetlands and Fishing farms**
5.	**2) Bioenergy** • Biogas production • Electricity production • Ethanol production • Biochar production
6.	**Mitigation of GHG emissions in livestock production** • Enteric fermentation (Better feeds and improved feeding technology; Improved breeding and Better foods for Buffalo) • Manure management
7.	**3) Mitigation of GHG emission from poultry production**
8.	**4) Agro-forestry & afforestation and mitigation GHG**

No.	Agriculture Sector Activity Opportunities
9.	**5) Low-emission farming systems** • Agro-ecology • Organic Farming • Conservation agriculture • Integrated Crop Management
10.	**6) Climate Smart agriculture**
11.	Promotion of good agriculture Practices • Change in agricultural practices • Soil health and fertility management • Cropland management: tillage/residue management
12.	**Change in agricultural water management** • Improve On-farm irrigation management (irrigation and drainage) • Water harvesting, reuse and recycling
13.	**Agricultural advisory service and information systems**
14.	**Promote Practices for Postharvest Handling and Food Waste** • Improved postharvest handling and value addition • Improved food waste management

III.2.5 Housing Sector

Egypt is home to the largest population and market in the Middle East, this implies a steady – if not growing – need for residential and commercial property. Real estate is one of the most important sectors contributing to economic growth and affecting more than 90 industries related to construction. It is considered a labor-intensive sector as it accommodates at least 8% of the total labor force.

Real estate market in Egypt as a whole has been seeing strong growth. Housing is a basic human need, like food and clothing, and a basic human right that is guaranteed by all legislations and constitutions. Therefore, Egypt is in a dire need for a prudent and firm housing policy that aims at not only meeting the growing needs of the Egyptian society year after year, but also at solving the accumulating housing problems and meeting the shortage in housing units that resulted from previous policies and legislations.

There is a great demand for residential construction in Egypt where there is a high population growth rate and a high urbanization rate, such demand is mainly driven by the demand for low and middle income housing; a gap that is yet to be satisfied. It is important to know that 29% of the population is under 40 years old and almost half of the Egyptian population is under 19 years old implying a growing demand.The construction industry is booming based on massive demand for residential real estate serving population for over 84 million.

Table III.9 gives the opportunity GHGs emissions mitigation actions in the housing sector and Table III.10 presents policy instruments aimed at mitigating GHGs emissions in the building sector.

Table (III.9): Available GHGs emissions mitigation options in the housing sector

No.	GHGs Emissions Mitigation Options in Buildings
1.	**Overview of Energy Efficiency Principles**
	• Reduce heating, cooling and lighting loads
	• Utilize active solar energy and other environmental heat sources and sinks
	• Increase efficiency of appliances, heating and cooling equipment and ventilation
	• Utilize high efficient motors for water pumping and other uses.
	• Implement commissioning and improve operations and maintenance
	• Change behavior
	• Utilize system approaches to building design
	• Consider building form, orientation and related attributes
	• Minimize halocarbon emissions
2.	**Thermal Envelope**
	• Insulation
	• Windows
	• Air leakage
3.	**Heating systems**
	• Passive solar heating
	• Space heating systems

No.	GHGs Emissions Mitigation Options in Buildings
4.	**Cooling and Cooling Loads**
	• Reducing the cooling load
	• Passive and low-energy cooling techniques
	• Air conditioners and vapour-compression chillers
5.	**Heating, ventilation and air conditioning (HVAC) systems**
	• Principles of energy-efficient HVAC design
	• Alternative HVAC systems in commercial buildings
6.	**Building energy management systems (BEMS)**
	• Commissioning
	• Operation, maintenance and performance benchmarking
7.	**Active collection and transformation of solar energy**
	• Building-integrated PV (BiPV)
	• Solar thermal energy for heating and hot water
8.	**Domestic hot water**
9.	**Lighting systems**
	• High efficiency electric lighting
10.	**Daylighting**
11.	**Household appliances, consumer electronics and office equipment**
12.	**Supermarket refrigeration systems**
13.	**Energy savings through retrofits**
	• Conventional retrofits of residential buildings
	• Conventional retrofits of institutional and commercial buildings
	• Solar retrofits of residential, institutional and commercial buildings
14.	**Trade-offs between embodied energy and operating energy**
15.	**Trade-offs involving energy-related emissions and halocarbon emissions**

Table (III.10): Impact and effectiveness of various policy instruments aimed to mitigating GHGs emissions in the building sector

Policy instrument	Effectiveness [b]	Cost effectiveness [c]	Special conditions for success, major strengths and limitations, co-benefits
1. Control and regulatory mechanisms			
Appliance Standards	High	High	Factors for success: periodical update of standards, independent control, information, communication and education.
Building codes	High	Medium	No incentive to improve beyond target. Only effective if enforced.
Procurement Regulations	High	Medium	Success factors: enabling legislation, energy efficiency labeling& testing, ambitious energy efficiency specifications.
Mandatory labeling and certification programmes	High	High	Effectiveness can be boosted by combination with other instrument and regular updates.
Energy efficiency obligations and quotas	High	High	Continuous improvements necessary: new energy efficiency measures short-term incentives to transform markets etc.
Utility demand side management programmes	High	High	DSM programmes for commercial sector tend to be more cost effective than those for residences.

Policy instrument	Effectiveness [b]	Cost effectiveness [c]	Special conditions for success, major strengths and limitations, co-benefits
2. Economic and market-based instruments			
Energy performance contracting	High	Medium	Strength: no need for public spending or market intervention, co-benefit of improved competitiveness.
Co-operative procurement	High	High	Success condition: energy efficiency needs to be prioritized in purchasing decisions.
Energy efficiency certificate schemes	Medium	Medium	No long-term experience yet. Transaction costs can be high. Monitoring and verification crucial. Benefits for employment.
Kyoto Protocol flexible mechanisms [d]	Low	Low	So far limited number of CDM & JI projects in buildings.
Taxation (on CO2 or household fuels)	Low	Low	Effect depends on price elasticity. Revenues can be earmarked for further efficiency. More effective when combined with other tools.
Tax exemptions /reductions	High	High	If properly structured, stimulate introduction of highly efficient equipment and new buildings.
Public benefit charges	Medium/low	High in reported cases	
Capital subsidies, grants, subsidized loans	High	Low	Positive for low-income households, risk of free - riders, may induce pioneering investments.

Policy instrument	Effectiveness [b]	Cost effectiveness [c]	Special conditions for success, major strengths and limitations, co-benefits
Voluntary certification and labeling	Medium/ high	High	Effective with financial incentives, voluntary agreements and regulations.
Voluntary and negotiated agreements	Medium/High	Medium	Can be effective when regulations are difficult to enforce. Effective if combined with financial incentives and threat of regulation.
Public leadership programmes	High	High	Can be used to demonstrate new technologies and practices. Mandatory programmes have higher potential than voluntary ones.
Awareness raising, education/ information campaigns	Low/Medium	High	More applicable in residential sector than commercial.
Mandatory audit & energy management requirement	High, but variable	Medium	Most effective if combined with other measures such as financial incentives
Detailed billing and disclosure programmes	Medium	Medium	Success conditions: combination with other measures and periodic evaluation. Comparability with other households is positive.

a) For definitions of the instruments see: Crossley et al. (1999), Crossley et al. (2000), EFA (2002), Vine et al. (2003) and Wuppertal Institute (2002).

b) Effectiveness of CO2 emission reduction: includes ease of implementation; feasibility and simplicity of enforcement; applicability in many locations; and other factors contributing to overall magnitude of realized savings.

c) Cost-effectiveness is related to specific societal cost per unit of carbon emissions avoided. Energy savings were recalculated into emission savings using the following references for the emission factors: Davis (2003), UNEP (2000), Center for Clean Air Policy (2001). The country-specific energy price was subtracted from the cost of saved energy in order to account for the financial benefits of energy savings (Koomey and Krause, 1989), if they were not considered originally.

III.2.6 Water Resources Sector

Egypt depends mainly on the Nile River since it constitutes more than 95% of Egypt's total water resources, The agricultural sub-sector (including fisheries) is estimated to be the major water consumer, with approximately 86% of the water consumption. Municipal and industrial sub-sectors consume only about 8% and 6%, respectively, Water infrastructure system in Egypt is mainly composed of irrigation, drainage, water and wastewater pumping stations, in addition to the water and wastewater treatment facilities. Potential of GHGs emissions mitigation opportunities is presented in Table III.11.

Table (III.11): Irrigation sector GHGs emissions mitigation opportunities

No.	NAMA Opportunity
	Irrigation & Drainage Pumping
1.	Replacement/Rehabilitation of pumps working with low efficiency
2.	Operating the pumps using renewable energy sources
	Water Pumping Stations
3.	Replacement/Rehabilitation of pumps working with low efficiency
4.	Operating the pumps using renewable energy sources

III.2.7 Tourism Sector

Tourist industry mainly considers potential risks from climate change and work with the government to develop strategies for reducing vulnerability to climate change. Given the uncertainties about how tourism could be affected by climate change but the potential for large losses, it would be prudent for the industry to monitor tourist behavior. Government should consider the importance of tourism in allocating water resources and in coastal areas' planning. Tourism is of such high economic value, adequate water supplies for future tourism need to be secured. Coastal planning should consider critical importance of protecting tourism facilities from sea level rise and change in coastal storm regime. This should be done in a manner that protects the attractiveness of tourism facilities.

It is essential to develop a Low Carbon Strategy (LCS) as part of GHGs emissions mitigation scheme, for the Egyptian tourism sector which should include, but not limited to, the following policy lines:

- Improve energy efficiency and load/energy management.
- Increase on-site energy production from renewable sources, in particular solar energy.
- Promote for sea water desalination-based concentrated solar power and using high efficient desalination technologies.
- Set achievable specific energy, water consumption and waste generation targets.

- Maximize use of natural gas when possible.
- Establish energy efficiency, renewable energy and waste certification body for tourism sector. This body will mainly certify and offer incentives to the tourist facility that achieves target specific energy consumption, use renewable energy and minimize waste generation.

TableIII.12 presents NAMAs opportunities of GHGs emissions in the Egyptian tourism sector.

Table (III.12): NAMAs opportunities for GHGs emissions in the Egyptian tourism sector

No.	NAMA Opportunity
	Energy Efficiency Measures
1.	Efficient lighting
2.	Energy management system
3.	Waste heat Recovery
4.	Cogeneration
5.	High efficiency motors and drives
6.	High Efficiency Chillers
7.	Improving Combustion efficiency
8.	Steam system improvements
9.	High efficiency desalination units
10.	Building design /orientation (new bid)
11.	Shading/Double glass
12.	Efficient Internal transportation
	Renewable Energy Measures
13.	Solar water heaters
14.	Photovoltaic PV
15.	Concentering Solar Power (CSP)
16.	CSP-Solar water desalination
17.	Wind power

Some of the proposed tourism NAMA sections are being implemented on small scale in support of Ministry of Tourism, include the following programmes:

1. Boilers tune-up
2. High Efficiency lighting
3. Solar water heaters
4. Cluster cogeneration
5. CSP-water desalination
6. PV for public lighting

III.2.8 Waste Sector

Wastes can be broadly classified into liquid wastes and solid wastes. The liquid wastes comprise mainly wastewater, both domestic and industrial. On the other hand, the solid wastes have various origins and compositions. The following are the main solid waste types:

- Municipal solid waste (MSW).
- Agricultural wastes.
- Sewage sludge.
- Industrial waste.
- Animal Manure.
- Medical waste.
- Hazardous waste.

This section presents possible technologies for reducing the GHGs emissions in the waste sector. The technologies have been selected based on their technical viability both locally and internationally. Other technically viable technologies yet on the pilot or demonstration scale have been excluded. Figure III.1depicts mitigation opportunities in the waste sector based on a hierarchal order.

Common mitigation opportunities for different solid waste types include:

- Improved Sanitary Landfilling.
- Incineration with Energy Recovery (IER).
- Gasification.
- Anaerobic Digestion.
- Composting.
- Co-firing in Cement Kilns.

Table III.13 summarizes GHGs emissions mitigation options in the waste sub-sectors. Tables III.14, III.15 and III.16 give GHGs emissions mitigation measures for currently untreated domestic wastewater, currently anaerobically treated domestic wastewater without biogas recovery and for currently untreated industrial wastewater, respectively.

Figure (III.1): Recommended mitigation opportunities in the waste sector based on a hierarchal order

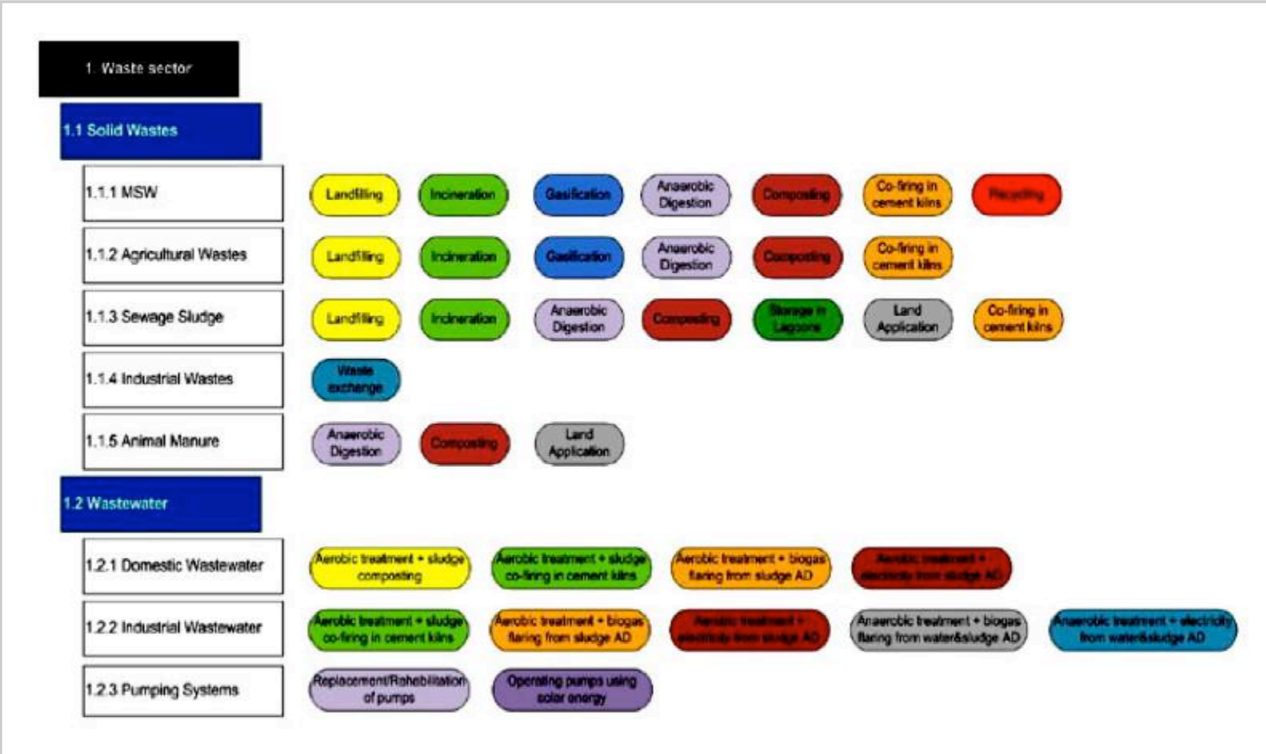


Table (III.13): GHGs emissions reduction opportunities in the waste sub-sectors

No.	NAMA Opportunity
1.	**Solid Wastes Sub-Sector**
	MSW Management
1.1	Improved Landfilling
1.2	Incineration with energy recovery
1.3	Gasification
1.4	Anaerobic Digestion
1.5	Composting
1.6	Co-firing in Cement Kilns
1.7	Recycling
	Agricultural Waste Management
1.8	Improved Landfilling
1.9	Incineration with energy recovery
1.10	Gasification
1.11	Anaerobic Co-Digestion
1.12	Composting
1.13	Co-firing in Cement Kilns
	Sewage Sludge Management
1.14	Improved Landfilling
1.15	Incineration with energy recovery
1.16	Anaerobic Co-Digestion
1.17	Composting
1.18	Storage in Lagoons
1.19	Land Application
1.20	Co-firing in Cement Kilns
	Industrial Waste Management
1.21	Waste Exchange
	Animal Manure Management
1.22	Anaerobic Digestion

No.	NAMA Opportunity
1.23	Composting
1.24	Land Application
2.	**Wastewater Sub-Sector**
	Domestic WW
2.1	Aerobic treatment & sludge composting
2.2	Aerobic treatment & sludge co-firing in cement kilns
2.3	Aerobic treatment & sludge anaerobic treatment with biogas flaring
2.4	Aerobic treatment & sludge anaerobic treatment with electricity generation
	Industrial WW
	Aerobic treatment & sludge co-firing in cement kilns
	Aerobic treatment & sludge anaerobic treatment with biogas flaring
	Aerobic treatment & sludge anaerobic treatment with electricity generation
	Aerobic treatment of wastewater and sludge with biogas flaring
	Aerobic treatment of wastewater and sludge with electricity generation
	Putrmine system modification
	Replacement / rehabilitation of pumps

Table (III.14): GHGs emissions mitigation measures for currently untreated domestic wastewater

Mitigation Measure	Emission Reduction Potential (kg CO_2e/m^3ww)	Cost of Mitigation (US$/$m^3$ww)
Aerobic Treatment of wastewater and composting of sludge (Aer+comp)	0.29	Shallow Ponds: 0.015 Aerobic WWTP: 0.05
Aerobic Treatment of wastewater and co-firing of sludge in cement kilns (Aer+CFC)	2.25	Shallow Ponds: 0.014 Aerobic WWTP: 0.05
Aerobic Treatment of wastewater andanaerobic treatment of sludge with biogas flaring (Ane+BF)	2.55	Shallow Ponds: 0.134 Aerobic WWTP: 0.17
Treatment of wastewater andanaerobic treatment of sludge with electricity generation Aerobic (Ane+EG)	2.79	Shallow Ponds: 0.154 Aerobic WWTP:0.19

Table (III.15-): GHGs emissions mitigation measures for currently anaerobically treated domestic wastewater without biogas recovery

Mitigation Measure	Emission Reduction Potential (kg CO_2e/m^3ww)	Cost of Mitigation (US$/$m^3ww$)
Aerobic Treatment of wastewater and composting of sludge (Aer+comp)	1.72	Shallow Ponds: 0.015
		Aerobic WWTP: 0.05
Aerobic Treatment of wastewater and co-firing of sludge in cement kilns (Aer+CFC)	3.68	Shallow Ponds: 0.014
		Aerobic WWTP: 0.05
Aerobic Treatment of wastewater and Anaerobic treatment of sludge with biogas flaring (Ane+BF)	1.84	Shallow Ponds: 0.134
		Aerobic WWTP: 0.17
Aerobic Treatment of wastewater and anaerobic treatment of sludge with electricity generation (Ane+EG)	4.22	Shallow Ponds: 0.154
		Aerobic WWTP: 0.19

Table (III.16): GHGs emissions mitigation measures for currently untreated industrial wastewater

Mitigation Measure	Emission Reduction Potential (kg CO_2e/m^3ww)	Cost of Mitigation (US$/$m^3ww$)
Aerobic Treatment of wastewater and co-firing of sludge in cement kilns (Aer+CFC)	4.09	Shallow Ponds: 0.014
		Aerobic WWTP: 0.05
Aerobic Treatment of wastewater and anaerobic treatment of sludge with biogas flaring (Aer+BF)	2.46	Shallow Ponds: 0.134
		Aerobic WWTP: 0.17

Aerobic Treatment of wastewater and anaerobic treatment of sludge with electricity generation (Aer+EG)	2.7	Shallow Ponds: 0.154 Aerobic WWTP: 0.19
Anaerobic Treatment of wastewater and sludge with biogas flaring (Ane+BF)	0.82	0.12
Anaerobic Treatment of wastewater and sludge with electricity generation (Ane+EG)	4.38	0.14

CHAPTER IV: VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE

IV.1. INTRODUCTION

The vulnerability and adaptation of various sectors in Egypt to potential impacts of climatic changes has been presented in the second national communication as of 2010 (EEAA, 2010). Recent reviews indicated that a number of gaps including detailed potential impacts of climate change on health, tourism and biodiversity as well as the detailed assessment of increase of frequency and severity of extreme events on various sectors of development, have not been treated thoroughly in the second national assessment. In addition, the impact of climate change on urban systems has not been treated at all.

So, in the work towards the development of the third national communication report, it was decided to remedy these issues through updating vulnerability and adaptation according to most recently published literature and including a detailed account of the above mentioned issues.

The shortage of governmental institutional systems necessary to monitor, build data basis, analyze data and advice decision makers concerning adaptation measures and follow up implementation of policies and measures to face climate changes, constitute a major problem. This gap is being fixed by development of data base to serve all sectors of development. In addition, building human capacity in lines of physical, technological and socio- economic considerations is still going on at very slow rate.

This report represents an updated vulnerability assessment report for various sectors based on reports of each sector.

IV.2. WATER RESOURCES

Water in Egypt, as it is in many parts of the world, is life. The country is composed of a huge area of desert land, only a small portion of which is inhabited. This portion does not exceed 5% of the total area while the remaining 95% is barren desert which is largely empty of any sign of real life. The reason for this odd configuration is the fact that the River Nile crosses the country from the far south to the Mediterranean on the far north carrying water for the Egyptians who live on its banks in the upper part (the Nile Valley) and the lower part in the Nile Delta. Egypt is therefore largely dependent on Nile water which is used for: potable water supply, agriculture, industry, fish farming, power generation, inland river navigation, mining, oil and gas exploration, cooling of machinery and power plants in addition to the most important goal of protecting the environment from pollution. This wide range of water utilization for different purposes explains the reason of concern against negative impacts of climate change which might cause, as reported by many agencies, that the natural flow of the River Nile will be reduced due to the reduction of rainfall on the upper Nile Basins as well as the reduction of rainfall on the east Mediterranean coastal zone plus the effect of sea level rise on the quality of groundwater in the coastal aquifers.

IV.2.1 Water Resources in Egypt

IV.2.1.1 Nile Water

Egypt depends on more than 95% of its water resources on the River Nile. The country enjoys, so far, the use of 55.5 billion m^3 of water from the river every year, based upon an agreement signed with Sudan in the year 1959. Rainfall on the Nile Basin throughout the past decades since measurements started have the average of 1600 billion m3 out of which no more than 100 billion m^3 is received as surface run off. Egypt and Sudan divided the amount received at Aswan (84 billion m3) of this run off as 55.5 billion m3 for Egypt, 18.5 billion m3 for Sudan and the remaining 10 billion m3 are left for evaporation from the Lake of High Aswan Dam reservoir normally called Lake Nasser.

IV.2.1.2 Rain fall and flash floods

Rain in Egypt only falls effectively on the North Coast running parallel to the Mediterranean. The intensity varies from 300 mm/year on the far eastern border city of Rafah, decreased towards the west direction until it reaches 200 mm/year at Port Said, 150 mm/year at Alexandria and it increases again towards the west reaching 250 mm/year at El-Salloum on the border with Libya. Rain diminishes fast going south inside the country where it reaches 30 mm/year at Cairo and practically zero at the far southern end at Aswan.The Red Sea area enjoys high intensity rates of rain at the southern end in Halayeb, Shalatin and Abu Ramad which sometimes is close to 500 mm/year, while the northern oil cities Hurgada, Kousair, Safaga and MarsaAlam have less intensity of 100 mm/year and less.The Red Sea area can be subject to flash floods which occur once every a number of years (5-10) caused by differences in pressures coming from cool Europe and warm Asia. These flash floods, which are not early warned, might cause destruction of property and loss of life. The Egyptian Government is always keen on the use of flash floods water for the recharge of groundwater aquifers and storage for the beneficial use of humans and animals.

IV.2.1.3 Groundwater

Groundwater in Egypt although of minor qualities is scattered over a number of aquifers of different characteristics: shallow and deep, renewable and fossil, fresh and saline.

The ***Nile Basin Groundwater Aquifer*** is located underneath the cultivated land in the Nile Valley and Delta. It is mainly fed from the Nile and the surplus of irrigation water of the cultivated land. The aquifer is used, especially in the southern part of the Delta and the Upper Egypt to supplement Nile Water due to the fact that its quality is normally suitable for irrigation and sometimes for potable supply. Groundwater quality towards the north tends to be gradually saline and becomes almost salty on the coast of the Mediterranean.

The ***Nubian Sandstone Aquifer*** covers huge area of land in the Western Desert, Eastern Desert and Sinai Peninsula. Water in this aquifer is not renewable. The amount is large according to many researches; however, being non-renewable the water table becomes deeper with abstraction. The quality of this water is extremely fresh. The ***Limestone Aquifer*** is located above the Nubian Sandstone Aquifer in some parts of the Western Desert. Water in limestone flows in the fissures and cracks of the stone. Since the stone is abrasive water salinity is moderate. The ***Coastal Aquifer*** is fed by the rain which falls on the sand dunes running parallel to the Mediterranean Sea shore. The aquifer is confined to lenses of fresh water which sit above the saline aquifer caused by sea water intrusion. If abstraction from coastal aquifers is excessive, pumping of saline water may take place.

IV.2.1.4 Recycling of Water

Egypt is, at the present time, suffering a deficit of about 10 billion m^3/year. This is due to the fact that supply is less than demand by this amount. In order to overcome this deficit, water recycling is heavily practiced all over the country. Agriculture land drainage, treated sanitary sewage treated industrial effluent and even desalination of sea water is practiced in Egypt for decades.

IV.2.2 Water Demand

IV.2.2.1 Potable and Municipal Requirements

Potable and municipal water supply is a fast growing part of the Egyptian water budget due to the rocketing increase in population. Consumption of tap water is as high as 9 – 10 billion m^3 at the present time. This amount is expected to double during the coming 40 – 50 years partly because of the increase in population and partly due to the expected raise in the standard of living.

IV.2.2.2 Agriculture

The area of cultivated land in Egypt at the present time is almost 8 million feddans. This area is consuming about 50 billion m^3/year. This amount is covered mainly from Nile water. Groundwater is used either as a supplement to Nile water or completely separate in location where Nile water cannot be made available. Agriculture is the main consumer of water since it takes almost 80% of the country's water budget.

IV.2.2.3 Industry

Egypt has a growing industrial base which includes heavy industries (steel, cement, aluminum, ceramics, porcelain, chemical fertilizers, paper mills,etc); medium size and small size factories. The total number of factories in the country big and small is reported to be as large as 35,000 which need water both for the manufacturing process as well as for the cooling of the machinery.

IV.2.2.4 Tourism

Tourism in Egypt is one of the important sources of national income. The number of tourists visiting the country in the year 2010 reached more than 14 million spending about 140 million tourist nights in the country. The major connection between tourism and water is the sailing ferries in the Nile and its branches which require certain depth of water in the navigable channel to accommodate for the ever increasing draft of these vessels which is now little less than 3 meters. Other water consuming elements within the tourism activity could be the irrigation of green areas in the hotels and resorts, especially golf courts which are now increasing in numbers from only 15 in 2000 to more than 25 at the present time. The filling of artificial water lakes, the washing of hotel towels, sheets etc. and the kitchen water needs are also part of tourism water requirements.

IV. 2.2.5 Fish Farming

Egypt relies on fish farming in 80% of the total fish production. This implies that the production of fish farms which is now standing at a level of about 1.5 million ton per year and which is required to be increased to bring the per capita consumption from the existing low level of 0.1 kg/day to a higher level of 0.18 kg/day.

