



# Foreword

The prevailing stereotype of deserts is usually linked with low productivity, heat and scarcity of resources. This is true in terms of ecological conditions, but for a country that has 90% of its area classified as “drylands”, the Jordanian desert is a unique area of spiritual, religious, cultural and ecological characteristics.

Deserts and dryland represents a wide range of nature’s beauty and are host to a dynamic ecological and human nexus that has shaped the livelihoods of populations throughout history in Jordan and other Arab countries. The sustainable management of drylands is in the heart of the development challenge facing Jordan and its people.

Jordan is one of the countries most affected with the process of desertification, which is defined as a process of land degradation due to human and natural factors. Deserts are an intrinsic component of the culture of our region, but desertification is seen as a major threat to livelihoods and ecological integrity. This means that the battle to combat desertification will be won or lost in the drylands themselves. They can be managed in a sustainable way to make them ecologically balanced and economically productive, or the degradation will continue with high acceleration.

Desertification is seen as the main environmental problem affecting natural resources in arid, semiarid and dry sub-humid climatic zones. The interaction between physical factors of climate and human induced factors is the main cause of the land degradation process that has been globally known as desertification. This fact has emphasized the need for international commitment towards controlling desertification and concluded that such a problem has no political borders. Therefore, the landmark “United Nation Convention to Combat Desertification (UNCCD)” was developed as the main international effort to stop the threat of land degradation and open the way for sustainable land management options. The UNCCD was opened for signature in 1994.

As a result of the Jordan commitment towards conservation of the local and regional environment, the Ministry of Environment coordinated the process of preparing the National Strategy and Action Plan (NAP) to combat desertification that includes long-term strategies for combating desertification within the context of the UNCCD. The NAP includes description of the country’s environment and current status of desertification in Jordan. Subsequently, a combination of bottom-up and top-down approach was followed to build up future programmes addressing local environment and community issues.

The government of Jordan, represented by the Ministry of Environment, is committed to ensure the implementation of its NAP jointly with other governmental and non-

governmental institutions. Despite the limited resources of the country, sustainable programmes are suggested to combat desertification and its adverse impacts. The proposed programmes, related to different sectors and components of environment, are focused on management and conservation practices, participation of local communities, land use planning, water management and identification of short-term and long-term indicators for monitoring desertification. One expected output is a monitoring programme with data and information available on the web jointly with e-government and national information system.

The implementation of the NAP is not the responsibility of the Ministry of Environment in isolation. The task of the sustainable management of the country's land resources and combating desertification requires integrated interventions at various sectors including water, agriculture, energy, rural development, etc... Therefore, the Ministry will seek for technical assistance of the international organizations, the industrial community and other parties of the Convention, to implement the suggested programmes to combat desertification and to mitigate the diverse effects and the associated problems of poverty and land degradation. This will be achieved in a participatory governance system while maintaining a coordination and evaluation role for the various activities and initiatives aiming for the common goal of sustainable land management and combating desertification.

I would like to take this opportunity to express my deepest thanks and gratitude to all the national experts and national institutions that have worked together during the past two years in a participatory manner to develop a strategy that responds to the real needs of the National environment and the needs of Jordanian people. I hope this strategy will be a cornerstone in the policy framework to conserve and manage natural resources in a sustainable way for the benefit of current and future generations.

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# Abbreviations and Acronyms

ASEZ	Aqaba Special Economic Zone
ASEZA	Aqaba Special Economical Zone Authority
ASL	Above Sea Level
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVHRR	Advanced Very High Resolution Radiometer
BSL	Below Sea Level
BRDC	Badia Research and Development Center
CCD	Convention to Combat Desertification
CDMP	Center of Drought Monitoring and Prediction
DIS	Desertification Information System
DOS	Department of Statistics
ETM+	Enhanced Thematic Mapper Plus
GCEP	General Corporation for Environmental Protection
GIS	Geographical Information System
HCST	Higher Council for Science and Technology
HTS	Hunting Technical Services
INCD	Intergovernmental Negotiating Committee of Desertification
IRS	Indian Remote Sensing Satellites
IT	Information Technology
JAZPP	Jordan Arid Zone Productivity Project
JD	Jordanian Dinar
JMD	Jordan Meteorological Department
JOSCIS	Jordan Soil and Climate Information System
JRV	Jordan Rift Valley
JVA	Jordan Valley Authority
lpcd	Liter per capita per day
LUT	Land Utilization Types
MCM	Million Cubic Meters
MDG	Millennium Development Goal
MMRAE	Ministry of Municipalities, Rural Affairs and Environment
MoA	Ministry of Agriculture
MODIS	Moderate Resolution Imaging Spectrometer

MoE	Ministry of Environment
MWI	Ministry of Water and Irrigation
my	million years
NAP	National Action Plan
NASA	National American Space Agency
NCARTT	National Centre for Agricultural Research and Technology Transfer, Jordan
NCB	National Coordinating Body
NDVI	Normalized Difference Vegetation Index
NEAP	National Environment Action Plan
NFCD	National Fund to Combat Desertification
NGO's	Non-Governmental Organizations
NIC	National Oceanic and Atmospheric Administration, NASA
NOAA	National Oceanic and Atmospheric Administration
NSMLUP	National Soil Map and Land Use Project
P	annual precipitation
PE	annual potential evapotranspiration
ppm	parts per million
PRB	Population Reference Bureau
QIZ	Qualified Industrial Zones
RJGC	Royal Jordanian Geographic Center
RSCN	Royal Society for the Conservation of Nature
SPOT	Satellite Pour Observation de la Terre
TDS	Total Dissolved Solids
UNCCD	United Nation Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNCOD	United Nations Conference on Desertification
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
UNPACD	United Nations Plan of Action to Combat Desertification
USDA-SSS	United States Department of Agriculture, Soil Survey Service
WAJ	Water Authority of Jordan
WFP	World Food Program



# 1. Introduction

Desertification has become the most commonly used term as an unsightly word for an insidious environmental problem producing many disasters affecting human lives and civilization all over the world. In 1977, a United Nations Conference on Desertification (UNCOD) was convened in Nairobi, Kenya to produce an effective, comprehensive and coordinated programme for addressing the problem of land degradation (UNEP 1992). The UNCOD recommended the United Nations Plan of Action to Combat Desertification (UNPACD). However, the implementation of PACD was severely hampered by limited resources. The United Nations Environment Programme (UNEP) concluded in 1991 that the problem of land degradation in arid, semi-arid and dry sub-humid areas was intensified, although there were “local examples of success”. In 1992, UNEP produced a World Atlas of Desertification (UNEP, 1992). Many studies over the preceding 20 years indicated that, the problem of desertification continued to worsen. The studies have also indicated that irrational cultivation, overgrazing, deforestation, and poor irrigation practices are the main factors for land degradation process.

The question of how to tackle desertification was a major concern for the United Nations Conference on Environment and Development (UNCED), which was held in Rio de Janeiro in 1992 known as “the Earth Summit”. The Conference has adopted a new, integrated approach to the problem, emphasizing action to promote sustainable development at the community level. It also called on the United Nations General Assembly to establish an Intergovernmental Negotiating Committee (INCD) to prepare a Convention to Combat Desertification in countries experiencing serious drought and/or desertification. In December 1992, the General Assembly of the UN agreed and adopted resolution 47/188. The Committee

was established in early 1993 and held five preparatory sessions before adopting the Convention on 17<sup>th</sup> of June 1994 in Paris. The convention was then opened for signature on 14–15 October 1994. The Convention entered into force on 26<sup>th</sup> December 1996, 90 days after it had been ratified by 50 countries. As of August 2005, 191 countries have acceded/ratified the Convention. The Hashemite Kingdom of Jordan was among those countries and ratified the Convention on 21<sup>st</sup> of October 1996.

## 1.1 Purpose and objectives of the UNCCD

The main objective of the Convention is to combat desertification and mitigate the effects of drought in countries experiencing serious drought and/or desertification, through effective action at all levels, supported by international cooperation and partnership arrangements, in the framework of an integrated approach consistent with Agenda 21, with a view to contributing to the achievement of sustainable development in affected areas.

Achieving this objective will involve long-term integrated strategies that focus simultaneously, in affected areas, on improved productivity of land, and the rehabilitation, conservation and sustainable management of land and water resources, leading to improved living conditions, in particular at the community level. Therefore, the convention provides the involved countries with an integrated framework to secure the long-term commitment towards a joint work to implement national action programmes, main tools for implementing the CCD at the national level.

## 1.2 Need of National Action Plan and Programmes

As pursuant to the UNCCD article 5 (UNCCD, 1994), the affected countries in carrying out their obligations shall, as appropriate, prepare, make public and implement national action programmes. This action plan shall utilize and build relevant successful plans and programmes to combat desertification and mitigate the effects of drought. Accordingly, these programmes shall be updated through a continuing participatory process on the basis of lessons learned from field action, as well as results of research and studies. The preparation of national action programmes, therefore, is expected to be closely interlinked with other efforts to formulate national policies for sustainable development. These programmes should be developed in the framework of a participative approach involving the local communities and they should spell out the practical steps and measures to be taken to combat desertification in specific ecosystems. According to the UNCCD (1994), the main objectives of these programmes are:

1. To identify the factors contributing to desertification as first step required to formulate feasible measures necessary to combat desertification;
2. To specify the respective roles of the different stakeholders and decision-makers;
3. To establish early warning systems, integrated with regional and sub-regional programmes, that consider seasonal and inter-annual climate predictions; and
4. To identify appropriate measures to combat desertification with particular emphasis on the community-based approach and poverty alleviation.

Accordingly, the NAP shall incorporate long-term strategies, within the national policies for sustainable development, to combat and mitigate desertification. It is also expected that NAP to be sufficiently flexible and corresponds to changing socio-economic, biological and geo-physical conditions with more focus on the implementation of preventive measures for lands that

are not yet degraded or which are slightly degraded. Furthermore, each NAP should enhance national climatological, meteorological and hydrological capabilities and the means to contribute in drought early warning and should promote policies and strengthen institutional frameworks which develop cooperation and coordination, in a spirit of partnership between the donor communities and governments at all levels, local populations and community groups, and facilitate access by local populations to appropriate information and technology. As a participatory approach, NAP is expected to provide effective participation at the local, national and regional levels of non-governmental organizations and local populations, both women and men, particularly resource users, including farmers and pastoralists and their representative organizations, in policy planning, decision-making, and implementation and review of the NAP; and require regular review of, and progress of implementation.

## 1.3 Desertification

The concept of desertification emerged during colonial rule in West Africa out of concerns about signs of desiccation and the creeping of the Sahara desert into the Sahel (Herrmann and Hutchinson, 2005). The term 'desertification' was firstly used to describe the change of productive land into desert as a result of human activity in the tropical forest zone of Africa. Renewed attention was drawn to the desertification concept when a series of drought years began in the late 1960s that contributed to famine conditions in several African countries in the Sahel, and was exacerbated by political instability and unrest.

As many of the definitions of desertification have not been precise, much of statistics and maps are "guesstimates" and lacking reasonable accuracy. However, with regard to land degradation process, desertification is not limited to the African continent. Rough estimates suggest that one-third of the world's total land surface is threatened by desertification (Barrow, 1994).

### 1.3.1 Global Extent of Desertification

Spatial distribution of desertification was identified and produced in several maps (e.g. UN world map of desertification 1977, Dregne, 1983; UNEP, 1997; Kharin *et al.*, 1999). Global extent of the problem of desertification was expanded in the revised edition (second edition) of the World Atlas of Desertification, (UNEP, 1997). The Atlas included related environmental issues, including concerns about surrounding biodiversity, climate change and the availability of water. Maps in this Atlas show land that is lost, or is in the process of being lost. About 130 million hectares can no longer be used for food production which is about the land area of France, Italy and Spain combined.

Social and economic conditions (poverty and food security) also have major impact on the process and control of desertification. Over one billion people are at risk as they face malnutrition, or worse through decreasing productivity of the soil on which they depend on for food. The Atlas also included estimates of population in the areas at risk and also included some facts of the impacts of desertification on migration and refugees. The UNCCD confirmed these impacts and indicated that desertification is a worldwide problem affecting directly 250 million people and a third of the earth's land surface (UNCCD, 2005).

