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UNESCO
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United Nations
Educational, Scientific and
Cultural Organization

منظمة الأمم المتحدة
للتربية والعلم والثقافة

INTEGRATED DROUGHT RISK MANAGEMENT – DRM

NATIONAL FRAMEWORK FOR IRAQ

EXECUTIVE SUMMARY

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FOREWORD

One of Iraq's main challenges is *preparedness* – that is, "a state of readiness" – to the increasing variability of the country's climatic and meteorological conditions, especially in terms of water supply irregularity, cropland reduction, and health associated with drought impacts. The impact of an increased variability in meteorological conditions includes inability to store water during heavy rain, abandonment of agricultural land during drought, an exacerbation of already diminishing discharge rates in the perennial rivers of Iraq, the alarming trend of the regressing Marshlands, loss of soil and hence, soil-fertility, and increasing salinization of the Shatt al-Arab and groundwater potentials, notably in the south of the country. Visible symptoms of drought include a reduction in surface water flow, lowering of groundwater levels, drying-up of open shallow surface wells, increasing water salinity and soil salinization, progressing desertification, decrease in agricultural production, growing frequency of dust storm conditions, and an associated increase in respiratory infections.

Droughts have led to deterioration of livelihoods and health for people living in vulnerable communities. Deteriorating environmental conditions will likely lead to an aggravation of the above. Insufficient access to potable water and a lack of proper sanitation in many districts will continue to impose a growing challenge to the Iraqi people, if not addressed. For example, during the drought from 2007 and 2009, cropland throughout Iraq experienced reduced coverage, and livestock was decimated. The situation in 2009 caused a significant number of rural inhabitants to move in search of more sustainable access to drinking water and livelihoods.

Currently, Iraq is losing some 100,000 donum per annum of agriculture lands due to desertification and soil salinization. The Ministry of Agriculture has indicated that between 40-50% of what used to serve as agricultural land in the 1970s is now prone to desertification. Twelve out of eighteen governorates in Iraq stated they have experienced drought in the past, and most of them do not have any action plan in place addressing adequate response, any mitigation measures or adaptive strategies. It is expected that similar occurrences in the future will further increase the pressure on the Government's infrastructure and the provision of basic services.

This scientific review assesses drought in Iraq, including the status of sector knowledge, the availability of data and scientific evidence, and the given and predicted vulnerabilities of Iraq towards the occurrence of drought, in the context of its physiographic and socio-economic dimensions. The review aims to facilitate the development of a National Framework for Drought Risk Management in Iraq with the longer term goal of reducing the associated risks for the environment and humanity.

This is part of a series of scientific investigations carried out by the **UNESCO Office Iraq** for the concerned governmental authorities of Iraq, mandated to responsibly observe, monitor, and appropriately manage environmental issues of national concern.

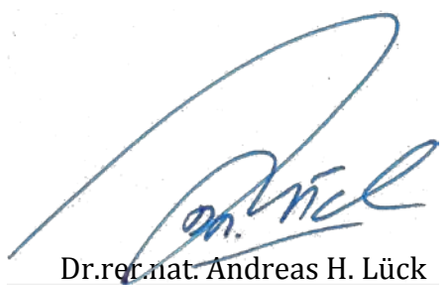
ACKNOWLEDGMENTS

This analysis report, the “Drought Risk Management-Desk Review, Data Mining, and Mapping Exercise”, is funded by United Nations Development Assistance Framework (UNDAF). The report fits within the framework of the joint UNESCO-UNDP Project “Development of a National Framework for Integrated Drought Risk Management (DRM) in Iraq”, which is also funded by UNDAF. The project involved the following relevant line ministries and authorities: the Prime Minister’s Advisory Commission and the Ministry of Environment (MoENV), in collaboration with the ministries of Water Resources (MoWR), Transport (MoT), Planning (MoP), Science and Technology (MoST), Agriculture (MoA), Municipalities and Public Works (MMPW), Electricity (MoE), and Health (MoH), as well as the following authorities in the Kurdistan Regional Government: the Ministry of Agriculture and Water Resources (MoAWR-KRG), the Ministry of Transport (MoT-KRG), the Higher Committee on Environment, and the Bureau of Tourism.

The establishment, thematic structure, and compilation of this report was facilitated by the Sector of Natural Sciences at the UNESCO Office Iraq. Under the supervision of UNESCO, JAU led the phases of data classification and preparation, information analysis, production of maps and graphs, as well as thematic information processing, production of findings, report consolidation, editing, design, and translation.

The report greatly benefitted from the committed and qualified efforts of the Drought Risk Management (DRM) steering committee and task force members who assisted in the provision of data and contributed to the discussions of the draft report.

On behalf of UNESCO, I would like to extend gratitude to all concerned ministries, with special thanks to the Ministry of Environment for facilitating the data collection and engaging with the involved partners.UNESCO wishes to thank the team working on Natural Sciences within UNESCO Iraq Office for its continued efforts and dedication, namely, Dr. Radhwan Abdul Haleem, Mrs. Lobna Farahat, and Ms. Menahil Hannouna, as well as our colleagues who were involved in earlier stages of the process.



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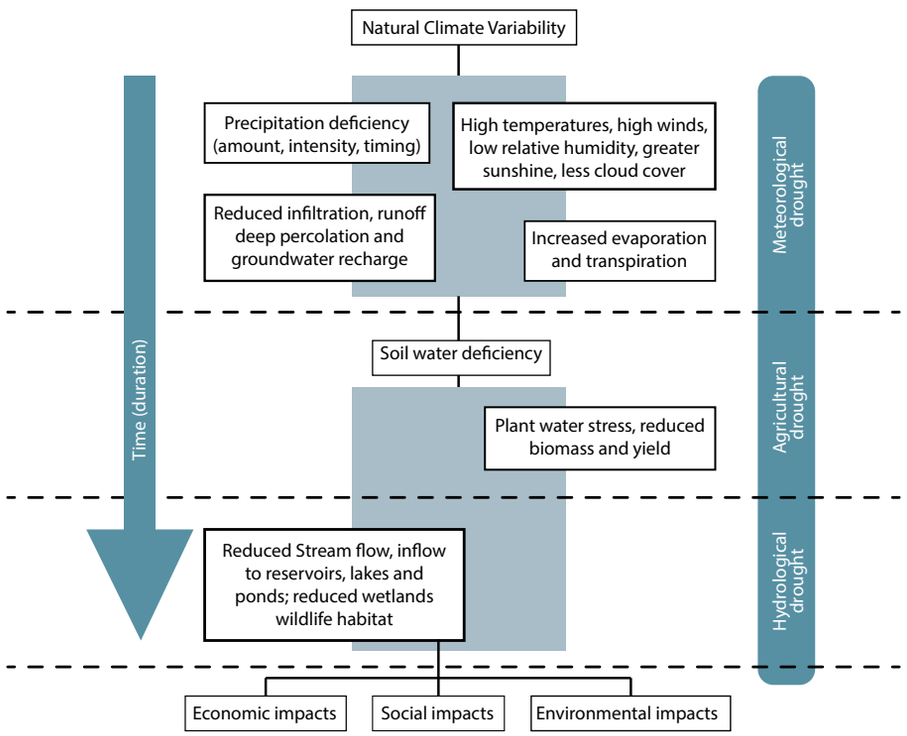
EXECUTIVE SUMMARY

1. Overview

Iraq, with a population of more than 33 million, borders Syria to the northwest, Turkey to the north, Iran to the east, Jordan to the southwest, and Kuwait and Saudi Arabia to the south and southwest. Situated across the Tigris and Euphrates rivers, Iraq occupies today what was once ancient Mesopotamia, the area referred to as 'the cradle of civilization'. Around 97% of the country's total area (of 438,317 km^2) is arid and semi-arid land with low and erratic precipitation. Among the range of environmental issues faced by Iraq, drought is recognized as the most serious disaster[i]. As indicated by the analysis in this report, droughts in the country are increasing in severity and frequency – a trend that is likely to continue and needs to be addressed.