IV.2.3 Vulnerability of Water Resources in Egypt to Climate Change

Water resources in Egypt are not only vulnerable to climate change, they are also vulnerable to a number of factors which might be of more influence than climate change, some of these factors are:

IV.2.3.1 Fast growing population

The increase in population at the present time is more than 2.0 million capita per year. Estimates call for the doubling of the quantity of water needed for potable and municipal supply in the coming 30 – 40 years when the population which stands now at 90 million reaches a higher figure of 150 million.

IV.2.3.2 Relationship between Egypt and other Nile Basin countries

The relationship between Egypt and Nile Basin countries during the last 3 – 4 years came to a situation where six of these countries namely Ethiopia, Uganda, Tanzania, Kenya, Rowanda and Borondi signed separately on a “Framework Treaty”

that is not acceptable to Egypt and Sudan. The Republic of Congo did not sign with other countries. This tense situation puts question marks on how to guarantee receiving the quota that has been obtained throughout the last six decades.

IV.2.3.3 Division of Sudan

Sudan has been divided and south Sudan has been created in July 2012. The new state includes within its official boundaries the Bahr El Ghazal Sub-basin on which one third of the total precipitation of the Nile Basin falls. However, the contribution of this sub-basin to the main river comes almost to nil. It was always the target of Egypt to implement some of the losses capturing projects which reduces the flow to the swamps and marches of Bahr El Ghazal and direct it to the main stream of the river. It is not expected that the newly created South Sudan to be in favor of implementing any water loss capturing projects due to the prevailing political unrest in the newly born country.

IV.2.3.4 Construction of Dams in the Nile Basin Countries

Ethiopia is taking the lead in the construction of dams on the Blue Nile which contributes to the main stream of the River Nile by some 72 bm^3 or about 80% of its natural flow. Although Ethiopia always confirm that these dams are only for the production of hydropower, yet, the large number of dams that is going to be constructed represent high risk to water supply that reaches Egypt. Not only Ethiopia that intends to construct dams on the Nile Basin, Uganda, Kenya and Tanzania has their own plans to construct other dams in the part of the Nile Basin inside their countries.

IV.2.3.5 Pollution of Water Resources

Pollution of Nile water might be outside Egypt as water takes its way from upper Nile countries; this is mainly due to the disposal of DDT loads used for treatment against Malaria. If some of the Nile Basin countries opt for irrigated agriculture, use of agro-chemicals and chemical fertilizers will be necessary. In this case most probably water reaching Egypt will be changed from the existing excellent quality into more polluted features.

IV.2.3.6 Vulnerability of Nile Water to Climate Change

Nile water originates from three different sources namely the Equatorial Lakes Plateau, Bahr El Ghazal sub basin and the Ethiopian High Lands. The three sub basins are climatically independent and, therefore, the effect of climate change has to be investigated on each sub basin separately.

A conference held in Cairo, 24-25 February 2013 on “Climate Change Impact on the Nile Basin, Exchange of Experiences within the Basin”. In this conference, a number of country reports were presented; most of them are not informative. The only country report that can be taken into consideration is that of Egypt which gave the results of a statistically down scaled model from the UK MO Regional Circulation Model. The conclusion of the report was that changes in rainfall, temperature and potential evapotranspiration were all smaller than previous studies. Following are the ranges of change in flow:

- Blue Nile (Diem): (-19%) to (+29%)
- White Nile (Malakal): (-8%) to (+10%)
- Main Nile (Dongola): (-13%) to (+36%)

The report also states that the results confirm uncertainty regarding the direction of change for rainfall and flow. The Regional Circulation Model reduced uncertainty in bandwidth but “care must be taken that not all sources are included”.

The Research Report (2) published by the International Water Management Institute and the Utah State University on “Climate Change Impacts on Hydrology and Water Resources of the Upper Blue Nile River Basin, Ethiopia revealed the following:

- Climate in most Upper Blue Nile River Basin is likely to become wetter and warmer in the 2050’s (2040 – 2069).
- Low flows may become higher and severe mid-to long- term droughts are likely to become less frequent throughout the entire basin.
- Potential future dam operators are unlikely to significantly affect water availability to Egypt and Sudan based on predicted outflows from six GCM’s and many dam operation scenarios.
- The results, however, uncertain with existing accuracy of climate models, suggest that the region is likely to have the future potential to produce hydropower, increase flow duration and increase water storage capacity without affecting outflows to the riparian countries in the 2050’s. Potential impacts of climate change on the hydrology and water resources of the River Nile Basin downscaled from runs of

11 GCM's and 2 global emission scenario's (A2 & B1) show the following results:

- A2: Unconstrained growth in Emission Global average CO_2 concentration will reach 850 ppm by 2100.
- B1: Elimination of global emission increase by 2100. Increase at the same rate as A2 but then level off around mid-century and reach 550 ppm by 2100 (due to increasing dependence on clean and resource efficient technologies).)
- The Nile Basin will experience increase in precipitation early in the century (Period I, 2010-2039), followed by decreases later in the century (Period II, 2040-2069 and Period III, 2070-2099) with the exception of the eastern-most Ethiopian highlands which is expected to experience increases in summer precipitation by 2080-2100.
- Summarized as spatial average over the entire Nile Basin, multi model – average Nile Basin precipitation changes as percentage of the period (1950-1999) are 115 (117), 98 (104) and 93 (96) while temperature changes are 1.5 (1.3), 3.2(2.8), 4.4 (3.6).[1]
- These changes in precipitation and temperatures resulted in stream flow at High Aswan Dam that are 111 (114), 92 (93) and 84 (87) percent of historical simulated stream flow (1950-1999).
- Hydropower production at High Aswan Dam will increase early in the century to 112% (118%) but then decrease to 92% (97%) and 87% (91%) (A2 & B1: Global Emission Scenarios).

In its Fourth Assessment Report (2007), IPCC identified Africa as one of the most vulnerable regions to climate change specifically with respect to water resources. The report indicated that most of north and southern Africa will be subject to water stress while east, central and West Africa is projected to receive heavy rain resulting in increased flooding.

These strong statements of IPCC reflect the importance of having timely and adequate action to adapt to the anticipated risks of climate change. UNDP and UNESCO in cooperation with the Egyptian Ministry of Water Resources and Irrigation launched a project on "Climate Change Risk Management". The project was divided into four components: i) Energy efficiency policy, ii) Clean development mechanisms, iii) Flood forecast and IWRM; and iv) Adaptation of agriculture.

The four components were implemented by the Ministries of Electricity, Environment, Irrigation and Agriculture respectively.

IV.2.3.7 Nile Basin Countries Vulnerability to Climate and Climate Change

No statistically significant trend for precipitation change can be observed in Ethiopia between 1960 and 2000. Reliable data on the flow of the Nile are difficult to find. Models generally agree on a further warming in the range of 1°C - 5°C by the 2090's with higher increase in the north (Egypt and north Sudan) than in the south. On the Blue Nile catchment rainfall reduction is predicted in 10 out of 17 GCM's for the 2090's with a spread of -15% to +14%. Predictions of flow at Aswan vary extensively in the literature. Elshamy et al (2009) reported downstream flow changes of -62% to +43%, Conway distinguishes dry and wet case of

1. The given figures are for A2 scenarios and B1 figures between brackets.

-9% to +15% for 2025.Strezpekand Block (2012) predict change between -90% and +18% in the 2090's. Climate change is expected also to increase the occurrence of extreme events like floods and droughts to which all Nile countries are vulnerable. Brooks et al measured national vulnerability using a set of 11 indicators and rated Ethiopia and Sudan among the most vulnerable and Uganda among the moderate to high while Egypt was classified somewhat lower vulnerable due to its higher level of development, yet it faces the most severe challenges of the riparian countries due to its great dependence on the Nile water.

IV.2.4. ADAPTATION

In the context of climate science, sensitivity can be defined as "the degree to which a system is affected either adversely or beneficially by climate variability or change". The sensitivity to possible changes in environmental conditions in the River Nile Basin due to climate change will place a stress on the societies in the riparian countries, which adds to the challenge posed by demographic changes and economic development. However, adaptation to climate change is possible at different levels. While antonymous adaptation, e.g. farmer shifting sowing and harvesting dates and changing crop patterns is to some extent taking place, large scale challenges and especially those related to trans boundary water resource are likely to be best addressed by planned adaptation at the national level, generally in conjunction with development mechanisms independent of climate change.

The "Adaptive Capacity" of a country is an indication of the degree to which a society is able to adjust to changes in environmental conditions. It is defined as "the ability to take measures in response to or in preparation for the effects of climate change". Pressure on natural resources is strongly exacerbated by population growth.

By 2050, population of Egypt is expected to increase by a factor of 1.5. The growth factor of Ethiopia is 1.7, Sudan 2.1, Uganda 2.7 or even higher. This is not the extreme scenario but rather a moderate projection among several plausible trends. This type of high growth factor will certainly lead to increased demand on water and food as well as large number of employment opportunities.

At the present time Egypt is water scarce (678 m^3 per capita in 2010), Sudan and Ethiopia are water stressed (1436 and 1493 m3/per capita, respectively), Uganda have relatively water sufficiency at 1953 m3 per capita. By 2030 Ethiopia and Sudan will be water scarce and water scarcity in Egypt will be even worse than what it is at the present time. The level of development among Nile Basin countries vary considerably.

The Human Development Index of Egypt HDI = 0.62 (Rank 101), Sudan HDI = 0.379 Rank (154) Ethiopia HDI = 0.328 (Rank 157) and Uganda HDI = 0.422 (Rank 143). Although the low HDI is reflected in more specific indicators such as availability of infrastructure, education and technological options which are mostly low in Sudan and very low in Ethiopia, the overall level of development in most Nile Basin countries is likely to increase appreciably in the coming decades. Reduction of the Nile total flow, would increase dependency of upstream countries on Nile water, downstream countries would be hard pressed to maintain their status quo.

IV.2.4.1 Increased Nile Flows

Although increased Nile flows would ease the relationship between upstream and downstream countries since then will be enough water for every country. However, higher flows might overwhelm the capacities of existing and future dams unless this possibility is taken into account. Furthermore infrastructure on the river and branching canals might be endangered and siltation may be increased.

IV.2.4.2 Stable Nile Flows, Increased Variability

Increase in variability, especially of precipitation is the most securely predicted impact of climate change. More floods and droughts make dam operation more challenging, perhaps sometimes non-viable. Cost-benefit ratio of large dams under climate change is questionable, and therefore, high level cooperation in the management of dams is more than necessary. A basin wide early warning system would be highly beneficial to all. In conclusion, one particular incentive for Egypt to join a cooperation scheme on Nile water could be its increasing dependence or information about rainfall and flows upstream in order to efficiently manage the High Aswan Dam and prepare for floods and droughts. On the other hand, impacts of climate change could also affect the developing capacities of upstream countries which enable them to challenge Egypt's hydro-hegnomy. This would, therefore, reduce the incentive to Egypt to cooperate with its neighbors about the allocation of Nile water.

IV.2.4.3 Selected Adaptation Options for Water Resources Management in Egypt

The national and regional policies for adaptation for water resources management include:

- Water conservation measures in agriculture, industry and municipal supplies.
- Upgrading water quality and sanitation to minimize pollution.
- Construction of infrastructure for water collection in flash flood areas (e.g. Sinai, Red Sea and Upper and Middle Egypt).
- Use of renewable energy (solar and wind) for water desalination.
- Storage of drainage and fresh water in coastal lakes.
- Public awareness campaign on water scarcity and water shortage.

As for institutional and research measures, they include:

- Encourage meteorology departments in universities and otherwise to study impacts of climate variability and change.
- Strengthen cooperation and exchange of information between research institutes and universities working on different aspects of water resources.
- Improve adaptive capacity on climate variability and change.
- Improve rain harvesting techniques.
- Increase abstraction of groundwater both fresh and brackish.
- Improve recycling techniques of treated sewage and industrial effluent, desalination and improved water conveyance.

IV.2.4.4 Expected Sources of Hazards and Risks

Climate model projections over most of the Nile Basin show warming in all four seasons across the countries but a wide range of rainfall patterns, with no clear direction of change. This high level of uncertainty in the future behavior of rainfall is a significant challenge to understand and act upon the risks posed by climate change.

IV.2.4.5 Potential Sources of Systematic Observations

Egypt has a coastal line along the Mediterranean which extends from the western border city of Salloum to the eastern border city of Rafah. The Mediterranean climate is characterized by wet winters and mild, dry and generally warm summers. The Mediterranean is considered a transitional region between mild-latitudes and subtropical climate regions with a division line moving seasonally across the basin. This semi-enclosed relatively large mass of water exerts an important and strong influence on the environment, climate economy and culture of the coastal areas. It is an important source of moisture and heat reservoir. Information is already available in global simulations and it can be used to provide regional projections which for the Mediterranean are surprisingly consistent among different models. On the other hand, global simulation cannot be considered adequate for the description of the Mediterranean region and downscaling by statistical methods or dynamical models, can in some situation be used to provide better insight and provide results at high resolution.

IV. 3. AGRICULTURE SECTOR

IV. 3.1 Vulnerability and adaptation

Egypt appears to be particularly vulnerable to climate change, because of its dependence on the Nile River as the primary water source, its large traditional agricultural base, and its long coastline, which is already undergoing both intensifying development and erosion (EEAA, 1999 and EEAA, 2010).

Egypt is one of the most vulnerable countries to the potential impacts and risks of climate change, even though it produces less than 1 % of the world total emissions of greenhouse gases. More than 95 % of the water budget of Egypt is received from the River Nile which is generated outside Egypt's territory. Numerous studies showed that River Nile is very sensitive to temperature and precipitation changes (World Bank, 2007). Agriculture in Egypt is expected to be especially vulnerable because of hot climate. Further warming is consequently expected to reduce crop productivity. These effects are exacerbated by the fact that agriculture and agro-ecological systems are especially prominent in the economics of Egypt as one of the African countries (Riebsame, 1995).

More studies were made to assess the potential impacts of climate change on crop productivity and crop water use under different agro-climatological zones in Egypt. Adaptation is a key factor that will shape the future severity of climate change impacts on food production (Easterling, 2007). Although relatively inexpensive changes, such as shifting planting dates or switching to an existing crop variety, may mitigate negative impacts. The biggest benefits will likely result from more costly measures including the development of new crop varieties and expansion of irrigation (SADS 2030, 2010). These adaptations will require substantial investments by farmers, governments, scientists, and development organizations, all of whom face many other demands on their resources. Prioritization of investment needs, such as through the identification of "climate risk hot spots" (Burton and van Aalst, 2004), is therefore a critical issue but has received limited attention to date.

IV.3.1.1 Assessment of Climate Change Impacts on Food Security

As per the reports of FAO (2012) and IPCC (2001) and report of Hassanein (2010) of indicated The most important challenges that the agricultural sector at present has to face and that are very likely to grow in importance, especially under future conditions of climate change, include among others: (1) increasing population growth rates and decreasing the per capita share of agricultural land; (2) increasing production-consumption gaps for the main food crops, especially for cereals, edible oils and sugar; (3) scarcity of water resources; (4) future climatic changes and the reduction in productivity of major crops; and (5) shortage in water supply as well as SLR with its negative effects on salinization of North Nile Delta.

As far as the assessment of the driving forces of food chains is concerned, the analysis presented in the report is mainly restricted to examining the impacts that have been caused by the liberalization reforms and the removal of governmental controls in the area of input supply and domestic marketing, in particular, on the development of cropping patterns and yields.

Based on the SADS 2030 (2010), the current situation of national food security is summarized in table (IV.1).

Table (IV.1): Self- sufficiency for the main food commodities under current conditions

Main Food Commodities	Production (1,000 tons)	Requirements (1,000 tons)	Self-sufficiency ratio (%)
Wheat	7,388	13,591	54.4
Milled rice	4,553	3,273	139.1
Maize	6,300	11,900	53.2
Sugar	1,487	1,933	76.9
Faba beans	301	578	52.1
Potatoes	2,793	1,548	180.4
Tomatoes	7,888	7,623	103.5
Citrus	3,594	2,672	134.5
Grape	1,783	1,294	128.5

Main Food Commodities	Production (1,000 tons)	Requirements (1,000 tons)	Self-sufficiency ratio (%)
Milk	4,400	4,859	90.6
Red meat	670	1,001	66.9
White meat	850	847	100.4
Eggs	240	240	100
Fish	971	1,001	97

The assessment of the agricultural sector's vulnerability to climate change is based on the findings of the major negative impacts are expected through:

- The expected rise in temperature and change of its seasonal pattern would lead to decreasing the productivity of some crops and livestock, as well as a change in environmental agricultural zones;
- Marginal agricultural areas would be negatively affected, and desertification rates would increase;
- Higher temperatures would increase water evaporation and water consumption;
- Socio-economic effects such as labor migration from marginal and coastal areas; and
- The probable rise in sea water level, and its negative effects on coastal areas, tourism and agricultural land in the Delta area.

The agriculture in Egypt is expected to be especially vulnerable to the negative effects listed above because of hot climate, and additional negative impacts are expected to be further exacerbated particularly due to the fact that for the Egyptian economy agriculture and agro-ecological systems are of extremely high macroeconomic importance. In this regard, the ecological regions for some deciduous fruits will be shifted towards northern Egypt. Fruit species are grown under marginal chilling conditions are susceptible to even slight warmer trends. This will give long term costs and commitments involved in planting and maintaining fruit orchards (Farag et al, 2010).

Table (IV.2) the potential impacts of climate change on crop productivity and crop water use in different agro-climatic zones in Egypt are again highlighted, and generally concluding that climate change could decrease national food production by 11 % to a maximum 51 %.

Table (IV.2): Change in major crop production due to climate change

Crop	Increasing in temperature of 1.5°C	Increasing in temperature of 3.5°C	Reference
	Change in crop yields %		
Wheat	- 11 to - 12	-27 to - 31	Hassanein et al, 2012
Maize	-40 to - 47		El-Marsafawy et al, 2012
Rice	-26 to - 47		El-Marsafawy et al, 2012
Sunflower	-29		El-Marsafawy et al, 2007b
Sorghum	-19		El-Marsafawy, 2007a
Vegetable	-28		Smith et al, 2013
Onion	-1.53		
Lentil	-28		
Cotton	19.8		
Citrus	-15.2		
Soybean	-28		
Sugarcane	-15.2		
Potato	-11 to -13		Abdrabbo et al, 2010
Faba bean	-8.40 to -38.35		El-Marsafawy et al, 2013

Self-sufficiency in strategic crops shown in table (IV.3) indicated that, under future climatic changes conditions towards 2030 (with no action scenario), it can be predicted that if the agricultural area and production as the same current, self-sufficient with wheat, maize and milled rice could reach 33.6, 24.8, 86.9 % compared to 57.4, 53.9, and 160.0 % under current conditions. In addition, increasing in population growth rate and the shortage in water supply as well as the rising in sea level with its effect on salinization of North Nile Delta which could decrease the total agriculture area, the situation in food security will more and more seriously in the future.

Yield declines for the most important crops. Climate change will have varying effects on irrigated yields across regions, but irrigated yields for all crops in Egypt will experience large declines. Climate change will result in additional price increases for the most important agricultural crops–rice, wheat, and maize.

On the other hand, with positive action against risks of climate change on self-sufficiency in strategic crops table IV.2shows that under increase of agricultural area and production with 10% (depend on SADS (2010), self-sufficient with wheat, maize and milled rice could reach 49.4, 36.7, and 133.7 %, respectively.

It is therefore vital that action be taken now to counter this threat. Actions should include measures to reduce agriculture's role as a driving force for climate change, through the reduction of GHG emissions, as well as measures to mitigate and adapt to climate change.

Table (IV.3): Estimated rates of self-reliance and self-sufficiency in the main food commodities, under climate change with action and no action of adaptation

Main food commodities	**Current production of 2011**			**2030 estimates*** with no climate change impact**		
	Production* (1,000 tons)	Requirements (1,000 tons)	Self-suf. (%)	Production (1,000 tons)	Requirements (1,000 tons)	Self-Suf. (%)
Wheat	8407	14650	57.4	8407	18709	44.9
Milled rice	5675	3528	160.9	5675	4664	121.7
Maize	6876	12827	53.6	6876	20600	33.4
People population	83 millions			106 millions		
	2030 estimates*** with climate change + no adaptation action			2030 estimates *** with climate change + adaptation action		
	Production (1,000 tons)	Requirements (1,000 tons)	Self-Suf. (%)	Production (1,000 tons)	Requirements (1,000 tons)	Self-Suf. (%)
Wheat	6279.8	18709	33.6	9247.7	18709	49.4
Milled rice	4052.17	4664	86.9	6242.5	4664	133.8
Maize	5103	20600	24.8	7563.6	20600	36.7

Main food commodities	Current production of 2011			2030 estimates*** with no climate change impact		
	Production* (1,000 tons)	Requirements (1,000 tons)	Self-suf. (%)	Production (1,000 tons)	Requirements (1,000 tons)	Self-Suf. (%)
People population	106 millions			106 millions		

* FAOSTAT I © FAO Statistics Division 2013
** CAPMASI Central Agency for Public Mobilization and Statistics 2013
*** SADS 2030 I Sustainable Agriculture Development Strategy Towards 2030

IV.3.1.2 Impacts of Climate Change on Plant Pests and Diseases

It is generally concluded from recent scientific research that the severity of some pests and diseases affecting crops of strategic importance have increased in the last few decades, and that this increase in severity can mainly be attributed to both climatic and socioeconomic factors. There is also clear evidence that climate change is generally altering the distribution and potential distribution, incidence and intensity of plant pests and diseases. Climate change creates new ecological niches, potentially allowing for the establishment and spread of plant pests and diseases to new geographical areas and from one region to another. Accordingly, it might also result in the emergence of new plant diseases and pests. Furthermore, changes in species composition might augment the occurrence of unexpected events, including the emergence of new diseases and pests. These additional opportunities for entry, establishment and spread might generally result in higher uncertainty.

The report of Fahim (2010) was expected to contribute to the potential impacts of climate change on agricultural pests and diseases is concerned, the study - in line with the results of the vulnerability assessment presented in the SNC and the NSACC – in a first step elaborates on the general relationships between climate change as evidenced by higher temperatures, changing humidity regimes, higher variability as well as an increase in extreme weather events (including spells of very high temperatures and droughts) and how these might affect the incidence of insects and plant diseases.

Severe epidemics of tomato late blight (*Phytophthorainfestans*) emerged in the last few years. In practice, an epidemic onset is expected to lead to 2-4 additional sprays to be applied at the coming decades of the 2025-2100's. Furthermore, it is a challenge for potato late-blight researches in the future to find a balance between reduction use of pesticides usage and the pressure to increase pesticide utilize due to changes in climate and challenging the pathogen populations. Another study indicated that, the severities of current cultivars of wheat to leaf rust caused by *Pucciniatriticina* and stripe rust disease caused by *Pucciniastriiformis* increase with increasing temperature, which is projected under climate change conditions (Abolmaaty, 2006).

Some studies found that, generation numbers of *T. absoluta* under climate change conditions increased especially in Qena governorates (south Egypt). However, the expected generation numbers of the pest at 2050 and 2100 are be 12-14 and 13-15 generations per year, respectively (Abolmaaty et al, 2010). The similar results revealed to cotton pink bollworm *Pectinophoragossypiella (*Yones et al, 2011). Other studies revealed that, the insect generation period will be shorter under climate change conditions in Egypt. For example, peach fruit flies (*Bactrocerazonata*) and potato tubeworm, the generation number will increase during the growing seasons (El-Marsafawy et al, 2013 and Farag et al, 2010).

IV.3.1.2.1 Climate Change Impacts on Pesticides Demands

The increasing incidence of diseases and pests will not only result in higher costs related to inspection, treatment and compliance with the obligations of the importing trading partners, but trade disputes under WTO might also become more frequent and more costly to resolve. Investments in early control and detection mechanisms will undoubtedly be valuable, in order to avoid higher costs of eradication and control. Adaptation to the increased potential of spread of plant pests

and diseases under different climate scenarios requires higher levels of forecasting, prevention, early warning and early reaction. Early detection and identification, including through genotypic characterization, preparedness for and rapid response to new and emerging pests are further critical elements.

IV. 3.1.2 .2 Adaptation Recommendations for Plant Pests and Diseases

The main conclusions and recommendations (Fahim, 2010) are as follows:

- Additional information and research is required on the distribution of plant pests and diseases, and on their epidemiology. In particular, there is a need for better surveillance methodologies; epidemiological knowledge; and information on biological control organisms and mechanisms; resistant crops breeds and species. Better accessibility and analysis of existing historical data and more detailed data for all regions in relation to different climate change scenarios would contribute to improving the baseline studies needed to identify and assess adequate adaptation measures.
- The best economic strategy for farmers is to use integrated pest management practices to closely monitor insect and disease occurrence. Keeping pest and crop management records over time will allow farmers to evaluate the economics and environmental impact of pest control and determine the feasibility of using certain pest management strategies or growing particular crops.
- Improvement of crop programs with the objective of developing a map for the observation of plant diseases and their causes, their prevalence in different agricultural environments and major crops as a result of changes in climate indicators, and assisting plant breeding programs in developing priorities on how to combat pathogens, and how to neutralize their impact on the efficiency of production.
- Strengthening plant protection programs to follow up on the changes in the biological diversity (species and varieties) of insects, and its association with trends in the relevant climate change indicators. Identifying how to maintain a positive balance which benefits agricultural production in different environments.

Finally, it is suggested that for complementing the vulnerability assessments done so far in the area of agricultural pests and diseases, the potential impacts of deteriorating irrigation water quality and the projected increase in the reuse of treated waste water on the incidence of pests and diseases should also be systematically taken into account.

IV.3.1.3 Assessment of Climate Change Impacts on Livestock

Depending of report of Khelifa (2012) and as estimated in the SADS (2010), livestock production currently represents some 24.5% of the agricultural GDP. In general, under Egyptian conditions meat production is more important than milk production, with cows, buffaloes, sheep, goats and camels being the main animal types. During the last 20 years the stocking numbers have increased sharply (except for camels). However, these increases have been insufficient to meet the requirements of the rapidly growing population, although average per capita red meat consumption is rather low compared by international standards. Especially for dairy products, the rapidly growing demand is increasingly met by imports. The majority of farms are family farms of less than one hectare, with mixed livestock and crop production.

The direct impacts of climate change on livestock mainly involve heat exchanges between the animal and the surrounding environment that are related to radiation, temperature, humidity and wind speed (Khelifa, 2012). Under present climate conditions, the lack of ability of animals to dissipate the environmental heat determines that animals suffer heat stress during, at least, part of the year. Heat stress has a variety of detrimental effects on livestock, with significant effects on milk production and reproduction in dairy cows. Extreme events, such as heat waves, may particularly affect beef and dairy cattle.

An increase in air temperature, such as that expected in different scenarios of climate change, would affect directly animal performance by affecting animal heat balance. Under Egyptian conditions many livestock are already subjected to periods of high heat stress in summer and in some regions to cold stress in winter. The projected rise in ambient temperature due to climate change could reduce livestock productivity through lower growth due to appetite suppression, decrease reproductive rates, increase animal welfare concerns, and, in extreme cases, cause death. Meanwhile, higher minimum temperatures might reduce the frequency and severity of cold-stress events conditions that foster high lamb mortality. In this context, the direct effects of heat stress on animal production, reproduction and animal immunity are reviewed in more detail and the results of previous work in Egypt are summarized.

Indirect effects of climate driven changes in animal performance might result mainly from alterations in the nutritional environment, i.e. the availability of feed resources in quality and / or quantity. In this regard, the main pathways in which climate change can affect the availability of feed resources for livestock are distinguished: (1) land use and systems changes; (2) changes in the primary productivity of crops, forages and rangelands; (3) changes in species composition; and (4) quality of plant material.

