REPUBLIC OF IRAQ
MINISTRY OF HEALTH
AND ENVIRONMENT

Iraq's Initial National Communication to the UNFCCC

2016

Speech of H.E. Minister of Health and Environment

The Iraqi environment has experienced many problems and demolition over generations as a result of repeated wars, neglect and mismanagement during the past four decades. This increased its vulnerability to face climate changes effects on all vital sectors in the country, as the drought and heat waves increased to directly affect the growing dust storm rates and increased the desertified areas over the cultivated lands. A clear impact was on our national economy as Iraq was considered the food basket of the Middle East, but currently, it barely meets its national needs of food. Furthermore, it decreased employment opportunities, increased poverty and greatly affected the health of the Iraqi citizen.

This report reflects the easy part of the country's sufferings of the adverse effects of climate change on its most important and vital sectors. It also shows the most important national sectors which emit greenhouse gases and reflects all the actions that have been taken on the national level to mitigate the apparent vulnerability on these sectors. The report also displays several pilot projects which Iraq is willing to achieve, but it requires financial and technical support and technology transfer to correctly implement them in order to ensure proper procedures, both in terms of adapting to impacts of climate change, or at the level of mitigating emissions.

The world has reached a dangerous point in the challenges faced as a result of climate change and any decision taken in this regard would on the long run clearly affect our countries, in particular, and the world, in general. Therefore, we call upon the developed countries to have a clear and constructive role to enable the developing countries face these risks and mitigate greenhouse gas emissions resulting there from in order to ensure a healthy life and sustainable environmental resources for the future generations.

Dr. Adelah Hmood
Minister of Health and Environment

Speech of H.E. Deputy Minister of Health and Environment for the environmental issues

This report is considered a vivid example of Iraq's commitment to all decisions of the conferences of parties of the United Nations Framework Convention on Climate Change, joined by Iraq at the end of 2009. Iraq works hard, since that date, to form all national entities and units concerned to facilitate the implementation of all its provisions through developing the required national mechanisms and programs.

This report demonstrates a series of national programs, strategies and laws included into important paragraphs that help to seriously deal with the case of climate change and ensure the development of appropriate solutions, in order to ensure facing impacts of climate change on our territory in the strongest way. Iraq is considered, according to the UN studies, one of the most vulnerable states to climate changes as a result of the previous fierce terrorist attacks, and still going on, that caused harm to our economy and infrastructure and loss of several opportunities to enable the achievement of the principles of sustainable development for all national sectors.

There is a close relationship between peace and security situation in every country and the achievement of sustainable development. This is what Iraq aspires to ensure the right of the coming generations in well-being and safe living, in addition to participating its concerns with the international community to keep the increase in earth's temperature below 2 °C from that temperature limits before the industrial revolution.

Dr. Jasim Abdul-Aziz Humadi
Technical Deputy Minister

Acknowledgements

The Ministry of Health and Environment on behalf of the Iraqi Government would like sincerely to present its gratitude and appreciation to the support of the Global Environment Facility (GEF) which assisted in accomplishing this report to meet the international requirements and commitments towards the United Nations Framework Convention on Climate Change (UNFCCC).

Special thanks to the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP) for their efforts in supporting the implementation and preparation of the report and its finalization.

Furthermore, we are grateful to all authors of chapters for their efforts in preparing this document and to all the international and national experts who submitted their reports and accurately followed-up the information, despite the challenging security circumstances, which coincided with the implementation of this significant project.

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EXECUTIVE SUMMARY

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National Circumstances:

The Republic of Iraq is a united independent federal country of full sovereignty. Governance is republican, representative, parliamentary and democratic. Iraq is bordered on the east by Iran, on the north by Turkey, on the west by Syria and Jordan and on the south by Saudi Arabia and Kuwait. The area of Iraq is about (435,052) km^2. Iraq's climate is considered a semi-continental climate influenced by the Mediterranean Sea. The climate is also characterized by the expansion of the daily and annual thermal range.

The demographic conditions in Iraq are one of the main factors affecting the development opportunities. Number of the Iraqi population was estimated in 2011 by (33.3) million people, 69% of them lived in cities, 31% lived in the countryside and with a growth rate up to 2.6%. Despite the growth of the economy over 2010 of about 24.1% compared to the previous year, this increase resumed declining in 2015 due to the large decline of oil process which is considered the main resources of the GDP growth.

The proven oil reserves of Iraq are estimated of about 143.1 billion barrels, constituting the third largest reserves of the conventional oil in the world after Saudi Arabia and Iran. As for the natural gas reserves, Iraq enjoys large quantities of about 132 trillion SCFD, to be the tenth country in the world in terms of natural gas reserves.

Iraq occupies a strategic geographic location in the Middle East, south-west the Asian continent. Transportation in Iraq consists of rail lines with a total length of more than 2,000 kilometers, highways, waterways, pipelines, ports, harbors, airlines and airports. The Arabian Gulf is the sea port of Iraq to the world, with a sea coast of about 58 kilometers length, in addition to the passage of the Tigris and Euphrates Rivers in the country from the north to the south.

Iraq is characterized by the existence of biodiversity on its territory due to the presence of migratory species, which Iraq represents an important part of their life cycle. This includes the endemic species or semi-endemic, particularly in the unique Iraqi ecological systems, as well as threatened or endangered species. The red list of the International Union for Conservation of Nature (IUCN) referred to the cases of preserving the Iraqi species. The reports of the Ministry of Environment and Civil Society Organizations also referred to the presence of about 417 species of birds, of which 182 are migratory species and 18 worrisome types in terms of sustainability.

Furthermore, the same reports indicated the existence of 106 species of marine fish and freshwater fish and confirmed lack of information pertaining to insects, amphibians, reptiles and mammals. There are approximately 4,500 species of plants recorded in the (Flora of Iraq), with a secondary list of 195 kind of Iraqi endemic plants. The biodiversity in Iraq faces direct, indirect challenges and threats as a result of the steadily growing population, urban expansion, urbanization and the climate changes. Although, Iraq enjoys many oil and natural resources wealth, but 78% of the Iraqi families are within the average or very low standard of living due to the deterioration of many productive sectors, most important of them are the industrial and agricultural sectors. These sectors witnessed neglect, lack of trained technical cadres, old used equipment and machinery and not keeping pace with the technological development, in addition to the weak investment performance of the private sector. All the above mentioned were a result of repeated wars experienced by the country. It is important to accelerate the elimination of widespread poverty among Iraqis because there is a link and integration among population, development and environment.

Although some achievements were accomplished during the past few years in the field of health care, but the health sector is still facing many problems and challenges due to the exceptional conditions experienced by the Iraqi society. The health care system is still witnessing a large deficit in funding which was reflected on the quality of provided services and the shortage of medical supplies.

The neighboring countries have since several years established a number of dams on riverbeds of the Tigris and Euphrates Rivers and their tributaries. This would threaten to drop water amounts received by Iraq and lead to the drought of large areas of the agricultural land extended along the banks of the rivers, especially the Tigris River. The agricultural sector, in particular, is one of the most consuming sectors of water in Iraq (about 25 billion cubic meter/year), with 85-90% proportion of water consumption in this sector. This will greatly and badly affect the economy and lead to the loss of many farmers' lands. It will also cause expensive financial losses as a result of Iraq's dependence on foreign imports of agricultural corps. Other developmental losses are represented in the increasing unemployment rates after the cessation of work in many agricultural projects, as well as the increased poverty rates which are closely related to the establishment of projects, particularly agricultural and industrial ones. The above mentioned issues are expected to cause the drought of the marshlands in Iraq, particularly Al-Chibayish and Huweizah marshes. It will also lead to the waste of efforts and money which were depleted for the reconstruction of these unique areas of wild habitats and neighbourhoods and its cultural and natural standards

following the announcement of this area as a wildlife sanctuary in Iraq. Causing any damage in this area would be a violation of the regulations of safeguarding the global nature; it's one of the vulnerable areas surrounded by the governmental and international care since years ago. In addition to the impact on the fishing activity in the Tigris River basin, especially in the marshlands; this is considered a transit station for marine fish which take the river places for their proliferation and migration to the Arabian Gulf. As well as its effect on the economic situation of the population who practice the profession of fishing and depend on it to meet their needs. Thus, there is a need to sign agreements with neighboring countries (Turkey, Syria and Iran) on joint water to determine the incoming water portion to Iraq; in quantity and quality, to be convenient with principles of sharing and equity, meet the current and future requirements and establish joint water projects.

The national electricity system in Iraq experiences shortage of electric power generation with an average processing power of eight hours a day only. This would constitute an expensive cost to the economy represented by the lack of access to the production levels and damage to capital assets due to power outages and inability to carry out normal commercial operations according to a schedule that can be relied upon. In a country of cold weather in winter and harsh heat in summer, shortage of electricity forms considerable difficulties for the individuals. The absence of electrical power, which can be relied on from the electric network, has caused the spread of diesel generators which represent high costs for operating, environmental pollution and emission of large amounts of carbon to the atmosphere. It is estimated that the total cost incurred by the Iraqi economy due to lack of electricity power has annually exceeded US$ 40 billion.

According to the forecasts report of the environmental situation in Iraq (First report) issued early 2014, the amount of 2,242 kg/day is generated in Iraq from the domestic, industrial, health, oil and commercial activities. The organic wastes constitute 55-60% of the municipality waste and the Iraqi individual generates a daily rate of 0.75-1.1 kg wastes. The available traditional systems of waste management are not able to meet the community's needs after the increase of the population, change of consumption patterns and the high standards of living and per capita income. The waste quantities collected at best should not exceed 40% of the generated waste quantity.

National List of Greenhouse Gases Inventory:

The inventory of the main three greenhouse gases: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) of 1997, was accomplished as a base year, the closest to 1990 and with the availability of the required data. The revised guidelines of the Intergovernmental Panel on Climate Change of 1996 regarding the inventory of the national greenhouse gases stocks were used. In addition to the three main gases, carbon monoxide (CO), sulfur dioxide (So_2), non-methane volatile organic compounds (NMVOC) and nitrogen oxides (NO_X) were also within the inventory. Lists of greenhouse gases inventory also included energy sectors, industrial processes and wastes, according the guidelines and with the exclusion of lands usage sector, land-usage change and forestry (LULUCF) of the stock due to lack of data.

Iraq's National List of Greenhouse gases Inventory of 1997, according to sectors and gases:

Iraq contributed in 1997 by about 72.658 Gg equivalent of carbon dioxide (CO_2) of greenhouse gases in the atmosphere. The following are details of the total emissions for each of the emitting sectors:

- **Energy**: 54.419 Gg of carbon dioxide-eqv., equivalent to 75%.
- **Industrial processes**: 6.422 Gg of carbon dioxide-eqv., equivalent to 8.8%.
- **Agriculture**: 8.084 Gg of carbon dioxide-eqv., equivalent to 11.1%.
- **Waste**: 3.733 Gg of carbon dioxide-eqv., equivalent to 5.1%.

Details of the emissions for 1997 according to the quality of the emissions of gases are as follows:

- The total of emissions of carbon dioxide (CO_2) was estimated about 60.379 Gg.
- Methane (CH_4) = 319 Gg.
- Nitrous oxide (N_2O) = 18 Gg, equivalent to 3.2 Mg/per capita of carbon dioxide (CO_2), 0.02 Mg/per capita of methane (CH_4) and 0.001 Mg of nitrous oxide (N_2O), (estimated population in 1997 about 19,184,543).

Affectivity and Adaptation Measures:

Water Resources Sector:

Any study assessing effects of climate on water resources in Iraq or the sensitivity of water resources to climate change was not properly conducted

yet. The objective reasons for that were that most parts of Tigris River basins and all of the Euphrates feeding basins are located in upstream countries, in addition to the lack of data on groundwater in transit. Reports of the United Nations, in this regard, have forewarned of the climate change effects on water shortage (UNDP, 2010). It also indicated that effects of climate change on Tigris and Euphrates basin are currently under investigation by the concerned countries. Water in Iraq is affected by lower rainfall from outside its borders which is one of the critical issues and makes the management of water resources in the country vulnerable to climate change and storage projects in the neighboring countries. The shortage of water resources due to lack of rainfall will directly cause shortage in surface and groundwater supply.

The water problem in Iraq is expected to greatly aggravate in the future and would increase to the extent that individual's share of water will decrease to less than 500 m^3 in 2025, according to the global estimates models of the Middle East countries. The currently available water is under great and increasing pressure, due to the ongoing drought, growth of pollution and irrational use of water resources, in addition to the followed water policy, size of irrigation projects in the upstream countries and their impact on the volume of imports to Iraq.

It is likely that the adverse effects of climate change on water resources would reduce the agricultural production and make the problem of water shortage in Iraq worse. Thus, several serious measures should be taken for adaptation; mitigate effects of climate change on water resources, and to develop the non-conventional sources of water that can be exploited in the future.

Integration of adaptation measures with the effects of climate change in strategies and policies of national development would lead to enhance these strategies and increase their advantages. The following considerations can be adopted to promote planning of adaptations strategies according to the environmental and economic situations in Iraq:

- Management of surface water resources and operation of dams.
- Develop a program to collectively run reservoirs and dams (reservoirs optimization operations), or operation of dams by following the method of central control based on modern mathematical models supported by the National System data for remote monitoring.
- Usage of modern methods for integrated management of water resources and building a mathematical model that simulates water resources system in Iraq and its relationship with other different variables (Iraq water systems planning model). This is considered the basic foundation for strategic study of water and land, which is

currently being established in the Ministry of Water Resources in cooperation with some specialized companies.

- Accelerate the completion of the second phase of water resources and land usage strategy in Iraq until 2035 in order to depend on results in the Ministry's future plans.
- Preparation of annual water budgets according to the achieved water incomings and control of water demand management.
- Continue the implementation and set up of the national system for hydrological control of surface and groundwater, collecting information from neighboring countries on water situation and development of hydrological data bank.
- Establish procedures for early warning to warn of drought and flood disasters.

Agricultural Sector:

The impact of rising temperatures as a result of climate change is expected to be represented in the increase of water demand for agricultural crops. In order to study the impact of projected increases in temperature on irrigated agricultural systems in Iraq, the (CROPWAT) program of Food and Agriculture Organization (FAO) was applied to identify the effect of rising temperatures on the increasing rates of evaporation-transmittance and as a result, the increasing water requirements for planted corps. The wheat crop was selected as a model for winter crops and the Maize for summer crops. The program was applied depending on the climate data of a climatic station for the central areas of Iraq and the adoption of a virtual increase of temperature for the annual rates (1-2-3-5) C°. The results indicated the increase of water requirements for wheat crop by (2.79%, 6.01%, 13.01% and 17.17%) of the four scenarios respectively, compared with the increase of water requirements for Maize crop (1.99%, 3.85%, 5.84% and 9.97%), respectively. This means there will be a pressure on available water resources to meet the requirements of required water to grow crops. In view of these originally limited resources, the expected impact in case of using same varieties of agricultural crops and continuation of using agricultural technologies; such as fertilization, mechanization and others without development, will be a decrease in the annual cultivated land to compensate for the increased water requirements of crops and would, of course, mean a decrease in food products to meet the growing population needs for food.

The expected decrease of rainfall and the increase of droughts caused by climate change will generate pressure on natural pastures, which already suffers from degradation as a result of the decline of the natural vegetation. This will directly be reflected on benefit from pastures in the provision of food for cattle. An increase is also expected of desertified land area as a result of the advance of

sand dunes from the desert towards agricultural lands, as well as the increased dust and sand storms and their adverse effects on humans and environment.

The following are the most important and required adaptation actions resulting from climate change on the agricultural sector:

1- Improve management of rain-fed agriculture by digging water wells and applying complementary irrigation.

2- Raise the irrigation efficiency in irrigated agriculture through development of field irrigation and usage of systems of sprinkler irrigation, drip irrigation and developed surface irrigation methods.

3- Conduct further research to create crop varieties which are durable to high temperature and drought, with less water consumption.

4- Establishment of an effective monitoring system of weather/crop during the agricultural harvest seasons, including an early warning system.

5- Strengthen the strategic crops storage like wheat and barley to address potential drought seasons.

6- Dig water wells for drinking and livestock grazing in desert areas and expand establishing nature reserves.

7- Use advanced systems to restore and increase numbers of natural vegetation in pastoral areas, especially the western desert. This expansion includes production of (pastoral) wild plants seeds.

8- Expand projects of soil stabilization to reduce the problem of creeping sand dunes through usage of sophisticated methods which commensurate with the problem in Iraq.

9- Apply water harvesting techniques and expand them in desert areas to take advantage of rain floods.

10- Develop an effective monitoring system for desertification and natural pastures.

11- Use integrated methods for agricultural pest management and reduce reliance on pesticides and herbicides in agricultural systems.

12- Introduce and invent plant varieties that are resistant to disease and adapted to climate change.

13- Work to develop strains of cattle adapted to climate change, disease-resistant and highly productive.

Biodiversity Sector:

Natural systems and biodiversity in Iraq are vulnerable to the effects of climate change in different rates, according to their geographical location on the map of Iraq, type of motive and climate influential. According to the Iraqi Meteorological Department reports, the rain line has changed in the Millennium than it was in the period of 1970s of the last century. The rain line has moved at least 100 mm from latitude 32 from the west, 29 from the east towards latitude 33.3 from the west and 30 from the east, in addition to the disappearance of 700 mm rain line from the map of rain distribution in Iraq. Reports also indicate a significant statistical high increase of temperature rate in all parts of Iraq. Thus, natural systems and biodiversity will be greatly vulnerable to these changes and may cause displacement of some species, particularly based on rainfall amounts or on wet land.

Three locations can be identified as affected by climate change/vulnerable to biodiversity in Iraq:

1- Ecological system of marshlands across the country, especially in southern Iraq where many indigenous communities historically depend on them and large part of the local economy is based on its previous area.

2- Forests in the mountain region in northern Iraq (Iraqi Kurdistan region).

3- Lakes and rivers across the country.

Marshlands represent the most sensitive areas.

Required policies and legislation to face and mitigate the effects of climate change in the future are essential tools for affected sectors. The most important requirement is the presence of coordination between sectorial policies and legislative measures in order to efficiently and effectively activates their results. Legislation, at this stage, is the basis for implementing measures of protection/treatment/prohibition, which are necessary to prevent or mitigate effects of climate change. Legislation should deal with some fields in particular, including the following:

1- Develop a national legislative framework for water and/or cross-border legislations which ensure the flow of water to major rivers and streams feeding main gatherings of marshes in Iraq, focusing in particular on areas which serve the continuity of living.

2- Create and implement a framework code taking care of wildlife (animals and plants) to regulate hunting, fishing, and collection and handling of natural resources by defining seasons and methods of implementing these activities.

3- Develop and update a clear legal framework for water quality.

4- Impose a number of caveats and penalties on introduction of harmful items and hazardous types (such as invasive types) to natural systems. As well as preparing a list of dangerous practices that should be avoided in the agricultural sector, aquaculture, domestication of aquatic, fishing, hunting, scientific research and laboratory tests.

5- Develop a national legal framework concerning reserves, focusing on organizing tourism activities.

The mitigation measures alone may not be enough to avoid these adverse effects; therefore, focus should be on a range of adaptation measures to promote development of nature reserves, including marshlands. National efforts are also to be guided towards measures to increase flexibility of the overall biodiversity in various methods, including:

1- Fight or remove threats to biodiversity and natural species/ecosystems.

2- Establish channel networks providing migration and spread routs for animals and plants and allow avoiding local cases of extinction. Iraqi Ministry of Environment works currently under the umbrella of international conventions, including the Convention on Biological Diversity to announce about 15 national reserves until 2020, as part of the convention objective to protect 17% of the total area of Iraq.

3- To increase the flexibility of the new protected areas at its establishment, it is important to achieve a range of actions, such as:

- Maintain the natural vegetation across environmental gradients (shades of longitude, latitude and gradients of soil moisture, etc...).
- Establish buffer zones around nature reserves.
- Reduce fragmentation of habitats and road construction.
- Maintain genetic diversity within and among the numbers of local species.

Health Sector:

Iraq is one of the Arab region countries that may be affected by climate change, as it is facing a series of changes in recent years with high frequency and severity of weather events associated with drought, increased dust phenomena and increased environmental degradation. Climate change might affect the health sector in Iraq resulting in the increase of mortality and incidence of certain diseases that may be transmitted to polluted water and food, as well as some transitional diseases like cholera, malaria, typhoid and

non-transitional diseases like allergy, asthma, heart attacks and increased malnutrition cases. Effects of climate change on health sector depends on many factors, including safety systems of public health, community, behavior, gender and individual's economic situation. It also vary from an area to another depending on the sensitivity of the population and the extent of exposure to the effects of climate change (Report of UNICEF, WHO, WFP and UNDP 2012).

The Iraqi government has sought to expand basic health care services to all citizens free of charge through plans and programs. Ministry of Health in Iraq also adopted, during the past period, a health system based on health care system as a foundation and includes provision of health services according to quality standards as the first level of services provided to the citizen, while ensuring integration of these services with the second level (public hospitals) and third level (specialized centers) under the supervision of the Ministry of Health, through the application of family medicine system in health centers and visiting health system.

However, there is an urgent need to develop clear and specific adaptation measures to assist specialized health actors in Iraq to be prepared and mitigate the adverse effects that may increase the vulnerability of health conditions. This will be accomplished through enhancing health systems and public health services, access of population to clean drinking water, follow-up mosquito breeding areas and prepare studies regarding them. In addition to following-up improved sanitation services to reduce diseases that may progress with climate change like diarrhea, follow-up monitoring programs of controlling infectious diseases and focus on health awareness.

Reference Scenarios (Baseline) for Different Sectors

Reference Scenario for the Energy Sector:

This scenario was adopted based on the trends, strategies, plans and national policies for the energy sector in Iraq, as follows:

- Increase production and use of natural gas and reduce dependence on heavy fuel in the country.
- Increase the efficiency of operational processes to reduce use of fuel and thus, reduce emissions.
- Planning and study the possibility of using burning gas in a number of fields to produce light products with (Gas To Liquid-GTL) technology, which will positively reflect on emission reduction.
- Develop a plan to construct a number of fuel stations for vehicles operating with liquid petroleum gas (LPG) - clean fuel, gasoline and

diesel in Baghdad and governorates. Gas Filling Company has started in cooperation with Oil Products Distribution Company to add a line of clean fuel to equip vehicles in Al-Mansour station in Baghdad, work is underway for Al-Qanat and Al-Doura stations to be within this program as well.

- Construct dams for electric power generation.
- Convert gas stations to combined cycle stations, which are one of the most harmless technologies to environment and more efficient in fuel consumption compared to fossil fuels.
- Establish 23 new stations until 2017 to add about 11-12 thousand MW of capacity to the currently available one. Types of these new stations are: gas, steam, diesel and hydroelectric stations. They can operate by natural gas over the long term and also capable of operating by fuel oil, when required.
- Develop the capacity of solar and wind energy to connect with the national network.
- Launch a program of smart network to monitor the performance of networks, enhance management at peak time, establish control loads programs and reduce the high loads of power of residential areas.
- Use gas stoves and solar water heaters.

Reference Scenario of the Waste Sector:

- Recycle 25% of solid waste and establish a treatment plant with total capacity of up to 700,000 metric tons/year in 2020.
- Recycle 25% of solid waste and establish two treatment plants with total capacity of up to 1,400,000 metric tons/year in 2030.
- Continue establishing wastewater treatment plants to cover all Iraqi governorates and local communities in remote areas.
- Effectively use wastewater, which is increasing with the constant increase of the population, to ease the pressure on freshwater resources.

Reference Scenario of the Industry Sector:

- Iraq is planning to activate the industry sector and transforming it from the planned economy to free market economy.

- Promote the international business community to participate as partners in the investment of this transformation through importing modern technology, advanced skills, financial resources and investment in Iraq to improve the economy, increase employment opportunities and build the capacity of the country.
- A set of key strategic objectives were identified to be achieved by 2013:
    - Increase the annual growth rate of the industrial added value to about (10%).
    - Increase the contribution rate of the manufacturing to GDP to about (18%).
    - Increase the rate of employment in the industrial system.
    - Increase the rate of investment in the industrial system, compared with the total size of the investment.
    - Increase the rate of industrial products to total industrial production.
    - Increase the rate of private sector contribution in the manufacturing.

- Construction of five new industrial cities and continue implementing Khor Al-Zubair project, as a major industrial city for energy-intensive industries by 2017. Thus, the number of industrial cities will be seven in 2022, while seeking to construct an industrial city in each governorate, as well as three technological cities and complete the implementation of the industrial city of Khor Al-Zubair by 2030.
- Establishment of a simple and transparent control system by 2017 and develop this system to be more effective before 2022, in order to establish an effective and integrated control system at all levels, with the participation of stakeholders and implementation of decentralization in 2013.

The Mitigation Scenario:

The mitigation team has proposed a total of 20 projects to reduce the emission of greenhouse gases related to primary energy areas, renewable energy, energy efficiency, waste and agriculture.

These proposed projects reveal that the key areas to be focused on are changing the quality of used fuel, introducing natural gas to the national system of electricity production and renewable energy.

NATIONAL CIRCUMSTANCES

1-National Circumstances

This chapter includes a brief description of the political system in Iraq, except for Kurdistan region. It also includes the geographical, climate, demographic and economic situations. As well as describing sectors of transportation, health, water, waste and agriculture. It also presents the basic elements of the actual energy situation in Iraq. Annex (1) shows the national circumstances of Kurdistan region.

1.1 The Political system

The Republic of Iraq is located in southwest of Asia and forms the north-eastern part of the Arab world. Iraq is bordered by Turkey to the north and Iran to the east, Syria, Jordan and Saudi Arabia to the west and the Arabian Gulf, Kuwait and Saudi Arabia to the south. It is located between latitudes '5°29 and '22°37 north and between longitudes '45 °38 and '45 °48 east. Area of Iraq is 435,052 km^2. (Annual statistical abstract- part one/ physical features, (2012-2013))

The modern Iraqi state was established in 1921, independent of the Ottoman rule of the states of Mosul, Baghdad and Basra. Baghdad was the largest and dominant state over the rest of Iraqi states. The Constitution had organized the political, social and economic life in the country starting from the Iraqi basic law of 1925 during the monarchy after establishing the Kingdom of Iraq and through the interim constitution of 1958. After that was the transition towards the Republican system with the establishment of the Republic of Iraq and the interim constitutions of 1964, 1968 and 1970. The last granted all powers to the President of the Republic, who is at the same time the head of the state and commander in chief of the armed forces.

Article (1) of the current Constitution of Iraq, which was issued in 2005, states that: The Republic of Iraq is a single, federal, independent country with full sovereignty. The system of government is republican, representative, parliamentary and democratic. Article (116) of the constitution stipulates that the federal system of the republic of Iraq consists of the capital, regions, decentralized governorates and local administrations. Kurdistan region, the autonomous, represents a federal region consisting of three Iraqi governorates Duhok, Erbil and Sulaymaniyah. As for the other 15 governorates that are not incorporated in a region, including the capital Baghdad, they were granted broad administrative and financial powers to be able to manage their affairs according to the principal of administrative decentralization (Figure 1-1).

The legislative power consists of the Council of Representatives and it is authorized with terms of reference, most important of them are the legislation, monitoring the performance of the executive power, election of the President and ratification of treaties and agreements. While the executive power consists of the President and the Council of Ministers, the Prime Minister is the executive officer who is directly responsible for the general policy of the state and commander of the armed forces. The constitution has followed the principal of the independence of judiciary, regarding the judicial authorities. Judges are independent without any authority over them except that of the law and with no interference by any authority in the affairs of the judiciary and justice affairs.

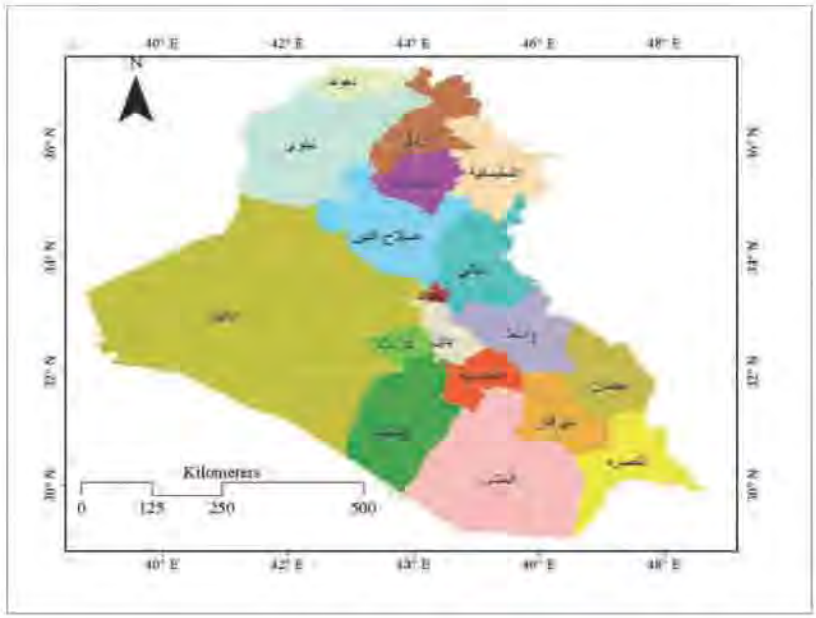


Figure (1-1): Administrative borders of the governorates of Iraq

Environmental Institutional Framework:

Department of Environment Protection and Improvement was established under law of environment protection and improvement No. 3 of 1997, whereby it established the Board of Environment Protection and Improvement, headed by the Minister of Health and membership of representatives from environment-related ministries. The Ministry of

Environment was formed in Iraq on August 7th, 2003. It was assigned tasks and functions set forth in the law of environment protection and improvement No. 3 of 1997. Other functions were added that suit the global concern for the environment, it would protect and sustain environment with identification of potential risks to human health caused by pollution.

The Ministry of Environment, its administrative structure, tasks, and management were reorganized under the Ministry of Environment law No. 37 of 2008. The administrative structure included general departments in four geographical areas of Iraq, followed by directorates for environment in each governorate: northern area, central area, middle Euphrates area and the southern area. The rules of procedure No. 1 of 2011 was also issued to organize the Ministry's departments, sections and other sub-formations according to the Law of the Ministry of Environment.

The law of environment protection and improvement No. 27 of 2009 has organized the technical and legal work of the Ministry, by including provisions for the protection of human, environment and biodiversity from water, air and soil pollution. It also protects from the pollution emerging of oil and gas extraction, waste management and hazardous materials. There are other provisions related to organizing environmental control, sanctions for polluting activities and compensation for damages, all issued according to a number of regulations and instructions (implementing regulations) to implement the provisions of this law.

Iraq has a clear vision of the importance of work with the international community to reduce the effects of climate change on its territory; therefore it joined the Framework Convention on Climate Change under law No. 7 of 2008, published in the Iraqi Gazette No. 4114 on March 23rd, 2009. Iraq has ratified the Framework Convention on Climate Change and the Kyoto Protocol on July 28th, 2009, where the Convention entered into force on October 26th, 2009. Iraq, and since then, is working hard to meet its obligations towards the convention. It also formed a national unit; in form of a division, within the section of air and noise quality monitoring of the Technical department at the Ministry of Environment. This unit was for the capacity building of personnel working in this field to lead the issue of climate change on the national level and perform the necessary regional and international coordination. The work of the Ministry of Environment was expanded, after training many cadres and building their capacity, to address issues of climate change through forming the Climate Change Center. This center is linked technically and administratively with the Ministry of Environment to be granted more powers on the national level and also to enable it lead the operation of capacity building of staff on the national level. The expansion was also through the Permanent National Committee on Climate Change which is concerned with

following-up national policies and strategies developed towards climate change. As well as to motivate all ministries through their representatives who are members of this committee to work on the implementation of these policies, develop necessary work plans for implementing them, raising awareness and capacity building.

1.2 Geography

The surface of Iraq is divided to four geographical regions:

A- **The Mountainous region**: Located in the northern and eastern part of Iraq, extended to the joint borders with Turkey, Iran and Syria in the north, east and west. This region occupies an area of about 92,000 km^2, representing 21.1% of the total area of Iraq.

B- **The Undulating region:** A transition area between the lowlands in the south and the high mountains in the far north and northeast of Iraq. It occupies half of the mountainous region area or 67,000 km^2, 42,000 $km^2$of it is out of the mountainous region. Height of this area is 100-200 meters and the height of 25,000 km^2 within the mountainous region is 200-450 meters. It constitutes about 9.7% of the area of Iraq.

C- **The Deseret plateau**: Located in the west of Iraq and occupies less than half of the area of Iraq, about 168,552 km^2 with 100-1000 meters height. It includes the area of Al-Jazeera and constitutes 38.7% of the area of Iraq.

D- **Sedimentary plain**: Occupies 132,500 km^2. It extends like a rectangle of 650 km length and 250 km width, extending between the town of Balad on the Tigris River and the city of Ramadi in the black hill area on Euphrates River from the north. Iranian borders from the east and the desert plateau to the west, marshlands and lakes are also included in this area. It constitutes 30.5% of the area of Iraq. Figure (1-2).

Figure 1-2: Geographical areas of the surface of Iraq

1.3 Climate

Iraq is located within the northern temperate zone between latitudes '5°29 and '22°37 north and between longitudes '45°38 and '45 °48 east. It has gained from this location the sub-continental climate influenced by the Mediterranean climate. The climate of Iraq is described with the widening of the daily and annual temperature range due to lack of large water bodies that reduce the coldness of winter and heat of summer and lack of rain from the north-east to south-west direction. Most of its rain is in the seasons of winter, autumn and spring, but lacking in summer (Iraqi Meteorological Organization & Seismology, 2011).

Iraq is surrounded by five water bodies: the Caspian Sea, the Black Sea, the Mediterranean Sea, the Red Sea and the Arabian Gulf. However, its impact on the climate of Iraq is significantly limited to the Mediterranean Sea and the Arabian Gulf. The Mediterranean corridor is considered appropriate for air depressions that take its way eastward, causing rainfall in winter as a result of the movement of the virtual sun towards the Tropic of Cancer and provides high-pressure area to the north of its previous positions which makes the area free of rainfall in summer, dry and with westerly winds. It is also affected in winter by the air depressions coming from the south-east to make

warm fronts with Mediterranean depressions and helps for rainfall. Iraq is affected in summer by the warm moist winds, especially on the southern and central parts of it, causing rising temperatures (Ali Hussein Al-Shalash, 1961). Northwest wind blowing on Iraq throughout the seasons of the year; in winter it is cold, dry and accompanied by blue skies. While, in summer it soothes the atmosphere and reduce high temperatures. East or north-east winds blow in winter accompanied by severe cold and a clear sky. As for the south-east winds, it is relatively warm, moist and brings clouds and rain at times (Balsam Shakir Shanshal, 2010).

Iraq's climate is divided into three types:

A- **The Mediterranean climate**: Where the mountainous area extends in the northeast. It is characterized by cold winter and snow fall on the mountain tops. Rainfall ranges between 400 and 1,000 mm per year. Summer is mild and the temperature does not exceed 35 degrees °C in most parts.

B- **Steppe climate**: A transitional climate between the mountainous area climate and the warm desert climate in the south. It is located within the borders of the undulating area. Annual rainfalls range between 200 and 400 mm, which are sufficient for the spread of seasonal pastures.

C- **Warm Desert climate:** It prevails the sedimentary plain and the western plateau and includes 70% of the area of Iraq. Annual rain rate is about 50-200 mm. It is characterized with large thermal extent between night and day, summer and winter. In winter, the warm weather prevails and keeps temperatures above freezing, not falling below that only for a few nights (Iraqi Meteorological Organization & Seismology, 2011).

The climate change in the long run may lead to environmental, social and economic consequences with a wide unpredictable influence. Weather conditions will play a role in the contrast and speed of sand dunes, as rain makes the soil of the dunes more moisture during the rainy months. Thus, reducing its' advance speed and offers a bigger opportunity for the growth of natural vegetation on its surface. Decline of rainfall rates is one of the factors that contribute to the increase of the dry area in the region contributing to the feeding of dust storms through its role in increasing the pace of desertification.

Climate of Iraq is affected by the phenomenon of dust, a rise of dust particles from the surface of earth and its spread causes decline in visibility. The form and size of these dust particles varies depending on its source; physical and chemical composition and speed of the wind carrying it. It is generally composed of different ratios of mud, silt and sand. Diameters of particles range from 0.05 to 100 micrometers and the small ones rise to about 1 km from the surface of earth. It could be divided depending on the particles'

concentration, speed of the wind causing it, such as suspended dust, rising dust, dust storm and sand storm. Dust distribution in Iraq is related, in terms of frequency of occurrence, to the geographical nature of the dust region and the climate elements affecting its rise. Increase of surface winds, provision of dry surfaces covered with sand and dust, instability of the atmosphere (a feature that helps the activity of rising and falling air currents) all lead to the spread of dust and sand in a large thickness in the atmosphere. In addition to these general conditions, there are special pressure distributions leading to increased surface winds speed. The nature of these distributions and their causes vary with seasons of the years. Although there is rainfall in winter, but the dust phenomenon does not disappear in this season, due to its link with the activity of cold fronts coming from the Mediterranean weather depressions. This phenomenon reaches its top activity in spring and summer due to the arrival of depressions coming from north of the Arabian Gulf and from central Asia causing northwesterly winds with a varying severity according to the depression's severity.

The climate elements of the climate zones in Iraq are monitored through forty stations (Figure 1-3). These elements are represented in degrees of usual temperature (dry and wet) measured in Celsius, as well as the minimum and maximum temperature, barometric pressure, relative humidity, speed and directions of surface winds at an altitude of 10 meters above the ground, rain, evaporation. As well as, the intensity and duration of solar radiation, soil temperatures at different depths (0, 10, 20, 30, 50 and 100 cm), density and height of the clouds, visibility, recording dust storms and any other air changes. In addition to the documentation of the current climate and future forecasts (Nahla Jassim and Eman Habib, 2012). The Ministry of Agriculture has initiated since 2010 to set up and operate a specialized network for agricultural meteorology. There are currently 45 automatic agricultural meteorological stations. The number of stations is expected to increase and reach 100 stations by 2016, figure (1-4).

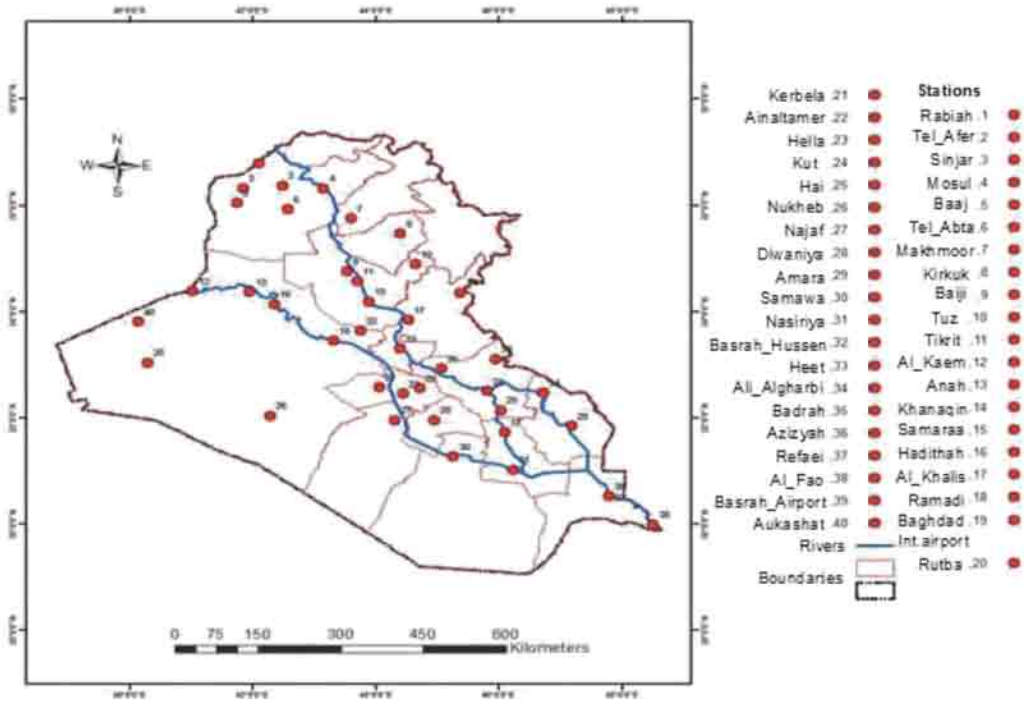


Figure (1-3): Distribution of weather stations

Figure (1-4): Distribution of agricultural meteorological stations

Meteorological data of Baghdad station was used to study the dust phenomenon (Iraqi Meteorological Organization & Seismology, 2011). Figure (1-5) shows the annual changes of the dust phenomenon and annual changes of the suspended dust, rising dust, dust storms with data from the 1970s and the Millennium. The dust phenomena on the level of Iraq started to worsen in the last decade of the twentieth century as a result of many environmental and climatic factors. Data of ground-based monitoring stations and the elements of the atmosphere are analyzed using space visualizations with different accuracy providing comprehensive coverage of extreme weather, such as NOAA METEOSAT meteorological satellite and satellites like Terra and Aqua of spatial resolutions ranging from 250 to 1,000 meters and multiple wavelengths to study the recurrence of dust phenomena according to the stations' locations, figures (1-6), (1-7) and (1-8).

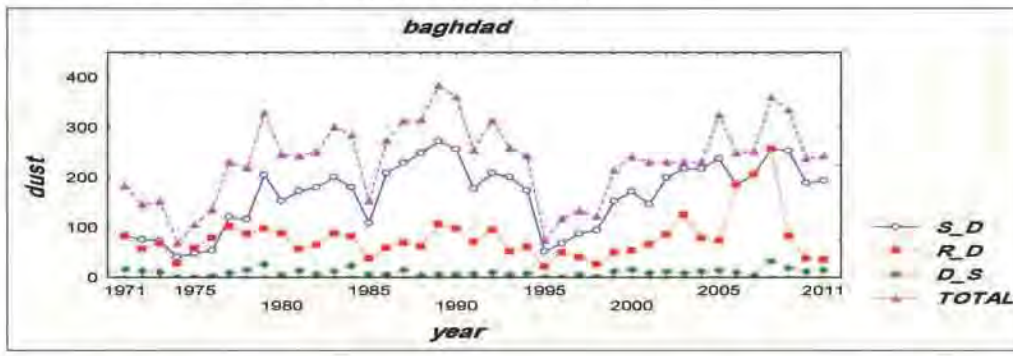


Figure (1-5): Annual changes of total dust phenomena and annual changes of suspended dust, rising dust and dust storms in Baghdad

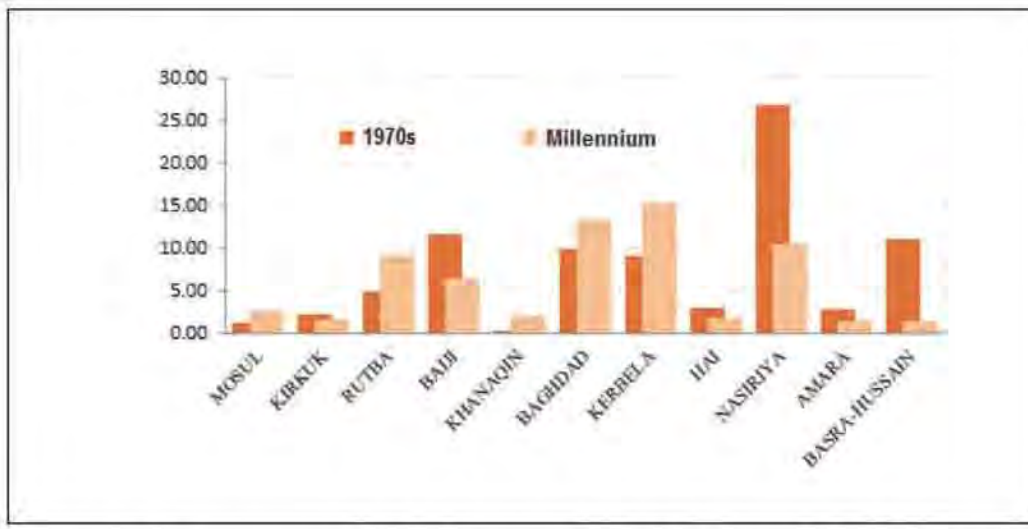


Figure (1-6): Recurrence of dust storms during 1970s and the Millennium

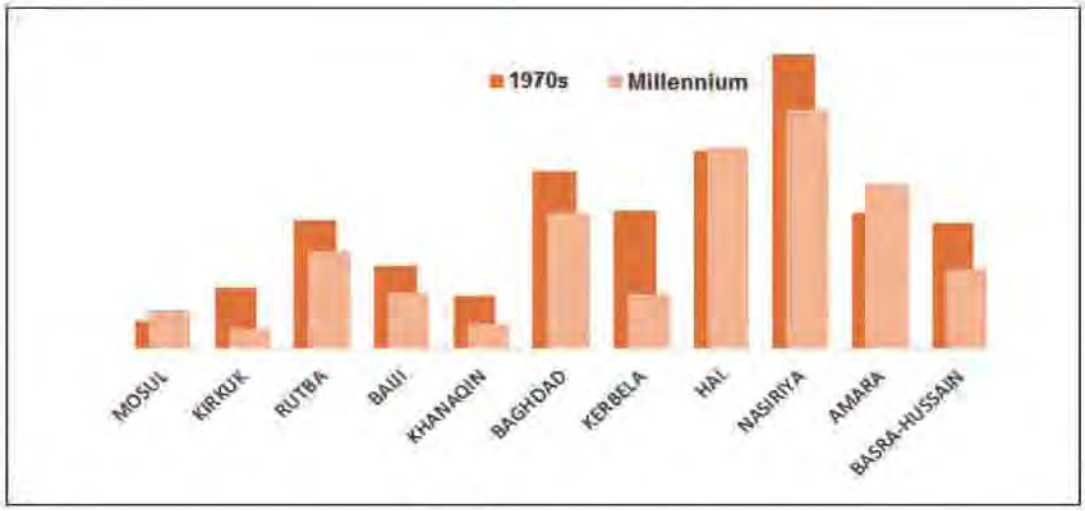


Figure (1-7): Rising dust during 1970s and the Millennium

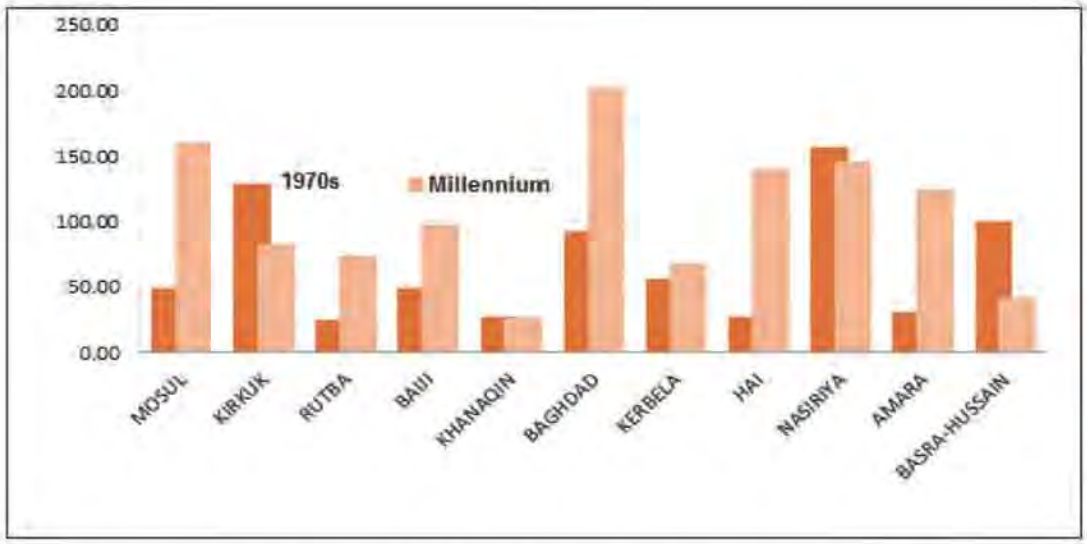


Figure (1-8): Suspended dust during 1970s and the Millennium

Rain in Iraq is generally characterized by irregular distribution in terms of space and time. The amount of recorded rainfall in the meteorological stations varies from one place to another depending on the altitude and the geographical location of the meteorological station. Rain could be studied

through two indications; spatial distribution and temporal distribution, as well as through rates. The general rate of rainfall for all areas of Iraq in the 1970s was higher than the overall rate of the Millennium period, figure (1-9).