Drought is defined as the consequence of a period of lower than expected or lower than normal precipitation over an extended period of time, which leads to a water shortage for certain activities, groups, or environmental sectors. The impact of drought depends on the interaction between a lack of precipitation, demand for water, and human activities, which may exacerbate the impacts. In terms of impacts, the literature commonly classifies drought in four categories: meteorological, agricultural, hydrological, and socio-economic.

FIGURE I. RELATIONSHIP BETWEEN DIFFERENT TYPES OF DROUGHT



SOURCE: WMO 2006

Due to the challenges faced by Iraq, assessments of drought are only carried out after the rainy season ends (i.e., following the event). Accordingly, as part of the efforts of the Development of a National Framework for Integrated Drought Risk Management (DRM), UNESCO, in partnership with the Joint Analysis Unit (JAU), prepared an Integrated Drought Risk Management (DRM) Analysis Report, which supports the development of a National Framework for DRM in Iraq and provides significant baseline references as data and related sector information.

[i] The Government of Iraq (GoI) and the High Level Committee for Disaster Risk Reduction (HLCDRR) as cited in: United Nations-Iraq UNDAF Fund Joint Programme. Available online at http://mdtf.undp.org/document/download/7152 (accessed 1 November 2012).

This study aims to assess the available information on drought in Iraq and analyse its severity, trend, and impact on key sectors and societal groups. This includes defining stakeholders and identifying information gaps. In this regard, the study analysed the spatial-temporal pattern of drought by introducing the first drought index applied for Iraq: the Standard Precipitation Index (SPI). The index is used to assess drought patterns across the country in order to help the government to improve its capacity and performance in drought monitoring.

2. Study observations and limitations

The report benefited from efforts by and collaboration with government institutions of Iraq that provided data on drought and its impacts, which enabled the present analysis. Consequently, the study involved a close examination of the available information as well as government capacity. However, this study was difficult to carry out since current information on drought in Iraq is limited in quantity and variable in quality.

3. Methodology

The report assesses the drought phenomenon in Iraq and evaluates its spread, severity, and trends. It investigates water shortage and evaluates the impact of drought in Iraq on various sectors, including water resources, environment, health, poverty, food security, employment, agricultural production, hydropower generation, and migration.

The analysis presents the trend in precipitation and air temperature for Iraq for the last 31 years, identifying the differences among governorates. Forty-two (42) meteorological stations across the country were chosen according to their geographical and spatial distribution across Iraq, as well as according to completeness and availability of data. Based on recorded data on annual precipitation, a standard precipitation index (SPI) was calculated for each governorate to assess the temporal and spatial characteristics of droughts. A three-month SPI (3 SPI)was calculated for a short-term meteorological drought assessment, while a six-month SPI (6 SPI) provided for an agricultural drought assessment, and a 12-month SPI (12 SPI) was used to calculate an intermediate to long term drought index, applicable in hydrological drought analyses and applications. Moreover, the SPI values for the 18 governorates were analysed in order to identify drought prone areas.

After reviewing the institutional response to drought, the study team proposed a number of drought mitigation measures and plans incorporating regional and best practices to enhance the current capacity of the government with regards to drought preparedness, monitoring, and management.

4. Finding and Discussions

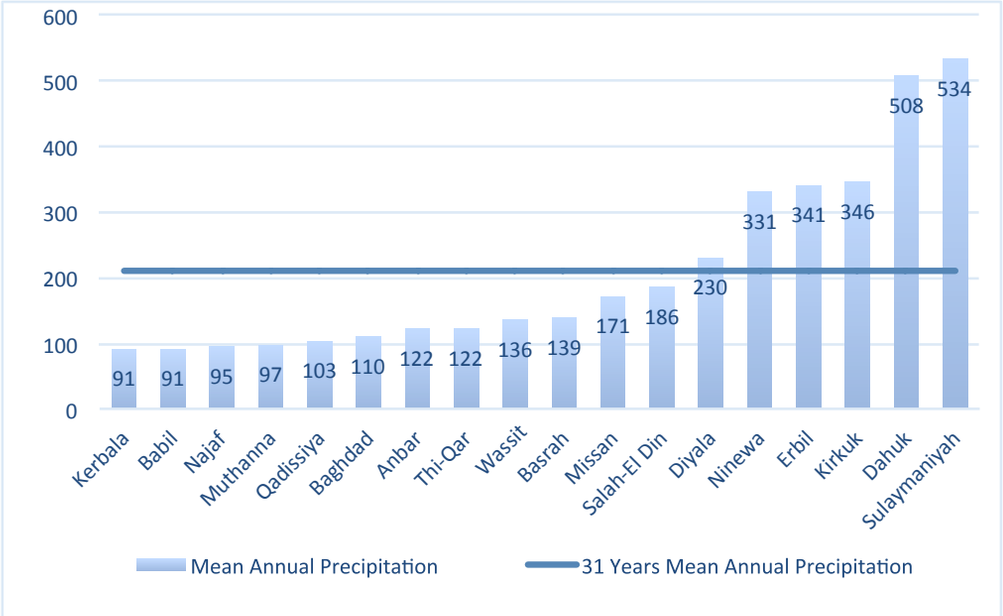
Meteorological analysis

The meteorological analysis conducted for the period 1980-2011 showed 31-years Mean Annual Precipitation (MAP) equal to 207 mm/m^2[ii] and a Mean Annual Air Temperature (MAAT) of 23.0 ^{o}C.

Sulaymaniyah and Dahuk observed the highest precipitation levels while Babil, Karbala, Najaf, and Muthanna received minimum levels of precipitation below 100 mm.

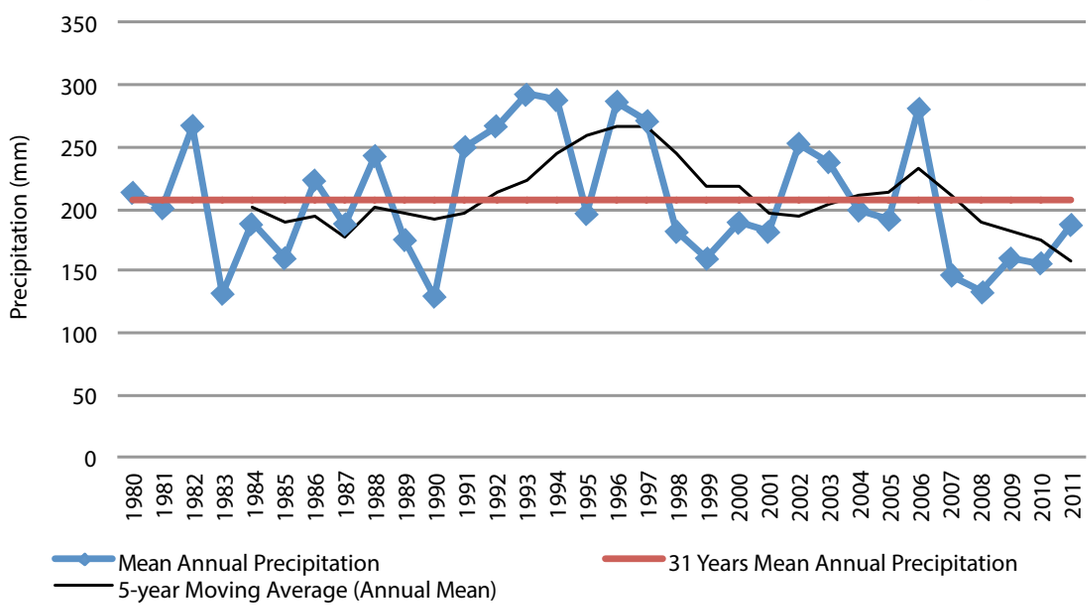
[ii] Millimetres per square meter

FIGURE II. PRECIPITATION AMOUNT DISTRIBUTED BY GOVERNORATE (1980-2011)