The main effects of climate change are the decrease in livestock production under hot and cold climates due to a decrease in feed intake and increase in maintenance requirement under hot climate, while under cold climate they are due to a more increase in maintenance requirement than in feed intake. Heat stress affects all reproductive performance parameters e.g. puberty, spermatogenesis and semen quality, estrous cycle, fertilization, embryonic development and conception rate and fertility and hatchability of poultry eggs. It also increases livestock morbidity and mortality. The increase in morbidity is by increasing non-infectious diseases due to the decrease in livestock immunity, affecting feed availability and quality which decreases animal resistance and increase microbial insult as a result of behavioral thermoregulation.

In terms of national policies, strategies and programs for the effect of changing demands for livestock products, the study mainly refers to the national Egyptian strategic plan for achieving self-sufficiency in livestock products, the overall goal of which is to increase livestock production taking into consideration its effects on: (i) livestock production systems; and (ii) environment. The specific objectives assigned to this strategy of improving and developing production systems and properties with a view of meeting the expected increase in future demand for livestock products read as follows: (1) to improve animal breeding and productivity; (2) to overcome the shortage of local feed and water resources; (3) to improve animal health; and (4) to reduce the impact of increasing livestock production on environment.

The possible adaptation options for coping with climate change in field-based livestock systems include matching stocking rates with pasture production, rotating pastures, modifying grazing times, altering forage and animal species/breeds, altering the integration of mixed livestock/crop systems, including the use of adapted forage crops, re-assessing fertilizer applications, ensuring adequate water supplies and using supplementary feeds and concentrates.

Possible adaptation options for direct and indirect impact of climate change presented in the study also include:

- Environmental modification adaptation options: technology to avoid solar heat loads or increase heat losses from the animal to maintain heat balance, including shelter, housing and cooling systems;
- Nutritional adaptation options: including nutritional modification, and minerals treatment, such as ration formulation and Fibrolytic enzymes (ZADO) supplementation;
- Hormonal treatment;
- Animal adaptation, selection and breeding, taking however into account the potential conflicts between breeding adapted indigenous low producing animals or high producing less tolerant exogenous ones;
- Biotechnological adaptation options: such as reproductive biotechnologies including artificial insemination (AI), embryo transfer (ET), in vitro fertilization (IVF), sexing and cloning; and molecular biotechnologies: various molecular biotechnology or DNA-based biotechnology applications are relevant to animal health and production;
- Adaptation options against livestock diseases.
- Carrying out research areas on heat-related illness, non-communicable diseases and socioeconomic impacts from extreme climatic events, waterborne and food-borne diseases, vector-borne and rodent-borne diseases, impacts of the pollen of neophytes to better understand the relationship between weather and climate and pollen transmission, and understanding vulnerabilities with urban environment, including how the urban heat island enhancement will evolve;
- Improvement of vaccination programs by establishing vaccination program against avian flu.

The adaptation options presented for closing the gap in feed production include (i) the avoidance of wastage of berseem protein due to feeding it alone, by supplementing animals fed on berseem only with silage made from corn stalks; (ii) the improvement of rangelands; as well as (iii) the development of high-yielding certified berseem seed.As regards increasing feed supply, the main adaptation measures might include: (i) using crop residues and by-products; (ii) feeding on hydroponic barley fodder; (iii) alleviation of rangeland degradation; (iv) pasture improvement; (v) utilization of saline water for crop/forage production; and (vi) integration of livestock into farming systems.

Finally, some adaptation options related to altering livestock systems are also discussed and include continuously matching stock rates with pasture production, altered rotation of pastures, modification of times of grazing, and timing of reproduction, alteration of forage and animal species/breeds, altered integration within mixed livestock/crop systems including using adapted forage crops, reassessing fertilizer applications, care to ensure adequate water supplies, and use of supplementary feeds and concentrates.

In terms of actions needed to facilitate adaptation responses, the study generally points to the following issues: (i) climate monitoring efforts and communication of information; (ii) policies that support research, systems analysis, extension capacity, industry and regional networks; (iii) investment in new technical or management strategies; (iv) training for new jobs based on new land uses, industry relocation and human migration; and (v) new infrastructure, policies and institutions: such as investment in irrigation infrastructure and efficient water-use technologies, appropriate transport and storage infrastructure, revising land tenure arrangements and property rights, and establishing accessible, efficient markets for products, financial services including insurance, and inputs including seed, fertilizer and labor.

IV.3.1.4 Assessment of Climate Change Impacts on Aquaculture

According to the NSACC and as per the report of Abdel-Aal (2011),Egypt produces 93% of its fish consumption needs from the River Nile and its tributaries and drains, the Mediterranean and Red Seas, the northern lakes as well as fisheries north of the Delta, while the remainder is represented by imports of low-cost products mainly from China, Vietnam and East Asia. Although in Egypt fish food does not necessarily contribute significantly to total daily calorie intake, at present it contributes an estimated 20% to animal protein intake, also providing essential micro-nutrients in the form of vitamins and minerals and some co-enzymes.

Egypt's limited freshwater resources are seen as the major constraint to aquaculture development. With the absolute priority given to drinking water supply and irrigation, more than 90 % of the country's fish farms are depending on agricultural drainage run-off.

As regards the vulnerability of the aquaculture sector to the impacts of climate change, temperature, pH and salinity are the key variables affecting fish production in both a positive and negative way. In this regard, the vulnerability assessments can briefly be summarized as follows:

- Climate change is expected to increase sea temperature causing fish distribution to shift northwards and to move to deeper water. Aquaculture may suffer from water shortages due to the expected scarcity in fresh water supply, and increased temperatures might also affect the production of some fish species.
- The increased salinity of water in the coastal lakes may gradually reduce the existence of fresh water fish, increasing the portion of saline water fish which is more sensitive to environmental changes. This will negatively affect most of the coastal area population who rely almost completely on cheap fresh water fish.
- Fish farms will face stronger competition in water use, with a direct impact of temperature on the productivity of some varieties of fish. The likelihood of increased water salinity in the north Delta will negatively affect the productivity of fresh water fish, and increase the productivity of salt-water fish,

despite the fact that many social classes rely on fresh water fish as a primary source of animal protein.

- The rise in atmospheric and water temperature will lead to an increase in the growth rate of fish and their vulnerability in fish farms and small waterways, which are more vulnerable than fish in the sea and large water bodies. Furthermore, the fish ecosystem will change as the rate of nutritional assimilation rises, leading to a higher need for nutrition, and increasing competition between different species and thus raising the Biological Oxygen Demand (BOD).
- The expected Mediterranean Sea level rise will have a significant impact on the rates and locations of egg hatching. The increased salinity will limit the spread of fresh water fish in the northern areas of the Delta, and alter the specific mix of the fish. The general vulnerability and impact assessment of the NSACC has been completed by pointing to the following more specific aspects:
- Large-scale changes in temperature, precipitation, wind and salinity in the short term are likely to have negative impacts on the physiology of fish in localities where temperature increases, through limiting oxygen. This would have significant impact on aquaculture and result in changes in distribution, and probably abundance of both freshwater and marine species. This impact would be felt through changes in production and marketing costs, changes in sales prices, and possibly the increase of risk of damage or loss of infrastructure, fishing tools and housing.
- For Nile Tilapia as the most common species, temperature increases will have a positive effect in fresh water aquaculture, mainly through increased food conversion efficiencies and growth rates in warmer waters, increased length of the growing season, shorter overwintering, more artificial feed produced, early spawning and higher production per unit of area.
- Marine aquaculture relies mainly on collecting wild fry from the coastal areas where the freshwater connects with marine water. Increased storminess that may come with climate change affects coastal ecosystems in several ways. Increases in water runoff from more intense precipitation can reduce salinity along coast, bring more nutrients in the runoff, and increase sediments in the water. The changes can lead to changes in production and distribution of species, including change in migratory paths, when combined with the warming coastal waters; there may be considerable ecological change. For these reasons, the stress for fry collection of marine species like mullet, in particular, might increase.
- Climate changes will also affect safety at sea fishing and settlements, with communities living in low-lying areas at particular risk. Water stress and competition for water resources will affect aquaculture operations and are likely to increase conflicts among water dependent activities. Livelihood strategies will have to be modified as changes occur in fishers' migration patterns due to change in timing of fishing activities. Reduced livelihood options on aquaculture sector will increase social pressures.
- Changes in distribution, species composition and habitats will require change in fishing practices and aquaculture operations, as well as in the location of landing, farming and processing facilities. Extreme events will also impact on infrastructure, ranging from landing and farming sites to post harvest facilities and transportation routes.
- Sedimentation rates of isthmus lakes and main Nile drainage outlets in the Mediterranean sea which will influence migration patterns of high quality fish species

- Changes in sea waves, sea water currents and sea water levels will also affect drainage systems in north Nile Delta and consequently on aquaculture activities. Increasing sea water levels will affect aquaculture infrastructure and evaporation rates.
- Effects of ambient temperature on water quality parameters especially CO_2 absorption, O_2 production and abundance of natural food.

The potential adaptation options and measures were still to be identified in detail and that for this purpose further studies on the impacts, vulnerability, and adaptation to CC impacts were still needed for this economically important sector. The main adaptation measures examined and proposed in the study report are summarized as follows.

Since climate change induced temperature variations can have a strong impact on the spatial distribution of aquaculture and on their productivity, suitable site selection and aquaculture zoning can be important adaptation measures. Large area planning should be seriously considered and could facilitate investment by minimizing conflict with other users and more importantly by removing some of the risk. By Egyptian law, aquaculture projects may use only land which is not suitable for agriculture. These lands would be identified as suitable and secured for aquaculture use and where appropriate would indicate the suitability of cultures species. This would have the added advantage of clustering aquaculture producers in a concentrated geographical area. Local authorities can assist in implementing integrated monitoring system accompanying risk strategies and early warning systems. This zonation might also help in promoting commercial investment, because apart from reassuring investors by identifying areas that are suitable, it could encourage clustering of production, within the limits of local environmental carrying capacity, providing opportunities for specializing professional roles such as in fry production, feed manufacture, or product processing. It is also easier to provide infrastructure as transport link, access to utilities and other links of a supply chain and marketing infrastructure.

The study advocates that the current law limiting aquaculture activities to agriculture drainage water and land which is not suitable for agriculture, should be revised and amended and positive effects on both agriculture and aquaculture are expected from such a reform.

Although there is now a greater understanding of the environmental impacts of climate change, the field of aquaculture in Egypt still requires extensive investigation. This should include intensive surveys on main areas on livelihood in the areas of aquaculture activities in northern Egypt most likely to be affected by climate change and the influences of these activities on other agricultural activities. Investigations should be undertaken on appropriate ways to protect fresh or marine water aquaculture.

Research institutes are in need of further capacity building to increase multi-disciplinary research in this integrated field. Establishment of confidence between scientific institutions and awareness on the importance of climate change research is needed and will require advocacy efforts.

IV.3.1.5 Climate Change Adaptation Policy Framework (CCAPF)

The purpose of Egypt Climate Change Adaptation policy Framework is to outline a set of principles, actions, roles and responsibilities, and financing recommendations to guide different stakeholders engagement in implementing agriculture- related climate change adaptation programmes in Egypt (Siam, 2013).

The framework should guide engagement at all levels from national to local and across the levels. The framework will form a common strategy for proactively addressing climate change through adaptation measures, linking together partners at all levels, all focused on achieving the goals and objectives of development. The objectives or value added of the Climate Change Adaptation Framework are:

- To maintain a high degree of emphasis on linkages between climate change, sustainable land management, alleviation of food insecurity, and poverty reduction in Egypt and policy and development programming
- To highlight roles played by different partners in addressing climate change in Egyptian agriculture
- To facilitate collaboration and coordination of efforts in climate change policy, research and development as it relates to agriculture, in order to increase impact
- To provide a clear investment programme for Egyptian agriculture that delivers on the twin objectives of meeting current food security needs whilst building capacity of rural systems and agricultural assets (e.g. soils) to offset or respond to climate change effects.

The Framework will provide for:

- Comprehensive and systematic and coherent programmes;
- Systematic reforms in policies;
- Integrated attention to organizational and human capacity, institutional arrangements;
- Integrated and programmatic approach across the sectors, disciplines, ecosystems as well as trans boundary;
- Coherent framework to guide partnerships including alignment of the development partners support to Egyptian agenda

Certain principles should govern the actions to be taken in the context of the climate change framework. First, concrete actions should be identified in a way to build on existing efforts where possible. Second, they should focus on ex ante climate change adaptation measures that add resilience to systems and offset predicted climate change effects and importantly address current food security needs. Third, they should complement and link with development plans. Fourth, actions should be at significant scale and for medium term in order to have impact. Fifth, flexible governance and financing mechanisms should be identified to facilitate rather than hinder investment (e.g. could allow earmarks for certain thematic or geographical areas).Sixth, actions should encourage innovation and be rigorously monitored for livelihood and climate change impacts. Seventh, climate change should be integrated into national development plans.

The core of the framework is the scaling up best practices related to climate change in agriculture. To achieve this there are several elements including: Technologies; R&D; policies; capacity building; financing .Other elements related to application of best practices include: organization; partnerships; training; knowledge management.

IV.4. COASTAL ZONES

IV.4.1. Vulnerability

The coastline of Egypt comprises over 3500km of tide affected coast. Of this total length, 1150km is primary wave-affected Mediterranean coast, 1500km is primary Red Sea coast (including Gulf of Suez and Gulf of Aqaba), 550km is secondary Mediterranean coast (shorelines of coastal lagoons), and 450km is Suez Canal area 'coast', including the adjacent lakes' shorelines. There is a very wide variation in coastal characteristics and types and extent of coast-related activities. The entire coast is considered, although attention is focused on the *lower Nile delta coast,* because of its predominant importance. The inland boundary of the coastal zones of the Nile Delta is set at the contour line of + 3m with respect to Mean Sea Level at Alexandria. The future effects of subsidence, storm surges, sea level rise and associated effects on salinity intrusion are in general believed to take place below this elevation (Elshinnawy, 2014).

Table (IV.4) includes temperature projection values of mean air temperatures and expected sea level rise from 2025 to 2100, for the low scenario (B1) and high scenario A1FI of SRES; as given by the First IPCC first Assessment Report in the West, Middle, and East Delta regions.

Table (IV.4) Temperature Change and Sea Level Rise According to B1 & A1FI Scenarios (Elshinnawy, 2008)

Predicted Temperature and Sea Level Rise for Years 2025, 2050, 2075 and 2100 (°C)					
Year		2025	2050	2075	2100
B1	Temperature (°C)	0.9	1.3	1.8	1.8
	SLR West Delta (cm)	7.0	16.0	27.0	28.0
	SLR Middle Delta (cm)	8.75	29.5	32.25	35.0
	SLR East Delta (cm)	18.12	39.5	64.3	72.5
A1F1	Temperature (°C)	1.2	2.2	3.2	4.0
	SLR West Delta (cm)	13.0	34.0	55.0	72.0
	SLR Middle Delta (cm)	14.75	37.5	60.3	79.0
	SLR East Delta (cm)	27.90	68.8	109.6	144.0

Inundation of coastal low lands

Inundation threat was addressed in the reviewed studies. It was concluded that coastal section of the Nile Delta that would be inundated under the worst Sea Level Rise (SLR) scenario, while assuming no protection systems till year 2060, are displayed in Figure (IV.1). As stated in table (IV-5), high SLR Scenarios, showed significant loss of fertile lands in the delta region whether protection measures are considered or not.

Table (IV.5) Estimated loss of low-lying lands in the northern Nile Delta in km²

Scenarios for year 2060	East Delta	Middle Delta	West Delta	All Delta
Worst SLR Scenario (With Protection)	25.8	137.2	15.0	178.0
Worst SLR Scenario (Without Protection)	774.3	523.9	625.6	1923.8

Employing the conservative rates of delta land subsidence

Table (IV.6) presents the vulnerable areas in the Nile Delta (west, middle and east) according to the high scenario A1FI for the case of protected lakes' borders and the low lands of Abu-Qir Bay are protected by Mohamed Ali Sea Wall.

Table (IV.6): Vulnerable areas in the Nile Delta coasts (A1FI scenario with current protection systems), (Elshinnawy, 2008)

Year	2025			2050			2075			2100		
Region	West	Mid	East	West	Mid	East	West	Mid	East	West	Mid	East
SLR (cm)	13.0	14.8	27.9	34.0	37.5	68.8	55.0	60.3	109.6	72.0	79.0	144
Affected Area (km²)	29.7	63.7	59.5	38.7	140.7	76.9	80.1	284	85.7	104.5	565	91.0
% of Nile Delta Area	0.12	0.25	0.24	0.16	0.56	0.31	0.32	1.14	0.34	0.42	2.26	0.36
Total Affected Area (km²)	152.9			256.3			449.8			761.3		
% of Nile Delta Area	0.61 %			1.03 %			1.8 %			3.04		

W=West Delta   M=Middle Delta   E=East Delta

Three scenarios were considered: CoRIscenario and two of SRES scenarios B1 and A1F1.

Fig (IV-1)-Projected inundation area including lakes of Maryut, Edku, Burullus and Manzala without any protection measures

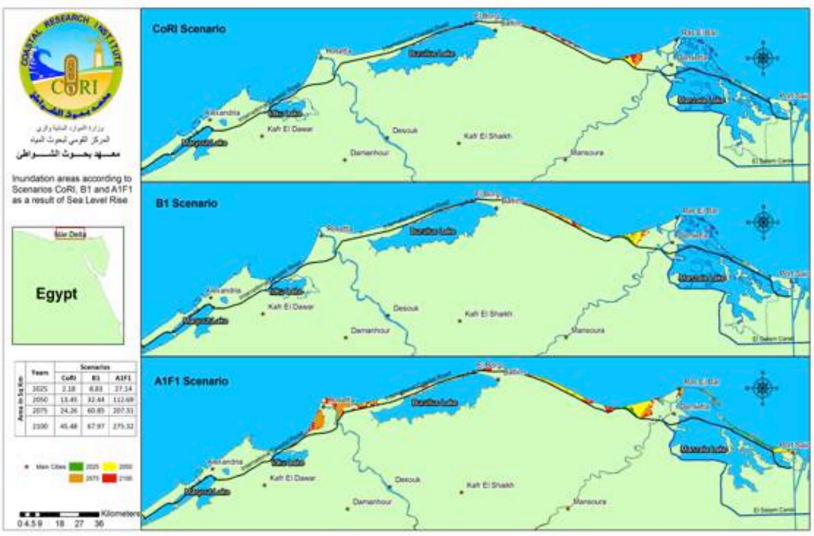


Fig (IV-2): Results of CoRI, B1 and A1F1 scenarios analysis indicating the high vulnerability of the delta coast

It is estimated that a sea level rise of up to about 100cm is expected until year 2100, taking into account land subsidence in the delta.

In general the vulnerability of the coastal zone of Egypt can be summarized as:

- Vulnerability of the Nile delta region due to sea level rise particularly in low land areas, constitutes a major problem.
- The local phenomenon of land subsidence of the Nile delta increases the level expectation of impacts of sea level rise on the coastal zone.
- Vulnerability due to salt water intrusion into coastal groundwater causing excessive groundwater contamination, soil salinization, deterioration of crop quality and loss of productivity.
- One third of Egypt's fish catches are made in the lagoons. Sea level rise would change the water quality and affect most fresh water fish. Valuable agricultural land would be inundated (AbuZeid et al2012).
- Vulnerability of the coral reef in the Red Sea due to the impact of increasing coastal water temperature on bleaching of coral reef.
- Increase of ocean acidity and changes of circulation pattern on coastal areas, which would affect fish catch in coastal waters.
- Vulnerability of the coastal zone due to increasing frequency and severity of extreme climatic events such as marine surges, sandstorms and flash flooding
- Socioeconomic losses and shortage of awareness due to migration of fishermen and labor force from the coastal zone.

IV.4.2. Adaptation

The process of selecting the appropriate approach for adaptation to and coping with the risks resulting from climate change (including extreme events such as tsunamis, expected sea level rise, high tidal waves, and repeated exposure to floods and cyclones)depends on the extent and type of potential harm to the sectors in coastal areas. These means usually include a myriad of methods of positive or precautionary defense lines accompanied by a package of preventive measures of social and economic development. According to the Intergovernmental Panel for Climate Change (IPCC 1992), the adaptation responses to deal with sea level rise are:

- Retreat according to plans prepared in advance.
- Accommodation.
- Protection.

This strategy primarily adopts accommodation and protection as the basis for adaptation to the risks resulting from climate change, taking into account retreat, according to plans prepared in advance, in the event that the coastal areas are exposed to storms and hurricanes or any extreme event.

The vulnerability and the potential harm that might affect the Egyptian coastal zone by potential disaster risks of sea level rise, which are classified under 5 degrees as follows: Severe harm - Moderate harm - Low harm- Changing events - Safe.

Structural and architectural interventions are recommended including conventional and unconventional engineering protection works (maritime walls, submersible barriers, shore coating, soil fixation, and prevention methods for seawater intrusion into land including the implementation of covered and uncovered sanitary drainage projects), and the protection of coastal building sand constructions and electricity, water, and sanitation grids.

Other measures include artificial nourishment with sand to compensate for the erosion of the beach, which, if necessary, may be accompanied by the establishment of solid protection measures such as stone heads or submersible barriers, in order to increase the space, which will lead to the protection of the back shore from attacks by the sea, and address the rise of sea level. In addition, reinforcement of anti-flood protection structures and construction of new ones are civil constructions that would break flash floods or prevent them from reaching populated areas, and areas of economic infrastructure.

Adaptation measures also include rehabilitation of installations, such as the International Coastal Road (Rafah to Salloum), and the embankments of Al Salam Canal (from Damietta to Sinai), and strengthening of the existing protection structures to act as wave breakers, in addition to their regular functions.

Other approaches are reinforcement by natural protection such as sand dune stabilization through the cultivation of wild plants and wooden barriers and preserving natural defense lines against sea encroachment or sea level rise, i.e. rocky coral reefs adjacent to the shores of the Red Sea or limestone barriers along the northwest coast from Alexandria to Salloum

In particular, this includes:

1. Adaptation measures for the SL rise

- Establishment of a strong systematic observation system and associated database and information exchange and data analysis system
- Study of geological and morphological systems for the coastal aquifer systems. Enhancement of Digital Elevation Model (DEM) for the coastal zones of the Nile Delta. Construction of necessary protection works
- Institutional enhancement and legal reform and enhancement of cooperation and coordination and considering bottom-up approach for community-based adaptation approach.
- Initiation of a proactive sustainable development plan according to integrated coastal zone management approaches and control of land- based pollution sources.
- Development of regional numerical models and increase research activities in detailed studies to quantify the impacts of climate change and SLR on northern lakes

- Establishing and promoting an institutional capacity for "adaptation", through initiating the establishment of a National Center for Climate Change, with main concern of adaptation.
- Upgrading environmental regulations through adopting Strategic Environmental Assessment for large scale and national projects in coastal zones.

2. Adaptation measures of SLR on erosion rates and inundation

- Maintenance and repair for existing protection defenses, enhancing Mohamed Ali sea wall to protect the low-lying areas south of Abu-Qir Bay.
- Provide further protection for the international road across the delta, creating wetlands and/or fish farms in the low-lying strip located between the coastal road and the shore line in vulnerable areas defined.
- Carry out appropriate protection works for the low-lying area of El Malaha East of Port Said (Shark El-Tafreaah) which is under high risk of flooding.
- Periodic maintenance of break waters and sand nourishment at different locations along the coastline.

3. Adaptation measure for salt water intrusion

- Continue analysis of observation wells program in the delta; propose some constrains for land use and proper management of groundwater extraction within the highly effected zone
- Implementation of a local monitoring network with various depths to monitor and assess any change in fresh/saline interface movement;

4. Adaptation measures to extreme events

- Modeling and assessment of various options of protection of coastal zone including underwater wave breakers, protective structures and economic incentives
- Finding best available configurations for protection of sensitive shorelines against surges floods and collection and treatment of rain water of flash floods in Sinai

5. Adaptation measures for Socio-economic aspects

- Create wetlands in areas vulnerable to the impacts of sea level rise, protecting and fixing natural sand dunes systems which constitute an important natural protection
- Reduce coastal pollution from land based sources to upgrade water quality and strengthen coral conditions in the Red Sea
- Increase awareness of population and decision makers of the negative impacts of climate change on social, economic and health situation.

IV.5. TOURISM SECTOR

IV.5.1. Vulnerability

The number of incoming tourists to Egypt in 2013 was 9.5 million compared to 11.4 million in 2012 with decrease of -17.9% in growth rate,. However, comparing the numbers of 2012 to the numbers in 2011which was 9.8 million there was a 17% increase. In addition, tourist nights decreased by -31.5%, decreasing to 94.4 million nights in 2013, compared with 137.8 million nights in 2012.The number of tourists from ten countries accounted for 65% of the total number of incoming tourists in 2010 (Ministry of Tourism, Tourism Satellite Account Unit, 2014.).

European tourism represented 74.3% of the total inbound tourism to Egypt in 2010, about 70% of tourist nights then. The average stay in 2010 was about 8.9 nights per tourist. This is below the general average of 9.2 nights per tourist. The European market is dominated by tourist groups seeking moderate prices but the seasons are distributed across the year due to multiple holidays.

Tourists from Arab countries accounted for 14.2% of the total inbound tourism, about 19.8% of tourist nights. The average stay in 2010 was about 12.4 nights per tourist, exceeding the general average of 9.2 nights per tourist. This is a market that promises growth, although it is affected by seasonal demand, and is associated with short holiday seasons.

Egyptian tourism revenues in 2008 amounted to US$10.9 billion, compared with US$9.5 billion in 2007; a 14.7% increase. Egyptian tourism contributed about 19.3% of the country's foreign exchange proceeds. It accounted for 11.3% of the GDP, directly and indirectly, and represented 40% of total services export.

In general, Tourism in Egypt is one of the important sources of national income. The number of tourists visiting the country in the year 2010 reached more than 14 million spending about 140 million tourist nights in the country.

The vulnerability of tourism sector due to potential impacts of climate change includes:

- Climate change and sea level rise are associated with direct impacts, which include the erosion and inundation of sandy beaches, and thus, the gradual regression of shorelines. Another impact is the possible increased frequency of recurrence of storms and hurricanes, which would have a negative impact on multiple sectors of the coastal zone
- A major connection between tourism and water is the sailing ferries in the Nile and its branches which require certain depth of water in the navigable channel to accommodate for the ever increasing draft of these vessels which is now little less than 3 meters
- The gradual sea level rise may possibly lead to increased erosion rates of the low lying coastal zone. This may cause beach erosion at the narrow and low-level sand barrier - which separates the sea from the northern lakes – which will result in the gradual merging of those lakes with the sea, as is foreseen for Lake Manzala.
- Coral reef may be affected by the sea level rise, especially if the rising rate is higher than that of coral growth. The rate of coral bleaching may also increase as a result of environmental pressures. However,

the rock formation of the coast - which characterizes the Red Sea, and which is slightly above sea level, 2 - 5m – is considered a natural barrier against rising sea levels in these areas.

- It is expected that, all low-lying beaches with levels ranging between 0 and 1m, will be inundated. The beaches of the Mediterranean and Red Seas that are characterized by levels higher than the expected sea level will remain safe, according to the topographic characteristics of each individual area. If no appropriate and effective measures are taken to protect the coastal zone, lowlands will be vulnerable, at varying degrees, to inundation according to the specific nature of these areas
- There will be an evident negative impact on the social and economic aspects of the coastal zones. It is possible that the severity of this impact may decrease depending on the measures that will be taken to reduce the negative impact of climate change, and the expected rate of sea level rise.
- The negative impacts of increasing temperature on the colors and lifetimes of monuments is expected to affect its quality and hence the number of visitors
- Salt water intrusion in low land coastal areas are expected to affect buried monuments in the coastal areas leading to enhancing deterioration rates
- Socioeconomic losses based on the above

IV.5.2. Adaptation

Touristic development in particular, as well as on the tourism sector in general, includes a combination of protective and precautionary measures, and other direct and positive defense measures.