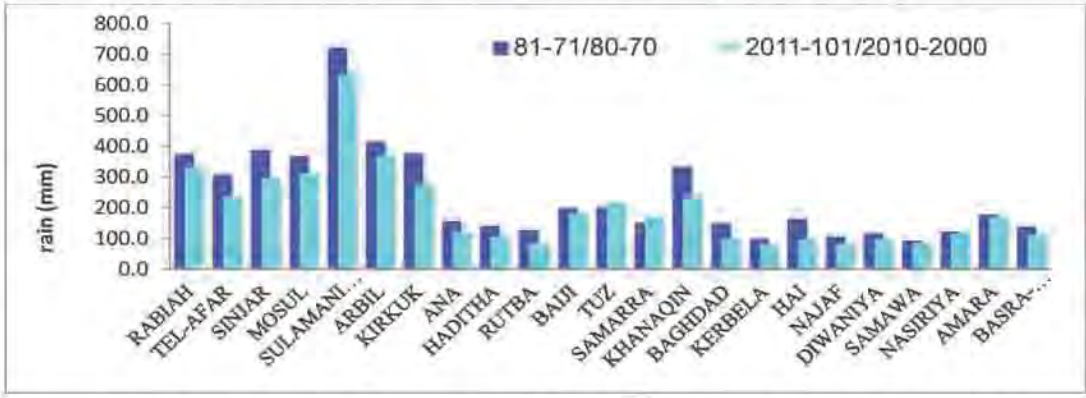
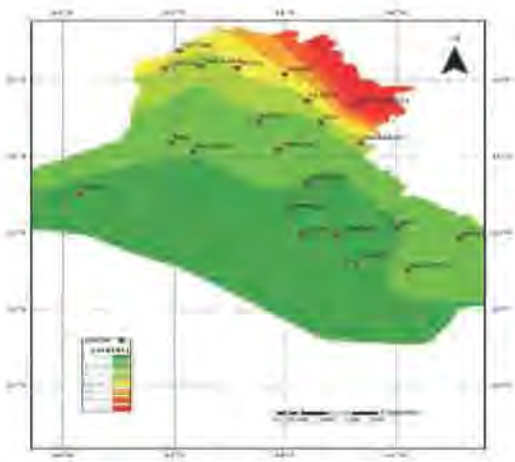
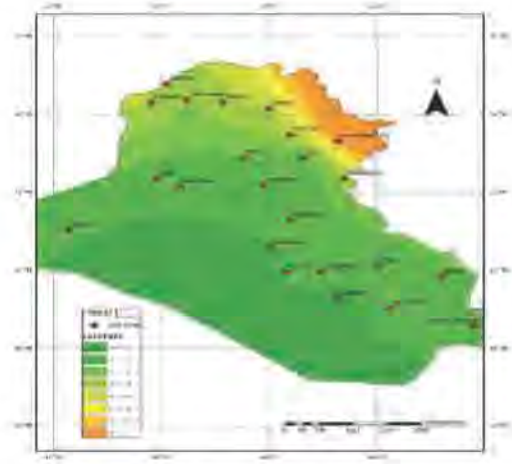


Figure (1-9): Rainfall rates during 1970s (1970-1980) and during the Millennium (2000-2010) for all study stations

Figure (1-10) of equal quantity of rainfalls lines (mm) in 1970s and the Millennium illustrates that the rain line that is less than 100 mm covers a larger area in the last Millennium and number of stations within this line were only Karbala and Samawah stations. While during the last Millennium, this line has expanded to include seven stations, namely: Al-Rutba, Baghdad, Karbala, Beji, Najaf, Diwaniya, and Samawah. The rain line increased in the Millennium to include stations within the rain line 100-200 mm. This explains the large decrease of the rainfall amount less than 100 mm. Although this amount of rainfall is little, it is exposed to evaporation as well, resulting in a water deficit characterizing the dry areas and increase of dry areas in Iraq. The rain line of less than "100 mm" extended in 1970s between latitude 32 of the western side and 29 of the eastern side. While in the Millennium, this rain line extended between latitude 33.3 of the western side and 30 of the eastern side. In addition, the rain line of more than 700 mm, noticed in the 1970s maps, has disappeared in the Millennium (Nahla Jassim and Eman Habib, 2012).



Equal rain line for the Millennium



Equal rain line for 1970s

Figure (1-10): Equal rain line of the 1970s and the Millennium

- Data of eight meteorological stations were used in table (1-1) to analyze the climatic factors in Iraq. Statistical analyzes indicate that there are increasing trends in the temperature rate in all selected stations, which are considered a signal of climate change (statistically significant) with 95% in Baghdad station and 99% in the rest of stations of the level of confidence. Decreasing trends in total annual rainfall in the selected stations were observed as well, except for Nasiriya and Al-Rutba stations which began moving towards decreasing. The end of 1990s and beginning of the Millennium were the start of the trend towards decreasing in precipitation and number of rainy days in the selected stations, except for Al-Rutba station which indicated a trend towards increasing of the number of rainy days. These decreasing trends of precipitation are considered a signal of climate change (statistically significant) of 99% of the level of confidence in Baghdad, Basra, Mosul, Nasiriya, Kirkuk and Al-Hay stations, except for Diwaniya station where the decrease did not reach the statistical significance. It is noted that during end of 1990s and beginning of the Millennium, is the beginning of the trend towards the decline in the number of rainy days. (KheshtkarySani and sayyad,2014) (D.K. Karpouzos , S. Kavalieratou and C. Babajimopoulosm 2010).

1.3.1 Account of the Direction of Climate Elements:

The simple linear regression method was used, it represent the regression coefficient (b), from the engineering standpoint, the degree of regression line inclination. If the value is positive and greater than zero (0 <b), the regression line will be upward, meaning that the relation between the independent variable (years) and the dependent variable (the climate component) is a

direct correlation. The value of the dependent variable (the climate component) will then increase with the increase of the independent variable (years). If the value is negative (b <0), the regression line is descending and the relationship between the two variables is an inverse relationship, meaning the increase in the independent variable (years) offset by a decrease in the dependent variable (the climate component), (Shahatha, 1997).

I- Trends of Rain in Iraq

a- Total of Annual Rainfall:

The regression coefficient indicates a decrease in the amount of rainfall over time for most study stations during (1938-2009) except for Nasiriya and Al-Rutba stations. The more decreased station in rainfall is Mosul as the regression coefficient reached -1.36, followed by Kirkuk -1.29, Baghdad -0.93, Basra -0.38 and Diwaniya -0.35. The lowest rainfall decrease is observed in Al-Hay station -0.31. Nasiriya and Al-Rutba stations witnessed an increase in rainfall, the highest was in Al-Rutba station 0.19 during 2002, and value of (b) in Nasiriya was equal to 0.16, table (1-1).

Table (1-1): Regression coefficient (b) of total annual rainfalls of the study stations

Duration	Station	Regression Coefficient
1938-2009	Mosul	-1.36
1938-2009	Kirkuk	-1.29
1938-2009	Baghdad	-0.93
1938-2009	Basra	-0.38
1939-2009	Diwaniya	-0.35
1941-2009	Al-Hay	-0.31
1941-2009	Nasiriya	0.16
1941-2002	Al-Rutba	0.19

a- Number of Rainy Days:

The regression coefficient indicates a decrease of number of rainy days in most of the study stations over time, except for Al-Rutba station. The largest decrease in number of rainy days in Baghdad station as the value of regression coefficient reached -0.26, followed by Basra -0.30, Mosul -0.50, Kirkuk -0.32, Diwaniya -0.03 and Nasiriya -0.17. The lowest number of rainy days is observed in Al-Hay station -0.32. Al-Rutba station witnessed an increase in rainfalls 0.33 (during the recording period 1971-2002), table (1-2).

Table (1-2): Regression coefficient (b) of rainy days number in study stations

Duration	Station	Regression coefficient
1941-2009	Baghdad	-0.26
1941-2009	Basra	-0.3
1941 -2009	Mosul	-0.5
1942 -2009	Kirkuk	-0.32
1941 -2009	Diwaniya	-0.03
1941 -2009	Nasiriya	-0.17
1941 -2009	Al-Hay	-0.32
1971 -2002	Al-Rutba	0.33

II- Trends of Temperature in Iraq:

a- Average Annual Temperature:

The regression coefficient indicates an increase in temperature over time in all study stations. The most increase in temperature was in Diwaniya station where the regression coefficient reached 0.06, followed by Al-Rutba and Basra stations 0.05, Nasiriya 0.04, Al-Hay 0.03 and Kirkuk 0.02. The lowest increase was in Mosul and Baghdad stations 0.01, table (1-3).

Table (1-3): Regression coefficient (b) of average annual temperature of study stations.

Duration	Station	Regression coefficient
1971 - 2009	Diwaniya	0.06
1971 -2002	Al-Rutba	0.05
1941 -2009	Basra	0.05
1941 -2009	Nasiriya	0.04
1941 -2009	Al-Hay	0.03
1941 -2009	Kirkuk	0.02
1941 -2009	Mosul	0.01
1941 -2009	Baghdad	0.01

1.3.2 Representation of Climate Zones in Stations:

Koppen equation was relied on in representing the climatic zones, relying on variation in the amount of precipitation rainfall and the quarterly

distribution. The monthly temperature distribution is used to discriminate between those regions (Fadhel Al-Hassani and Mahdi Al-Sahaf, 1990). Stations of Mosul and Kirkuk are located within the steppe tropical climate; semi-dry and hot. While Baghdad, Al-Rutba, Al-Hay, Diwaniya, Nasiriya and Basra stations are located within the tropical desert climate; dry and hot, table (1-4).

Table (1-4): Type of climatic zone for study stations

Duration	Station	Type of Climatic Zone
1941 -2009	Mosul	Steppe tropical climate (semi-dry & hot)
1941-2009	Kirkuk	Steppe tropical climate (semi-dry & hot)
1941-2009	Baghdad	Tropical desert climate (dry & hot)
1971 -2002	Al-Rutba	Tropical desert climate (dry & hot)
1941 -2009	Al-Hay	Tropical desert climate (dry & hot)
1971 2009	Diwaniya	Tropical desert climate (dry & hot)
1941 -2009	Nasiriya	Tropical desert climate (dry & hot)
1941 -2009	Basra	Tropical desert climate (dry & hot)

1.4 **Population**

Iraq has witnessed a significant increase in the number of population as it increased from 12 million in 1977 to 33 million in 2011. This number is expected to reach 38.9 million people in 2017. Statistics shows that annual population growth rate of 3% of the population will double the population every 23 years. If this high rate continues, then it would require doubling of the available water, food, energy and ability to process wastes to be capable to meet the multiple needs of growing numbers of population in the near future, achieve sustainable development and accomplish the Millennium Development Goals. In addition to the above mentioned, the unbalanced geographical distribution of the population due to the absence of the former population policies adds another pressing factor to the available resources. Many phenomena of population concentration in large cities, sagging and growth of slums on the outskirts of cities and its surroundings have appeared. This was reflected on the environmental degradation of cities, the low level of services and management of environmental resources in it. As well as number of factors such as: natural factors (water-environment-climate),

administrative factors (administration centers that attract the population) and economic factors (economic, social and urban development levels).

The number of Iraq's population was estimated in 2009 of about 31.6 million people, including 16.1 million male and the rest are females. Table (1-5) shows the increase in population and growth rate since 1947, where the population was equivalent to 4.8 million people. Table (1-6) presents the unbalanced geographical distribution in governorates in 2011. The distribution also refers to the lack of balance between the governorates area and the population.

Table (1-5): Increasing population growth rates during (1947-2011)

Year	Population (million people)	Annual growth rate
1947	4.8	----
1957	6.3	٪2.7
1977	12	٪3.3
1987	16.3	٪3.1
1997	22	٪3
2009	31.6	٪3
2011	33.3	٪2.6

Table (1-6): Distribution of population in the Iraqi governorates in 2011, according to the annual statistic of the Ministry of Planning/Central Statistical Organization

Governorate	Area km^2	Rate %	Urban	Rural	Total
Ninewa	37,323	8.6	1,988,872	1,282,502	3,271,374
Kirkuk	9.679	2.2	1,000,369	395,615	1,395,984
Diyala	17.685	4.1	692,206	751,125	1,443,330
Anbar	137,808	31.7	756,737	804,836	1,561,574
Baghdad	4,555	1	6,152,511	905,225	7,057,736
Babel	5,119	1.2	859,420	961,489	1,820,909
Karbala	5,034	1.2	709,437	357,350	1,066,787
Wassit	17,153	3.9	701,558	509,258	1,210,817
Salah Din	24,363	5.6	622,770	785,533	1,408,303
Najaf	28,824	6.6	914,014	371,810	1,285,823
Qadisiya	8,153	1.9	640,557	493,910	1,134,467
Muthana	51,740	11.9	314,605	404,512	719,117
ThiQar	12,900	3	1,155,629	680,897	1,836,526
Missan	16,072	3.7	703,588	268,144	971,732
Basra	19,070	4.4	2,025,218	507,613	2,532,831
Total of 15 governorates	**395,478**		**19,237,492**	**9,479,820**	**28,717,311**
Kurdistan Region					
Erbil	15,074	3.5	1,341,844	271,379	1,613,223
Duhok	6,553	1.5	828,192	300,621	1,128,813
Sulaymaniyah	17,023	3.9	1,596,214	283,195	1,879,409
Total of KR governorates	**38,650**		**3,766,250**	**855,195**	**4,621,446**
Total of Iraq	**434,128**		**23,003,742**	**10,335,015**	**33,338,757**

* Population projections are calculated according to the results of listing and numbering of 2009.

1.5 Environment

The Iraqi environment is considered the most important victim of wars experienced by Iraq as a result of conflicts that have caused the greatest damage. The previous regime have deliberately built early 1980s sites for manufacturing weapons (Military Manufacturing Facilities) amounting to more than 40 facilities. These sites are one of the contributing factors to the environmental degradation, as well as the wars experienced by Iraq, during

which the parties of the war did not spare any effort to destroy and burn as much as possible of the territory and beaches of the country where chemical weapons were used, ships were sunk and seawaters were polluted. Unique ecosystems like marshlands were also subjected to drying and damage to facilitate armies crossing the borders as it was considered a strategic border area. The drying process of marshlands in southern Iraq has resulted in changing the nature of the environment and its devastating effects were reflected on wildlife and biodiversity. Some mammals, fish, birds and plants that abounded the area have become vulnerable to extinction. The problem of increased frequency of dust storms phenomenon, that left obvious effects on the economy and public health, has emerged too. In addition to the previously mentioned, direct and indirect effects of the climate change phenomenon, which appeared in the Iraqi environment, have left its doubled adverse effects on it, (Forecasts of the Iraqi environment situation, 2013).

1.6 **Economy**

Development of gross domestic product (GDP) is considered the main index adopted to determine the performance of the economy during a certain period. Available data indicate a growth in the Iraqi GDP during 2010 of 24.1% compared to 2009. The positive situation of the oil sector represents the main source of growth in GDP since the rise of global oil prices after its decrease in 2008 and 2009 due to the global financial and economic crisis, in addition to the increased size of Iraqi oil exports, table (1-7).

Table (1-7): GDP and contribution of economic sectors (current prices)

Activity	2009	2010	Increase %
GDP / Trillion ID	130.6	162.1	24.1
Average GDP per capita / Million ID	4.2	5	19
Contribution of Oil sector %	42.5%	44.7%	4.9
Value of GDP for oil sector/ Trillion ID	56	72.9	30.2
Contribution of Industry sector %	2.6%	2.3%	-11.5
Contribution of Agriculture sector %	5.2%	5.1%	-1.9
Contribution of Government sector GDP %	16.1%	14.7%	-8.7

The general revenue of 2010 achieved a growth of (22.5%) more than the previous year. The monetary value have increased from (50.4) trillion ID to about (61.7) trillion ID, while the oil revenues have formed about (90.8%) of

the general revenue, with a growth rate of (30.1%) for 2009. The tax revenue has contributed with (9.2%) of the total general revenue, with a growth of (11.4%) for 2009.

Although, Iraq has a wealth of oil, but 78% of the families are of average to very low living standard. Elimination of widespread poverty among Iraqis must be accelerated because there is a link and integration between population, development and environment. This is reflected by the low human development in Iraq and the urgent need and priority to improve the educational situation, focus on literacy programs, intensification of basic health care programs, raise the income level with equitable distribution, protect the environment, ensure its safety and invest the environmental resources in a sustainable method (Annual Statistical Abstract-Living Conditions Statistics- Ministry of Planning, 2012, 2013).

1.7 Energy

Improvement of the energy efficiency and consumption rationalization are good ways to achieve sustainable development, obtain remarkable savings in energy demand and thus affect the financial investment that is required to ensure the necessary energy for economic and social development. It is important to control and rationalize the usage of energy at all levels to maintain the right of the coming generations, take into consideration the safety of environment and consider this as an indirect source of available energy that contributes to the achievement of sustainable development of this vital sector. The energy efficiency and consumption rationalization are essential for the economic development of any country, not only when energy prices rise, but it is also a vital issue for the economy of institutions and families alike. This is because the reduction of energy consumption saves money, ensures the continuation of energy and reduces the emission of gases affecting the phenomena of global warming, thereby contributing to the achievement of sustainable development. Iraq has large energy resources which depend mainly on oil and natural gas produced by oil and gas fields in the north, south and some central areas.

1.7.1 Oil and Gas:

Since the 1950s of the last century, the oil industry has been able to achieve advanced development in combining the activities of this industry (extractive, manufacturing, transportation and distribution). That was accompanied by continuation of progress in production rates to reach 714 million barrels in 2006 with refining rates up to 130 million barrels in the same year to meet the local consumption of all petroleum products. At the beginning of 2011, the proven oil reserves of Iraq were estimated at 143.1 billion barrels, constituting the third largest reserves of conventional oil in the

world after Saudi Arabia and Iran. Three-quarters of the oil reserves are concentrated in seven giant fields (West of Qurna, Rumaila, Majnon, Kirkuk, Al-Zubair, East of Baghdad and Bin Omar fields). All these fields are located in the south of the country, except for the fields of Kirkuk and East of Baghdad. As for the reserves of natural gas, Iraq enjoys large quantities of natural gas making it the tenth state in the world in terms of natural gas reserves; there are about 132 trillion SCFD.

The gas oil constitutes 70% of Iraq's natural gas reserves; it is the dissolved gas in the crude oil underground, which requires to be separated from oil when rising to the surface. Reserves of gas oil in Iraq are concentrated in the south, particularly in the giant oil fields of Rumaila, West of Qurna, Bin Omar, Majnon and Al-Zubair fields.

A percentage of 20%, among the remaining known reserves, is of free gas which is extracted from gas fields and does not have a large content of oil. As well as 10% from gas domes, it is a gas cover above the oil reserves. Most of this free gas and gas domes fields are in northern Iraq.

Iraq exports two types of crude oil; they are light crude oil of Basra with a density of 34 degrees and 2.9% sulfate and crude oil of Kirkuk with a density of 36 degrees and 2.3% sulfate, according to the specifications of the American Petroleum Institute (API). They are exported through the ports of Basra and Al-A'miya on the Arabian Gulf and through the Turkish port of Ceyhan on the Mediterranean. Iraq's crude oil exports have reached in 2006 about 551 million barrels, while the rates of invested natural gas have reached in 2006 up to 6,603 million m^3 and the flaring quantities were 6,787 million m^3. Dry gas quantities processed for the electricity sector were up to 2,119 million $m^3$and up to 709 million m^3were supplied the industry sector in the same year.

The Ministry of Oil has developed a strategy after 2008 through contracts licensing rounds which were planned and implemented according to an objective and future vision with several specialized global oil companies, including (US Exxon Mobile, British BP, Dutch Shell, Russian Lukoil, Italian ENI, Chinese CNBC and others).

It is planned to raise the roof of crude oil production to 6 million barrels/day in 2017 after it was 2.2 million barrels/day in 2002 and 2.3 million barrels/day in 2010 with a rise in 2011 to 2.7 million barrels/day. In addition to rising the export capacities to ensure the local consumption and access to the export markets in accordance with the international adopted standards of products and quality standards.

The annual growth rate of crude oil production was reported up to 5.6% million barrels (56.2 thousand barrels) in 2006 more than 2005, while the

annual growth rate of natural gas production was about 3.1% million cubic meter (31.2 thousand m^3) for 2006 more than 2005.

Tables (1-8) and (1-9) show the quantities of produced, exported and injected crude oil in the refining units and quantities of produced, invested and flaring natural gas, respectively.

Table (1-8): Produced, exported and injected crude oil inside the refining units, according to the reports of the Ministry of Oil

Year	Produced million barrels	Exported million barrels	Injected crude oil million barrels	Refined crude oil million barrels
1997	547	262	60.1	**205,7**
1998	792	572	12.8	**197,5**
1999	928	759	0.2	**170,4**
2000	952	735	2.6	**212,6**
2001	944	736	10.4	**216,3**
2002	813	592	19.4	**212,6**
2003	561	369	45.2	**139**
2004	730	562	19.1	**147,8**
2005	676	512	20.8	**137,7**
2006	**714**	**551**	**21.4**	**130**

Table (1-9): produced, invested and flaring natural gas, according to the reports of the Ministry of Oil

Year	Produced natural gas million m^3	Invested natural gas million m^3	Flaring natural gas million m^3
1997	9772	8018	**1755**
1998	12418	9114	**3305**
1999	13780	9470	**4310**
2000	13760	9483	**4277**
2001	13930	9888	**4042**
2002	13017	9857	**3161**
2003	9255	5243	**4011**
2004	13408	6824	**6584**
2005	12984	6702	**6282**
2006	**13390**	**6603**	**6787**

The Ministry of Oil includes within its administrative structure the following:

- Extractive sector companies, including: (South Oil Company, North Oil Company, Midland Oil Company, Missan Oil Company, Iraqi Drilling Company and Iraqi Oil Exploration Company).
- Transformative sector companies and gas industry, including: (North Refineries Company, Midland Refineries Company, South Refineries Company, North Gas Company and South Gas Company).
- Distribution and transport companies, including: (Oil Pipelines Company, Oil Products Distribution Company and Gas Filling Company).
- In addition to companies of (Oil Marketing Company, Oil Projects Company, Heavy Engineering Equipment Company and Iraqi Oil Tankers Company).
- Petroleum Research and Development center and four Oil Training Institutes to graduate specialized technical cadres in the field of oil industry.

The Ministry of Oil is trying hard to provide its services efficiently to citizens, whether direct services through outlets for equipping citizens with petroleum products with subsidized prices, or indirectly through planning and implementing programs and plans that will contribute to the provision of world-class petroleum products free of polluting additives like sulfur and lead. In addition to supplying stations for electricity power generation and industrial projects with natural gas and petroleum products, as required and available (Report of the Ministry of Oil, 2014).

1.7.2 Electricity:

The industry of electricity started in Iraq in 1917 through the investment company (Belgian Company of Tanweer Baghdad) and passed through several development stages, then turned into a body in 1999, later to a ministry in 2003. The Ministry of Electricity is characterized, other than the productive industries, by the specific relationship between production of electric power and meeting its demand, as the produced energy could not be stored and it is generated for the immediate need. The Ministry has since 1973 developed a short, medium and long-term centralized plans to produce, transmit and distribute power, control and communications, renewable energies and for human capacity building.

The Ministry of Electricity works through its departments and general directorates to improve the work of the electrical system of three functions: production, transmission and distribution of power to consumers, in a good reliable way. To achieve this, the following objectives were identified:

a- Halt the system deterioration through comprehensive rehabilitation of production stations and transmission and distribution networks.

b- Increase the available capacity of the system to cover the growing demand for electrical power through gas stations, steam stations and diesels to produce gas and steam energy.

c- Develop and expand both transmission and distribution networks, in addition to increasing the capacity building of workers.

d- Improve the performance of the system, maintain the continuity and stability of the supplied electrical power and increase the degree of reliability.

e- Provide the best services to consumers of all types (domestic, commercial, industrial and governmental).

f- Improve the rates of annual energy consumption per capita.

Introduce studies of uses of renewable energy (solar and wind) with the adaptation projects and programs (like energy conservation programs and public awareness in this regard). As well as projects of greenhouse gases mitigation and air pollutants, such as fuel conversion and units of simple cycle to complicated ones. Development policies of 1970s and 1980s have paid great attention to the provision of electrical power to consumers and economic activities for their general importance to achieve sustainability.

The system suffers a deficit in the electrical energy, as the average power amounted to eight hours a day only, thus it formed expensive costs on economy, represented lack of access to production levels, damage to capital assets due to power outages and inability to carry out the usual commercial operations according to a reliable schedule. The lack of electricity in a country suffering of cold weather in winter and harshness of temperature in summer, represent great difficulties for individuals as well.

Absence of electrical power of the electricity network that can be relied on, has led to the spread of private diesel generators. The continued operation of these private generators represents high generating costs, lead to environmental pollution and emission of large amounts of carbon to the atmosphere. Estimates indicate that the total cost incurred by the Iraqi economy due to lack of electric power annually exceeds US$ 40 billion (National Integrated Strategy of Energy 2013-2030).

This deficit to meet the demand for energy is due to a range of factors, including outdated stations, transmission and distribution networks, destruction of large parts of the system because of the security events, delay in projects' implementation due to the circumstances experienced by Iraq and lack of fuel supplied to stations. The current generating capacity is 11-12 thousand MW, produced through gas turbine (44%), steam turbines (30%), hydroelectric stations (11%) and diesel generators (15%). This capacity is widely distributed in Iraq as a whole. The National Development Plan has given great attention to increasing the production of the electric power system to meet the growing demand (National Development Plan 2013-2017).

1.8 Industry

The Ministry of Industry and Minerals includes in its formation 71 public companies and 276 factories of a range of sectors. Known Industries in Iraq are divided into two main parts: the major industries and the medium and small industries, listed in the following:

1.8.1 Major Industries: They include all industries or energy-intensive projects that consume large amounts of energy. They include six industries (iron and steel, fertilizers, aluminum, petrochemicals, cement and bricks).

1.8.2 Medium and small industries: The small industries or projects include the private sector, provided that the number of workers is not less than ten. While medium industries and projects include the private sector too, provided that the number of workers is not less than fifty.

Iraqi national industries of the public, mixed and private sectors are divided to, according to the type of production:

- Construction Industries: they include cement, bricks, lime, tiles, marble, stone and white block industries. As well as glass, ceramics, sand and gravel quarries in both public and private sectors.
- Chemical Industries: which include petrochemical, chemical, medicine, fertilizer, types of acids (chlorine and sulfuric), paper, school supplies, paints, inks, mining, phosphate, sulfur and other industries.
- Textile Industries: Include woolen and cotton fabrics, hand-woven and machine carpet, ready-made clothing, medical cotton, gins, leather and other industries.
- Engineering Industries: they include automobiles, agricultural machinery, plows, tractors, trucks, loading vehicles, waste containers, wires and electric cables. As well as aluminum, iron, steel, bridge, forklifts and mobile cranes. In addition to gates of dams, electrical transformers, household appliances, civil and military boats, alloys, forgings, turnkey construction (steel structures) and solar cells. Also systems of solar energy, wind, and hybrid power production, electronic systems, electrostatic precipitators and other industries.
- Food and Medicine Industries: vegetable oil, tobaccos, cigarettes, sugar, dairy, medicines, medical supplies and other industries.

In addition to the above mentioned, the general Directorate of Industrial Development is the sponsor of the private sector for all types of the above mentioned industries.

The industrial sector is considered one of the most important economic sectors for promoting development. The monarchy did not pay great attention to the manufacturing industry, except for the industries established by the private sector and mainly related to the agricultural raw materials like sugar, diary, textile and construction materials industries. Interest was

increased in the manufacturing industry after the transformation of the political regime in Iraq from royal to republican in 1958. Plans of economic development affirmed during the 1960s on establishing manufacturing industries across Iraq, such as glass, ceramics, paper and mechanical industries, in addition to the existing traditional industries at that time, based on the principle that the manufacturing industry is the basic platform to build strong material foundations of economy and freedom from the economic dependence of the industrialized states. Economic plans for this phase considered establishment and deployment of these industries in governorates would suspend the great migration from countryside to the city, especially after the exacerbation of migration to Baghdad in that period. This policy was enhanced in the 1970s and 1980s with the great expansion of various industry branches; engineering, metal, heavy and chemical industries, in addition to the prevailing traditional industries of (food, textile and construction), even if some of those industries did not have a relative competitive advantage at the regional or international level. The public sector, according to the directives of the ruling regime before 2003, has fully dominated on the oil and electric power sectors. The private sector did not have any significant role in the manufacturing industry and was given a role in the small and medium industries. Some supportive laws were legislated for the private and mixed sectors, enabling the private sector of establishing about 40 thousand small and medium industrial projects.

The military industries expanded in the 1980s and 1990s, whether directly or indirectly associated with the military effort. Huge compounds of military industries were established in several locations with investment allocations for the industrial sector to about 50% of the total allocations of some programs. However, the industrial sector have significantly suffered from the deterioration of the manufacturing industries due to the successive wars and economic blockade until the events of 2003, which destroyed most of the large industries, particularly of the military nature and power generating stations. The subsequent security situations have also deepened the problem and led to the suspension of operating the private industrial sector projects. This contributed to a significant decline in the contribution of manufacturing industries to GDP. The industrial sector is characterized with the following set of basic features:

- Although the private sector represents 98.3% of the total number of operating industrial units in Iraq, amounting to 17,752 firms in exchange to 1.5% state-owned and 0.2% of common ownership, yet this distribution does not reflect the contribution of each sector in the total industrial production. Public sector companies represent the backbone of the

industrial sector in Iraq, as it is responsible for producing 90% of the total industrial production.

- Although 56% of the public companies factories could be classified, in terms of technological level of its operations which lead to the prescribed production in accordance to the international standards, as companies of high and medium technological component products, compared to 28% low-tech component and 16% dependent on raw materials, but all factories are currently with outdated machines, equipment and not keeping up with technological developments and modern systems for operation and control.
- The contribution percentage of the industrial sector in the GDP reached an average of 2.4% during (2008-2011) with a decrease of the industrial added value to negative values in a number of companies. In addition to the weak export performance. The known conditions have led to the cessation of production in most factories of public companies and reduced the production to very low levels. The percentage of halted factories until July 2013 is estimated to about 30% of the total factories of public industrial companies, as indicated by the report of the executive summary of the industrial strategy of Iraq until 2030.
- With the severe deterioration in productivity and high percentage of unemployed workers in all productive and service units of industry; in both public and mixed sectors, about 70% of the public companies are only operating with 30-50% of its designed energy, as well as the low quality of Iraqi industrial products. Public and mixed companies are committed to the minimum standards (deprived from international standards), while -most- of the private sector companies fail to apply these standards.
- Industry does not play a major role in the employment of labour in Iraq, as the total labour force working in all sectors of industry (public, mixed and private) is estimated of about 500 thousand workers. In addition, about 40% of the public sector companies rely on the governmental subsidies to pay wages of workers, while the mixed and private sector companies do not enjoy these subsidies.
- There is a neglect of adverse effects of industrial activities resulting from industrial pollutants, existence of a clear wastage of energy and water usage and adverse effects of the overlapping of some private sector industrial factories with residential neighbourhoods.
- The investment performance of the public sector companies is weak, particularly regarding establishment of new companies, which is a result of focusing the attention -in directing the governmental financial allocations

in the annual investment approaches- on operations of the existing governmental projects and addressing its failures.

- Extension of weak investment performance to the private sector, especially the small and medium industrial project. The -direct foreign investments- also have no great importance in the Iraqi industry in the current time due to lack of industrial units wholly owned by foreigners (except for those in Kurdistan region). The foreign presence is limited in the form of partial ownership of shares of some private and mixed companies (Industrial strategy in Iraq until 2030 and implementation mechanisms, July 2013).

Iraq has serious weaknesses in the infrastructure supporting the industry, as follows:

- Lack of sufficient number of industrial cities and areas where there are infrastructures, conditions and requirements for establishing various industries; have contributed in the difficulty of starting a business.
- Severe deterioration in all transport and communications facilities (land, sea, rivers, and air).
- A significant shortfall in the production and provision of electric power and natural gas for industrial purposes, with sudden interruptions and complete power cut.
- Weak knowledge infrastructure, including communication and information technology networks, as well as the infrastructure of standards and quality.
- Control of the central government on the industrial system through ownership of industrial entities and managing them. Thus, contrasting the governance principles that require separation of ownership and management.
- The role of local governments in developing and implementing their own development strategies is not enabled, although this role is specified in the Constitution.
- Weak efforts to support the private sector and enable it become a key partner in the economic development through clear programs and with a high degree of efficiency.

The industrial sector in Iraq has a real chance to be one of the pillars of Iraq's non-oil economy. Iraq aims in the long term to achieve a sophisticated and diversified economy which depends on advanced technologies and has value-added industries, as well as to provide high standard of living. Therefore, the Ministry of Industry seeks to be the engine of industrial reform.

It has exerted great efforts for the implementation of the re-structuring plan to move away from its traditional role; being centrally responsible for the state-owned institutions, and to be responsible for developing and promoting the industrial sector and the organizer of the private sector.

The National Development plan has paid attention to increase Industry's contribution in GDP through rehabilitation of production lines of companies with economic feasibility to enable them rise the energies, focus on competitive potential of industries at both levels, regional and international, also to increase their productivity, marketing and make it attractive for investment. Sales of the Ministry of Industry and Minerals increased in 2011 by 12.5% more than of 2009. The role of private sector strengthened in manufacturing industry through granting establishment licenses and promoting contribution in manufacturing industry. The last five-year plan paid a great attention to the role of private sector in development and to increasing its contribution to the GDP through promoting small and medium industries and partnerships with the public sector, by establishing 1,239 projects. The Ministry also began to re-operate the state-owned institutions and their formations, introduced investment to the industrial sector and formulated the national policy for industrial development led by the private sector (work actually started in 2004 and continued thereafter). Nevertheless, the contribution of the private sector is still less than the ambition for several reasons, including weak banking system and poor knowledge of the law for local products protection.

1.8.3 Strategy of the Ministry of Industry:

- The Ministry of Industry and Minerals started since 2008 implementing two parallel programs for technical rehabilitation, as follows:
  - First Program: Rehabilitation of 196 factories out of 264 factories managed with the supervision of the Ministry of Industry and Minerals and by direct funding from the federal budget.
  - Second Program: An agreement to participate in production with investors to rehabilitate and manage public sector companies for a limited period.

The key strategic objectives in the industrial sector until 2030:

In light of the vision, a set of key strategic objectives were identified to be achieved by 2030, as follows:

- Increase the annual growth rate of the industrial added value to (10%).

- Increase the proportion of manufacturing industry contribution in the composition of GDP to (18%).
- Increase the proportion of employment in the industrial system.
- Increase the investment proportion in the industrial system compared with total investment.
- Increase the proportion of industrial exports in the total industrial production.
- Increase the proportion of contribution of the private industrial sector in the manufacturing industry.
- Building five new industrial cities and continue the implementation of the major city of Khor Al-Zubair for energy-intensive industries by 2017, to be seven cities by 2022 with building an industrial city in each governorate. In addition to three technological cities and completion of the industrial city of Khor Al-Zubair by 2013.
- Establish a simple transparent monitoring system by 2017; develop it to be more elaborated by 2022 and up to an integrated efficient governance system at all levels. As well as an integrated control and evaluating system with the participation of stakeholders and appliance of decentralization by 2030 (Industrial Strategy in Iraq until 2030 and implementation mechanisms-July 2013).

1.9 Water Sector

Agriculture in all areas of the Iraqi sedimentary depends on irrigation and due to the arid climate and lack of rain in Iraq, this leads naturally to continue relying on surface water sources primarily to meet these requirements, in addition to the requirements of other different sectors. It should be noted that these sources are limited, with instable quantity as it is greatly affected by natural conditions in recent years; whether inside Iraq or outside in upstream countries. In addition to the water policies followed in these countries by setting up irrigation projects, particularly dams and reservoirs, not to mention the constant increase of population.

1.9.1 Water Resources:

Water resources in Iraq currently include:

I- Surface Water:

Surface water is considered the major water resources in Iraq. It consists of waters of Tigris and Euphrates Rivers, their tributaries and Shatt Al-Arab. The quantity of surface water before the construction of dams in the upper Mesopotamia was changing from season to another during the year. It increased during spring (rain or flood season) and decreased during summer and autumn (dry season). The quantity varies from year to another depending on the variation of rain and snow from sources.

Feeding basins of these rivers are located inside and outside Iraq (Turkey, Syria, Iran and some areas in Saudi Arabia). The term river basin of Tigris and Euphrates Rivers is called on all land that descends its water to these rivers. Figure (1-11) shows the map of river basins of Tigris and Euphrates inside and outside Iraq.

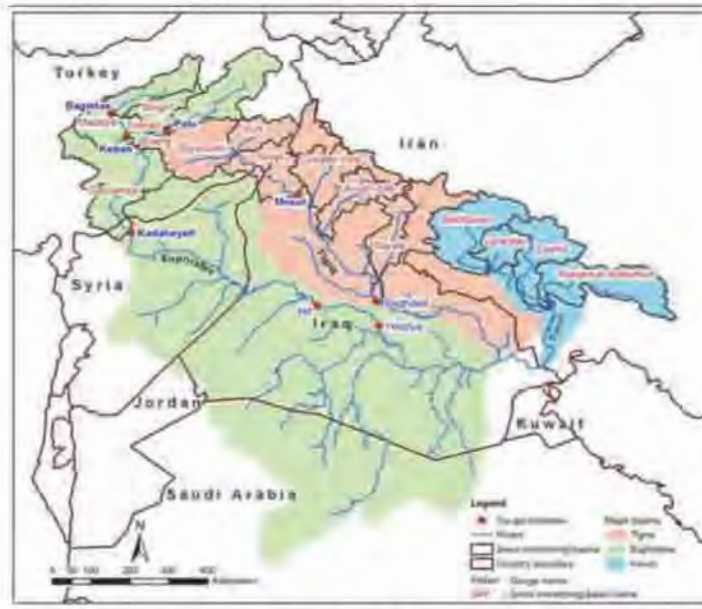


Figure (1-11): River basins of Tigris and Euphrates inside and outside Iraq

The following are characteristics of Tigris and Euphrates rivers, their river basins and track of flow in the passing areas.

- **Tigris River**: 1,900 km long with headwaters in southeast of Turkey from the heights of Kolgk lake, between Van lake in the east and Hazar lake in the west. It consists of three main tributaries; Tigris, Batman and Bhutan, they all meet before the city of Also in Turkey to make the main Tigris River. The length of Tigris River inside the Turkish territory is about 445 km, 40 km inside the Syrian territory and then enters the Iraqi territory north of Fishkhabour. As for its length inside Iraq, it is up to 1,415 km till Al-Qurnah. The total area of the river basin of Tigris is 235,000 km^2; about 17% of it is inside Turkey.

- **Tributaries of Tigris River**: There are many tributaries of the Tigris River; the most important are Khabur and great Zab originating from Turkey, little Zab and Diyala from Iran and Al-Edhaim inside Iraqi territory. Table (1-10) shows the value of annual water resources rate for Tigris River and its tributaries for the periods of (1932-1998) and (1999-2011). It is noted in this table the impact on the imports of these tributaries due to establishment of agricultural irrigation projects and to the climate changes in the headwaters of these tributaries in both Turkey and Iran.

Table (1-10): Annual water resources rate (billion m^3) for Tigris River and its branches for the periods of (1932-1998) and (1999-2011)

Period	Great Zab River	Little Zab River	Diyala River	Tigris River Mosul	Comments (Tigris River)	(Total) Tigris River
1932-1998	14	7,22	5,88	21,2	Natural Revenue	48,5
1999-2011	11	4,24	2,96	14,9	Development of irrigation facilities & climate changes	33,19

- **Euphrates River**: Headwaters of Euphrates River are located on the high plateau of Armenian mountains and the eastern Anatolia in Turkey between Van Lake from the east and the Black Sea to the north. The main Euphrates River consists of two main tributaries; Furat Su and Murat Su. Length of Euphrates River inside Turkey is 1,230 km with a large number of tributaries and valleys before it enters Syrian territory with a length of 710 km and three tributaries; Sajur, Balikh and Khabur. Then it enters the Iraqi territory in Al-Qa'im. Its length inside Iraqi territory is 1,160 km to Al-Qurnah. Total area of North Qurnah river basin is 444,000 km^2, 177,600 km^2 of it inside Iraq; about 40% of the total basin area. While 75,480 km^2 is inside Syria, 124,320 km^2 is inside Turkey and 15% of the rest of the basin is inside the territory of Saudi Arabia.

Table (1-11) shows the rate of annual resources (billion m^3) of Euphrates River waters at Al-Qa'im area.

Table (1-11): Rate of annual resources (billion m^3) of Euphrates river waters at Al-Qa'im area

Period (year)	Average annual flow (billion m^3)	Comments
1932-1973	30	**Before building dams in Turkey and Syria**
1974-1989	23,5	**Before building Atatürk dam in Turkey**
1990-1999	19	**After filling lake of Atatürk dam**
2000-2011	15,2	**Due to development of irrigation facilities in Turkey or Syria and climate changes**

The neighboring countries have since several years established a number of dams on the riverbeds of the Tigris and Euphrates Rivers and their tributaries. This would threaten to drop water amounts received by Iraq and lead to the drought of large areas of the agricultural land extended along the banks of the rivers, especially the Tigris River. This will greatly and badly affect the economy and lead to the loss of many farmers' lands. It will also cause expensive financial losses as a result of Iraq's dependence on foreign agricultural corps imports. Other developmental losses are represented in the increasing unemployment rates after the cessation of work in many agricultural projects, as well as the increased poverty rates which are closely related to the establishment of projects, particularly agricultural and industrial ones. The above mentioned issues are expected to cause the drought of the marshlands in Iraq, particularly Al-Chibayish and Huweizah marshes. It will also lead to the waste of efforts and money which were depleted for the reconstruction of these unique areas of wild habitats and neighbourhoods and its cultural and natural standards following the announcement of this area as a wildlife sanctuary in Iraq. Causing any damage in this area would be a violation of the regulations of safeguarding the global nature; it's one of the vulnerable areas surrounded by the governmental and international care since years ago. In addition to the impact on the fishing activity in the Tigris River basin, especially in the marshlands, this is considered a transit station for marine fish which take the river places for their proliferation and migration to the Arabian Gulf. As well as its effect on the economic situation of the population who practice the profession of fishing and depend on it to meet their needs. Thus, there is a need to sign agreements with neighboring countries (Turkey, Syria and Iran) on joint water to determine the incoming water portion to Iraq; in quantity and quality to be convenient with principles

of sharing and equity, meet the current and future requirements and establish joint water projects (National Strategy for the protection of the environment of Iraq and the executive work plan for 2013-2017).

- **Shatt Al-Arab**: Originates from the confluence of the Tigris and Euphrates Rivers in Al-Qurnah with a length of about 180 km. There are increasing sediments of the Tigris and Euphrates that require constant removal to open the navigation road. Water levels, due to the contact of Shatt Al-Arab with the Arabian Gulf, have been affected by the tides which occur twice a day. The tides facilitate entry of small and medium cargo ships from the Arabian Gulf to Shatt Al-Arab and Basra port, as well as irrigating the dense orchards along the sides of Shatt Al-Arab. One of its main tributaries is the Karun River flowing from Iran. Al-Karkhah River, with its largest basin part in Iran, flows in Huweizah marsh within the Iranian borders; connected to the same marsh within the Iraqi borders and some of its water goes to Tigris River through Al-Sweib River. Iraq's water imports have been adversely and significantly affected. Water quality in Shatt Al-Arab has also deteriorated due to the significant increase of establishing irrigation and storage projects on Karun River in Iran. Also because of building large irrigation projects on Al-Karkhah River and the continued impact of natural conditions of climate change on these two basins.