Global, continental and national maps of desertification or desertification process are useful to inform people about the general status of desertification and to call for attention to the presence or absence of the problem. These maps, however, are indicative and their accuracy is relatively small as their scale is very small and their mapped area is very large. Setting the priorities and planning to combat desertification require more detailed maps covering medium to very large scale. The former scale (1:50,000) enables prioritization at the level of region while the latter scale (1:1,000) provides planning tool at the level of local community and village. Many of the countries, including Jordan, are still lacking these maps. Therefore, the outputs

from NAP programmes are expected to include semi-detailed and detailed maps on desertification status and priorities of actions.

### 1.3.2 International Debate on Desertification

Many debates have grown up around the notion of desertification as a process of degradation that affects the arid, semiarid and sub-humid zones of the globe (Herrmann and Hutchinson, 2005). Evolution of these debates and their context were mainly related to definition and causes of desertification. These debates could be attributed to the nature of studies and research related to desertification, namely in the fields of climate, ecology, social and political sciences. Terms used when discussing drylands degradation include: desertification, desertization, desert-encroachment, aridization, aridification and xerotization (Barrow, 1994). Not only has there been a diversity of terms, but the same term has been differently defined by various authors and sources.

### 1.3.3 Definition

Despite the different debates in definition and causes of desertification, the term "Desertification" was used to indicate irreversible land degradation process that is mainly accelerated by human factors. The most widely accepted definition of desertification comes from the UNEP (1992) as:

This definition is also used as the basis of the UNCCD. As included in the definition, the problem of desertification is mainly occurring in dry and arid areas. Several

"Desertification is land degradation in arid, semiarid and dry sub-humid areas resulting from various factors including climatic variations and human activities".

definitions of aridity were tackled by different research and formula. The most commonly used formulas are: Thornwaite; Emberger and Koppen. According to the modified Thornthwaite formula (used in Jordan to classify main climatic zones), aridity index is defined as the ratio of P/PE, where P is the mean annual precipitation and PE is the mean annual potential evapotranspiration. Accordingly, degree of aridity can be classified as:

Climate Zone	P/PE ratio
Hyper-arid (deserts)	<0.05
Arid	0.05-0.20
Semi-arid	0.21-0.50
Dry sub-humid	0.51-0.65
Humid	0.65

It is important to understand that desertification, though it produces conditions similar to deserts, is not occurring in hyper-arid deserts. In fact, the «growth» of deserts along their edges is a natural condition, often followed by periods of desert shrinkage. The size of all deserts will vary from year to year based on short-term weather and precipitation patterns. This process of desert area oscillation is not the basis of the more damaging sequence of desertification. As the United States Geological Survey (Walker, 1998) explains «the presence of a nearby desert has no direct relationship to desertification».

In conclusion, desertification is a deterioration process in which ecosystems lose the ability for survival leading to deterioration of land, its production and leading to the vanishing of land economic output.

### 1.3.4 Processes and Aspects of Desertification

It should be kept in mind that desertification is not a single term but a combination of one or more processes that might take place simultaneously or in succession. Processes of desertification were well-defined in

huge number of literature. The major processes are vegetation degradation, soil erosion by water and wind, salinization and alkalinization of soil, soil compaction and crust formation. The locally important processes include contamination of soil and groundwater, lowering of groundwater levels and damaging changes in soil functions and quality.

### 1.3.5 Causes of Desertification

There are two major causes of desertification, namely natural-physical and human induced factors resulting from different activities. The former includes climatic factors of periodic droughts and climate change, natural fires and disasters and in some areas locust invasion. Human factors are seen as more important than the physical and many aspects considered as feedback mechanisms for physical factors (Herrmann and Hutchinson, 2005). The human induced factors are mainly related to mismanagement of natural resources and can include: land mismanagement and fragmentation, export-import policy, political acts, poverty and changeable socio-economic aspects, poor advisory services, little or no problem-solving research.

In many of the Mediterranean countries, including Jordan, the process is accelerated by changeable socio-economic factors including high population growth, industrialization, tourism and recreation, urbanization and intensive agricultural development. In arid and semi-arid zones of the Mediterranean, rangelands, plowing for land claimship and barley cultivation, overstocking and uprooting of woody plants are the major causes of desertification of their fragile ecosystems. Subsequent changes in land use pattern and the tendency towards profitable livestock systems created more pressure on the limited resources of the arid and semiarid areas. Therefore, vegetation removal by overgrazing and irrational land use is seen as a major cause of land degradation in these zones (Conacher and Sala, 1998).

### 1.3.6 Indicators

Identification of indicators of desertification is the first step prior to implementation of monitoring schemes and identification of possible changes in status and rate. These indicators are dependant on the target or component of environment, scale of monitoring and the ecosystem. Some indicators like extent and distribution of wind erosion might be useful at regional level and has little value at the level of a village. On the other hand, the extent of gullies and their density is time and cost consuming at the country's level.

Selection and aggregation of indicators require the following:

1. Representation of the target and its performance;
2. Sensitivity to change; and
3. Ability of measurement, analysis, interpretation and comparison.

Data collection may involve a large number of indicators that should be aggregated into fewer indices. Hammond *et al.* (1995) called for aggregation of much primary data into 20 indicators that could be combined to produce few aggregated ones. Regardless of the desertification process, the indicators can be divided into three main groups and listed as:

#### 1. Physical indicators

- Decrease in soil depth,
- Decrease in soil organic matter and fertility,
- Soil crusting and compaction,
- Appearance/increase in frequency/severity of dust and sand dunes,
- Salinization/alkalinization,
- Decline in ground water quality and quantity,
- Increased seasonality of springs and small streams,
- Alteration in relative reflectance of land (Albedo change).

### 2. Biological indicators

#### Vegetation

- Decrease in vegetation cover and above ground biomass,
- Decrease in yield,
- Alteration of key species (biodiversity),
- Deterioration and reduction of seed bank.

#### Animal

- Alteration in key species distribution and frequency,
- Change in population of domestic animals,
- Change in herd composition,
- Change in livestock yield.

### 3- Social/economic indicators

- Change in land use/water use,
- Changes in settlement patterns and increase of abandonment,
- Change in population and demographic structure.

## 1.4 NAP in Jordan

This document represents guidelines of the national actions needed to combat desertification in Jordan. The overall objective of the NAP is to provide integrated development plan and subsequent programmes targeting local communities and environmental components in areas under the threat of desertification. The NAP is prepared in accordance with the UNCCD directives and articles and includes detailed survey of the environment and the most affected areas in Jordan, detailed analysis pertaining to land resources, causes and aspects of desertification. Subsequently, programmes and projects are to be initiated in the short term and in the long term to combat desertification in the country. The programmes form integrated strategies and plans

for sustainable development and management of land resources, particularly in arid and semiarid zones of Jordan.

#### **1.4.1 Background to Process and methodology of Establishing the NAP**

The key frameworks for implementing the CCD are the Action Programmes. The convention calls upon affected countries to develop National Action Plan (NAP) with the full participation in the process of all parties with a stake in the issue of desertification. These programmes need to reflect the factors that contribute to desertification as well as generate practical solutions. The convention calls for building of partnership -both within the country and with external partners- as well as for the development of innovative resource mobilization strategies to ensure effective implementation.

The process of NAP preparation was based on the following principles:

- The NAP preparation was based on the "project support document", in which the country's vision is clearly reflected,
- The resource mobilization strategy which was prepared as part of the NAP process constitutes an effective tool in the implementation phase,
- To be result-oriented and successful and to avoid any discouragement and uncertainty about its effectiveness, the NAP was processed in a well-designed time frame. Moreover, the innovative projects have been formulated based on priorities determined throughout the process in order to maintain credibility with affected communities,
- The national experience in desertification control were assessed and reviewed; both "best practices and failures" were identified in order to assist in developing the priority programs, (1<sup>st</sup> and 2<sup>nd</sup> National Reports),
- Decentralized consultations at different levels were undertaken to identify main stakeholders, build long-term commitment, mobilize support and to create consensus for action.

## The First National Forum

This forum was held as a part of the consultative mechanism to enable various interest groups to reach consensus on how to proceed with the NAP, which priorities to address, and in what order. The preparation for this important forum has required extensive consultation with all key stakeholders at all levels. Different stakeholders, ranging from community representatives to decision makers of high level have attended the event.

### Forum outputs:

- A clear mechanism for coordination among the existing concerned institutions developed, i.e. all relevant activities and consultations have been overseen by the UNCCD,
- Participation of all concerned stakeholders ensured,
- Credibility with affected communities maintained,
- Identification of priority areas in which projects are to be formulated and implemented.

### Thematic areas/priorities identified in the forum:

- Degradation of Natural Resources,
- Environmental indicators,
- Traditional knowledge,
- Rangeland management,
- Public Awareness,
- Capacity building,
- Socio-economic aspects of Desertification,
- Project Proposing,
- Legislations,
- Integration and harmonization of NAP with the existing policies and frameworks.

### The forum has concluded the following:

- Endorsing the need to establish the NAP in Jordan,
- The objective, scope and vision of the NAP process,
- The key programme areas to be addresses by the NAP,
- The funding mechanisms of the proposed projects and activities,
- The roles and responsibility of each stakeholder,
- The effective way of integrating NAP process into the national development planning system.

Participants in the forum have also identified a number of obstacles and important considerations. One obstacle was the absence of an interdisciplinary approach between the natural and social aspects. The lack of an integrated approach presents another obstacle, and extends to questions of project formulation, funding, participatory processes, long-term political commitment to monitoring and making the results known to decision-makers and local communities. Technological capability, including costs compared to available resources, complexity of and access to available technology and the transfer of information, also presents a constraint.

## The forum identified some possible solutions and recommendations:

- Training communities to recognize desertification,
- Encouraging research across national boundaries,
- Using local knowledge as a data source.

A detailed review of the national policies and legislations pertinent to combating desertification was undertaken by NAP. The report identified several important omissions, contradictions and in some cases disincentives regarding combating desertification and land degradation. Several policies, including those on water, agriculture and lands should be revised

### 1.4.2 Structure of the NAP document

The document of NAP is divided into the following parts:

1. Introduction: The introductory part includes definition of desertification and need of NAP within the context of the UNCCD,
2. Biophysical characterization of Jordan: This includes description and brief analysis of the country's climate and natural resources,
3. Socio-economic characterization of the country: This part include the demography, economy, administrative structure as well as sectors analysis,
4. Legislative framework: This part of NAP summarizes the main environmental laws and by-laws related to land degradation, desertification and management of natural resources. Deficiencies and gaps in current legislations are also briefed in this part,
5. Desertification in Jordan: The main zones affected by desertification, causes, indicators and aspects of desertification in the main affected areas are discussed this part of the document.

6. Action Plan: This part utilizes the previous information in synthesis of action plan divided into programmes. Listing and justification of programmes and projects are also included in this part.

Additional details and information are included in the document's appendices.

### 1.5 Outlook and future objectives

The NAP has benefited and made use of the results and recommendations of previously conducted research and studies related to land degradation and socio-economic aspects of desertification. Monitoring and evaluation of the plan and subsequent impacts of interventions from the different programmes are future objectives and tasks of the Ministry of Environment. This is a very important task as it provides a feedback mechanism for modification of programmes, setting priorities and implementation of activities based on needs and requirements of local communities in most affected areas.

## 2. Biophysical characterization of Jordan

Jordan is located about 80 kilometers east of the Mediterranean Sea between 29° 11' to 33° 22' north, and 34° 19' to 39° 18' east (Figure 1). The area of land mass is approximately 88,778 km<sup>2</sup> (DOS, 2003), while area of water bodies is approximately 482 km<sup>2</sup> that includes the Dead Sea and the Gulf of Aqaba. Altitude ranges from less than -400 m (below mean sea level) at the surface of the Dead Sea up to the 1750 m of Jebel Rum. The climate varies from dry sub-humid Mediterranean in the north- west of the country with rainfall of about 630 mm to desert conditions with less than 50 mm over distance of only 100 km. The geology includes basement complex rocks, sandstones, limestones, chalks, marls and cherts, and various Pleistocene and Holocene deposits, alluvial, Aeolian, and extensive lava flows in the north of the country. This wide range in physical features has produced an equally wide range of soils and landscapes. The Following sections include detailed descriptions of the climate, geology, water, land/soils and their use, and the biological environment.