Preventive and precautionary measures include:

- Proclamation of marine and wildlife protectorates: This is one of the effective adaptation measures for environmentally vulnerable areas within tourist sites, which are most vulnerable to risks according to the criteria governing the selection of protectorates.
- Implementation of integrated environmental management systems in touristic sites: The Tourism Development Authority has already submitted a proposal for an integrated environmental management system for the coasts of the Red Sea – funded by the Global Environment Facility (GEF) –which included several suggestions that are considered as efficient adaption means.
- Assessing the degree of fragility and vulnerability to risk of touristic sites and sites of archaeological value: This assessment should be carried out in accordance with effective standards, as a method of adapting to the impacts of climate change.
- Orienting tourism growth away from environmentally sensitive areas and areas that are most at risk to less sensitive and vulnerable ones: The objective is to deal with adaptation to climate change on the planning level in a protective and precautionary manner, through the orientation of expected tourism growth away from environmentally sensitive areas and the areas that are most vulnerable to climate change. The outcome should be that tourism will be directed towards areas that are less sensitive and less vulnerable to these risks, by adapting to the expected changes before they actually occur.

- Developing a monitoring system for the expected impacts of climate change in touristic sites: This includes the determination of specific measurable indicators and criteria that assess the various effects of climate change which are detected in touristic locations. The assessment of results and different indicators must be exchanged in order to ensure an effective and speedy response, and to finally propose suitable adjustments to the strategy. This will trigger the establishment of the requested database.
- Analyzing the effectiveness of the enforcement of environmental protection laws, and their development over the past years, since the approval of the protectorates law in the early 1980s, before environment laws and regulations were issued in 1994: Many concepts and ideas have arisen since then. Some are associated with the degree of enforcement of these laws, while others are associated with the possibility of using the laws as one of the adaptation measures to climate change, through the identification of the shoreline, storm water spillways and their limits, as well as all other measures that support the adaptation measures.
- Encouraging and supporting civil society organizations to participate in applying strategic operational policies: Any proposed methods for the adaptation to climate change will rely on different operational mechanisms and policies for their implementation. At the forefront comes the reliance on the participation and support of the local civil community and its various organizations in touristic locations. These include local, regional and national tourism investors' associations, and civil societies that are interested in the matter, along with local universities and others.

IV.6. URBAN SECTOR

IV.6.1. Vulnerability

Globally, rapid urbanization and population growth have been common phenomena, especially in developing countries. Most of this urbanization has occurred in Developing Countries including Egypt where urban growth is not the result of industrial growth and economic development, but rather the outcome of regional imbalances and Egypt is no exception. These are manifested in a successive influx of rural migrants to urban settlements related, in part, to disparities in income and employment opportunities; and continued policies that favor urban settlements with regard to investment and services.

Urbanization in Egypt has been fueled by high fertility rates, substantial rural-urban migration, international labor migration and the concentration of economic activity in urban areas. Housing policies have also contributed to urban growth. Infrastructure development has not kept pace with this growth. Rural development activities often intended to counter urbanization trends, have received low priority attention. Therefore, the need for better understanding and management of existing urban settlements growth, in Egypt, is a critical issue in urbanization process due to climate change impacts and adaptation.

Unplanned urban development in all major cities in Egypt, urban encroachment in agricultural land and spreading of slum areas constitute very serious long range problems. In particular:

- Vulnerability due to increasing rates of energy and water consumption, especially in highly populated urban and industrial cities

- Vulnerability of comfort and health due to increasing air pollution, stress on green areas and pressures on infra-structure
- Increasing rates of deterioration of buildings and roads and increasing rates of risk of hazards due to increasing temperatures and extreme events
- Vulnerability due to potential impacts of climate changes on various types of urban infra-structure and energy resources
- It is expected that the impact of extreme events (Heat waves, flash floods, dust storms and marine surges) on urban infra-structure will be severe
- Vulnerability of coastal population due to shortage of proactive planning, increasing risk of storms and socioeconomic implications
- The most vulnerable parts in Egypt will be the governorates Alexandria, Port Said, Beheira, Kafr El Sheikh as well as other parts such as the south Mediterranean coastal areas of Al-Burullus and Manzala. There are indications that the city of Damietta, Ras el-Barr, Gamasa, the areas around Lake Burullus, Lake Manzala and Lake Bardaweel will be inundated between years 2040 and 2050

Urban centers in Egypt contain a large proportion of the urban poor most at risk from the effects of climate change. Many urban dwellers face life-threatening risks from the increased intensity of storms, flooding and landslides that climate change is bringing. These and other impacts will also bring the threat of damage to their livelihoods, property, environmental quality and future prosperity. Increased vulnerability of slum areas to flood damage, and increased frequency of floods, wind and fires in rural, as well as, in some urban areas. Little attention has so far been paid to adaptation in urban areas. Although low- and middle-income are often perceived as predominantly rural, they now constitute most of urban population and most of largest cities in Egypt. So, adaptation to climate change is worse in the secondary cities than in capital cities, particularly the response to floods.

Urban roads in Egypt are also vulnerable to climate changes in several ways:

- Coastal roads: The northern road in Delta, running east west suffers from uplifting pressure of the water table at the area of the city of al- Borg. Coastal roads are vulnerable to sea rise.
- Desert roads: Sand dunes play the main role in forming the instability of the road system in west desert area. Floods are expected to affect these roads
- Mountainous roads: Roads in Sinai and in eastern desert pass through rich morphology that is subjected to flash floods.
- Agricultural roads: In the Delta and the Nile Valley. Floods are expected to affect some of these roads

IV.6.2. Adaptation

Adapting to climate change means adapting to risks from observed or expected changes. Local governments, enterprises and households will all have to adapt. In most urban areas, community organizations and local non-governmental organizations are also important, especially where they are influential in building houses and communities and providing social services within informal settlements. Successful adaptation is about the quality of local knowledge, local capacity and willingness to act. Local governments should have key roles, not only in changing what they do, but also in the adaptation they encourage and support. This includes:

- Ensuring the availability of an appropriate and widely understood information base about local climate change impacts which does not exist or enough in most Egyptian cities
- Land-use planning that avoids high-risk areas and shifts activities away from them, including ensuring that urban poor can find affordable shelter; land for housing on safe sites
- Revising building codes and infrastructure standards, in ways that do not impose unaffordable costs.
- Planning and public sector investment for infrastructure that considers local climate change impacts to cope with likely changes over 30 to 50 years.

As for roads, there are a number of protection measures that can be adopted, including:

- Re-orienting flood routes away from road: By means of a canal or a group of canals, water is drained towards another natural flash flood root, or to a nearby depression. Drainage system, if presented near by the crossing, could be utilized.
- Slowing down and limited time storing for water: through surgical perpendicular canal/canals at the bottom of the flood route, water could slow down its speed, and in the meantime gets rid of sediment materials. Boulders of massive sizes could be thrown in the path of water to hinder the way. Minor multiple and repetitive dams could be built to periodically store water and consequently lessen the amount of resultant water at the crossing.
- Bridging water: Mentioning the high cost for constructing a bridge over the water path, it is considered the best way in dealing with the problem.

IV.7. HEALTH SECTOR

IV.7.1. Vulnerability

Climate change can affect health directly in case of extreme weather events; in the form of storms, floods, and heat waves, or indirectly through changes in the ecological ranges and distribution of vectors-borne diseases, water-borne pathogens, air quality, water and food availability and quality (IPCC, 2007). Major killers; such as diarrheal diseases, malnutrition, malaria and dengue fever, are high climate-sensitive health problem, and expected to be worst with the climate changes (WHO, Fact sheet No. 266, 2012).

IV.7.1.1. Direct adverse impact on human health

The human body has limited capacity to lose excess heat, when the surrounding environment exceeds body temperature at high humidity, over time the core temperature will rise with fatal consequence. Humans cannot tolerate sustained periods of wet-bulb temperature above 35º C (Sherwood and Huber, 2010). Mortality and morbidity due to heat stress are expected to rise, especially among particularly vulnerable infant and elders (Tolba and Saab, 2009), and pregnant women.

Globally, the number of reported weather-related natural disasters has been more than tripled since the 1960s. Every year, these disasters result in over 60,000 deaths, mainly in developing countries (WHO, Fact sheet No. 266, 2012). In Egypt, rising sea levels and increasingly extreme weather events may lead to destruction of homes, medical facilities and other essential services. So, people in the coastal zones may be forced to move, which in turn heightens the risk of a range of health effects, from mental disorders to communicable diseases.

IV.7.1.2. Indirect adverse impact on human health through natural systems

Evidence on the associations between climatic conditions and infectious diseases is well established (WHO, 2003).Direct impacts of climate change on Egypt may include also increased prevalence of human parasitic diseases. Climate change and environmental variables may influence the global ecological system including the geographic distribution of the snails; the intermediate host for schistosomiasis, fascioliasis, etc.. Expected climate change in Egypt effects the spread and prevalence of mosquito-borne diseases (malaria and lymphatic filariasis), fly-borne diseases (leishmaniasis and mechanically transmitted parasites), and snail-borne parasitic infections (schistosomiasis and fascioliasis) (Lotfy, 2014). Due to climate harming, the snails *Bulinus* and *Biomphalaria* moved from their habitats in Upper Egypt to avoid extreme temperatures resulting in an increase in *Schistosomamansoni* and concomitant decrease in *Schistosomahaematobium* prevalence from the Nile delta into Upper Egypt. *S. mansoni* has almost totally replaced *S. haematobium* in Lower Egypt, and is spreading into Fayyoum in Upper Egypt (Ahmed et al., 2014).

Vector-borne infectious diseases transmitted by arthropods, such as mosquitoes, ticks, sandflies and blackflies, and rodents, are climate sensitive and are the most studied in terms of relation with climate change. Changes in climate are likely to lengthen the transmission seasons of important vector-borne diseases and to alter their geographic range (WHO, Fact sheet No.266, 2012). Egypt is vulnerable to vector-borne diseases; such as malaria, lymphatic filariasis, dengue fever and rift valley fever. This is because of the presence of suitable climate and habitat for the vector especially with the increasing of climatic events; water shortage or floods, in addition to non-immune people.

Since 2009 there was no reported indigenous ***malaria*** in Egypt, and the mortality rate due to malaria in children under 5 years was zero (World Malaria Report, 2012). As for ***dengue Fever,*** the presence of *Aedes*mosquito and endemicity of dengue fever in the neighboring regional countries must be in mind of the Authorities in the Ministry of Health in Egypt. Studies suggest that climate change could expose an additional 2 billion people to dengue transmission by the 2080s (WHO, Fact sheet No. 266, 2012).

As for water borne and food borne diseases, ***diarrheal diseases*** are directly influenced by climate change due to the occurrence and the survival of bacterial agents, toxic algal blooms in water, and viral pathogens, in addition to lack of safe water that can compromise hygiene (WHO, Fact sheet No. 266, 2012). Some predicted climate change in Egypt include floods, droughts, water shortage, and salinity of groundwater and estuaries in coastal areas due to sea level rising may cause contamination of public water supplies and encourage unhygienic practices. All that causes fluctuation in the percent of diarrhea in children under 5 years; according to the results of Egyptian Demographic and Health Survey during the period (1990 - 2008) in Egypt (EDHS, 2009), and makes their reduction more difficult as climate change proceeds.

Acute respiratory infection (ARI), particularly pneumonia, is considered as a disease vulnerable to climate change. The 2008 EDHS revealed that of the mothers surveyed mentioned that 13% of their children under the age of five had a cough during the two-week period prior to the survey, and several mothers reported that 9% of children with a cough experienced fast or difficult breathing (EDHS, 2009).

Climate change and migration patterns may result in re-emerging of old diseases, such as ***tuberculosis (TB)***, due to changes in the epidemiology of regions and populations. Mortality and morbidity rates of TB in Egypt is regressing, despite of the observed fluctuation in the case detection rate that reached 65% in 2011, as the mortality rate in all age groups dropped in Egypt by 77.1% from 3.5 to 0.8 deaths per 100,000 populations between 1992 and 2011 (Saad-Hussein and Mohamed, 2014).

Additionally, from 2003 to 4 June 2013, 630 laboratory-confirmed human cases with ***avian influenza A(H5N1) virus*** infection have been officially reported to WHO from 15 countries, of which 375 died (WHO, 2013). In Egypt, the number of bird flu human cases reached 87 since the disease appearance in Egypt due to the contact with infected domestic birds, and 27 of them died since February 2006 until September 2009 (Egypt State Information Service, website http://www.sis.gov.eg).

During the year 2013, four human cases of H5N1 virus infection were diagnosed (from: Behera, Menofia, Elmanzala, and Sohaq), three of them died (WHO, 2013). The total number of deaths in Egypt from the virus increased to seven in the year 2014 out of 14 identified cases (Egypt State Information Service, website (http://www.sis.gov.eg).

With regards to non-communicable diseases, climate change may exacerbate existing ***cardiovascular disease*** by increasing heat stress, extreme weather events, and increasing the body burden of airborne particulates. In Egypt, there are lack in research and registration for detection of this relationship.

As for ***respiratory diseases,*** climate change can lead to increases in ground-level ozone and higher atmospheric concentrations of fine particulates, such as dust and allergenic pollen, thus, individuals with respiratory impairments may become at higher risk (CCSP 2008; IPCC 2007). The Egyptian Environment Affairs Agency (EEAA) reports that air pollution is responsible for an average of 3,400 deaths each year in Cairo, in addition to about 15,000 cases of bronchitis, 329,000 cases of respiratory infection, and a large number of cases of asthma (UNEP, 2007). Hence, research on the potential effects of climate change on air quality, and consequently on human health, is needed in the Arab world (Tolba and Saab, 2009).

Allergic diseases are common climate-sensitive health problem. The increases in CO_2 concentrations and in temperatures were associated with an increase in pollen production and prolongation of the pollen season (IPCC, 2007). Warmer conditions generally favor the production and release of air-borne allergens (such as fungi and lower plant spores and pollen) and, consequently, they may affect asthma and other allergic respiratory diseases, conjunctivitis and dermatitis (Beggs and Bambrick, 2005).

Saad-Hussein et al. (2011) detected a significant rise in the relative frequency of the eyes fungal infections (keratomycosis) in Greater Cairo. This rise was correlated significantly with rises in minimum temperature and the maximum atmospheric humidity over the same period. Through climate change models, Saad-Hussein et al. (2011) predicted increase in keratomycosis with the predicted increase in CO2 emissions and surface temperature in Egypt up to the year 2030.

IV. 7. 1.3. Indirect adverse impact on human health through human systems

Outdoor Occupational impactshave been linked with disease and injury caused by heat waves. Moreover, there was significant increase of fungal spores in the environment of different workplaces in Egypt. Saad et al. (2006) found that *Penicillium*was the most dominant in the ceramic indoor environment followed by *Aspergillusfumigatus* and *Aspergillusniger.* Also, textile, ceramic and wheat handling workers were proved to expose to high airborne counts of fungi mainly *Penicillium* and *Aspergillus species* (Saad-Hussein et al., 2012a,b; Saad-Hussein et al., 2015). These environmental exposures were found to be a risk factor for elevation of aflatoxin B1 (carcinogenic mycotoxin) and the tumor biomarkers among the exposed workers (Saad-Hussein et al., 2013; Saad-Hussein et al., 2014).

Malnutrition remains one of the largest health crises worldwide. Rising temperatures and variable precipitation are likely to decrease the production of staple foods in many of the poorest regions – by up to 50% by the year 2020 in some African countries (IPCC, 2007). Global warming and changes in rainfall patterns will affect water resources and food production capacity and quality that affect agricultural cropping patterns, that will have a severe effect on food intake per capita. This will increase the prevalence of malnutrition and under nutrition, which currently cause 3.5 million deaths every year (WHO, Fact sheet No. 266, 2012).

Malnutrition and under-nutrition, a major contributor to all the child-mortality wedges, will be more difficult to control as climate change proceeds. Using growth standards generated by WHO from data collected in a Multicentre Growth Reference

Study, the 2008 EDHS found that 29% of Egyptian children age 0-4 years showed evidence of chronic malnutrition or stunting (short for age), and 7% are acutely malnourished. A comparison of those results with the 2005 EDHS showed that children's nutritional status deteriorated during the period between the two surveys, stunting level increased by 26% (El-Zanaty and Way, 2009).

Global mean sea level is expected to rise by 9-88 cm by the year 2100 (IPCC, 2001). Rising sea levels increase the risk of coastal flooding, and may necessitate ***population displacement***. More than half of the world's population now lives within 60km of the sea. In Egypt, the most vulnerable regions are the Nile delta (WHO, 2005).

Moreover, severe weather events may lead to ***mental or emotional trauma*** before, during, and following the event. Analyses of pre- and post-disaster cognitive status showed decreases in working memory for middle-aged and older adults (Cherry et al., 2009). Nursing home residents and staff have been found to have mental health needs even 5 months after the disaster (Laditka et al., 2008).

IV.7.2. Adaptation

Adaptation measures for global climate change are required. Many policies and individual choices have the potential to reduce greenhouse gas emissions and produce major health co-benefits. For example, promoting the safe use of public transportation and active movement – such as cycling or walking as alternatives to using private vehicles – could reduce carbon dioxide emissions and improve health (WHO, Fact sheet No. 266, 2012). In 2009, the World Health Assembly endorsed a new WHO work-plan on climate change and health. This includes:

- **Advocacy**: to raise awareness that climate change is a fundamental threat to human health.
- **Partnerships**: to coordinate with partner agencies within the UN system, and ensure that health is properly represented in the climate change agenda.
- **Science and evidence**: to coordinate reviews of the scientific evidence on the links between climate change and health, and develop a global research agenda.
- **Health system strengthening**: to assist countries to assess their health vulnerabilities and build capacity to reduce health vulnerability to climate change.

The following items will facilitate the process of mainstreaming the adaptation response to the national planning and policy:

- ***Mapping of the areas at risk*** including arid lands, coastal cities prone to sea-level rise, areas around dams and irrigation projects, and overcrowded cities (Tolba and Saab, 2009). This needs more facilitations and working needs.
- ***Mapping of vulnerable populations*** include age and socioeconomic structure of the population. Vulnerable age groups include children, elders and people under physiological stress; such as pregnant women. Poor people who most likely have poor health with high infant mortality rates and low life expectancies are also considered as vulnerable group.
- ***Mapping the effects of a given event*** attributed to climate change: Maps of disasters related to climate change; such as flood risk zones, can be eventually prepared and populations at risk can be warned in time. In addition, heat wave warning systems to warn the population about upcoming heat waves are recommended. So, that a preparedness plan must address the three phases of a disaster: pre-disaster phase (e.g., mitigation; awareness; warning systems), disaster phase (e.g., response; health care facilities), and post-disaster phase (e.g., rehabilitation; long term impact; evaluation) (Tolba and Saab, 2009).
- ***Decreasing of the urban heat islands*** can be reduced through proactive urban planning and environmental preservation such as reducing automobile use, enhancing public transportation, planting trees, protecting biodiversity, and adoption of the building designs taking into consideration future heat waves due to climate change (Tolba and Saab, 2009).
- ***Controlling for the communicable (infectious) and non-communicable diseases.*** Fortunately, Egypt's capacity to control emerging and infectious diseases has been built through its experience in addressing priorities for surveillance, biomedical research, prevention and control and public health

infrastructure. Also, general health insurance has been applied as one of the main strategies provided to large Egyptian categories either through their own or another family member's employer or through their syndicate. Recently, insurance has been also provided in Egypt through schools and universities. The Egyptian health system was strengthened through disease specific interventions that improved the efficiency and effectiveness of disease control, along with construction of an effective network for disease surveillance and response.

Also, support is provided through implementation of the Egyptian government in partnership with USAID investments directed primarily to fighting schistosomiasis, vaccine-preventable diseases, viral hepatitis and most recently, emerging viruses

The Ministry of Health and Population (MOHP) in Egypt devoted resources to integrating laboratory science and epidemiology to optimize public health practice. It worked to build up the infrastructure in urban health facilities, district health offices and governorate facilities to support surveillance and implement prevention and control programs. The MOHP laboratory based disease surveillance system provides population with accurate reports and timely health data, investigates and contains outbreaks, and handles both communicable and non-communicable diseases. The MOHP has a viable network throughout the country for monitoring and managing communicable diseases.

Vaccine-preventive diseases

Egypt has achieved significant progress in vaccine-preventive disease control and prevention according to the guidelines of the WHO. In addition, Egypt's childhood immunization programs recommend that children receive three doses of the hepatitis vaccine. Routine immunization coverage with the **diphtheria, pertussis, and tetanus** vaccine 3rd dose reached more than 95% of the population. Indigenous wild **poliovirus** transmission was eliminated in 2006 and is monitored by ongoing environmental surveillance for wild polioviruses in a program assisted by CDC and other partners. Egypt is also moving toward elimination of measles and rubella through high routine immunization coverage with two doses of the **measles, mumps, and rubella** vaccine and by large-scale measles-rubella vaccination campaigns conducted during 2008 and 2009, vaccinating over 35 million children and reaching more than 95% of the population (CDC, 2012).

More than 90% of children in Egypt are fully immunized, but the full immunization coverage in rural areas was highest in 2000 (92%) and decreased to 89% in 2005 before rising again to 91% in 2008. While the immunization coverage in urban areas falls from 98% in 2005 to 94% in 2008. Overall, 92% of children between the ages of 12-23 months were fully immunized (i.e. received BCG vaccine, 3 doses of the polio vaccine, 3 doses of the DPT vaccine, and measles vaccine), (UNICEF, 2010).

In Egypt, national immunization days against polio virus have been carried out since 1976, and on a yearly basis since 1989. Multiple yearly national immunization days were conducted between 2002 and 2005 until eradication of wild virus circulation. House-to-house polio immunization strategy began in 2000 and became a national strategy in 2002. Surveillance reporting started in the early 1990s, and shifted to virological case classification in 1996 and since then acute flaccid paralysis surveillance indicators have been maintained at WHO certification standards. The quality of its performance is checked in parallel with the national public health laboratory in Helsinki, Finland. Recently, VACSERA, the national poliovirus laboratory in Cairo, Egypt, is a WHO-accredited regional reference laboratory of the Eastern Mediterranean Region poliovirus laboratories network.

Emergency response was conducted and coordination efforts are ongoing between MOHP, the government of Egypt and Global Polio Eradication Initiative partners, WHO and UNICEF for environmental sampling and field investigation for cases in the areas in which the wild virus (WPV1) imported from Pakistan was detected in the environment. Environmental samples will be collected fortnightly

instead of monthly from the areas at risk. Supplementary immunization activities with trivalent oral polio vaccine (OPV) are being planned for a large-scale Cairo-wide campaign for children under 5 years age, targeting approximately 3 million children (WHO EMRO, 2013).

The 2008 EDHS found that around one in six households owned or kept poultry. This is about half the level reported in the 1988 Egypt DHS (33%). To reduce the potential for transmission of the avian influenza virus from birds to humans, it is recommended that poultry or birds be located away from the household living area; however, around one in five households were keeping poultry or birds within the family living area. About 99% of women and men age 15-59 had heard about avian influenza, only 8% were able to mention at least four ways in which the virus might be transmitted to a person and only 21% were able to name four ways to limit the chance of infection (El-Zanaty and Way, 2009). So, awareness of modes of transmission and prevention of avian influenza must be increased and need to be at wider scale.

Moreover, a cooperative agreement between CDC and NAMRU-3 with the MOHP was established in the beginning of 21st century to provide support to conduct epidemiological and laboratory surveillance for **influenza** and to build capacity in Egypt's National Influenza Center (NIC) to detect and isolate seasonal and novel influenza viruses. The program also conducts population based studies of the burden of influenza and effectiveness of preventive measures (CDC, 2012). Also, MOHP laboratory based disease surveillance system provides information to Egyptian citizens about ways to protect themselves from H5N1 and H1N1 and has been vigilant in monitoring these threats (USAID, website). In addition researches are ongoing in the National Research Center to develop vaccine against Egyptian strain of avian flu (H5N1) to be available in the Ministry of Agriculture. WHO will publish information on human cases with H5N1 or H7N9 avian influenza infection on a monthly basis on the Influenza web page:

http://www.who.int/influenza/human_animal_interface/HAI_Risk_Assessment/en/index.html

Both WHO and the Health Ministry predict that a vaccination for H5N1 human to human virus would be available, but in limited quantities. The humanitarian implications are serious. Since vaccine manufacturers would probably pass on only small amounts to developing countries, countries like Egypt would have to give vaccination priority to a selected few, according to the pandemic preparedness plan.

Community-bases Chemotherapy

Community-based chemotherapy has been used during outbreaks in several countries and for selective treatment of infected individuals. But, it has not been used in large community-based control programs because of its limited availability (WHO, 2007). Application of this strategy in treatment of schistosomiasis led to reduction in the prevalence of schistosomiasis in rural Egypt from over 50 percent in 1983 to less than 1 percent in most areas throughout the country, except for a few “hot spots” where prevalence is 1–3 percent (USAID, web).

Egypt is the only country that is currently implementing control activities against hepatic Fascioliasis. Activities started in 1996 with the identification of the six endemic districts in Beheira Governorate.

Since then, school surveys have been conducted in all the Delta governorates and in some Upper Egypt governorates. Raising health awareness in the Egyptian population is the most important tool for prevention of HF, in addition to the application of molluscicides to decrease the population of Lymnaea snails, early diagnosis of infection, and effective medication. Priority setting for disease control at the country level is based not only on mortality and morbidity indicators, but also on the availability of effective, safe, cheap and simple tools. Behavior changes have the potential to be the most effective and cost efficient approaches to disease control and thus education is an essential aspect of any public health effort. The primary message of Fasciola hepatica campaigns is to keep domestic animal herds separate from the growing sites of aquatic food plants. This limits the risk of contaminating the vegetation and thus decreases both human infection and the animal reservoir. Teaching the washing of vegetables in either 6% vinegar or potassium permanganate for 5 to 10 minutes, which destroys the encysted metacercariae, is another useful educational effort. This approach has proven more acceptable to communities than past attempts to entirely halt the consumption of raw vegetables. Despite the prevalence of fascioliasis in many regions, physicians and health workers often do not consider the possibility of Fasciola hepatica infection when treating patients and thus would benefit from awareness training. From 1998 to 2002, the program screened almost 36,000 schoolchildren in six districts, treating 1,280 cases of hepatic Fascioliasis. Prevalence in the endemic area was reduced from 5.6 to 1.2% (Curtale et al., 2005).

Application of World Health Organization control strategy for* tuberculosis *(TB)

World Health Organization (WHO) control policy for TB includes BacilleCalmette-Guérin (BCG) vaccine at birth, case detection, and treatment of cases with directly observed therapy short-course (DOTS). Application of the WHO control strategy for TB in Egypt is considered as complementary to each other towards elimination of the disease. Even the compulsory BCG vaccination at birth may play a role in decreasing the burden of disease either through its non-specific effect on immune system and/or through prevention of progression of infection to disease (Saad-Hussein and Mohammed, unpublished).

Quarantine measures

World Malaria Report (2012) mentioned that Egypt is one of the countries applying prevention of reintroduction phase in spite there was no reported indigenous malaria since 2009, and in 2010 the mortality rate due to malaria in children under 5 years was zero.