II- Groundwater:

The annual renewable groundwater amounts to (4 billion m^3), with an increase or decrease depending on rainfall amounts. It represents about 7.44% of the total water resources in Iraq. Lack of rain and drought negatively and significantly affect the situation of groundwater feeding, as most of the main and secondary basins are fed by rainwater. The proportion of Al-Edhaim basin feeding, as an example, has decreased during the last thirty years up to 21% with the dryness of some springs in several parts of Iraq. In addition, many areas have witnessed lack or reduction of groundwater level due to heavy usage and lack of clear policy for the usage of this water, as well as not activating the national legislations for its use.

Current estimates do not cover all the area of Iraq, but only three distinguished hydro geological areas; mountainous area, desert area and at the feet of mountains (or north of the sedimentary plain). The groundwater of the sedimentary plain is often considered unusable due to high salinity; even the renewed water is quickly mixed and acquires its salty qualities. The promising investable water ranges in the above mentioned areas to 58 ranges, most of them are in the desert area and characterized by being stored water

with weak regeneration. Groundwater is currently exposed to unsustainable use by pulling water from the upper aquifers, leading to the reduction of groundwater level in some basins and deterioration of water quality in others.

III- Water from Other Sources

A- Water of General Downstream:

The general downstream water is mainly the relapsing water from agricultural projects between Tigris and Euphrates Rivers. About 1.2 billion m^3 of it comes out to marshes in poor quality for agricultural crops with salinity of more than 3,000 parts per million. Salinity of the downstream ranged in 2004 between 2,230 mg/liter in Baghdad governorate-Abu Ghraib to 2,900 mg/liter in ThiQar governorate, with a continuation of gradual increase in some areas of Baghdad, Babel, Diwaniya and Nasiriya governorates.

The annual salinity rate of the general downstream water increased during 2009 in areas of Abu Ghraib to 4,000 mg/liter, Mahmudiya to 3,800 mg/liter, Al-Fajir area to 7,684 mg/liter and Nasiriya to 5,400 mg/liter. The annual rates of downstream water salinity during years 2010-2012 ranged between 3,300 and 3,800 mg/liter in locations of Abu Ghraib to Mahmudiya, while these rates ranged in locations of Al-Numaniya-Al-Shomali 4,300-4,650 mg/liter. These rates witnessed a clear increase in Al-Fajir and Al-Budair areas more than in Nasiriya area -except for the last two years- and other areas where the rate ranged 5,350-5,400 in the last three years, while the rate and salinity of general downstream water of Nasiriya during this period ranged 4,500-6,900 mg/liter.

The high amounts of salinity in the general downstream water, especially near Basra; do not represent the actual salinity of that water, perhaps it belongs to the tidewater or to the sever salinized groundwater it is near the sea level in some areas. Scarcity of water imports in major rivers also has impact on the high salinity in rivers. General downstream water mainly represents the relapsing water from agricultural land. It is used to feed marshes and by the Ministry of Oil in oil extraction facilities. There are currently few desalination stations used by some departments of the Ministry of Agriculture.

B- Treated Wastewater:

The amount of wastewater increases with the population increase in spite of its relatively large quantity. The amount of treated wastewater in recent years was 580 million m^3. Its usage as a source of water is still in its early

stages, as it was used in Baghdad and some governorates in very limited irrigation of some green belts areas. This water could provide room for expansion of using it for specific purposes in the future, particularly for agricultural purposes after developing the necessary plans for sustainable use in various areas within the strategic study of water resources and land and the rehabilitation of a number of treatment projects in different governorates of Iraq.

1.9.2 Water Quality:

The quality of incoming water to Iraq from Tigris River near the Syrian borders is considered a good one, as the salinity of Tigris River at Fishkhabour village is 220-398 mg/liter in 2012. The water quality deteriorates with the flow of the downstream with the presence of flows of pollution from major urban areas, like Baghdad, due to the poor infrastructure of wastewater treatment. The Euphrates River water entering Iraq is considered of lower quality than that of the Tigris and is currently affected by the relapsing wastewater from irrigation and sanitation projects in Turkey and Syria. Amount of salinity of Euphrates river water at Husaiba city on the Iraqi-Syrian borders in 2012 was 432-898 mg/liter. The low quality of this water is expected to be worse in case of increased use of land within the irrigation agriculture in these countries.

Water is stored in the Tharthar Lake in floods season in Iraq, this lake is fed from Tigris River, and thus salts are absorbed in the lake through stored water. This storage of saline water in the lake is transferred to the water of rivers water leading to increased salinization of water of major rivers.

The following actions were taken to improve the quality of water in Iraq:

- Linking the sub-drainage stations with the general downstream project and clear the water of agricultural drainage saltwater.
- Establish East Furat drainage station to collect the drainage water from east of Euphrates River and deliver it to the general downstream.
- Implementation of a project for monitoring water quality and pollution areas inside Iraq through a monitoring network is going on. Sources of pollution will be identified through it as well, and thus there will be easy treatment of water quality and sources of pollution.

1.10 Agricultural Sector

The agricultural sector is one of the most water consuming sectors in Iraq (about 25 billion cubic meters/ year) with a percentage of water consumption of 85-90%. The irrigation water quantity have increased more than the necessary water rations due to use of open and old irrigation canals, poor management of water resources in the field of infrastructure, use of old irrigation techniques (surface irrigation for some crops like rice) and traditional patterns of agriculture, thus resulting in high levels of groundwater, water logging and soil salinization.

1.10.1 Plant Production:

I- Agricultural Land:

There are large arable areas available in Iraq with a total gross irrigated and rain-fed area of (44.46) million donum. The total area available for irrigation is (22.86) million donum. Naturally covering those areas with irrigation networks depends on the availability of water, particularly when there are wide plans for the use of water from the upstream countries, in light of the ongoing inequitable use by riparian countries of the shared basins of rivers.

Area of irrigated land amounts to 13.24 million donum and represents 58% of the total viable land for irrigation, which is a low rate because Food and Agriculture Organization has estimated the percentage of irrigated agricultural land in the Middle East and North Africa at the average of 62%. A large section of land has been affected by the problem of salinization and water logging with groundwater, especially in the central and southern areas due to poor operation and maintenance and lack of integrated drainage networks.

Field corps cultivation occupies a large area of agricultural land, about 10 million donum, 41% of it in Ninewa governorate. As for the area cultivated with vegetables and potatoes, it amounted to 2.5 million donum. Statistics indicate the decline of palm trees area and thus decreasing the number of palm from 32 million trees in 1960 to 16.2 million trees in 1989 and about 10 million trees in 2007 with a total production of 431 thousand tons. This places Iraq in less regional and global rank in terms of palm tree number, after it was globally ranked the first a few decades ago (Annual Statistics Reports of the Ministry of Agriculture).

II- Production and Crop Yield:

The natural factors are still a key influence in determining the levels of production and yield of major crops in Iraq. The indicators of production and yield of field corps are characterized by a large fluctuation according to years. The total production of wheat reached in 2002 up to 2.6 million tons, about 392 kg productivity per each donum, while the total production of wheat was in 1997 less than 1 million tones, about 172 kg productivity per each donum.

As for barley, it recorded in 1990 the higher production and productivity by 1.8 million tons, 232 kg per each donum, while rice recorded the higher production and productivity in 2007 by 400,000 tons and 790 kg/donum. The production and productivity of field crops and other corps varies according to years with clear contrast in productivity by governorates according to climate, soil, water resources and human cadre capacities (Annual Statistics Report of the Ministry of Agriculture and Ministry of Planning).

Najaf and Qadisiyah governorates were recorded at the first rank in the productivity of wheat in 2007 at a rate of 666 and 645kg/donum respectively due to the provision of water depending on irrigation projects. The lowest rate of wheat productivity was in Ninewa governorate by 169 kg/donum due to rain disruption and the dry land as more than 90% of the cultivated land in the governorate depends on rain-fed irrigation. Qadisiyah and Wassit governorates came in the first place in barley crop productivity by 450 and 325 kg/donum, respectively. Both governorates depend on surface irrigation for cultivating this crop. Governorates of Ninewa and Salah Din were in very low ranks with a productivity of 100kg/donum. As for rice crop and due to its large water requirements for the germination process, governorates of Najaf and Qadisiyah came in the first place in terms of cultivated area. Muthana and Babel governorates were of the less cultivated area. Najaf was the first in productivity, followed by Babel and Diyala, while Muthana and Wassit recorded the lower levels of rice productivity.

Production of dates has suffered a significant deterioration in indicators of the area of palm groves and productivity, as a result of water scarcity and successive wars, particularly those which took place in Basra governorate. Basra was the first in terms of palm trees' numbers and productivity in previous decades until the 1970s. There was a spatially change in the relative importance of distribution of number of palm trees and productivity at a number of governorates and a decline of the role of Basra governorate in this regard. Governorates of Salah Din and Wassit were in first place of palm trees productivity in 2007 at 75 kg and 74 kg/palm, respectively. Other governorates such as Najaf, Missan, Karbala and Diyala were in last ranks with productivity of 44-48.5 kg/palm.

As for orchards, fruit is considered an important food item for population, but the local production does not meet the market requirements. The demand for fruits is increased with the improved living conditions of people; therefore, the demand requires increasing imports which will cost a lot of money. The demand could be fulfilled locally if the productivity is improved.

The high cost of capital for establishing orchards and the long period of time between establishment and fruiting, in addition to the flow of imported fruits in relatively low prices have all led to the weak competition of local fruits with the imported ones from one hand, and with other crops that are characterized by limited production cycle on the other hand. The recent years have witnessed a significant drop in the amount of productivity due to the spread of diseases and epidemics of trees, such as the whitefly on citrus trees. As well as low use of pesticides and fertilizers, weakness of introducing modern technologies in orchards services and lack of high productive assets which suits the local conditions and security. All were negatively reflected on the productivity rate and consequently had to resort to imports for replenishment.

As for summer fruits, number of fruitful trees with grape representing the greatest percentage of them, was in 2004 on the country level (17.2) million trees with a productivity rate at the country level of (23.5) kg/tree. In 2007 this number of fruitful trees was increased at the country level to (18.4) million trees with a productivity rate at the country level of (20.1) kg/tree. While the winter fruits with orange representing the greatest percentage of them, the number was in 2004 on the country level (8.1) million trees with a productivity rate at the country level of (13) kg/tree. Governorates of Salah Din and Baghdad came first in 2007 with increased number of fruitful trees to (8.5) million trees at the country level and a decline in productivity rate to (10.2) kg/tree. (Annual Statistics Abstract of – Agricultural Statistics- Ministry of Planning-Part three)

1.10.2 Livestock/Animal Production

I- Livestock:

A- **Cattle**: Iraq possesses many animal species, but the most important and largest in number are (sheep, cows, goats, buffalos and camels) due to their provision of meat and milk to people, usually rich in protein. In addition to leather and wool for industry.

Results of livestock census of 2001 indicate that the numbers of cattle at the country level were: (6,009,139) sheep, (1,232,147) cows, (736,198) goats and (117,778) buffaloes. While numbers in the last census of 2008 were: (7,722,375) sheep, (2,552,113) cows, (1,474,845) goats, (285,537) buffalos

and (58,293) camels. The livestock have been affected and the result of diseases; like the foot-and-mouth disease, dropped. In addition to the decrease of fodder production, lack of natural pastures and the decreased productivity of livestock meat; for example from 125,000 tons in 2002 to 42,000 tons in 2007 (Report of National Survey of Livestock of Ministry of Agriculture and Ministry of Planning).

Livestock has been affected by the war conditions experienced by the country and infection of diseases, such as the foot-and-mouth disease, as well as, the lack of pastures and weak veterinary services. All the mentioned factors led to the loss of a number of animals and affected the whole herd. The existence of such a basic herd of that size reflects the potential of doubling it, particularly in governorates where basic requirements; such as pastures, factories and stores of fodder and experienced breeders, are available. The importance of raising the awareness of breeders is highlighted, regarding most important and modern methods used in breeding, while preserving the available natural resources.

B- **Fish**: The production of fisheries decreased from (36,935) tons in 1997 to (25,998) tons in 2001 due to drying of marshes and low water levels (which 40% of it was re-immersed in water since 2003, with a sharp decline of the immersion proportion in the current situation). Iraq's production of fisheries (fish farms, rivers and fishing) in 2003 was about (50,000) tons only. Main types of Iraqi fish has disappeared from the markets as a result of wrong practices used by some fishermen, like using poisons and explosives to kill large numbers of fish, lack of fishermen commitment to instructions of fishing prevention during the breeding season, lack of fodder and medicines, and weak follow-up. Reports of Food and Agriculture Organization indicate the continuous decline of the total energy of fish production in freshwater around (13.6) and (12.3) thousand tons between 2000 and 2004, respectively (Annual Statistics Abstract of – Agricultural Statistics- Ministry of Planning-Part three).

The usual carps form the largest part of the fish content of the bodies of inland waters in Iraq, followed by Hippuri, Cyprinidae, Barbus/Shabut, Red fish, Shillk, Baz, and Cat-fish/Silurustriostegus. There also other non-economic fish, which are largely available in bodies and coasts of interior rivers, such as Liza Abu and Allsaf. As for the marine species, they are Grouper/ Hammour, Spondyliosome/ Black-sea-bream, Mullet, Pampusargenteus/Pomfrete, some Crustaceans and Shrimp.

Food and Agriculture Organization report of 2003 confirms that number of fish farms in Iraq was 1,787, while the number of fish farms in northern Iraq was 178 farms and in central and southern Iraq 1,609 farms. The main type of breeding fish is the common carp, followed by grass carp and silver carp.

Fish hatcheries in Iraq are distributed as follows:

1- Central Al-Suaira fish hatchery, buildings and facilities of this project were fully destroyed after the events of 2003.

2- Erbil and Sulaymaniyah fish hatcheries, each contains 80 incubators. The production capacity for both hatcheries is about 15 million larvae.

3- Private hatcheries with a total number of 24 hatcheries until 2003. They contain 749 incubators with a production capacity of 129 million larvae.

Production: Livestock production is considered the main and supplementary part of the food basket, particularly in insuring protein. It is also an important source of raw materials in many industries.

The livestock production in Iraq did not improve to be consistent with the nutritional requirements of people, mainly represented by high rates of population growth, rising income levels and standard of living in Iraq in the recent years. Red meat has not achieved any marked improvement since the beginning of this decade, as its annual production ranged about (135-140) thousand tons annually. Poultry meat production was also decreased from about 125,000 tons in 2002 to about 42,000 tons in 2007, due to high production costs, especially of fodder. As well as the inability to compete; as markets were dumped by cheap products, also the loss of important episodes of the production process such as asset fields in Samarra. In addition to reluctance of investors to operate their fields because of the absence of studied support for this industry and for table egg production too, this is currently about (604) million egg.

There was a noticeable increase in fish meat production from about (40,000) tons in 2002 to about (58,000) tons in 2007 due to establishing unlicensed lakes and containers for breeding fish. Nevertheless, there was a clear decline in the production of the single donum of fish in the internal water bodies not exceeding (4) kg/donum, compared with some countries of (50) kg/donum productivity in this field. The global average rate is (35) kg/donum and productivity rate in breeding containers is about (500) kg/donum (Annual Statistics Abstract of – Agricultural Statistics- Ministry of Planning-Part three).

1.11 Waste Sector

1.11.1 Solid Waste:

Iraq has gone through difficult economic conditions and experienced recurrent wars during the past period resulting in the negligence of solid

waste management and no attempt for improvement it, despite its direct impact on human health and environment. Health and environment problems related to solid waste management were worsened as a result of the enormous population growth and urban communities increase, accompanied by increased human activity in the industrial, agricultural, service and other fields that generate all kinds of waste.

The amount of 2,242 kg/day of waste from domestic, industrial, health, oil and commercial activities is generated in Iraq, according to the (first) Report of environmental situation in Iraq issued beginning of 2014. The organic wastes constitute 55-60% of the municipal waste, while the average waste generation rate of the Iraqi individual is (0.75-1.1) kg/day. The existing traditional systems for waste management are not capable to meet the community needs after the population growth, change of the consumption patterns, high living standard and income per capita. The collected waste does not exceed, in its best conditions, the amount of 40% of the generated waste quantities.

I- **Types of Solid Waste**: There are many classifications regarding solid waste, including dividing them into biodegradable and non-biodegradable waste, combustible and non-combustible waste, and hazardous and non-hazardous solid waste.

II- **Recycling Stations**: Most of the governorates, except for Baghdad, lack systematic recycling stations to receive the generated waste quantities, thus large quantities of waste have accumulated in streets and public roads causing various health and environmental damages. In addition, most of the present recycling stations are open areas for collecting waste.

III- **Landfill**: They are lowlands where waste is thrown, then covered with soil and sometimes leveled; most of them are left after being filled without any follow-up. Most of these locations are not considered systematic landfills (except for the ones in Kirkuk, ThiQar and Missan), but as waste dumps due to lack of the systematic, environmental and engineering conditions specified for landfill locations. In addition to the on-site burning that causes serious environmental damages.

IV- **Challenges Facing the Waste Sector**: There are many challenges facing the waste sector and they could be summarized as follows:

a- Laws, regulations and instructions regarding integrated management of all types of solid waste are limited.

b- Lack of public awareness among various segments of the society.

c- Lack of advance planning for solid waste management.

d- Limited specialized mechanisms.

e- Lack of sufficient recycling stations to absorb the generated waste quantities.

f- Absence of systematic landfill locations.

g- Lack of systems for sorting waste and adoption of the principle of reducing waste through recycling.

h- Spread of waste abusers.

i- Burning the waste.

j- Lack of resources management and optimal utilization.

k- Limited studies regarding waste management, in general.

Table (1-12) shows preliminary information on waste management and figure (1-12) shows lifted quantities of waste from each governorate, except for Kurdistan region, according to the Statistics of the Ministry of Planning of 2012.

Table (1-12): Preliminary information on waste management in Iraq

Preliminary information	Estimate
Quantity of lifted waste for 2012	11,633,621 tons
Number of population served by the process of collecting waste	11-12 million
Number of served (urban) population	11-11,5 million
Number of served (rural) population	400,000-500,000
Number of distributed waste containers	500,000-550,000 containers
Number of unsystematic landfill locations	222 locations
Number of model landfill locations	2 locations
Number of model middle stations for collecting	21 stations
Number of temporary and non-typical waste collecting stations	59 locations
Solid waste recycling factories	2 factories
Average rate of individual's waste generation	1 kg/day
Daily quantity of generated domestic waste	13,000 ton/day
Daily commercial generated waste (20% of the	2,600 ton/day
Daily industrial generated waste (10% of the	1,300 ton/day
Number of municipalities	249 municipalities

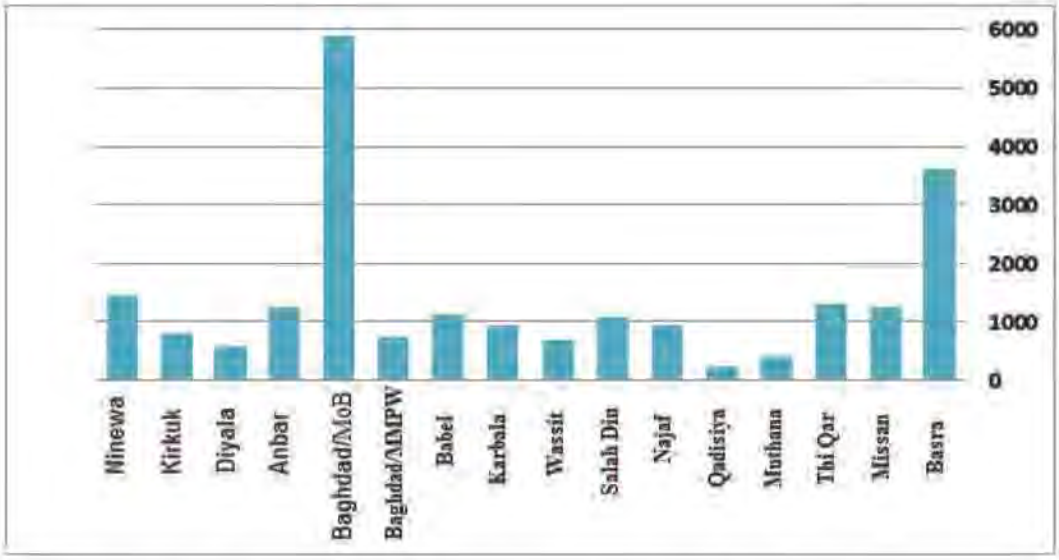


Figure (1-12): Lifted quantities of waste in (ton/day) from each governorate, according to the Environmental Statistics report in 2011

1.11.2 Liquid Waste:

Wastewater consists of several solid and dissolved elements in water. Water represent 99.9% and the rest are pollutants including (stuck materials, organic biodegradable materials, disease-causing organisms, planet nutrients, nitrogen, phosphorus, potassium, organic materials resistant to degradation, heavy minerals and dissolved mineral salts). Wastewater in Iraq has high concentration of organic materials represented by the vital demand of oxygen, according to laboratory results. Wastewater is produced as a result of using clean water for domestic, industrial and general purposes. It is considered a threat to public health as they contain micro-organisms and disease-causing bacteria, in addition to its smell.

The Underdeveloped liquid waste management behind various life activities in general, is considered totally inefficient due to the suffering of the existing stations in Baghdad and other governorates from being old, lacking maintenance and inefficiency of treatment units on one hand. On the other hand, stations lack chemical treatment and shortage of capacity. Part of the heavy water is directly sent to the water resources without treatment because the quantity of the incoming water is larger than its designed capacity.

As a result of the above mentioned, rainwater networks are converted to unsystematic links which are also sent to the water resources without treatment. As well as, the existence of rifts in sewage networks transferring to stations, which leads to its mixture with the drinking water and negatively affects the public health.

Wastewater Treatment Units in Iraq:

The number of disposal stations of wastewater across Iraq is about 314 stations for disposal only, without treatment of wastewater, except for Baghdad city which has two giant stations for wastewater treatment. The first treatment project is of Karkh in Albuaitha area serving Karkh district and the other is of Rustumiya in Resafa district. There are also other rainwater disposal stations directly to the river without any treatment or even partial treatment. Average rate of disposal for the individual in Baghdad is up to 150 liter/person/day. Below are some details about the two mentioned stations. Table (1-13) shows wastewater treatment units in Baghdad and table (1-14) shows preliminary data of wastewater stations.

Table (1-13): Wastewater treatment units in Baghdad *

Project	Designed capacity m^3/day	Actual capacity * m^3/day
Wastewater treatment project of South Rustumiya	175,000	225,000
Wastewater treatment project of North Rustumiya	300,000	450,000
Wastewater treatment project of Karkh	205,000	525,000

* Actual capacity represents quantity of wastewater arriving to the project and directly sent to the river without treatment through the main channel as a surplus drainage.

Table (1-14): Preliminary data of wastewater stations

Description	South Rustumiya	North Rustumiya	Karkh
Number of served population (person)	1,500,000	1,500,000	**1,800,000**
Standard disposal for each person (liter/day)	114	200	**114**
Designed capacity (m^3/day)	175,000	300,000	**205,200**
Biochemical Oxygen Demand-BOD (mg/liter)	40>	40>	**40>**
Suspended Solids (mg/liter)	**60>**	**60>**	**60>**

1.12 Transport Sector

Iraq occupies a strategic geographical location in the Middle East, south-west of the Asian continent. Transportation in Iraq includes rail lines of more than 2,000 km length, high ways, waterways, pipelines, ports, harbors, airlines and airports. Ministry of Transport is in charge of all these activities, except for the pipelines. The Arabian Gulf is the sea port of Iraq to the World with a sea coast of about 58 km for Iraq, in addition to the passage of Rivers of Tigris and Euphrates from the north to the south of the country.

The General Company for Maritime Transport, one of the Ministry of Transport formations, manages the ports of Iraq. This Company was founded in 1952 and contributed in transporting imports and exports and supporting the foreign trade of Iraq with a naval fleet composed of different 26 ships and a river fleet working between Basra and Baghdad. As a result of blockade and war conditions witnessed by the country, the qualitative activity of the Company was stopped and resumed through building four new ships which started working during 2012-2014. The first ship carried 7,850 tons and the other three ships carried 17,500 tons of multi-purpose. These ships entered service at the beginning of 2014; its transportation capacity for (2012-2013) was about 260,000 tons. In addition to building a barge for water transportation of about 2,500 tons capacity and a barge for fuel transportation of 500 tons capacity. Iraq has currently four commercial ports and two platforms for oil export. Platforms of commercial ports currently amount to 48 with an annual capacity of 17.5 million tons; the actual operating ones are 43 with an annual capacity of 15.90 million tons. With regard to the river transport, in 2012 the project of passenger transport in the Tigris River was included in the investment plan of the Company to operate the river taxi. The project was started with a contract to build 30 boats; 10 are

completed, and announcement for building river stations for the project. This project is expected to contribute in activating river tourism and alleviate traffic congestion (Annual Report of the Ministry of Transport-General Company for Maritime Transport, 2014).

Length of the Iraqi railways in 2012 was of 2,370 km; 1,922 km of it were trunk lines and 448km sub-lines. Number of operating locomotives was 106 out of 414 locomotives, 45 operating transport locomotives out of 145 locomotive, 255 passengers' wagons out of 307 and 529 trucks for transporting goods out of 9.315. Number of passengers during 2012 was 702,000 with transported goods weighted 850,000 tons. (Railways Activity Statistics for 2012-Ministry of Planning, National Statistical Organization)

The Iraqi Airways, with regard to management of the civil aviation sector, is in charge of transporting passengers and goods by air through its fleet of airplanes using the airports (Baghdad International Airport, Basra International Airport, Mousel Airport, Erbil International Airport, Sulaymaniyah Airport and Najaf Airport). In 2014 the Iraqi Airlines owned modern airplanes of Boeing B737-800 (models of 2013 and 2014) and a modern airplane of Boeing B777-200 (model of 2013). The Iraqi government, as part of its plan to update the operating fleet of high-efficiency airplanes in fuel consumption, has bought in the few past years six Canadian Bombardier airplanes (CRJ-900), six French Airbus airplanes (model A320/321), one (A330) airplane, two (B747-400) airplanes and two (B767-300). All the aforementioned airplanes are run by the Iraqi Airways in internal and international flights to different parts of the world, within the latest systems for air operations management used internationally, including the Air traffic system to reduce the vertical separation between aircraft (called RVSM-Reduced vertical separation minima), in addition to shortening the paths of air corridors for aviation. Number of flights cross Iraqi airspace was about 500 flights daily (about 15,000 monthly) and the number is expected to increase in the future. New measures in fields of navigation and air traffic have contributed in reducing the time spent in trips and reduced the consumed fuel, thus reducing emissions of carbon dioxide. As well as the existence of other four Iraqi airlines operating in Iraq as a national carrier supported by the Iraqi Civil Aviation and they own another nine Iraqi airplanes (Report of the Ministry of Transport-Iraqi Airways, 2014).

Total number of international and local flights landing at all Iraqi airports for 2012 was 15.144flights and the departing was 15.218flights, while the total number of arriving and departing passengers was 2.261.000 passengers. The total carried weight of goods and postal materials was about 5.814.000 kg (Aviation transport Activity Statistics for the years 2011, 2012-Ministry of Planning, National Statistical Organization).

During the past three decades Iraq has witnessed a significant increase in the traffic volume, as the total registered vehicles of the private sector in Iraq (permanent, temporary check and new plates) in2012(3,830,187) cars as of 31/12/2012, including governorates of Kurdistan region. The increase was 9.4% more than 2011, as the total number of private sector vehicles then was (3,501,380) cars. The percentage of the registered vehicles number for each 1,000 person of population was 112 vehicles, and the average number of these vehicles for each paved kilometer of roads was 64 vehicles. This confirms the clear and sudden increase of the number of vehicles with the absence of national controls and limitations for the import of vehicles, absence of limitations for roads and lack of regular checking of vehicles across all governorates of Iraq, except for the Kurdistan region which conducts an annual check with renewing vehicles' annual registeration card, including check of emissions.(Statistics of Private Sector Registered Vehicles in traffic directorate until December 31, 2013-Ministry of Planning, National Statistical Organization)

The impact of the heavy traffic is seen clearly inside governorates and major cities, especially in the capital Baghdad. The number of trips of vehicles crossing inside the center of the city has increased, while the country did not witness any projects of constructing roads, bridges or crossing corridors during the same period to keep pace with these changes of the increased traffic volume. The total length of highways accomplished in Baghdad was (90 km). A network of ring roads of (500 km) length surrounding Baghdad city was supposed to be achieved by 2000, consisting of four ring roads directly surrounding the center of the city, the longest would be the fourth road parallel to the external borders of the city, but this project was stumbled due to wars and the economic blockade imposed on the country during the last decades.

The vast majority of operating vehicles in Iraq are of more than two decades since the date of manufacturing, meaning engines of these vehicles have been consumed compared to standard specifications of suitability, in terms of durability, safety and efficiency of operation. Number of vehicles manufactured during 1990s composes a low percentage compared to vehicles manufactured in 1970s and 1980s, as shown in table (1-15). Table (1-16) indicates number of vehicles in Baghdad governorate of 2007 according to statistics of the General Directorate of Traffic.

Table (1-15): Number of vehicles and their models in Iraq until 2000

	Private sedan		Taxi/ public		Cargo truck	
Model	**Number**	**%**	**Number**	**%**	**Number**	**%**
1971-1980	151,427	32.2%	101,416	48.6%	139,247	54.3%
1981-1990	314,368	66.9%	106,114	50.9%	110,749	43.2%
1991-2000	4,193	0.9%	1,064	0.5%	6,605	2.5%
Total	**469,988**	**100%**	**208,594**	**100%**	**256,601**	**100%**

Source: the General Directorate of Traffic

Table (1-16): Statistics of vehicles registered in Baghdad city until 4/2/2007

Category	Number
Private car	**327,951**
Taxi	**79,677**
Cargo truck	**97,342**
Farm vehicle	**11,080**
Truck/for construction	**5,965**
Bicycles	**21,060**
Temporary check	**456,277**
TOTAL	**999,352**

Method of public transport within city centers in Iraq depends on a network of buses operating by gas oil or gasoline and it is the only available means, in addition to private sedan. No projects for other alternatives were submitted for the public transportation to contribute to solve the transportation problem and to reduce impact of emissions resulting of operating those vehicles and consumption of their engines due to their old manufacturing and lack of continuous maintenance procedures.

1.12.1 Impact of Exhaust Pollutants to the Ambient Air:

Relatively large amounts of air pollutants are emitted by transportation vehicles, such as unilateral carbon dioxide, sulfur oxides, nitrogen oxides, hydrocarbons, precision parts of lead and soot and other materials. These materials negatively affect the human health; particularly the functions of the nervous, respiratory and cardiovascular systems and some of them are also toxic and carcinogenic. Rates of these materials' emission are increased with the increase of vehicles numbers and it's out datedness, leading to the exacerbation of the air pollution problem and deterioration of its quality,

which has become an inherent problem for the modern pattern of life in large cities.

Ministry of Transport is currently initiating legislation for sustainable transport law consisting of a set of systems and procedures that lead to safely ensure the individual and society needs in consistency with public health, environment, economy and energy requirements. As well as to provide optimal usage options for means of transport and support the national development.

The objectives of the law are as follows:

a- Achieve the highest levels of safety and security for various means of transportation and needs of the individual and society. Also reducing the harmful effects on environment and public health.

b- Encourage investment in mass transport and support the private transport.

c- Develop the infrastructure of sustainable transport and improve its quality.

d- Follow-up concerned authorities in the implementation of programs and plans relating to sustainable transport.

e- Work to change the prevailing behaviour in society and promote using concepts of sustainable transport.

1.13 Biodiversity

The biodiversity is considered one of the important elements in life. Ecosystems are also an essential source of food and for sustaining life. There is a close link between biodiversity and the local population depending on ecosystem services.

Most important global factors that affect the biodiversity are rise of sea-level, increase in acidic oceans and rivers, high temperature on land and oceans and wet land. The fourth report of the Intergovernmental Panel on Climate Change (IPCC) indicated that the increase in average temperature of the earth (1.5-2.5 °C) will lead to the extinction of 25%-30% of the species. Temperatures are expected to increase (2-4 °C). Iraq is part of the world and has many natural areas that are sensitive and vulnerable to climate change and other effects and threats.

Studies of the Iraqi Meteorology indicated that local average of temperature has increased by (0.4 °C) during the last forty years and is expected to continue increasing in the coming decades. On the other hand, rainfall rates continue to decrease. Moreover, the synthesis report of IPCC issued in 2007 confirmed the early appearance of signs of spring in the ecosystems of earth. It also noted the transmission range of areas where

plants and animals live to the direction of poles and upside, in addition to their link to a very high degree of confidence with the phenomena of global warming. As well as, the abundance of algae and plankton in the marine systems, associated with changes in the ice cover and levels of oxygen (Fourth Assessment report of IPCC, 2007).

The importance of biodiversity in Iraq lies in the presence of migratory species, as Iraq represents an important part of their life cycle. This includes endemic or semi-endemic species, particularly in the unique Iraqi ecosystems, as well as endangered or threatened species. The red list of the International Union for Conservation of Nature (IUCN) has indicated the cases for preserving the Iraqi species. Furthermore, reports of the Iraqi Ministry of Environment and civil society organizations have also indicated the presence of about 417 species of birds; 182 of them are migratory species and 18 are causing concern in term of their durability. Furthermore, the same reports indicated the existence of 106 species of marine fish and freshwater fish and confirmed lack of information pertaining to insects, amphibians, reptiles and mammals. There are approximately 4,500 species of plants recorded in the (Flora of Iraq), with a secondary list of 195 kind of Iraqi endemic plants. The biodiversity in Iraq faces direct, indirect challenges and threats as a result of the steadily growing population, urban expansion, urbanization and the climate changes.

Biomes could be considered as main types of habitats. Eco-regions are more accurately known as "geographically distinct areas of land characterized by a distinctive climate, ecological features and unique planet and animal communities". On this basis, the following categories are considered the main habitats in Iraq, taking into account the presence of additional very small coastal marine patches of ecosystems on the Arabian Gulf: Marshes, Shrubs Deseret of Mesopotamia, Middle East steppe habitats, Zagros Mountains forests and marine and coastal habitats.

1.14 Health Conditions

Although some achievements were accomplished during the past few years in the field of health care, but the health sector is still facing many problems and challenges due to the exceptional conditions experienced by the Iraqi society. The health care system is still having a large deficit in funding which was reflected on the quality of provided services and the shortage of medical supplies. The Ministry of Health seeks to adopt a health system that depends on primary health care as a basic pillar, including provision of health services in accordance to international quality standards as the first level of services provided to the citizen, the second level of public hospitals under the

supervision of the Ministry of Health and the third level of specialized centers through applying family medicine system in the health centers and the health visitor system. This system focuses on introducing a package of basic health services in health centers. Tables (1-17) and (1-18) shows total and average number of public hospitals per 100,000 person, in addition to number of health care centers across Iraq, respectively (according to the annual report of the Iraqi Ministry of Health, 2012).

Table (1-17): Total and average number of public hospitals per 100,000 persons in governorates of Iraq, including Kurdistan region, 2012

Government hospitals			Private hospitals	Total number of hospitals	Population/ Government hospital	Government hospital for each 100,000 person
Teaching	Non-teaching	Total				
66	173	239	96	335	143,127	0.7

Population/ government hospital = number of population for each governorate / number of government hospitals in the governorate.

Table (1-18): Number of sectors and primary health care centers according to specialization and health departments in governorates of Iraq, including Kurdistan region, 2012

Number of sectors	Main centers	Sub-centers	Health houses	Mobile teams	Training centers	Family medicine centers	Dentists centers	Chest diseases centers	Total
128	1,174	1,364	316	77	26	99	39	19	**3,117**

Mortality rate of (2004-2012) according to the statistics of the Ministry of Health is shown in (Figure 1-13). Total number of births of (2001-2012) is shown in (Figure 1-14); while number of specialized centers providing tertiary health care services has reached 87 centers.

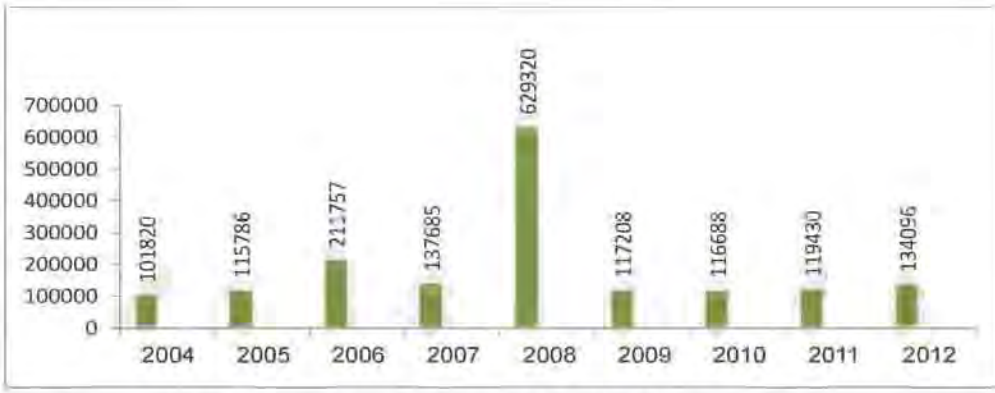


Figure (1-13): Total mortality of (2004-2012) for all age groups

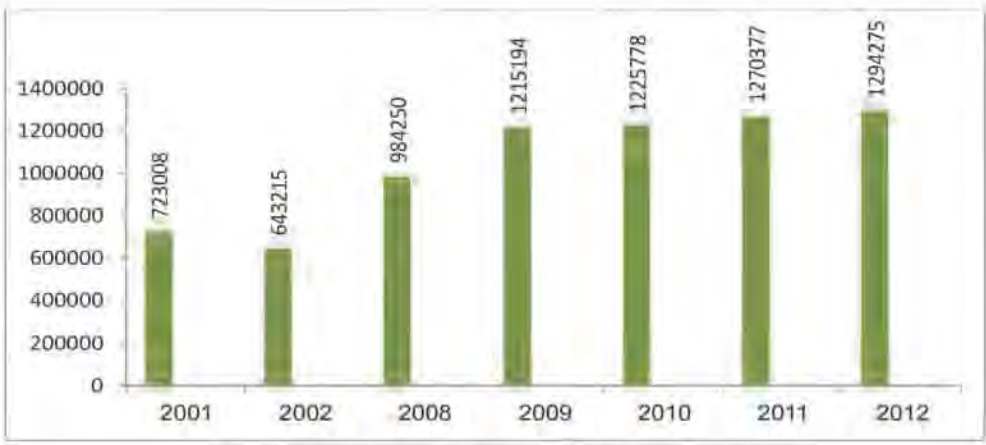


Figure (1-14): Total births of (2001-2012)

The health system in Iraq includes all preventative and curative institutions, including reproductive health centers, school clinics, fixed and mobile health centers, laboratories, medicine factories and others, of direct or indirect relation to the health of citizen. Total households in Iraq, according to 2012 statistics, reached 44,470 families, including Kurdistan region. Number of nursing staff in Iraq, including Kurdistan region and according to the annual statistics report of the Ministry of Health was 55,896 nurses, while the number of doctors across Iraq, including Kurdistan region and according to the same report, was 28,897 doctors.

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Greenhouse Gas Inventory

2. Greenhouse Gas Inventory

2.1 Introduction

The greenhouse gases (GHG) inventory project aims to assist Iraq and enable it prepare the necessary activities to submit the Initial National Communication (INC) to the Conference of Parties (COP), in accordance with the guidance of the United Nations Framework Convention on Climate Change (UNFCCC). This project will also assist to strengthen Iraq's capacity to fulfil its commitments to UNFCCC. It is expected that it will enhance public awareness and national knowledge on related issues of climate change in Iraq and taking the environmental considerations related to climate change into account in the national planning and policies.

The phase of greenhouse gases (GHGs) inventory for 1997 is considered one of the key components of Iraq's project for preparing the Initial National Communication which is one of the most important commitments of Iraq towards the Framework Convention. Inventory was carried out based on the revised guidelines of the Intergovernmental Panel for Climate Change (IPCC) of 1996. Four main sectors were included in the greenhouse gases emissions inventory: energy, industrial and agricultural processes and waste sectors. Sector of land use and change of land use was not included in the inventory due to lack of available data regarding this sector resulting of bad circumstances experienced by Iraq at that period.

The project was implemented in the framework of cooperation among various national parties in Iraq, in coordination with the Ministry of Environment. The Global Environmental Facility (GEF) has ensured the project budget, which was delivered to the Iraqi Government through United Nations Development Programme (UNDP), the implementing agency of this project. The role played by United Nations Environment Programme (UNEP) with the Government of Iraq was cooperative through providing technical, advisory and training experience to the Climate Change Center at Ministry of Environment and to other relevant ministries in preparation of their technical parts of the project.

The greenhouse gases inventory has been compiled by a team work consisting of twenty-three local experts from relevant ministries and national institutions. Participation of stakeholders has contributed in benefit mainstreaming, increased the possibility of verification of the inventory results and facilitated collecting data from primary sources. The team work for greenhouse gases inventory was formed in a way that enabled it control the input data, ensure the quality of the estimated emissions to the maximum possible extent. Most of the ministries have participated in the survey team,

including Ministry of Oil, Ministry of Electricity (MoE), Ministry of Industry and Minerals (MoIM), Ministry of Municipalities and Public Work (MMPW), Ministry of Agriculture(MoA), Ministry of Transport (MoT), Ministry of Science and Technology (MoST) and Ministry of Environment (MoEn). As well as other stakeholders, like the Mayoralty of Baghdad, Federation of Industries and Government of Kurdistan Region (KRG).

2.2 Approach and Methodology

The greenhouse gases Inventory was prepared for the first time in Iraq as part of conducting this report, where the three main greenhouse gases; carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) were inventoried for 1997 as a base year because it is the nearest year to 1990,of which data and information were available. Revised Guidelines of (IPCC), 1996 were used for the National greenhouse gases Inventory. In addition to the aforementioned three main gases, another three gases were also inventoried: carbon monoxide (CO), sulphur dioxide (SO_2), non-methane volatile organic compounds (NMVOCs) and oxides of nitrogen (NO_x). As prescribed by these guidelines, the greenhouse gases inventory lists consisted of the following sectors: Energy, Industrial Processes, and Waste. The land use sector, land use change and forestry were excluded from the storage due to lack of data. Greenhouse gases Inventory process included the good practice elements defined in the IPCC Good Practice Guidance and Uncertainty Management.

The greenhouse gases inventory process under the Initial National Communication included the following tasks: Identification and collection of data, checking and verification of input data, entering the activity data and emission factors, calculating the emissions, recalculation and verification of emissions estimates, analysis of key sources, uncertainty management, review of national experts, review of international experts and finally writing the inventory report.

The IPCC software was used for the calculations of the greenhouse gases emissions. Mainly default emission and conversion factors specified by the IPCC guidelines were adopted in these calculations.

The greenhouse gases inventory included the emissions resulting from fuel combustion as well as the fugitive emissions from extraction, transmission and distribution of liquid and gaseous fuels. All activity data of the annually issued energy balances were used. CO_2 emissions were estimated using two methods:

1- **Reference approach (top-down)**: uses the apparent fuel consumption accounting flows into and out of the country

2- Sectoral approach (bottom-up): has been used to estimate greenhouse gases emissions and removals from the energy, agriculture, waste, and industrial processes sectors.

Table (2-1) is a summary report of National Greenhouse Gases Inventory of 1997 (Annex 2 shows detailed information of the inventory).

Table (2-1): Summary of greenhouse gases inventory, 1997

SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)												
GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PF
										P	A	P
Total National Emissions and Removals		60,379	0	319	18	0	8	30	3,909	0	0	0
1 Energy	Reference Approach (1)	64,647										
	Sectoral Approach (1)	53,957		22	0	0	0	0	0			
A Fuel Combustion		53,957		0	0	0	0	0				
B Fugitive Emissions from Fuels		0		22		0	0	0	0			
2 Industrial Processes		6,422		0	0	0	8	30	3,909	0	0	0
3 Solvent and Other Product Use		0			0			0				
4 Agriculture				134	17	0	0					
5 Land-Use Change & Forestry		(2) 0	(2) 0	0	0	0	0					
6 Waste				163	1							
7 Other (please specify)		0	0	0	0	0	0	0	0			
Memo Items:												
International Bunkers		0		0	0	0	0	0	0			
Aviation		0		0	0	0	0	0	0			
Marine		0		0	0	0	0	0	0			
CO_2 Emissions from Biomass		0										

2.3 Summary

2.3.1 Reference Approach Compared with Sectoral Approach:

The reference approach is a top-down approach, using energy supply data of a country to calculate the emissions of CO_2 from combustion of mainly fossil fuels. The Reference Approach is a straightforward method that can be applied on the basis of relatively easily available energy supply statistics. Excluded carbon in some processes in Iraq led to the need for availability of data to some extent. However, potential comparability between the sectoral and reference approaches allows the country to prepare other independent estimate of CO_2 emissions resulted of fuel combustion, with additional limited efforts and availability of other data.

2.3.2 Emissions per Capita:

The estimate of the Iraqi per capita in 1997 was equal to 3.8 ton/per capita. It was calculated by dividing the total emission of equivalent carbon dioxide gas by the total population; as follows: (60,379 + 319 × 21 + 18 × 310)/ 19184543, with the adoption of the impact of nitrous oxide gas (N_2O), which is equivalent to 319 times as much as carbon dioxide. As well as, the impact of methane gas, which is equivalent to 21 times more than the effect of CO_2 gas on the increased occurrence of the global warming.