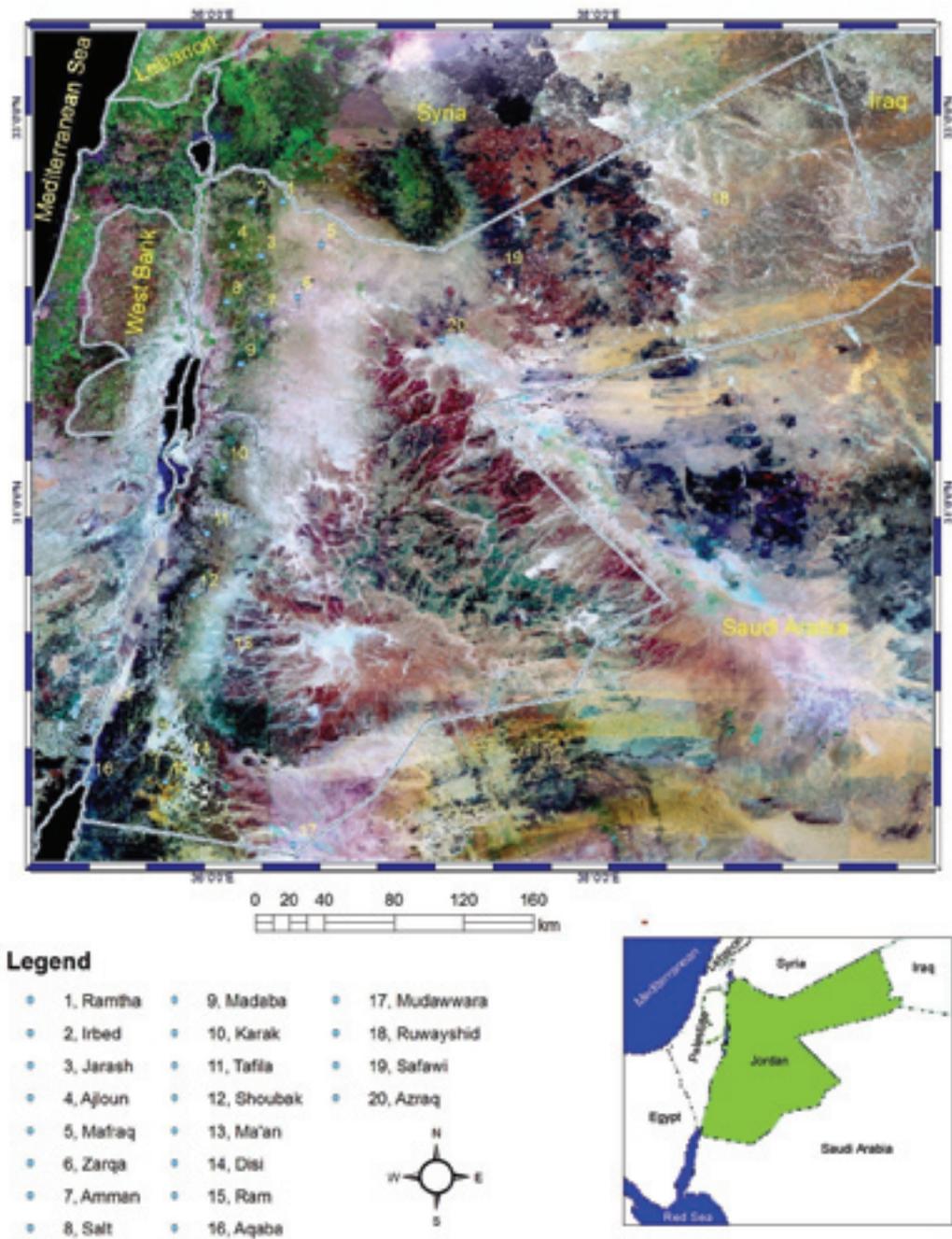
### 2.1 Climate

More than 80 % of the country's area is arid and receives less than 200 mm annual rainfall (Figure 2), with precipitation pattern being latitude, longitude and altitude dependent. Rainfall decreases from north to south, west to east and from higher to lower altitudes. Where the ground rises to form the highlands east of the Jordan Valley, precipitation increases from less than

300 mm in the south to more than 500 mm in the north. The Jordan Valley forms a narrow climatic zone that annually receives up to 300 mm of rain in the north and less than 120 mm at the northern edge of the Dead Sea; *the lowest point on earth*. The farther inland from the western highlands forms a considerable part of the country and known as the "Badia". The name Badia is an Arabic word describing the land where Bedouins live and practice seasonal browsing. This area includes all lands receiving annual rainfall of 50 to 200 mm annually and has general characteristics of seasonal contrasts in temperature with high variations in rainfall within and among years (Dutton *et al.*, 1998).

The major characteristic of the country's climate is the contrast between hot, dry, uniform summers and cool variable winters. The rainy season is between October and May with 80 % of the annual rainfall occurring between December and March (JMD, 2005). During the rainy season, most of precipitation is orographic resulting from the passage of frontal depressions across the Mediterranean near Cyprus. According to the recent records of the Jordan Meteorology Department (JMD) of 2005, a slight decrease in precipitation was observed in the country, except the rainy season 1991/1992 which was the highest in the last 75 years. An example on this decrease is the record of Amman Airport which shows that the average annual rainfall in the first half of the century was 320 mm and has dropped to 285 mm in the 1980's and 1990's. The winter months have moderately cool and sometimes cold weather, averaging about 13°C, with January as

Figure 1: Location of Jordan



the coolest month. Except in the Jordan Valley, frost is fairly common during the winter with occasional snow in the Capital Amman, western and northern highlands and the al-Sharah Mountains.

The country has a long summer, might extend from mid of May to end of September, which reaches a peak during August with daytime temperatures frequently exceeding 36°C and averaging more than 32°C. Atmospheric pressures during summer months are relatively uniform. For a month or more before the summer dry season, hot, dry air from the desert, drawn by low pressure, produces strong winds from the south or southeast that sometimes reach gale force. This wind is known as the *khamasin* and usually accompanied by great dust clouds, a falling barometer, a drop in relative humidity to about 10 percent and a 10°C to 15°C rise in temperature. These windstorms ordinarily last a day or more and result in advection that causes much discomfort and frequent failure of many rainfed field crops at the flowering stage. Another wind of some significance comes from the north or northwest, known as *shammal*, generally at intervals between June and September. Remarkably steady during daytime hours but becoming a breeze at night, the *shammal* may blow for as long as nine days out of ten and then repeat the process. It originates as a dry continental mass of polar air that is warmed as it passes over the Eurasian landmass. The dryness allows intense heating of the earth's surface by the sun, resulting in high daytime temperatures that moderate after sunset.

Several maps for the country's climate were produced from climatic records of JMD or from the available records of meteorological satellites (Smith *et al.*, 1999).

The maps of the JMD covered all climatic parameters and were originally produced in 1984. Most of the produced maps showed wide gaps between annual rainfall and potential evaporation with arid and semiarid zones dominating most of the country. The bioclimatic map of the country was revised by Al-Eisawi (1985) and was digitally reproduced by the GIS team of the University of Jordan. According to this map (Figure 3), the country is divided into the following nine bioclimatic Mediterranean zones:

1. Dry sub-humid Mediterranean, warm and cool: restricted to a very small area in Ajloun and Ras Muneef.
2. Semi-arid Mediterranean, warm: includes Irbid, Amman, Taybeh and Baka'a.
3. Semi-arid Mediterranean, cool: restricted to Shoubak in the south west.
4. Arid Mediterranean, cool: areas of Mafraq, Jiza, and Wadi-Dhuleil.
5. Arid Mediterranean, warm: includes the cities of Zarqa and Ramtha.
6. Arid Mediterranean, very warm: Deir-Alla, al-Baqura, Shuneh North and Wadi Yabis.
7. Saharan Mediterranean, cool: very arid areas of al-Jafr, Ma'an, Safawi, Rwayshid and Azraq.
8. Saharan Mediterranean, warm: very arid strip or belt of land with an average depth of 20 km where annual rainfall ranges between 100 and 150 mm.
9. Saharan Mediterranean, very warm: includes the areas of the southern Ghors (south of Dead Sea), Wadi Araba, Aqaba and Disi area.

Figure 2: Mean annual rainfall in Jordan.