Controlling for the Non-communicable diseases

Regarding the management of children with ARI, results from the 2008 EDHS show that 90% of these children were given drugs and roughly 58% of them were given antibiotics (UNICEF, 2010). In addition, reducing short-lived climate pollutants is critical to reduce near term climate change. Short-lived climate pollutants particularly harmful to health include soot particles and gases emitted by sources such as: inefficient biomass and coal cook stoves; diesel exhaust; traditional brick kilns; and methane emissions from oil and natural gas production, sewage, landfills and rice paddies. Improving combustion of solid-fuel in poor households will both help reduce acute respiratory illness, and mitigate climate change through reduction in Climate -Altering Pollutants (CAPs) as a co-benefit. Indoor pollutants emitted from natural gas were proved to be significantly less than those emitted from butagas combustion, except for NO_2 gas, and the use of artificial ventilation in kitchens would significantly decrease the levels of indoor pollutants.

However, dehydration caused by severe diarrhea is a major cause of death amongst young children, only 28% of children suffering from diarrhea were given a solution prepared using a packet of oral rehydration solution (ORS). Antibiotics and anti-diarrheal medications are generally not recommended to treat diarrhea in young children; however, results from the 2008 EDHS shows that antibiotics were given to one-third of children with diarrhea: 15% received anti-motility drugs, while 34% were given other drugs, e.g. antipyretics to treat the fever accompanying diarrhea. In contrast to this, about one-quarter of the children with diarrhea were not given any treatment. The inclinations of uneducated, poor and rural mothers, in relation to how they deal with a child who has diarrhea, wind up being far more accurate than women who have a higher education and come from wealthier families. This discrepancy might be explained due to the success of awareness materials and TV shots, which were designed (in most cases) to target rural women (UNICEF, 2010).

Controlling for malnutrition

Egypt has special supplementation programs; inform of: vitamin A supplementation program for new mothers and for babies, and iodization of salt. Mothers reported receiving a vitamin A capsule postpartum in the case of nearly 57% of all births in the five year period before the 2008 EDHS. Around 12% of children age 6-59 months had received a vitamin A capsule. Also, Egypt has adopted a program of fortifying salt with iodine to prevent iodine deficiency. Overall, 79% of households were found to be using salt containing some iodine (El-Zanaty and Way, 2009).

IV.8. BIODIVERSITY

Biodiversity is a term that implies the variety of plant and animal life in a particular ecological system or habitat, a high level of which is usually considered to be important and desirable. In 1992, Egypt signed the Biodiversity Convention and ratified it in 1994. Article 6 of this Convention required the parties to formulate national strategies setting framework for the conservation of biodiversity

IV.8.1 Vulnerability

IV.8.1.1 Marine Ecosystem

Climate change will probably affect marine species through ocean acidification, or ecosystem stratification, or increasing oceanic dead zones.

Coral Reef

In Egypt, Hanafy and Ismail (2012) conducted a detailed survey in August and October 2012, in comparison to the baseline survey conducted in 2011, in order to quantify the level of impact of increasing temperature on bleaching event of the Egyptian reefs of the Red Sea. For this purpose, 136 sites were checked by sighting the presence or absence of bleached coral colonies along the coast of the two Gulfs of Suez and

Aqaba, and the Red Sea. Moreover, a total of 16 sites were surveyed quantitatively. The surveyed reefs were located on the Egyptian coast of the Red Sea, starting from Neweibaa in the northern part of the Gulf of Aqaba ending with Shalatien on the Egyptian southern border. Sites were selected carefully to cover the geographical range of the bleaching event and to cover both exposed and sheltered reefs as well as inshore and offshore reefs. They found that the increase of water temperature affected certain reef building coral genera including; *Montipora, Porites, Acropora, Stylophora and Pocilliopora* and some non-reef building corals including, *Millipora* and some of the soft corals and sea anemone. The mass bleaching event was restricted mainly to the first 6 meters of depth, and then reduced sharply in depths between 6 meters to 10 meters. Although sheltered areas were found to be more impacted by coral bleaching, the mass bleaching event affected both sheltered and exposed sites. The mass bleaching event also affected inshore and offshore sites

Marine Turtles

Five species of marine turtles have been observed in the Egyptian Mediterranean and Red Seas; the green turtle (*Cheloniamydas*), the hawksbill (*Eretmochelysimbricata*), the loggerhead (*Carettacaretta*), the olive-ridley turtle (*Lepidochelysolivacea*) and the leatherback turtle (*Dermochelyscoriacea*). At present time, these species are enlisted in the IUCN Red List either as critically endangered or endangered species (IUCN 2011). Furthermore, they are enlisted in Appendix I of the Convention on International trade of Endangered Species (CITES), which forbids their trade in signatory countries (CITES 2011).

Another major threat to sea turtles is the increasing of temperature that can cause a reduction to their populations. Since temperatures in the sands define the sex of the turtle while developing in the egg, many feared rising temperatures would only produce one sex, but more research remains to be done in order to understand how climate change might affect sea turtle gender distribution.

Lessepsian Migration

In spite of physical and hydrographical impediments, hundreds of Red Sea species crossed the Suez Canal and settled in the Mediterranean in a process termed ‘Lessepsian migration’. To date more than 250 species from the Red Sea have been found in the Mediterranean, including crabs, mollusks, worms and 69 species of fish, which now comprise some 20 % of all the fish species in the Mediterranean. In general, it seems that Lessepsian species seem to be gradually expanding their distribution from Port Said (Egypt), both towards the west along the African coast, and towards the east along the coasts of Israel, Lebanon, and Syria, progressing from there, towards the southern Turkish coast and the coasts of Cyprus, and finally towards the Aegean Sea.

Climatically driven changes may affect both local dispersal mechanisms, due to the alteration of current patterns, and competitive interactions between non-indigenous species (NIS) and native species, due to the onset of new thermal optima and/or different carbonate chemistry.

Although it is difficult to differentiate natural range expansion through time from climate-induced effects, particularly in regions lacking systematic field monitoring and temperature records, it seems that the last twenty years have seen an accelerated rate of westward migration of Lessepsian species. Some strong examples for this statement are the one of the westward spreading of the rabbitfish *Siganusluridus*, recently reaching the Gulf of Lions and this of the blue spotted cornetfish *Fistularia comersonii* recently reaching the French coast in the northwestern Mediterranean.

From the review of the available literature, it can be concluded that it is necessary to continuously monitor the relevant environmental parameters and the state of the natural environment for the better understanding of Lessepsian migration mechanisms and pathways. Moreover, predictions of the future changes and the impacts of increasing temperature on fish species composition as well as the non-indigenous organisms on the indigenous environment are essential.

Marine Mammals

Many scientists reported that changes of behavior of sharks in Egyptian Red Sea during the last decade might have a relationship with climate changes including water temperature, circulation and pH. Changing in physical parameters of water can impact on electric impulses they receive.

Dolphins are marine warm-blooded mammals found mostly in the shallower areas of the Red Sea. Most species of dolphins are enlisted in the IUCN Red List either as critically endangered or endangered (IUCN 2011). They use echolocation to find prey or avoid predation, so changes in physical characters of water will impact them.

The Dugong or the sea cow (*Dugong dugong*) is a quite large mammal, found along the coasts of the Red Sea, East Africa and across most of southern Asian coasts. In Egypt they are found in the southern Red Sea shores, but in summer it can be seen as far north as Ras Muhammed Protectorate, as this species is very sensitive to temperature changes. The Dugong is in extreme danger of being extinct, as it has been hunted in the past for its meat and leather.

IV.8.1.2 Freshwater Ecosystems

Freshwater ecosystems in Egypt include the River Nile, wetlands in Delta region and some lakes. Climate-induced changes in air temperature, precipitation, and other stressors are already affecting the physical, chemical and biological characteristics of freshwater ecosystems and species.

River Nile and Wetlands

The impact on the River Nile and wetlands would be very serious. A high percentage of Egypt's fish catches are made in the lagoons. Sea level rise would change the water quality and affect most of freshwater fish. The expected increased temperature in our northern lakes and increased eutrophication allows algae to grow producing algal blooms. Also, the increased evaporation rate could affect the salinity of the closed water bodies such as Qarun and Wady El-Rayan lakes.

Based on a search of the scientific and grey literature, the following implications of climate change for species, populations, and biological communities have been identified: shifts in species range and distribution; altered phenology and development; shifts in community composition, competition, and survival and altered interaction with non-native and invasive species.

Appearance of Harmful Algal Blooms

A direct consequence of global warming is thermal expansion of water is the photosynthesis and plankton growth. In October 2003, a wintertime algal bloom appeared in the Suez freshwater canal; the drinking water supply for the Suez City. Unpleasant odor and color of the drinking water caused panic in the urban community. *Microcystisaeruginosa*, *Oscillatoriaforomosa* and *Oscillatoriaprinceps* dominated the phytoplankton and were the cynobacterial bloom-forming species. A recent study in Egypt revealed that 25 % of 75 Anabaena and Nostoc strains isolated from soil, rice fields and water bodies contained microcystins Toxin. In Lake Nasser overgrowth of Cyanophyceae species causes floating crusts and scum, where plants die quickly and disintegrate in the intense sunlight. This causes depletion of oxygen below the point required for fish and other aquatic animals.

On the other hand, the highest species richness of mollusks in Afrotropical Africa is found in the Egyptian Nile where 39 species are present. In the 20th century, due to the disappearance of swampy habitats along the borders of the Egyptian Nile, many smaller gastropod species that live in debris and among aquatic vegetation became restricted to the slow flowing and stagnant canals of the Nile Delta where vegetation was still abundant and the bottom was muddy. Compared to the Nilotic molluscan community recorded in 19th century, the present one shows only a slight decrease in species richness, due to the disappearance of a couple of Palaeartic species that were already relicts one hundred years ago. Their disappearance may have been caused by global climate change. It should be pointed out however, that the only endemic Afrotropical bivalve in Egypt, *Chambardialetourneuxi*, which was confined to the Delta has not been collected since the late 19th century and should be considered as Extinct.

The mosquito fish (*Gambusiaholbrooki*) is among the most invasive fish in Egypt and abundant in most Mediterranean countries. It is unable to tolerate the colder winters of northern and central Europe. Understanding the effects of latitude on its life-history traits is essential to predict the potential for its invasion in different scenarios of climate change.

The future impacts of climate change on fisheries and aquaculture are still poorly understood. The key to minimizing negative impacts and maximizing opportunities will be understanding and promoting the wide range of creative adaptive measures and their interactions with existing policy, legal and management frameworks.

IV.8.1.3 Terrestrial Fauna

According to IUCN (2008) 108 terrestrial animal species in Egypt currently face major threats which will be augmented in the future due to the repercussions of climate change. Egypt has a diverse landscape that its geographical position has provided. Laying at the junction of four biogeographically regions, Saharo - Sindian, Irano - Turanian, Mediterranean and Afrotropical, Egypt has a unique mixture of vegetation types, which support a corresponding diversity of faunal elements (Kassas 1993). Scientists recorded about 130 mammal species in Egypt, of which 3 are critically endangered, 3 endangered, 8 vulnerable, and one is near-threatened (IUCN, 2008). Avifauna is an important component of Egypt’s biological resources, indeed it is the most diverse and prominent of all of the country’s non - aquatic vertebrate fauna. More than 470 bird species are known from Egypt, compared to 110 species of reptiles and amphibians.

Birds

Some of the most profound effects of climate change are likely to be driven by changes in the timing of biotic interactions between species. Many organisms alter the timing of their seasonal activities in response to climate change, whether it be flowering in plants, budding of trees, emergence of insects or breeding and migration in birds. Monitoring devices and control of birds Zaranik protected area, Arish City, recorded early migration of birds before the fall schedule by about 25 days in its journey from Europe across the Mediterranean to continue through their emigration to Africa through the protected Zaranik. Environmental management in northern Sinai registered several flocks of birds' freebee, and the gull Alepesharush and some other species.

Odonata insects

The Odonata of Egypt is mainly of Eurasian and tropical origin but the region houses a few additional south-west Asian species. There are marked differences in the dragonfly fauna within distinct areas of the Egypt which reflect past and current climates and topography.

The Odonata of Egypt is dominated by Afrotropical species owing to the key role of the Nile River, which facilitates the crossing of the Sahara Desert. There are 7 endemic species and among these, two (*Calopteryxexul* and *Gomphuslucasii*) are assessed as threatened, one (*Cordulegasterprinceps*) as Near Threatened, another (*Lestesnumidicus*) is Data Deficient and 3 (*Ischnurasaharensis, Enallagmadeserti*, *Platycnemissubdilatata*) are judged as Least Concern. Six species (7.3%) were first assessed as Regionally Extinct was discovered in the lower Nile valley and delta. Only four species should be maintained as Regionally Extinct (4.9%). Two of them (*Ceriagrionglabrum* and *Phyllomacromiapicta)* were recorded in the past from the Nile Valley, where new investigations are urgently needed.

Sinai butterfly

Climate change phenomenon has been recorded by monitoring disappearance of living organisms on peaks of St. Katherine mountains due to raise of temperatures, which may expose some organisms to the danger of extinction, among which Sinai baton blue (pseudophilotes) the smallest butterfly in the world. The length of its wings doesn't exceed 6 mm. It is endemic to St. Katherine Mountain and cannot be found in any place in the world except in this area. Its larva feed on buds of Sinai Thyme (Thymus decussates), while adult butterflies feeds on nectar of its flowers. Peaks of Sinai Mountains are the only place in the world where Sinai Thyme (*Thymus decussates*) can be found, as it is an endemic plant species.

Studies proved that annual change in temperatures, expedite its exposure to danger of extinction and if temperature degrees continue its raise Sinai Thyme will continue its decrease leading to decrease in the numbers of Sinai baton blue (pseudophilotes) exposing it to danger of extinction in a very limited period, especially if exposed to human threats, such as over grazing and collection of Sinai Thyme for medical purposes.

IV.8.1.4 Role of Protected Areas in conserving biodiversity

Leach *et al*. (2013) studied in Egypt the role of Protected Areas in conserving biodiversity from the future climate change and increasing of temperature. In this study they used two techniques in conservation science, first, to estimate the likely impacts on the distributions of mammals and butterflies in Egypt (MaxEnt), and second, to measure the effectiveness of Egypt's Protected Area network (Zonation). They predicted that future climate will have significant effects on species richness and the relative value for conservation of sites in Egypt; some areas will increase in species richness, whilst others will decrease significantly.

Currently, the sites of highest relative conservation value are found in the Nile Delta, southeastern and Sinai regions of Egypt and along the Mediterranean and Red Sea coastlines, with Protected Areas having a higher conservation value than unprotected areas. Under future climate scenarios the relative conservation value of Protected Areas are predicted initially to decline and then gradually increase by the 2080s. It is predicted that many areas, especially the Nile Delta and the southeast, will require extra protection in the future; areas that are currently not protected, but have high species richness and conservation value, may need to be protected to prevent loss of biodiversity.

IV.8.2. Ongoing Studies and Systematic Observation

Many studies addressed the sensitivity of the **River Nile waters** to climate change. The sensitivity of different Nile basins to uniform changes in rainfall have been documented (Sayed, 2004). It is clear that the Eastern Nile (Atbara and the Blue Nile) is extremely sensitive to the change in rainfall both positive and negative, where an increase of 10% in rainfall results in a 36% increase in water flow at Khartoum, and a decrease of 10% in rainfall results in flow reduction of 31%. The sensitivity of Nile water flows and consequently species diversity are also affected by the change in temperature, which causes corresponding changes in evaporation and evapotranspiration. An increase of 4% in evapotranspiration would result in a reduction of Blue Nile and Lake Victoria flows by 8% and 11% respectively.

The coastal zones and inland lakes of Egypt are perceived as vulnerable to the impacts of climate change, not only because of the direct impact of sea level rise, but also because of the potential impacts of climate changes on their water resources, agricultural resources, biodiversity, tourism and human settlements. In particular, the low lying Nile Delta region, which constitutes the main agricultural land of Egypt and hosts over one-third of the national population is highly vulnerable to various impacts of climate change.

Salt water intrusion and its potential impacts on wetlands and ground water quality in the coastal zone cannot be overlooked especially in low land areas along the Mediterranean coast of Egypt. This will in turn lead to disappearance of freshwater biota and deterioration of wetland diversity. This phenomenon is considered of utmost importance and warrants full investigation.

The increase of intensity and frequency of **environmental extreme events** is also expected to affect the coastal zones of Egypt and extend over the whole country as well as across the Mediterranean. Saharan dust and heat waves are well known to seriously affect land agricultural productivity, materials lifetime and public health. Increased intensity and frequency of marine storms will necessarily increase risks of transportation accidents and health risks. A change of wind direction and coastal current pattern is also expected due to climate changes; that will seriously affect the marine fauna. Decreases of precipitation on the Red Sea coastal area, changes of the well-known Nawwat pattern of extreme events at Alexandria, increased rates and frequencies of dust storms and prevailing temperature inversions are only a few examples of climate change observations in the coastal areas.

The impact of climate change on **mangrove trees and coral communities** in the Red Sea will include coral bleaching due to increasing temperatures, loss of habitats as well as loss of biodiversity hence deterioration of fisheries and tourism.

Reduction of plant and animal diversity due to high temperature and very dry environment is typically what happened in **Elba and south Sinai mountains**. Air temperature at Elba Mountain increased about 3^0C since 1960s that led to disappearance of some sensitive plant species (such as Embet trees) down land the mountains and moving some of them to the upper parts of the mountains, where low temperature and high humidity.

Despite its predominantly hyper-arid environment Egypt enjoys a considerable diversity of habitat. Egypt has a unique mixture of vegetation-types, which support a corresponding diversity of faunal elements. Egypt is tenuously connected with sub-Saharan Africa through the Nile River and the Red Sea, along both of which many African faunal and floral elements extend north, adding a further dimension to Egypt's biodiversity. The Nile, with its enormous water resources, supports almost all of the country's major wetlands. Long coastlines on two seas with very different marine ecosystems and terrestrial environments, encompassing a wide variety of topographic features; ranging from the rugged mountains of South Sinai and the Eastern Desert (up to 2,641 m) to the Qattara Depression (134 m below mean sea-level), contribute to the diversity of Egypt's habitat-types Wetlands are some of Egypt's most important habitats in terms of biodiversity (second only to the Red Sea's coral reefs), supporting both the greatest diversity and density of bird species. Most Egyptian wetlands have been degraded drastically during the past 50 years: drained, polluted, over-fished and over-hunted. It should be a conservation priority in Egypt to protect at least representative wetland habitats (Baha ElDin, 1997)

There are six major inland wetland areas in Egypt: the Bitter Lakes, Wadi El Natrun, Lake Qarun, Wadi El Rayan Lakes, Nile River and Lake Nasser. In addition, there are many smaller wetlands dispersed in the Nile delta and valley, and in oases in

the Western Desert. Of the Mediterranean coastal wetlands, the most important are the six major coastal lagoons on the Mediterranean: Bardawil, Malaha, Manzala, Burullus, Idku and Maryut. The remainder of the Egyptian Mediterranean coast is of rather limited importance for birds. The Red Sea coastal habitats and wetlands include mudflats, reefs, mangroves and marine islands,(BahaElDin, 1997)

Desert habitats cover over 90% of Egypt's territory. The Mediterranean coastal desert receives the highest rainfall in the country (up to 200 mm annually), and has a fair amount of plant cover and the greatest floral diversity nationally. The influence of coastal rains extends up to 60 km inland. In contrast, the desert bordering the Red Sea is very dry. The vegetation is typical of that of the Eastern Desert, being largely restricted to the mouths of larger wadis and along the coast, where saltmarsh vegetation grows (BahaElDin, 1997)

In general, the vulnerability of biodiversity in Egypt involves:

- Global climate change, in terms of modifying the biology of the oceans, is the main vulnerability of anthropogenic CO_2 on the pH of the oceans, which will affect the process of calcification for some marine organisms

- The resulting changes in the chemistry of the oceans disrupt the ability of plants and animals in the sea to make shells and skeletons of calcium carbonate, while dissolving shells already formed
- Increasing ocean acidification is expected to lead to deteriorated biodiversity of a large number of marine species
- Increasing temperature and aridity on land is expected to affect negatively biodiversity in protected areas
- Vulnerability of migrating birds due to potential impact of salinity and temperature of the wetland

In this respect, priority research areas within the different fields include:

- Developing new strains tolerant to heat, salinity and water stresses.
- Adaptation options based on genetic engineering applications.
- Evaporation and evapotranspiration reduction.
- Simple and cheap marine aquaculture techniques.
- Non-conventional water resources development.
- Advanced research in the area of improved water use efficiency and water demand management as no- regret solutions to cope with climate change.
- Vulnerability assessment of the coastal zone and exploration of options for adaptation in view of adopted scenarios of sea level rise.
- Monitoring, modeling and assessment of impacts of salt water intrusion on coastal wetlands.
- Monitoring, modeling and assessment of potential impacts of climate changes on mangrove trees and coral reef and impacts on tourism
- Socioeconomic considerations of immigration of vulnerable communities and employment considerations in safe areas

IV.8.3. Adaptation Actions

Adaptation actions are undertaken either to avoid, or take advantage of, actual and projected climate change impacts either by decreasing a system's vulnerability or increasing its resilience. This may entail reprioritizing current efforts as well as identifying new goals and objectives to reduce overall ecosystem vulnerability to climate change. The following is the number of actions that should be done:

- Conduct/gather additional research, data, models and products
- Create/enhance technological resources to make adaptation actions easier and more accessible. These resources can help planners, managers, scientists, and policy makers to identify priority species and areas for conservation, generate inundation and hazard maps, and ascertain organizations

and communities that have successfully implemented adaptation strategies. For the coral reefs and mangrove plants, implementing a program for the management of existing communities and encouraging of ongoing artificial coral and mangrove cultivation and expanding coral and mangrove protectorates.

- Conduct vulnerability assessments and studies to evaluate potential effects of climatic changes on ecosystems, species, and human communities. This will help in identifying which species or ecosystems are likely to be most strongly affected by projected changes; and understanding why these resources are likely to be vulnerable, including the interaction between climate shifts and existing stressors.
- Conduct scenario planning exercises
- Increase organizational capacity to support adaptation activities at all levels of government.
- Create/host adaptation training and planning workshops
- Provide training for people whose livelihoods are threatened by climate change. This strategy directly addresses the potential economic consequences of global climate change. Increased water temperatures and ocean acidification will severely impact fisheries, aquaculture, and ecotourism and recreation based on natural resources.
- Create new institutions (training staff, establishing committees). Technical experts, scientists, and other staff can contribute important knowledge and recommendations to support governmental decision-making on climate adaptation.
- Coordinate planning and management across institutional boundaries increased cooperation may include information sharing, improved communication, and establishing formal partnerships to share resources, funds, and knowledge.
- Invest in/enhance emergency services planning and training. Warmer temperatures and changes in precipitation patterns will likely increase incidences of wildfires and drought, pests and diseases, and intense heat waves. Integrating climate change concerns into emergency services planning and training, including police, fire and rescue, and emergency medical services, will be important to limit public health and safety risks.
- Create stakeholder engagement processes.
- Increase/improve public awareness, education, and outreach efforts.
- Evaluate existing monitoring programs for wildlife and key ecosystem components.
- Improve coordinated management and monitoring of wetlands, by offering financial and other incentives; using legislative reauthorizations to protect biodiversity and ecosystems and supporting research on the impacts of climate change on wetlands. Also, it is very important to incorporate climate change into wetland restoration planning.
- Incorporate predicted climate change impacts into species and land management.

- Incorporate climate change considerations into aquatic invasive species management plans.
- Incorporate climate change considerations into Ecosystem-Based Management.
- Climate change adaptation and mitigation measures in fisheries.

IV.9. EXTREME EVENTS

Weather and climate extremes have significant societal, ecological, and economic impacts across most regions of the world. Climate extremes include dust storms, heat waves, localized flash floods and, very rarely, unaccustomed snowfall in the north. A particularly unpleasant, occasionally dangerous, phenomenon in spring and early summer is a dry and dust laden wind that, from time to time (periodically), carries very hot air northwards into northern Egypt ahead of weak cyclonic disturbances in the Mediterranean.

Storm surges over northern coastal cities occur occasionally. It is usually associated with severe impacts on coastal structure, infra-structure and transportation systems, navigation and health.

IV. 9.1 Analysis of Long-Term features in the Mean Temperature

Monthly mean anomalies from CRUTEM3 are averaged over each 3 month season (June-July-August – JJA and December-January-February – DJF) of mean temperatures from 1960 to 2010 over Egypt using the median of pairwise slopes method to fit the trend. And in agreement with increasing global average temperatures (Sánchez-Lugo *et al*. 2011), there is a spatially consistent warming signal for temperature over Egypt. For both summer and winter the spatial pattern is similar. However, for summer, more grid boxes show warming signals with higher confidence (in that the 5^{th} to 95th percentiles of the slopes are of the same sign) than for winter. Regionally averaged trends show warming but with higher confidence only for summer. There is stronger warming during summer at 0.31oC per decade than during winter at 0.07 oC per decade.

IV.9.2 Analysis of Long-term Features in Moderate Temperature Extremes

Studying changes in the frequency of cool days and nights and warm days and nights which are moderate extremes have been done and it's found that, warm nights have become more frequent while cool nights have become less frequent across the region with higher confidence. The signal for warm days and cool days is more mixed. Also Night-time temperatures (daily minima) show a widespread positive shift in the distribution with fewer cool nights and more warm nights. Regional averages show high confidence signals of fewer cool nights and more warm nights. Daytime temperatures (daily maxima) show a mixed signal lacking regional consistency and low in confidence. There is low confidence in the regional average signals of small decreases in the frequency of both cool and warm days. The small numbers of stations present in most grid boxes means that even if there is higher confidence in the signals shown, uncertainty in the signal being representative of the wider grid box is large.

IV.9.2.1 Precipitation and Flash Flood Extremes

Precipitation extremes, either excess or deficit, can be hazardous to human health, societal infrastructure, and livestock and agriculture. Flood or drought can have serious negative impacts. These are complex phenomena and often the result of accumulated excesses or deficits or other compounding factors such as changes in land use.

Analysis of the meteorological elements and synoptic situation during the period (1968-2006) that the floods have been existed over Egypt during it appeared that, Egypt was under the influence of two different low-pressure systems. First, one over the northern part of Egypt associated with cold air mass from Europe. The second one was over the Red Sea region associated with warm air mass from the south. In addition, there were cold advections aloft, increasing the instability of weather conditions. There was an extreme positive anomaly in precipitation over all of Egypt during flash flood. The existence of two different cloud types increased the instability weather conditions over Egypt. Also the synoptic situation over Egypt was blocking system persisted over Europe, which persists the instability weather condition over Egypt. The flash floods were more frequent during autumn season, and these impacts on the economy and the society in term of significant property damage and loss of lives.

IV.9.2.2 Black Cloud Extreme

Black clouds, other extreme weather events in Egypt. Analysis of the meteorological elements during the period of the black cloud existence found that, Egypt lies under influence of high pressure system and invaded by south desert air over Egypt. In addition, the lower temperature inversion occurred approximately between 500 and 1000m height. This combination between synoptic situation and increase of temperature leads to suspension of dust, sand and other aerosols near the surface, which create black cloud. These results, with respect to reasons of black clouds, were agreeing with Flocas*et al.* (2009) who found that air pollution episodes in urban areas follow certain pre-determined patterns, being associated with certain local meteorological conditions and emission of primary pollutants. Also it is noted that the black cloud began to occur when the temperature was above normal in surface, and levels 925, 850hpa by values 7.7 and 8 ^{o}C, respectively. In addition, the lower temperature inversion occurred approximately between 500 and 1000m height that there were many responsible reasons for the black clouds over Greater Cairo during months October and November. First one is the existence of warm dry air at the surface and the temperature was above normal at least 8oC at Level (850hpa). Second, one the lower temperature inversion occurred approximately between 500 and 1000 m and the third one burning of rice straw. In addition, topography of Cairo is responsible for existence of black clouds where Greater Cairo is located on both sides of the Nile River in a rectangular depression extend from Shobra-El Kheima City in the north to Helwan in the south (industrial sites). Moreover, higher aspects of this low to the east in the direction of Mokattam Mountain and the desert eastern in direction Plateau pyramid-Saharan and desert western.