2.3.3 Emissions by Sectors:

2.3.3.1 Energy Sector:

The energy sector In Iraq is considered one of the most important and major economic resources sectors. Most of the information from this sector is very integrated and accurate, due to the fact that data of this sector has been well documented and preserved so as not to be exposed to sabotage operations which were witnessed by Iraq as a result of successive wars. The inventory included emissions resulting from fuel combustion as well as the fugitive emissions from extraction, transmission and distribution of solid, liquid and gaseous fuels. Practically, all activity data are taken from the annually issued energy balances. Estimates of CO_2 emissions were calculated using two methods: Reference approach (top-down), which uses the apparent fuel consumption accounting for the carbon flows into and out of the country, and Sectoral approach (bottom-up), which focuses on the fuel consumption by sectors.

Emissions in the sectoral approach were separated in the following categories, according to the IPCC methodology: energy industries, manufacturing industries and construction, transport, commercial/residential and institutional, agriculture/forestry/ fishing and other. Emissions were calculated with the IPCC Excel software using the emission factors provided in the IPCC Guidelines or local emissions for all fuels. The results of the total CO_2 emissions from the energy sector for 1997 (base year) were about 64,447 Gg CO_2, using the reference approach and 53,957 $GgCO_2$, using the sectoral approach. The difference between the two aforementioned approaches was about 16.17%, which is a large percentage.

There is a big difference between the two approaches in calculations as a result of the presence of large quantities of other kinds of fuel oil which was out of the needs of the Iraqi marketing, surplus and unknown quantities were injected in depleted wells because the Iraqi oil refineries uses preliminary refining techniques. In addition to the above mentioned, quantities of fuel used in the generation of electricity power in industrial, agriculture, residential, and commercial sectors has not been calculated due to the lack of accurate information and data.

Amount of total CO_2 emissions in 1997 was estimated using the reference approach at about 64,447 Gg CO_2, including 52,136.45 Gg CO_2 (81%) emitted from liquid fossil and 12,310 Gg CO_2 (19%) emitted from gaseous fossil, tables (2-2) and (2-3).

Table (2-2): Total CO_2 emissions of energy sector in 1997, using sectoral approach-1

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)							
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total Energy	**53,957**	**22**	**0**	**0**	**0**	**0**	**0**
A Fuel Combustion Activities (Sectoral Approach)	**53,957**	**0**	**0**	**0**	**0**	**0**	**0**
1 Energy Industries	**0**	**0**	**0**	**0**	**0**	**0**	**0**
a Public Electricity and Heat Production							
b Petroleum Refining							
c Manufacture of Solid Fuels and Other Energy Industries							
2 Manufacturing Industries and Construction	**281**	**0**	**0**	**0**	**0**	**0**	**0**
a Iron and Steel							
b Non-Ferrous Metals							
c Chemicals							
d Pulp, Paper and Print							
e Food Processing, Beverages and Tobacco							
f Other (please specify)							

Table (2-3): Total CO_2 emissions of energy sector in 1997, using sectoral approach-2

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)							
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
3 Transport	**18,518**	**0**	**0**	**0**	**0**	**0**	**0**
a Civil Aviation	87	0	0	0	0	0	
b Road Transportation	18,431	0	0	0	0	0	
c Railways	0	0	0	0	0	0	
d Navigation	0	0	0	0	0	0	
e Other (please specify)	0						
Pipeline Transport	0						
4 Other Sectors	**10,918**	**0**	**0**	**0**	**0**	**0**	**0**
a Commercial/Institutional	0	0	0	0	0	0	
b Residential	10,918	0	0	0	0	0	
c Agriculture/Forestry/Fishing	0	0	0	0	0	0	
5 Other (please specify)	**24,239**	**0**	**0**	**0**	**0**	**0**	**0**
B Fugitive Emissions from Fuels	**0**	**22**	**0**	**0**	**0**	**0**	**0**
1 Solid Fuels	**0**	**0**	**0**	**0**	**0**	**0**	**0**
a Coal Mining		0					
b Solid Fuel Transformation							
c Other (please specify)							
2 Oil and Natural Gas	**0**	**22**	**0**	**0**	**0**	**0**	**0**
a Oil		7		0	0	0	0
b Natural Gas		15					
c Venting and Flaring		0					

* Note 1: Cell (4) in the energy sector (other sectors) indicates the following:

1. Commercial and Institutional consumption: including fuel oil consumption in industry, specifically in brick factories.
2. Residential consumption: consumption of liquefied petroleum gas (LPG) and kerosene, including military consumption of kerosene.
3. Agricultural, forestry and fishing boats: results are not available due to lack of information and data.

** Note 2: Cell (5) in the energy sector (other) indicates the following:

1. Fuel oil consumed in the production of electricity and oil projects.
2. Gas oil or diesel consumed in the production of electricity and oil projects.
3. Naphtha in oil projects.
4. Refinery gas in oil projects.
5. Natural gas used in the production of electricity, oil and industrial projects.

*** Note 3: Gasoline and diesel fuel consumption were included in the military sub-sector within the transport sector.

2.3.3.2 Industry Sector:

Greenhouse gas emissions are produced from a variety of industrial activities, unrelated to energy. The main emission sources are industrial production processes which chemically or physically transform materials. During these processes, various greenhouse gases, including CO_2, CH_4, N_2O, and PFCs, are released. Greenhouse gases emissions were calculated for the industrial process for the following key sources, according to the Revised 1996 IPCC Guidelines and as shown in the following table (2-4).

Table (2-4): Total CO_2 emissions of industry sector in 1997, using sectoral approach

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)												
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		C
								F	A	F	A	F
Total Industrial Processes	6,022	0	0	0	0	30	3,989	0	0	0	0	0
A. Mineral Products	4,762	0	0	0	0	25	103	0	0	0	0	0
1. Cement Production	4,437						3					
2. Lime Production	306											
3. Limestone and Dolomite Use	0											
4. Soda Ash Production and Use	18											
5. Asphalt Roofing					0	0						
6. Road Paving with Asphalt						25						
7. Other (please specify)	0	0	0	0	0	0	100	0	0	0	0	0
Glass Production						0						
Concrete Pumice Stone							100					
B. Chemical Industry	1,485	0	0	0	0	5	3,886	0	0	0	0	0
1. Ammonia Production	1,485				0	5	0					
2. Nitric Acid Production			0	0								
3. Adipic Acid Production			0	0	0	0						
4. Carbide Production	0	0										
5. Other (please specify)		0		0	0	0	3,886					
C. Metal Production	776	0	0	0	0	0	0	0	0	0	0	0
1. Iron and Steel Production	776			0	0	0	0					
2. Ferroalloys Production	0											
3. Aluminium Production	0			0	0		0				0	
4. SF_6 Used in Aluminium and Magnesium Foundries												
5. Other (please specify)	0											

The CO_2 emission and other greenhouse gases of this sector for 1997 were estimated using the general approach of IP emissions through the application of the equation below:

TOTAL ij = AD j x EF ij

As:

TOTAL ij = industrial process emission (ton) of gas i from industrial sector j.

AD j = amount of activity or production of the industrial process of (AD) materials in industrial sector j (ton/year).

EF ij = emission factor associated with gas i per unit of activity in industrial sector j (ton/ton).

The key industrial processes that contribute to the emissions of greenhouse gases in the Republic of Iraq are cement, lime, ammonia, and iron and steel productions. The cement production activity leads to CO_2 emissions, while the key gas emitted in lime production is CO_2. The total CO_2 emission from the industrial processes in 1997 was estimated about 6,422 Gg and the SO_2 emission was about 3,909 Gg, while the NMVOC emission was 30 Gg, and CO was only 8Gg.

2.3.3.3 Agriculture Sector:

This sector deals with methane (CH_4) and nitrous oxide (N_2O) from two main sources: Enteric fermentation and Manure management. Methane from enteric fermentation is produced in herbivores a by-product of the digestive process. Amount of released CH_4 depends upon the type, age and weight of the animal and the quantity and quality of the consumed feed. Methane emissions from enteric fermentation for 1997 were estimated, according to the IPCC Guidelines, as shown in tables (2-5) and (2-6).

Table (2-5): Total methane (CH_4) emissions and nitric oxide (N_2O) from enteric fermentation and manure management in agriculture sector for 1997, using sectoral approach

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)					
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CH_4	N_2O	NO_x	CO	NMVOC
Total Agriculture	**134**	**17**	**0**	**0**	**0**
A Enteric Fermentation	**113**				
1 Cattle	68				
2 Buffalo	5				
3 Sheep	31				
4 Goats	4				
5 Camels and Llamas	0				
6 Horses	1				
7 Mules and Asses	4				
8 Swine	0				
9 Poultry	0				
10 Other (please specify)					
B Manure Management	**5**	**0**			
1 Cattle	2				
2 Buffalo	0				
3 Sheep	1				
4 Goats	0				
5 Camels and Llamas	0				
6 Horses	0				
7 Mules and Asses	0				
8 Swine	0				
9 Poultry	0				

Table (2-6): Total methane (CH_4) and nitric oxide (N_2O) emissions from agriculture sector for 1997, using sectoral approach

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)					
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CH_4	N_2O	NO_x	CO	NMVOC
B Manure Management (cont...)					
10 Anaerobic		0			
11 Liquid Systems		0			
12 Solid Storage and Dry Lot		0			
13 Other (please specify)		0			
C Rice Cultivation	16				
1 Irrigated	16				
2 Rainfed	0				
3 Deep Water	0				
4 Other (please specify)					
D Agricultural Soils		17			
E Prescribed Burning of Savannas	0	0	0	0	
F Field Burning of Agricultural Residues (1)	0	0	0	0	
1 Cereals					
2 Pulse					
3 Tuber and Root					
4 Sugar Cane					
5 Other (please specify)					
G Other (please specify)					

The agriculture sector in the Republic of Iraq is an emerging sector and one of the major contributors in the release of greenhouse gases. Thus, most of the crops in Iraq are grains like wheat, barley, rice and corn representing the largest percentage of cultivated areas, in spite of the presence of horticulture crops and date palm trees, which relatively require less amounts of fertilizer. The agricultural land constitutes about 7% of the total area of the territory of Iraq. The amount of direct and indirect emissions of N_2O from soil was about 33.4 Gg. Direct N_2O emissions included emissions from soil due to volatility of fertilizers and animal manure of about 4.17 Gg, while emissions from soil due to sediment from the atmosphere of nitrogen in soil and water leaching from agricultural waste are considered indirect emissions.

Small amounts of methane gas (CH_4) are emitted from animal husbandry, which is the clearly released gas from the agricultural sector in the Republic of Iraq, especially of cultivation of the popular crop of rice. As for emissions from other sub-sectors, such as burning of savannah, there is no such kind of forest in Iraq.

According to the IPCC Guidelines, the methane emissions from enteric fermentation for 1997 were about 113,153.33 tons. The total amount of N_2O emissions from the agricultural sector was estimated at 118.14 Gg for 1997. As for CH_4 emissions, the total estimated amount for 1997 was134 Gg. The

total estimated amount of N_2O emissions for 1997 was equivalent to 17 Gg. No other gases were observed from this sector for 1997. From the aforementioned information, the total CO_2- equivalent emissions which were emitted from the agricultural sector will be equal to:

8084 Gg CO_2-eqv. = (134 × 21 + 17 × 310)

2.3.3.4 Waste Sector:

Calculations in this sector included Methane emissions from:

1- Solid waste disposal sites.

2- Domestic /commercial waste water.

3- Sludge and industrial waste water.

It also included indirect nitrous oxide emissions from human wastewater. Table (2-7) shows total emissions of methane gas (CH_4) from waste sector in 1997, using the reference approach.

Table (2-7): Total emissions of methane (CH_4) from waste sector in 1997, using the sectoral approach

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)						
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	NO_x	CO	NMVOC
Total Waste	0	163	1			
A Solid Waste Disposal on Land	0	163	0			
1 Managed Waste Disposal on Land						
2 Unmanaged Waste Disposal Sites						
3 Other (please specify)						
B Wastewater Handling	0	0	1			
1 Industrial Wastewater		0				
2 Domestic and Commercial Wastewater		0	1			
3 Other (please specify)						
C Waste Incineration						
D Other (please specify)						

Team work in the waste sector, within the Initial National Communication, had difficulties due to the unavailability or lack of accurate data in this sector, absence of studies due to the critical security circumstances experienced by Iraq since 1990, wars and burning of most national data. Therefore, the results in this sector depended on estimations methods. Information of the liquid waste from the industrial sector was not included due to lack of data.

The key greenhouse gases emitted from waste disposal is the methane (CH_4). (CH_4) is also emitted from domestic and commercial wastewater, organic wastewater and sludge. The methodology in the IPCC manual provides a classification of solid waste disposal sites into *"managed"* and *"unmanaged"* sites through knowledge of the extent and type of active site management carried out. It has been assumed in 1997 that all the waste is disposed to unmanaged sites. Computations have been made in 1997to estimate (CH_4) emission from wastewater and sludge in the Republic of Iraq, using the IPCC default methodology. It was assumed that about 60% of the total population that was living in Iraq had benefited from wastewater collection in 1997. The net estimate of (CH_4) emission from waste sector was 163.05 Gg, which constituted about 51% of the total (CH_4) emission.

Figure (2-1) illustrates the contribution of each sector in the increase of greenhouses gas emission in 1997 as CO_2- equivalent. It is clear that the agricultural sector had added a large amount of greenhouses gas in Iraq in 1997, due to lack of data and information of the forest, land use, and land use change. In this context, Iraq requires to establish a data information system to collect data on this sector and in preparation for the second national communication.

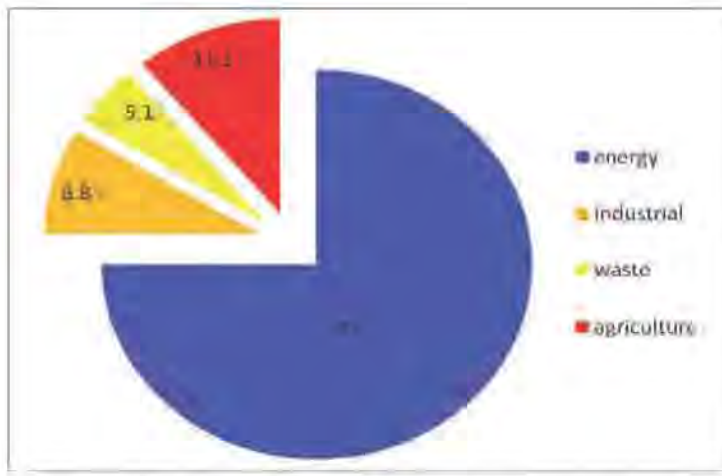


Figure (2-1): Sectoral distribution of total greenhouse gases emissions in Iraq as CO_2- equivalent, 1997

Emissions of greenhouse gases for each sector can be summarized as follows:

- Energy: (54,419 Gg CO_2eqv.), equivalent to 75%.

- Industrial processes: (about 6,422 Gg CO_2eqv.), equivalent to 8.8%.
- Agriculture: (8,084Gg CO_2eqv.) equivalent to 11.1%.
- Waste: (3,733Gg CO_2eqv.), 5.1%.

2.3.4 Emissions by Each Type of Greenhouse Gases:

Figure (2-2) illustrates description of emissions by all types of greenhouse gas estimated in Iraq in 1997. Included greenhouse gases are CO_2, CH_4, N_2O, NO_X, CO, SO_2, and NMVOC.

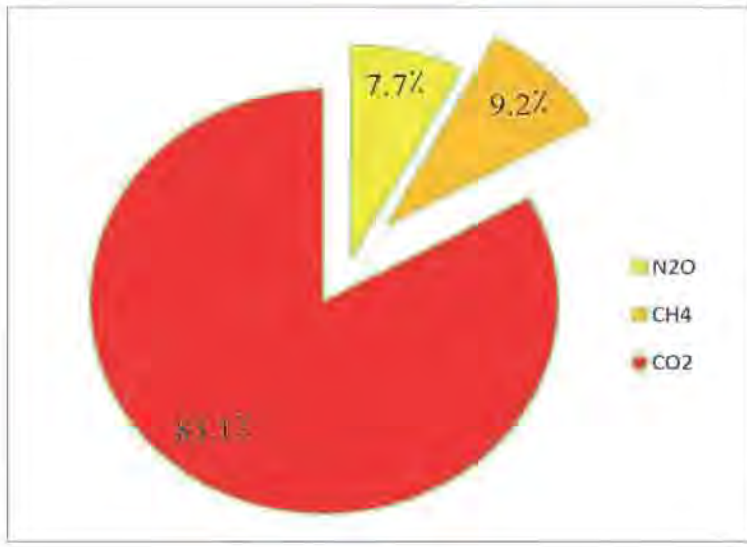


Figure (2-2): Rates of greenhouse gases emitted in Iraq, 1997

- **Carbon Dioxide (CO_2):**

Net emissions of CO_2 were estimated at 60,379 Gg, about 83.1% of Iraq's total greenhouse gases emissions in 1997. These emissions arise from energy and industrial processes at 89.4% and 10.6% of the total emission, respectively. The main source of CO_2 emissions is combustion of fossil fuels, the largest single contributor to CO_2 emissions in energy industries and refineries in sub-sectors (mainly power generation which relied on heavy fuel oil in 1997), followed by road transportation at 30.7%. The industrial

processes sector (mainly mineral production) contributed in 10.6% of the total CO_2 emission in 1997. Emissions of CO_2 from land use, land use change, and forestry could not be calculated due to lack of data.

- **Methane (CH_4):**

Methane represents the second largest share of Iraq's greenhouse gases emissions in 1997. CH_4 emissions were estimated at 319 Gg, about 9.2% of total greenhouse gases emissions in 1997.The largest contributor to CH_4 emissions in 1997 was the waste sector. Methane emissions generated from local solid waste landfills constitute about 51% of the total CH_4 emissions. Agriculture and energy sectors contributed with 42%, and 6.9% of the total CH_4 emissions, respectively.

- **Nitrous Oxide (N_2O):**

Emissions of N_2O were estimated to be 18 Gg, about 7.7% of the total greenhouse gases emissions in 1997. Nitrous oxide emissions generated from agricultural sector and treated wastewater was about 94.4%, and 5.6% of the total N_2O emissions.

2.3.5 Conclusions:

a- Total greenhouse gases emissions in 1997 were estimated at 60,379 Gg of CO_2, and 319 Gg of CH_4 , and 18Gg of N_2O which are equivalent to 3.2 Mg/capita of CO_2 and 0.02 Mg/capita of CH_4 (population in 1997 was estimated about 19,184,543). All other emissions of gases were excluded. The energy sector contributes with about 89.4% of CO_2 emissions while the waste sector represents51% of $CH_4$and the industrial process sector contributes with 10.2% of CO_2 emission and about 100% of SO_2 emission. The electricity generation projects, oil projects and transport are the major contributor to CO_2 emission with 45%, and 34%, respectively. Residential areas contribute with about 20% of CO_2 emissions in the energy sector. Emissions from agricultural, forestry and fishing boats sectors were considered equal to zero due to lack of relevant data and information.

b- Contribution of each sector in Iraq in 1997 of greenhouse gases emissions was as follows: 75% of greenhouse gases emissions as CO_2 equivalent from energy sector, 11.1% from agricultural sector, 8.8% from industrial processes and 5.1% from waste sector.

c- Methane emissions from household solid waste landfills amounted to 51% of the total emissions of this gas. Agriculture and energy sectors contributed with 42% and 6.9%, respectively, in the total methane emissions.

d- Emissions of nitrous oxide are generated from agricultural and wastewater treatment sectors by 94.4% and 5.6%, respectively.

2.4 Uncertainty and Verification of Estimates

2.4.1 Uncertainty:

- The IPCC Good Practice Guidance describes uncertainty as a key element of a complete inventory. The purpose of estimating uncertainty is not to challenge the validity of the inventory estimation, but to help prioritize efforts and resources allocation to improve the accuracy of inventories in future. In addition, guiding decisions on methodological choice and using the most reliable emission factors.

- Calculation of greenhouse gases emission in 1997 contained uncertainty for many reasons; one of these reasons is the unavailability of sufficient and appropriate data. There are many reasons why actual emissions and expenses are different from the calculated number in the national inventory lists. The estimation of uncertainty for emission from individual sources (e.g. thermal electric plants, vehicles, number of cattle, agriculture, etc.) is a combination of individual uncertainties of emission calculation elements, including:

- Uncertainty associated with continuous monitoring of emissions. Most of Iraq's power stations, refineries and industries do not monitor their emissions due to Iraq's circumstance since 1980. Therefore, there are no measured data to be used in calculating efficiency.
- Uncertainty associated with emission factors collected from published references.
- Uncertainty associated with activity data. Iraq have passed several times through wars since 1980 until 2003, these led to loss of most of its ministries records and lack of active records systems in most of these ministries. Therefore, it was very difficult to collect complete and reliable data.

Calculation of greenhouse emission in Iraq is mainly based in this report on emission factor data from the Convention manual (IPCC 1996 Revised Guidelines), which is also one of the sources of uncertainty.

Data of cattle and agriculture were collected from various studies and documents, which may lead to uncertainty as well. Some of the data have been derived from Statistical yearbook prepared by Ministry of Planning. Oil ministry records were the most reliable one; therefore it was used in calculation inventories for electricity, industries and transportation.

One of the important factors of uncertainty was the fugitive during production, transport and distribution processes; but it was not taken into consideration in this report. To take the fugitive into consideration, a survey is required to be conducted in most of oil and electricity generation facilities for processes for venting, flaring, leaks, equipment and accident in pipelines and trucks.

2.4.2 Verification of Estimates:

Verification processes, in the current context, aims to help improving the quality of data inputs and verify the credibility of inventories lists. The IPCC manual has recommended a set of simple completeness and accuracy checks. For example, revision of calculation mistakes, comparison of the national inventory with independently published estimations, comparison of national data with international statistics and revision of calculation of CO_2 emission from fuel combustion by comparing the sectoral approach with IPCC reference approach, etc.

Furthermore, verification may be achieved through international cooperation and comparison with other countries national inventories. In preparation of the national inventory of the emissions in Iraq, several steps have been taken with the aim of verifying the completeness and reliability of calculation:

1. Comparison with national inventories of other countries (Jordan and a number of other countries not included in Annex 1).
2. CO_2 emission from fuel combustion, under the IPCC methodology has been calculated in two ways: detailed sectors approach and the reference approach, difference was about 16.17%.

2.4.3 Quality Assurance/ Quality Control:

Activities of monitoring quality assurance/quality control (QA/ QC) are integral part of any inventory development processes, as they improve

transparency, consistency, comparability, completeness and accuracy of greenhouse gas inventories lists. Unfortunately it is difficult to implement QA/QC in Iraq at this stage. It is expected that the implementation of IPCC regulation concerning the preparation of the emission inventory, including the greenhouse gases inventory, will regulate this issue in more details.

Quality Control activities were performed in this report through the following steps:

- Verify accuracy and quality of collected data and checking it, for the possibility of recurrence of calculating input values through cross revision of the information received from various officials in charge of sectors with the available information at the Ministry of Planning and international bodies, such as Food and Agriculture Organization and World Health Organization. Table (2-8) illustrates number of organized meetings by the team work for greenhouse gases inventory and verification of input data accuracy and quality.
- Verify that emission and removals are estimated and calculated correctly.
- Verify that proper conversion factors were used.
- Verify that all sources have been calculated.
- Verify the compatibility of emissions factors.

Table (2-8): Number of organized meetings for quality control

	Transport	Electricity	Industry & Minerals	Agriculture	Oil
No. of organized meetings	2	3	4	4	7

There is an urgent need for financial assistance and experts, as well as continuous training for all staff involved in the process of data collection, estimations of emissions, calculations of emission factors, and others in order to address this issue properly. Iraq could benefit from the international support in the following:

- Assistance of experts in preparation of introductions, analysis and utilization of best methodological practices (e.g. emission factors, estimation of uncertainty, revision of results, review quality control procedures, and others).

- Financial support for procurement of necessary equipment (hardware and software) for data collection, processing, archiving and web presentation.
- Financial assistance for the staff training, as part of the training programmes of the Intergovernmental Panel on Climate Change and other international organizations concerning national greenhouse gases emission inventories.
- Financial support for the drafting of implementing regulations and methodologies in the field of environmental statistics, emission inventories, compilation of national emission inventories, introduction of data quality control system, reporting, permanent storage, protection and confidentially of data, etc.

Several meetings were held under the supervision of United Nations Development Programme and United Nations Environment Programme experts in order to review data, calculate and compare the results with other countries results.

2.4 References

- IPCC, 1997. Revised 1996 Guidelines for National Greenhouse Gas Inventories.
- IPCC, 2006. Guidelines for National Greenhouse Gas Inventories.
- IPCC, 2000. IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.
- IPCC, 2003. IPCC Good Practice Guidance on Land Use, Land Use Change and Forestry.

VULNERABILITY AND ADAPTATION

3 Vulnerability and Adaptation Measure

3.1 Water Resources:

Iraq is considered, in terms of climate, arid or semi-arid country. These circumstances are directly related to the available and renewable water resources, which largely depend on surface water, resulted of rain or snow; whether in joint Tigris and Euphrates Rivers basins outside Iraq, inside Iraq, or in desert areas and groundwater.

Rate of annual imports of Tigris River at front part of Mosul Dam and of Euphrates River at Husaiba area during (1990-2000) and (2000-2011), compared with the overall rate of both Rivers (figure 3-1), indicates that water resources in the second period are less than in the first, and so is the case with the overall rate for both Rivers. This might indicate lack of rainfall or establishment of irrigation projects at upstream countries.

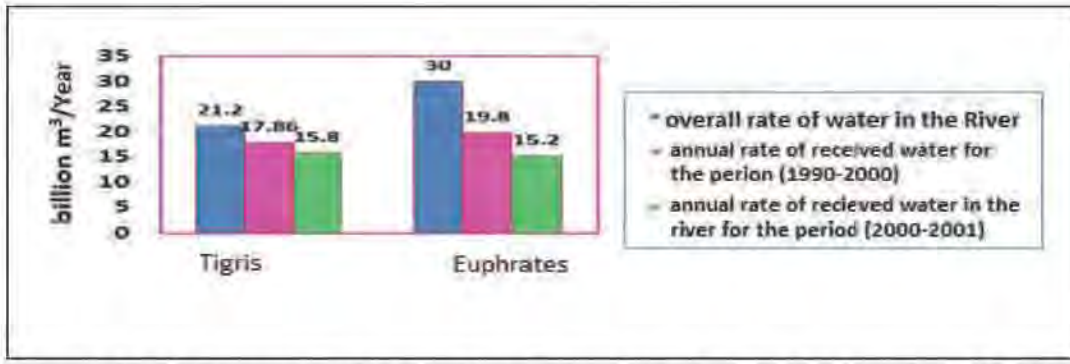


Figure (3-1): Decrease of annual rate of received water by Iraq from Tigris and Euphrates Rivers at the Iraqi borders

Total amount of annual incoming water of Tigris River was in 2011 (33 billion m^3), while of Euphrates River reached (14.62 billion m^3) for the same year. Table (3-1) illustrates rates of annual incoming contribution of Tigris and Euphrates in various uses.

Average total annual imports of Euphrates River were about 15.2 billion m^3/ year for (2000-2011), while average of total imports of River Tigris was 15.8 billion m^3/ year for the same period.

The lack of incoming water from basins of upper rivers is basically due to the establishment of upstream countries various dams and reservoirs within the river basin, as well as establishment of irrigation and other development projects. This might also be due to lack of rain and high temperature. Increase

of water consumption in agricultural sector and other civil uses are due to population increase.

In addition to the decrease in water quantity, water quality, particularly in Euphrates River, it also witnessed a marked deterioration because of the returned salty water from the agricultural land or from wastewater by upstream countries to the river. Furthermore, water quality inside Iraq has deteriorated as a result of evaporation that is associated with lack of water resources, in addition to the returned agricultural drainage water from agricultural land.

Table (3-1): Annual incoming contribution of Tigris and Euphrates Rivers in various uses

River	Annual Imports (2011) billion m^3	Agricultural uses %	Municipality & Civil uses %	Electricity & Industry uses %	Oil uses %
Tigris	33,0	76	17,017.0	4,0	2,0
Euphrates	14,6	91,0	7,0	2,0	-----

The current annual average amount of water per capita in Iraq for 2012 is slightly more than 1,400 m^3/ year; in case of using total incoming surface water. During the period of (2000-2011) it was about 1,787 m^3/ year and of (1990-2000) it was about 3,040 m^3/ year, regardless of the deteriorating water quality due to increased water salinity in long distances within the sections of Tigris and Euphrates, mainly inside Iraq (Figure 3-2). Taking the water quality in consideration, the average annual water share of the Iraqi individual would be less than this figure, compared to individual's share on the international level which amounts to 7,500 m^3

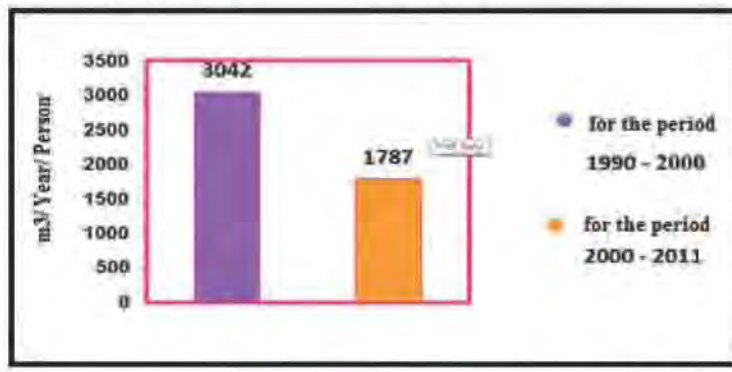


Figure (3-2): Decrease of annual individuals' share of the annual total average of surface water incoming to Iraq at the borders

3.1.1 Assessment of Vulnerability/Fragility of Water Resources and Adoption Measure:

The problem of water in Iraq might largely and increasingly exacerbate in the future to the extent that the individual's share would decrease to less than 500 m^3 in 2025, in accordance with the global estimates models of Middle East countries, which complies with the results shown in (Figure 3-2). Current available water is under great and increasing pressure due to the continuous drought, aridity, population growth, irrational use of water resources, followed water policy and size of irrigation projects in upstream countries and their impact on the imports volume to Iraq.

3.1.1.1 Assessment of Vulnerability/Fragility of Water Resources:

Water imports are affected by climate change, particularly rainfall and high temperature; as the potential climate change would affect the water resources sector, including imports of Tigris and Euphrates Rivers and the groundwater sector as well. The following is an assessment of potential impact of climate on this sector.

I- Assessment of climate change on joint water revenues:

Most properly that any change in current climatic conditions might significantly affect rainfall and temperature patterns (Abdulla F. and Al-Omari A., 2008). Therefore, it is likely that these changes might decrease the supply of water and thereby, increase the pressure on the demand of water resources.

No studies have been properly carried out to assess climate impact on water resources in Iraq or the sensitivity of water resources to climate change yet. That was because of objective reasons; as most parts of Tigris River basins and all feeding basins of Euphrates River are located at upstream countries, as well as the lack of data on the crossing groundwater. In this regard, United Nations reports have warned of the climate change effects on water shortage (UNDP, 2010). It indicated that the current impact of climate change on Tigris and Euphrates basins is under investigation by the concerned countries. Water of Iraq is affected by the decrease of rainfall from outside its borders which represents one of the critical issues. This makes the management of water resources in the country vulnerable to climate change and storage projects in neighboring countries. Lack of water resources due to shortage of rainfall will directly cause shortage of surface and groundwater supply.

Of the main objectives of evaluation of fragility of water resources sector due to climate change are:

A- Verification of climate change impact on water resources in basins of Tigris and Euphrates Rivers and desert area.

B- Identification of possible adaptation measures (policies and sustainable work plans regarding water resources) in order to confront potential climate changes.

Methods of assessing climate change impact on water resources sector could include the following most important items:

- **Data collection**: All data related to water resources in this report was collected by the Ministry of Water Resources. As for the climate data of temperature and rain regarding Al-Edhaim basin, it was collected by the Iraqi Meteorology Organization and Seismology, which included available hydrological and meteorological data for (1960-2006).
- **Hydrological modeling**: Work is underway within the implemented strategic study of water and land in Iraq to adopt mathematical models for the purpose of analysis, study and planning. Taking into consideration the possibilities of flood, drought and other climatic changes in order to have the optimal management of water resources in the coming period until 2035. One of these models is the hydrological one (HEC-HMS) of surface flow, which was basically designed to simulate the rain process-surface flow of Dendritic Watershed systems (http://www.hec.usace.army.mil/software/hec-hms).
- **Assessment of climate change impact of surface flow:** through using the expressing model to simulate the monthly surface flow.
- **Proposal of adaptation measures**: Identify the necessary adaptation measures to confront climate change impact on water sector.

A- Euphrates River:

About 88% of Euphrates incoming water to Iraq comes from rainfall and snow falling in Turkey, therefore, water drainage in the Euphrates River is considered very sensitive (or vulnerable) to rainfall and snow rates and storage projects in Turkey. Impact of climate change on water resources was assessed through a study of Euphrates River case as one of the main surface water source in Iraq; it was conducted by (Onol and Semazzi) in 2006. The study indicated the presence of general decline mainly in rainfall, melting of snow and high temperature. In addition to indicating the importance of snow and it's melting on upper headwaters of Tigris and Euphrates Rivers. As well as the impact of climate changes on water imports resulted from water basins in upstream countries which directly affect the water imports in Iraq, in addition to the impact of irrigation projects established by the mentioned countries.

Estimates of climate change of the water basins areas of the upper Tigris and Euphrates indicate that the significant decline in water resulted from melted snow might affect the drainage of these two rivers; as the decline reaches about 100 mm in snow water (Onol and Semazzi, 2006). The sensitivity of the climate derived from the model of Euphrates River drainage shows that the possibility of increasing or decreasing rainfall by about 25% would increase or decrease the drainage of the river, while maintaining the hydrographic shape of the river without any change (Smith et al, 2000). This forecast means that the annual drainage is increased to 40,655 million m^3 or is decreased to 15,751 million m^3 (in comparison with the reference value which is 27,048 million m^3); representing an increase of 50% or a decrease of 42% which constitutes about twice of the assumed percentage of change in rain. Studies of regional modeling have expected that the decrease in water imports may reach about 40-50 mm in basins of Euphrates and upper Tigris. It is a decline of about 7% of the average rainfall. These reductions are expected to result in a shortage of about 11% in the drainage of Euphrates River (Evans, 2008).

Other studies expect a decrease of about 10-25% in the surface flow of the river of the upper river basins of Euphrates and Tigris by 2070, compared with the average flow of 2000 (Lenher et al, 2001; EEA, 2004). However, imposition of any change in temperature will change the shape and size of the drainage of Euphrates River. The increase of temperature by 5 degrees would lead to significantly increase evapo-transpiration, thus the drainage curve would also significantly decrease (the annual drainage decrease will be from 27,048 million m^3 to 16,329 million m^3; i.e. the decline in drainage will be about 60%). A shortage of 100 mm of snow water of Euphrates headwaters will result into the decrease of drainages by end of summer, when water will be scarce and there is a high demand. A similar sensitivity (similar vulnerability) was also noticed to change temperature in the upper Tigris River.

Iraq obtains more than 58% of the annual measured renewable water resources of Euphrates River on the Turkish-Syrian borders. Therefore, the decline in these drainages will affect many sectors that depend on derived water from the flow of the Euphrates River. Large irrigation projects on river basin will be more vulnerable to this kind of change, in terms of quantity and quality of irrigation water, which affects the percentage of cultivated land with crops and the quantity of yield. In addition, the lack of melting snow that flow through dams reduces the stored water and negatively affects the future generation of hydroelectric power.

Although results of the above mentioned study indicate the presence of climate change effects at the upper sides of Euphrates and Tigris basins, but

figures (3-3) and (3-4) show that there is a decrease in water imports to Iraq in recent years in both Tigris and Euphrates Rivers more than it was in previous years. However, the decrease in imports from Euphrates is much larger than it is in Tigris. This decrease in Euphrates imports could be mainly due to construction of dams, reservoirs and other irrigation projects, as well as the increased usage of water in both Turkey and Syria. Moreover, the degree of salinity of Euphrates water at the Iraqi borders sometimes exceeds 800 ppm. This certainly indicates the pollution of this water before entering the Iraqi borders as a result of the flow of agricultural drainage and wastewater to Euphrates River from the territory of these countries. Imports of Tigris River from tributaries of Little Zab and Diyala River, which originate inside the Iranian borders, have also been exposed to severe shortage in recent years. Although there is a lack of studies to accurately determine the impact of climate change in this aspect, but the decline in river imports is primarily due to the increased usage of this water from the Iranian side, establishment of agricultural irrigation projects and impact of climate change.

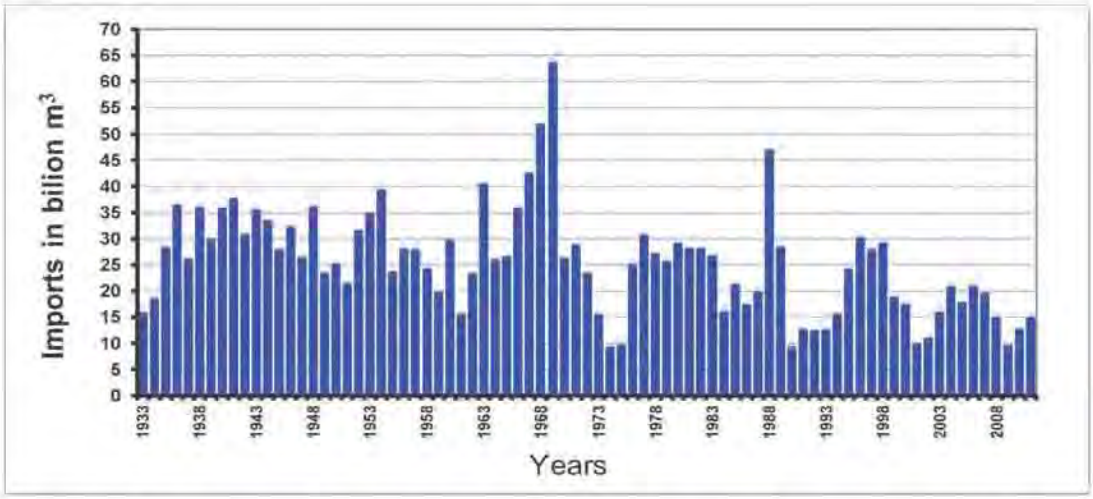


Figure (3-3): Annual water imports of Euphrates River at borders in Al-Qa'im

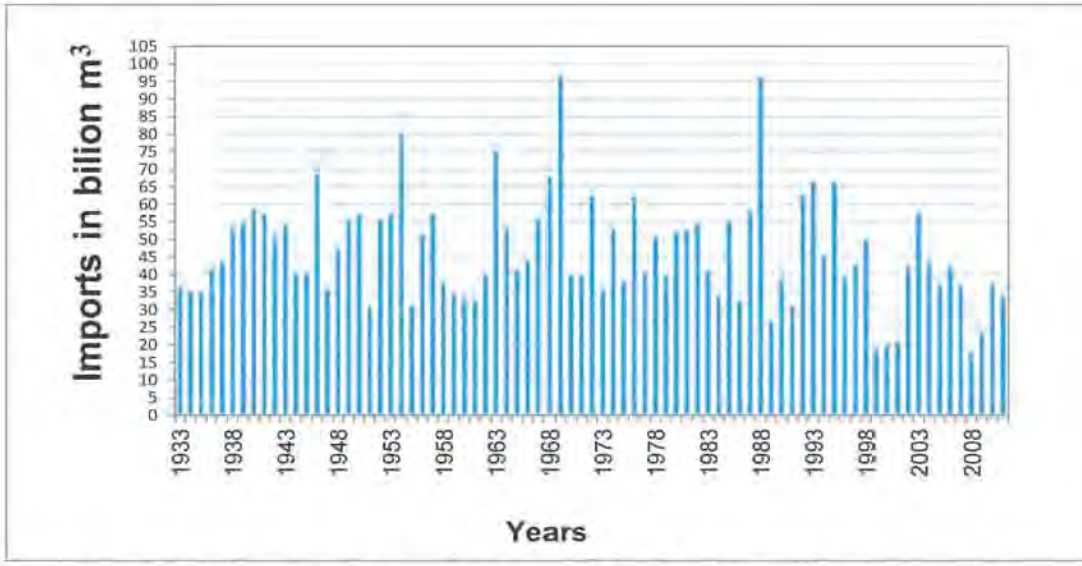


Figure (3-4): Annual water imports of Tigris River and its tributaries

3.1.2 Assessment of the Impact of Climate Change on Local Water Imports:

It includes assessment of climate change impact on local surface water which has basins inside Iraq and the groundwater.

3.1.2.1 Assessment of the Impact of Climate Change on Local Surface Water Imports:

The Al-Edhaim basin represents one of the feeding basins of Tigris River. It is completely located inside the Iraqi territory. Assessing the impact of climate change on this basin gives an idea about its impact on surface water resources in Iraq. Al-Edhaim River is located north-eastern Iraq and springs from an area, partially of mountains of 1,400-1,800 meters height above sea level. Al-Edhaim meets with Tigris River at about 150 m height and 130 km from the city of Balad. Length of Al-Edhaim from the source to the junction is about 230 km, and an area of about 13,000 km^2; an area of -practically-no snow falling and limited levels of rainfall. Therefore, the actual flow occurs only during the raining season. The annual rain of Al-Edhaim basin is about 187 to 360 mm, while temperature is around 6.7 degree to 50 degree. Accordingly, Al-Edhaim basin could be classified as an arid one.

Al-Edhaim basin is considered a representative of many parts of Iraq for being affected by climate change. Iraq has been exposed to these conditions since the end of the last century and the beginning of this one. This is reflected in the increased temperature and decrease of rainfall. Figure (3-5) illustrates the increase of annual temperature rates in Al-Edhaim basin.

Increase of temperature necessarily lead to the increase of the rates of evaporation and evapo-transpiration in this basin, thus resulting into shortage of water resources abundance. The climatic changes in Iraq included, particularly in this basin, pattern of rain distribution and the rate of rainfall. Figure (3-6) shows the decrease of the annual average of rainfall within this basin for the period (1953-2009), while figure (3-7) shows the decrease of water imports resulted from this basin for the same period, especially the recent years of (1999-2010) as the annual general average was 0.56 billion m^3. Climate in Iraq is generally dry and arid; therefore the climate change of rainfall appears to be slight compared to the change of increased temperature, which is clear whether in Al-Edhaim basin or in other parts of Iraq. Other special forms in the climate chapter illustrate the increase of temperature rates, especially in the recent years. There is a need to conduct another deeper study regarding the relationship between rains and water imports in Al-Edhaim basin.

Any increase of temperature will lead to basic evapo-transpiration (ET_O) which will result into increased evaporation rates and reduction of water supply from annual rainfall. Thus, a decline in the annual feeding layers of groundwater will occur and a reduction in surface flow. There is a need for studying the impact of climatic changes on groundwater levels using the special dynamic relations through standardization of a number of mathematical models of groundwater and through calculating the flow of some springs.

Special mathematical models for groundwater will be applied in future, which are implemented through Powersim Studio program within the strategic study of water resources and land for the purpose of assessing the natural groundwater budget. This study could include analysis of individual components of the water movement and the impact of certain hydrological scenarios. In addition, this model allows estimating the amount of available groundwater for usage and characterization of the special quality of water salinity. It is important to conduct another study regarding calculations of climate change impacts on requirements of irrigation water. The increase of the calculated evapo-transpiration (ET_O) could be used, which is counted to calculate the increased irrigation requirements for various types of crops in different parts of Iraq.