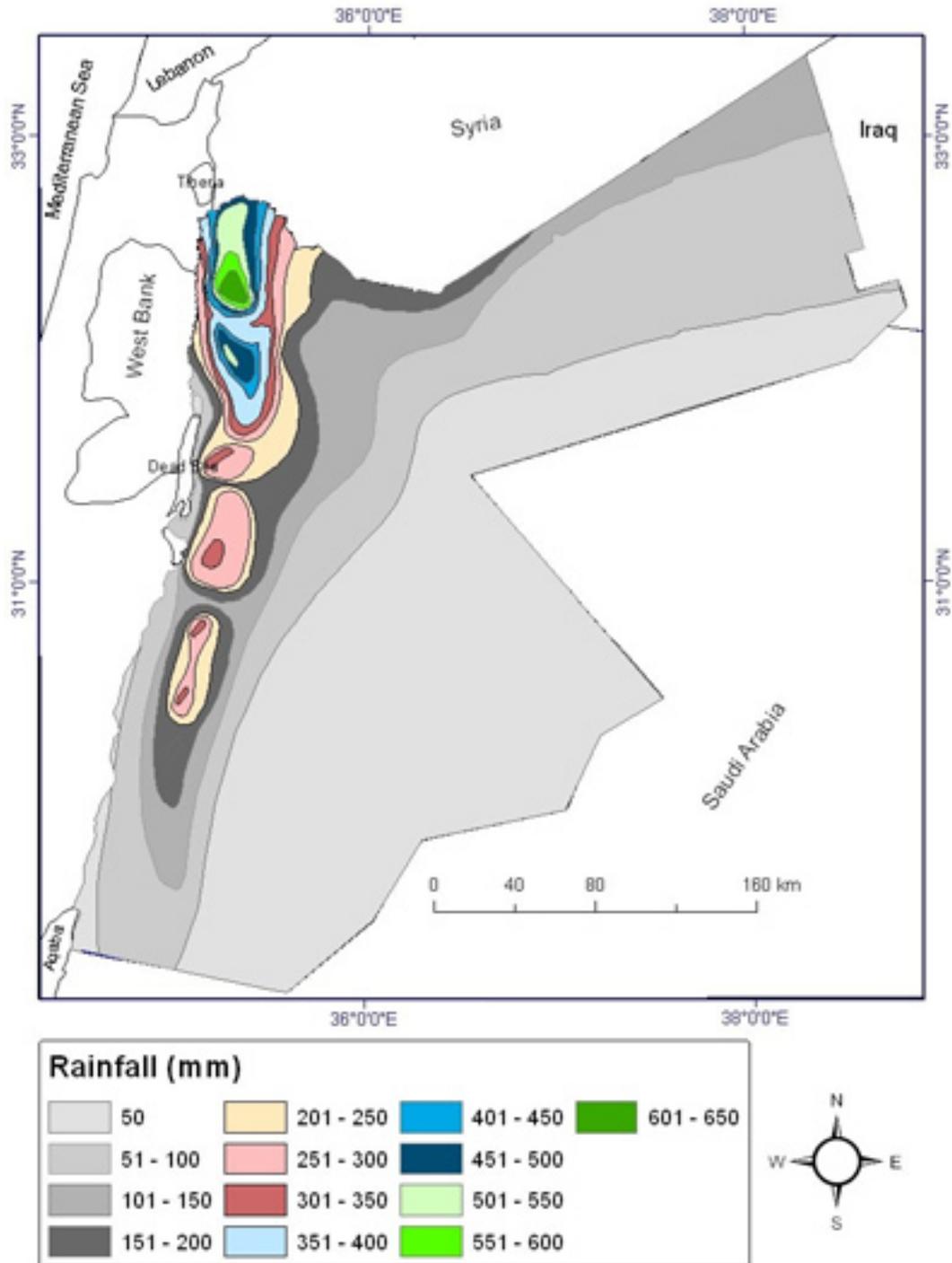
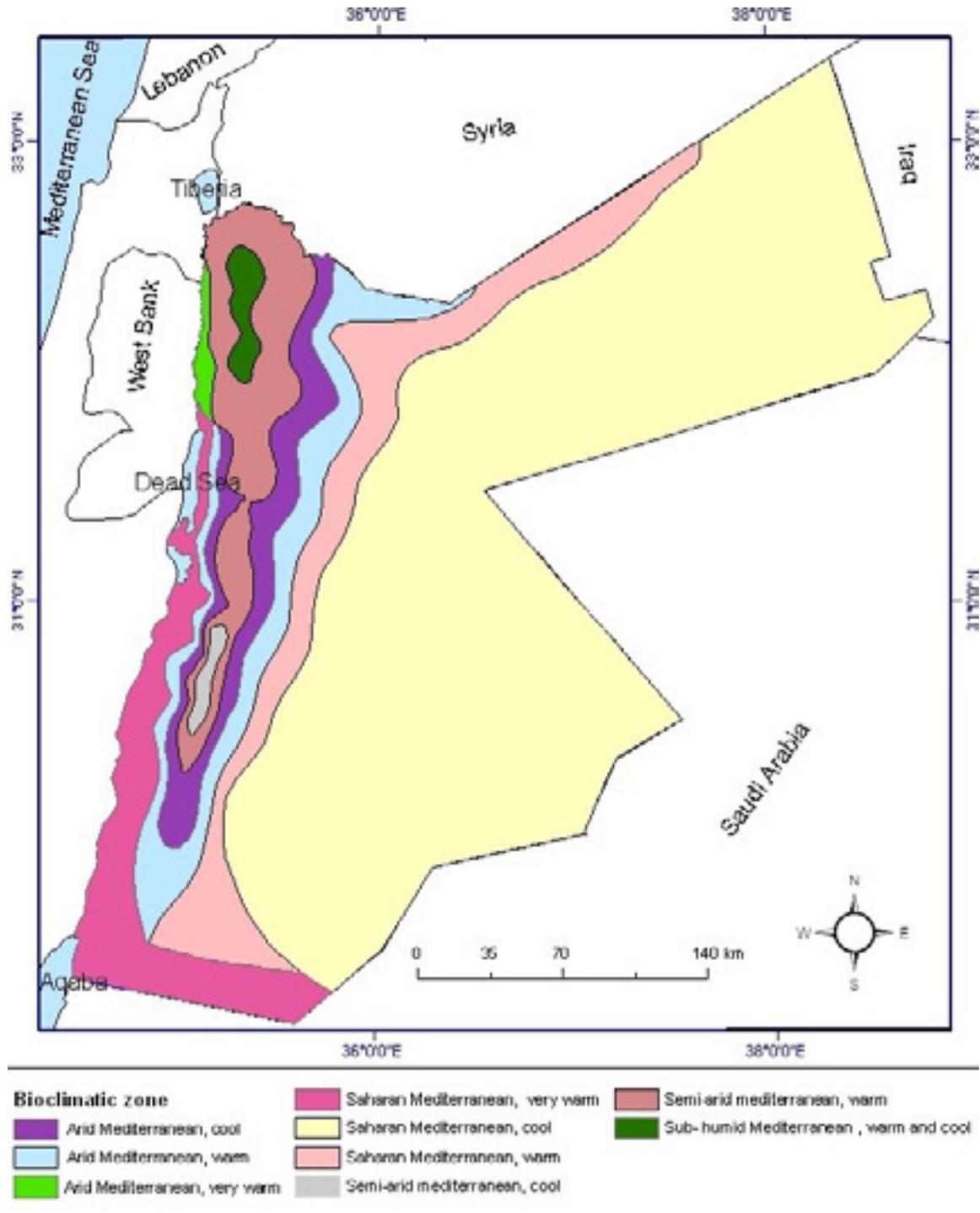


Figure 3: Main bioclimatic zones of Jordan (after Al-Eisawi, 1985).



A good time-series of climatic records is available, particularly for rainfall and temperature. Subsequently, the country's climate is well defined and can be summarized as:

- Low rainfall amounts in most of the areas.
- The high rainfall zone is limited to small strips of the country, mainly western and northern highlands.
- Hot summers and cold winters are dominant.
- Compared with crop water requirements, rainfall is inadequate to sustain production.
- Variations in rainfall amounts among and within years.

## 2.2 Geology

Jordan is situated at the northwestern part of the Arabian plate separated from the African plate along the Red Sea - Dead Sea rift. The oldest igneous and metamorphic rocks, which go to more than 600 million years (my) in age, are exposed in the southern and southeastern parts of the country. Paleozoic sandstone and shale sediments (570 - 280 my) attaining 1800 meters in thickness of marine and continental origins overlie the rocks of the Basement complex. These rocks are exposed mainly in the southern and southeastern parts of the country and central parts of Wadi Araba (Jreisat, 1995).

The oldest Mesozoic marine sediment of Lower Triassic age (224 my) outcrops in the lower reaches of wadis. Marine sedimentation during this epoch was restricted only in the northern and western parts of the country. At the end of the Triassic (190 my) the sea regressed and the whole area was subjected to erosion. In the Cenozoic Era (65 my - present), the Tertiary marine sediments of the Paleocene and the major part of the Eocene were deposited in a gentle swells and basin systems (Jreisat, 1995).

As a result of uplifting and tilting, Triassic rocks were deposited. The process was repeated several times during the Mesozoic. The Jurassic to Lower Cretaceous succession are mainly clastics and marine carbonates. These formations with the sediments of the Paleozoic age form an important aquifer in Jordan. The thickness of the sediments increases in a north-east direction where relatively the younger sediments are exposed (Bender, 1974).

The trend of geology and geomorphology of the country is in general north-south direction, which is a function of the major geological event and the rifting along Jordan valley Red Sea line. There are several east-west faults and short north-south strikes resulted from the rifting activity; one major fault is the Wadi Zarqa Main Fault with traceable length of about 50 km. The faults and strikes acted as canals for the basalt dykes and flows. The volcanism is more clear north east of Jordan where excessive fissure flows have formed about 45000 km<sup>2</sup> of basalt plateau that extend into south east Syria (Bender, 1975).

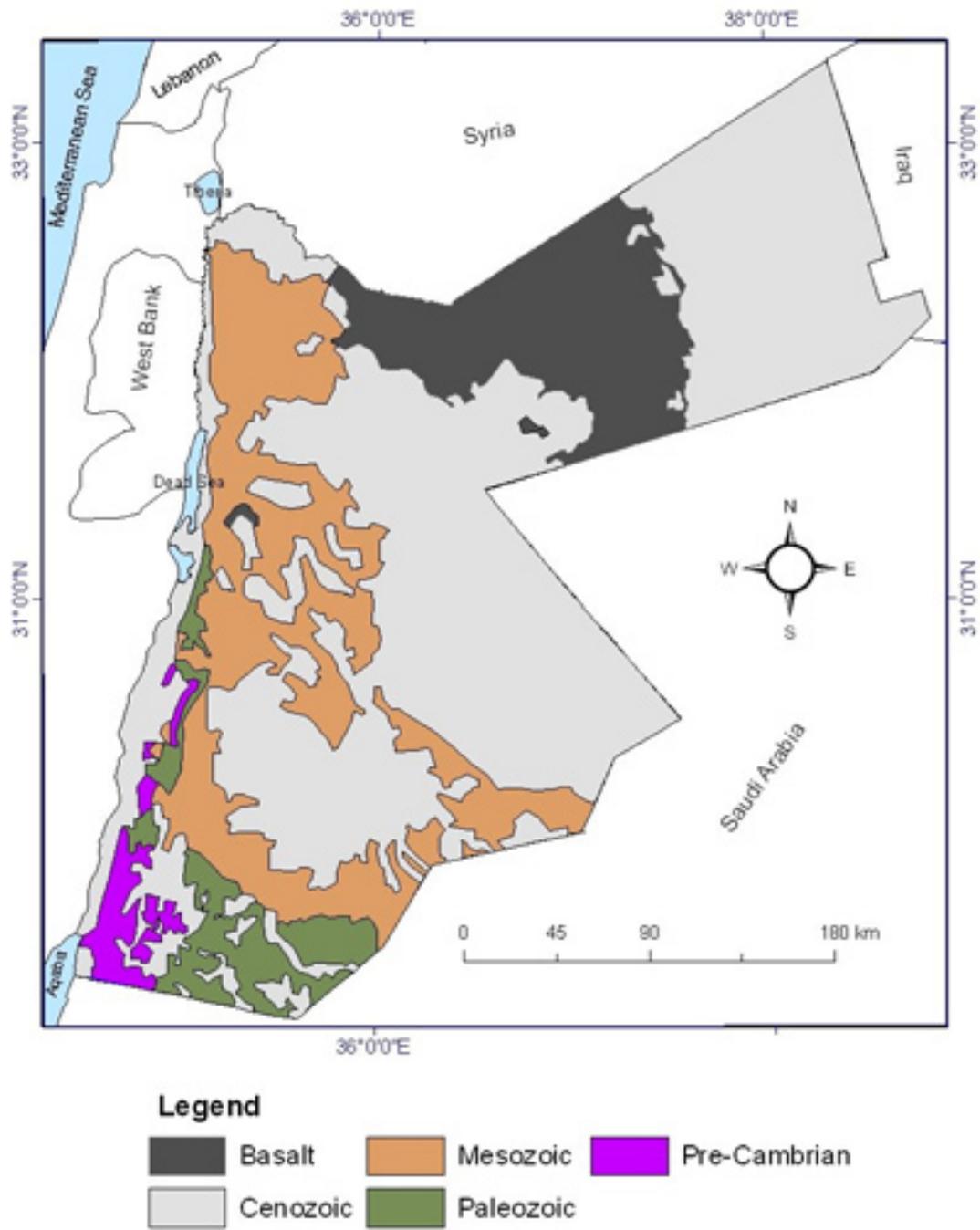
The result of this activity is the formation of the Jordan Rift Valley (JRV) and the high lands on both sides. The JRV is part of the Syrian-African Rift Valley which extends from north-western part of Syria to the Rift Valley in Eastern African passing through the Dead Sea and the Red Sea. The JRV is about 375 km in length and its width ranges from 30 km in Wadi Araba to 4 km near Lake Tiberia area. The valley bottom elevation varies from sea level at Aqaba at the shores of the Red Sea to about 240 m above sea level (ASL) at 80 km

north of Aqaba. From there it drops to below than 400 m below sea level (BSL) at the Dead Sea and further to about 750 m BSL at the bottom of Dead Sea. Then the elevation rises to about 210 m BSL at the shores of Lake Tiberia in the north.

The highlands east of the rift valley rise to elevation of more than 1000 m ASL in the north and to more than

1200 m ASL in the south. These mountains consist mainly of sedimentary rocks and the width of these highlands varies from 30 to 50 km. The elevations drop gradually to the east towards the plateau and the desert and sharply to the west towards the rift valley. Figure 4 shows the geological feature of Jordan while Table 1 shows the geological succession area in Jordan.

**Figure 4:** General Geological era of Jordan



**Table 1:** Geological Succession of Jordan.

ERA	PERIOD	EPOCH	GROUP
CENOZOIC	Quaternary	Holocene	Fluvialite, lacustrine, eolian rocks
		Pleistocene	volcanics
	Tertiary	Pliocene	
		Miocene	
		Oligocene	volcanics
		Eocene	
		Paleocene	
MESOZOIC	Upper Cretaceous	Maestrichtian	Balqa
		Campanian	
		Santonian	
		Turonian	Ajloun
		Cenomanian	
	Lower Cretaceous	Albian	Kurnub
		Aptian	
		Neocomian	
	Jurassic		Zarqa
	Triassic		
PALEOZOIC	Permian		
	Carboniferous		
	Devonian		
	Silurian		Khreim
	Ordovician		
	Cambrian		Disi
PRE-CAMBRIAN	Late Precambrian		Saramuj
	Early Precambrian		Basement Complex

(sources: Burdon, 1959 and Jreisat, 1995)

## 2.3 Water Resources

### 2.3.1 Overview

Jordan is classified among few countries of the world with limited water resources and it is one of the lowest on a *per capita* basis. The available water resources per capita are falling as a result of population growth and are projected to fall from less than 160 m<sup>3</sup>/capita/year at present to about 90 m<sup>3</sup>/cap/year by 2025, putting Jordan in the category of an absolute water shortage. The scarcity of water in Jordan is the single most important constrains to the country growth and development because water is not only considered a factor for food production but a very crucial factor of health, survival and social and economical development. As a result of scarcity, the demands and uses of water are far exceeding renewable supply. The deficit is made up by the unsustainable use of groundwater through overdrawing of highland aquifers, resulting in lowered water table in many basins and declining water quality in some. In addition to that, the deficit is overcome also by supply rationing to the domestic and the agricultural sectors.