Observation of the long-term trend in precipitation shows that **Iraq is currently experiencing drought.** Although there are some differences in the trend across governorates during the reference period, all governorates experienced a reduction in the precipitation throughout the last decade when severe droughts affected the whole country. Almost all governorates are considered drought prone areas; some are currently experiencing drought, while others are considered highly vulnerable to it.

FIGURE III. PRECIPITATION FIVE-YEAR MOVING AVERAGE IN IRAQ (1980-2011)



The SPI calculated for each governorate shows that the severity of drought in Iraq has worsened significantly during the past 12 years. Two significant drought periods occurred across the country in 1999 and 2008 during which moderate to severe drought covered more than 53% and 73% of Iraq. Eleven governorates were affected by drought at the end of 2008.

MAP I. STANDARD PRECIPITATION INDEX FOR THE YEAR 2008 (SPI 12)

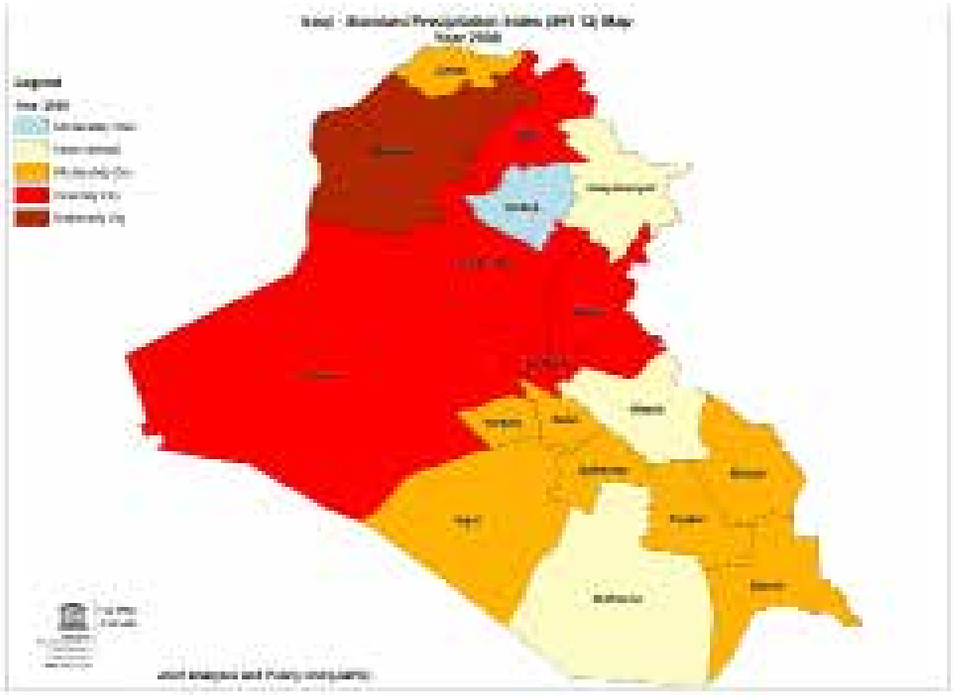


FIGURE IV. 3 SPI, 6 SPI, AND 12 SPI VALUES FOR IRAQ (1980-2011)

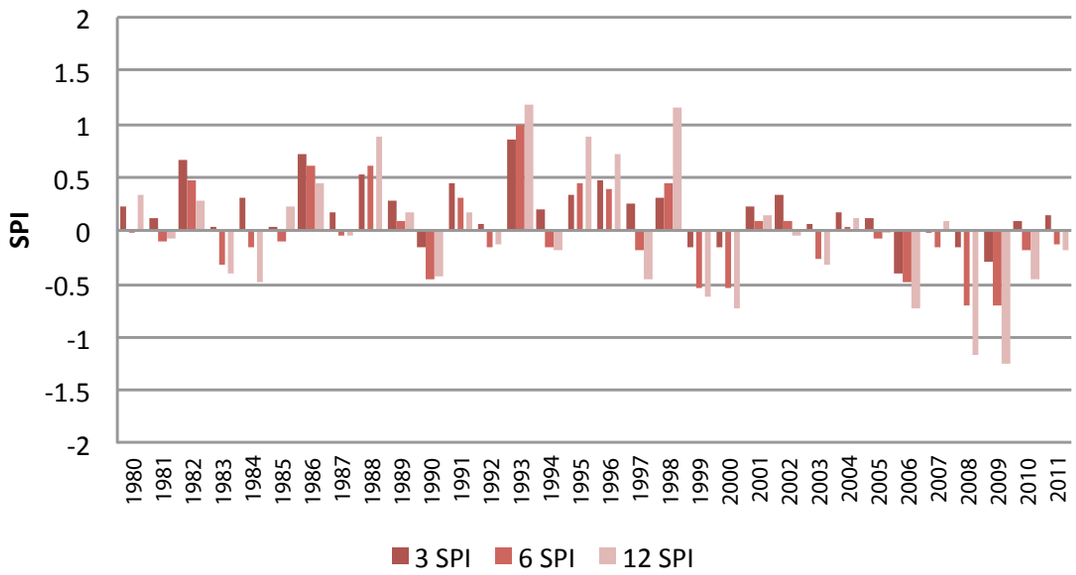
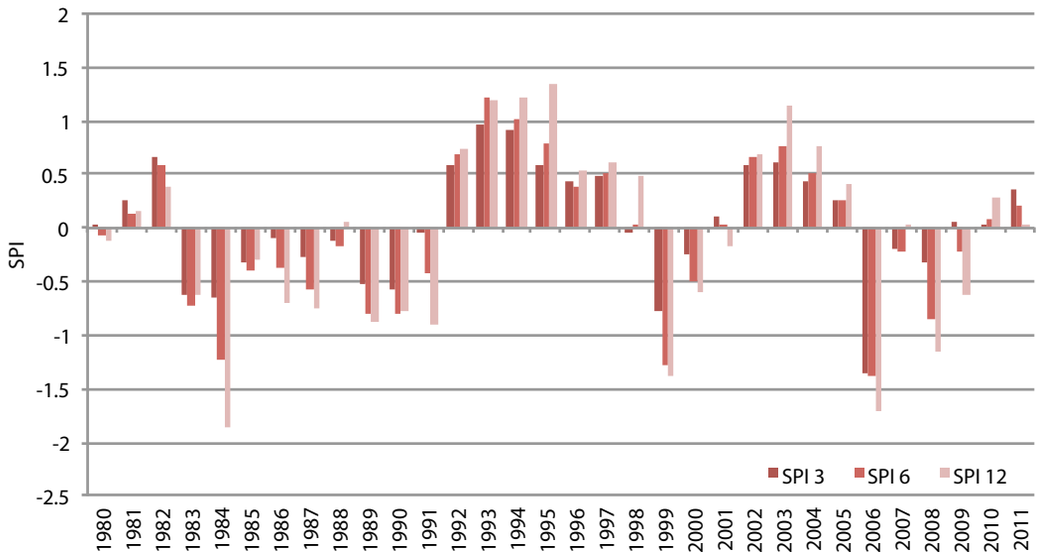