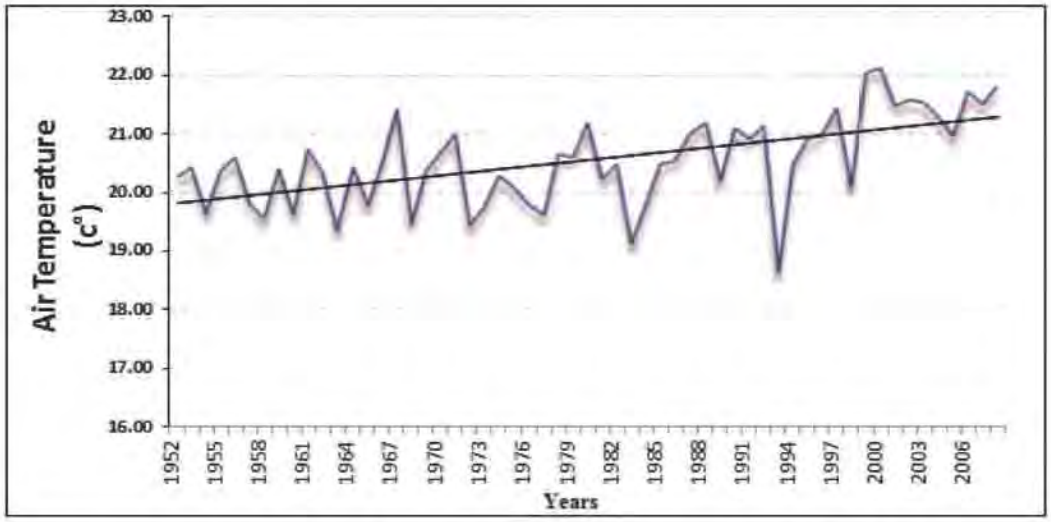


Figure (3-5): Increase of annual temperature rates of air for the period (1952-2008)

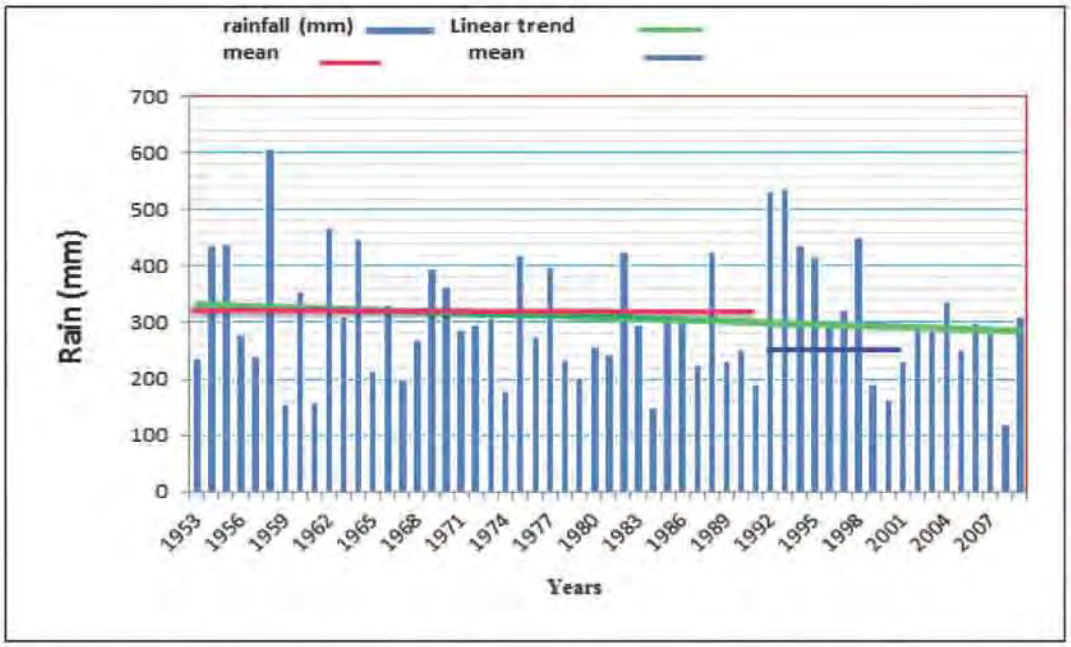


Figure (3-6): Decrease of rainfall in Al-Edhaim basin for the period (1953-2009)

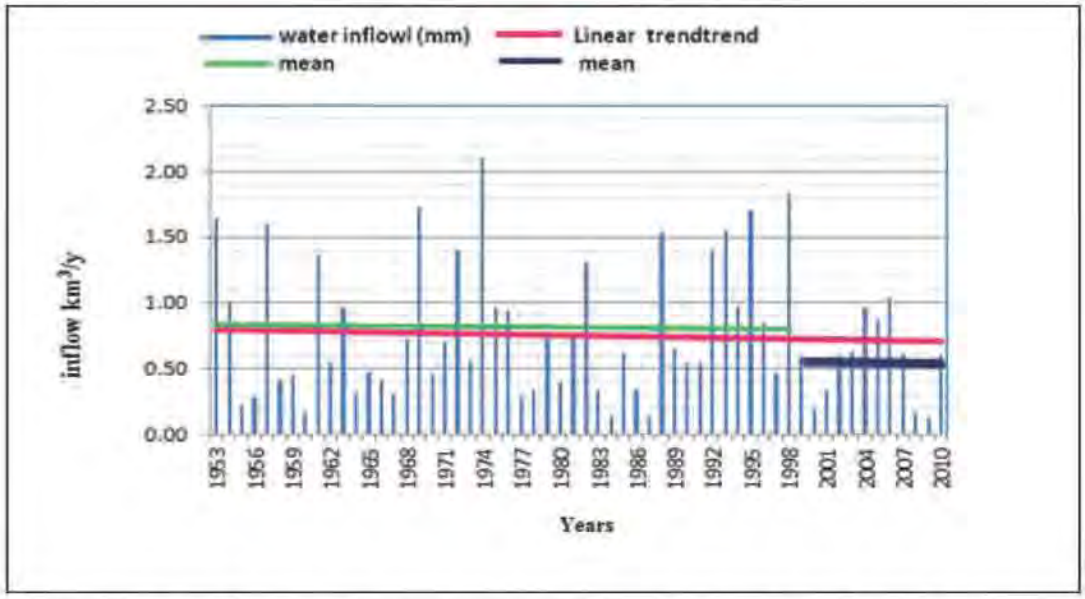


Figure (3-7): Change of water imports (annual rate of flow) in Al-Edhaim basin

3.1.2.2 Assessment of Climate Change on Groundwater Imports, in general, and on Desert Area, in particular:

Groundwater is considered a critical water resource in the arid desert or the very arid areas. It has a largely increasing importance during periods of drought. There are few exceptions, but most of the groundwater basins in Iraq suffer from a deficit in the sustainability of stocks of these basins.

Figures in table (3-2) indicate to the decrease of groundwater levels as a result of lack of rain in Iraq in general, and in the desert area in particular.

Table (3-2): Decrease of groundwater levels during (2010-2011)

Location	Decrease of groundwater levels during (2010-2011) (meter)
Mosul	– 0.8
Erbil	– 2,55
Karbala	– 0.17
Najaf	– 0.41
Karbala-Shethatha	– 0.67
Anbar	– 0.16
Basra	+0.1
Diyala	– 0.49
Kirkuk	– 0.40
Muthana	– 0.18

3.1.3 Impact of Indicators and Other Factors on the Vulnerability of Water Sector:

Climate change is not the only vulnerability factor of water resources in the basins of Tigris and Euphrates, but there are other indicators also, as follows:

Population Growth and Urbanization: Population growth and extension of populated areas lead to the increase of water consumption for various purposes, particularly in the agricultural sector. This will also lead to the increase of wastewater resulting into the increasing deterioration of the quality of river's water; starting from the spring to the estuary. Increased urbanization and the extension of its area in the upstream areas result in increasing the land area which does not allow water to pass through because of the existence of construction. Consequently, this leads to lack of natural plants area, lack of evapo-transpiration, and lack of water leaking into the soil.

- **Water-related Conflicts and Water Policies of Neighboring Countries**: Upstream countries directly depend on rainfall to preserve forests, wildlife, wet land and rain-fed agriculture, as well as fishing and groundwater feeding. In Iraq; as an estuary area, water of Tigris and Euphrates are the only source of irrigation for agriculture and provision of drinking water. Water problems are mainly related in estuary areas to water scarcity.

United Nations has warned in many published reports and on several occasions of an increased risk of conflict over scarce water resources, it is a

threat to the region. In addition, these reports have warned of the effects of climate change on water shortage.

One of the sensitive issues is the significant dependence of water of Iraq on rates of rainfall and snow melting, as well as other climatic factors from outside its borders (in addition to water policies of neighboring countries represented by the impact of water storage projects). Therefore, the water resources management in the country is vulnerable to climate change, storage projects and irrigation facilities in neighboring countries on one hand, and on the other hand change of course of some tributaries has led to a serious decline in water level and a large deficit in the drinking water and irrigation.

There is a great possibility to find a trans-boundary collaboration, rather than conflict. Upstream countries could use the surface water flow to generate power for the development and provision of groundwater in remote areas. Projects of reducing the lost and preventing flooding problems in the upstream to generate additional disposal for rivers and for the benefit of downstream countries, could be developed as well.

- Decrease of usual rainfall rates in Iraq, particularly during the recent years, has led to decline of main rivers disposal, decreased groundwater levels; especially in desert areas, and drought of water resources, particularly springs and aquifers water which had existed in the past years.
- Inadequate management of water resources by the local communities and farmers.
- Lack of long-term strategic irrigation projects.
- Lack of a long-term and comprehensive strategy to combat effects of drought, developed since years to plan drought risks.

Special report on Iraq of 2009 that was prepared by offices of IAU, UNAMI, and OCHA indicates the severe impact of drought in Iraq. It also resulted in different mechanism and attempt of the Iraqi society to address this issue, such as deepening shallow wells in an attempt to obtain water, buying or renting water tanks to transfer potable water for their livestock and household usage and migration to the nearest town where water is available. Awareness of the deterioration of water resources and ecosystems in Iraq is considered high among Iraqi decision-makers, but concrete actions at the local and national levels remain uncoordinated and limited.

Deterioration of Water Quality: High temperature, increased rates of evaporation from rivers and water bodies have led to a decrease in water levels of rivers, which results into increasing the water salinity values. In

addition to the increased water pollution resulted of increased concentration of pollutants in the rivers; whether caused by untreated wastewater poured in the river, or other types of pollutants, as:

- Increased temperature led to the increase of evaporation rate and thus, increase of water consumption values, increase of soil salinization in the sedimentary plain, increased dryness of soil surface, lack of vegetation, increase the wind erosion with the presence of winds and crash of the structure of soil surface layer, and thereby increasing dust storms inside and outside the sedimentary plain.
- Water receded and drought increased in large areas of marshes.
- Levels of water are low in Shatt Al-Arab, which led to an increase in the proportion of sea water in it. Hence, there were significant high salinity ratios due to the tide and entry of very salty water into the territory of orchards.
- Increased growth of bushes in major rivers, such as reeds, papyrus and other aquatic bushes as a result of low water levels and reduced speed of stream.

3.1.4 Effects of Water Shortage on Water Resources Sector and Other Sectors:

Adverse effects of water shortage on other sectors are clarified as follows:

- Adverse effects on river navigation.
- Increased problem of pollution and increased degree of salinity in rivers and lakes will directly affect water-based industries and raise the cost of production.
- The problem of low water levels in lakes of dams results into an environmental pollution caused by lack of water storage or lack of waterspout that leads to a difference between hot water surface temperature and bottom of the lake which is of less heat. This would lead to the occurrence of load streams, turbulence and mixture of existing sediments in the bottom with water; this is particularly observed in Dukan Dam.
- Identify cultivated areas and other effects on the agricultural sector, such as effects on livestock, aquatic life and biodiversity.
- Environmental deterioration in Shatt Al-Arab due to lack of water and arrival of tides to Basra city and neighboring lands of Shatt Al-Arab have resulted into the deterioration of orchards and other agricultural areas.

- Increased area of desertification, land deterioration, increased saline desertification, deterioration of vegetation and increased dust and sand storms.
- Hydroelectric power: lack of water has led to the suspension of electric power systems in dams, thus affecting the infrastructure of industrial and water purification stations, oil and other industries which depend on hydroelectric power generated at dams.

Social and Economic Impacts: There will be expected significant impacts of water shortage on social and economic conditions in Iraq. The well-being, development and survival of urban and rural communities and the sustainability of the national economy are directly affected by the shortage of water resources. It also explains the role of these impacts of increasing demand of water, as it is expected that the policies of neighboring countries and the potential climatic changes will lead to a significant increase of water demand for civil, industrial and agricultural purposes at once. It will also result into the reduction of water supply, in terms of quality and quantity.

3.1.4.1 Adaptation Measures:

The above mentioned adverse effects will continue, unless serious measures are taken to reduce and mitigate them on water shortage and reducing the increased rates of water consumption. IAU report (2010) has indicated that water levels of Tigris and Euphrates Rivers-main sources of surface water in Iraq- had declined to less than one-third of the natural capacity. The critical issue is that this trend is expected to continue in the future.

The expected loss of rates of surface water imports in Iraq to Tigris and Euphrates Rivers could decrease in 2025 to 50-80% less than the water imports of 2009. The drought that is affecting the region might cause a decrease of water imports to main rivers, in addition to the construction of dams on water resources in neighboring countries. Moreover, water levels had declined in reservoirs, lakes and streams to a critical level, forcing many people to rely on groundwater. Therefore, these signs indicate the decline of groundwater quantities as well. It had also affected the over-exploitation of many groundwater wells ant its quality, in addition, many of these groundwater sources have become useless due to high salinity and pollution and also became deeper.

Properly the adverse effects of climate change on water resources will cause a reduction of agricultural production and make the problem of water

shortage in Iraq worse. Thence, several serious measures for adaptation should be taken to mitigate the impact of climate change on water resources, and develop non-conventional sources of water that can be exploited in the future.

The expected impact of climate change on water resources could be used as a guide to find the integrated measures and procedures for water resources management. The following possible adaptation measures are also proposed, which the future water policy can be based on. It is the called "Facing the Challenges" strategy that should be sustainable in order to include several measures. It could be divided into three main themes, as follows:

a- Development of the available water resources and protecting them of waste and deterioration in quantity and quality.

b- Improvement of the efficiency of using currently available water resources.

c- Protection of public health and environment.

3.1.4.2 Required Measures to Adapt to Water Resources Shortage and Climate Change:

Integration of adaptation measures with the impact of climate change in strategies and policies of national development to strengthen these strategies and increase their benefits. The following considerations could be adopted to promote the planning process of adaptation strategies, in accordance with the environmental and economic situations in Iraq:

- Management of surface water resources and operation of dams.
- Develop a program to operate reservoirs and dams collectively (Reservoirs optimization operations), or operate dams by the central control method based on modern mathematical models that are supported by national system data of remote monitoring.
- The use of modern methods for integrated management of water resources and establishment of a mathematical model that simulates the water resources system in Iraq (Iraq Water Systems Planning Model) and its relationship with various variables. This is considered the fundamental basis of strategic study of water and land that is being prepared in the Ministry of Water Resources in cooperation with some specialized companies.
- Accelerate the completion of the second phase of water resources strategy and land use in Iraq for 2035 because future plans of the Ministry depend on its results.

- Preparation of annual water budgets according the derived water imports and control of water demand management.
- Continuation of implementing and completing the national system for surface and groundwater hydrological monitoring, as well as collecting information from neighboring countries regarding the situation of water and development of the bank of hydrological data.
- Develop early warning procedures to warn of drought and flood disasters.

Maintenance and Establishment of Irrigation Facilities System:

- Continuation of sustaining and assessing the efficiency of established dams, particularly Mosul Dam, and finding permanent solutions to assist their operation according to the designed capacity.
- Attention to be given for establishment of power generating stations when establishing future dams to optimize the clean energy and strengthen the national electric power system.
- Remove central sediment in streams and major rivers and identify the optimal section of the river.
- Completion of main dams system, proposed earlier, particularly of Upper Zab River for the optimal operation of water resources.
- Support efforts for the recovery of marshland to return it to its previous environmental status and secure water-fed. Attention is also to be given to establishing infrastructure and encouraging Iraqi ministries and state institutions to provide necessary services to the region.
- Management and study of groundwater.
- Continuation of exploring the common groundwater layers with neighboring countries and cooperate with them to conduct regional studies in order to identify common specifications of common ground storage to agree on investing it reasonably and equitably.
- The use of groundwater storage in a sustainable manner, especially the renewed for agriculture to compensate for the shortfall in surface water imports. This should be accurately calculated, in order to avoid any drainage, particularly in desert areas where the storage is nonrenewable. It is necessary to monitor and re-evaluate the national resources of groundwater. As well as preparing a monitoring and protection plan for this resource through a strong legal base and legislations for the use of groundwater. In addition to the continuation of the necessary measures taken to protect imports of groundwater resources of all sources of pollution.

- Initiate studies and procedures regarding artificial groundwater feeding.
- Continue establishing small dams in desert and non-desert areas and benefit from the stored water for drinking, agriculture and livestock requirements.

Water Use rationalization:

- Avoid wasteful use of water in all sectors; agricultural, industrial and civil.
- As the largest water consumption is in the agricultural sector and taking into account the limited water resources in the process of developing future agricultural policies, therefore the following procedures are considered among the required strategies to increase the productivity of water and land that are important for development of water resources and use rationalization:

- Follow the modern alternative irrigation methods, such as dripping and sprinkler irrigation, as well as raising awareness among farmers towards this direction.
- Using modern methods of managing field irrigation.
- Use of salt water and sewage in irrigation, in a programmed way without damaging the soil resource and supporting researches and pilot projects in the field of using saline water in agriculture, like the drainage water and groundwater.
- Find plants that are resistant to drought and other effects of global warming.
- Find different patterns of agriculture, such as covered agriculture and hydroponics (soilless) to rationalize water consumption and dispose of prevailing salinity in soil.
- Increase the efficiency of field irrigation, like adoption of closed irrigation method and lining field channels to reduce waste in case of using this method.
- Transfer surface water from areas of water surplus.
- Application of irrigation shortage (deficit irrigation).
- Application of agricultural biotechnology to improve crop productivity.
- Development of new patterns of crop cultivation on the basis of availability of water (crops efficient in using water).
- Water harvesting techniques, particularly in desert areas.

- Expand the experience of applying modern irrigation methods, establish water users association and promote cultivation of alternative crops of less water consumption.

Studies, Training and Development:

- Take advantage of satellite imagery techniques in using remote sensing techniques in the management of water resources to achieve greater benefit.
- Train technical staff from Iraq to establish a database that provides required information for decision-makers regarding water sector. Take advantage of training on climate modeling and hydrological modeling.
- Continue institutional development and capacity building in the study, implementation and operation of technical water projects that are capable of dealing with the requirements of applying the technical progress.
- Assess the performance of drainage network in Iraq and complete linking the main drainage in downstream to purify the rivers and canals of salt pollution found in drainage water.
- Conduct studies regarding cloud seeding.
- Prepare research and development programs and collect important and reliable data regarding water and rain in basins, drainage and water qualities. In addition to relevant data of high importance in planning use of water in future.

Protection of Water from Pollution:

- Establish a national project for the development of wastewater treatment by relevant departments. It is not to be disposed in rivers before treatment with a study of the possibility of reusing it.
- Use desalination techniques in areas where water is of high concentration of salts.
- Continue the regular monitoring of water resources quality, mainly through the monitoring network of the Ministry of Water Resources and Ministry of Environment, which aims to achieve the preservation and protection of water resources.
- Departments of the Ministry of Water Resources will carry out monitoring and control operations of major rivers' water and lakes of dams to determine the water quality for crop irrigation purposes.

Policies, Legislations and Awareness:

- Review and develop water legislation and general legislations; including administrative, financial and legal, of the Iraqi State to protect surface and ground water resources in quality and quantity. As well as activating the control mechanisms on violations of use.
- Education through various media regarding the importance of avoiding wasteful use of water in all sectors.
- Attention to be paid to the joint international water issue and continuation of making efforts with neighboring countries to form committees of high-level in the state, so as to negotiate the right of Iraq in its international water.

3.1.5 Actions Taken by Iraq in the Environmental Fields Related to Climate Change:

Ministry of Environment, as the national liaison actor, in cooperation with Ministry of Water Resources, Ministry of Agriculture and other relevant ministries and departments has taken several necessary actions to protect water resources, as follows:

Preparation of studies and follow-up on drought and desertification management issues, as follows:

- Accession of Iraq to the United Nations Framework Convention to Combat Desertification (UNCCD) under law No. 7 of 2009. It was published in the official Gazette of Iraq No. 4128 dated July 6th, 2009. Iraq has become a member of this Convention as of July 6th, 2009.
- Forming a special committee to develop a plan to confront and manage risks of drought, in cooperation with other relevant ministries and UNDP; coordinator for implementing this project.
- Prepare a comprehensive study regarding the integrated framework for the drought risk in Iraq (DRM), in collaboration with both UNDP and UNESCO.
- Form a committee with the assistance of international experts from UNEP, UNDP, UNESCO and FAO to study the phenomenon of repeated soil and dust storms (SDS).
- Cooperation with UNEP is in progress to train Iraqi cadres regarding dealing with desertification issues and the requirements of (UNCCD), reporting, prepare strategies, programs, national legislations and projects of mitigating desertification phenomenon.

- The first national report of Iraq was submitted to the secretariat of the Convention on June 24th, 2014. That was after the opening of the program for presenting the Convention reports in its fifth session. Iraq was distinguished for being the second Arab country submitting its report among all Arab countries and the twelfth among 194 states in the world. This reflects the keenness and determination of Iraq to fulfill its obligations and its openness to successful experiences of the civilized world.

- The national strategy for environment included the importance of preparing a national strategy for dealing with problems, causes and solutions in regard of combating desertification, land degradation, drought and adopting national action programs. It is considered one of Iraq's most important obligations towards UNCCD. Implementation mechanism, actors to be coordinated with by Iraq to implement the strategy and preparation will be considered within the coming days, particularly after the official launch of the National Strategy.

Preparation of Studies and Follow-up Issues of Climate Change:

- Drought has broad impacts on different sectors. There are several types of drought, most important ones are: meteorological, agricultural and hydrological drought. Most important actions directly taken by Iraq regarding drought management and shortage of water resources are as follows:

3.1.6 Measures of Iraq for Water Resource Management:

- Work is underway to complete the second phase of the national strategy for water and land and using them to be adopted with impacts of climate change and coping with drought. Realization of Iraq of the size of water scarcity threat led the Ministry of Water Resources to develop a comprehensive strategy in April 2010, entitled "Strategic study of water resources and land". This strategy aims at setting objectives and plans for the long-term up to 2035, that Iraq seeks to achieve in the sector of water and land on the basis of optimal and sustainable use, integrated management of these resources and update the priorities of infrastructure for the projects of major relevant sectors in using water to meet the requirements of sustainable development. In addition, prepare a comprehensive strategy on the basis of international law to negotiate with states on basins of Tigris and Euphrates, ensure the rational and equitable use of water and build the capacity of workers in the field of water resources management.

- Water is considered one of the most important issues addressed by the National Strategy for the protection of Iraq's environment and the Executive Work Plan for (2013-2017), launched based on Resolution No. 89 of the Council of Ministers in 2013. This issue was included within the second strategic objective "Protection and improvement of water quality" to include several necessary projects in its executive plan and be able to adapt the conditions of this vital sector in the country.
- The Ministry of environment is seeking through the Center of Climate Change to initiate developing a national strategy for adaptation of impacts of climate change, water resources sector will be one of the most vital sectors included in this strategy. Work is underway with regional countries to adopt a regional project to combat drought, dust storms and desertification after completion of strategy discussions and approving it in its final form.
- Establishment of associations for water users in the agricultural sector in order to enhance the experience of field irrigation management methods, water use rationalization in agricultural sector and raise awareness among farmers regarding water use rationalization.
- Formation of the National Commission for Water until the adoption of the law of forming the Supreme National Council for Water, which will supervise the formulation of strategic plans for the use of water in different sectors.
- Carry on conducting studies and researches regarding field irrigation management, water use rationalization in agriculture, water consumption studies and studies related to saline water use in irrigation. As well as studies related to usage of treated wastewater in agriculture and linking that with climate conditions.
- Development of timely operational plans for dams, reservoirs and water distribution to all consumers in order to confront the shortage of water imports incoming to Iraq. This is included in the strategy of managing drought risk.
- Plan to use saline water and wastewater for irrigation to maximize the freshwater resources on one hand, and to address the sustainable environmental treatment of these two sources, in cooperation with relevant ministries.
- Continuous use of meteorological techniques in basins of Tigris and Euphrates inside and outside Iraq to follow-up now casting of drought periods and rainfall.

- Follow-up the subject of changes in water imports from neighboring countries and follow-up the continuous negotiations with them to organize joint surface water imports of Iraq.
- Establishment of hydrological stations to monitor water in major control locations along Tigris and Euphrates Rivers and their tributaries. Ministry of Water Resources has installed more than 70 measuring stations and work is going on to install other stations in new locations. These stations are of different qualities, in terms of providing data (measuring water level, water quality, stream speed and temperature). Stations are linked to a central monitoring station to receive data from each sub-station. Stations for monitoring some of groundwater basins have been installed as well.
- Ministry of Environment has installed 17 stations within the borders of Baghdad governorate, including 12 remote sensing stations to monitor and measure water quality of Tigris and Diyala Rivers and the estuary (to measure acid function, oil and grease, total dissolved salts, nitrates, dissolved oxygen, electrical conductivity and temperature), in addition to five stations for monitoring wastewater. Other stations were installed in the rest of governorates to monitor water quality of water resources in these governorates.
- Statistical analysis of rainfall: The strategic study uses the statistical analysis of rainfall and its relationship with surface water through advanced models and software to find out the quantity of surface water imports from outside Iraq.
- A model of dams and reservoirs management was implemented in Hindiya Barrage and its tributaries with the (Scada System) to experience the remote control system of gates. In case of success, this case will be circulated on water resources system, dams and reservoirs in the country.
- Monitor and control pollution of major rivers and dams' lakes: The regular process of monitoring water resources is achieved mainly through the monitoring network at Ministry of Water Resources aiming to achieve reservation and protection of water resources.
- Departments of the Ministry of Water Resources operate modeling and monitoring processes of water of major rivers and dams' lakes to identify water quality for crops irrigation purposes.
- Establishment of small dams in desert areas and take advantage of stored water to secure drinking water, agricultural and livestock requirements in those areas.

- Carry out of forestation operations around dams in Iraq to maintain the surrounding areas from effects of erosion and protect reservoirs of sediment.
- Adaptation measures were taken to reduce demand and reliance on water resources in the power generation sector through orientation towards establishment of gas stations for power generation, that do not largely depend on water (Integrated National Energy Strategy, 2013-2030).

3.1.7 Conclusions and Recommendations:

Water resources are one of the important resources affected by climate change. Results have indicated that water resources have been affected, more or less, by these changes; whether inside Iraq or at upstream countries. It was also adversely reflected on water imports of Iraq in recent years.

3.1.7.1 Conclusions:

- Natural drainage of Tigris and Euphrates Rivers is sensitive (affected) by rainfall and temperature changes, which lead to evapo-transpiration. There is a shortage of water resources in Iraq, particularly due to establishment of dams, reservoirs and irrigation projects in upstream countries, in addition to climate change.
- Both high and low natural drainage of Tigris and Euphrates Rivers water have positive and adverse effects on water distribution system in Iraq. High drainage requires high storage capacity, transmission network and larger distribution. While lower natural drainage rates reduces the economic development capacity and the accompanied growth of various sectors.
- Population growth, accompanying development of industrial and commercial activities and expansion of the agricultural area are considered the most important challenges facing the country, as it led to the increase of demand for water.
- Rainfall is mainly weak and temperature is high, in view of the fact that climate in Iraq is dry and arid. Clear results were observed in the recent years of the increase of temperature and drought rates. The impact was obvious in the increasing of the vulnerability of water sector and led to the following:
  - Increased and intensified desertification with clarity of numerous appearances.
  - Increased water consumption for crops.

- Decline of groundwater levels, particularly in deserts.
- Break of the vegetation and extinction of many varieties of natural plants in the western desert.
- Increased levels of wind erosion and sand and dust storms in the desert and inside the sedimentary plain.
- Increased salinization of soil.
- Increased water salinity and pollution.

- Water decline and increased drought in large areas of marshes.

  Low water levels of Shatt Al-Arab have led to the increase of sea water proportion in its water. Hence, the significant increase of water salinity due to tide and entry of very salty water into the territory of orchards.

3.1.7.2 Recommendations:

a. Capacity building and organizing training courses regarding establishing mathematical models for climate change and its relationship with water resources, also on required adaptation measures.
b. Guide graduate students to prepare their research papers about mathematical modeling of the climate and its relationship with water resources.
c. Raise awareness and counseling among farmers regarding following alternative methods of irrigation to reach sustainable ways of managing water and soil resources and adapt to future climate changes.
d. Enact necessary legislations to rationalize water use in order to avoid water resources shortage in the future.
e. Iraq requires the financial and technical support of international organizations to enable personnel in the sector prepare in-depth studies regarding climate, its changes and its impact on water resources.
f. There is a need to thoroughly study vulnerability of water resources.
g. Carry out thorough studies regarding groundwater in cross-border areas and relationship between groundwater levels and climate change.
h. Carry out thorough studies on feeding basins of Tigris and Euphrates Rivers inside and outside Iraq, in addition to their vulnerability to climate change and other challenges related to water source.
i. Studies to identify the impact of climate change on water resource and its relationship to economic and social aspects.

j. Completion of strategic projects and plans of integrated management of soil and water resources.

k. Enhance cooperation with the Iraqi Meteorological Organization and relevant departments, monitor and utilize the available monitoring and control devices.

l. Continue conversations with neighboring countries regarding Iraq's share of surface water imports and seek the assistance of specialized organizations in this field.

3.2 Agricultural Sector

The agricultural sector constitute a major part of the economic and social life in Iraq, it makes up about 8% of the GDP value, including oil sector, and about 32.8% without the oil sector. Although the agricultural policies and for more than 50 years have aimed at achieving the food security for the country, but that was not achieved in any stage because of the problems suffered by this sector, including salinity and land degradation. Those problems have exacerbated after 2003 due to the destruction of sector infrastructure, especially infrastructure of irrigation and drainage systems.

Total arable area is about 11.1 million hectares and constitutes about 26.2% of the total area of Iraq, while almost half of the arable area (about 6.5 million hectares) is located within the available areas for irrigation from Tigris and Euphrates Rivers and their tributaries in accordance to the technical and economic perspective. However, the available water resources of these water resources are not sufficient to irrigate an area of about 3.3 million hectares. About 15% of the other half of arable area is located within areas of guaranteed rain of more than 450 mm /year rate of rainfall. A percentage of 23% of these areas are within the semi-guaranteed rainy areas of an annual rainfall rate of 350-450 mm /year. The rest of about 62% is within the unguaranteed-rain areas of 50-350 mm /year rainfall rate, according to geographical location and distribution of rain lines. As for non-arable areas which represent about three-quarters of the area of Iraq, most of them are suitable to be seasonal pasture, except for some areas of limited use that have difficult mountainous topography.

Cultivation of field crops, particularly wheat and barley in winter and Maize and rice in summer, constitutes the greater part of irrigated agriculture, in addition to other field crops, winter vegetables, fodder, permanent gardening like palm and various fruits. Figure (3-8) represents a comparison between rates of field crops and vegetables within the irrigated agriculture for 2010, calculated by Iraqi donum (1 donum=2,500 m^2) to clarify the relative

importance of wheat and barley crops, which represent together 61% of the total annually cultivated areas.

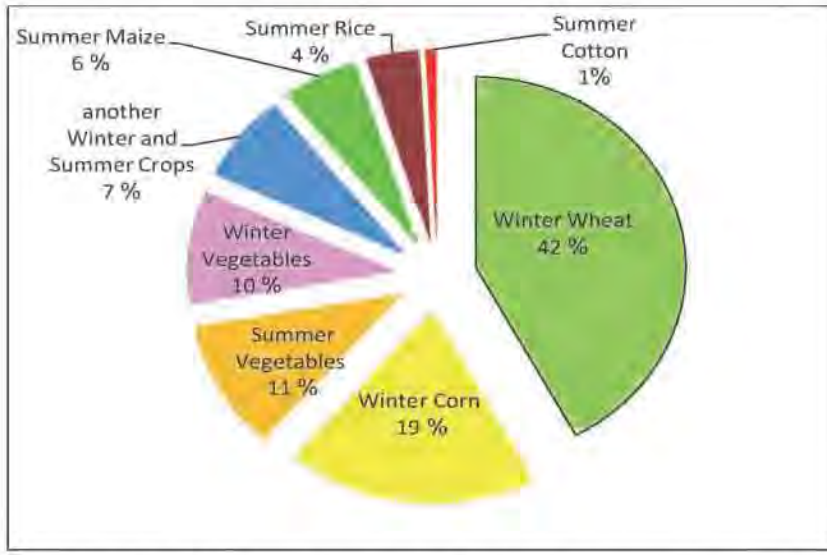


Figure (3-8): Distribution ratios of irrigated crops in Iraq, 2010

As for rain-fed agriculture in winter, which is concentrated in northern governorates of Iraq; such as Ninewa and governorates of Kurdistan region, it is represented in mainly cultivating wheat and barley; wheat in the rain-guaranteed areas for its good economic returns and both crops in semi-guaranteed rain areas. Agricultural yield rate varies according to irrigation sources, state of soil, climatic conditions and others. Yield rate of wheat within the irrigated agriculture ranges between 1,600 and 2,000 kg/ hectares, while its 650-1,000 kg/ hectares in rain-fed agriculture, both yields are considered low compared to global rates.

Irrigated agriculture consumes more than 80% of total water resources of Tigris and Euphrates Rivers and their tributaries. Large areas of agricultural land suffer from salinity and water logging, particularly in central and southern Iraq where salinity is considered the biggest problem facing the irrigated agriculture in Iraq. It has largely exacerbated over the past years as a result of aging infrastructure of irrigation and drainage projects and failure to complete many projects, especially land reclamation projects. Great efforts and significant financial allocations are required for upgrading irrigation and drainage networks and completion of land reclamation to alleviate this problem and reduce its adverse effects on agricultural production.

Surface irrigation constitutes more than 95% of followed field irrigation methods with low irrigation efficiency. It contributes in water waste, increase salinity and land water logging. Government is currently implementing a project which aims at spreading use of sprinkler irrigation, particularly for cultivation of strategic crops like wheat and barley.

As for the livestock, Iraq possesses many animal species; the most important and largest in number are (sheep, cows, goats, buffalos and camels). Results of livestock census of 2008 indicate that the numbers of cattle were: (7,722,375) sheep, (2,552,113) cows, (1,474,845) goats, (285,537) buffalos and (58,293) camels. The livestock have been affected by diseases; like the foot-and-mouth disease. In addition to the decrease of fodder production, lack of natural rangeland and the decreased productivity of livestock meat; for example from 125,000 tons in 2002 to 42,000 tons in 2007.

Followed methodology in preparing this report was based on the study of the reality of agricultural sector, then identifying vulnerabilities according to climate causes. As well as identifying affected social categories and nature (aspects) of impact on these categories according to the affected systems, such as the rain-fed agriculture systems, irrigated agriculture systems, natural pasture systems, livestock sector and plant diseases sector. In addition, suggesting adaptation methods that reduce those effects and finalizing the report with conclusion and appropriate recommendations.

3.2.1 Vulnerability of Agricultural Sector (Fragility):

Most parts of Iraq are located within the known arid and semi-arid climatic regions of the world, according to quantities of rainfall and prevailing temperature rates. Therefore, most prominent effects of climate change on ecological system of the country are mainly reflected on the agricultural system and water supply. Most highlighted climate causes of this impact on agriculture are high temperature, variation and decrease of rainfall systems and increased frequency of droughts more than previous years; for example years of drought 1989, 1999, 2000-2001 and 2008-2009.

Farmers, small peasants, livestock breeders and all relevant categories to agricultural production are mostly and directly affected by the consequences of climate change on agriculture. This impact is reflected on food provision systems for the entire population as a result of reduced food source of agricultural, plant and livestock production. As well as, the economic and social effects on a large category of the community due to the decrease of farmers' income, migration from countryside to the city and other impacts.

Iraq lacks studies and research of climate change impact on agricultural sector; plant and livestock sections. This could be as a result of unstable

situation suffered, and is still, by the country and late accession to the UNFCCC, that resulted into lack of local expertise to deal with climate change issues and its impact on various sectors, including the agricultural sector. Most prominent vulnerability (fragility) features in the agricultural sector in Iraq could be classified as follows, according to the nature of expected impact of climate change:

3.2.1.1 Vulnerability/ Fragility of Rain-fed Agriculture:

Wheat and barley crops constitute the core part of rain-fed agriculture in Iraq. Cultivated areas with these two crops within the rain-fed areas compared to the total cultivated areas by both crops in the country amounts to 30% for wheat and 50% for barley.

Vulnerability of rain-fed agriculture is represented in the great fluctuation of rainfall amount from year to another and it varies from month to another during months of the rainy winter season, or sometimes declines at the beginning of the agricultural season or at its end. It is negatively reflected on cultivated crops productivity in those areas. The vulnerability of rain-fed agriculture is increased when rain begins to decline by the end of spring season, while the planted grain crops, particularly wheat are at advanced stage of ripeness and needs additional amounts of rain. Rain decline at that critical period causes water strain on plant and is reflected in the weakness of crop productivity, sometimes loss of almost complete crop and not harvesting it.

Expected Impacts:

The accomplished research of (Nawal Mohammed, Eman Hazem and Reem Mahmoud) from University of Mosul; entitled (Study of utilization of rain water and complementary irrigation in Mosul) was adopted as a model to assess the impact of rain dates and quantities on the success or failure of rain-fed agriculture season and the productivity of wheat. Mosul represents the largest governorate in Iraq in terms of rain-fed agriculture. The research studied daily rainfall for 28 years (1980-2008) and its distribution during the growing season of the crop, two simulation models was formulated for that. In the first model, rain-fed agriculture timing was identified and years of success and failure depending on that timing. The second model included a simulation of the moisture of the root part of crop throughout the growing season for each year included in the study. That was accomplished through adopting a water balance for the root part and finding the relationship of productivity rates with the cultivating timing and end of agricultural season.

Search results showed that number of years in which rain-fed agriculture failed were 11 years out of 28, representing 39.3% of the total years of the study. Reason of failure ranges between delayed rainfall at the beginning of the season, early end of rainy season or lack of sufficient moisture during the growth season. Results also showed that despite adding two complementary irrigation processes; one at the beginning of the rain-fed agriculture season and another at the end, but it reduced only one year of failure. While adding two irrigation processes at the end of the rainy season had the impact of reducing failure years to 6, i.e. almost the half. This obviously indicates the impact of rainfall decline at end of the agricultural season within the rain-fed agriculture. Table (3-3) illustrates research results regarding years of failure of agricultural season in rain-fed agriculture in different scenarios of adding complementary irrigation before and after the rainy season for the success of agricultural season.

Table (3-3): Summary of years of agricultural rain-fed failure season in different scenarios of complementary irrigation

Cases	Years of Failure
1. Pure rain-fed agriculture	11
2. Rain-fed agriculture with 1 complementary irrigation process at end of rainy season	10
3. Rain-fed agriculture with 1 complementary irrigation process at beginning of rain-fed agriculture season	10
4. Rain-fed agriculture with 2 complementary irrigation processes at beginning and end of rain-fed agriculture season	10
5. Rain-fed agriculture with 2 complementary irrigation processes at end of rainy season	6
6. Rain-fed agriculture with 1 complementary irrigation process at beginning of rainy season and 2 complementary irrigation processes at end of rain-fed agriculture season	5

3.2.1.2 Vulnerability/ Fragility of Irrigated Agriculture:

Irrigated agriculture consumes more than 80% of the total available water resources from Tigris and Euphrates Rivers. There are three major factors that contribute to the vulnerability of irrigated agriculture, which include the largest part of rural population constituting about 33% of the population of Iraq, as follows:

a- Most of the sources and tributaries of both rivers are located in neighboring countries of Iraq such as Turkey and Iran. These countries follow unilateral policies in managing joint water resources. These water resources remain at risk of being constantly decreasing in the absence of joint agreements that ensure Iraq's equitable and reasonable share in this joint water and due to increased usage within the boundaries of these riparian countries with Iraq. The continuous decrease of water imports of Iraq will be directly reflected on crops agriculture systems and livestock in the country.

b- Deterioration of agricultural infrastructure, particularly irrigation and drainage facilities as a result of long years of neglect due to the difficult circumstances experienced by Iraq for more than 30 years. These conditions are still going on to increase the vulnerability of irrigated agriculture system. For example, most of the main channels, sub-systems and gates of the existing irrigation projects operate with efficiency below the designed level due to constructional problems. In addition, there are management and operational problems, low efficiency of the performance of field drainage channels which lead to the exacerbated salinity problem and various problems suffered by pumping for irrigation and drainage stations.

c- Low efficiency of irrigation water usage, particularly in irrigated fields due to the weak level of awareness among farmers regarding the importance of the rational use of water and modern applications of water management in their fields in order to avoid water waste and consequently contribute in increasing the problem of salinity and water logging of land.

Expected Impacts:

a- The impact of drought seasons on Iraq and source countries of its water resources; such as Turkey, Iran and Syria, is expected to be adverse on available water resources from Tigris and Euphrates Rivers. Thus, this would lead to the decline of cultivated areas with irrigation. Figure (3-9) illustrates a comparison of total cultivated areas with irrigation of all crops (except the permanent gardening) for the period 2006-2012. A decline of cultivated areas to the lowest level is observed for 2009 due to consequences of drought seasons 2008-2009 which was reflected in the large decrease of water imports coming to Iraq than its general rates, as well as the depletion of most of the water storage in the Iraqi dams and reservoirs.

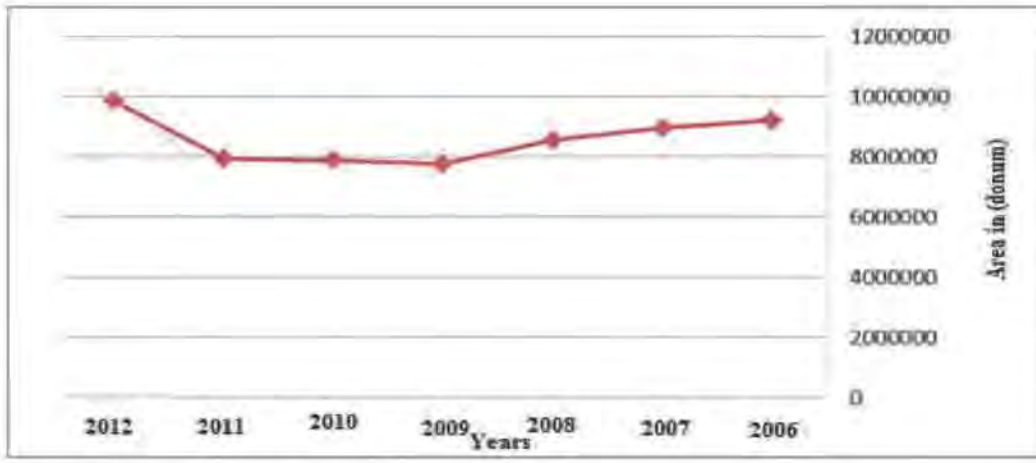


Figure (3-9): Total cultivated areas with irrigation, except for gardening (2006-2012)

b- The impact of rising temperatures as a result of climate change is expected to be an increase of water demand for agricultural crops. In order to study the impact of projected increases in temperature on irrigated agricultural systems in Iraq, the (CROPWAT) program of Food and Agriculture Organization was applied to identify the effect of rising temperatures on the increasing rates of evapo-transmittance, thus increasing water requirements for planted corps. The wheat crop was selected as a model for winter crops and the Maize for summer crops. The program was applied depending on the climate data of a climatic station for the central areas of Iraq and the adoption of a virtual increase of temperature for the annual rates (1-2-3-5) C°. The results indicated the increase of water requirements for wheat crop by (2.79%, 6.01%, 13.01% and 17.17%) of the four scenarios, respectively, compared with scenario zero which represents the current situation. While the increase of water requirements for Maize crop was (1.99%, 3.85%, 5.84% and 9.97%), respectively (Figures 3-10 and 3-11). This means there will a pressure on available water resources to meet the requirements of water needed to grow crops. In view of these originally limited resources, the expected impact in case of using same varieties of agricultural crops and continuation of using agricultural technologies; such as fertilization, mechanization and others without development, will be a decrease in the annual cultivated land to compensate for the increased water requirements of crops and would, of course, mean a decrease in food product to meet the growing population needs for food.

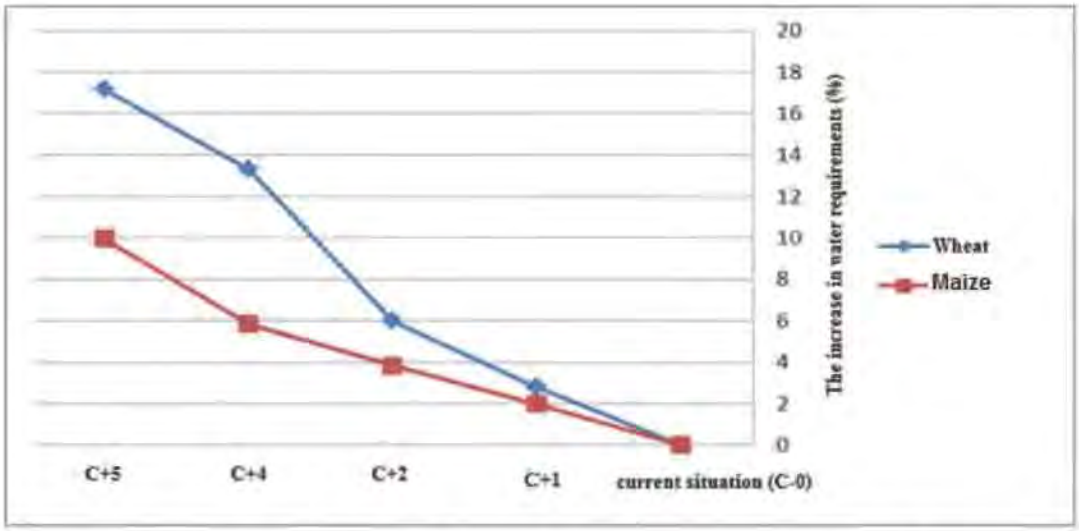


Figure (3-10): Comparison of annual water consumption (mm) for some crops using CROPWAT program and according to high temperature scenarios.

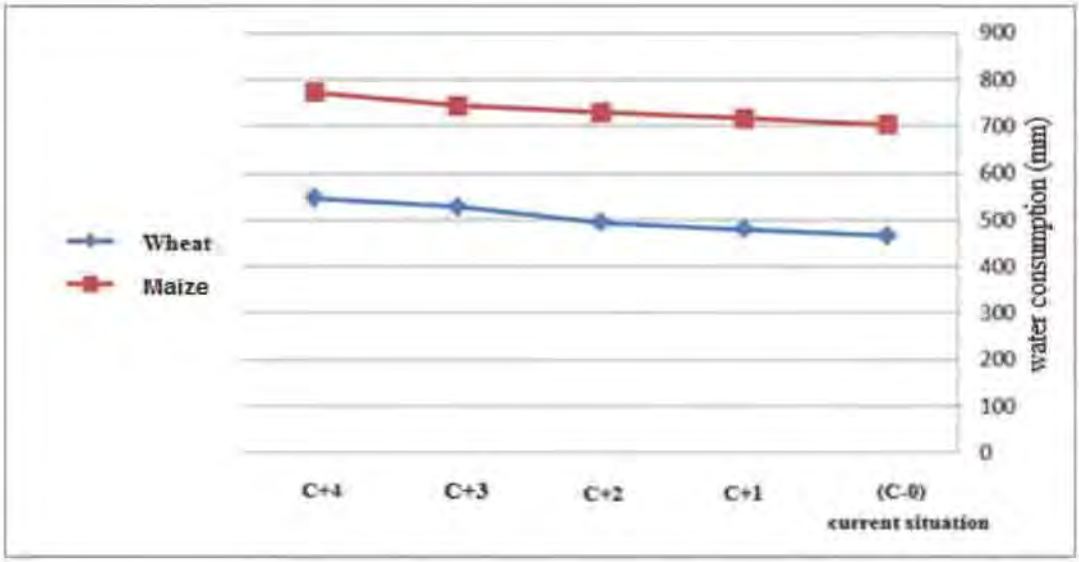


Figure (3-11): Increase of annual water consumption (Percentage)

3.2.1.3 Vulnerability/ Fragility of Natural Rangeland Systems:

Suitable land for grazing constitutes about 70% of the area of Iraq. Most of it is located in the unguaranteed rain areas and mostly under rain line 200 mm/ year. The vulnerability of natural rangeland systems is represented in the

strong affected land as a result of shortage and variation of annual rainfall and the resulting decline of suitable land for grazing. The unjust use of available natural rangeland due to lack of awareness of the importance of good and rational grazing among herders leads to the increase of the vulnerability of natural rangeland systems. Grazing cattle is done in early stages of natural plant life which leads to the depletion of natural plant and its non-growth again even if a suitable rainfall is available. The decrease of natural rangeland effectively affects the livestock based on grazing as a food source, which is estimated of about 50% camels, 36% goats, 34% sheep, 25% buffalo and 23% cows of total livestock in Iraq (National Survey Report of Livestock 2008/ Ministry of Agriculture and Ministry of Planning).