IV.9.2.3 Aerosol Impact in Urban Areas

The analysis of the temporal variation of the aerosol's optical depth (AOD) and spectral dependence suggests that the aerosol is generally a mixture of at least 3 main components differing in composition and size. The components of the aerosol are found to be:

- Highly absorbing background aerosol produced by daily activities (traffic, industry)
- An additional, ‘pollution’ component produced by the burning of agricultural wastes in the Nile delta, and
- A coarse desert dust (DD) component. In July, an enhancement of the accumulation mode is observed due to the atmospheric stability favoring its building up and possibly to secondary aerosols being produced by active photochemistry.

More generally, the time variability of the aerosol's characteristics is due to the combined effects of meteorological factors and seasonal production processes.

The instantaneous aerosol radiative forcing (RF) at both the top (TOA) and bottom (BOA) of the atmosphere is maximal during these events. For instance, during the desert dust storm of April 8, 2005 RFBOA, RFTOA, and the corresponding atmospheric heating rate peaked at–161.7W/m2,–65.8 W/m2, and 4.0 K/d, respectively. Outside these extreme events, the distributions of the radiative forcing values at BOA and TOA are Gaussian with means and standard deviations of–58 (±27), and–19 (±11) W/m2, respectively. In April, the contributions of DD to the month averages of the instantaneous radiative forcing are as high as 53% at BOA, and 66% at TOA. In October, the biomass burning mode contributes 33 and 27% of these forcing, respectively. Noteworthy is that the contribution of DD to RF is never less than 17% (at BOA) and 27% (at TOA), emphasizing the importance of the mineral dust component on the transfer of solar radiation above Cairo, and this even in months when no major dust storm is observed.

The long records of surface solar irradiance SSI (36 years) at Cairo, Bahtim, Kharga and Aswan as indicate an initial dimming and more recent recovery; this result was reported by (Abdel Wahab*et al.,* 2010) who found that the long-term variations in SSI at four countries from North Africa countries (Algeria, Egypt, Libya and Tunisia) from 1985 to 2005. The SSI continued to decrease from the early 1970s up to the present, by 0.17, which corresponds to a decrease of ~35 Wm-2 over 36 years, a result close to that found by Ohmura (2006) in Egyptian sites

IV.9.3 HISTORIC CLIMATE TRENDS AND EXTREME EVENTS

IV.9.3.1 Historic trends

The lineartrendestimationsoftemperatureandprecipitationchangesoverthe periodfrom1960 to 2005 (usingdatafrom11meteorologicalstationsequallydistributedover thecountry) show that, the annual temperature has increased by 2.1^{o}C,with most of the increase taking place in winter (3.6oC).Spring and fall temperature haveincreasedby1.8and1.9 Co respectively and summer temperature by1.1 Co. The warming trend has been observed over the whole territory of Egypt. The years since 1990 have been consistently warmer than the average.

Precipitation has not significantly changed over the pas tdecades.Intermsofcountry spatial average, a decrease of 7% than the normal of the period (1975 -2005) has been observed.

IV. 9.3.2 Changes in Extreme Climate Indices

Extreme climate events have frequently occurred, especially during the last decade and there are indications that their intensity is increasing due to climate change. The study has considered daily maximum and minimum temperature and precipitation data, which were recorded at 11 meteorological stations over Egypt from 1976 to 2005 that has been selected as the baseline climate.

Extreme temperature indices show an increase in both daily maximum and minimum temperature. However, the warming trend of the minimum temperature is higher than for the maximum temperature. These observations are also consistent with decrease of the diurnal temperature range over Egypt. Both tails of the distribution have shifted towards a higher temperature with the shift of the minimum temperature being larger than the shift of the maximum temperatures.

Concerning the trend in precipitation, a decreasing trend is observed all over the country except in the red sea region. This also corresponds to indices of wet extreme condition. In general, the trend analysis shows that extreme temperature indices are changing towards warming while precipitation is decreasing.

IV.9.3.3 Climate Change Scenarios and Regionalization of the Extreme Climate Event

The output from the model was used to set the boundary conditions for the regional circulation model PRECIS model runs (Wilson *et al.,* 2004). Two model runs were performed: the first one to simulate the historic climate for the period 1961-1990 and the second one to project future climate conditions for the period 2071-2100using the A2 emission scenario.

According to present climate, mean temperature is -4 to -8^o C in Altai, Khangai and Khentii mountainous range, -2 to +4 ^{0}C in steppe and desert steppe, and +6°C in desert region. These values are in line with observed present climate of Mongolia based on meteorological stations and give some confidence about the model's capability to project future climate of Mongolia. The projection of future mean climate has given results in the order of -2 to +2 ^{0}C in Altai, Khangai and Khentii mountainous range,+6 ^{o}C in steppe and +10 ^{o}C in desert steppe and desert under SRES A2 emission scenarios. Mean annual temperature increases 4 - 5 ^{o}C everywhere.

IV.9.4 VULNERABILITY OF THE EXTREME CLIMATE AND ADAPTATION

With Egypt's quickly growing population, the agricultural sector needs to better conserve resources to ensure that every Egyptian has access to adequate food and water. Egypt depends on suitable climate and natural resources (land and water) for agricultural production and for food supply. Currently, about 85% of water in Egypt is used on agriculture. With expected population increase, water share per capita will decrease, and climate change will further stress water supply issues.

This would mean less food to feed the growing population. This means that with or without climate change we must adapt to our limited resources and start conserving.

Increasing the minimum, maximum and average of temperature in the winter 2010 was above the normal rates, gave the highest decrease in wheat yield -21.2% at Upper Egypt and gave the lowest decrease -8.2% at Nile Delta, while decreasing the minimum and maximum temperatures during January 2008 than the normal caused damages in crops where citrus crop gave the highest damage 50 % and potato crop gave the lowest damage according to (Abdel Raouf, 2008).

Also Mougou*et al.* (2008) applied climate projections from the HadCM3 GCM under A1 and B2 SRES emissions scenarios to simulate rain-fed and irrigated wheat yield under various adaptation measures. The regional temperature increases corresponding to the A1 and B2 scenarios were 3.6°C and 1.5°C, respectively. Under the SRES B2 scenario, rain-fed wheat yield declined by more than 50% if rainfall was reduced by 20%. However, an increase in rainfall by 20% increased yield by less than 5%.

IV. 9.5 CONCLUSION

It is well recognized that all sectors of development in Egypt are highly vulnerable to impacts of climate change and that institutional structure for monitoring, integration and modeling is necessary for proper adaptation. So the studies are now being aimed to improve efficiency of resource use, protect vulnerable coasts and help the communities build up resilience to better manage their land, environment and crops.

CHAPTER V: ACHIEVEMENT OF THE OBJECTIVES OF THE CONVENTION

V. 1. EFFORTS EXERTED

V.2. NEEDS FOR MITIGATING THE EFFECTS OF CLIMATE CHANGE

V. 1. EFFORTS EXERTED

V.1.1. Transfer of Technology

A number of efforts have been undertaken by the Government of Egypt to achieve the objectives of the convention. They include:

- ***Technology Cooperation Agreement Pilot Project (TCAPP)***

Acknowledging technology transfer as one of its highest priorities, Egypt is focusing on such initiatives as the Technology Cooperation Agreement Pilot Project (TCAPP), in cooperation with the U.S. Country Studies Program. The TCAPP is chartered to develop consensus among key Egyptian organizations on a set of high priority, climate-friendly, technology issues aimed at successful commercialization. Results are expected to produce candidate technology transfer areas for consideration under the guidance of the National Climate Change Committee. Market development plans for selected technologies are currently underway.

- ***Promotion of Wind Energy for Electricity Generation***

This is an active program within the Ministry of Electricity and Energy, through the New and Renewable Energy Authority. Supported by many international donors, this project aims at installing 600 MW of wind turbine by the year 2005. The first 300 MW is already contracted through different donors, and most of them are scheduled to be operating by 2003.

- ***Fuel Cell Bus Demonstration Project***

Through the GEF, the UNDP is currently supporting fuel cell bus demonstration projects in Cairo, San Paolo, New Delhi, Beijing, and Mexico City to reduce GHG emissions and other pollutants. The demonstration in Cairo features eight fuel cell buses with associated hydrogen production and supply facilities. The program will run for five years, with three years devoted to driving, monitoring and testing performance. Service is targeted for implementation in the year 2001. With a focus on technology transfer, Egypt hopes to expand the success of this demonstration in its transportation fleet.

- ***Hybrid-Electric Bus Technology in Egypt***

The overall objective of the project is to introduce to Egypt a viable Hybrid-electric bus that will have significant benefits and sustainability in various segments of the country. The project is funded by GEF and implemented by UNDP and the Egyptian Social Development Fund. The project will be applied to high priority historical sites starting with the Giza plateau where the ancient pyramids are located.

- ***Natural Gas Motorcycles***

This is a demonstration project in Egypt of a Canadian technology developed to reduce the emissions of GHG by converting two-stroke engines used in motorcycles to compressed natural gas (CNG). The project will be implemented in three phases: identification of capabilities and barriers, demonstration of the technology, and a hand-over and transition to the local market.

- ***Methane Recovery from Landfills***

This is a demonstration project on the recovery of methane generated in landfills in cooperation with the Canadian government and Industry Canada. The proposed work plan involves the design and construction of two bioreactor landfill cells in Cairo. After the completion of the project, the team will hand over the two bio-reactor cells to the Cairo Solid Waste Management Authority. On-site training will be provided to the Egyptian staff for future operation and monitoring.

- ***The Integrated Solar Thermal/Natural Gas Power Plant at Kuraymat***

The New and Renewable Energy Authority (NREA) has prepared a program for implementing a series of solar thermal power plants. This includes the first Integrated Solar Combined Cycle System (ISCCS) with a 100-150 megawatt (MW) capacity in Kuraymat, Egypt. The GEF/World Bank funded project began in 1997 with a target date of operation during 2001. A second project of almost similar capacity is anticipated to go into operation before 2005.

- ***The Energy Efficiency Improvement and Emissions Reduction Project***

A four-year project implemented by the UNDP with GEF funding was designed to achieve reduction in GHG emissions. This would be achieved through the adoption of policies that promote demand-side management and energy conservation activities, and the creation of an enabling environment for energy efficiency. It focuses on the transmission and distribution of electrical systems, cogeneration policies, and market support for emerging energy service companies.

- ***Fuel Switching***

Current Egyptian energy policy calls for shifting the demand from liquid fuel oil to natural gas. This is due to the abundance in natural gas supply estimated at 45 trillion cubic feet (CF), and with the identified 3D seismic potential, can reach 120 trillion CF. Fuel switching is currently being applied to the electricity generation, industry, and residential sectors. The USAID-assisted Cairo Air Improvement Program (CAIP), important CNG technologies have been introduced to Egypt. In 2000, CAIP furnished Cairo's municipal bus companies with fifty CNG-powered rolling bus chassis, and the Government of Egypt is contributing the bus bodies. By the end of 2000, all fifty buses will be placed into commercial service in Greater Cairo. CAIP has also helped equip the CNG bus maintenance garages required for these fleets, and worked collaboratively with the Government of Egypt to introduce CNG-related safety standards for fuel tanks, fueling stations, and fuel systems. As an example of public-private sector partnerships, the private sector has responded favorably to the promotion of CNG in Egypt by building and operating twenty-seven CNG fueling stations and converting over 27,000 vehicles including taxis to CNG since 1996. The USAID Commodity Import Program helped in purchasing fueling equipment for many of these CNG filling stations.

V.1.2 RESEARCH & SYSTEMATIC OBSERVATION AND NETWORKING

Research and systematic observation are contained in Article 5 of the Convention. The UNFCCC has included research and systematic observation network in its agenda since COP3. The Parties are encouraged to exchange their experiences concerning developments in their climate systems and to participate in research and development on the climate, atmospheric and oceanic observation systems.

The Global Climate Observation System (GCOS) is the key international organization responsible for the systematic observation network that supports the Convention. The UNFCCC has requested the Parties to support the implementation of the climate observation system network. Regional workshops have been organized to exchange views and information related to GCOS, as well as regional needs for the development of climate observation systems. The Parties have also been encouraged to communicate their national activities in this regard.

V.1.2.1 Regional Development of Climate Observation System

Since 2000, activities carried out in Africa through the research and systematic observation network were limited to exchanges of information and experiences among climate change experts on capacity building needs in the region. Key issues concerning the region's systematic observation network have been identified.

The regional GCOS workshop called for regional coordination to support the global climate observation system and to harmonize global, regional and national needs. The need for national capacity development, a regional information centre and information exchange, and a communication system has been highlighted. A sense of ownership of information from the countries is important, in order to sustain participation. Hence, it is important to encourage the use of climate information at the national level, such as for climate change forecasting or warning system. The workshop's outcomes were reported to the UNFCCC, but no concrete actions were taken.

Observations relevant to climate change have been actively implemented with major focus on the atmosphere, ocean and agriculture. Furthermore, to efficiently implement the observation activities, collaborative systems with international organizations and groups have also been established for each sector.

A. Meteorological and Atmospheric Observation

The entities responsible in Egypt for meteorological observation include the Egyptian Institute for Meteorological and Atmospheric observation and the Central Laboratory for Agriculture Climate (CLAC).

The Egyptian Meteorological Authority (EMA) measurement network consists of more than 112 stations including surface stations, upper air stations, global radiation and agro-meteorological stations of these; 26 are connected to international networks. As for the central laboratory for Agriculture climate, it was established in 1996 under the auspices of the Agriculture Research Center (ARC) and aims of maximizing the utilization of agro-meteorological data in the agriculture sector.

There are also special programs addressing atmospheric observation including the Egyptian Environmental Affairs Agency (EEAA) supported by Danidaestablished the Environmental Information and Monitoring program (EIMP). Moreover, some ministries and authorities in Egypt carry out ancillary activities relevant to climate observation as part of these agencies official mandate.

B. Coastal Zones Observation System

The Egyptian coastline, including the Sinai Peninsula, extends to 3,500 kilometers. The wetlands of the Nile delta constitutes about 25% of the total wetlands area in the Mediterranean region, and produce 60% of fish catch of Egypt. The coastal zones of the Red sea incorporate about one third of the national tourist income through its illustrious cities and nature.

The coastal zone of Egypt suffers from a number of problems, including high rate of population growth, subsidence, excessive erosion rates, water logging, soil salinity, land use interference, ecosystem pollution and degradation, lack of appropriate institutional management systems, lack of consistent information system as well as metrological and oceanographic measurements.

The Institute of Graduate Studies and Research (IGSR), Alexandria University, is responsible for monitoring the Mediterranean coast of Egypt and the National Institute of Oceanography and Fisheries (NIOF) is responsible for monitoring the Red Sea coast.The monitoring institutions also participate in a laboratory quality assurance program supervised by an independent reference laboratory at the Faculty of Science, Ain Shams University. The following parameters have been monitored on a bimonthly basis over the past 10 years:

- Bacteriological parameters: Total coliforms, ISO 56679; E.coli, ISO 9308-1; Fecal Streptococci, ISO 78992;
- Physical Parameters: Depth; salinity; conductivity; pH; temperature; dissolved oxygen; transparency;
- Chemical Eutrophication Parameters: Nitrite; nitrate; total phosphorus; total nitrogen; ammonia; reactive phosphate; Chlorophyll–a.

EEAA has an established a website where the listed data are published. It has also established requirements for the quality of data in proficiency tests in order to have uniform evaluations of the results of all participating laboratories. The physical parameters monitored by this network verify and complement satellite measurements of Sea Surface Temperature (STT) so as to provide useful information on changes of SST at various localities of the coastal zone. Data include:

- Metrological and oceanographic data of the Mediterranean and Red sea petroleum platform's sites
- Data provided by earth observation satellites and various airborne sensors
- Maps and spatial data for the evaluation and monitoring of natural resources and natural hazards
- Monitoring Program (EIMP) aims at establishing national environmental monitoring program for ambient air and coastal waters. (http://HYPERLINK "http://www.eeaa.gov.eg/arabic/main/achivements.asp"www.eeaa.gov.eg/arabic/main/achivements.asp)

- SRI has a monitoring program for the sea level changes along the Mediterranean and Red sea for recent years in the cooperation with the marine forces.

C. Oceanographic Observation

It included oceanographic measurements along the coasts of the Mediterranean and Res Sea like tide gauge; Automatic tide gauge, Wave gauges, the costal Acquisition System wave Recorder (CIAS), Opera Wave Suspended Recorder (OSPOS) and S4DW Wave-current Recorder.

D. Forest Observation System

The Agricultural Research Centre (ARC) in Egypt has established research sites as subjects for the long term study and monitoring of structure, function and dynamics of the upcoming forestry plantation and its role to mitigate environmental changes.

Egypt offers great opportunities for large-scale afforestation projects due to the availability of sufficient sewage water and wide expanses of desert land. Following basic treatment, sewage water can be efficiently used as a resource for the production of wood, woody biomass and biofuel crops. Egypt produces over 6.3 billion m3 of sewage water annually. Only 5.5 billion m^3 of sewage water is needed to afforest over 650,000 hectares (1.5 million feddans1) of desert and thus store over 25 million tons of CO_2 annually. Large-scale afforestation may also stimulate cloud formation and may result in rainfall that the country urgently needs.

E. Terrestrial Observation

Some institutions such as Soil and Water Research Institute (SWRI), Agriculture Research Center, Ministry of Water and Land Reclamation, National Research Center (NRC), and the General Organization for Physical Planning (GOPP) have carried out land use mapping and for land /land cover mapping on the National/or Regional levels using standard methodologies.

Hydrological observations in Egypt are one of the main responsibilities of the Ministry of Water Resources and Irrigation (MWRI) and its affiliated institutions. These observations include water quality, quantity and demand and supply data.

F. Space-based Observations

Satellites provide useful measurements on land cover and land use, as well as spectral proprieties that can be used to estimate vital biological processes and variables such as leaf are indices, soil moistures and biomes. In addition, satellites provide a great variety of data related to meteorology, oceanography, and hydrology as well as links between these areas. Satellites have been in operation for a long time during which large data sets on several climates related issues have been accumulated.

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1 One feddan = 4200 m2

The following institutions deal with space-based observations:

- General Meteorological Authority
- NOAA Satellite Receiving Station at the Desert Research Center.
- National Authority for Remote Sensing and space sciences.

G. Air Pollution Monitoring:

The Egyptian Environmental Affairs Agency (EEAA) has contracted the Environmental Hazards and Mitigation Center (EHMC) at Cairo University, and the Institute for Graduate Studies and Research (IGSR), Alexandria University for sampling, measuring and carrying out laboratory analyses for a number of air pollutants.

The National Institute for Standardization (NIS) acts as the reference laboratory for standardization, quality assurance and control. A network of 47 stations is established over Cairo, Alexandria, main cities in the Delta and Upper Egypt. The parameters monitored are: CO, NOX, O3, TSP and SO2. The ambient air pollution monitoring network does not monitor greenhouse gases except tropospheric ozone at a limited number of stations.

H.Satellite Systematic Earth Observations:

The earth observation system of the National Aeronautics and Space Administration (NASA) has established a large number of satellites in orbit to collect various types of indicators related to climate, pollution and atmospheric parameters. So far no systematic observations have been established in an operational system for collection, analysis and interpretation of these data in Egypt.

The National Authority of Remote Sensing and Space Sciences (NARSS) has been responsible for launching Egypt's first satellite, EgyptSat-1, in 2007. EgyptSat-1 carries two remote sensing devices, an infrared device and a multi-spectrum one. EgyptSat-1 is the country's first satellite for scientific research. A data base has been built for EgyptSat-1 for several months. So far, the data collected has not been disseminated to the scientific community except through an intranet. A multi satellite receiving station has also been established in Egypt. NARSS has also established a station for receiving data from National Oceanic and Atmospheric Administration (NOAA) satellites, Sea viewing Wide Field-of-view Sensors (SeaWifs) and Satellites Pour l'Observation de la Terre (SPOT). A database is being held by NARSS, however, no mechanism for the accessibility of these data to external researchers has been established so far.

I. Agriculture Sector Observation:

There are 26 agro-meteorological stations in addition to two environmental stations distributed in the agriculture regions in Egypt, all belonging to the Ministry of Agriculture and Land Reclamation. All these stations are equipped with measurement equipment for the regular minimum and maximum temperatures, relative humidity, total radiation, wind speed and direction, soil temperature and leaf wetness. These stations are marginally covering the agriculture areas, and most of them need substantial calibration and maintenance. The required number of stations for proper coverage is at least three times the number of existing ones. Monitoring of nitrous oxide, methane and carbon dioxide on hourly basis in all agricultural areas is lacking. As a minimum one station for each of the 28 governorates is required in order to monitor the emissions of these gases from agricultural activities.

J. Water Resources Sector Observation:

Tide gauge stations are installed by the Ministry of Water Resources and Irrigation at several spots of the Nile Delta and Mediterranean coast as shown in Table (V.1), with two stations installed on the Red Sea coast, and eleven automatic tide gauge stations installed along the Suez Canal.

Table (V.1): Tide gauge stations in the Delta and on the Mediterranean coast

Tide Gauge Location/Name	Starting Date
Alexandria Port	1944
Abu Qir Port	1992
Rosetta Mouth	1964
Burullus Inlet	1972
New Damietta Harbor	1997
Damietta Mouth Estuary	1990
El Arish Power Plant	1996-1998

Difficulties in the measurement of precipitation over the Nile Basin countries remain an area of concern in quantifying trends of natural flow to downstream riparian countries of Egypt and Sudan. The number of rain gauges is not sufficient, distribution of rain gauges does not reflect the importance of catchments and sub-basins and the difficulty facing Nile Basin countries in the exchange of their precipitation data makes it difficult to analyze and predict future changes.

In addition, many hydro-meteorological variables such as stream flow, soil moistures and actual and potential evapotranspiration in the Nile Basin are either not measured or inadequately measured. Potential evapotranspiration is generally calculated from parameters such as solar radiation, relative humidity and wind speeds. Records are often very short and available only for few countries or even few regions inside each country which impedes complete analysis of change during droughts.

Nile stretches in Sudan and Egypt are rich with river flow data collected over more than 100 years. This is only because of the large number of dams in the system (e.g. Sennar, Rosaires, Khashm El Girba, Aswan Dam and High Aswan Dam). Dams are perfect measuring points since electricity generation is a function of static head and discharge.

Groundwater is not well monitored and the process of groundwater depletion and recharge is not well modeled especially in the fossil aquifers which form strategic reserve in the case of prolonged droughts.

Data on water quality, water use and sediment transport determine the suitability of water use for different development activities. Sediment transport shows the accumulation of sediments upstream of the High Aswan Dam which could give indications of when to clear these sediments or when the reservoir will be full of sediments which would reduce its suitability for storage or energy generation.

In addition to the above, the Nile Delta needs a refined grid parallel and perpendicular to the seashore till at least the middle of the Delta. Water table level and salinity need to be monitored on a daily basis and logged centrally in an accessible data base.

K. Health Sector Observation

The Ministry of Health and the Ministry of State for Family and Population have systematic observations on the significant health population indicators, with the Ministry of Health regularly monitoring overall infectious diseases including, lately, bird and swine flu. This is carried out through its central laboratory in cooperation with a reference laboratory, the Communicable Disease Control Center (CDC), in the USA.

A regular Egypt Health Demography Survey, prepared by an independent consultant for the Ministry, is issued every three years by the Ministry of Health. It reflects all health and demographic changes which have occurred within the period it covers, including incidence of infectious diseases and, lately, non-communicable diseases.

The National Council for Childhood and Motherhood (NCCM) regularly issues an international report on children affairs. Different health issues are regularly reported within the Millennium Development Goals with information being supplied from different relevant ministries.

Statistical analysis of climate data demonstrates that disease incidence vary over time with climatic patterns. Satellite data serve as an important source of continuous global information that can be used to monitor disease pattern. Results from scientific research conducted to estimate the possible occurrence of the emerging and re-emerging infectious diseases, change in the distribution of infectious diseases and ecological adaptation as a result of climate change have yet to be put together and analyzed.

V.1.2.2 Networking

- ***International Cooperation***

The Internet plays a critical role in the development of information systems and networks. At the international level, the UNFCCC, IPCC and other international organizations have developed good information systems and linkages with the national focal point (NFP). However, at the regional level, support is restricted to specific areas, such as the establishment of a database for emission factors.

One of the key obstacles that continue to face Egypt's development process is the lack of well-coordinated and transparent decision-making that is based on solid information and data, integrated sectorial analysis and research-based policy advice and recommendations. Another chronic problem has been the absence of an institutional memory and a hands-on inventory of successful development projects and programs from which to scale up across Egypt.

- ***Information and Networking***

Information and networking are key mechanisms that link various components related to the national communication process and other activities related to climate change. In this regard, the UNFCC has requested the Parties to share with the public their activities concerning climate change, as well as to develop an information network at the national and regional levels.

- ***Implementation at the Regional Level***

There has been many information networking on climate change under the UNFCCC at the regional level in Egypt, example for the pilot phase of the information network on technology and education, training, and public awareness (e.g. National Capacity Self Assessment (NCSA) projects assist developing countries to assess capacity to meet requirements under the three UN Conventions:

- United Nations Convention for Biological Diversity (UNCBD)
- United Nations Framework Convention on Climate Change (UNFCCC)
- United Nations Convention to Combat Desertification (UNCCD).

However, there are other sources of climate change information in Egypt, such as databases on emission factors and climate change research studies.

- ***Implementation at the National Level***

As the national focal point, the Office of Natural Resource and Environmental Policy and Planning is the core agency responsible for climate change activities in Egypt. Because global warming and climate change relate to nearly all sectors of the economy, the national focal point plays an important role as the coordinating body for climate change activities, including information and networking. Many public agencies and other bodies disseminate information through the Internet.Below are some examples.

In the past few years, climate change has been widely publicized in all countries. In Egypt, seminars, trainings, conferences and workshops have been held to exchange knowledge and to disseminate information on climate change. The Internet has also come into popular used as a means to transfer information to the public and to network among researchers.

In 1999 Egypt produced its "Initial National Communication", following a number of relevant documents in this regard, such as the First National Environmental Action Plan (NEAP), the Support for National Action Plan (SNAP). Currently, Egypt has just finished the "Second National Communication" (SNC) to the UNFCCC. In this respect, this report is a study of the national environmental, economic and development aspects of climate change. It is primarily based on the outputs of the SNC and the related background papers, with the economic analysis specifically carried out here in order to address the associated financial needs supports the development of a climate change information database, including information concerning activities and projects of agencies under the National Strategy for Climate Change.

Additional to water resources networking, networking already exists between research institutions working on monitoring and assessment of extreme events, early warning systems, risk assessment and disaster reduction. Furthermore, networking also exists with Arab Mashrek and Maghreb countries in the field of electrical interconnection. There is also networking links with the Mediterranean countries in the areas of renewable energies and energy efficiency. However, there is also a need to establish networks (or join existing ones) between African Arab states, the rest of African countries, and when feasible, with other countries that have similar environmental, economic and social conditions to work together on responding to climate change. This could be shaped in the form of joint research projects, exchange of experts and post graduate students and exchange of information.