FIGURE V. 3 SPI, 6 SPI, AND 12 SPI VALUES FOR KURDISTAN REGION (1980-2011)



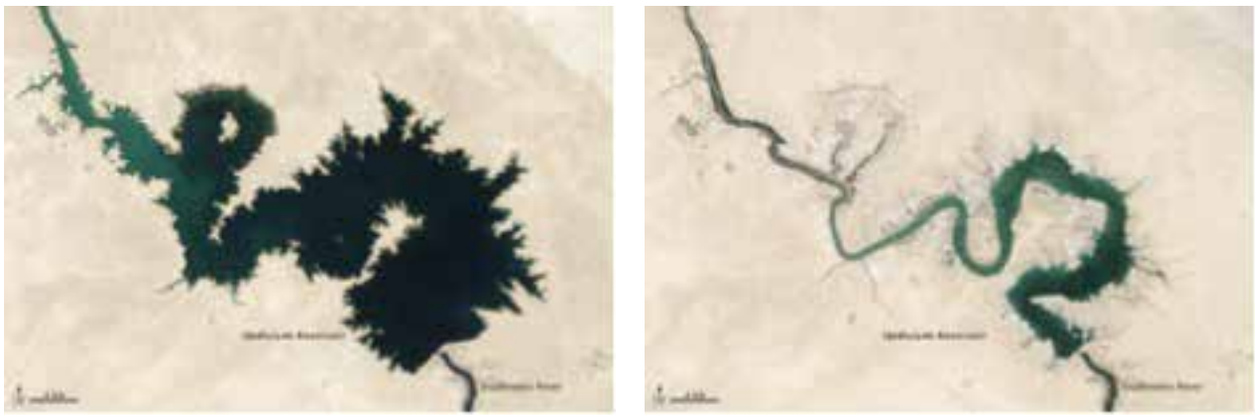
The governorates in the southern and north-western parts of Iraq are the most affected by drought; the frequency of drought is higher in these regions compared to the rest of the country. The future values of the SPI indicate that moderate to severe droughts are expected at certain locations starting from 2017-2026. In contrast, the predicted SPI for Kurdistan shows that the region is not expected to experience noticeable droughts.

The effects of droughts in Iraq during the last decade changed the vegetation cover in the country. The comparison between the vegetation cover in 2009 and 2012 reveals significant reductions of vegetation particularly in the governorates of Diyala, Salah Al-Din, and Basrah.

Water resources

Iraq depends mainly on surface water from two renewable sources: the Euphrates and Tigris Rivers. A significant percentage of Iraq's water resources originates from outside its international boundaries, mainly from Turkey and Iran. Therefore, the country is extremely vulnerable to development plans and aspirations of upstream states. The analysis confirms that the current annual flow of the Euphrates and Tigris entering Iraq has dropped dramatically. Although this decline can be attributed to many factors such as dam construction in all riparian countries and an increased withdrawal of water for irrigation, years of drought have clearly reduced the runoff in the river basin, particularly in the Tigris River. Taking into account the predicted reduction in precipitation due to climate change, a decline in the levels of water in the Tigris and Euphrates is expected for the coming years. In the Kurdistan Region, according to Ministry of Agriculture and Water Resources, almost 40% of the springs in the region were depleted during previous drought periods.

FIGURE VI. THE SHRINKING OF THE QADISSIYA RESERVOIR IN IRAQ BETWEEN 7 SEPTEMBER 2006 AND 15 SEPTEMBER 2009



SOURCE: NASA IMAGES BY ROBERT SIMMON, USING LANDSAT DATA/EARTHOBSERVATORY

Groundwater resources are of strategic importance for various purposes including agriculture and drinking water. However, between 2006 and 2009, a decline in water levels was observed for a number of aquifers across the country[iii]. The data show a seasonal fluctuation of total water storage and an overall downward trend, which suggests groundwater is being exploited at an alarming level, exceeding natural recharge capacities.

The future of the Iraqi Marshlands and of its inhabitants strictly depends on the availability of water resources in the country. In fact, droughts occurring during the past decade have reduced the size of the marshes to the surface area they occupied in 2003, neutralizing the effort made by the government to bring them back to 75% of the area occupied in 1973.

Water supply and quality

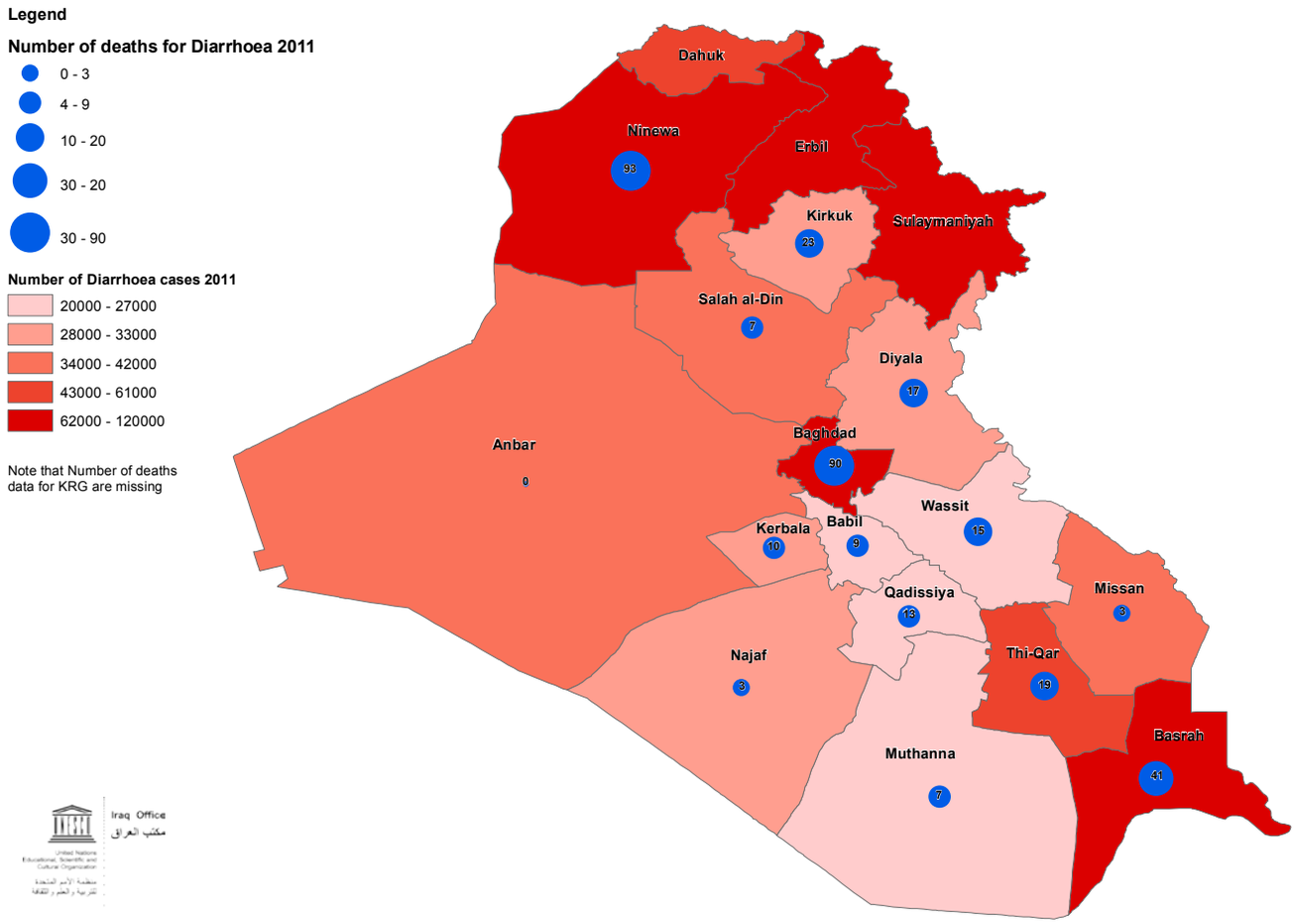
The decrease in water levels has made the Euphrates River more exposed to the decline of water quality. Large evaporation losses due to increasing air temperature, in combination with the dissolution of salts leaching from salted soils, are contributing to an increase in salinity of the fluvial water, hindering its usability. In general, the water quality of the Euphrates River has deteriorated due to the decrease in quantity and the increase in salinity, exacerbated by wastewater discharge in upstream countries.