Decline of vegetation, land degradation, lack of forestation and problems of salinity have also contributed in the increase of desertification phenomenon suffered in Iraq. They constitute significant environmental problems, particularly creeping of desert sand dunes on the agricultural land, agricultural infrastructure, roads and others.

Expected Impact:

Expected decline of rainfall and increased drought caused by climate change will be a pressure on natural rangeland, which already suffers from degradation, resulted of the depletion of natural vegetation. This will be directly reflected on the benefit of rangeland in providing food for cattle. An increase of desertified land area as a result of the creeping sand dunes from the desert towards agricultural land and increase of dust and sand storms with their adverse effects on humans and the environment are also expected.

3.2.1.4 Vulnerability/ Fragility of Livestock Sector:

This sector could be affected by the consequences of climate change as a result of several factors, mainly:

a- Decline of cultivated land area of fodder.

b- Adverse effects on animal health resulted of emergence of new diseases.

c- Adverse effects on animal productivity due to thermal stress.

There is a need for detailed studies on the impact of climate change on farm animals' health, meat and dairy production.

3.2.1.5 Vulnerability/ Fragility of Planet Pest Sector:

The expected impact on plant pest varies according to the climate cause, as the climatic conditions constitute one-third of the responsible factors for occurrence of the disease within the Disease Triangle. Those factors are the live pathogen, susceptible host and suitable environmental conditions. Impact of temperature might accelerate or delay the appearance of the pest, for example; the Dubas Bug (Ommatissus binotatus lybicus Bergevin) which widely spread in Iraq is affected by high temperature and appearance of pest nymphs at timing of pest combat. There is a need to conduct in-depth studies in this regard.

3.2.2 Adaptation:

3.2.2.1 Adaptation Procedures:

The Iraqi Government has taken, through the Ministry of Agriculture and other relevant national stakeholders, several procedures that could be considered for adaptation to the impact of climate change which clearly appeared on Iraq in recent years. Most important procedures are:

a- Implementation of a project to use sprinkler irrigation in cultivating strategic crops like wheat and barley in particular, in order to rationalize water use and support drip irrigation in cultivation of vegetables and horticulture.

b- Establishment of rangeland stations in the pastoral areas in Iraq to produce pastoral planets, especially planets tolerant to drought and salinity. Then, transfer these plants and cultivate them in pastoral areas in order to develop the deteriorated natural planet and reduce the area of open land exposed to drought and thus, causing dust storms.

c- Implementation of a project to stabilize moving sand dunes that affect the cultivated land, infrastructure of irrigation and drainage projects and roads. As well as the establishment of green belts at areas where sand dunes were treated.

d- Establishment of desert oases project depending on groundwater to save drinking water stations, grazing cattle and increase green rangeland, as it is considered sources for propagation and development of natural planet types.

e- Establishment of agricultural meteorological stations in all governorates of Iraq to provide relevant information and analysis of weather and climate sector, including climate change impact.

f- Development of strains of drought-tolerant crops, resistant to salinity and compatible with the local environment, especially for wheat crop.

g- Establishment of Al-Berjesseh oasis project (entertaining-tourist) of 409 donum area and includes a green belt of 4 km length and 9 lines of Conocarpus trees width (about 20 meters). Depending on drip irrigation and wells dug in cooperation with the Ministry of Water Resources in the area and implemented by the Ministry of Oil/ South Oil Company in the governorate of Basra, south of Baghdad. Iraq requires financial and technical support to expand working in such important projects.

3.2.2.2 Proposed Adaptation Procedures:

The proposed adaptation procedures could be divided according to the nature of climate change impact on various sectors, as illustrated in table (3-4) below:

Table (3-4): Proposed Adaptation Procedures in the agriculture sector

Nature of Impact	Proposed Adaptation Procedures
• **Lack of crop production due to expected decrease in cultivated land areas within the rain-fed land.**	1- Improve management of rain-fed agriculture by digging wells and applying complementary irrigation. 2- Upgrade irrigation efficiency in irrigated agriculture through development of field irrigation using developed drip, sprinkler and surface irrigation methods. 3- Further research on development of crop types tolerant to high temperature and drought, with less water consumption. 4- Establish effective monitoring system of weather-crop during the agricultural seasons, including early warning system. 5- Enhance the capacity of strategic crop storage, like wheat and barley to confront potential drought seasons.
• **Degradation and decline of rangeland.** • **Increased area of desertified**	1- Dig wells for drinking purposes and cattle grazing in desert areas and expand establishing natural reserves. 2- Use sophisticated methods to restore and increase natural plant in pastoral areas, particularly in the western desert, including expansion of (pastoral)

Nature of Impact	Proposed Adaptation Procedures
land	wild plant seeds production. 3- Expansion of soil stabilization projects to reduce the problem of creeping sand dunes, using sophisticated methods that commensurate with the nature of the problem in Iraq. 4- Apply water harvesting techniques and expand it in desert areas to take advantage of the resulting floods of rain. 5- Develop an effective system to monitor desertification and natural rangeland.
• **Emergence of new types of animal and plant pest and diseases.**	1- Use integrated agricultural pest control methods to reduce reliance on pesticides and herbicides in agricultural systems. 2- Introduce and develop plant varieties resistant to disease and compatible with climate change. 3- Develop strains of cattle adapted to climate change, disease-resistant and of high productivity. 4- Conduct studies and researches to improve understanding of the climate change consequences on animal and plant health, confrontation methods and required adaptation.
• **Institutional issues**	1- Review agricultural policies and strategies with consideration to climate change issues and required adaptation methods. 2- Promote research and studies regarding climate change impact on agriculture and better ways of adaptation, e.g. study of cultivating timing to confront high temperature and increase of water requirements. 3- Develop an effective system for monitoring and control, as well as awareness to improve the understanding of climate change consequences, especially drought impact. It ensures, at the same time, easy access to information at appropriate times for the purpose of suggesting possible response behavior. Thus, rapid deployment of results and information to allow both government and farmers benefit and take appropriate adaptation procedures.

3.2.3 Conclusion and Recommendations:

The agricultural sector is the most affected by the contrast of weather conditions and climate change in Iraq. This is mainly caused by the impact of rainfall variation and decline of water resources on the agricultural production; both plant and animal. These effects are mainly reflected on small farmers and livestock breeders. Most important recommendations regarding effects and adaptation to climate change in the agricultural sector could be summarized in the following, as a priority for the current phase:

a- Conduct targeted studies to identify climate change impact on staple crops, particularly wheat and fodder crops, in conditions of irrigated and rain-fed agriculture, alike.

b- Work to establish and develop an effective system for monitoring and enhancing agricultural seasonal climate predictions.

c- Improve field irrigation at the farm level and raise the efficiency of using water unit.

3.3 Biodiversity

Biodiversity is one of the important elements in life. Ecosystems are also considered an important source of food and life sustainability. There is a close linkage between biodiversity and local population dependent on ecosystem services. The Synthesis report of the Intergovernmental Panel on Climate Change (IPCC, 2007) indicated that the warming of the climate system has become clear and unambiguous. The past eleven of the twelve years since 1995 to 2006 were the warmest years in the measurements records of the global surface temperature since 1850. Reports of IPCC of (1990, 1995, 2001 and 2007) indicate that the expected climate change is considered one of the main threats to biodiversity. This will be reflected on ecosystem services and sustainability of species in the future. Meetings of State Parties to the Convention on Biodiversity confirmed in 2010 after meeting at COP10 in Nagoya, Japan, the importance of containing the global strategy objectives of

diversity the basic components for planning to reduce biodiversity loss and the importance of building resilience for ecosystems and biodiversity. As well as, the need to distinguish the contribution of ecosystems, diversity in mitigation and adaptation of expected climate change (BirdLife International, 2011). Talks of State Parties to UNFCCC COP18 in Doha has also referred to the need for states to develop national plans for climate change and identify loss and damage spots attributed to climate change (Bird Life International, 2012).

Most important global factors that affect the biodiversity are rise of seal level, increased acidity of oceans and rivers and high temperature on land, oceans and wet land. The fourth report of IPCC pointed out the rise of average temperature in the globe about 1.5-2.5 °C leading to the extinction of 25-30% of species. The Synthesis report of the Intergovernmental Panel on Climate Change (IPCC, 2007) confirmed that early appearance of signs of spring in land ecosystems was noticed. In addition, transition range of areas where plants and animals live towards polar direction and above, the undoubtedly proven phenomenon of global warming. As well as, the abundance of algae and plankton in the marine systems related to changes of ice cover and levels of oxygen. Temperature is expected to increase 2-4 °C in the Arab region. Iraq is part of this region and has natural areas that are very vulnerable and sensitive to any climate change, as well as other effects and risks. Iraqi meteorological studies indicated that the average rate of temperature has increased 0.4 °C over the past forty years; it is expected to continue increasing in the coming decades along with the continuous decline of rainfall rates.

The importance of species biodiversity in Iraq is due to the presence of migratory species, which Iraq represents an important part of their life cycle. This includes the endemic species or semi-endemic, particularly in the unique Iraqi ecological systems, as well as threatened or endangered species. The red list of the International Union for Conservation of Nature (IUCN) referred to the cases of preserving the Iraqi species. Reports of the Ministry of Environment and Nature of Iraq Organization also referred to the presence of about 417 species of birds, of which 182 are migratory species and 18 worrisome types in terms of sustainability. Furthermore, same reports indicated the existence of 106 species of marine fish and freshwater fish and confirmed lack of information pertaining to insects, amphibians, reptiles and mammals. There are approximately 4,500 species of plants recorded in the (Flora of Iraq), with a secondary list of 195 kind of Iraqi endemic plants (Fourth Biological Diversity Report, 2010). The biodiversity in Iraq faces direct, indirect challenges and threats as a result of the steadily growing population, urban expansion, urbanization and the climate changes. Several ecosystems were identified in Iraq, according to the regional bio geographic plan

proposed by the World Wide Fund for Nature (WWF). Table (3-5) illustrates these systems.

Table (3-5): Ecosystems in Iraq, according to the classification of WWF

Range (Biogeography Region)	WWF Middle East Biomes	WWF Eco-regions according
	Land	
North Pole	Wide temperate forests	1- Eastern Anatolia deciduous forests. 2- Zagros Mountains forests.
	Temperate grassland, Savannas and shrub lands	1- Middle East Steppes. 2- Eastern Anatolia Mountainous Forest.
	Flooded Grassland and Savannas	1- Euphrates alluvial marshlands. 2- South Iraq Nubo-Sindian Desert and semi-desert.
	Mediterranean forests, woodland and Scrub	1- Eastern Mediterranean forests.
	Deserts and shrub lands	1- Desert of Mesopotamia. 2- Arabian Desert and Arabian desert shrub lands. 3- Desert and semi-desert of the Red Sea. 4- Desert and semi-desert of the Arabian Gulf.
	Marine	
Range	**District**	**Eco-region**
Western Pacific and Indian Ocean	Arab Somali	Arabian Gulf

Biomes could be considered as main types of habitats. Eco-regions are accurately known as "geographically distinguished areas of land that are characterized by a special climate, unique ecological features and distinctive plant and animal communities". Based on that and with consideration of the availability of additional very small areas of coastal marine ecosystems on the Arabian Gulf, the following six categories could be considered the main habitats in Iraq: 1- Marshland, 2- Arabian Desert, 3- Mesopotamia Shrub Deseret, 4- Middle East steppes habitats, 5- Forests of Zagros Mountains, and Coastal Marine habitats.

1- Marshland:

Marshlands are one of the most important ecosystems of Iraq. They represent one of the richest areas of biodiversity in Iraq. They are located in southern Iraq and administratively included within the governorates of Thi-Qar, Basra and Missan. They receive water from permanent rivers (their main sources are Tigris, Euphrates and their tributaries) and seasonal streams (valleys) receiving seasonal rain fall. Part of the marshes of southern Iraq have been included in the Ramsar list of wetlands of international importance, since they regularly harbour considerable numbers of threatened, endemic and restricted-ranged bird and mammal species and they also provide a home and livelihoods for many indigenous people living there; the Marsh Arabs (Ma'dān), figure (3-12).

Figure (3-12): Iraqi Marshlands (Nature of Iraq, 2013)

2- Arabian (Western) Desert:

The Arabian Desert spreads, as an ecosystem, from Oman into Iraq and it is characterized by very little rainfall with oases and occasional seasonal water coming from the valleys only during spring and winter rain season. The natural features and biodiversity of this area almost completely unknown and require

more study. Hyenas, wolves and gazelles are well known in this region and among them the threatened Goitered Gazella (Gazellasubgutturosa), while the Arabian Oryx is considered extinct. This ecosystem is populated by the nomads (Bedouins) that use the oases and seasonal rain habitats to seek pastures for their herds of goats, sheep and camels, figure (3-13).

Figure (3-13): Al-Anbar Desert (Nature of Iraq, 2013)

3- Deseret of Mesopotamia:

The ecosystems pass through Tigris and Euphrates valleys and include part of the Syrian Desert and the northern steppe region. The climate is arid and hot, similar to that of the Arabian Desert. Human settlements are primarily located around river basins. Main natural features and important species of this region include seasonal wetlands and valleys which support the survival of types of birds (such as, the critically-endangered Sociable lapwing) and other wild species, as well as of cattle and people depending on it, figure (3-14).

Figure (3-14): Desert of Mesopotamia (Nature of Iraq, 2013)

4- Middle East Steppes Habitats:

This area could be divided into a dry/moist steppe of open shrub or grassland extending from western Jordan and Syria to northern Iraq, crossing the Tigris-Euphrates valleys and ending in the foothills of Zagros Mountains. This grassland habitat is considered very important for the Bedouins that use to bring their herds here during spring and summer. Many bird and mammal species which are locally or globally protected depend on this diverse environmental system, which is dry and wet at the same time.

5- Forests of Zagros Mountains:

This region crosses the northern mountainous border of Iraq in Kurdistan and expands further into Iran. The climate is semi-arid and semi-temperate, with temperatures that can decrease to -25 °C in winter. This region is very important in terms of biodiversity, as it has been assessed as an area with a high rate of endemism; figure (3-15).

Figure (3-15): Barzan Forests in Kurdistan region (Nature of Iraq, 2013)

6- Coastal Marine Habitats:

Tigris and Euphrates Rivers end at the Gulf forming the Delta of Shatt el Arab. Iraq has about 70 km of coastline and 712 Km^2 of regional water. The water quality of the input rivers is greatly influenced by the Gulf. Quality has been recently declining due to the increasing sedimentation caused by the drainage of the marshlands. Coral reefs in this area are of particular concern and they represent a threatened natural wealth.Recently, University of Basra has discovered a 28 km^2 of Coral Reef in the Iraqi regional water in the south of Iraq after the thought that no Coral Reef exist in Iraq (Pohl, T. and et al.

2014). This discovery extends the work area in this field and motivates the Iraqi government, the international organization, local organizations and scientific institutions to pay more attention, focus, and support this field by conducting further detailed studies and scientific papers, especially those interested in the impact of climate change on the coral reef. The coral reef is affected by the rise of water temperature and the water acidity due to climate change; figure (3-16) and figure (3-17) illustrates the general natural environments in Iraq.

Figure (3-16): Al-Faw in southern Iraq (Nature of Iraq, 2010)

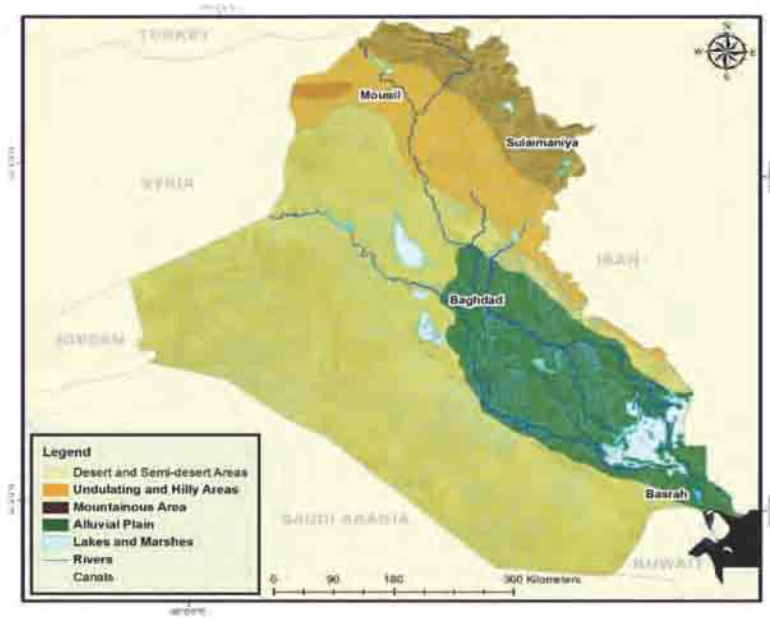


Figure (3-17): General natural environments in Iraq

3.3.1 Vulnerability/ Fragility of Biodiversity:

Ecosystems and biological diversity in Iraq are vulnerable to climate change impacts in various rates according to their geographical locations, type of motive and climate impact. Reports of the Iraqi Meteorology Organization indicate that the rain line has changed in the new millennium from the former status in the 1970s, the 100 mm rain line has moved from Lat. W: 32, E: 29 to Lat. W: 33.3, E: 30; and the disappearance of 700 mm rain line from the rain map of Iraq. In addition, reports indicate a proven increase in temperature throughout Iraq which could impact changes to ecosystems and biodiversity, thus they could cause the removal of some species especially those depending on rain or wetlands in their lifecycles. Table (3-6) presents some examples of various ecosystems in various geographical locations.

Table (3-6): Vulnerability, sensitivity and adaptability to climate change of some examples of ecosystems

Geographical System	Example	Location in Iraq	Climate Change Vulnerability	Sensitivity	Adaptability
Wetlands	Marshes	South	✓	Highly sensitive	Governmental intervention with high costs
Steppe	Al-Baghdadi, Haditha	West	✓	High	Governmental intervention
Mountains	Piramagroon	North	✓	Medium	Adaptable
Marine coasts	Khor Al-Zubair	South, Arabian Gulf	✓	High	Adaptable with high costs

Three main vulnerable to climate change locations could be identified of biodiversity in Iraq, represented by:

1. The marshland ecosystems all over the country, particularly in southern Iraq, where many indigenous communities historically depend on them and where, due to their former extension, a great part of the local economy is based on.
2. The forests in the mountainous region of northern Iraq (Kurdistan Region).
3. Lakes and rivers all over the country.

The marshland environment represents the most vulnerable area.

3.3.1.1 Marshland:

Southern marshlands of Iraq are divided into three main marshes and ten sub-marshes according to the Atlas of CIMI (2010a). The southern marshlands, according to the categorization of the Ministry of Environment, consist of eight sequential sites containing four natural heritage components and four cultural heritage components. This property extends in the governorates of Amara, Nasiriya and Basra with an overall area of 418,541 hectare, including water bodies and their shores. According to Koppen (1936) categorization of the global climate, marshlands lie within the main dry climate area that is characterized by high evaporation and transpiration in comparison to the rainfall quantity. Such climate extends 20 to 35 degree north and south of the equator. It is represented by great continental areas mainly surrounded by mountains. The main climate is divided into sub-climates, here it is dry arid of the actual desert climate and covers 12% of the surface of earth with heat-resistant plant cover or adaptive vegetation in areas of few water. Temperatures in the area are more than 50 °Cin summer and reaches zero in winter with annual temperature rates ranging between 22.2°Cand 27.2 °C.

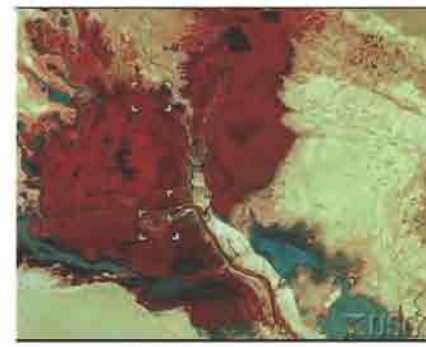
Reports of the Iraqi Ministry of Environment and Nature of Iraq Organization of the Biodiversity Areas consider the marshlands as Key Biodiversity Areas (KBA), especially the Important Bird Areas (IBA).There are 42 IBA in Iraq, 7 of them are in the southern marshlands (Evans, 1994). However, after the draining of marshlands in the 1990s, they shrank to 14% in 2002 of their original quantity in the 1970s (Figure 3-18), (Nature Iraq Master Plan, 2006). The scene in the marshlands changed upon restoration efforts in 2003, especially for IBA and KBA, as immersion this time differed from that of the 1970s and it restored only 55% at best (Nature Iraq Master Plan, 2006).The Iraq government, in cooperation with UNEP and UNESCO, is considering the possibility of regarding marshlands for World Heritage Site according to the international world heritage agreement and the IUCN. Such effort serves other international conventions like Convention on Biological Diversity and Ramsar Convention for Wetlands. The study of Garstecki and Amr (2010) analyzed the most of the available data on marshlands in relation to the world heritage criterion five (biological diversity) and they noticed a significant correlation in the value of marshlands in terms of criteria four and five. Biological diversity and ecosystem of the marshlands support the economy and culture of the marsh dwellers that add an important and indirect cultural value.

Marsh dwellers had been using marshlands for millennia. The traditional ways of using the natural resources throughout history are considered a vital heritage value for the management of the natural system of marshlands and provide the answer for the fifth criterion of the world heritage. That requires an exceptionally traditional human settlement or a traditional use of lands or

seas in such a way that represents a culture or human integration with vulnerable and irreplaceable environment (Garstecki and Amr (2011).

The lifestyle of the marsh dwellers which they inherit from their Sumerian ancestors is most prominent feature of the marshlands. Many of the marsh dwellers still used to live inside the water vastness of the marshes and along the shores, as well as the huge numbers of buffalos as the important feature of marshes. Records of the national survey of the Ministry of Agriculture of 2008 indicate that there were 49,283 buffalos in Nasiriya, 24,345 in Amara and 57,704 in Basra. Those numbers are in general for urban areas and marshlands. Haidar, et al (2007) reported in their study that there are about 40,008 buffalos only in marshlands of Amara and Nasiriya with milk production of both governorates of about 22,055 L/day. These figures area good indicator of the amount of services provided by the environmental marshland system for the marsh dwellers and reflecting the necessity of setting adaptation planning for the marshlands and the marsh dwellers to face threats like urban expansion, migration from other places into the marshlands, oil development, impacts and stresses of human activities and climate change as this ecosystem is highly vulnerable (Figure 3-18). Table 3-7 shows the key values urging the conservation of marshlands and planning for their future adaptation.

1990



1972

2013

1997

Figure (3-18): Satellite image showing the area of marshlands: 1970s and 1990s

Table (3-7): Key values for some ecosystems to be natural protected areas

	Traditional knowledge	Distinguished natural features	Ecosystem services	Cultural value	Supporting dwellers	Red listed species	Important for natural habitats
1. Marshlands	☑	☑	☑	☑	☑	☑	☑
2. Al-Baghdadi-Haditha	☑	☑	☑	☑	☑	☑	☑
3. Piramagroon			☑	☑	☑	☑	☑
4. Khor Al-Zubair			☑		☑		☑

3.3.2 Methods of Adaptation:

Policy makers and stakeholders in Iraq have to cope with the effects of climate change on biodiversity. They have to intensify efforts to address the current and future effects, try to adapt to the new conditions and to stimulate and enhance resilience of the affected ecosystems. Some suitable adaptation strategies for Iraq could be identified through the system of enhanced steps to adaptation, which focus on three main dimensions at this stage. It is represented in promoting procedural policies, natural protected areas, raising awareness and promoting human capabilities.

3.3.2.1 Procedural Policies:

Policy and legislation to address and mitigate the future effects of climate change are essential tools for all affected sectors; coordination among sectoral policies and legislative measures are mostly required in order to make their results effective. Legislation at this phase is the baseline for

implementing every protection/remediation/prohibition measures that are necessary to mitigate or to prevent climate change impact. In particular, some of the fields that legislation should address are as follows:

1. Establishment of a national water framework and/or cross-borders regulations that would guarantee a regular water flow for the main rivers and tributaries which feed the main marshland clusters in Iraq, with a particular focus on those areas that provide substantial livelihoods for people.
2. Establishment and implementation of a wildlife (animals and plants) framework law to regulate hunting, fishing and collection and trading of natural resources through defining the seasons and methods of implementing these activities.
3. Develop and update a clear legal framework for water quality.
4. Impose a number of restrictions and sanctions concerning the introduction of hazardous noxious substances and species (e.g. invasive species) into natural systems. As well as preparing a list of hazardous practices to be avoided in: agriculture, breeding, aquaculture operations, fishing, hunting, scientific research and laboratory testing.
5. Develop a national legislative framework for protected areas, focusing on organizing tourism activities.

3.3.2.2 Protected Areas:

Climate change impact on ecosystems and their biodiversity might be rapid and threatens many of them in the coming years. Therefore, mitigation measures alone are not adequate to avoid these adverse effects and thus, adaptation measures should be focused on to promote the status of natural reserves, including marshlands. National efforts should be directed towards procedures to increase the resilience of overall biodiversity by several methods, including the following:

1. Combat or remove threats to biodiversity and natural species/ecosystems.
2. Establish networks of protected areas with passages that provide spread and migration routes for animals and plants and allow avoiding local extinctions. Ministry of Environment is currently working under the umbrella of international conventions like Convention on Biological Diversity to announce about 15 national protected areas until 2020, as part of the convention's objective of protecting at least 17% of the total area of Iraq.

3. Once the nature reserves have been established, it is important to take a number of procedures, such as:
    - Maintain the natural vegetation through environmental gradients (e.g. latitude and altitude gradients, soil moisture gradients, etc.).
    - Establish buffer zones around natural reserves.
    - Minimize habitat fragmentation and road construction.
    - Maintain genetic diversity within and among numbers of native species.

3.3.2.3 Promotion of Awareness:

Many achievements can be accomplished to promote adaptation strategies to climate change if the awareness of stakeholders is raised regarding usage of these natural environments and its various imports. This would assist in removing some of the pressures on natural ecosystems, to be based on a set of relevant concepts and information and that it should be delivered to stakeholders, in order to enhance communication between them and the decision-maker. Most important issues to focus on in the coming period are:

- Rationalize water use in agriculture and avoid wasting and polluting water.
- Illegal hunting, fishing (like poisons and explosives) or the so-called overfishing. As well as preventing fishing in spawning times and all animal and plant species in an unsustainable method.
- Use fertilizers and other chemicals in an unsustainable method.
- Polluting water sources and the importance of establishing waste collection and treatment stations and water treatment stations.
- Avoid root-cutting of trees and other agricultural practices that can increase the erosion risk and promote desertification and dust storms.

3.4 Health Sector

Climate change contributes in increasing the global burden of diseases and premature deaths. Humans are exposed to climate change through the change of weather patterns, such as temperature, rainfall, rise of sea-level and extreme and more frequent weather events. As well as, the indirect exposure through water quality, air, food, and changes in environmental, agricultural, industrial, settlements and economic systems. At early stage, these effects are few, but they are expected to gradually increase in all

countries and regions in the coming years. Properly climate change would lead to the change in distributing of some infectious disease vectors, change of seasonal distribution of some types of pollen that cause allergies, increase of heat waves related deaths, increase of diarrheal diseases, increased morbidity rates of respiratory system and mortality and increased number of people at risk of dengue fever; as temperature is expected to increase worldwide, especially in developing countries (IPCC, 2007). Report of the United States Environmental Protection Agency (EPA) of 2012 indicates that climate change impact on health depends on many factors, including effectiveness of the safety of public health and society for treatment or preparedness to risk, behavior, gender and economic status of affected people. It is likely that the impact varies according to the region, sensitivity of population, extent and duration of exposure to effects of climate change and society's ability to adapt with this change (EPA, 2012).

Report of WHO for 2012 indicates that climate changes have impacts on health, because they affect the basic requirements of health and safe shelter. High temperature increase directly contributes to deaths caused by heart disease, mental illness and common vector-borne diseases, such as malaria and dengue fever. In high temperature levels of pollen rise and other substances found in the air and cause allergens and asthma, which will increase due to the continued increase in temperature. Change in rainfall patterns increase the risk of diarrhea and water scarcity lead to drought and famine. As for floods, they are considered one of the pollution factors of freshwater supplies because they increase the risk of water-borne diseases and constitute a breeding ground for disease-carrying insects, such as mosquitoes. High temperature and change of rainfall patterns will result into the decline of basic food production and increase of prevalence rate of undernourishment, malnutrition and malaria. Worldwide population will be affected by climate change, but developing countries population are the more vulnerable, especially children living in poor countries, elderly and disabled or of ill health (Factsheet, November 2013). Infectious diseases cause serious damage to population around the world. Some of the deadly diseases are highly sensitive to climatic conditions. Temperature, rainfall and relative humidity have strong impact on the proliferation of mosquitoes that carry malaria, dengue fever and food and water-borne diseases, such as cholera and other diarrheal diseases. Dry warm climate helps infection with meningitis. Health departments have achieved in the recent years significant progress in the control of all these diseases; that might cause death and human suffering in the foreseeable future (WHO, 2012).

One of the important challenges to control all these diseases is in understanding its spatial and temporal distribution and to predict it, if

possible, to allow control programs guide interventions and predictions of epidemic diseases and its prevention. All these diseases are affected by climate and weather changes. Their impacts are determined by other factors, directly related to poverty and poor capacity of health programs that do not provide water, vaccinations, drugs and health facilities that could be relied on by population. Unplanned urban expansion contributes in the spread of dengue fever and locations for mosquito breeding in the waste of families. Meteorology departments could through work with disease control programs and the assistance to know places, apply the received information as effectively as possible (WHO and WMO, 2012).

Iraq, one of the Arab region countries, might be affected by climate change as it has been facing a series of changes in recent years; high frequency and severity of weather events associated with drought, increased dust phenomena and increased environmental degradation. Climate change could impact health in Iraq and result into increased mortality rate, certain diseases transmitted by water and food, some communicable diseases like cholera, malaria, and typhoid. As well as, other non-communicable diseases like respiratory diseases of allergy, asthma, heart attacks and increase of malnutrition diseases. Impact of climate change on health depends on many factors, including safety of public health, community behavior, gender, economic status of individual which vary from one region to another, sensitivity of population and extent of exposure to climate change (Report of UNICEF, WHO, WFP and UNDP, 2012).

Iraqi government has sought through plans and programs to expand basic health care services to all citizens free of charge. Ministry of Health in Iraq has adopted during the past period a health system of primary health care as a fundamental pillar. It includes provision of health services according to quality standards as the first level of services provided to the citizen, while ensuring integration of these services with the second level (public hospitals) and the third level (specialized centers) under the supervision of the Ministry of Health and through applying family medicine system in health centers and health visitor system.

This system focuses on the introduction of a package of health services in health centers that provide monitoring and examination services for women and children, tables (3-8) and (3-9). These services are provided at maternal and child hospitals as well. The health system in Iraq includes all preventive and curative institutions, reproductive health centers, school clinics, fixed and mobile health centers, laboratories, pharmaceutical factories and other of direct and indirect relationship to health of the citizen.

Iraqi Ministry of Health has adopted many decisions and laws, among them the launch of the strategy of non-communicable diseases, the national

strategy of reproductive health, survey of maternal mortality and the national health policy to provide integrated and comprehensive services to all members of the community, at highest levels of quality and through investment of available resources in accordance to the ethics of the profession and society values to ensure sustainable health development and reduce incidence of diseases and mortality. Figure (3-19) illustrates the percentage of population with access to primary health care services (Iraqi E-government portal, 2013).

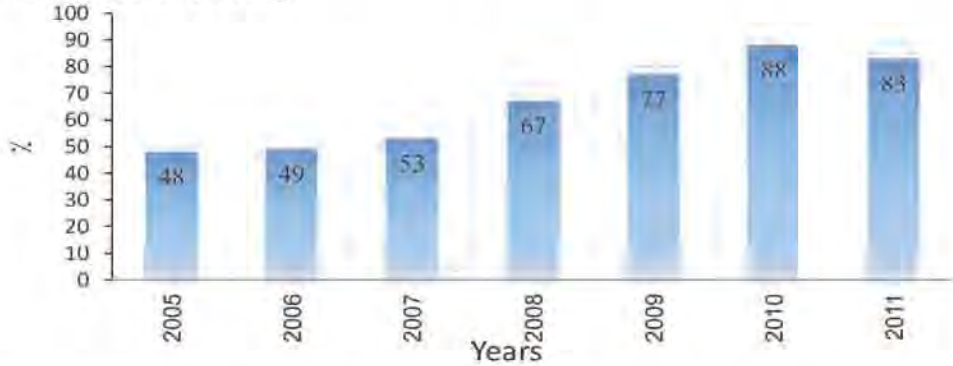


Figure (3-19): Percentage of population with access to primary health care services for (2005-2011), Statistics of the Iraqi Ministry of Health

3.4.1 Vulnerability of Health Sector (Fragility):

Over the past four decades, Iraq faced serious health risks as a result of environmental degradation and destruction of infrastructure due to wars, sanctions and occupation that led to a decline in human, financial and technical capacity of the health sector (Iraqi E-Government portal, 2013). Health services were deteriorated, mortality rates increased and spread of some epidemic and contagious diseases increased, particularly cholera and dysentery (Al Hilfi, 2013 and UN, 2012). Tuberculosis and leishmanias are diseases still represent a problem for health institutions, although number of patients have decreased (UNAIDS, 2012; Khwaif et al., 2011 and Al-Nasrawi et. al., 2010). Iraq suffers from water-borne diseases that have become common, such as typhoid, cholera, malaria, malnutrition diseases and childhood diseases; figure (3-20) illustrates number of cholera infections for (1999-2012) for all governorates, except for Kurdistan region (Statistics of the Iraqi Ministry of Health, 1999-2012).

Figure (3-20): Number of cholera infections for (1999-2012) for all governorates, except for Kurdistan region (Statistics of the Iraqi Ministry of Health, 1999-2012)

Control of malaria in Iraq was achieved through taking environmental therapy procedures and measures. Table (3-8) illustrates some of the communicable diseases; by disease and age groups for 2011.

Table (3-8): Some of the communicable diseases; by disease and age groups for 2011

Disease		Under 1 year	(1-4)	(5-14)	(15-44)	(+45)	Total
Measles		260	354	327	70	6	1,017
Rubella		8	7	3	2	0	20
Chickenpox		2,056	13,779	48,236	8,943	786	73,800
Typhoid		203	1,976	7,004	18,384	6,298	33,865
Cholera	Infected	0	0	0	0	0	0
	Carrier	0	0	0	1	0	1
Anthrax		0	0	0	2	0	2
Hemorrhagic fever		0	0	0	5	1	6
Leishmaniasis	Cutaneous Leishmaniasis	204	761	1,016	919	146	3,046
	Black fever	389	730	79	9	0	1,207
Toxoplasmosis		1	0	8	1,083	4	1,096
Echinococcosis		14	19	187	922	309	1,451
Malta fever		14	149	997	4,168	1,623	6,951
Hepatitis	A	37	1,780	2,252	486	54	4,609

Disease		Under 1 year	(1-4)	(5-14)	(15-44)	(+45)	Total
	B	8	37	242	2,204	808	3,299
	C	8	61	117	592	393	1,171
	E	0	24	88	273	18	403
	Clinical	639	2,564	4,094	5,980	1,952	15,229
Bilharziasis		0	0	0	0	0	0
Leprosy		0	0	0	0	0	0
Dysentery		190	338	301	397	242	1,468

Source: (Annual Report of the Iraqi Ministry of Health, 2011)

Iraq faces serious health risks due to the declining economic potential of the citizen. Thus, leading to high mortality rates (figure 1-13); deterioration of health services and exacerbate the psychological and physical burden on citizens. According to the statistics of the Iraqi Ministry of Health, incidence of diarrheal diseases has increased of less than one year ages for (2004-2012), figure (3-21). Percentage of asthma incidence rates remained very high during (1997-2012), as shown in figure (3-22).

Figure (3-21): Number of Diarrhea cases for ages of less than five years for the period (2004-2012), Statistics of the Ministry of Health

Figure (3-22): Number of Asthma cases in all governorates, except for Kurdistan region for (1997-2012)

3.4.2 Means of Adaptation:

There is an urgent need to develop clear and specific adaptation measures to assist the specialized health authorities in Iraq be prepared and mitigate adverse effects that might increase the vulnerability of health conditions. This could be done through enhancing health systems, public health services, access of people to clean drinking water, follow-up mosquito breeding areas and conducting studies in this regard. As well as, follow-up of upgraded sanitation services to reduce diseases that may exacerbate with climate change, like Diarrhea. Programs of communicable diseases outbreak control and focusing on health awareness are also to be strengthened. Table (3-9) illustrates most common diseases that might be affected by climate change in the coming period.

Table (3-9): Most common diseases that might be affected by climate change in Iraq

Disease	Type of Disease	Iraq, according to WHO reports	IPCC
Communicable Diseases	Parasitic diseases	Yes	Yes
	Vector-borne diseases	Yes	Yes
	Malaria	Yes	Yes
	Cholera	Yes	Yes
	Hepatitis	Yes	Yes
	Typhoid	Yes	Yes
	Tuberculosis		

Disease	Type of Disease	Iraq, according to WHO reports	IPCC
Water and Food-borne Communicable Diseases	Diarrhea	Yes	Yes
Non-communicable Diseases	Cardiovascular pulmonary diseases	Yes	Yes
	Respiratory system diseases	Yes	Yes
	Malnutrition	Yes	Yes

Iraqi Ministry of Health works hard to achieve the strategic objectives of the state in the health sector through developing specific policy and objectives, taking into consideration the demographic and geographical factors and their impact on health sector, table (3-10).

Table (3-10): Strategic objectives of the Ministry of Health

Strategic Objective	Policy (Specific Objective)
Establishment of institutional work culture, improve and develop quality level and enhance control systems	Adoption of unified mechanism for strategic planning based on participation in formulating, implementing, monitoring and updating administrative regulations, laws, legislations and development of control systems.
Development of information and e-health systems	Development of infrastructure to operate information systems and unify health information and management systems.
Optimal use of financial resources and application of health economics	Enhance operational efficiency, expenditure of financial resources, develop financial planning methods and adopt modern methods for budgeting.

Strategic Objective	Policy (Specific Objective)
Adoption of integrated and comprehensive approach of health care and promotion of scientific research activities	1- Upgrade infrastructure of health institutions. 2- Develop primary health care and health promotion. 3- Develop emergency services and management of crisis and disaster. 4- Prevention and control of communicable diseases. 5- Prevention and control of non-communicable diseases. 6- Development of specialized secondary and tertiary health care. 7- Development of diagnostic and testing laboratory services, oral and dental health services and enhance health scientific research activities.
Development of human resource	Development of planning methods for human resources management and capacity building of human resources in all fields.
Insurance and optimum use of medicines and medical technology	1- Develop procurement, storage and distribution methods. 2- Develop methods of estimating needs of medicines, medical supplies and devices. 3- Promote rational use and ensure safety of medicines and medical supplies. 4- Support local pharmaceutical industry and enhance strategic partnership with global pharmaceutical companies. 5- Develop management mechanisms and usage of medical equipment and technologies. 6- Develop pharmacological control and vigilance methods.

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MITIGATION OF GREENHOUSE GASES

4. Mitigation of greenhouse gases

4.1 Introduction

This chapter provides an overview of reduction of priority greenhouse gases emission. Iraq, as a non-Annex I signatory to the UNFCCC, is not obliged to reduce emission. Nevertheless, an evaluation of key technology options to reduce greenhouse gases emissions in Iraq will provide a better understanding of potential synergies. These options are integrated with national development goals and priorities to assist setting specified and clear lines and policies for the sustainable development. Benefits of preparing this report include, but are not limited to, reduced air pollution levels, enhanced institutional environment for new and diversified technologies, power supply, reduced traffic jam, and employment creation.

In 2009, Iraq became the 194th country to ratify the United Nations Framework Convention on Climate Change (UNFCCC). Therefore, after almost three decades of isolation from the international community, Iraq has to work hard to catch up with other countries in this regard. The Ministry of Environment has only recently been established. Thus, there is limited national expertise to assist in addressing challenges of climate change and to assess potential threats and impacts on its natural resources, environment and people.

The inventory of greenhouse gases emissions for Iraq in 1997 indicates a set of conclusions; the following are the most important:

- 75% of total greenhouse gases as CO_2eqv.were from the energy sector; 11.1% from the agriculture sector; 8.8% from industrial processes and 5.1% from waste sector.
- Methane emissions generated from household solid waste landfills was 51% of the total CH_4 emissions. The agricultural and the energy sectors contributed by 42% and 6.9% of the total CH_4 emissions, respectively.
- Nitrous oxide (N_2O) emissions generated from agricultural sector and wastewater treatment (human sewage) were 94.4%, and 5.6% of the total N_2O emissions.

This chapter aims to provide an analysis of measures to reduce greenhouse gases emissions and enhance drainage as part of the Initial National Communication of Iraq. It also describes the mitigation methodology and discusses issues that came up during conducting mitigation assessments for specified sectors. Two types of scenario were used for the analysis; the baseline scenario and mitigation scenario.

The baseline scenario was based on the trends, plans and policies prevailing in Iraq. This baseline scenario is different from the usual business scenario, since the Government of Iraq has committed itself to long plans which introduce major changes to the existing structure of the economy. Some of these changes may be considered as mitigation options.

The baseline scenario was developed in close cooperation with relevant stakeholders. The required data on the activities of production of greenhouse gases emissions were collected from sources identified through the revision phase of available data. Data included periodical reports issued by relevant institutions, specialized sectoral and sub-sectoral studies, surveys and relevant scientific papers of local and international standards and specifications. Development of scenarios required a projection of current situation data to future predictions for each type of targeted activity. Strategies approved and endorsed by the Government of Iraq in deferent sectors formed the basis for the baseline scenario. Current programs and measures directly affect greenhouse gases emissions and they are considered a part of the mitigation scenario.

To date, Iraq has not submitted any Clean Development Mechanism (CDM) project to UNFCCC. Iraq seeks to develop future mitigation options under CDM to benefit from associated opportunities of these projects.

4.2 Baseline Scenarios for Various Sectors

4.2.1 Baseline Scenario for Energy Sector:

4.2.1.1 Current Situation of Oil and Gas Resources in Iraq:

Oil reserves of Iraq are estimated of about 143.1 billion barrels, constituting the third largest protected areas of the conventional oil in the world after Saudi Arabia and Iran. Approximately three-quarters of the proven reserves are concentrated in seven giant fields; West Qurna field, Rumaila, Majnoon field, Kirkuk field, East Baghdad field, Al-Zubair field and Bin Omar field. All these fields are located in the south of the country, except for fields of Kirkuk and East Baghdad. Not all oil resources in Iraq have been discovered yet, they might exceed the current estimates of over than 200 billion barrel.

Peak production of crude oil was in 1979 of 3.5 million barrels per day, this production was not achieved since then. In 2010 average production was 2.3 million b/d and in 2011 it raised to 2.7 million b/d. 80% of the current production is from four main fields: Rumaila, Kirkuk, West Qurna and Al-

Zubair. Fields of Rumaila and Kirkuk are considered the most achieving in regard of reserve ratios to production, which amounted to about 45 years for Rumaila and 80 years for Kirkuk. Other fields achieved more than 100 years as ratios of reserve to production with a great potential to grow production capacity.

As for the natural gas protected areas, Iraq is blessed with large quantities of about 132 trillion SCFD, to be the tenth country in the world in terms of natural gas protected areas. Gas associated with oil constitutes 70% of Iraq's natural gas reserves concentrated in the south, particularly in the giant fields of oil, including Rumaila, West Qurna, Bin Omar, Majnoon and Al-Zubair.

Iraq's production of natural gas reached 1.7 billion SCFD in 2009, a figure that is considered low in light of the size of reserves. It is assumed to be up to 6.5 billion SCFD, according to the global average for reserves ratio to production which amounts to 47 years. Furthermore, about 40% of currently produced gas in fields is flared, which is not only considered a practice of wasting precious natural resources, but a great pollution of air and contributes to emission of huge amounts of carbon too. This is because most of Iraq's oil fields lack the required infrastructure for managing the transition process of gas associated to oil from wellheads to consumption. Most of the gas pipeline network in Iraq suffers from damage. Thus, Iraq suffers from inability to supply gas to consumption centers at a time of overflowing fields. In fact, quantities of natural gas that are flared are sufficient to fulfill current needs of Iraq, if treated in a proper manner.

As for marketing of crude oil, Iraq's capacity was limited, until recently, to export about 2.5 million b/d through Basra port and 0.7 million b/d through the pipeline to Turkey. This discharging capacity is of adequate level for export production in Iraq during 2011, but it will need to be expanded to accommodate the increased production. Iraqi Ministry of Oil suggested rehabilitation of oil ports in the south of the country and raising the capacity of transport pipeline in the north of the country.