V.1.2.3 Ongoing Studies and Research in the Field of Climate Change

The UNFCCC encourages the Parties to cooperate in climate change systematic observation networks. The Global Climate Observation System (GCOS) was established to accelerate international investments in the system. Despite these efforts, most development has so far been at the national level, particularly among developed countries. Egypt's Second National Communication

Egypt participates in GCOS through the WMO data transfer network. Standardized air and weather data from Thailand are regularly collected and submitted to WMO. Data on oceanic conditions, pollution, radiation and ozone are limited, raising the need for technology and data collection system support.

Learning from the tsunami disaster, Egypt has implemented the Community Based Disaster Resilience Management (CBDRM) Program to enhance the capacity of local communities to cope with disaster risks. The program has introduced climate factors in disaster risk management. Egypt has developed a pilot program to integrate climate change and disaster risks into sustainable development planning for the community.

A. Research and Technology Development Project

During the second comprehensive plan period of the UNFCCC (2002~2004), Egypt has been reinforcing its tools to tackle a variety of issues on climate change. Great efforts in technology have been made through diverse research and developments to derive and analyze direct and indirect impact of climatic change.

Furthermore, dramatic results have been achieved in the research and technology sectors in the effort to approach the level of developed nations.

B. Climate Change Research and Technology Development Projects

It cover all areas of society including energy, transportation, building, agriculture and livestock, forestry, fisheries, the Coastal zones, atmosphere and environment and natural ecosystem (Terrestrial and Marine) at large.

In recent years, climate change research has been carried out by governmental agencies, science academies, universities, institutes and NGOs with international assistance at different levels and in various forms. In general, research themes center on basic climate change knowledge, and vulnerability analysis and assessment of Egypt's coastal zones.

B1. Energy and Industry

In the energy sector, the expansion of the alternative energy utilization base is being pursued to secure technology for clean use of fossil fuels and to simultaneously maximize technology development results for select primary developmental areas as a reinforcement measure for research and technology development projects.

Reduction of greenhouse gases may be considered a complex, energy-related technology development, but, in essence, it possesses characteristics of public technology in which it is difficult for nongovernmental sectors to participate. Hence, the Egyptian government is actively preparing for the UNFCCC by unearthing innovative technologies with high greenhouse gas reduction potential to focus on long-term promotion and the enhancement of the ripple effect of developed technologies. Research areas include middle and large scale energy conservation, energy equipment and process technology, energy conservation technology, next generation, superconductivity and application.

Development of innovative next generation power equipment and digital devices Superconductivity power equipment demonstration experiments, commercialized product technology, development of application technology of superconductivity information processing device and commercialization.

- ***Carbon Dioxide Capture & Commercialization***

This includes:

- Clean energy technology
- Commercialization of carbon dioxide capture & sequestration technologies
- Reduction of HFCs, PFCs, SF6 emissions
- Recall, decomposition, post-treatment, refinement technologies for HFCs, PFCs, SF6 ;
- High efficiency PFCs, SF6 contained gas mixture utilizing equipment insulation technology
- HFCs, SF6 recovery equipment and standardization of refining quality

- Existing system and alternative process optimization technology

- ***High Fuel Economy and Low Emission Vehicles (ISCV)***

High efficiency energy, environmentally friendly, high technology digital vehicles, Hybrid Electric Vehicles (HEV), and Fuel Cell Electric Vehicles (FCEV) maximizing the mitigation of green-house gas emissions through improvements in mid- to long-term national technology development programs.

Active support is being granted to selected research and technology development projects on renewable energy and energy equipment & process technologies. Furthermore, based on the inference that the efforts toward energy conservation and renewable energy technology development is inadequate, carbon dioxide reduction and sequestration has been selected as a core area to be promoted for technology development.

In addition, carbon dioxide reduction and sequestration technology R&D programs have been selected as a part of the 21th Century Frontier R&D Programs. Hence, the core practical technology development for the three carbon dioxide emission reduction areas with promising potential - oxy-fuel combustion, reaction/separation process, and unused heat recovery - and the infra-technology development for CO_2 sequestration have been promoted.

By securing the economic advantages of new and renewable energy, fossil energy may be substituted by newly developed sources of energy through continuous promotion and proliferation.

Furthermore, demonstration and application projects will secure and reflect the technological and economical reliability of the developed technologies; finally, developed technology will be commercialized through the establishment of an overall foundation.

To focus on the improvement of fostering energy conservation and efficiency in the building sector, research and technology development projects are being actively promoted. For example, research for mid-to long-term action strategies on building energy conservation have been conducted.

Furthermore, research for the development of building Life Cycle Assessment (LCA) program and the improvement of relevant systems are being promoted.In addition, basic research for developing the energy efficiency certification and green building certification programs has also been promoted.

B2. Transportation

Relevant research and technology development projects have been pursued in the following areas: sustainable traffic system) countermeasures for reducing greenhouse gas emissions by local authorities, appraisal of traffic/environment costs, characteristics of vehicle emissions and measurement of emission levels, etc.

B3. Agriculture, Livestock, Fisheries and Forestry

Limiting factors for agricultural growth in Egypt, some of which raising the vulnerability to climate changes, such as; Egypt's irrigation system sustains full irrigation for more than 95% of the total cultivated area. The high vulnerability of the agriculture system to climate change impacts in Egypt is attributed to the current critical situation of water consumption in agriculture. In the agriculture and livestock sectors, research and technology development have focused on countermeasures to methane and nitrous oxide emissions. Especially, research and technology development on reduction of methane and nitrous oxide from rice paddies and uplands and methane from manure decomposition have been promoted.

In the forestry sector, research has been carried out on biomass and greenhouse gas inventory system, soil carbon contents, forest biodiversity and forest ecosystem change due to global warming, etc.

It is recommended to:

- Develop appropriate aquaculture technologies by improving productivity through investment in research, extension and technical support.
- Rationalize capture fisheries by reducing capacity in inshore fisheries, establishing community organizations to manage inland fisheries, and promoting the sustainable expansion of offshore fisheries.
- Enhance the fish supply and value chain by making high-quality fish seed and financial services available to poor farmers and fishers, building up postharvest processing enterprises to higher quality standards, and reforming tariff and price policies.
- Build the necessary institutions to expand extension and research; rationalize policies on land and water use; organize poor fishers, farmers and processors; and engender regional collaboration in natural resource management and trade.

B4. Atmosphere and Environment

Research and technology developments have been promoted to predict and monitor climate change and the environmental impact. For atmospheric monitoring, research has been carried out with a focus on monitoring GHGs concentration in Egypt and development of climate change measurement technologies. Furthermore, research on the assessment of the socio-economic environmental impacts of climate change, the correlation between climate change and human health and the development of policy measures have also been implemented. In addition, the integrated cli- climate change impact model has been developing to formulate sectorial and regional adaptation strategies

V. 1. 3. EDUCATION, TRAINING AND PUBLIC AWARENESS

Article 6 of the UNFCCC encourages the Parties to integrate climate change knowledge into national education systems, training, and public awareness campaigns. Regional cooperation in climate change education and training, under the UNFCCC has been limited to exchange of information and experiences and networking. The same is true in the Mediterranean region and its sub-regions.

Egypt’s new education system and modern information technology strongly support the promotion of climate change education. Climate change knowledge is developed and shared through the home pages of schools, colleges and universities. The revised education curricula expose students to more indigenous and local environmental experiences, including those associated with climate change. Climate change awareness campaigns through the education system have expanded greatly at all levels. Public awareness campaigns promoting waste reduction, energy conservation, reducing plastic bag use, and so on, have emerged in the past few years.

Egypt has already introduced an integrated environmental component in its secondary schools curricula and many universities started offering postgraduate studies in environmental sciences. Moreover, a resource book of the experts of formal and non-formal education material has been prepared, offering information for the introduction of environmental concepts into the curriculum for formal and non-formal environmental education. In addition, the general framework of a National Strategy for Environmental Education for Sustainability was prepared, and in 2007 and 2008 nine training workshops on climate change were organized by EEAA and targeted NGOs and Media.

Furthermore, GEF funded initiatives have played a significant role in introducing climate change on the national level and increasing the general awareness on climate change mitigation and adaptation issues and its linkages to the national sustainable development agenda. The INC project has established a common platform for national experts in related areas to work together and exchange information for the first time on climate change. Meanwhile, the implementation of GEF climate change projects, such as energy efficiency, has contributed to the introduction of climate

change mitigation approaches to government officials in several ministries. The project has trained a large number of engineers and practitioners inside and outside Egypt in different fields related to energy efficiency improvement techniques including power generation, transmission, standards, labels, and testing of electric appliances, efficient lighting systems, building codes, etc.

Meanwhile, since it was launched in 1992, the UNDP GEF Small Grants Programme in Egypt has directed more than 60% of its 175 grants in small scale projects to NGOs implementing small scale climate change projects. This has significantly contributed significantly to awareness and on-job and field training of civil society organizations and NGOs on climate change related issues and in particular in the areas of renewable energy use, energy efficiency, recycling of agriculture wastes and sustainable transport.

Within the area of awareness, the UNDP has orchestrated a national energy efficiency awareness campaign that was funded by three international companies in collaboration with the Ministry of State for Environmental Affairs and the Social Fund for Development (SFD). Throughout the campaign three television spots have been produced and broadcasted on six regional satellite channels about energy efficient lightings and energy efficient equipment. This was followed by another television campaign organized by the Egyptian NGO Federation to promote the use of energy efficient compact florescent lamps.

V.2. NEEDS FOR MITIGATING THE EFFECTS OF CLIMATE CHANGE

V. 2. 1. Transfer of Technology

Future national adaptation proposals for mitigating the effects of climate change include:

- Assessment of available options for coastal zones
- Survey of vulnerable sectors (water, agriculture, and coastal zone) for available options, including projected outcomes and costs
- Risk assessment and management of the industrial sector as an option to mitigate potential impacts from climate change
- Increased awareness of climate change impacts
- Study of institutional capabilities for adaptation

Technology Needs Assessment (TNA) is the first step in understanding the needs for technology transfer in the country. TNA is a country driven activity to assist in identifying and analyzing the priority technology needs for mitigating and adapting to climate change. It provides an opportunity to realize the need for new techniques, equipment, knowledge and skills for mitigating greenhouse gas (GHGs) emissions and reducing vulnerability to climate change. Upon exercising the assessment, it will enable the countries to identify and determine technology priorities based on the circumstances of each countries.

Priority technologies for climate change mitigation and adaptation identifying and prioritizing relevant technologies for a low emissions and low vulnerability development to achieve maximum development goals and benefits for mitigation and adaptation.

Research and technology are needed to adapt and mitigate climate change. Low carbon emission and energy efficient technology is needed immediately to reduce GHG emission in the sectors that consume energy such as power plants, industry, transportation, as well as household and commercial sectors. Proper management of coastal erosion is therefore critical to Egypt's efforts in combating climate change.

Furthermore, for adaptation need in agriculture sector, technology to develop plant varieties that are resilient to climate change impact is required. Agricultural technology that saves water also should be implemented to anticipate water scarcity during longer dry seasons. To increase the preparedness of various parties in addressing the conditions of extreme climate, Egypt needs weather prediction technology; Early Warning System (EWS) that can produce more accurate results. With this technology, fisherman and farmers can plan more proactively for their activities, thus reducing the losses that they may suffer because of the extreme climate and weather events (drought, storm etc.). In addition, early warning technology should also be implemented to reduce the general public's exposure to the negative impacts related with extreme climate.

International cooperation and transfer of technology should be strengthened to share the benefit of technological knowledge worldwide. Egypt needs to prioritize the development of low-cost technologies with substantial local content.

In Egypt's northern coast and Delta are also strongly affected by climate change (coastal erosion, sea level rise and soil salinity). Increased frequency of severe events is leading to increased crop losses in these areas. An integrated approach that is smallholder-driven and that includes technology development and spatial planning is a key.Sea level rise and changing rainfall patterns in combination with extreme wave and high tide are threatening small islands. These undermine the local economy and ecology and may also lead to the loss of the small islands. Programs in these areas should focus on enhancing general human development while strengthening ecological sustainability. More effort will be put on developing adaptation and mitigation measures for small islands.

To increase the resilience of the sectors and community to current and future climate risk, the development and implementation of a comprehensive communications strategy to increase the capacity in using climate information is needed as well as institutionalizing the use of climate information. The development and promotion of tools for adaptation planning tailored to user's requirements that include (i) decision-support tools such as methods for assessing the costs and benefits of adaptation strategies, and guides for risk management, (ii) methods for understanding social impacts, and (iii) a national 'one stop shop' website where decision makers and their advisers can access information about climate projections, likely climate change impacts, tools, guides and approaches to adaptation planning will be required.

Climate change mitigation requires a dramatic shift towards low carbon technologies in every walk of life – a shift that must ultimately take place globally. Among other things, this means that countries that lack access to low-carbon technologies will find their development options increasingly limited. This in turn will have predictable deleterious effects on a host of human rights. To avoid this scenario, renewable energy technologies will need to be gradually universalized.

Climate change adaptation is of greatest urgency in the developing world, where the worst effects of climate change are already being felt. Here too, access to technologies is critical. In these cases, threats to human rights can function as a kind of early warning system, helping locate where technologies will be most useful and are needed most urgently. Examples include technologies relating to seawalls, desalination, seeds and agricultural techniques, vaccines, and so on.

There are a number of ways in which such a link could be shown, ultimately focusing on the following three types of arguments:

- **Adaptation-based arguments** – the transfer of technology is required for adaptation in order to allow individuals to enjoy their human rights despite experiencing climate harms.
- **Mitigation-based arguments** – the transfer of technology is required to allow people to continue to enjoy their human rights without thereby contributing to climate change.
- **Restitution-based arguments** – the transfer of technologies is necessary as a form of compensation by those who have overused a public good (i.e., the atmosphere's absorptive capacity) to those who have as a result been unfairly deprived of this public good. The argument assumes people are entitled to a fair share of the atmosphere.
- **Egypt's Climate Change Initiatives** – Egypt's commitment to contribute to the global effort of facing the threats of climate change is evident through a multitude of institutional initiatives including:

1. National Committee on Climate Change
2. Climate Change Capacity Building
3. The Energy Efficiency Council (EEC)

The ***National Committee on Climate Change*** is an inter-ministerial committee formed in 1997 representing a wide range of governmental and non-governmental stakeholders. The Chief Executive Officer of the Egyptian Environmental Affairs Agency (EEAA) heads the committee, which is responsible for coordination, establishment, and communication of national policy on climate change.

The ***Climate Change Capacity Building*** initiative is a continuation of the previous GEF-assisted Capacity Building Project aimed at institutionalizing climate change issues on a national level. This second phase focuses on assessing technology needs for adaptation measures for coastal zones, agriculture, and water resources. Other activities include studying impacts on coral reefs and human health, and assessing technology needs to alleviate negative effects.

The ***Energy Efficiency Council (EEC)*** is a consortium of public and private agencies associated with the energy sector to guide the energy efficiency practice in Egypt. A key focus of the EEC is developing interagency cooperation to promote efficient use of energy resources. The council is currently overseeing the development of a National Energy Efficiency Strategy assisted through USAID's Egyptian Environmental Policy Program (EEPP). The Council formed five working groups to evaluate issues that are critical to the development of the Strategy such as: quantitative targets, public-private partnerships, information integration, codes and standards, and training and outreach. The Strategy is expected to be completed during the first quarter of 2001.

Global initiatives include the ***National Strategy Study on Clean Development Mechanisms (NSS-CDM)***. Within the framework of promoting market-based instruments for GHG emissions reduction through CDM, the World Bank, with Swiss funding, is assisting Egypt in exploring opportunities and benefits through the adoption of this mechanism.

Technology can be defined in a broad sense to include physical infrastructure, machinery and equipment, knowledge and skills and the capacity to organize and use all resources and knowledge available. In many ways, technology in agriculture can lower costs, reduce resource-use stress or improve ecosystem services; it can improve output quality, reduce climate related risks and lessen vulnerability to climate variability.

Adaptation priorities (Table.V.2) in the agricultural sector range in three types of actions: capacity building, organization and institutions, and construction and physical transformation.

Table (V.2): Examples of technologies for adaptation in agriculture

Response Strategy	Adaptation Options
Use different crops or varieties to match changing water supply and temperature conditions	• Conduct research to develop new crop varieties; • Mechanisms for seed/crop distribution; • Integrated pest management.
Introduce systems to improve water use and availability and control soil erosion	• Pumps and water supplies; • Drip irrigation systems; • Networks of reservoirs; • Canal networks; • Level fields, recycle tailwater, irrigate alternate furrows; • Water diversion systems; • Improved drainage.
Land management	• Technologies relating to ploughing, tillage, mulching, landscaping, livestock management,

V. 2. 2. RESEARCH NEEDS

Technical and financial support is urgently needed in Egypt to establish research programs with teams from existing universities and research institutes. In this respect, priority research areas within the different fields include:

Agriculture Sector:

- Developing new cultivars tolerant to heat, salinity and water stresses.
- Changing dates of sowing.
- Adaptation options based on genetic engineering applications to choose a crop able to cope with climate change.
- Simple and cheap applications of solar energy in agricultural sector.
- Agricultural wastes recycling and reuse.
- Soil preservation and healing technologies.

- Evaporation and evapotranspiration reduction.
- Irrigation with treated waste water and/or low quality water.
- Traditional techniques for coping with high temperature for crop management.
- Adaptation of livestock production.
- Simple and cheap aquaculture techniques.

Water Resources Sector:

- Prediction and adaptation to variation in Nile flow.
- Non-conventional water resources development.
- Low cost technologies for wastewater treatment, water quality improvement and reuse.
- Advanced research in the area of improved water use efficiency and water demand management as no- regret solutions to cope with climate change.

Coastal Zone and Ecotourism Sector:

- Vulnerability assessment of the coastal zone and exploration of options for adaptation in view of adopted scenarios of sea level rise
- Monitoring, modelling and assessment of impacts of salt water intrusion on soil salinity.
- Monitoring, modeling and assessment of potential impacts of climate changes on coral reef and impacts on tourism
- Socioeconomic considerations of immigration of vulnerable communities and employment considerations in safe areas.
- Ecotourism as part of adaptation strategies in biodiverse regions undergoing change in use.
- Climate change, coral reefs and ecotourism

Energy Sector:

- Upgrading of low-efficiency fossil fuel-fired Industrial Boilers.
- Combined heat and power cogeneration.
- Recovery of residual and waste heat and pressure.
- Fuel Substitutes.
- Biomass energy technologies.
- Energy efficient transport systems and technologies.

- Potential of CO_2 separation, capture and storing in geological formations.
- Utilization of heat pumps and condensing gas furnaces.

Health Sector:

- Heat related illness and death.
- Non-communicable diseases.
- Water-borne and food-borne diseases.
- Vector-borne and rodent-borne diseases.
- Better understanding of the relationship between weather and climate and pollen transmission.
- With the possible forced migration of populations from coastal zones as a result of climate change and sea level rise, the population density will increase and basic requirements for health can be jeopardized. This needs a study of the socioeconomic burden of diseases especially the non-communicable diseases like hypertension, diabetes mellitus and coronary heart diseases.

Weather Sector:

- Carrying out vulnerability assessments to extreme weather events
- Application of Early Warning System to predict climatic change and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss.

Future research is needed in following sectors:

Biodiversity and Ecosystem

- Vulnerability, Assessment and Adaptation of Biodiversity to the Impacts of Climate Change in Egypt
- Role of protected areas in mitigation and adaptation of Climate change
- Reducing non-climatic stresses, such as pollution, over-exploitation, habitat loss and fragmentation and invasive alien species.
- Wider adaptation of conservation and sustainable use practices including through the strengthening of protected area networks.
- Facilitating adaptive ecosystem management through strengthening monitoring and evaluation systems.
- Conservation and sustainable use management strategies that maintain and restore biodiversity can be expected to reduce some of the negative impacts from climate change
- Maintenance, development and restoration of mangroves ecosystem and other coastal and marine ecosystems.

- Conservation and restoration of forests.
- Establishment of diverse agro-forestry systems to cope with increased risk from changed climatic conditions.
- Conservation of agro biodiversity (including rangeland) to provide specific gene pools for crop and livestock adaptation to climate change.
- Strengthening Environmental Protection and Biodiversity Conservation Education and Awareness at All Levels
- Establishing a biodiversity monitoring and management system in Egypt for soil, endangered wild animals, vegetation and climate-logical changes.

Climate Change

- For basic scientific studies, the main research areas include theories, methodologies and technologies for climate change observations; reconstruction of highly precise long sequences of past climate; behaviors and mechanisms of global climate change; multi-sourced and multi-scale data integration; development of an Earth system model; and climate change simulations and predictions.
- In aspect of climate change impacts and adaptation, the main research areas cover mechanisms of climate change impacts in key sectors (e.g. water resource, agriculture, forestry, ocean, human health, ecosystem, major construction projects, disaster prevention and mitigation) and assessment methodologies; R&D of climate change adaptation theories and technologies; adaptation demonstrations in typical vulnerable regions and sectors.
- For mitigation, the main research areas contain innovations and marketing of non-fossil energy and clean coal technologies, development of new energy saving and high-efficiency technologies in key sectors (e.g. industry, building and transport);R&D of key technologies for forestry carbon sinks and industrial carbon sequestration; cost reduction and market-oriented applications of key technologies (e.g. carbon capture, utilization and storage); carbon emission statistical and monitoring systems in support of achieving the binding targets of CO2 emission and energy consumption intensities.
- From perspective of sustainable socio-economic development, the main research areas include major strategies and policies on climate change; construction and comprehensive demonstration of technological support systems for low-carbon and sustainable development; raising public awareness of participation in actions to tackle climate change; and international collaborative research.
- Application of Early Warning System in Coastal zones (EWS) to assess and Mitigate environmental hazards related to climate change
- The design of monitoring and early warning systems which should be developed to avoid consequences on Environment, recharge, runoff, soils and plants.
- Vulnerability, Assessment and Adaptation of Desert Ecosystem to the Impacts of Climate Change in Egypt
- Future studies should compile and review SLR studies conducted in different coastal regions of Egypt

and analyze similarities/differences with global SLR.

- The impacts of possible rise in sea water level on the ecosystems and desertification hazards in coastal belts of Egypt.
- The impacts of climate change on possible increase in reference evapo-transpiration using data from all meteorological stations in different parts of Egyptian harbors.
- The impacts of climate change on possible decrease in surface runoff in different parts of Egypt using more detailed data and local hydrological information in different regions of Egypt.
- The impacts of increase in salinity level on the yield of cropped areas using more detailed information about the soils, cultivated crop types and areas and water in different Agriculture regions.
- The impacts of climate change on possible decrease in aquifer recharge using more detailed.

Energy and Industry:

- Air pollution, water pollution, solid wastes
- Oil and petrochemical refining, catalysts, and polymers
- Solar energy, fuel cell technology, energy storage, economics of renewable energy, electricity infrastructure
- Research, development, deployment, dissemination and scale up of technologies that can achieve significant reduction in CO2 capture costs.
- Gaining a better understanding of the science behind CO2-EOR for future use in Saudi Arabia.
- Develop appropriate actions for carbon storage in subsurface reservoirs, both aquifers and hydrocarbon traps.
- Work towards proofing the technology and its qualification as a CDM activity.
- Green Oil technologies:
- Develop technological solutions that reduce CO2 emissions from mobile sources.
- Identify and develop industrial applications for emitted CO2.
- Strengthen efficiency in upstream and downstream activities.
- Technological development of non-energy uses of hydrocarbon.

Agriculture, Livestock and Fisheries:

- Mapping of agriculture's productions (agricultural production, rubber, livestock, forestry and fisheries) and of land use.
- Developing and using integrated socio-economic and climate scenarios with climate, and land use models and Establishment of Carbon Accounting Systems for agriculture, forestry and fisheries.
- Institutional Mainstreaming Climate Change Adaptation by building capacity and scaling up community resilience.
- Promote marginalized groups and women participation to climate change adaptation and mitigation strategy.
- Enhance knowledge management related to climate change adaptation and promote innovation that is needed based

V. 2. 3. Systematic Observation Needs

For systematic observation, the following is needed:

- The establishment of proper systematic observation systems, monitoring networks and institutional information systems on sea lever rising to support decision making.
- The systems primary objectives would be the identification of vulnerable areas; the building of databases; the development and implementation of measures for resource protection; and the follow up and enforcement of planning regulations
- Support of the EEAA air quality network with a number of monitoring stations for CO2 , CH4 , and VOCs.
- The institutionalization of systematic observations of sea surface temperature, coastal land use and sea level variations, ensuring the availability of results for to the scientific community and policy makers.
- The establishment of a network of tide gauges over the Mediterranean, the Red Sea, and Lake Nasser.
- The establishment of institutional capacities for monitoring coastal and sea surface temperature variations in the Red Sea, Lake Nasser and Lake Qarun.
- Maintaining and strengthening disease surveillance systems for monitoring incidences and prevalence of diseases vulnerable to climate change, including more effective use of remote sensing and non-traditional observing strategies.

V. 2. 4. Modeling Needs

For modeling, the following is needed:

- Building up capacity on Regional Circulation Models.
- Building capacities for modeling and early warning of extreme events and disasters such as flash floods, tsunamis, dust storms and droughts.
- Developing of adaptation models and contingency plans for risk reduction.
- Building capacities for regional models development and operation so as to allow the assessment of predicted temperature and precipitation conditions in coastal zones.

V. 2. 5. Adaptation Needs

For adaptation, the following is needed:

- The identification and assessment of selection criteria for different adaptation measures options.
- The identification and protection of high risk areas such as areas below sea level (Abu Qir Bay and South of Port Said).
- Increasing awareness of population and decision makers of the negative impacts of climate change on social, economic and health situation.

V. 2. 6. Institutional Needs

There is an urgent need to establish a Ministerial Committee headed by the Prime Minister and including all relevant ministers, particularly those of Agriculture, Water Resources, Environment, Health, Energy, Tourism, and Higher Education and Scientific Research. The Technical arm of this Ministerial Committee should be an independent technical committee established by the Prime Minister to include 25 to 30 top Egyptian scientists in the different relevant fields such as Agriculture, Water Resources, Metrology, Health, Energy, Coastal Protection, Remote Sensing, Modeling, Sociology, etc. The committee would elect its own chairman from among its members and report directly to the Prime Minister. The committee would:

- Review all literature and results of research, monitoring and adaptation activities ongoing in Egypt and those published abroad;
- Based on the above, develop a draft policy for addressing climate change in Egypt and present it to the Prime Minister;
- When this policy is adopted by the Council of Ministries, the Technical Committee would assist the Ministry of Economic Development to draw four five year plans, covering the period from 2011 to 2035, addressing climate change;
- The Committee could be turned into a virtual centre for coordinating national activities and follow-up

actions reported abroad. This centre can be hosted within the IDSC or the Bibliotheca Alexandrina. The role of the host would be to store data reported by the Committee, establish a database and update it and host the quarterly meetings of the Committee. This would mean that no new physical entity would be needed.

V. 2. 7. Other Needs

Further to what is listed above, additional needs include the following:

- Upgrading hospitals with efficient laboratories necessary for diagnosis and follow up of communicable diseases.
- Establishing an effective energy savings data bank with full transparency through an information management system for knowledge dissemination and management.
- Water supply management is generally practiced in Egypt where supply is released according to the country's requirement for different uses. Narrowing the gap between supply and demand will ultimately balance both and keep the difference to a minimum. Demand management is meant to provide each activity with its timely requirements through measured volumes. This type of management requires a piped system running under pressure. Construction and running costs of such a system does not seem to be affordable by Egypt, especially with the level of fragmentation of the irrigation system in the country. Egypt certainly needs technical and financial help to reach this goal.
- New observing stations for the Nile river flow are needed.
- Developing awareness program among stakeholders and officials of the coastal governorates regarding the impacts of climate change on coastal zones.