Drought effects on health

The decline of water quality increases the risk of waterborne diseases, such as diarrhoea, cholera, typhoid, and different forms of hepatitis. Moreover, the dusty and dry conditions and the occurrence of wildfires irritate the airways and lungs resulting in aggravating chronic respiratory illnesses. According to the Ministry of Health, the highest number of diseases transmitted through contaminated water and food (Cholera, Typhoid, Dysentery, Hepatitis B) was registered between the years 2007 and 2010, during the most severe droughts that affected the country in the last decade.

[iii] NASA Earth Observatory. (2013). Freshwater Stores Shrank in Tigris-Euphrates Basin. Available online at: http://earthobservatory.nasa.gov/IOTD/view.php?id=80613.

MAP II. TOTAL NUMBER OF DIARRHOEA CASES AND DIARRHOEA DEATHS FOR THE YEAR 2011



SOURCE: INFORMATION FROM THE MINISTRY OF HEALTH, GOVERNMENT OF IRAQ, 2013

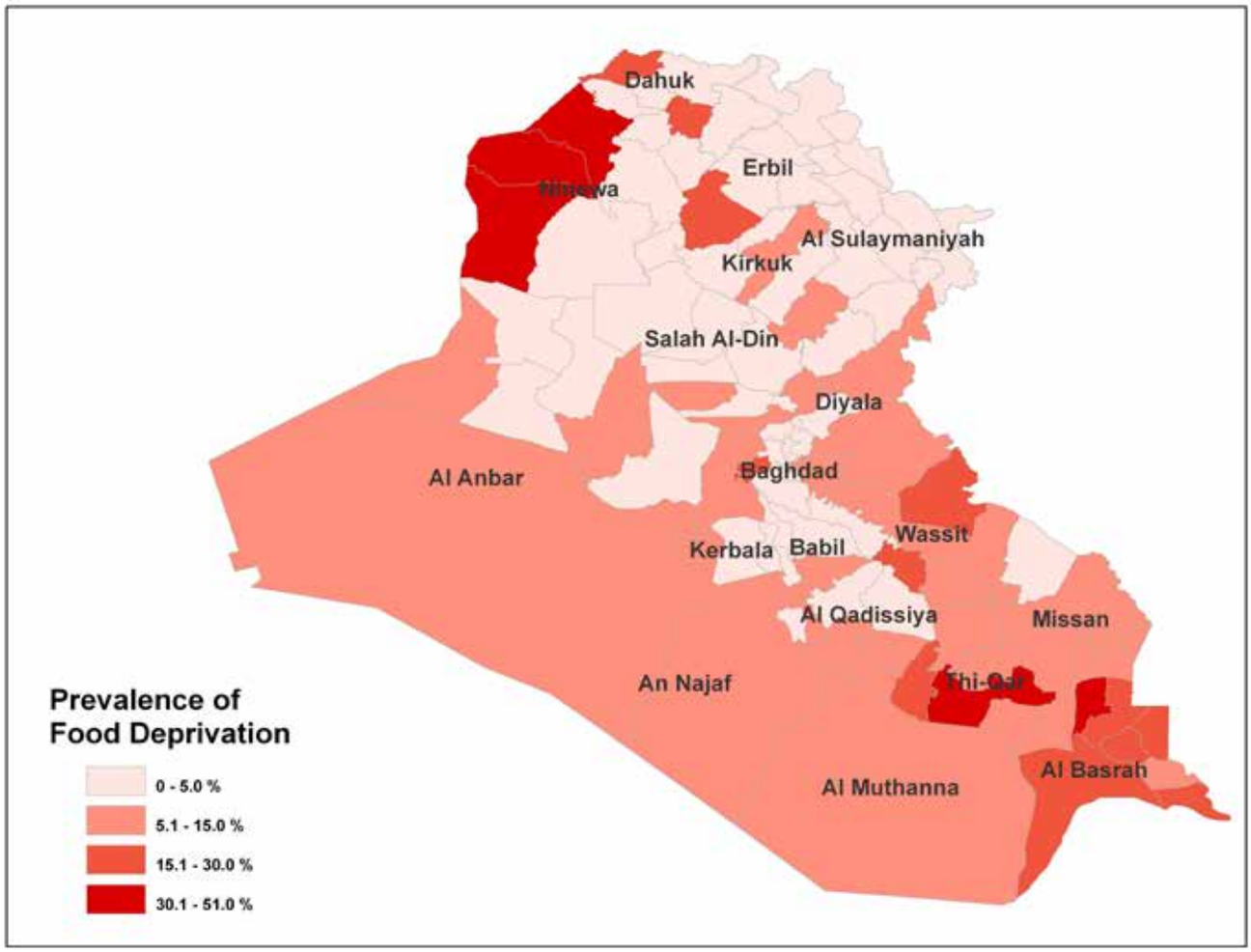
Drought effects on poverty, unemployment, and food security

Water scarcity impacts poverty and socio-economic development in different ways: some effects can be easily observed, while others are more difficult to assess and to quantify. A reduction in the availability of water negatively affects the welfare of the population. It slows economic growth and undermines the livelihoods of a large number of people, often contributing to poverty.

The earliest and most visible consequences of drought relate to agricultural production. In fact, agricultural yields depend mainly on the availability of water, via precipitation or irrigation, and any respective shortage translates directly into production losses. In general, people living in rural areas whose income depends on agricultural production, livestock, forestry, and fishery are the most vulnerable to the effects of drought.

Drought causes food insecurity and increases poverty, particularly in rural areas where most of the population relies on agriculture as its main source of livelihood. Recurrent droughts and periods of water scarcity negatively affect food production, aggravating the current imbalance between food supply and domestic demand. Effects and impacts of climate change and growing population are expected to further increase Iraq's dependency on imports in the coming years, with relevant impact on national food security.