Water resources consist of surface and ground water, with reclaimed wastewater being used at an increasing scale for irrigation. Water Desalination water has also become an optional source where 40 Million Cubic Meters (MCM) are presently produced from over 10 desalination plants for domestic supply and about 9 MCM for irrigation. Renewable water resources are estimated at about 840 MCM per annum, including 280 MCM of groundwater and 560 MCM of potentially exploitable surface water. An additional amount of 143 MCM is estimated to be available from the non renewable aquifers. The volume of effluent from the different wastewater treatment plants was estimated to range from 75 to 80 MCM in the year 2004.

### 2.3.2 Surface Water Resources

Surface water resources in Jordan are distributed

among 15 major basins (Figure 5). Based on the general drainage direction, these basins can be classified into three major groups:

1. Basins that drain into the Dead Sea,
2. Basins that drain into the Red Sea, and
3. Basins that drain eastward into mudflats of the desert.

Surface water resources vary considerably between seasons and years. The long-term average annual base flow is about 328 MCM and flood flow of about 334 MCM giving a total average surface flow of about 690 MCM per year. Of these renewable surface water resources, an estimated 505 MCM are useable or can be economically developed. The Dead Sea basins are located in the most humid part of the country and mostly characterized by base flow and spring discharge as well as flood flow. The main source of surface water at the present time is the Yarmouk River followed by Zarqa River. Yarmouk basin is shared between Jordan and Syria with one third of the long term average surface runoff within Jordan. The next most potential surface water basin is Zarqa River Basin where the major wastewater treatment plant, Khirbit as-Samra, is located. The flow in River Jordan, which was one of the main water resources prior to the control of releases from Lake Tiberia by Israel in 1964, has dropped to trickle except during flood season when the lake is full. The water of most of the rivers and wadis draining water towards the Dead Sea basin are being utilized or stored by some nine reservoirs with a total capacity of 221 MCM. The major reservoirs are King Talal Reservoir (KTR) with storage capacity of 85 MCM followed by Wadi el-Arab and Tanour dams; each with a capacity of about 17 MCM. On the Yarmouk, the unity dam is being constructed with a reservoir capacity of 110 MCM expandable to 225 MCM in the future. There are 18 desert dams storing about 31 MCM for the purpose of animal watering and artificial groundwater recharge. In addition, there are a number of water harvesting projects that utilize the surface water in forms of large ponds and small earth reservoirs.

Due to urbanization, upstream uses and climatic changes, the base and flood flows of most of the rivers and wadis have been affected significantly. The total flow of the Yarmouk River has dropped from about 430 MCM before 1970 to about 260 MCM in the 1980s and early 1990s, due to the construction of more than 25 dams at the Syrian part of the basin. The base flow of river witnessed further drop in late 1990s and early 2000s due the heavy abstraction of groundwater which has significantly reduced the base flow to less than 5 m<sup>3</sup>/s in summer months. On the other hand, the heavy utilization of groundwater in Amman-Zarqa basin has resulted in reducing the base flow of Zarqa River from 5 m<sup>3</sup>/s to less than 1 m<sup>3</sup>/s. The flow of the river now consists only of effluent discharge from three treatment plants. Similar conditions are observed in other side wadis such as Wadi el-Arab. The utilization and overdrawing of groundwater aquifers have been the main factor in lowering the discharge of springs from an average total of 317 MCM prior to 1985 to less than 130 MCM after 2000 (MWI annual report, 2003).

### 2.3.3 Groundwater Resources

The ground water aquifers in Jordan are classified into three main complexes, the deep, middle and shallow aquifer complexes. The deep aquifer complex is formed from sandstone and it is found as one unit in the south and two units in the north separated by thick limestone and marl layers. The middle complex (the upper and middle cretaceous complex) consists of limestone, dolomite, marl stone and chert beds. The shallow aquifer complex, which is the mostly exploited, consists of two main systems: the basalt aquifer system and the sedimentary rocks and alluvial deposits of Tertiary and Quaternary ages system (Bender, 1974).

Twelve groundwater basins (Figure 6) are identified having a total renewable annual supply “safe yield” of about 280 MCM. Groundwater development was rapid in the 1980s and early 1990s, as successive Governments freely awarded licenses for tube-wells.

As a result, by the mid-1980s, a pattern of systematic overdraw of groundwater had been established. Over-abstraction is evident in six of the basins where the safe yields have been exceeded by more than 100 percent in some cases space. The total groundwater abstraction from all basins in 2003 was about 520 MCM representing an over-draft of about 226 MCM. Water levels in the main aquifers are declining due to this over-exploitation with some aquifers showing considerable deterioration of their water quality due to salinity. There is, in addition, an annual abstraction of about 70 MCM of fossil water mostly from the Disi basin (in the south of Jordan) which is being exploited for irrigation supplies (55 MCM) and domestic supply to Aqaba (15 MCM). Many studies indicate that an annual abstraction of 125 MCM can be supported over a 50-year period with a drawdown not exceeding 250 meters. The other non-renewable groundwater source is that of the Jafr basin with annual yield of 18 MCM, estimated to be sustainable over a 40-year period.

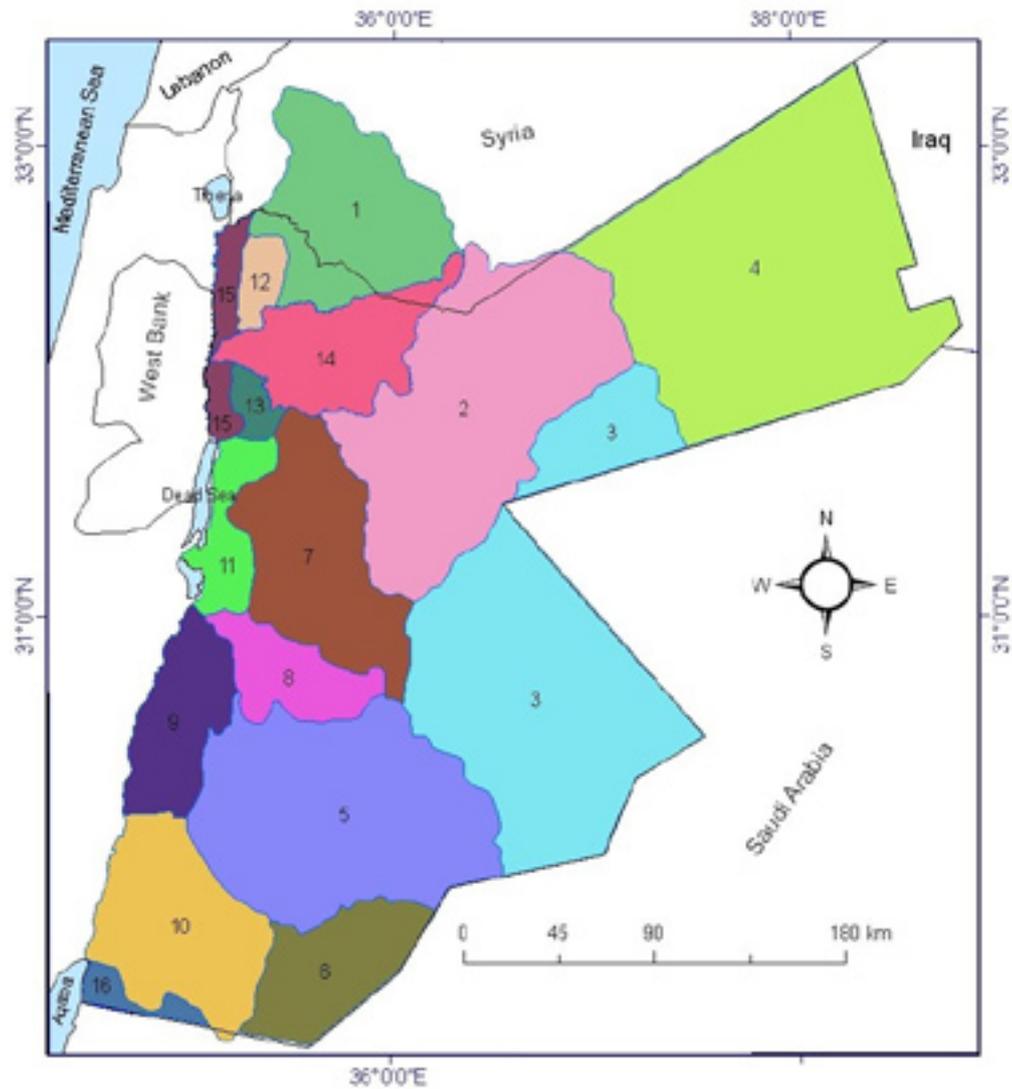
**Below are some details about the most affected aquifers that suffer from overexploitation:**

#### 1. Amman-Zarqa Basin

With its safe yield of 88 MCM per annum, Amman-Zarqa Basin is the critical renewable ground water basin in Jordan. This basin is situated in the most urbanized part of the Jordan where Amman and Zarqa cities are located and is hosting 54% of the total population. One of the first agricultural expansions in Jordan started in this basin in the area of Dhuleil and Hallabat, and resulted in over-pumping that reached 157% of the safe yield. The intensive urbanization where sewage infiltration from septic tanks and broken sewer networks were

combined with over pumping and resulted in the fast depletion in water quantity and quality in the aquifer contributing to rapid desertification in this part of the country. On the other hand, the basin hosts about 70% of the small to medium size scale industries.

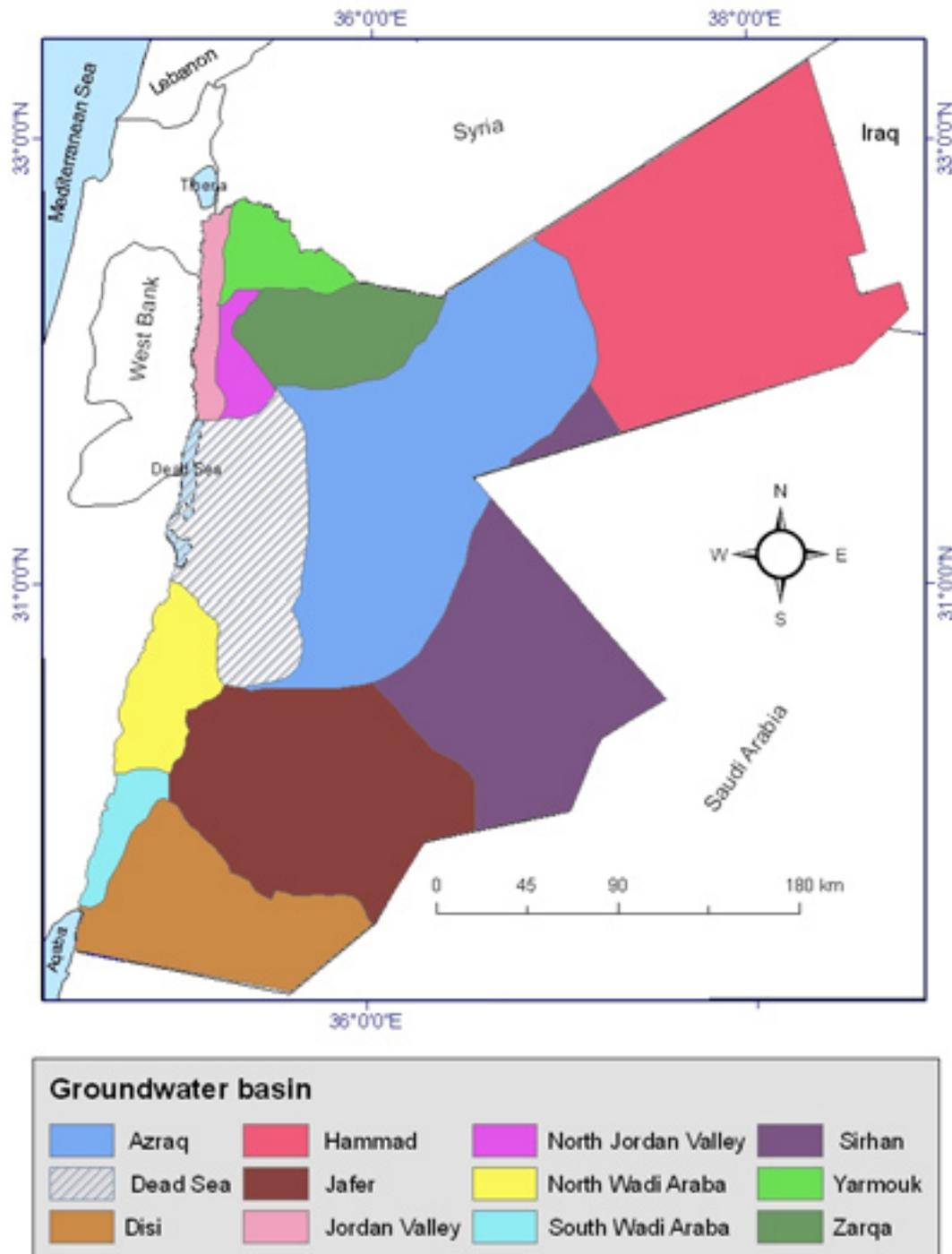
Figure 5: Surface water basins.