CHAPTER VI: CAPACITY BUILDING, INSTITUTIONAL AND TECHNICAL NEEDS

VI.1. INTRODUCTION

VI.2. CAPACITY BUILDING & INSTITUTIONAL STRENGTHENING

VI.1 INTRODUCTION

The main objectives of the study include updating the information provided in the SNC. Establishment of a network of contacts for accessing data and designing a system for data management, improve and upgrade information related to crosscutting components including improved documentation and archiving and elaborate an acceptable report on education, training & public awareness and capacity building including gaps, needs, new areas of work and baseline according to guidelines.

Adaptation to climate change and variability necessitates the adjustment of a system to moderate the impacts of climate change, to take advantage of new opportunities, and to cope with the consequences. In many cases, adaptation activities are local – district, regional or national – issues rather than international. Because communities possess different vulnerabilities and adaptive capabilities, they tend to be impacted differently, thereby exhibiting different adaptation needs.

Capacity building must be an integral component of any climate change adaptation strategy due to existing uncertainty within the climate models, particularly at local and national levels. The capacity to adapt to climate change is perhaps the most vital area for development. Adaptation projects should be based on a solid scientific consensus with flexible implementation methods that consider possible externalities created through the implementation of the project. Routine incorporation of climate risk management into an agency's existing projects will allow for the integration of adaptation strategies to climate change. Furthermore, climate risks must be assessed within other country assistance programs and national development plans.

Inadequate capacity (technical, financial and institutional) remains one of the significant challenges affecting climate change adaptation in Egypt. The foregoing assessment highlights the high vulnerability to climate change as a result of limited capacity at the national level. Adaptive capacity was influenced largely by the ability to communicate potential risks to vulnerable communities and the ability to react as a result of perceived risks. Although there may be high adaptive capacity locally or nationally, most governorates in Egypt have low capacity to adapt to abrupt or extreme events". In view of the importance of forecasting to climate change adaptation, support to institutions active in this area to enhance their capacity and operations will go a long way toward improving adaptation.

VI.2 CAPACITY BUILDING & INSTITUTIONAL STRENGTHENING

VI.2.1 Capacity Building

VI.2.1.1 Key Elements

Strengthened capacity of government to promote and support climate change adaptation and mitigation with appropriate measures to protect land-related sectors against climate change is essential. Support should be directed at: (i) ensuring legal frameworks/policies and climate sensitive in various sectors; (ii) encouraging adopt more climate-resilient behaviors; (iii) supporting women and the most vulnerable and marginalized groups; (iv) supporting the implementation of reduced emissions, activities; (v) contributing towards the increasing of public awareness of environmental and natural resource considerations, including enhancement of women's engagement; (vi) particularly at the community level, with a view to changing practices and offering alternatives and (vii) supporting the national implementation of key environmental conventions.

Strengthening the capacity of major sectors aids government, local, and research sectors through the National Climate Change Committee, NCCC to fulfill its mandate to address climate change and to enable line ministries and Civil Society Organizations (CSOs) to implement priority climate change actions, through either transforming into national authority or national council. Gender will be a cross cutting parameter.

The mandate of the government is:

- Improved capacity to coordinate national policy making, capacity development, outreach/advocacy efforts, and to monitor the implementation of national climate change strategy, policy and plans.
- Improved access to updated Climate Change information, knowledge and learning opportunities at all levels.
- Creation of a common platform for Climate Change technical and policy dialogue.
- Strengthened capacity within the National Climate Change Committee (NCCC) to mobilize and to effectively administer climate change funds and to prepare for a nationally owned trust fund.

The past experience of the central department for climate change and the TNC show that:

- The majority of communities were able to identify and form partnerships with the stated aim of reducing vulnerability to climate change. The formation of these groups created long-term, local supporters for building climate resilience.
- Communities increased their levels of communication with non-local actors and raised their internal awareness of climate change and its dangers.
- The building of coalitions led to some form of agreement between community groups and external institutions. As a result, local-non-local alliances were strengthened.
- Local communities have limited access to financial or material resources to adapt to climate change.

In addition,

- Climate change vulnerabilities and impacts are highly diverse and locally specific, long-term, and difficult to predict.
- The vulnerability framework of exposure, sensitivity and adaptive capacity is practical as a general guide to identifying the problems and risks associated with climate change. Nevertheless, it is limited in certain respects. Specifically, the definition of "exposure" is misleading to community groups, traditional definitions of "sensitivity" are incomplete and should be expanded to include social sensitivities like conflict, and the definitions of "adaptive capacity" are theoretical and vague and need to be developed further.
- Some interventions designed to respond to impacts exacerbated by climate change can actually

increase community vulnerability. This can happen when policy decisions lead to perverse incentives to continue the very activities that made people vulnerable in the first place.

- Inequitable adaptation can increase vulnerability to climate change.
- Migration is not only a climate change impact and adaptive strategy, but also a source of vulnerability. This is because the exodus of community leaders creates a "leadership drain" and increases the workload of women and other groups who are forced to take over the responsibilities of those that emigrated.

With "Scientific Approach of Development" as guidance, ***Science & Technology (S&T)*** shall play a basic and leading role in response to climate change. To this end, S&T innovations and advances shall be promoted and EEAA adaptation capacities shall be enhanced, with the aims that strong S&T supports shall be provided to maintaining sustainable socio-economic development, safeguarding the national interests, and fulfilling the international commitments.

VI.2.1.2 Principles, Targets and Objectives

The principles of capacity building are:

- Combining government leadership with enterprise participation based on national demands, emphasis shall be given to solving major S&T issues related to climate change.
- Combining technological researches with policy studies on the basis of independent innovations and aiming at future trends of climate change-related S&T, the efforts shall focus on solving key issues and on developing key technologies so as to bring Egypt's climate change research to a new level.
- Combining short term demands with long term objectives. Technical solutions and response strategies shall be provided, which should be effective and scientifically based to tackle the practical and emerging issues encountered in international climate change cooperation and in domestic demands for energy saving and pollutants emission reduction technologies.
- Combining overall planning with separate implementation taking into consideration the current S&T funding channels and division of responsibilities of agencies as well as the necessity to integrate the available resources, an overall planning and layout of climate change S&T shall be made.

Targets to be met at long term are:

- To significantly improve the capability for making independent innovations in the research on climate change;
- To make breakthroughs in and wider applications in social and economic sectors of key technologies related to climate change mitigation;
- To notably enhance the adaptive capacity of key sectors and typical venerable areas in response to climate change;
- To markedly improve the ability of S&T support to international cooperation, engagement and decision

making on climate change;

- To make substantial progress in building up the climate change disciplinary, and in improving S&T infrastructure, research conditions and qualification of research teams;
- To noticeably increase the public's awareness of climate change and related scientific knowledge.

The short-term objectives are:

- To put in place a national S&T policy framework and coordination mechanism in response to climate change and to further improve the capacity of integrating S&T resources;
- To achieve internationally recognized research findings in key climate change areas;
- To develop and improve prediction, analysis, assessment and decision-making models on climate change;
- To advance research on key technologies for climate change mitigation and to launch pilot projects at local level and in industrial sectors;
- To make breakthroughs in the studies on the impacts of climate change on agriculture, water resources, coastal areas, fishery, bio-diversity, desertification and human health and to implement demonstration projects on adaptation in typical vulnerable areas;
- To formulate the National Adaptation Strategy on Climate Change;
- To make Egypt's contributions to the design of international climate change regime;
- To build up highly professional research teams as well as research bases on climate change.

VI.2.1.3 Measures to Enforce the Implementation of the S&T Actions

The key factor in implementing S&T actions is networking among all the correlated research centers in Egypt that have a leading experience in climate change areas including the (1) Cabinet of Ministers information Center (2) Agriculture Climate Change laboratory (3) Ministry of Water Recourses and Irrigation Climate Change Center and (4) The National Research Center. Other measures include:

Strengthening leadership and coordination for jointly promoting S&T research progress on climate change
Recognizing the significance of S&T on climate change, the Government should strengthen the macro management and policy guidance. To this end, a full support should be given to the Climate Change steering Committee on Global Environmental S&T in leading, supervising and coordinating national S&T activities on climate change.

Mobilizing more financial resources from diverse channels to support scientific research and technological development on climate change
The Government via the Ministry of Environment should be the main source of S&T resources for the

research on climate change, and all national S&T programs should strengthen their supports to climate change, and promote the implementation of S&T actions.

Strengthening human resources development and its introduction from overseas and enhancing disciplinary build-up in the field of climate change
Efforts should be strengthened, especially for the availability of qualified academic team leaders, middle-aged and young talents with an international vision, and capable to steer the development of their own disciplines. Effective incentive and competitive mechanisms should be set up.

Strengthening S&T basic infrastructures and platforms in support to research on climate change.
A bunch of interdisciplinary, comprehensive and innovative research bases and laboratories on climate change should be established, improved and integrated at the national level, to put in place a well distributed national climate change research network. All available conditions should be fully utilized to strongly strengthen such S&T infrastructures as climate monitoring system, observational networks of agriculture, water resource, sea level rise and ecological system.

Strengthening popularization of scientific knowledge, and increasing public awareness of climate change
A communication mechanism involving governments, media, enterprises and the public should be established. Newspapers, television, radio and Internet should be used to disseminate scientific knowledge of climate change, response measures, current status and research findings on climate change both in Egypt and around the world. And mass media should become an effective way to provide guidance from governments, to call for actions by enterprises and to increase public awareness of climate change.

Strengthening international S&T cooperation and promoting international technology transfer
S&T cooperation on climate change should be incorporated into bilateral and multilateral intergovernmental S&T cooperation agreements, in order to enhance the scope and in-depth of the international S&T cooperation on climate change. The national, local, institutional and sectorial S&T programs can be further open to the international, according to the principle of “mutual benefit and win-win outcome and promoting independent innovations”. It is encouraged to take the lead in launching international cooperative programs in a given field of climate change as appropriate to enhance the climate change research capabilities.

VI.2.2 Policy and Institutional Framework

VI.2.2.1 Relevant Stakeholders

EEAA has the responsibility of implementing national environmental policies and of setting up environmental standards for cases of conflicting interests. In this respect, the Agency established inter-ministerial committees on each of the major relevant crosscutting environmental issues, such as water, energy, and climate change. These are chaired by the Minister of State for Environmental Affairs, and coordinated between multiple competent authorities for the different specific environmental processes of concern. Prime Minister renewed the “National Committee for Climate Change” that established in 1997 by his Decree No. 272 in 2007. The Minister of environment heads the new Inter-Ministerial National

Committee for Climate Change. The members represent a wide range of governmental, experts and non-governmental stakeholders. Recently, Ministry of State for Environmental Affairs scaled up the "Climate Change Unit" to strengthen climate change institutional framework on the national level, to be a Central Department in Egyptian Environmental Affairs Agency in 2009 National Council of Climate change.

Non-governmental organizations (NGOs) in Egypt play a key role in formulating and implementing environmental conservation efforts. The Government of Egypt facilitates the growth of the private sector and Non- governmental Federation for Climate Change encourages interested NGOs through increasing the scope of incentives aimed at responding to investors' needs for being fully integrated into the Egyptian economy.

The Egyptian Environmental Affairs Agency (EEAA) also encourages the use of cleaner technologies through environmentally-friendly industrial zones and processes aiming at increasing the efficiency of the use of resources, including reuse, recovery and recycling in order to reduce the amounts of waste generated from production activities.

Labor unions and political parties are vital in facilitating better environmental management due, in part, to their experience in addressing industrial change, in protecting the workplace and related natural environment, and in promoting socially responsible economic development.

A number of challenges face environmental management and protection in Egypt. One such challenge has been the need for the revision of Law 4/1994 following gained experiences in enforcement and compliance. For example, limit values stated in the executive regulations were found to be vague, therefore needing to be revised in order to improve enforcement and compliance. In this respect, EEAA introduced amendments, including them in the new environmental Law 9/2009.

The most significant constraint to effective environmental policy making and implementation in Egypt is the lack of reliable and timely information indicating how various sectors of society impact the environment and whether development is becoming more sustainable or not. Various constraints related to the processes of environmental information collection, production and dissemination are evident in Egypt. These include uncoordinated institutional set-ups for monitoring activities, the absence of a common information system for monitoring organizations to feed data and findings into, the absence of comprehensive systematic methodologies for monitoring, the absence of valuation, and/or the undervaluation, of many natural resources, and the lack of financial resources for maintaining monitoring processes.

VI.2.2.2 Institutional Challenge

Climate stabilization will not be possible without efforts to understand the institutional innovations that can deliver deep and co-ordinate emissions cuts over the rest of this century, while also ensuring an effective response to the impacts.

These innovations must also be considered in conjunction with the other key social, economic and environmental problems the world will face in the coming decades, in areas such as security, trade, finance, resource scarcity and so on.

In this report, we have argued that:

- EEAA is fundamental to climate stabilization, providing 'signals from the future' powerful enough to reshape human behavior in the present.

- The current architecture for climate change is not able fully to discharge today's requirements, let alone the more ambitious functions of a properly comprehensive climate settlement.
- An effective institutional architecture must embody a coherent goal, be credible in its discharge of key functions, and be resilient for the long periods of time.
- Objective, transparent and fair mechanisms for distributing the burden of climate stabilization are needed if an institutional architecture is to be effective in the long-term.
- Institutions based on arbitrary or expedient criteria, in contrast, will be neither effective nor lasting.
- The fundamental functions of an institutional architecture are to constrain emissions in line with scientific understanding, ensure equity in responsibility for both mitigation and adaptation, and to have sufficiently strong enforcement mechanisms to ensure participation and compliance.
- New types of institution will be needed, for example National Council, National Network of Research Centers and National Federation for NGOs as well as, to adjust the global carbon budget and allocate it to countries based on agreed criteria. These institutions will lead to significant changes in scope and power of the international system.
- The mandate of existing institutions will need to be reviewed. One consequence of this will be significant changes in governance in other areas such as trade, international development and the regulation of the global economy.

VI.2.2.3 Governance Interventions and Reform

In recent years, there has been much scientific debate about social barriers and limits to successful adaptations to climate change. Substantive research has already been conducted on barriers to transforming human behavior towards more sustainable lifestyles and adaptive action More recently, academics have started to investigate barriers that could hinder the governance process of developing and implementing climate change adaptation strategies, policies, and plans Although these debates are still in their infancy, numerous barriers to the governance of adaptation to climate change have been catalogued and more seem to be added with each new study. This list of what is thought to be a barrier to adaptation is extensive and ranges from behavioral and cognitive variables to large scale socio-cultural processes.

The global policy dialogue informs the national governance reform process. A review of some country-level policies and institutional frameworks revealed a number of critical issues that need to be addressed to enhance climate change adaptation. These include:

- Lack of an integrated approach in addressing climate change adaptation
- Increasing demand for natural resources coupled with climate change is compromising existing national development plans and strategies
- Conflicting sector-based policies dealing with different aspects of natural resources
- Inadequate coordination of the activities of the various sectors and programs that deal with natural

resources may affect adaptation to climate change and variability

The following are some of the critical policy and institutional issues that should be addressed to effectively formulate and implement related interventions for mitigating the impacts of climate change and variability. Policy and institutional reforms should strive to:

- Coordinate and harmonize climate change policies across several sectors.
- Embrace participatory management that gives more responsibility to users.
- Equitably share water resources and improve trans-boundary water management.
- Improve efficiency and sustainability of climate change interventions by building capacity of various stakeholders.
- Enhance adaptive and applied research and information sharing to enhance efficient uses of resources and climate change adaptation.
- Promote public-private partnerships and increase investment in climate change and adaptation to climate change.
- Stakeholders and Collaborators

VI.2.3 Recommendations for Capacity Building & Institutional Strengthening

Recommendations for capacity building are:

- Develop capacity-building sessions for professionals and policy-makers working in monitoring, hydro-meteorology, agriculture, water and other sectors to increase their knowledge about climate change impacts and adaptations and how these could be integrated with their sectorial planning and actions.
- Work with specific stakeholder groups, especially farmers. Provide information and practical training on sustainable land management to reduce erosion, using new climate change adapted techniques
- Build capacity among teachers and other educators to provide them with the information and materials they need to include climate change in their teaching.
- Develop materials for capacity development that could be used by stakeholders' groups and the public.
- Use information and communication technology, including mobile phones, for example to disseminate information about forecasts, disasters and mitigation, these could also be used to involve people's feedback in validating data and forecasts, assessing harvests to prepare for potential food insecurity, and monitoring diseases.
- Coordinate and harmonize climate change policies across several sectors.
- Involve participatory management that gives more responsibility to users.
- Equitably share water resources and improve trans-boundary water management.

- Improve efficiency and sustainability of climate change interventions by building capacity of various stakeholders.
- Enhance adaptive and applied research and information sharing to enhance efficient uses of resources and climate change adaptation.
- Promote public-private partnerships and increase investment in climate change and adaptation to climate change.
- Increase assessments of climate change impacts on water resources, key agricultural crops (commercial and food), and natural ecosystems.
- Develop vulnerability maps for different hazards and capacities and identify hot spots where areas with high levels of hazards or low capacities are estimated. Provide this information to the public and to stakeholder groups and ensure that projects for relevant adaptations are being implemented in these areas.
- Assess vulnerabilities and needed adaptation measures in health care and identify current public health challenges as well as future trends and adaptation needs.
- Consider further activities to ensure small-scale energy system development and water access.
- Develop a key set of priority adaptations that could be progressively implemented over next 10 to 20 years to ensure that the effectiveness of current adaptations is sustained and improvements are made.

For enforcement of S&T actions, the following are recommended:

- Strengthening leadership and coordination for jointly promoting S&T research progress on climate change
- Mobilizing more financial resources from diverse channels to support scientific research and technological development on climate change.
- Strengthening human resources development and its introduction from overseas and enhancing disciplinary build-up in the field of climate change.
- Strengthening S&T basic infrastructures and platforms in support to research on climate change
- Strengthening popularization of scientific knowledge, and increasing public awareness of climate change.
- Strengthening international S&T cooperation and promoting international technology transfer.

Short –term recommendations for institutional reforms include:

- The Inter-Ministerial National Committee for Climate Change is to be chaired by H.E. the Prime Minister and directly reports to H.E. The President. Ministry of Environment should hold the technical secretariat and coordinate all other technical contents for the NCCC.

- The NCCC/EEAA should develop clear, overall objectives and plans for climate finance in Egypt, including appointment of responsible managing agencies.
- The government should entrust the EEAA/ Central Department of Climate Change with greater power and functions and also improve the existing coordination mechanism among other governmental funding management agencies.
- The Ministry of Finance should provide clear arrangements on the funding of climate change programs, including the establishment of designated budget items and sub items for climate related programs to be managed by the Ministry of Environment / EEAA.
- The NCCC and the Ministry of Finance should establish an analysis and reporting mechanism for direct climate finance to cover the disbursement use and effectiveness of funding.
- Carbon reduction and adaptation to climate change should be incorporated in the national development strategy and management system for international cooperation and serve as a key criterion for project selection in national and international investments.
- Elevate climate change collaboration to the level of international relations strategy to facilitate climate funding into Egypt.
- The government should also raise awareness among businesses and local authorities about the risks and vulnerabilities created by climate change, to minimize impacts and help limit the cost of damages.

On the other hand, long-term recommendations for institutional reforms include:

- Endorse legislation detailing the responsibilities and status of government entities involved in organizing and managing climate finance at various ministries.
- Establish an international development administration with responsibility for climate related international cooperation (including finance) also under the direct supervision of the Ministry of International Cooperation.
- The Ministry of Finance should establish assessment and monitoring systems for climate finance and develop guidelines for assessing the performance of new climate funds.
- The Ministry of Finance/Ministry of Environment should establish a Carbon Trading Regulatory Commission (CTRC).
- The EEAA should have full responsibility for the monitoring and management of a national carbon market, including, but not limited to: allocation of emissions; development of appropriate standards, regulations and laws; establishment of appropriate bodies and mechanisms for the effective functioning of the market; oversee development of derivative markets; and provide guidance to concerned institutions.
- New and improved climate finance mechanisms are needed to leverage private sector capital in support of public climate. Action in three key areas is required:
    - Facilitate the development of green credit businesses.

- Establish a national carbon market.
- Develop new mechanisms for increasing adaptation financing

Awareness-raising is the keystone of climate change adaptation. People need to know about climate change and its effects, particularly its worst forms, and why it is harmful both to the affected societies as a whole. They also need to understand the benefits of mitigation elements. In many cases, people suffer more of the negative effects of climate change because of their unawareness of the overall problem or its mitigations fundamentals.

Strategic objectives include:

- Send a consistent unified message to our target groups (policy makers, government planners, NGO's, stakeholders, tourism developers, students, academic personnel, general public , etc)
- Initiate and inspire change by translating knowledge into action methodology
- Organize an effective awareness incentives that would reach potential change agents within Egypt
- Influence social norms changing existing attitudes and perceptions of Climate Change

Awareness campaigns will benefit stakeholders and the general public throughout Egypt in achieving the following:

- Provide an awareness of the dangers of climate change and its effects
- Highlight the importance of the environment
- Highlight negative human factors (garbage disposal etc.)
- Implement mitigation measures
- Initiate policy change

Awareness & Advocacy recommendations include:

- Promote stronger recognition of people/ community centered approach and needs in relevant international and regional conferences organized by EEAA.
- Monitor and attend whenever possible international forums with a focus on relevant sectors (i.e. agriculture, forestry, food security, water, health, migration and displacement, etc).
- Participate to relevant climate change policymaking processes at regional and international level
- Produce better evidence to influence policy making at different levels (international, regional, and national levels

- Support EEAA in building capacity to collect and analyses data on climate related impacts and evidence
- Support EEAA to raise awareness on supporting community-based implementation of climate change adaptation & mitigation activities
- Support EEAA promoting a better understanding of the consequences of climate change and to broker innovative solutions at community levels.
- Develop materials for the promotion of key messages on climate change during relevant national and international days.
- Support (when needed) to improve reporting, data collection and development of knowledge products
- Map existing initiatives at country/regional/global levels and proactively act to develop linkages and build synergies.
- Strengthen collaboration with other organizations addressing climate change to improve overall effectiveness of interventions.
- Strengthen partnerships with national and regional research centers to have up-to-date scientific knowledge
- Increase advocacy on climate change mitigation and key messages at relevant international and regional events, with key partners and nontraditional partners alike (i.e. NGOS, private sector)

VI.3 EDUCATION AND CLIMATE CHANGE (FORMAL AND INFORMAL)

Introduction to Climate Change Education By raising awareness and promoting knowledge and skills-development, education is an essential component and a catalyst for responding to global climate change. Its importance has been increasingly highlighted at the international level. In particular, Article 6 of the UN Framework Convention on Climate Change (UNFCCC) encourages Parties to promote, develop and implement educational, training and public awareness programs on climate change and its effects.

In addition, the United Nations General Assembly proclaimed the UN Decade of Education for Sustainable Development (DESD) 2005-2014, emphasizing that climate change is one of the key action themes of the Decade. Education for Sustainable Development (ESD) aims to promote the knowledge, skills, attitudes and values necessary to shape a sustainable future. It affects all components of the education system – which include, among others, legislation, policy, finance, curricula, teacher education, instruction, learning, assessment, school governance and infrastructure – and considers learning as a lifelong process taking place in various settings.

In addition, it proposes learning methodologies for promoting critical thinking, problem-solving skills, as well as predicting events affecting both natural and human ecosystems and acting on these in collaborative ways. ESD provides an umbrella for many forms of education. In this framework, Climate Change

Education (CCE) fosters understanding of the complexities and interconnection of the various challenges posed by climate change.

More specifically, CCE promotes learning about the causes and effects of climate change as well as possible responses, providing a cross-curricular and multidisciplinary perspective. It develops competences in the field of climate change mitigation and adaptation, with the aim to promote climate-resilient development and reduce the vulnerability of communities in the face of an uncertain future. Crucially, CCE helps individuals to make informed decisions. Additionally, by preparing learners, communities and education systems to face natural hazards, CCE contributes to disaster risk reduction (DRR) efforts.

Finally, CCE highlights the links between consumption patterns and climate change in order to mobilize responsible actions contributing to reduced greenhouse gas emissions through more sustainable lifestyles.

It is recommended to raise awareness and promote knowledge and develop skills of decision makers in the education sector responsible for developing and implementing educational policies includingcurriculum development specialists and education planners in charge of curriculum review, reform and development; primary and secondary teachers/youth educators; teacher training institutions; non-governmental organizations (NGOs) involved in the development and implementation of non-formal education programs; researchers working on education issues related to climate change; and interested citizens/youth/students.

VI.4 GENDER AND CLIMATE CHANGE IN EGYPT AS A CROSS CUTTING ELEMENTS

Climate change has become an issue of great concern in recent times, both locally and globally, and addressing it requires a collective response. However, attempts at mitigating this strain to safeguard the future of population have not gotten recognizable result. Many difficulties are encountering the process of developing and implementing consensus-based intervention policies and strategies towards reducing the negative impact of climate change (Rio Framework Convention, Kyoto Protocol, Copenhagen Conference, and Durban Conference).

A reflection on Gender and Climate Change in Egypt derives its legitimacy from two undeniable facts:

- Climate change not only causes danger, vulnerability and risk to life and property, it also contributes in particular to increasing the gap between the rich and the poor specially women.
- Climate change causes different impacts on men and women. It has an impact on the relationship that people have with their environment, their knowledge in relation to their environment, their social and economic positions and the power relationships between men and women in society.

Today, the most vulnerable and marginalized individuals are the most affected by the impacts of climate change. Due to the feminization of poverty and the dominance of male-controlled values, women have a limited capacity and opportunities to cope with the impacts of climate change or to participate in negotiations on issues relating to their mitigation.

Issues of gender gabs and climate change include:

- Most of the poorest people in Egypt especially at rural areas are women
- Women who can access credit is extremely lower than that of male
- Although, there are no legal differences between men and women that may hinder women's economic opportunities, including access to credit, culture values could hinder and limit women's economic opportunities

As for gender mainstreaming in disaster risk reduction, related issues are:

- Gender mainstreaming must be an important part of the adaptation process to ensure the success and sustainability of climate projects and policies.
- Integrating considerations of gender into medium- and long-term adaptation can help to ensure that adaptation is effective and implementable on the ground.
- Adaptation is a pressing developmental and cross-cutting challenge and provides an opportunity to improve the well-being of humans and the ecosystem.
- A gender-sensitive approach to creating, developing and strengthening institutional, systemic and human-resource capacity-building can foster gender balance in decision-making on, delivery of and access to means and tools of implementation for mitigation of adaptation actions.
- Adaptation finance, whatever its source, should be used to promote climate and development objectives, including gender equality.
- All stakeholders should make the empowerment of women and poor and marginalized groups a strategic priority in the fight against climate change.
- Action to mitigate climate change has the potential to also bring about local gender-positive impacts.

For gender involvement, it is recommended to:

- Include gender perspectives into disaster reduction efforts at the local, regional and national levels, including in policies, strategies, action plans, and programs. As well as, increase their participation and representation at all levels of the decision-making process.
- Analyze climate change data such as drought, floods, or desertification from a gender-sensitive perspective

- Include the traditional knowledge and perspectives of women in the analysis and evaluation of the characteristics of key disaster risks
- Ensure that women are visible agents of change at all levels of disaster preparedness, including early warning systems, education, communication, information and advocacy.
- Build the capacity of national and local women's groups and provide them with a platform to be heard
- Include gender-specific indicators to monitor and track progress on gender equality targets

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