MAP III. FOOD DEPRIVATION – DISTRICT LEVEL



SOURCE: WORLD FOOD PROGRAMME, 2012

Drought-induced migration

Protracted periods of drought and their related effects are among the reasons for population movements in Iraq. Between December 2007 and June 2009, 4,263 families (25,578 individuals) were displaced due to drought, with more than 80% from Salah al-Din and Ninewa governorates.[iv] In 2012, the International Organization of Migration (IOM) reported that 11% of the assessed Internally Displaced People migrated from their place of origin due to water scarcity. In some governorates, drought induced migration far exceeded migration related to security, conflicts, or lack of employment opportunities. In Muthanna, 94% of the assessed IDPs were displaced for drought reasons.

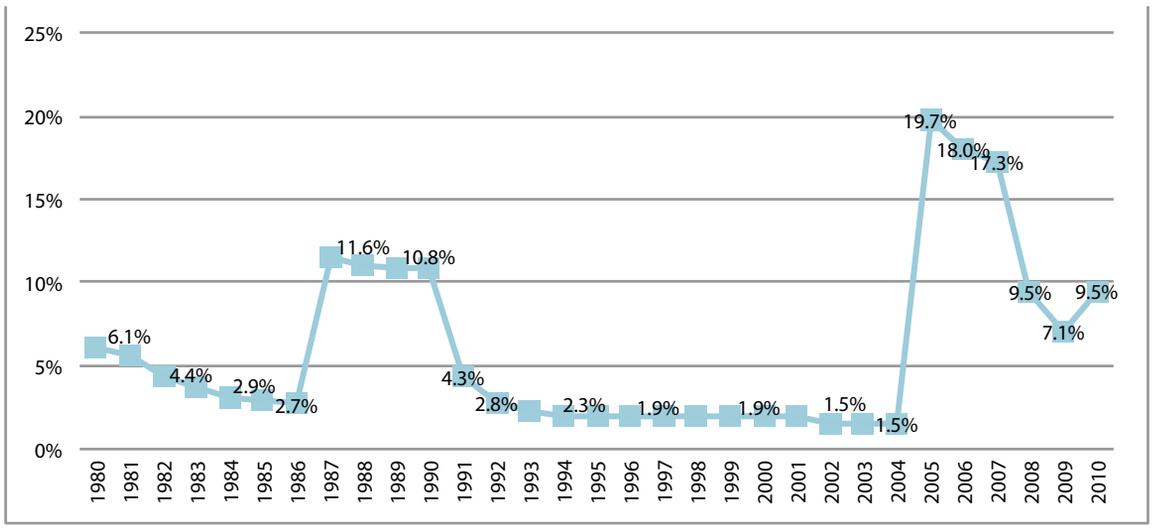
Hydropower generation in Iraq

Hydropower generation represents the most important source of renewable energy in Iraq, accounting for nearly 10% of the electricity generation mix in 2010 (around five TWh)[v]. The declining precipitation rate projected for the future years and the related reduction in water availability is expected to impair hydroelectric production in the future, adding to environmental issues in the country. In order to meet the demand for electricity from companies and households, higher shares of electricity production will need to be derived from combusting oil, gas, and coal resources to buffer the capacity losses on the side of hydropower plants. Therefore, in a drought scenario an increase in CO2 emissions is expected. Hydropower production strongly depends on the availability of surface water and conducive atmospheric conditions which favour low evaporation rates throughout the resource areas. Generally, the total electricity produced follows the trend in precipitation in resource areas, and it is evidently affected by the occurrence of a drought.

[iv] IOM Iraq Displacement Reports - Special Focus—Water Scarcity, September 2010

[v] International Energy Agency (IEA). (2012). World Energy Outlook Special Report 2012 - Iraq Energy Outlook. Available online at: http://www.worldenergyoutlook.org/media/weowebsite/2012/iraqenergyoutlook/Fullreport.pdf (accessed 1 July 2013).

FIGURE VII. TREND IN ELECTRICITY PRODUCTION FROM HYDROELECTRIC SOURCES (% OF TOTAL PRODUCTION)



SOURCE: WORLD BANK INDICATORS, 2013

Drought effect on agribusiness and the industrial sector

The agricultural sector is a vital component of the Iraqi economy. It is the main source of livelihood for poor and food insecure people as well as the largest source of rural employment. After an increase in agriculture's contribution to the GDP from 4% in 2008 to 8.1% in 2010 (mainly due to the Prime Minister's Agriculture Initiative to boost the sector), its contribution declined to 7.6% in 2011.[vi] One reason for the decline of agricultural production relates to climate change and the environmental challenges faced by the country.

Cereals are the major crop in the north of the country and their cultivation mainly relies on precipitation. In central and southern Iraq, agriculture depends mainly on irrigation from the Tigris and Euphrates rivers and their tributaries. The consequences of drought on rainfed crops have an immediate effect since the yield depends mainly on precipitation levels; thus, any shortage in precipitation translates directly into production losses. The moderate and severe droughts that are expected to affect the country in the next 15 years will have negative impacts on agricultural production, potentially affecting the most vulnerable people living in rural areas who rely on agriculture as their primary livelihood. This especially applies to those governorates characterized by a high dependency on agricultural production, under prevailing high unemployment rates. According to WFP, average wheat production is expected to fall by 12.5% by 2020, due to reduced precipitation and increasing air temperature. This will in turn increase food insecurity and poverty. The income of rural farmers is estimated to decrease by 8% by 2020; as a consequence, the average daily intake of dietary energy of residents may decrease by 3%.

In addition to agriculture, several industries are affected by water scarcity throughout the production process, sales, and other operations, which may result in capital losses and layoffs, thus increasing unemployment.

[vi] Food and Agriculture Organization (FAO), World Bank, Iraq Agriculture Sector Note, 2012. Available from http://www.fao.org/docrep/017/i2877e/i2877e.pdf (accessed 1 April 2013); Government of Iraq, National Development Plan 2013-2017

5. Institutional Response

Iraq's institutional response to drought involves a number of different stakeholders coordinated on an ad-hoc basis. Several ministries and agencies are directly or indirectly involved in dealing with drought topics, drought risk management, and mitigation. Another group of governmental stakeholders are those responsible for water resources and communication in the event of a drought. A third category of stakeholders are secondarily affected by drought and have to respond to its impacts, including socioeconomic impacts such as unemployment and migration. The various stakeholders (government institutions, agencies, donors, etc.) may be divided into actors operating at the national level and those primarily concerned with the Kurdish Regional Government.

Institutional setup as it relates to drought management

A few Iraqi ministries maintain specific units or have started to establish responsibilities related to drought. These include:

- Ministry of Water Resources (State Bureau for Groundwater) – through its responsibilities for hydrologic analysis and related modelling
- Ministry of Agriculture (Directorate for Combating Desertification) – through its efforts to combat desertification
- Ministry of Science and Technology (Environment and Water Technology Research Department) — through its research on dealing with water shortages
- Ministry of Transport (Directorate of Meteorological Monitoring) – through its mandate to predict precipitation and carry out related modelling
- Ministry of Environment – through a number of programmes focused on desertification and climate change

Activities related to awareness

Several stakeholders have implemented, or are in the process of implementing awareness campaigns related to drought, water efficiency, electricity efficiency, environmental conservation, and desertification. Going forward, steps to be taken include, inter alia: evaluation of the impacts of awareness campaigns; design of awareness programmes tailored to drought conditions at the governorate level specifically; and a concerted national effort uniting all ministries.