**Basin**

 1, Yarmouk	 5, Jafr	 9, Northern Wadi Araba	 13, Southern side wadis
 2, Azraq	 6, Disi	 10, Southern Wadi Araba	 14, Zarqa
 3, Sirhan	 7, Mujib	 11, Dead Sea	 15, Jordan Valley
 4, Hammad	 8, Hasa	 12, Northern side wadis	 16, Wadi Yutum

Figure 6: Groundwater basins.



## 2. Yarmouk Basin

Yarmouk basin is the next in size where it is recharged in the mountain areas north of Jordan and south of Syria with relatively high rainfall intensities. The Yarmouk Basin safe yield is estimated at about 40 MCM per annum. The pumping level reached 47.1 MCM in 2004. With the fluctuation in rainfall volumes, the over-pumping in the Yarmouk Basin raises the concern of depletion. The water quantity and quality is categorized as being at the higher end of the scale of ground water resources in Jordan.

## 3. Azraq Basin

One of the major groundwater basins in Jordan is the Azraq Basin which supplies most of the water to Amman Municipality. During the 1970s and later, agriculture activities started to bloom in the Azraq area using excessive amounts of the available ground water, abstracting twice the amount of safe yield of the basin, which is estimated to be between 30–45 MCM per annum. The over-pumping from the shallow aquifer resulted in a substantial depression on the groundwater level that exceeded 20 meters. The large water level depression resulted in the deterioration of the groundwater quality and the ecological habitats at the Azraq oasis located at the centre of the Basin where the groundwater level was above the ground surface and formed a desert oasis. The water quality deterioration is due to the intrusion of saline groundwater from the middle aquifer into the upper aquifer. The main two oases in the basin have almost dried up and thus affecting the entire ecological system in the area. Organic soils which were formed around the wetland have been completely degraded.

A list of groundwater basins, surface water basins and dams are shown in appendix 1.

### 2.3.4 Reclaimed wastewater

Treated wastewater emanating from nineteen existing wastewater treatment plants is an important component

of the Kingdom's water resources. About 75–80 MCM per annum wastewater is discharged into various water courses or used directly for irrigation, mostly in the Jordan Valley. About one-third of the municipal water supplied to Greater Amman eventually returns to the main treatment plant at Khirbit as-Samra. Wastewater quantity is increasing with the increase in population, increasing water use and development of the sewerage systems. Thus, by the year 2025 when the population is projected to reach about 10 million and the percentage of the population with sewerage services will have increased from the current 55 percent to over 65 percent, about 280 MCM per annum of wastewater is expected to be generated. Average salinity of municipal water supply is 580 ppm (range 430–730 ppm of TDS), and average domestic water consumption is low (some 50 m<sup>3</sup> per capita per year country wide), resulting in a higher than normal salinity in the wastewater. Technology of wastewater treatment used in Jordan is primarily the stabilization ponds with a considerable portion of losses by evaporation, thus increasing salinity levels in the effluent. The combination of these factors have resulted in salinity average of 1,180 ppm but as high as 1,800 ppm of TDS in the effluent of Khirbit as-Samra, impacting crops in areas reusing the effluent. The above factors have to be effectively addressed to deal with the constraints on the reuse of appropriately treated wastewater. The government new plans are to convert the stabilization ponds into mechanical treatment plants and to expand other plants.

### 2.3.5 Desalinated Water

Desalination water could be considered as a future source of supply to overcome the scarcity problem. According to the National Water Master plan, an estimated amount of 12,000 MCM of saline fossil groundwater are stored in the deep aquifers of Jordan which can be considered as a potential source. Some of the saline springs and deep wells in the Jordan River valley (JRV) and its side tributaries were expected to produce a total of 75 MCM of desalinated fresh water, made available in the near future (MWI, 2003).

At present, an amount of 40 MCM of desalinated water are produced to augment the domestic supply for Amman area and other cities a further 9 MCM are used for agriculture. The largest two projects are in Abu az-Zeigan with a capacity of 2500 m<sup>3</sup>/hr and al-Lajoun wells of 1200 m<sup>3</sup>/hr. There are other 6 additional projects that supply remote villages and towns. The main environmental concern for all desalination projects is the disposal of the brine.

Sea water desalination is viewed in conjunction with the execution of the Red Sea-Dead Sea canal project. If this project could be implemented, an amount of 500 MCM of desalinated sea water would be available for Jordan. The available energy to produce this amount is through utilization of about 400 m head difference between the Red Sea and the Dead Sea and flowing 40-60 m<sup>3</sup>/s of sea water in order to restore the Dead Sea to its original elevation of 395 m below the sea level.

### 2.3.6 Water Demand in Jordan

Water uses vary from year to year depending on the available surface water supply which is decreasing due to upstream uses and climatic fluctuations. According to available water supplies, a total of 520 MCM in 2003 were used in agriculture (representing about 63.5 % of the total water use); the domestic sector consumed 270 MCM (32.5 %); industry share was only 36 MCM (4 %).

The municipal water demand is growing rapidly faster than the population growth but due to system capacity and limited supply, the actual demand has never been met. The total amount that have been pumped to municipal uses in 2004 reached 270 MCM which indicated that the annual per capita share of water for domestic uses was only 50 m<sup>3</sup>/capita/year. This low amount averages a daily supply of 137 liter/capita/day. To overcome the shortage and gap between supply and demand, water consumption is rationed by rotating

supplies and providing intermittent services during most of the dry months (June - August).

Most of the industrial allocated water is consumed by two major industries: namely phosphate and potash production. These industries and others are located outside of cities limits and therefore secure their water supplies; either by using surface water like the Arab Potash company or drill their own private wells as the case of the phosphate company. The government is selling surface water to industry and imposing a resources tax of 0.25 JD/m<sup>3</sup> for groundwater. For industries that receive water from the domestic network distribution system, water price is 1.0 JD/m<sup>3</sup>.

Irrigated agriculture in Jordan falls under two categories in term of management and source of water. In the highlands, privately managed individual farms are irrigated by groundwater from private wells. The publicly managed irrigation system in the Jordan Valley uses surface water of Yarmouk River and side wadis as well as recycled wastewater.

Expansion of both systems has been rapid in the last 30 years. Highland irrigation expanded from 3,000 ha in 1976 to an estimated 43,000 ha in 2004 which uses mainly groundwater as a source of irrigation including 6,000 ha are irrigated by the fossil non-renewable groundwater in Disi and Mudawwara area for the production of cereals, vegetables and fruit.

Irrigation in the Jordan Valley and Southern Ghors have been developed by the Jordan Valley Authority (JVA) which covers 23,000 ha under full irrigation in the Jordan Valley plus 6,000 ha in southern part of Jordan Valley that are restricted by water availability to winter use only. There are about 3,000 ha in the Jordan Valley that are irrigated with groundwater using private wells.

In the Southern Ghors, south the Dead Sea, about 5,000 to 7,000 ha are irrigated using the base flow of southern wadis and release of the southern dams. As

such the total irrigated area in the Jordan Valley and Southern Ghors is estimated at 33,000 ha, totaling 76,000 ha as the irrigated area in Jordan including the highlands.

### 2.3.7 Water Management and Policy

In Jordan, there are three public agencies responsible for the management of water resources. The Ministry of Water and irrigation (MWI) is responsible for water resources policy and strategy development, water resources planning, research and development, information systems, procuring financial resources. The two agencies, namely; the Water Authority of Jordan (WAJ) and the Jordan Valley Authority (JVA) are executing bodies; they are under the umbrella of MWI and the Minister of MWI heads their boards of Directors. WAJ is responsible for providing water and sewage services throughout Jordan and for water resources management while JVA responsibilities cover the development of Jordan Rift valley, including water resources, primarily for agriculture in the Jordan valley and southern Ghors. JVA is also in charge of managing the scheme in the valley and all dams and reservoirs feeding JRV. The Ministry of Environment monitors the quality of surface water in natural environment and the quality of industrial wastewater discharged to the ecosystems to meet its mandate in conserving the environmental elements from pollution.

Up to 1996, management of the water sector had been characterized by short term planning focusing on increasing water supply, fragmented short-term policy and overlapping responsibilities between the three agencies (MWI, WAJ and JVA). In addition, there was no coordination between MWI and other ministries like the Ministry of Agriculture (MoA). For example, the responsibilities on up-land irrigation and on-farm irrigation management were vague lost between MWI and MoA. Also, there has not been any significant coordination between MWI and the Ministry of Environment as well as other entities in Jordan.

Prior to 1990, management of water resources was based on crises management principles. Every summer, rural and urban populations were faced with fresh water shortages which result in rationing of water distribution. The situation with the agricultural sector is similar. As a result of that, there was an urgent need to formulate a national water policy taking into account all issues related to the water resources and their uses and management. This need was strongly supported by the World Bank, FAO and other donor agencies as well as by other donating governments.

In 1998, a National Water Strategy was approved by the government. The strategy stresses the need for improved water resources management with particular emphasis on the sustainability of present and future uses. Special care was given to protect Jordan's water resources against pollution, quality degradation, and depletion. Furthermore, MWI was supposed to sustain the highest practical efficiency in the conveyance, distribution, and application and use of water resources. In addition, MWI was expected to adopt a dual approach of demand management and supply management, with tools of advanced technology being increasingly utilized to enhance the resource management capabilities.

The Water Strategy ensures that the rightful shares of the Kingdom's shared water resources shall be defended and protected through bilateral and multilateral contacts, negotiations, and agreements. Water and wastewater projects associated with regional peace processes, including the scheme for the development of the Jordan Rift Valley, shall be accorded special attention for construction, operation and maintenance. Due respect will be given to the provisions of international law as applicable to water sharing, protection and conservation, and those applicable to territorial waters. Bilateral and multi-lateral co-operation with neighboring states shall be pursued, and regional co-operation shall be advocated.

The strategy defines the long-term goals that the government of Jordan seeks to achieve in the water

sector. The Ministry plans was to formulate certain policies that would help achieve these goals.

Up to now, the Ministry has prepared and published the following four policies:

1. Groundwater management policy;
2. Irrigation policy;
3. Wastewater management policy and
4. Water utilities policies.

## 2.4 Land Regions-soil Types

Identification and mapping of soils and land regions are required to identify characteristics of land in relation to desertification. Generally, soil's sensitivity to degradation is widely dependant on its physical, chemical and biological quality. Resilience of soils is also highly affected by their initial conditions and distribution. Therefore, details on soil types and their distribution are needed before setting any sustainable programmes related to monitoring and management of land resources. Therefore, mapping of status, rate and hazard of desertification requires soil maps at different scale to identify the most affected areas and those under threat of desertification.