About 20% of Iraq's current crude production is refined into oil products for local consumption. Most three important refineries are located in Beji, Basra and Al-Doura, each is supported with a set of small refining units.

The designed refinery capacity of these refineries amounts to 900,000 b/d, but due to the deteriorated refineries status, the total available capacity is only 600,000 b/d. Still, with this low level of available capacity, the total production of Iraqi refineries is more than the total local demand which amounts to 412,000 b/d. Although there is a gap between demand and production, Iraq produces quantities of fuel oil that exceed the local demand, while the quantities of gasoline, gas oil and liquefied petroleum are less than

the local needs. Therefore, there was an increasing requirement for imports. As well as, the low quality of gasoline produces by Iraqi refineries; as it contains high proportions of sulfur, additions of lead and low proportion of octane. On the other hand, production of fuel oil exceeds the demand due to the inability to distribute it and take advantage, thus, the surplus is being injected or mixed with crude oil.

4.2.1.2 Current Situation of Power Generation in Iraq:

- Current demand of electricity is estimated between 16,000 to 17,000 MW, while the electricity generating capacity reached between 11,000 to 12,000 MW, according to summer 2014 estimates. Future plans require generation of 24,000 MW at an estimated budget of about US$ 4.5 billion over the next ten years.
- Electric power generating stations were destroyed and some of its parts were stolen as a result of the bad circumstances that been in Iraq during the past years. Demand for electric power in various sectors is annually increasing to about 7-9% with the continuous population growth and urbanization.
- Shortage of national stations power has led to the spread of different kinds of generators with various sizes in homes, farms, factories and various governmental and non-governmental institutions. Owners of large generators in residential and industrial areas use fuel oil mixed with gas oil because it is cheap fuel and due to lack of kerosene. This leads to increased greenhouse gases emissions (Forecasts of Environment situation in Iraq, 2013).

Iraq suffers from severe shortage of electricity estimated of about 20-25% of the total requirement in summer 2014. This shortage imposes major costs on economy and waste of production time. Damage of power interruption is also on capital assets and inability to carry on normal commercial processes according to a reliable schedule. In a country that experiences cold weather in winter and extremely hot weather in summer, the shortage of power also imposes significant hardship on individuals. Interruptions of power supply from the network has led to widespread installation of private diesel generators, which imposes high generation costs, creates noise, pollutes the air, and emits large quantities of carbon into the atmosphere. Initial estimates indicate that total cost to the Iraqi economy attributable to power shortages exceeds US$40 billion annually. Ministry of Electricity, to reduce the above mentioned effects, has developed in 2010 a plan to increase generation capacity to meet the actual demand of power by end of 2015. The current national system includes different stations of production (gas, steam and

water), illustrated in table (4-1) with contribution rate in power supply (INES/ 2013-2030- Page 17).

Table (4-1): Power stations and contribution rates in power supply

Kind of Station	No. of Stations	Effective Contribution Rate
Gas	27	44٪
Thermal	8	30٪
Diesel	11	15٪
Water	8	11٪

Rate of available capacity of the above mentioned stations amount to 60% of the designed capacity, in best cases. The electricity sector suffers from several problems and obstacles, as follows:

- Difficulty to meet environmental requirements, especially in old factories, which have become expensive and uneconomical.
- The supported tariff has created un-responsibility in energy consumption.
- Adverse effects resulting from the areas of electromagnetic radiation transmission of the high-voltage electric power lines distribution networks in cities and villages.
- Obstacles facing investors, including allocating appropriate land near the electric stations, secondary stations, and fuel lines.
- Most of generating, transport and distribution units have been established in the 1970s and 1980s of the last century.
- Decline in water level of rivers due to scarcity of water produced has led to stopping operations of power generation from water stations during important periods in the year.

Hydropower energy in Iraq contributes by about 11% of the total designed power capacity to generate electricity. The designed capacity of the hydropower stations is about 1,894 MW, while the available capacity is only 855 MW. This is because water in Iraq has witnessed since many years a noticeable decrease in the amount of water flowing into Iraq across Tigris and Euphrates Rivers, which negatively affected the plan of the ministry in the

electric energy production projects using hydropower stations. Studies showed the possibility of building dams to take advantage of power generation, but there are many technical and financial constraints to implement these projects. Table (4-2) informs about operating hydropower energy stations in Iraq, except of Kurdistan region.

Table (4-2): Operating hydropower energy stations in Iraq

No.	Station	Designed Capacity MW	Location in Iraq
1	Haditha	660	Center
2	Hamrin	50	Center
3	Mosul- Main	750	North
4	Mosul dam	60	North
5	Pumped Storage	240	North
6	Samarra	84	North
7	Dukan	400	KR
8	Darbandikhan	249	KR

4.2.1.3 Baseline Scenario for Waste Sector:

The most important objective of the current main plan of municipal solid waste is to achieve the best amount of waste reduction. The main plan has been elaborated through fact finding, interviews, meetings and workshops with officials from the Ministry of Environment, Mayoralty of Baghdad and Ministry of Municipalities and Public Work. The main plan proposals are based on several assumptions, due to lack of verified, reliable and/or updated data. However the general principles and calculations show the method to elaborate a municipal solid waste management (MSWM) plan with an initial investment plan due to the shortage of financial resources, with improved follow-up, monitoring and data collection. The responsible authority is expected to develop general principles for waste management and update the MSWM plan on a regular basis to be harmonized with other public facilities requirements, mainly water management, wastewater treatment and power supply.

The projection of waste generation has been simplified, based on an average of 2-4% net population growth, with a stable average of waste generation per capita. It is assumed that recycling will decrease up to 25% of

the generated waste (weight). The total generated waste amount for the coming twenty years is calculated to around 60 million tons. This study recommends certain scenario for land filling, as follows:

1. In 2020; 25% of MSW to recycling and one MSW treatment station to be established (total capacity 700,000 metric tons/y).
2. In 2030, 25% of MSW to recycling and two MSW treatment stations to be established (total capacity 2 x 700 000 = 1,400,000 metric tons/y).

Direct investment costs for a 20-year period (boxes, collection carts, establishment of landfills, incineration and all the other treatment methods) for the 2% population growth scenario add up to between ID 1,400,000-1,900,000 million (equal to US$ 1,200-1,600 million).According to these simplified calculations and based on a set of assumptions, although several costs, such as purchase or lease of land, ways of access and other infrastructure are not included. Improvement of waste management system in Iraq requires increased environmental awareness among the public and decision makers to accept changes and understand benefits for the citizen and environment, alike. Knowing that the Ministry of Industry and Minerals, officially authorized by the General Secretariat of the Council of Ministers, to implement waste projects, manufacturing of biogas factories, waste compressors, waste recycling factories and electricity production. Table (4-3) illustrates average waste of the Iraqi individual in the capital Baghdad and figure (4-1) shows ratios of waste components of the Iraqi individual.

Table (4-3) average waste of the Iraqi individual in the capital Baghdad

Location	Average waste generation Kg/p/d	Average waste components (kg/p/d)				
		Food waste	Glass	Paper	Minerals	Plastic
Inside the borders of Baghdad	0.799	0.412	0.020	0.118	0.060	0.012
Outskirts of Baghdad	0.619	0.535	0.073	0.085	0.097	0.103
Average	0.759	0.473	0.046	0.102	0.079	0.058
Percentage %		62.2	6.1	13.7	10.4	7.6

Source: Main plan of waste management in Baghdad, 2011. It was developed by the Ministry of Environment, in cooperation with Mayoralty of Baghdad and funded by the World Bank.

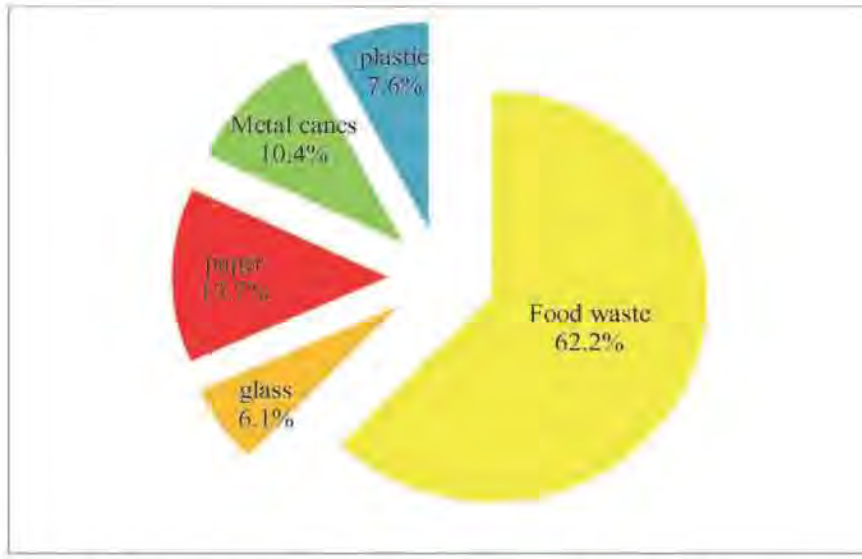

Figure (4-1): Percentage of waste components of the Iraqi individual

Integrated management of solid waste includes a series of complementary actions to reduce the quantities of generated waste and manage the residual waste in an economically and environmentally sound manner. This includes both source separation and recycling, pre-treatment of collected waste and disposal of the residual waste to apply the sustainable development principles. Today, the accepted principle in waste management is that the energy value of the waste should be utilized in the best possible way of "Waste to Energy" principle. "Waste to Energy" principle focuses mainly on incineration to recover heat value from waste, with other treatment options where energy in the waste can be generated from methane produced by the decomposition of organic waste.

4.2.2 Baseline Scenario for Industry Sector:

Industry sector was the backbone of Iraq's economy, but years of sanctions and war shattered the ability of Iraqi manufacturers to compete with cheap foreign imports. Thousands of factories have been closed or converted to warehouses and many were for sale. There is growing political will to improve the manufacturing capacity of Iraq. Ministry of Industry and Mineralsis keen to attract investment in all sectors, not just petrochemicals, but also construction, textiles, food, drugs, fertilizers, vehicles, and everything relevant to these industries (http://www.usbusinessiraq.com/iraq-briefing/sectors/manufacturing/). The importance of the industrial sector is

growing up in Iraq on the level of macroeconomic indicators as basic-born of resources upon which the federal budget of the State is based on, which exceeds 90%.If activities of oil, gas, electricity and manufacturing are taken into consideration as the major contributor; it will contribute to about half of the value of the whole GDP in 2020 (Report of the National Development Plan).

Several industries in Iraq depend on large and sustained energy supply. Each of these industries can serve as a foundation for the development of many other relevant manufacturing industries. It will provide a vital potential link in transforming Iraq's energy resources into national economic power. Requirements and potentials of this sector constitute an important element of the Integrated National Energy Strategy(INES/ 2013-2030, Page 51).

Six industries are within industries that require huge amounts of energy: petrochemicals, fertilizers, steel, aluminum, cement, and bricks. Each of these industries consumes large quantities of energy. Two of these industries (petrochemicals and fertilizers) require large quantities of natural gas components as raw material for their products; each of them provides a foundation for multiple secondary industries.The key industrial processes that contribute to the emissions of greenhouse gases in Iraq are cement, ammonia iron and steel productions. The total CO_2 emission in 1997 from the industrial processes was estimated about 6,422 Gg, which represent about 8.8% of the total emissions sources.

Iraq had in 2010 twenty cement factories, built between 1949 and 2009, with a combined designed capacity of 23 million tons annually. Some of these factories are in bad condition and led to the reduction of utilized power capacity in 2010 to approximately 10 million tons annually, including factories of Kurdistan region. This capacity supplies are estimated as half of Iraq's local cement consumption of 13.5 million tons annually; the remaining demand is supplied through imports at an annual cost of US$ 780 million.

Most important problems of industry sector are:

- Most of the production lines are old and outdated and there is lack of adequate funding to solve their problems.
- Investment files are not settled due to the security situation.
- Existence of hidden unemployment in many factories.
- Customs tariff law was not applied.
- Importance of activating the Law for Protection of National products.
- Lack of alternative fuel.

- Imposing strict environmental standards leading to higher production costs.

4.3 Strategies and Immediate Challenges Facing Energy Sector

4.3.1 Strategies and Immediate Challenges Facing Oil and Gas Sector:

Strategy of the Ministry of Oil, through licensing rounds, was planned in 2008 and begun to implement contracts according to an objective and foreseeable future through contracting several specialized international oil companies. Thereafter, the roof of crude oil production raised from 2.2 million barrels / d in 2002 to 6 million barrels / d in 2017 and to 9 million barrels in 2020.In addition to raising the export potential so as to ensure the local consumption and access to export markets according to the adopted international standards of products and quality standards.

The above mentioned plan was developed to be part of the national energy strategy for the period from 2013 to 2030.

1- This integrated strategy identified the immediate requirements for the development of infrastructure across all energy sectors in a coherent, sustainable, and environment-friendly way to meet all the local energy needs. In addition, to establish a national multi-aspect economic growth in order to improve the Iraqi citizens' standard of living, create new employment opportunities and to position Iraq as a major player in the regional and global energy markets. These sectors are: crude oil (manufacturing and extractive sectors), natural gas, electricity, and related industries. Development processes should be characterized by balance and integration among the above mentioned sectors; because they are all related to each other. Meaning, the progress of any sector depends on the progress of other sectors, thus itis required to develop these sectors in a balanced method.

2- This strategy developed three scenarios based on the peak of oil production, as follows:

   - High production Option of about (13) million b/d plateau by 2017 and rapid decrease after 2023.
   - Average production Option of about (9) million b/d by 2020.
   - Low production Option of about (6) million b/d by 2025.

   Ministry of Oil selected the average production option.

3- Dimensions for evaluation of the integrated national strategy for energy/oil sector are as follows:

- Ensure energy to meet local energy demand, in terms of products, quantities, quality and price.
- Achieve maximum level of revenues for the government through development of investments associated to oil industry.
- Provision of the highest level of employment opportunities and household income, as well as development and rehabilitation of national cadres to take up the oil industry in the future.
- Environmental sustainability through minimizing the adverse impact of the energy sector on environment.

4- To achieve these goals, Ministry of Oil will require implementation of the below mentioned projects within the extractive sector:

- Follow up and facilitate the implementation of extractive oil processes development plan and associated gas investment, particularly in the five main fields (West Qurna 1 & 2, Rumaila, Zubair, and Majnoon field), which constitute about 75% of additional production.
- Accelerate the establishment of sea water injection station with possibility to expand this project or identify alternative schemes to cover additional fields and work to ensure the treatment of produced water from oil wells and re-inject it.
- Ensure the establishment of infrastructure for unloading oil fields starting from the wellheads and to the main pipelines on time, in accordance with Iraq's Strategy to separate the crude oil.

5- The projects below, in refinery sector, will contribute in improving the quality of petroleum products (to maximize production of light and intermediate products) which will reduce emissions within the global and national specifications:

- Development of Al-Doura and Al- Basra refineries within the next three years, select small associated refining units for rehabilitation, close some operating refineries at present and establish others at Qayarra, Karbala, Kirkuk and Nasiriya during (2015-2019). In addition to establishing units for isomerization, hydrogenation and liquefied catalytic cracking. This program will increase the refinery capacity from 800,000 barrels to 1,400,000 barrels per day, which will enable Iraq meet the local demand of petroleum products according to the appropriate quality standards by 2019.

- In the future, Iraq should consider establishing a refinery to export petroleum products so as to add value to its crude oil and to diversify its energy-related exports. Such refinery should be of a capacity of at least 300,000 barrels per day. It should also be characterized by a high degree of development to enable it process heavy crude oil and produce products in line with the global demand.

6- For the natural gas sector, the implementation of the below projects during 2015, will significantly contribute in increasing production and usage of natural gas. Thus, reducing the amounts of flared gas which pollutes the air and contributes to the emission of huge amounts of carbon that causes global warming:

- Accelerate establishment of facilities for gathering, pressure, and treatment at the level of the fields.
- Install the required infrastructure to connect treatment stations with demand centers.
- Prepare a technical plan for the main gas system and a detailed study to design an optimum infrastructure plan, including technical standards and regulations for the development of the system and using it.

7- The above mentioned two initiatives require to be implemented in long-term exploration and development of gas reserves, as follows:

- Conclude contracts for gas export and construct pipeline connections with regional customers to absorb surplus gas production in the medium term.
- Ensure a long-term supply of free gas, through exploration and development of gas reserves, to be independent of oil production and flexible to meet requirements of demand.

This strategy, through implementation of the below procedures, will reduce greenhouse gases emissions to the atmosphere as follows:

- Increase the production and use of natural gas and reduce dependence on heavy fuel in the country.
- Increase the operational efficiency, which will lead to reduced fuel use and thus, reduction of greenhouse gases emissions.
- Plan and study the possibility of using flaring gas in a number of fields to produce light products by gas to liquid technique (GTL) which will be positively reflected on reducing greenhouse gases emissions.

- Develop a plan to construct a number of fuel stations for vehicles operating with liquid petroleum gas (LPG) - clean fuel, gasoline and diesel in Baghdad and governorates. Gas Filling Company has started in cooperation with Oil products distribution Company to add a line of clean fuel to equip vehicles in Al-Mansour station in Baghdad, work is underway for Al-Qanat and Al-Doura stations to be within this program as well.

Table (4-4) illustrates challenges facing Iraq in oil and gas sector and the available opportunities.

Table (4-4): Challenges (Strengths, weaknesses, opportunities, risks and threats) facing Iraq in oil and gas sector

Strengths	Weaknesses
Oil Sector: • The third–largest reserves of crude oil in the world. • Contractual production obligations with the world's largest oil companies and provide a wide range of services and equipment companies. • Planned expansion of crude oil supply. • Northern and southern export routes providing access to Europe, North America, and Asia. • Large demand for crude oil in the global markets will continue for a long period of time. • Crude oil grades with a distinctive trademark. • Three large refineries geographically well distributed. • Abundance of required raw materials for refineries at low prices. • Existence of a local distribution network of pipeline and facilities.	**Oil Sector:** • Underdeveloped infrastructure for water injection and oil evacuation. • Weak administrative experience in managing and coordinating the rapid expansion of production from multiple fields. • Poor status of crude pipeline network, with no link between north and south. • Poor condition and limited availability of refining stations, leading to disruption of oil product with the demand and low quality of local gasoline and gasoil. • Limited capacity of pipeline network. • Limited capacity for optimal storage. • Poor services quality for retail gasoline. **Gas sector:** • Inadequate infrastructure for gas collection, compression, and processing. • Inability to deliver existing

Gas sector: • Large local reserves of natural gas. • Provision of raw gas rich in valuable ethane and LPG. • Plans for rapid expansion of gas production. • Sign agreement with Basra Gas Company (BGC) for gas treatment.	production to users. • High levels of gas flaring. • Limited separation of raw gas into high-value components. • Lack of a supportive natural gas pricing policy.
Opportunities	**Threats**
Oil sector: • Popular global market for crude oil due to the widening gap between high demand for oil and supplies from existing fields. • Promising opportunity for expansion of Iraqi production, given Iraq's high reserves to production ratio. • Great potential for growth of oil reserves due to future exploration and expansion of prospecting in deep earth layers. • Future flexibility to re-transport exports from one geographical market to another. • Improvement of product quantity and quality through establishment and rehabilitation of refineries. • Improvement of distribution efficiency through construction of pipelines, storage and metering devices. • Develop gasoline retail services through restructuring of economic incentives and introduction of regulatory	**Oil sector:** • Escalation of global demand for renewable energy sources has led to reduced demand of fossil fuels, which is considered a threat to the national economy that mainly depends on crude oil. • Reduced total potential production of large oil fields due to early overproduction. • Decreased oil prices as a result of excess supply in the short term. • Pressure on chains of services and equipment supply due to the accelerated pace of increased production. • Obstacles in supervising and supporting projects. • Delay in the expansion of crude oil export facilities. • Deterioration of produced crude oil types. • Continued operation of facilities, refineries and distribution of non-compliant standards due to lack of interest and funds. **Gas sector:**

standards. **Gas sector:** • The high reserve to production ratio allows sustainable growth of gas supply. • High probability of large quantities of reserves in addition to those already identified. • Unachieved local demand in economic sectors that could create high value for Iraq. • Strong export potential.	• Failure to develop necessary infrastructure in time to accommodate the rapid increase of gas production. • Failure to take necessary arrangements for export at the right time to dispose surplus gas supplies from the local demand. • Subsequent increase in flaring and wasting vital economic resources.

4.3.2 Strategies and Immediate Challenges Facing Iraq in the Power Generation Sector:

The industry of electricity started in Iraq since 1917 through a Belgian Investment Company (named Tanweer Baghdad) and passed through several development stages, then turned into a body in 1999, later to a ministry in 2003. Since 1973, major plans were developed (short, medium, and long-term) to improve the national electricity network. In 2006, a detailed master plan was launched for development of the national network, and then in 2010 it was re-launched after being revised and developed to include the period up to 2030. Currently, this plan is being applied and a good percentage of it has been achieved. Thus, important sectors will be developed, such as power production, power transfer, power distribution, control and communications, renewable energies, human capacity building and adoption of environmental standards. Finally, other formats were developed within 2010 plan to preserve environment by using combined cycle units, as one of the mitigation measures.

Twenty three new stations will be built until 2017 in the framework of this plan, thus, adding 11-12 thousand MW to the available capacity. These new stations will consist of steam, gas, diesel and hydroelectric stations. They will be capable of operating by natural gas in the long run. They will also be capable of operating by fuel oil; when needed. This flexibility in fuel requirements will be necessary during the next few years, when gas infrastructure will be under development. There will be sufficient capacity in the system by 2017 (after adjusting it according to local operating conditions and expected technical losses) to meet peak demand with a reserve margin of

15%. Thereafter, system will expand to keep pace with demand growth, and newer stations will replace old ones in the system. The plan also includes converting gas stations to combined cycle gas stations; most efficient in fuel consumption and the least environmentally damaging compared to fossil fuel technologies and.

Renewable generation is expected to be used in the coming years to supply remote off-network locations. Solar and wind power capacity will be developed for connection with the network and the possibility for hydro-power development will be discussed. It is expected by 2030 that the additional capacity resulted from the renewable energies will exceed 2 GW and contribute with about %5 of the total system capacity (INES-Integrated National Energy Strategy, 2013-2030).

Ministry of Electricity's plan, in accordance with the Ministry of Oil's plan, will increase natural gas production to convert most of the gas stations to operate by natural gas. Heavy and light crude oil for energy production will be dispensed. It is hoped that the contribution of natural gas, which currently feeds one quarter of the energy production, will be about four-fifths of the energy production by 2030. Parallel with these improvements in generation capacity, technical losses will be reduced to acceptable levels and a smart grid program will be initiated to monitor network performance and enhance management capacity at peak time.

Once an acceptable level of supply is provided after 2017, Iraq will begin to increase tariffs, aiming at balancing price with cost. Tariffs will reflect the economics of power production. Demand management measures could be introduced, such as green building codes, load control programs, reduce high electrical energy loads of residential areas, use gas stoves, and solar water heaters.

As Iraq acquires self-sufficiency in power, it will be able to develop a strategy for international power exchange, either as an exporter or as a cooperative regional network for reserve sharing and balancing. Iraq has already acceded to energy exchange agreements with neighboring countries, such as Iran and Turkey. Iraq's location provides a strategic position for possible exchange of power between the Middle East and Europe. In future, the Middle East's solar potential will be developed to a point where it can provide substantial carbon-free power for export and Iraq could be an important crossing point to the network of regional and western energy markets.

Ministry of Electricity's plan for the short term includes implementing projects of converting some of the operating power stations to work by

combined cycle system. Table (4-5) shows stations that will operate by the combined cycle system.

Table (4-5): Stations that will operate by the combined cycle system

Development phases of Khor Al-Zubair, Taza, Al-Sader and Najaf stations	No. of stations planned to be converted	Total additional capacity (MW)	Planned time for capacity
First Phase	5	785	2017
Second Phase	3	1,380	2018-2019
Third Phase: Operating units by liquid fuel	10	2,690	2019-2020

* Estimated cost for the three phases is about US$ 4.5-5 billion.

Table (4-6) shows the challenges facing Iraqi power generation sector>

Table (4-6): Challenges (Strengths, weaknesses, threats and opportunities) facing Iraqi energy production sector

Strengths	Weaknesses
• Existence of a system for transmission and distribution covering most of the country.	• Lack of energy production. • Inadequate fuel resources and uncertainty of its reliability. • Operation of generating stations is below the required standards. • Weak electricity transmission and distribution systems. • High levels of technical and economic losses.
Opportunities	**Threats**
• Possibility of a significant improvement in power supply through current plans. • Ability to significantly improve the efficiency of generation through increased usage of natural gas. • Numerous opportunities for improvement of economic	• Incompatibility of plans to expand production with gas delivery system of the Ministry of Oil. • Delay in establishing new generation facilities. • Inefficient system, continued thefts and inadequate tariffs and fees.

practices.

- Enhance private investment in consumption and use of solar PV technologies (surface devices and distributed solar power stations).

4.3.2.1 Future Investment Opportunities in Electricity Sector:

Ministry of Electricity will invite private sector, for its importance and effectiveness, to invest in activities traditionally managed by the state. The Ministry has decided to generate 10,000 MW from generation projects over the coming decade and within its general plan, along with a range of transmission and distribution initiatives. Investment by the private sector is essential to meet the demand for the short and long terms to achieve balance between supply and demand and levels of desirable reliability for the achievement of sustainable economic growth and quality of modern life.

The Ministry of Electricity has submitted several models to the international investors to invest in the electricity sector in Iraq. The ministry has recently signed a contract with an international investment company to develop a model of an electricity station owned by the private sector, which will sell its production of electricity to the ministry. This indicates an unprecedented commitment to attract private investment in this sector. The ministry will continue its call for the private sector to invest in the electricity power generation sector.

4.3.3 Strategies and Immediate Challenges Facing Iraq in the Industry Sector:

Ministry of Industry and Minerals started implementing two parallel technical rehabilitation programs since 2008, as follows:

First program: Funding was directly from the federal budget, and has led to the rehabilitation of 196 out of 264 factories operating under the supervision of the Ministry of Industry and Minerals.

- **Second program**: It represents an agreement for sharing production with investors to rehabilitate and manage public sector companies in specific periods.
- **Key strategic objectives in the industrial sector until 2030**: a set of key strategic objectives were identified to be achieved by 2030, as follows:
  - Increase the annual rate of growth of the industrial added value to about (10 %).

- Increase the proportion of manufacturing industry contribution in the GDP to about (18%).
- Increase the proportion of employment in the industrial system.
- Increase the proportion of investment in industrial system compared with the total investment.
- Increase rate of industrial exports to the total industrial production.
- Increase the proportion of private sector contribution in the manufacturing industry.

* Construction of five new industrial cities and continue implementing Khor Al-Zubair project, as a major industrial city for energy-intensive industries by 2017. Thus, the number of industrial cities will be seven in 2022, while seeking to construct an industrial city in each governorate, as well as three technological cities and complete the implementation of the industrial city of Khor Al-Zubair by 2030.

* Establishment of a transparent and simple control system by 2017 and develop this system to be more efficient by 2022 to establish an integrated and efficient governance system at all levels, in participation of stakeholders and implementation of decentralization by 2030.

Six industries are currently categorized as huge energy consumer, underdeveloped and in various statuses of disrepair and neglect. Their operation is strongly limited due to chronic shortage of power and raw material. Iraq's needs for products of these industries are largely met through imports. Yet, these industries have the potential to develop into a significant and profitable producer, meeting all needs of Iraq and in some cases potential for export; if their capacity was well developed and they were supplied with sufficient power energy.Table (4-7) shows Challenges (strengths, weaknesses, threats and opportunities) of the Iraqi industrial sector.

Table (4-7): Challenges (Strengths, weaknesses, threats and opportunities) of the Iraqi industrial sector

Strengths	Weaknesses
• Abundance of low-cost hydrocarbon resources suitable for conversion to industrial raw material, fuel, and power.	• Support underdeveloped infrastructure.
Opportunities	**Threats**
• Increased local demand for building materials due to reconstruction. • Cost advantage vs. foreign producers due to low-cost energy resources. • Supplies of high-quality and low-cost ethane as an intermediate material, while foreign producers are experiencing ethane shortages.	• Delay of developing the hydrocarbon resources or providing the required power from industry. • Delay in developing the supporting infrastructure. • Potential global overcapacity in export markets, causing severe price decline of petrochemicals, fertilizers, and aluminum.

4.3.4 Investment Opportunities in the Iraqi Industry and Sector of Manufacturing Industries:

Iraq is planning to revitalize and transform its industrial sector from a command economy to a free market economy. Improvement of security in Iraq has stimulated major international companies from United Arab Emirates, Germany, Britain, China, Sweden and the United States to participate, or plan to, in projects. To facilitate the enormous economic potential, international business community is encouraged to participate as investment partners in this transformation by bringing modern technology, advanced skills, financial resources and investment to Iraq so as to improve the economy, increase employment and build the country's industrial capacity.

4.3.5 Strategies and Immediate Challenges Facing the Waste Sector in Iraq:

A major plan was developed for waste management through the project of emergency environmental management. It is to be implemented by the Ministry of Environment in cooperation with the World Bank and involvement of all relevant national actors. It includes several strategies; very ambitious and complex. There is also a need to implement it over a long period. It should depend on development of organizational capacities and implementation and enforcement of rules and regulations. This strategy takes into consideration the importance of a set of principles and guidelines that should be respected. One of the critical components in institutional capacity building at all levels is to increase the general knowledge regarding waste definition, classification, composition and environmental aspects related to the entire waste management system.

An investment program covering a 20-year period was submitted to implement these general guidelines. It is necessary to apply a practical approach and introduce "management of waste production" in stages (short-term, intermediate and long-term) to allow for adequate mitigation at all levels in Iraq. Introduction of a new waste management system based on a recycling and separation of waste at household level (including separation of hazardous components; such as batteries, chemicals, pesticides and electronic waste) involves a considerable degree of socio-economic factors, raising awareness, infrastructure development and cultural change; it is a slow process to implement. Hence, this area must be already addressed in a short-term phase through introducing and implementing solid waste management plan (MSWM), the first generation (the short-term phase measures). Ministry of Environment will be coordinating between the Ministry of Municipalities and Public Works and Mayoralty of Baghdad to manage the waste sector, as it had gained several years of increased environmental awareness by building its own experience. There will be sufficient time to think about the required development of second phase components (2020) and the third (2030). Table (4-8) explores Challenges strengths, weaknesses, threats and opportunities facing the Iraqi waste sector.

Table (4-8): Challenges (Strengths, weaknesses, threats and opportunities) facing the Iraqi waste sector

Strengths	Weaknesses
• Existence of a system for collecting liquid and solid waste, although it is not an integrated system. • High proportion of waste is solid.	• Old and open landfills. • Lack of integrated waste management system. • Lack of a system for sorting waste from the source. • Weak environmental awareness among citizens and workers in this field. • Lack of systematic landfills and wastes recycling facilities.
Opportunities	**Threats**
• Select the best technology options. • Impose fees for collection, according to the citizens' financial ability. • Accept the private sector as partners in the investment process of waste management.	• Create opportunities for funding and long-term operations. • Delay in establishing infrastructure. • Rapid population growth.

4.3.5.1 Investment Opportunities in the Waste Sector in Iraq:

Development of waste management and recycling has many important benefits in terms of economic and environmental outputs for sustainable development. This process of waste management and recycling is often considered as an environmental problem, although it could be a field for employment, as well as a financial resource. This sector is linked to the performance of decentralized local governments and participation of communities. The process of transforming waste to energy is also considered one of the effective methods to generate electric power and employment, thus diversifying the sources of national economy.

4.3.6 Laws and Policies:

Ministry of Construction and Housing has adopted in 2009 a project for developing codes system for the Iraqi buildings, consisted of two phases:

- **First Phase**: Preparing 42 Iraqi codes or numbering and technical specification for civil, electrical, mechanical, and roads and bridges areas. One of these codes is for green building.
- **Second Phase:** A plan to adopt the unified Arab system code during the next six years. One of the main reasons for this project is to take greenhouse gases into consideration. Ministry of Construction and Housing adopted in 2010 a national policy for housing supported by the United Nations (settlements) and issued specific policies, as follows:

Policy 2.6.4: Government will assess the state-owned companies for construction materials through implementing a complete assessment of each company and develop a specific plan for each. It might include liquidation, partial recapitalization, privatization, reorganization, or other plans.

- **Rationale:** Large majority of the construction materials companies in Iraq are owned and operated by the private sector. The state-owned companies of cement, glass, ceramics industries and other materials are inefficient and of low productivity. The government, after assessing each individual company, could increase its revenues and improve the performance of the sector through selling shares of the company to local or international investors. This could include other projects from the above mentioned ones. Presence of international investors of construction raw materials in the Iraqi market will enhance gains of efficiency and innovation.
- **Problem:** Most of the construction materials used in building houses in the Iraqi cities are of high environmental costs. Cement industry is an energy-intensive industry, while traditional bricks industry consumes valuable agricultural soil and emits large amounts of greenhouse gases.

Policy 2.6.5: Promote the production and use of environmentally friendly construction materials and local products through provision of economic incentives and research.

- **Rationale:** Introduction of "greener" construction materials, such as modern insulation, could assist in reducing the environmental costs imposed by the housing sector.If the distance between the production facility of such materials and the consumer was short, then the transportation requierments and the eco-footprint would be

lower.Economic incentives to producers of enviromentally friendly materials will encourage increasing the production.Government is also required to fund additional research regarding green construction materials to assist developing new products and enable training centers to include green construction materials in their scheduales.

- **Problem:** Some of the local construction materials products are of low quality compared to international products.

4.3.6.1 Energy-saving Standards and Symbols:

A national committee from different ministries was formed to suggest a strategy for energy saving. The committee prepared an integrated report of the required strategy, then it was approved by Iraqi Deputy Prime Ministerand distrbuted to iraqi ministries for implemtation.One of the recommendations is to form a national committee with the objective of adopting Arab adaptation methods to save energy. In addition to adopting international standareds to be implemented in Iraq.

Many new laws are under developing at the same time, they take greenhouse gases into consideration; such as:

- Soild waste managment law, which will encorage converting waste to energy, eliminating waste incineration and waste recycling.
- Sustainable transport law, which will reduce greenhouse gases emission casuing global warming from transporation sector by using clean fule and encorage using buses.

The major problem is the lack of enforcement mechanism to apply laws and regulations. They are not respected by the community. This fact requires adopting a program to increase awareness among the population and strengthen the enforcement mechanism.

4.3.7 Mitigation Scenarios for Various Sectors:

The CO_2- eqv. per capita in 1997 was equal to 3.8 ton /capita (greenhouse gases inventory results of this report).Statistics of the Ministry of Planning illustrates that the rate of population growth for the period (2009-2011) equals about (2.6%).If we suppose that this rate will be steady for the coming 25 years, the number of population in Iraq will be 54,945,000 capita by 2036. The aforementioned calculation indicates that the amount of emission will be equal to about (208,791,000) ton CO_2-eqv.In addition, increase of fuel consumption is expected to meet the power demand. Figure (4-2) shows quantities of fuel consumption that are expected until 2016, according to the type of the station. The current increasing amount of consumed fuel will raise greenhouse gases emissions in the coming years as a result of electric energy production.

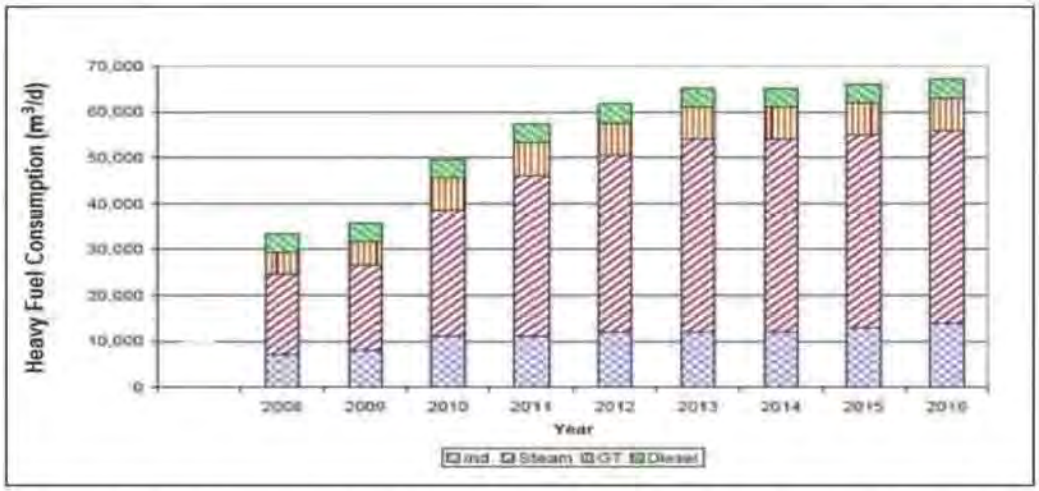

Figure (4-2): Quantities of fuel consumption that are expected until 2016, according to types of the station

Priority criteria for the current phase of mitigation options are represented in the sustainability of the option for achieving the strategic national objectives approved by the national committee, like security of supplies, increased access of people to resources, employment, poverty reduction and improving health. The mitigation team proposed a total of nineteen greenhouse gases mitigation projects as stated in the below table (4-9), related to areas of primary energy, renewable energy, energy efficiency, waste and agriculture.

Table (4-9): Proposed projects for greenhouse gases mitigation for various sectors

Project	Comments
1. Increase production and use of natural gas and liquid petroleum gas (LPG) to reduce dependence on heavy fuel in the country. In addition, increase the efficiency of operational processes to decrease use of fuel and pollutants.	
2. Improve specifications of petroleum products to	

Project	Comments
international standards through stop adding the fourth ethyl lead (which is polluting) to gasoline to increase its octane number and reduce the proportion of sulfur content in gas oil and kerosene through establishment of hydrogenation, isomerization and sulfur extraction units and cracking by liquid catalytic (FCC).	
3. Planning to use electric power generation stations with combined cycle in the new refineries.	This technology is able to operate more efficiently by utilizing large amount of heat from a primary gas turbine for generating steam in a second turbine. While, a traditional steam station achieves combustion efficiency between 30% and 33%,the advanced units of combined cycle fueled by natural gas (NGCC) can achieve combustion efficiency equal to 45%.
4. Establish 23 new power generation stations during (2013-2017) to add13-15 thousand MW of capacity to the 7 GW of capacity to the currently effective available. These new stations should consist of steam and gas turbines, capable of operating by natural gas in the long run and also capable of operating by fuel oil, when required.	This flexibility in fuel requirements will be essential during the next few years, when gas infrastructure will be developed and gas supplies may continue to be restricted.
5. Improve the performance of the electricity system to	

Project	Comments
maintain the continuity and stability with a high degree of reliability.	
6. Use of renewable energies, such as solar and wind energy, biogas and plasma to produce electrical energy.	Several renewable technologies represent potential opportunities to achieve integration in the energy system of Iraq.
7. Using renewable energy to supply remote locations with demand from outside the network. Solar and wind power will be developed in the medium and long-term, to connect with the network and potential for hydropower development will be considered.	It is expected by 2030 that renewable capacity will exceed 2 GW, approximately 4-5% of the total system capacity.
8. Improve the electric power factor.	Such projects have been applied by many ministries in areas of Ninewa and Baghdad. They were implemented by Al-Kindi Company of the Ministry of Industries and Minerals.
9. Production of electricity from waste using plasma technology.	
10. Apply an integrated waste management system.	It is important to concentrate on the following: 1- Recycling and separation of waste at household level (including separation of hazardous components, such as batteries, chemicals, pesticides, and electronic waste).

Project	Comments
	2- Having a set of socio-economic factors, raising awareness, infrastructure development and cultural change; which is a slow and tedious process to implement. 3- Work to generate methane from waste, particularly in waste landfill sites, like Kirkuk landfill.
11. Heat recycling in the cement and brick industries and in factories.	The operation is carried out through recycling heat from the oven to the grinding place of material.
12. Heat recycling in phosphate companies to produce electricity.	
13. Suspend use of fuel oil in cement factories and replace it by gas.	
14. Replace the automated burning systems in private sector brick factories with more efficient burning systems.	
15. Implementation of industrial projects and promote production of electric power from solar energy through manufacturing or assembly of solar products; including solar heater, solar lighting, solar fridges, solar vehicles, solar pumps, solar stoves and others.	
16. Reduce emissions of industrial processes in fertilizers industry.	

Project	Comments
17. Using the LPG as fuel for vehicles instead of benzene through importing dual-fuel vehicles (gasoline and liquefied gas).	Iraq started implementing this project, but there are obstacles still facing it due to shortage of the financial resources and technology requirements.
18. Setting national standards and specifications to import vehicles and other equipment to ensure that the global emissions are not exceeded.	
19. Public awareness.	It is very important to start integrated awareness programs at all sectors and to all segments of society, such as awareness programs on energy rationalization.

4.3.7.1 Mitigation Priority- Fuel Replacement (Energy and Industry):

Table (4-10) provides a list of main mitigation technologies in the long term. It is an indicative list to select what suits the situation in Iraq.

Table (4-10): Indicative list for mitigation technology

Sector	Available Technology	Technological Substitutes
Energy Production	1. Use of Hydropower energy represents about 11% of the total capacity of electricity. 2. Most of the generated electric power is produced by using thermal and gas stations.	1. Introduction of combined cycle units in the power generation stations. 2. Improve supply effectiveness and distribution efficiency. 3. Transformation towards using the cleaner fuel, like using gas instead of fuel oil. 3. Use of renewable energy and

Sector	Available Technology	Technological Substitutes
		combined heat and power (CHP). 4. Use of hunting techniques, storage of carbon dioxide gas (CCS) and electricity generation from biomass. 5. Use advanced techniques of renewable energy resources (tide, means of concentrating solar energy, etc.)
Transportation	1. Land use and planning transportation. 2. Start a project to use LPG as fuel for vehicles instead of gasoline.	1. Use hybrid vehicles depending bio-fuel consumption. 2. Shift in land transport to use railways.
Buildings	1. Energy-saving lighting. 2. Efficient devices/heating/ cooling.	1. Implement photoelectric power technologies for distributed electricity generation in small areas and cities. 2. Integrated design consisting of intelligent metering technology. 3. Use effective design in buildings for the optimum utilization of lighting and solar energy. 4. Integrated solar photoelectric in buildings. 5. Improve cooking stoves and mechanism of thermal insulation.
Industry	1. Recycling the resulting heat from	1. Control of CO_2 emissions using specific techniques within each

Sector	Available Technology	Technological Substitutes
	industrial processes for energy recovery. 2. Material recycling.	industrial process. 2. Efficient use of advanced energy. 3. Application of CCS project for cement, ammonia and iron factories. 4. Use inert electrodes for aluminum production.
Forests	1. Afforestation–reforestation. 2. Forest management. 3. Reduce deforestation. 4. Management of harvested wood product.	1. Use of forest products to produce bio-energy. 2. Improve particular species of trees to increase biomass and reduce carbon emissions. 3. Improve remote sensing technology to identify absorption areas of available greenhouse gases in the country and set up a national strategy for protection and development. 4. Develop special maps regarding land-use change.
Waste Management	None	1. Invest resulting methane from waste landfills by restoring energy of waste incineration or convert organic waste into fertilizer, control and treatment of wastewater, waste recycling and minimization. 2. Use bio-covers and bio-filters to improve oxidation of methane.
Agriculture	None	1. Improve crops and management of grazing lands to increase carbon storage in

Sector	Available Technology	Technological Substitutes
		the soil, restore cultivated soil peat and degraded land and improve rice cultivation techniques. As well as, improving manure management to reduce CH_4emissions, improving techniques of nitrogen fertilizer use to reduce N_2O emissions, dedicated energy crops to replace fossil fuel use and efficient energy use. 2. Improve the quality of produced agricultural crops.

4.3.7.2 Conclusion and Recommendations:

- Identify obstacles facing the implementation of financial, technical and administrative options.
- Emphasize the importance of raising awareness among other stakeholders and policy makers, as a condition for successful mitigation policies.
- Emphasis the need to adopt clean energy opportunities/renewable energy, identify the required support and take advantage of funding sources that grow rapidly all over the world.
- Emphasis the need for an energy efficiency (EE) national strategy to address raising awareness, capacity building, organizational and institutional reform, funding and establishment of energy efficiency services market in the long term.

4.4 References:

- INES-Integrated National Energy Strategy/ 2013- 2030. Advisory Commission Council of Ministers, Iraq.
- Report of national development plan/ 2013- 2017. Ministry of Planning. Iraq.
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- Industrial strategy in Iraq until 2030- Executive summary/2013- Ministry of Industry and Minerals, the Presidency of the Council of Ministers - Advisers' panel.
- Information provided by the representatives of the Ministry of Oil, Ministry of Electricity, Ministry of Industry and Minerals, Ministry of Municipalities and Public Works and Mayoralty of Baghdad.
- http://www.usbusinessiraq.com/iraq-briefing/sectors/manufacturing/

ANNEXES

Annex A: Kurdistan Region-Iraq

Contents:

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A-1 Political System:

Kurdistan Region consists of three governorates, Duhok, Erbil and Sulaymaniyah. The region enjoys a unique geographic diversity, which constitute more than 8.9% of the total area of Iraq. The city of Erbil is the capital of the region and the city is known locally as Hawler. Erbil Citadel is one of the oldest settlements densely populated in the world on an ongoing basis throughout ages.

After the 1991 elections, Parliament of Kurdistan Region was elected with the participation of all ethnic and religious components present in the region. At the end of April, the seventh composition of Kurdistan Region Government was established. President of Kurdistan region was also directly elected by the citizens of the region.

A-2 Demographic Situation:

Estimates of population for 2007 showed that 27.2% of the population in the region lives in rural areas, while 72.8% lives in urban areas (cities, districts and sub-districts).