Coordination mechanisms followed in drought management

In general, there is coordination between the relevant stakeholders in times of drought. The main mechanism of cooperation occurs via the establishment of higher committees for droughts formed from representatives of various governmental agencies as well as bilateral committees[vii]. The formation of higher committees for drought enables relevant stakeholders to effectively decide upon and implement actions. The way forward may involve the establishment and implementation of a clear coordination mechanism, which officially declares drought conditions, identifies drought impacts, the proper course of action, and relevant stakeholder duties and responsibilities.

[vii] Some examples of bilateral committees are as follows:

- Ministry of Water Resources / Ministry of Agriculture: a committee to decide upon the water shares allocated to the agricultural sector, the areas to be irrigated, the types of crops to be allowed, etc.
- Ministry of Water Resources / Ministry of Municipalities and Public Works: a committee to allocate the various municipal water quantities for residential and industrial uses
- Ministry of Water Resources / Ministry of Electricity: a committee to determine the minimum river water elevation needed to guarantee certain generation capacities at power generation plants

Existence of early warning systems

Due to extreme challenges, political instability, and years of conflict, prior to the conduct of this study, no drought indicators or early warning systems were established. The primary approach to drought was one of "disaster management" rather than "risk management". At present the Directorate of Meteorology of Baghdad is conducting eight pilot projects using time series analysis to better project future probabilities in support of the establishment of a warning system. The results of this effort need to be further developed and validated. Furthermore, the Erbil Directorate of Meteorology does not yet have the capacity to conduct such analysis. This is another area where intervention and support are needed, for example, through the establishment of an early warning system, a national drought information system, and/or an Automated Telemetric Observation Network (ATON).

6. Proposed Measures to Reduce and Mitigate Drought Impacts

Challenges and constraints for drought mitigation in Iraq

In Iraq, drought has often been dealt with in a reactive, crisis management manner, which responds to the impacts of drought once it occurs in an attempt to expedite the recovery process. This crisis management approach has been noted to be costly, untimely, and poorly coordinated. However, steps have been undertaken to move towards a drought risk management approach. This pre-emptive approach reduces vulnerability and makes effective use of scientific knowledge as well as all relevant information available.

In recent years, Iraq has become more concerned and aware of the need to develop drought management strategies. However, the country faces many challenges to realizing these objectives. Among others these include:

- a lack of reliable statistics to assess the long-term socio-economic effects of drought
- a need to document the impacts of drought using standardized methodologies, in order to identify those sectors most affected and to devise and implement mitigation measures in a systematic manner directed at reducing those impacts
- a need to understand the diverse impacts of drought on agriculture
- a need for improved policies related to national and regional drought risk management
- a need to implement drought early warning systems, consisting of monitoring, prediction, and well-developed information delivery structures and mechanisms
- a need for a comprehensive long-term national drought strategy with coordination and cooperation at local, national, and regional levels, even cross-border

An ideal strategy would involve operational early warning systems interconnected with international ones, which are the basis for effective drought policies and plans. The development of such systems requires biophysical and socio-economic data as well as professional/scientific expertise. All available drought mitigation measures should be adopted where possible, and investments should be made towards agriculture in dry areas and related research/development programmes.

There is a need for an improved understanding of the scientific basis of droughts – their definition, monitoring, impacts, and prediction – and a need to bring this knowledge to sector experts involved in various aspects of drought management. Understanding the historical frequency, duration, and spatial extent of drought assists planners in determining the likelihood and potential severity of future drought episodes.

- At the same time, successful experiences in adopting a comprehensive and active approach across various sectors in dealing with droughts should be widely shared, and the capacity to apply such approaches should be built and developed where needed. The establishment and institutionalization of a NATIONAL DROUGHT INFORMATION SYSTEM (NADIS) to facilitate the scientific and officially authorized information repository would comprise a central data-base and environmental information management system(s), plus rules and defined mandates for monitoring, early warning (preparedness) and drought management (action planning) per sector.

Proposed drought mitigation measures

A comprehensive drought mitigation system – being a structural element of NADIS - should consider the technical (drought early warning and mitigation), institutional, and policy aspects to encourage proactive measures. Key aspects that need to be developed for proper drought risk management in Iraq are as follows:

- Drought Early Warning System
- Agro-Ecological Characterization and Mapping of Drought
- Drought Mitigation
- Policies and Organization

A regional strategic drought preparedness programme may be established for Iraq in order to support individual regions in their drought preparedness initiatives and activities. Initially, it could take the form of a collaborative partnership network, as integral element of NADIS.

Drought risk adaptation

Drought risk adaptation is the process of selecting the appropriate level of drought preparedness conditional on drought risk. This covers the state of having planned and taken actions in advance which reduce drought vulnerability. Furthermore, it involves the actions people take in response to, or in anticipation of, projected or actual impacts of drought to reduce its adverse consequences.

The main strategies to be considered for proper drought risk adaptation in Iraq are as follows:

- Development and implementation of drought adaptation plans for the most affected areas
- Enhancement of adaptive capacity
- Adaptive measures

The government needs to focus on the following prerequisite measures to enhance drought adaptation:

At the national level:

- formulation of drought policy geared toward vulnerable sectors, with emphasis on poverty reduction and food security
- establishment of an integrated drought monitoring and information system, including an early warning system and farmer coping mechanisms
- development of policies and institutions to support adaptation at the community level and encourage private sector participation, allowing for greater dedication of resources to the development of adaptive technologies and innovations
- training of mid-level professionals working with different organizations and governmental departments and launching a regional, certified training programme with local universities on drought preparedness and adaptation
- resource allocation for the development of adaptive technologies and innovations

At the community level:

- establishment of appropriate social institutions and arrangements to discourage marginalization of vulnerable population and enhance collective/participatory decision-making processes
- diversification of sources of income and livelihood systems which reduce vulnerability and risks, especially for the poor
- introduction of collective security arrangements such as farmers' cooperatives and Community-Based Organizations (CBOs)
- building capacity of smallholder farmers and extension staff, including NGOs and Civil Society Organizations (CSOs) to adopt and promote interventions in compliance with principles of Integrated Water Resources Management (IWRM)
- provision of knowledge, technology, policy, institutional, and financial support similar to credit facilities for vulnerable communities
- upgrading of rainfed agriculture through on-site rainwater harvesting systems and other farming practices, which retain water in cropland (terraces, contour bunds, ridges, tied ridges, planting pits, conservation agriculture, etc.), and reuse of treated wastewater
- enhancing of supplementary irrigation systems and farming practices, which supply water to crops during critical growth stages

7. Conclusions and Recommendations

Conclusions

As confirmed by the SPI, during the last 31 years, severe droughts affected the whole country. All governorates are considered drought prone areas. Some are currently experiencing drought (Ninewa, Salah al-Din, Kirkuk, Missan, Anbar), while others are considered highly vulnerable to it (Baghdad and Basrah). During the 31 years analysed, four evident droughts took place in 2000, 2006, 2008, and 2009. Moreover, the severity and frequency of drought has increased. During the past 12 years, the highest drought magnitudes were identified in the governorates of Ninewa, Kirkuk, Basrah, Babil, and Diyala. Extreme droughts have been recorded for Ninewa and Basrah in 2008 and for Kirkuk during the years 1983 and 1992. Baghdad is one of the governorates which experienced frequent and severe droughts during the 31 years analysed. Governorates in the southern and north-western parts of Iraq are the most drought-affected ones compared to the northern and north-eastern governorates, where the frequency of drought is lower.