Soil maps were produced through a national project (National Soil Map and Land Use Project, NSMLUP) carried jointly by the Ministry of Agriculture (MoA), Royal Jordanian Geographic Centre and Huntings Technical Service (UK) during the period of 1989-1995. Using the USDA classification system (USDA-SSA, 1990), existing soil maps provide information on soil characteristics at the level of soil mapping unit at three levels (MoA, 1993 & 1995):

Level 1: Reconnaissance maps with scale of 1:250,000 for the whole country. This level was based on analysis

of Landsat TM imagery and aerial photography and a soil sampling density of one observation/7.6 km<sup>2</sup>.

Level 2: Semi detailed maps with scale 1: 50,000, for about 9,000 Km<sup>2</sup>. Maps were based on panchromatic SPOT imagery digitally merged with Landsat TM with field survey at a density of 3.5 observations/km<sup>2</sup>.

Level 3: Detailed maps with scale of 1: 10,000 that covered selected parts of the country (about 1,000 km<sup>2</sup>). This level was based on the interpretation of panchromatic aerial photography at a scale of 1:10,000 with soil series forming the basic mapping units. Soil survey involved field observations at a density of 15 observations/km<sup>2</sup>.

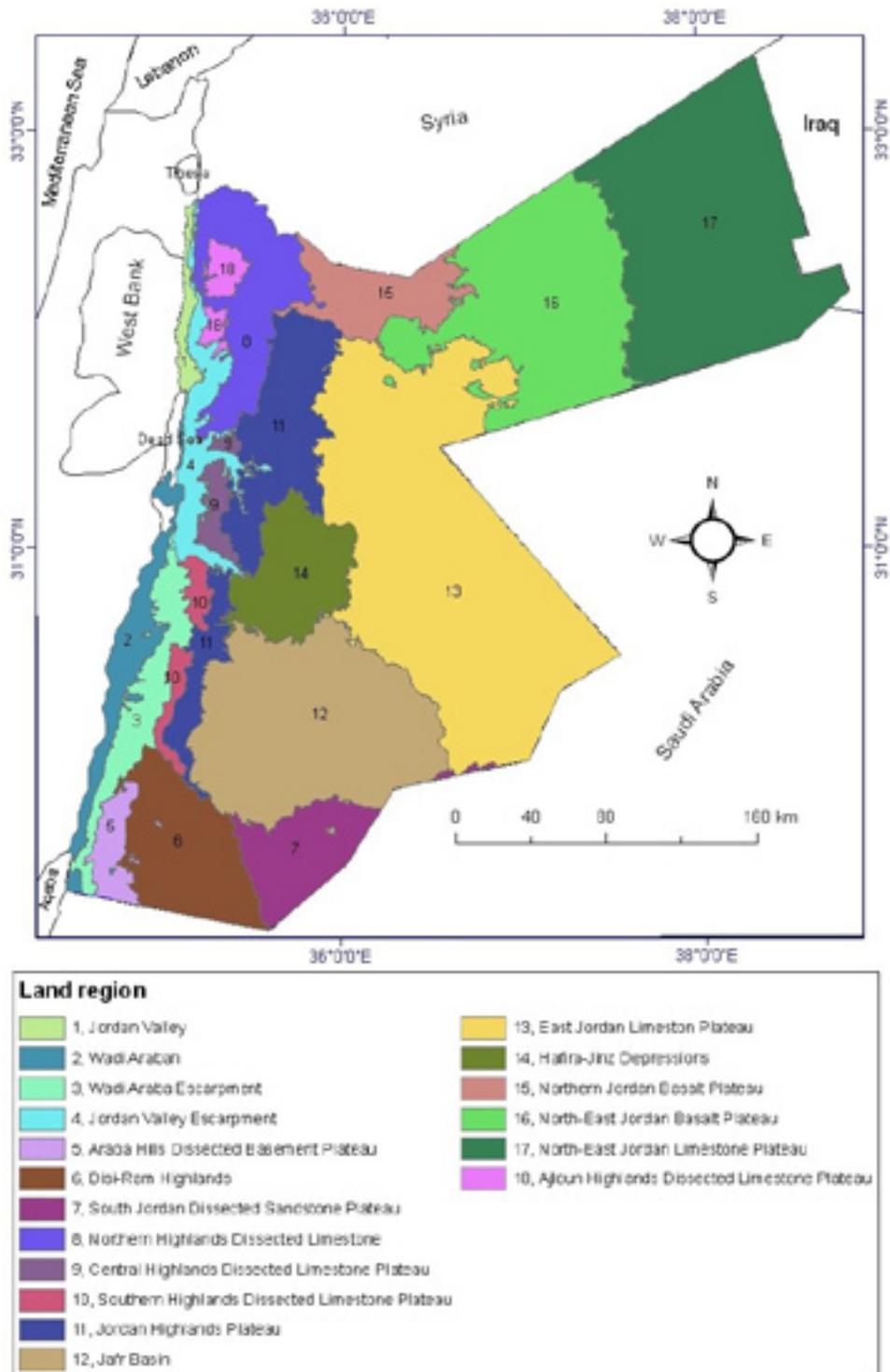
All maps are available as hardcopy sheets (Atlases) while all profile and pits were saved in Jordan Soil and Climate Information System (JOSCIS), held by the MoA. In this database, profile description of sampled sites is available. Detailed physical and chemical analysis is available for some profiles and sites at level 3.

Recently, soil maps of levels 1 and 2 were converted to digital formats by the GIS team of the University of Jordan. The corresponding legends were entered into spreadsheet and joined to ArcView GIS software with the attributes of map unit, parent material, vegetation/land use, A-horizon stoniness, rock outcrop, USDA subgroups and their percentages (each group in a column and its corresponding percentage in a separate one).

The soil map legend describing the individual map units is descriptive. It provides:

1. A description of the main physiographic features of the region including topography, geology, climate and vegetation,
2. A detailed physiographic description of the mapping unit,

Figure 7: Land regions in Jordan



**Table 2:** Analysis of dominant soil types and their proportions of the countries area.

Region	Number of units	% area	Dominant soil subgroups
1	3	0.61	Ustochreptic and ustollic camborthids and calciorthids, ustic torriorthents.
2	8	2.48	Typic calciorthids and camborthids, typic torriorthents, typic torripsammets, typic and lithic torriorthents.
3	4	2.76	Typic and lithic xerochrepts, lithic and calcixerollic xerochrepts, typic calciorthids and camborthids
4	6	2.55	Calcixerollic and typic xerochrepts, typic and lithic torriorthents, ustochreptic calciorthids and camborthids
5	3	1.18	Typic and lithic torriorthents, typic camborthids and calciorthids
6	9	5.38	Typic calciorthids, torripsammets and torriorthents
7	7	3.30	Lithic and typic torriorthents, typic camborthids, cambic gypsiorthids
8	16	4.31	Calcixerollic, lithic and typic xerochrepts, typic and entic chromoxererts
9	5	0.86	Calcixerollic and lithic xerochrepts, vertic xerochrepts
10	7	1.03	Calcixerollic and typic xerochrepts
11	18	6.58	Xerochreptic calciorthids and camborthids
12	17	12.01	Typic calciorthids and camborthids, lithic and typic torriorthents
13	21	22.30	Typic camborthids and calciorthids, cambic and lithic gypsiorthids
14	7	3.93	Typic camborthids and calciorthids
15	7	3.05	Xerochreptic calciorthids and Lithic xerochrepts
16	8	11.06	Typic camborthids, cambic and calcic gypsiorthids
17	11	15.75	Typic camborthids and calciorthids
18	3	0.85	Typic and lithic xerochrepts

Soil data showed full coverage of reconnaissance soil maps and well-identified land regions. However, semi-detailed soil maps cover about 10% of the country; and only few selected areas have detailed maps. The following remarks can be drawn from existing soil data:

- Most of the soils are aridic with high carbonate content and low organic matter.
- Sand and silt deposits dominate most of the low rainfall zones.
- Soils with good quality cover small parts of the country and have been altered by urbanization.
- A well-organized and updated soil database is needed.

3. The name and mapping code of the unit,
4. The subgroups which together occupy, at least 80–85% of the unit as determined by the observation sites and where possible, the distribution of the facets, with the proportion of each subgroup,
5. A brief description of the soil including color, depth, texture, reaction, salinity, gradient and topographic position,
6. The equivalent ACSAD legend for the soil map of the Arab World.

At the country level, 18 land regions were identified by the NSMLUP. They are depicted in Figure 7.

For further characterization of soil types within the different land region, land region map was intersected with the reconnaissance soil map to estimate percentage of each soil type within the different land regions. Results of this analysis are shown in Table 2. Detailed description of each land region is presented in appendix 2.

## 2.5 Biological Resources

Jordan enjoys tremendous ecological features of regional as well as of global significance. The ecological importance of Jordan lies within its geographical location, climatological and geological formations. Jordan has maintained and continues to maintain species related to different biota in a small area. The country is divided into three topographic regions (GCEP, 1998):

The **Jordan Rift Valley**, a fault that extends from Lake Tiberia in the north to the Gulf of Aqaba in the south. The Jordan Valley, the Dead Sea and Wadi Araba are located in this zone. The Dead Sea, at an elevation of less than -410 m (BSL), is the lowest depression on earth. Average rainfall in this region is 200 to 300 mm per year in the Jordan Valley, 50 to 100 mm in the Dead Sea, and less than 50 mm in Wadi Araba.

The **Mountainous Region** is forming the eastern boundary of the Rift Valley and extending from Lake Tiberia to the Gulf of Aqaba. Mountains in this region have elevations ranging from 1,200 to 1,500 meters (ASL). The region has a relatively mild climate with winter rains. The higher elevations receive occasional winter snows. Average annual precipitation in the mountainous zone varies from 600 mm in the northern highlands, to 100–300 mm in the south. Ninety percent of Jordan's population live in this zone (GCEP, 1998).

The **Eastern Desert** (also known as the **Badia**) lies east of the Mountainous Region and covers 85 percent of the land area of Jordan. This region is characterized by a dry, hot climate. Most of the zone is flat or hilly, but in the south there are the two highest mountains in Jordan, Rum Mountain and Umm Ishrin Mountain.

The rapid changes between these zones in a relatively small distances had enriched Jordan's flora and fauna (GCEP, 1998, 2000a). These conditions have contributed in identifying many of species as endemic and/or rare. Human interference and direct anthropogenic factors added many other species to threatened levels.

In 1977, IUCN-WWF defined 12 different habitats of conservation importance representing the majority of Jordan's biological significance. These 12 areas make up the network of Jordan's protected areas. In the year 2000, Bird-life International (BLI) and the Royal Society for the Conservation of Nature (RSCN) defined and globally declared 27 areas in Jordan as important bird regions (RSCN, 2000). Furthermore, thirteen areas were identified as valuable in Jordan during the inventory on wetlands in the Middle East (Budieri, 1995). Jordan represents truly a living museum to study the interactions of different species descended from different biological realms.

There have been and still sincere efforts to conserve those natural assets and their diversity which are facing threats of diminishing and miss utilization. One of these

main threats is population increase. Most literatures consider population increase as the root cause of many environmental implications in Jordan (GCEP, 1998; Disi & Oran, 1995; Hatough & Disi, 1991).

### 2.5.1 Biogeography of Jordan

Many researchers and scholars have studied ecosystems generally occurring in Jordan. Amongst main studies are those of Al-Eisawi (1985), Zohary (1962, 1973), Long (1957) and Kasaplagil (1956). Jordan forms part of the Mediterranean region and is characterized by the Eastern Mediterranean climate, which has a mild and moderately rainy winter and a hot rainless summer. However, spring and autumn do not have specific entity. Al-Eisawi (1985) and later Disi & Amr (1998) indicated the presence of four bio-geographical regions in Jordan (Figure 8), namely, Mediterranean, Irano-Turanian, Saharo-Arabian and Sudanian-Penetration.