As for the population distribution by gender, it was noted the convergence between genders, as the ratio of males was estimated to the total population at a rate of 50.4%. It is also noted when focusing in age structure that the region is one of the young communities, where the proportion of the working age population is estimated at 54% (age category is from 15 to 65 years); this shows that the Kurdish community is one of the productive communities and has a strong asset, in terms of human resources that the human development need. Estimated proportion of less than 15 years old was 43% of the total population of the region, which shows the existence of productive ammunition in future despite the high dependency ratio. This ratio is outside the circuit production at present, but it will supply the labor needed for future development plans and inter in the circuit of production over years. On the other hand, the sharp slope of the age category population aged 65 years and over, which estimates 33% of the total population of the region was noted; this category of the population is considered economically non active. This reality contradicts what is found on the floor of developed societies (especially the European) which is one of the old age communities, because the population pyramid stands on the head instead of the base, so the wheel productivity of those communities mostly depend on foreign labor.

The increasing number of Iraq's population during the last twenty years and the migration of many of the population from rural to urban areas in search of livelihoods have led to increased population density in urban areas,

especially in the governorates, which are considered as commercial centers where work aspects are available. As well as, increased monthly income rates for workers in the government sector, who make up a high percentage of the total population has led to diversity and change in consumption patterns, whether in cities or rural areas, which was adversely reflected on environment and public health, including the solid waste problem with its harmful symptoms clearly emerged in all governorates of the region. Latest statistics for 2007 prepared by the Ministry of Planning and Development Cooperation indicate that the number of the people of the region is estimated at four million people, as illustrated in the table(1-A).

Table (1-A): Population distribution in governorates of the region

No.	Governorate	Population Number according to 2007 estimates	Urban Population Number according to 2007 estimates	Rural Population Number according to 2007 estimates
1	Duhok	505,491	369,801	**135,690**
2	Erbil	1,542,421	1,170,733	**371,688**
3	Suleimaniya	1,893,617	1,327,737	**565,880**
	Total	**3,941,529**	**2,868,271**	**1,073,258**

Other Population Indicators:

Table (2-A):Some demographic indicators in 2007

Indicator	Erbil	Duhok	Suleimaniya	Total
Annual growth rate	3.2	2.6	3.1	**3.0**
Percentage of population of urban areas	75.9	73.2	70.1	**73.1**
Percentage of population living in rural areas	24.1	26.8	29.9	**269**
Percentage of the population under 15 years old	42.5	42.7	42.9	**42.7**
Percentage of young people (age category 15-24 years)	20.0	20.0	20.0	**20.0**
Active population (age category 25-64 years)	34.6	34.4	34.2	**34.4**
Percentage of population over 65 years old	2.9	2.9	2.8	**2.9**
Rate of fertility	**4.9**	**4.1**	**2.9**	**4.0**

Source: Depending on the Multiple Indicator Cluster Survey-Central Statistical Organization, p. 20.

A-3 Education:

Kurdistan region is rich with natural resources, but it is poor with efficient human capitalizing, due to weakness of exploitation of natural resources and the weakness of inherited economic and social structures. Therefore, refinement of economic and social underdevelopment is urgently required to change these structures. This change could not be implemented without changing and developing human capabilities and prepare efficient, educated and trained manpower that is able to apply effectively updated scientific and technological innovations in various productive areas to take its appropriate and decisive place in the development process. Thus, development of education and improving it have close link in raising the productive efficiency of human being, which is considered one of the important investments to increase capital. Education, in general, including in particular the professional, creates scientific talents and abilities for humans and helps its composition; in line with the new scientific innovations and easily interact with them.

The region has seven universities (table 3-A), including University Of Kurdistan, Hawler of English language in Erbil, which opened in September 2006 and the American University in Iraq in the city of Sulaymaniyah, which began teaching its curricula in winter 2007.

Table (3-A): Available Universities in Kurdistan region, included in Students' Manual 2011/2012

	Universities in Kurdistan region, included in Students' Manual 2011/2012
1	University of Suleimaniya
2	Salahaddin University
3	University of Dohuk
4	Koya University
5	Hawler Medical University
6	Technical Education / Erbil
7	Technical Education / Suleimaniya

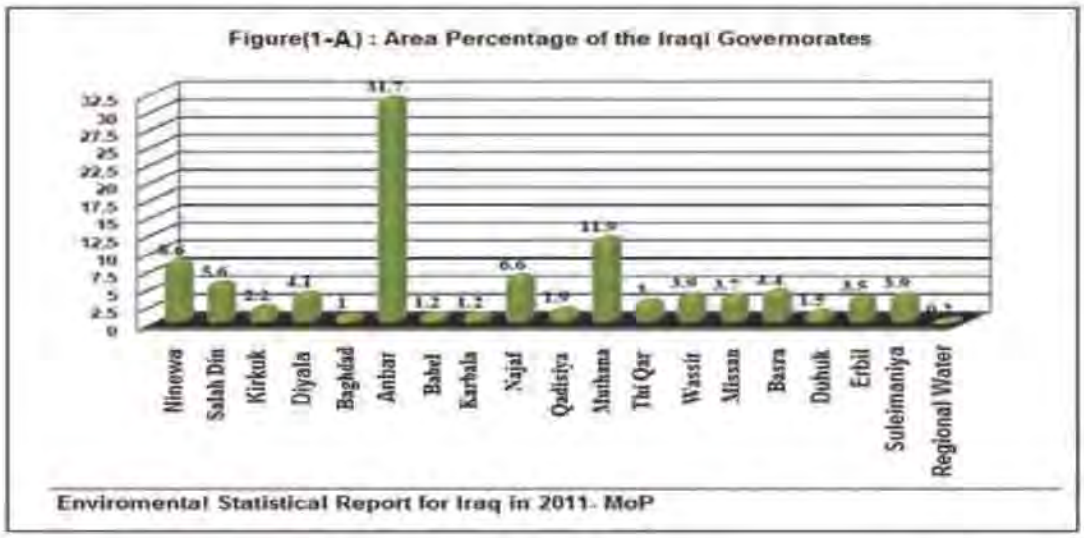
A-4 Economic Situation:

Economy in Kurdistan Region depends on income of oil, agriculture and tourism because of the stability in the region, as the economic situation is more advanced compared to other regions in Iraq.

The stability of Kurdistan Region has become a reason to move economic development to other parts of Iraq. At the beginning of 2004, the income rate per capita increased in Kurdistan Region compared to other regions in Iraq by 25%, international airports were established in both Erbil and Suleimaniya which connects Kurdistan Region with many countries in the Middle East and Europe through air flights.

A-5 Geographical Situation:

Kurdistan Region consists of governorates area of Erbil, Sulaymaniyah and Dohuk, which constitute more than 8.9% of the total area of Iraq (figure 1-A).

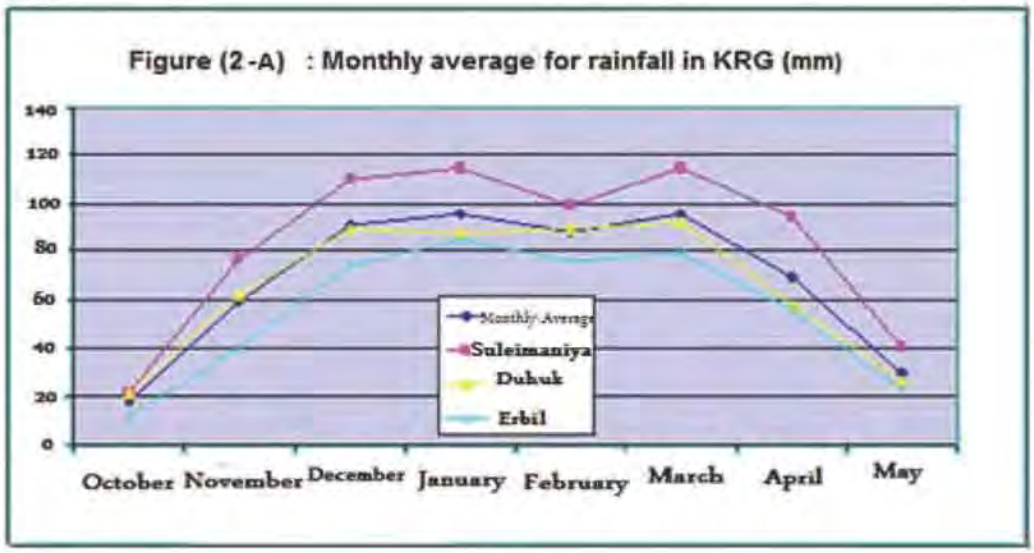


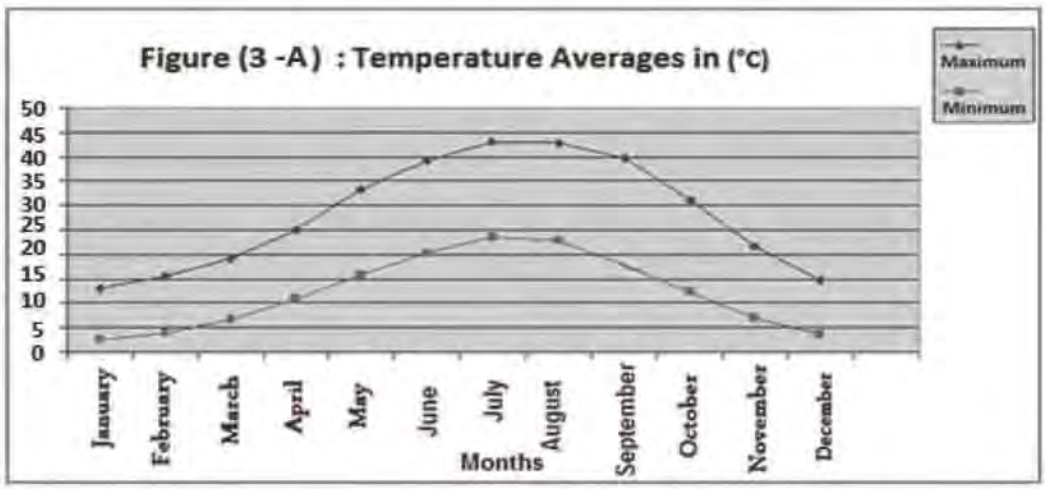
A-6 Climate:

In general, as we head towards the north and northeast in Iraq, temperature rate drops in this region because land in this north and northeast is higher than in the south. Northern sides of the Kurdistan region are located in that region, which are far away from latitudes that results into shortening the daytime in winter and reducing severe sunlight. It is characterized by lack of severe fall of the sun angle, length of daylight and the presence of the continental air currents in the dry summer period, which is considered one of the main factors for high degree of summer heat of the region. Temperature

rate in July records more than 30 °C, which is one of the months of high temperature.

There are significant differences in rainfall rates in Kurdistan Region. Generally, the percentage of rainfall in Kurdistan region increases as we head towards the north and northeast and the reason is the high and low ground. As well as, the proportion of air depressions that pass over the area and density of depressions increase as we head towards the north. Figure (2-A) shows the monthly average rainfall in the region / mm during the last thirty years and Figure (3-A) shows average temperatures in the region over the same period.





The above charts illustrate the following:

- Governorate of Suleimaniya ranks first in terms of rainfall amounts during the study period, which were more than (674) mm / year, while Erbil come in the last rank where the overall rate of rainfall was about 380 mm / year.
- The highest rate of rainfall at the regional level was recorded in the months of January and March by (95.67) mm and (95.54) mm, while the month of October comes in last rank in terms of rainfall quantities during the same period by about (17.69) mm.
- August witnessed the highest temperatures rate of (42.9 °C), while the lowest degree was in January with the average of (2.4 °C).
- General average of the minimum and maximum temperature is between 12.2 and 28.1°C, which confirm the location of the region within the moderate climate zones.

Region areas could be divided into two sub-areas in terms of rainfall, as follows:

1. **Permanent Rain Area:** This area includes northern part and the northern east part of Kurdistan region-Iraq. As for the southern borders aligning the southern mountainous areas of the region, it is difficult to identify the rainfall proportion; as the annual rainfall record was at least 500 mm. Thus, agriculture in this region can completely depend on rain.
2. **Intermittent Rain Area:** It includes the semi-mountainous area where the rainfall rate is low; less than the annual rate of 500 mm. This sub-area is known by the significantly unsteady proportion of monthly, quarterly and annual rain, compared with the previous area. Agriculture in winter, especially in the southern and southern west part might be exposed to drought risk.

Kurdistan region is divided in terms of climate into two areas:

1. **Mediterranean climate zone:** This area includes north and north eastern sections of the region and the southern borders of the mountainous area of the region. This area is very cold in winter, wet and inclined to cold in summer. It is the rainiest areas of Iraq, where the total annual rainfall rate is 500 mm. This percentage becomes low when heading towards east, north

and north-east, as rainfall rate increases in this area for several days and cause cut off transportation routes among various towns in that area.

2. **Semi-dry climate zone:** This area includes other parts of the region, in terms of rainfall system. It is similar to the previous region (summer is hot and dry and winter is wet and rainy). It is characterized by lack of rainfall (annual rainfall rate is less than 500 mm, increased temperatures in summer, less cold in winter with rare snowfall).

A-7 Institutions responsible for monitoring the environmental situation in the region:

The Environmental Protection and Improvement Board in the region is considered the only responsible body for capacity building in fields of monitoring, environmental inspection, oversight responsibility, on-site detections, follow-up and monitoring sites in accordance with the plans and application of in force laws against offending sites. As well as, follow-up granting licenses for the establishment of manufacturing stations and locations for landfill matching the environmental determinants of applicable laws. Tasks of commission also include preparation of the database related to the axis of its work. Ministry of Planning is responsible for data collection, preparation of an integrated statistical set for this sector and providing it to the concerned authorities to participate in data analysis, through which they can determine strengths and weaknesses, evaluate the current reality and prepare future plans.

A-8 Agriculture:

The agricultural sector is considered one of the important economic sectors, despite the existence of many problems and obstacles that impede development of this sector. Official statistics issued by the Ministry of Agriculture in Kurdistan Region Government indicate that agricultural production in this sector was not up to the required level and did not meet food needs of the population. Production of wheat during (1988-2007) in Kurdistan region did not fulfill the local needs during the mentioned period only with 50%, as an annual average. While the production of (Paddy/rice) during the same period fulfilled only5%ratio of the local need for rice.

Production of other crops, whether of winter or summer, was not better than wheat and Paddy. Livestock production has also witnessed an obvious decline in growth during (2003 - 2010), the decline reached (22%) during the mentioned period. Five-year strategic plans were developed by the Ministry of Agriculture in Kurdistan region during (2009-2013), for the purpose of

developing the agricultural sector and raising the plant and animal production. Specific amounts were allocated for agricultural investment and banks loans were granted to farmers and workers in the agricultural sector under certain conditions to increase plant and animal production.

Agriculture in the region is still far from achieving the objective, despite the provision of appropriate land for advantage of the agricultural investment and beside the misuse of land. Lack of investment in this field is noticed, as there are large areas of arable land which remain abandoned without exploiting during the agricultural year, of more than 30% of the total agricultural land due to farmers' ignorance and poor experiences in the field of agricultural extension. Leaving those lands without exploiting can be considered economically wasteful, because if it were exploited, it could add to the national economy about 30% of the total annual revenue achieved in the agricultural sector.

The following is part of the agricultural indicators:

1. Plant Production:

A- Land classification by type of use as illustrated by table (4-A):

Table (4-A): Land classification by type of use

Details	Area/Donum				%
	Duhok	Erbil	Suleimaniya	Total	
Total area	3,928,800	6,029,600	6,809,200	16,767,600	100
Arable	1,093,541	2,456,533	2,234,342	5,784,416	34,5
Non-arable	941,769	1,673,537	1,819,179	4,434,485	26.4
Allocated for orchards	129,875	103,083	153,791	386,749	2.3
Planted by forests	986,661	583,301	1,024,825	2,594,787	15.5
Natural pastures	724,227	1,145,641	1,489,012	3,358,880	20
Buildings and construction	52,727	68,405	88,051	209,183	1.3

B- Land classification according to method of irrigation:

Table (5-A):Area division according to irrigation method

Governorate	Area/Hectares				
	Total	Arable	Rain-fed	Irrigated	Non-arable
Erbil	1,514,120	626,280	580,645	45,635	887,840
Duhok	931,398	301,542	254,892	46,650	629,856
Suleimaniya	1,042,808	291,999	232,700	59,299	750,809
Total	3,488,326	1,219,821	1,068,237	151,584	2,268,505

Source: Ministry of Agriculture-Kurdistan region/Planning/Annual Bulletin, 2006.

Table (5-A) indicates that there is an area of more than 1.2 million hectares of land that could be exploited for agricultural purposes and which is estimated at 35% of the region territory. If that area was exploited in the cultivation of only wheat and barley, which are the simplest types of exploitation of agricultural land, it would have added huge amounts of money to the budget. In addition, it provides employment for tens of thousands of people, who earn their living through the agricultural sector. Investment in agricultural production, in addition to achieving abundance of foreign currency, it also provides food security requirements and liberalization of economic dependency; which is the most important pillar in the life of society in general.

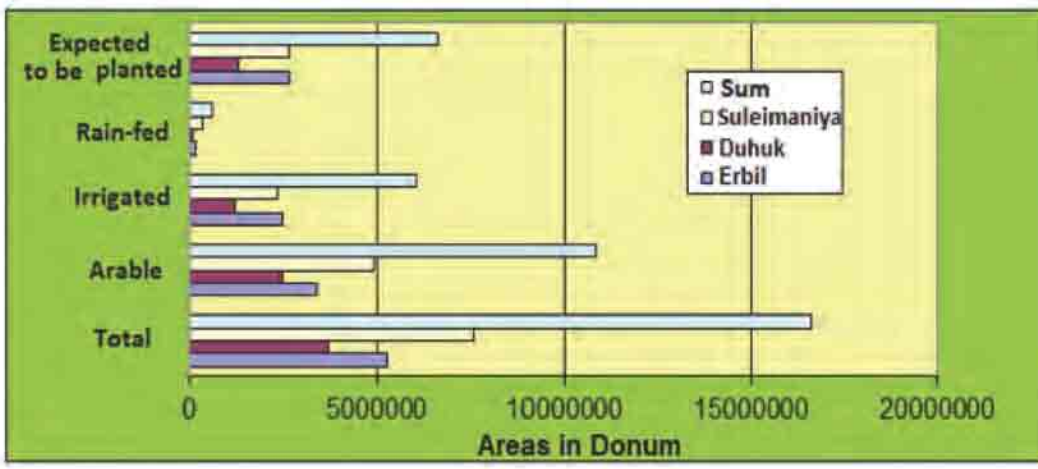


Figure (4-A): Areas of land according to its kind and watering type

Indicator of the cultivated area with winter and summer crops:

1. Barley crop is in the first rank, in terms of cultivated area amounting to more than a million and a half donum, which is estimated by 44.3% of the total cultivated land in the region and36% of the total cultivated area in Iraq. Annual production was estimated by (383) thousand tons, equivalent to half of Iraq's production. While the crop donum's productivity was estimated by 244.3 kg, exceeding the average productivity on the level of Iraq by 37.9%. The high rate of productivity compared to the national average of Iraq is the result of natural conditions of the territory, soil fertility and lack of need of the crop to large amounts of water during the production period, with its ability to withstand thirst.
2. Cultivation of wheat is in the second rank after barley. It was previously ranked the first before and during the imposed economic embargo on Iraq; after its invasion of Kuwait in 1990. Cultivation declined after the implementation of oil-for-food decision (986), which was approved in 1996 and implemented in 1997, allowing Iraq to sell part of the oil-for-food imports and distribute it to the population. It led to lower its prices in the local market due to low demand for it in the food making. Flour was distributed to the population under the card of ration, as well as the prevention of export of surplus foreign markets due to the blockade.

   Total area cultivated with wheat, on the level of the region, was about 1,352,000donum, about 38.3% of the total cultivated area, at the level of the region and 21% of the total cultivated area, at the level of Iraq.

   Donum productivity rate amounted to 295 kg, i.e. productivity rate of unit area of wheat crop is very low compared with agriculture in developed countries, even those developing and neighbors of the region. Cause of low productivity in the region is the effects of weather conditions (climate elements), entrapment and lower rate of rain or irregular along the weak potentials, material and scientific abilities of the Kurdish farmer. As well as, lack of scientific and technological innovations usage in agriculture, prevalence of primitive means (seeding, harvesting, fertilization and plowing methods) in many areas of the region, particularly the mountainous and dependence of agriculture on rainfall in irrigating the crop. All the mentioned factors affect productivity (Source: ARDI \ Erbil).

A-9 Water Resources:

Ministry of Agriculture and Water resources is responsible of the water sector, its administration, assessment of water availability and water quality in the region. It is also responsible of setting the water budget, strategic plans for the development, management and protection of this sector. The Ministry

is in charge of developing the operational plan, at the level of the region, management of dams and reservoirs, establishing water projects, canals, streams and their cleaning... etc.

Role of the Supreme Commission of Environment in this sector that concentrates on the field of water resources protection from pollution due to practices and activities of various institutions in the region, is to develop a monitoring program to control water resources quality in the region and polluting activities to ensure that the work of these polluting activities is corresponding with environmental determinants that keeps the vital water source, safety of bio-diversity and prevents the water sources from pollution in the form that damage it through regulating instructions and laws.

Table (6-A): Water Sources used in irrigation

Governorate	Number according to type of source			
	Shallow wells	**Artesian wells**	**Kahrez water system***	**Springs**
Erbil	3,463	1,077	565	3,461
Dohuk	1,561	313	34	2,950
Suleimaniya	2,161	255	1,447	6,457
Total	7,185	1,645	2,046	12,868

Source: FAO/Erbil, 2000.

* **Kahrez is the Kurdish name of the ancient water conveyance and irrigation system.** At the foot of rocky hills, water is collected in underground canals and carried to neighboring fields, where it is drawn off by strategically located well shafts, (http://www.unesco.org/new/en/iraq-office/natural-sciences/water-sciences/karez-rehabilitation).

There are also some irrigation projects that could be used in irrigating vast tracts of agricultural land, in case of establishing some irrigation projects there and using its water for crops irrigation at times of drought.

In addition to the aforementioned, there is a group of dams in Kurdistan region, namely:

- Dukan Dam located down Zab River with a capacity of 6.6 billion m^3.

- Darbandikhan Dam located on Sirwan River with a capacity of 3.2 billion m^3.

- Dohuk Dam for irrigation located on Dohuk River with a capacity of 55 million m^3.

A-10 Forests and Biodiversity:

Forests situation in the region has worsened in general, shortage of its density was noticed due to repeated droughts, bombing of the border areas, presence of hunters, shepherds, tourists and other causes as lack of fuel, previous wars and presence of large mined places, which leads to fires with presence of lack in ability to extinguish these fires.

Natural forests cover an area of 65% of the total area of Kurdistan region in Iraq. Bushes are founded on banks of streams and natural pastures in the plain land. Coniferous and oak forests could be converted to economic forests for the production of wood. Countryside of Kurdistan region-Iraq consumes wood (5.5) times as much as the city, which constitutes a pressure on the forests and causes eco-system disorder, with high rates of greenhouse gas emissions.

A-11 Artificial Woodlots:

Attention of artificial forests and woodlots have been taken since the 1960s in Kurdistan region. The pine of Zawita is the predominant type in woodlots, the vertical and horizontal cypress and eucalyptus in low-plain areas, Poplar is prevalent in valleys as well as willow and elm.

98% of forests are owned by the state and there is Poplar timberlands owned by the private sector of about 2%. There are also timberlands in Erbil, Sulaymaniyah and Dohuk governorates and they are managed by the regional government.

Table (7-A): Area of natural forest and grassland, distributed according to governorates (donum)

Governorate	Industrial forests	Natural forests	Natural pastures	Rocky ground	Total	%
Erbil	18,769	1,477,033	1,603,128	597,312	3,696,242	14.92%
Duhok	16,024	1,138,907	2,396,428	8,129,769	11,681,128	47.17%
Suleimaniya	8,172	4,220,867	2,172,948	530,725	6,932,712	27.99%
Garmian	4,139	74,053	1,833,446	549,920	2,461,558	9.94%
Total	47,103	6,910,859	8,005,951	9,807,726	24,771,640	
Percentage	0.19%	27.89%	32.32%	39.59%		100%
Source: Ministry of Agriculture and Water Resources/KRG						

A-12 Livestock Production

The region is characterized by abundant livestock which is of importance after plant production, in terms of agricultural income sources. It spreads all over the region and is considered one of the main occupations practiced by the rural population, as it represents a source of livelihood for their families. The following are some statistical data about the reality of this wealth:

Table (8-A):Classification of Livestock Wealth

Governorate	number of livestock according to their kind					
	Cows	Buffalo	Sheep	Goats	Horses	Donkeys
Duhok	67,634	678	463,550	293,265	1,722	7,092
Erbil	130,567	174	603,265	570,310	6,410	14,768
Suleimaniya	313,443	3,322	2,386,611	1,551,822	9,347	37,224
Total	**511,644**	**4,174**	**3,453,426**	**2,415,397**	**17,479**	**59,084**

Source: FAO statistics village survey, Erbil (1999-2000).

Table(8-A) indicates that sheep are in the first rank in terms of number with the amount of about three and a half million, followed by goat which is estimated at two million and four hundred thousand and cows which are more than half a million. In light of these figures, the region could be considered as one of the most important areas for breeding livestock wealth for its suitable natural and climatic conditions. The estimated average of livestock productivity per capita is about 1.53 animal head.

Projects of Livestock Wealth:

Table (9-A): Number of livestock wealth projects at the level of governorates of the region

Project type	Governorate			
	Erbil	**Duhok**	**Suleimaniya**	Total
Chicken meat	347	76	354	**777**
Whiting chicken	2	1	1	**4**
Fish farming	126	22	67	**215**
Fattening sheep	1	5	1	**7**
Fattening cattle	11	2	12	**25**
Animals butchery	1	1	2	**4**
Poultry butchery	**3**	**1**	**2**	**6**

Source: Ministry of Agriculture-Planning-Statistics.

A-13 Tourism:

Tourism is an important source for income, including foreign currency as it is restituted by foreign tourists. God has blessed Kurdistan region of Iraq and gave it many natural factors (mild climate in summer) and attractive monuments and natural sites for tourism. In addition, tourism is considered a social, cultural and civilizational phenomenon, being emerged from the growing need for comfort and change of atmosphere. It helps the growth of sensation and feeling of people who reside indifferent areas, as these natural areas bring them joy and fun during their period of stay.

The role of tourism is not limited to that, but it works to grow communications among different countries of various customs, traditions and cultures. Introduction of these cultures, which later became the fruit of commercial and industrial scale extension and of other means of transport. Then later it had a broad role in economic and social development of those countries.

Cities of the region are characterized by water springs and towering mountains and caverns, which tells story of the Iraqi human being since the earliest civilizations. Not to mention the sculptures, which are located at squares, waterfalls, summer resorts, evergreen trees, moderate climate in summer and even the climate of winter is encouraging for tourism. Greenness starts in Kurdistan with the beginning of spring festival Newroz; Kurdistan becomes the summer heaven of Iraq with its climate and history. There is still

a need to develop an attractive tourist industry and sophisticated tourist media. Tourism is a strategic economic resource and a means of communication between peoples and cultures.

To promote tourism in the region, a new liberal law for foreign investment was ratified in June 2006. It provides incentives for foreign investors, such as the possibility of owning land, tax exemption for ten years and provision of easy operations to send profits to the country of the investor. The region has two international airports in Erbil and Suleimaniya with direct flights to and from Europe and Middle East. Erbil international Airport has been largely expanded with the addition of a new aircraft station in 2010. International Air Transport Association (IATA) has scheduled flights to Kurdistan Region, including Austrian Airlines, Lufthansa, Royal Jordanian Airlines, Gulf Air lines and Middle East Airlines(MEA). Several members of the International Association for airlines are planning to start their flights to Erbil. In addition, several airlines contracted for flights to Kurdistan Region from Europe and the Middle East.

Amadiya Castle in Duhok governorate.

Tourism in Kurdistan region witnesses movement and activity due to the stable security situation than the rest of the governorates of Iraq. Government of the region, represented by the Ministry of Tourism, seeks to provide a proper atmosphere for rest and summer resort, as well as through attention to vital facilities.

Most prominent factor for tourist attraction is the archaeological sites of Kurdistan region, as it is one of the richest areas. There are about (30,152) declared archaeological locations. All governorates of the region are

characterized by historical specificity. Suleimaniya with the Sassanid civilization, Dohuk is more affected by the Abbasid and Ottoman civilization and Erbil with the Assyrian, Babylonian and Sumerian civilizations.

A-14 Industry:

The process of economic openness, economic and commercial expansion, construction and reconstruction, as well as creating trust for Kurdish venture capitalists started after 2007. Preparations for projects and industrial factories began to remarkably decrease in the region and main dependence became on tourism and imports of oil, as it is clear in table (10-A) below:

Table (10-A): Number of industrial factories and projects divided according to size of the factory and project, before 2007 to 2010

Industrial factories & projects	Before 2007	2007	2008	2009	2010	Total
	Numbers of projects	Numbers of projects	Numbers of projects	Numbers of projects	Numbers of projects	Numbers of projects
Small	1,300	190	72	114	200	**1,876**
Medium	175	24	17	10	33	**259**
Large	54	6	25	2	2	**89**
Total	1,529	220	114	126	235	**2,224**

Source: Kurdistan Regional Statistics Office- Statistical survey of large and medium industries.

There is great economic importance for industrial sector in general, in fields of employment, national income, creation of significant economic growth, the existence of strong relationship between industrial sector and other sectors, although there is no clear and significant attention for this sector. This sector is distinguished by lack of adequate investment, whether governmental or of private sector for its promotion. This sector also has an important role through linkages with other economic sectors, contribution to address the imbalance of economic structure, improvement of the balance of payments through promotion of imports and exports, absorption of labor and improvement of living standards.

Contribution of the industrial sector in generation of GDP, increased in 2008 compared with 2005, 2006 and 2007, but this percentage is considered low compared to other economic sectors. This indicates the low contribution of industry in Kurdistan region in generating GDP, low relative importance of

this sector for other economic sectors in the region and low if compared to neighboring countries.

A-15 Electricity:

Table (11-A) illustrates the relative distribution of the electrical power sources in residential units of Kurdistan region compared to other parts of Iraq, especially Baghdad:

Table (11-A): Sources of electricity supply in the residential complexes in Kurdistan region compared to the rest governorates of Iraq

Area	Percentage according to type of source (%)			
	Public Network	Private generator	Special generator	Other
Duhok	74.3	22.4	2.9	0.4
Erbil	36.5	59.4	4.0	0.1
Suleimaniya	86.2	11.7	1.6	0.5
Kurdistan	65.4	31.5	2.8	0.3
Baghdad	54.6	33.2	12.1	0.1
Rest of governorates	86.6	9.5	3.6	0.2

Source: Social and economic survey of family (2006-2007).

A-16 Fuel and Heating:

Table (12-A): Relative distribution of fuel and means of heating used in residential units in various areas of Iraq

Area	Main used fuel (%)			
	Electricity	Gas	Oil	Others
Duhok	8.6	0.8	82.9	7.8
Erbil	2.9	3.4	86.4	7.2
Suleimaniya	7.2	0.7	86.7	5.4
Kurdistan	6.0	1.7	85.7	6.6
Baghdad	6.6	0.6	92.7	0.1
Rest of governorates	18.1	0.9	75.7	5.2

Source: Social and economic survey of family (2006-2007).

A-17 Transportation:

Transport and communications sector are of the important sectors and play a significant and vital role in achieving development processes of all economic sectors and activities for all countries at all times. Therefore, transport and communications sector is one of the major means to implement link between the parts of the country and a link between the city and the village, i.e. between urban and rural to facilitate the commercial relations between them. As well as, strengthening social and economic relations to develop rural areas and bringing it closer to the life of the cities and the emergence of integration between them. Residents of urban areas depend on residents of rural areas in food supply and fulfilling needs for factories of raw materials and other productivity supplies. On the other hand, rural areas are funded with other livelihood requirements, often accomplished by the urban areas.

Prosperity of tourism through the region due to large number of tourist areas, prosperity of oil industry, crude oil extraction companies in the region and the increased number of population in the region, have all led to a noticeable increase in the number of means of transport, whether private vehicles, taxi vehicles or others. Table (13-A) shows the number of registered vehicles in traffic departments of the region in 2006.

Table (13-A): Number of registered vehicles (private sector) in traffic departments in the region in 2006, according to vehicles' type

Type of vehicle	Number by governorate			Total
	Erbil	Duhok	Suleimaniya	
Private	101,355	44,245	37,121	145,600
Taxi	23,333	6,828	15,765	30,161
Transport and carry	44,944	13,876	21,665	58,820
Agricultural	3,616	149	4,502	3,765
Construction	955	228	204	1,183
Governmental vehicles	5,346		4,373	5,346
Total	179,549	65,326	83,630	244,875

Source: Statistics departments in Erbil, Suleimaniya and Duhok governorates according to reports of tariffs departments.

* Total number of registered vehicles in traffic departments was (244,875) of various types, including (145,600) vehicle of private number, which is equal to (59.4%) of total number of vehicles in the region. Number of vehicles carrying a taxi number was (30,161), about (12.3%) of total vehicles in the region.

* Density rate of is one vehicle per 16.3 individual, on the level of the region. This rate is very high compared with the majority of countries of the world, which confirms the quality of standard of living of the family in the region.

Land Routs Situation:

Table (14-A) below shows numbers of roads and their suitability for vehicles within the borders of the region, compared with some other cities of Iraq.

Table (14-A):Indicators of nature of roads inside residential complexes during 2004

Area	Type of the road to houses				
	Roadway	Partial Roadway	Paved with gravel	Dusty	Other
Countryside	10	7	7	77	0
Urban	52	17	3	27	1
Iraq	43	14	4	38	1
The North	41	11	5	41	2
Dohuk	37	13	2	47	0
Sulaymaniyah	35	3	4	54	4
Erbil	51	21	6	22	0

Source: Survey of living conditions in Iraq, 2004.

A-18 Waste:

The responsibility for lifting, transferring and burying waste (in governorates of Kurdistan region) is of municipality directorates in each governorate through contracting local companies. Another responsibility of these directorates is provision of required allocations to establish landfills sites.

Ministry of Municipalities in Kurdistan region is responsible for the municipalities of governorates of Kurdistan region-Iraq (Erbil, Suleimaniya and Dohuk). Available data indicate that rate of waste production per capita is(0.83 kg/day) equivalent to 8.992.186.439 kg/year, 5.994.790.960 kg of it in urban areas and 2.997.395.479 kg in rural areas.

Table (15-A): Average daily Generated waste in the region during 2011, 2012 and 2013

Governorate	2011	2012	2013
Erbil	2,470 tons/day	2,900 tons/day	**3,400 tons/day**
Suleimaniya	2,500 tons/day	3,200 tons/day	**3,700 tons/day**
Duhok	1,400 tons/day	1,650 tons/day	**1,800 tons/day**
Total	**6,370 tons/day**	**7,750 tons/day**	**8,900 tons/day**

Part of the generated waste in urban areas is transferred to selected sites that do not comply with environmental determinants and are un-controlled. As for the rest of the waste, which is not continuously transferred, it is left in alleys and roads creating a suitable environment for breeding insects and rodents that cause different diseases. Residents burn this waste from time to another to get rid of insects and scents emitted from them. The generated waste in rural areas are dealt with by burning or burial in areas selected by the people without taking into consideration environmental determinants or other matters concerning emitted gases, which directly affect the public health.

Generated waste, including all types of waste in Kurdistan region-Iraq are listed in the below table; data in the table is only of household waste.

Types of Waste:

Types of waste transferred to manufacturing stations, including landfills are as follows:

1. Regular household waste, mentioned earlier.
2. Generated waste of demolition and construction.

Table (16-A): Ratio of types of generated waste in the region

Food items	Paper & cardboard	Plastic	Metal	Glass
57%	27%	9%	4%	3%

Table (16-A) shows the types of generated waste in KRG.

All governorates in the region increasingly witness demolition of old houses and construction of new ones or shops, which led to generate large quantities of rubble waste resulting from the work of construction and demolition. As well as, waste of rehabilitation services, including implementation of sewage, drainage and water networks and rehabilitation of damaged buildings as a result of military actions and others where part of them is mixed with household waste and transferred to landfills. They are not dealt with properly, like re-using these materials to be secondary and added materials for different building materials industry. The waste that is transmitted as remnants of buildings is often thrown in any area or an empty land inside or outside the basic border designs of cities.

Landfills:

Adopted landfills in the region are lowland where waste is thrown by covering and leveling the land in some parts, while most of them are left open after being filled with waste without follow-up. This makes wind gusts fly light waste which results in pollution of the environment and public health.

Table (17-A): Number of existing landfill sites and extent of compliance with environmental determinants for 2008

No.	Governorate	No. of landfill	Compliance with environmental determinants
1	Duhok	44	Not complying
2	Erbil	52	Not complying
3	Suleimaniya	81	Not complying
Total		177	

Table (17-A) indicates that governorates witness lack of sanitary landfills. Exploitation of lowlands for waste dumps is done without taking into account what environmental disasters it may cause, which cannot be controlled through pollution of surface water and groundwater, pollution of the soil and gases emitted into the atmosphere.

A-19 Health Situation:

Attention should be given to the health situation, as the health issues are of the basic requirements to increase and improve human capacities in the place and time. This could be achieved only through paying attention to health on a wide scale, through building health institutions of hospitals and clinics in urban and rural areas, with the increase of health staff of doctors, pharmacists and other health professionals so as to facilitate citizen's access to adequate treatment. Most important in this field of work, is to create health awareness among citizens through activating printed and audio-visual media means to introduce health issues and prevention of risk in case of neglecting of health rules.

Statistical data is considered an important indicator and effective tool for the advancement of health services, as it draws a real picture of the status, helps concerned health issues and the organization of programs and plans to provide better services to people. In order to identify the health situation in the region, we should have access to accurate and real data, which studies the health situation and numerical indicators to facilitate work of researchers and planners in this important area to support national economy.

The following are the most important indicators to give a clear picture of the existing health situation:

1. Total number of government hospitals in the region is (46), consisting (21.1%) of the total number of hospitals in Iraq.
2. Percentage of private hospitals (private sector) is (32.5%) of the total operating hospitals in the region.
3. Number of beds for treatment purposes is about (4,904) beds, representing (16.7%) of the total beds in Iraq.
4. Total number of doctors working in hospitals of the region is about (2,508) doctors. The average share of the doctor is estimated about (1,595) persons. This shows the quality of health situation in terms of staff, the fact that this average is close to developed countries.
5. Beds for patients sleeping, is estimated by (7.8) individual/ month. This rate is considered good, compared to developing countries.

In general, situation in Kurdistan of Iraq from all social, economic and environmental aspects is considered good. There has been a drop in infant mortality rates in the region to less than 6.8% for children under the age of five years, while this figure does not exceed 10% in areas of the center and south of Iraq. It is due to medical care for pregnant women and children who suffer from malnutrition, vaccination and continuous health awareness

against diseases such as tuberculosis and measles. Noted from table(18-A) that the high ratio of health units (hospitals) across the region is about 20% over 6 years and the private health units is 51%. In addition to the significant high number of beds for treated and visiting patients to those medical centers, staff and health professionals, that indicates the upgraded health situation level in the region.

Table (18-A): Data of indicators for the development of health situation

Some indicators of the health situation in the region, by governorates (2006-2011)									
Indicators	Erbil		Duhok		Suleimaniya		Total		Increase ratio
	2006	2011	2006	2011	2006	2011	2006	2011	
Number of governmental health units (hospitals)	19	22	7	9	23	27	49	58	20%
Number of private health units (hospitals)	4	10	3	5	9	18	16	33	51%
Number of beds for treated patients (governmental & private)	2,123	2,730	1,119	1,334	2,617	3,038	5,859	7,102	20%
Number of patients approaching health units	2,168,112	3,194,170	1,617,876	2,434,319	2,032,596	3,972,630	5,818,584	9,601,119	65%
Number of patients staying in health units	151,452	177,125	101,124	125,883	206,412	341,888	458,988	644,896	136%
Number of medical staff (doctors)	1,271	2,540	471	663	766	2,900	2,508	6,103	143%
Number of health professionals	5,677	8,772	1,787	4,263	6,589	8,122	14,053	21,157	47%

A-20 References:

1. Data from the Ministry of Municipalities and Tourism in the Government of Kurdistan region-Iraq.
2. Data and information of Environment Office in the Government of the region.
3. Data and Information of the Ministry of Electricity in the Government of the region.
4. Reports of the environmental status of the Government in the region.
5. Statistical Abstract No. (1), 2007 -Kurdistan region -Presidency of the Council of Ministers, Ministry of Planning, Kurdistan Regional Statistics Office.
6. Report of environmental statistics of Iraq, 2011.
7. Data of General Directorate of Traffic in the Government of the region.
8. Data and Information of the Ministry of Agriculture and Water Resources in the Government of the region.
9. Ministry of Higher Education and Scientific Research.
10. Meteorological Department, Government of the region.
11. Central Statistical and Information Technology Organization, Ministry of Planning and Development Cooperation.
12. Ministry of Trade and Industry of the Government of the region.

Annex B: Detailed Inventory Lists

INVENTORY SECTORAL REPORTS

1. Table B1: Sectoral reports for energy sector
2. Table B2: Sectoral reports for industrial processes sector
3. Table B3: Sectoral reports for agriculture sector
4. Table B4: Sectoral reports for Waste sector

Table B1: Sectoral reports for energy

TABLE 1 SECTORAL REPORT FOR ENERGY
(Sheet 1 of 3)

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)							
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total Energy	53,957	22	0	0	0	0	0
A Fuel Combustion Activities (Sectoral Approach)	53,957	0	0	0	0	0	0
1 Energy Industries	0	0	0	0	0	0	0
a Public Electricity and Heat Production							
b Petroleum Refining							
c Manufacture of Solid Fuels and Other Energy Industries							
2 Manufacturing Industries and Construction	281	0	0	0	0	0	0
a Iron and Steel							
b Non-Ferrous Metals							
c Chemicals							
d Pulp, Paper and Print							
e Food Processing, Beverages and Tobacco							
f Other (please specify)							

TABLE 1 SECTORAL REPORT FOR ENERGY
(Sheet 2 of 3)

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)							
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
3 Transport	18,518	0	0	0	0	0	0
a Civil Aviation	87	0	0	0	0	0	
b Road Transportation	18,431	0	0	0	0	0	
c Railways	0	0	0	0	0	0	
d Navigation	0	0	0	0	0	0	
e Other (please specify)	0						
Pipeline Transport	0						
4 Other Sectors	10,939	0	0	0	0	0	0
a Commercial/Institutional	0	0	0	0	0	0	
b Residential	10,918	0	0	0	0	0	
c Agriculture/Forestry/Fishing	0	0	0	0	0	0	
5 Other (please specify)	24,220	0	0	0	0	0	0
B Fugitive Emissions from Fuels	0	22	0	0	0	0	0
1 Solid Fuels	0	0	0	0	0	0	0
a Coal Mining		0					
b Solid Fuel Transformation							
c Other (please specify)							
2 Oil and Natural Gas	0	22	0	0	0	0	0
a Oil		7		0	0	0	0
b Natural Gas		15					
c Venting and Flaring		0					

TABLE 1 SECTORAL REPORT FOR ENERGY

(Sheet 3 of 3)

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)							
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Memo Items: (1)							
International Bunkers	0	0	0	0	0	0	0
Aviation	0	0	0	0	0	0	0
Marine	0	0	0	0	0	0	0
CO_2 Emissions from Biomass	0						

Table B2: Sectoral reports for Industrial Process Sector

TABLE B2 SECTORAL REPORT FOR INDUSTRIAL PROCESSES

(Sheet 1 of 2)

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)							
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total Industrial Processes	6,422	0	0	0	8	30	3,909
A Mineral Products	4,762	0	0	0	0	25	103
1 Cement Production	4,437						3
2 Lime Production	306						
3 Limestone and Dolomite Use	0						
4 Soda Ash Production and Use	18						
5 Asphalt Roofing					0	0	
6 Road Paving with Asphalt						25	
7 Other (please specify)	0	0	0	0	0	0	100
Glass Production						0	
Concrete Pumice Stone							100
B Chemical Industry	1,485	0	0	0	8	5	3,806
1 Ammonia Production	1,485				8	5	0
2 Nitric Acid Production			0	0			
3 Adipic Acid Production			0	0	0	0	
4 Carbide Production	0	0					
5 Other (please specify)		0		0	0	0	3,806
C Metal Production	176	0	0	0	0	0	0
1 Iron and Steel Production	176			0	0	0	0
2 Ferroalloys Production	0						
3 Aluminium Production	0			0	0		0
4 SF_6 Used in Aluminium and Magnesium Foundries							
5 Other (please specify)	0						

Table B3: Sectoral reports for agriculture sector

TABLE B3 SECTORAL REPORT FOR AGRICULTURE

(Sheet 1 of 2)

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)					
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CH_4	N_2O	NO_x	CO	NMVOC
Total Agriculture	134	17	0	0	0
A Enteric Fermentation	113				
1 Cattle	68				
2 Buffalo	5				
3 Sheep	31				
4 Goats	4				
5 Camels and Llamas	0				
6 Horses	1				
7 Mules and Asses	4				
8 Swine	0				
9 Poultry	0				
10 Other (please specify)					
B Manure Management	5	0			
1 Cattle	2				
2 Buffalo	0				
3 Sheep	1				
4 Goats	0				
5 Camels and Llamas	0				
6 Horses	0				
7 Mules and Asses	0				
8 Swine	0				
9 Poultry	0				

Table B4: Sectoral reports for Waste sector

TABLE B4 SECTORAL REPORT FOR WASTE

(Sheet 1 of 1)

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)						
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	NO_x	CO	NMVOC
Total Waste	0	163	1			
A Solid Waste Disposal on Land	0	163	0			
1 Managed Waste Disposal on Land						
2 Unmanaged Waste Disposal Sites						
3 Other (please specify)						
B Wastewater Handling	0	0	1			
1 Industrial Wastewater		0				
2 Domestic and Commercial Wastewater		0	1			
3 Other (please specify)						
C Waste Incineration						
D Other (please specify)						

Note :

Note :