In addition, from the precipitation forecast and SPI, drought severity is estimated to further increase over time. The average precipitation is projected to decrease by almost 3% as compared to the average for the same past timescale period.

Years of drought in Iraq are reflected by the reduction of water quantity and quality for both, surface and groundwater. Groundwater also experienced a reduction in quantity and an increase in salinity levels; thus, some resources are not suitable for either domestic use or agriculture. Water levels are anticipated to decrease significantly, as foreseeable droughts are expected to take place. The success of the Marshlands' restoration strongly depends on upcoming precipitation and availability of fluvial waters by the Tigris and Euphrates rivers.

Drought has negative consequences on health. Growing concentration of pollutants, sediments, and minerals in the water - due to the reduction in surface and groundwater levels, as well as the higher air temperature and the increasing occurrence of dust storm conditions - appear to be related with a higher incidence of diarrhoea, cholera, typhoid, further waterborne diseases, and chronic respiratory illnesses observed during years of drought.

The drought episode which occurred between 2007 and 2009 strongly affected hydropower generation in the main dams in Kurdistan Region, since production depends on the pattern of precipitation and the availability of water in the Dohukan Lake and Diyala River. The reduction in electricity generation is expected to raise additional environmental issues, with hydropower generation losses being buffered by electricity derived from the combustion of fossil, non-renewable resources, such as oil, gas, and coal. Therefore, in a drought scenario an increase in CO2 emissions is expected.

Drought also affects the production of the agricultural sector, which undermines food security and increases poverty. Moderate and severe droughts, which will be affecting the country in the next 15 years, are expected to have negative impacts on agricultural production, severely impacting most vulnerable people, such as the rural poor who rely on agriculture being their primary livelihood. The loss of income related to drought has already pushed many households to move from dry zones to areas with improved water availability – mostly cities – exacerbating negative outcome of steadily increasing urbanization, such as urban and rural impoverishment.

Recommendations

A comprehensive drought mitigation action plan should be established through the implementation of drought resilience policies, early warning and monitoring systems, drought contingency planning, drought mitigation, and relief plus rehabilitation measures. The report recommends the following measures to be taken by the government and other stakeholders as part of a national framework for Integrated Drought Risk Management (IDRM):

Data gap elimination

- Develop the current meteorological system to include an early warning system as well as a more efficient and accurate collection and classification of meteorological information based on an AUTOMATED TELEMETRIC METEOROLOGICAL OBSERVATION SYSTEM (ATMOS).[viii]
- Simplify access to this information to encourage the development of useful drought indexes to better represent the drought severity across the country.
- Develop a Master Plan for a Natural Resources and Drought Management Databank. From a scientific point of view, UNESCO highly recommends the development, establishment and institutionalization of a NATIONAL DROUGHT INFORMATION SYSTEM (NADIS) to facilitate and represent the scientific and officially authorized information repository comprising a central data-base and environmental information management system(s), plus rules and defined mandates for monitoring, early warning (preparedness) and drought management (action planning) per sector.
- Articulate needs and uses for hydrological, climatological, and meteorological data to guide an optimized spatial distribution and placement of hydro-meteorological observation stations. UNESCO highly recommends to establish a NATIONAL OBSERVATION PROGRAMME FOR IRAQ (NOPI), which maintains oversight of sector activities, and an effective institutional empowerment of NADIS.
- Under NADIS, develop a Meteo-Master Plan Application (MPA) to provide a comprehensive picture of Iraq's climatological and meteorological conditions, as well as any future scenarios, based on data derived from ATMOS. Key-data, sound indicators and appropriately chosen parameters are presently not sufficiently defined.

Enhancement of data communication

- Improve combined access to automatic data collection mechanisms and telecommunications. Automated meteorological (ATMOS) and gauging stations, such as a TELEMETRIC WATER RESOURCES OBSERVATION NETWORK (TeWaRON) where telecommunications are easily accessed, will reduce visits to stations, alert staff to equipment malfunction, and facilitate data sharing, which can shift the burden of data reduction and quality control to collaborators. Moreover, communicating data through data-sharing networks will improve real-time data visualization and reduce the burden of metadata management. TeWaRON and NADIS will be coordinated under NOPI on a national level, serving the regional and local governmental responsibilities at the same time and providing remotely accessible official data repositories and administrative support functions.

[vii]i The AUTOMATED TELEMETRIC METEOROLOGICAL OBSERVATION SYSTEM (ATMOS) will form an integral element of the National Observation Programme for Iraq (NOPI).

Integration of drought and water resources' planning

- Integrate drought and water resources' planning to benefit drought management and monitoring processes in Iraq. The occurrence of drought and floods relates to precipitation, water levels, and natural resources as well as hydrological and cultural practices. Hence, planning for drought or flooding takes on socioeconomic and environmental significance.
- Develop a model for integrating drought and water planning using a water resources database, feeding into sector information systems and planning tools for decision support. The database is a comprehensive data storage system for water-related data such as surface and groundwater supply and information about water use and demand, including flow requirements for ecosystems (establishment of NADIS, TeWaRON both under NOPI, see above).
- Incorporate socio-economic-environmental knowledge and norms into the planning tool to highlight vulnerabilities to reduced supply and ultimately inform water resource planning. Furthermore, understanding vulnerability is crucial to drought early warning and could help inform how to assess and monitor drought.

Comprehensive analysis of natural resources

- Undertake comprehensive resource analysis and a study of land use in drought-prone areas with consideration of water resources, potential productivity of crops, environmental problems, land use patterns, cropping systems, water and forest resources, livestock, and fodder resources.

Education and public awareness campaign on water usage and planning

- Create public awareness about drought in Iraq and educate about efficient use of water for effective drought planning and preparedness, particularly for the younger generations. Coordinated education campaigns should target all levels of the community on the importance of water conservation and tap the vast knowledge residing in community elders. Extension and awareness activities should reinforce an understanding of drought recurrence. The focus should be more on sustainable natural resource management as a part of institutionalized drought preparedness drills.

Enhancement of governmental policies and systems

Within the context of the "Development of a National Framework for Integrated Drought Risk Management (IDRM) in Iraq" project, UNESCO provides the Government of Iraq – represented by the Ministry of Environment and the Higher Committee on Environment for the KRG, and the relevant line ministries of the Central Government and KRG – with a foundation for the development of a Best-Practices' Toolbox offering guiding principles for DRM in Iraq. Such a toolbox shall enable stakeholders to appropriately address all relevant dimensions of DRM. These need to be fully reflected for each respective authority mandated with drought management. It is highly recommended to:

- Implement policies at all levels to encourage the uptake of more water efficient technologies such as new methods of irrigation and rehabilitation of traditional water storages.
- Promote new approaches, strategies, and methods to include farming systems, resources, and livelihood in drought-prone areas.
- Integrate watershed management with enterprise diversification based on carrying capacity and product value addition (e.g. encourage the use of improved and resilient crops to increase farming income).
- Sustain the current shortage in water resources.

This line of action offers the potential to ensure optimum resource utilization, sustainability, and income maximization, particularly for farmers.

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