**Mediterranean** region is restricted to the highlands of Jordan with altitude ranging from 700 to 1750 m above sea level and a mean annual rainfall ranging from 300 to 600 mm. This region supports the best natural vegetation in Jordan including forest stands of *Pinus*

*halepensis* (wild Pine), *Quercus calliprinos* (ever-green Oak), *Quercus ithaburensis* (deciduous Oak), *Juniperus phoenica* (Phoenician Juniper). In addition to natural vegetation, rainfed cultivation of wheat and other field crops, summer crops and orchards is practiced.

**Irano-Turanian** region surrounds the Mediterranean region from all sides except the north and is characterized by no forest cover. Altitude ranges from 500 to 700 m and annual rainfall ranges from 100 to 300 mm. Vegetation is mainly dominated by low shrubs and bushes (timberless land) and some rainfed barley cultivation.

**Saharo-Arabian** region comprises most of the country, known as the Badia, with altitude of 600 – 700 m and a mean annual rainfall of less than 100 mm. Dry hot

summer and relatively cold dry winter characterize this region. The region is classified as rangeland and provides home to a wide range of highly and diversified adapted organisms.

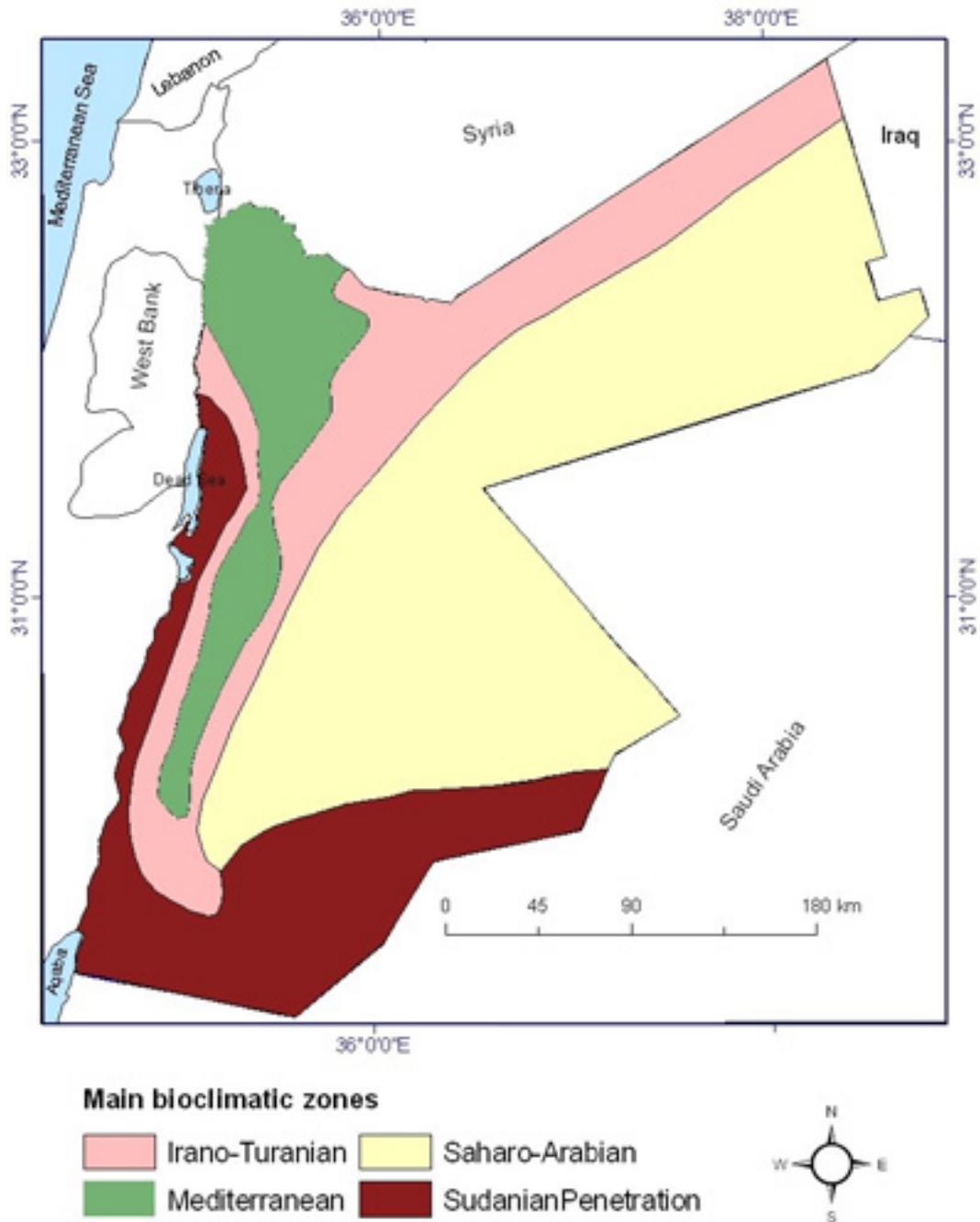
**Sudanian Penetration** (Sub-Tropical) region provides unique ecosystems as the altitude varies from 400 m below the sea level (at the Rift Valley and Dead Sea up to 1200 m in the south. This region is characterized by very hot summer and warm winter with mean annual rainfall of 50 mm or less. Vegetation is dominated by Acacia sp. in the low-altitude region and scattered shrubs and Juniper in the high-altitude region.

### 2.5.2 Plant Diversity

Al-Eisawi (1985) has recognized thirteen vegetation types in Jordan. Recent work by Albert, *et al.* (2003) indicated up to 19 recognizable types (Figure 9). Some types are strictly confined to one of the bioclimatic regions. For example, forest climax occurs executively within the Mediterranean region, while Steppe vegetation is confined to the Irano-Turanian region. Tropical and Acacia woodlands occur at the sub-tropical region. Hammad vegetation occurs predominantly at the Saharo-arabian region.

Plant species composition, habitat description and vegetation community were analyzed in various studies (Al-Eisawi, 1985; Kurschner, 1986, Robertson The total number of plant species is estimated to be between 2300 and 2500, of which 2000 are vascular plants (Al-Eisawi, 1982; GCEP, 1998; 2000). New species are added to the list of plant species almost yearly as new to Jordan and even new to science. Plant diversity in Jordan has declined dramatically and some have become extinct totally from the wild. Main reasons leading to this are habitat encroachment by urban and agricultural development, deforestation, and deterioration of rangelands by over-grazing and soil erosion, illegal collection, and depletion of the major water resources.

**Figure 8:** Biogeographic regions of Jordan (After Disi and Amr, 1998).



### 2.5.3 Woodlands

Reports indicate that woodlands covered vast areas of Jordan in the past. Most of this plant cover has been removed during the third and second Centuries B.C. mainly for land conversion to agriculture and for urban encroachment. Jordan to recent times (till fifties) was covered with large woodland areas. The area of woodlands in Jordan 100 years ago is estimated as twice as today's area (Tilawi, 1995). The area has decreased to half a million dunums (1 ha = 10 dunums) in the forties and 400 thousands during the fifties (Figure 10).

Atkinson and Beaumont (1971,) indicated that although of vital importance locally to the agricultural economy of the country, forests cover less than 1% of the total area of Jordan. In the northern highlands, the forests cover an area of some 80 km in length from Wadi el Arab in the north to Wadi Kuffrein in South, and with a maximum east to west width of 25 km in the Ajloun area. Five forest associations can be distinguished in northern forests. These are the evergreen forest of *Quercus coccifera* (*Q. calliprinos*, Kermes oak), the deciduous forest of *Q. aegilops* (*Q. ithaburensis*), the coniferous forest of *Pinus halepensis* (Aleppo Pine), the mixed forest of oak and *Olea europea* (wild olive). *Q. coccifera* is thought to represent a secondary (degraded) forest. It covers by far the largest area in the north and is considered to have been degraded by the overgrazing and human cutting.

*Q. aegilops* on the other hand cover an area of 100,000 ha, occurring in a well defined, discontinuous areas from Amman as far as the Yarmouk River in the north. In 1971, majority of these trees were estimated at less than 40 years old. These forests have been subjected to severe pressure from grazing and wood collection as well as from grain cultivation in recent years. Remnants of these magnificent trees still indicate that this forest has almost disappeared.

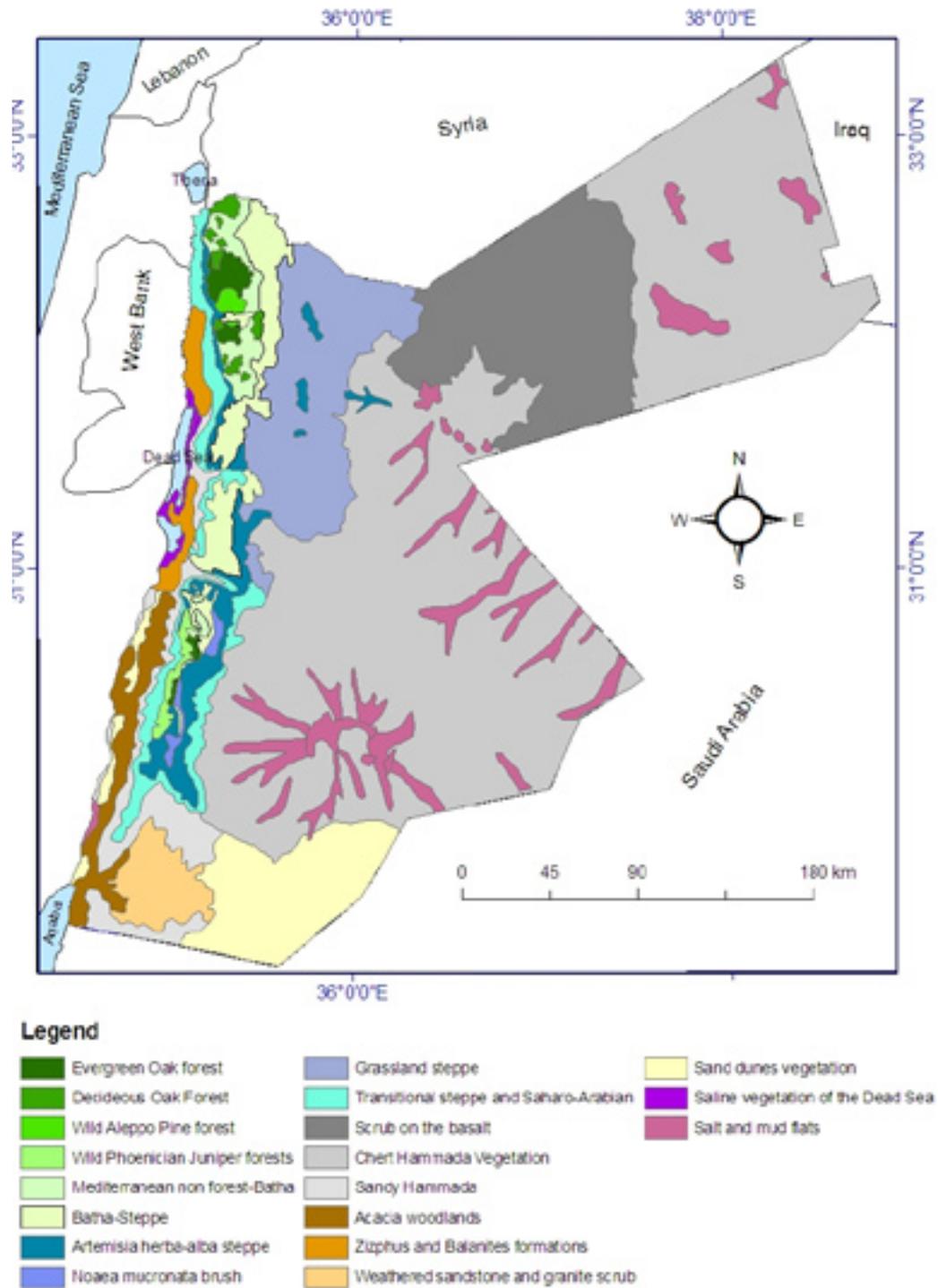
Atkinson and Beaumont (1971), in reviewing literature, indicated that in early times the rich forests of Gilead were almost as famous as those of Lebanon. Since that

time, man has been the main agent in the degradation of the natural forest and in reduction of its area. Several causes explain this decline. Overgrazing by goats has been prevalent for centuries. Probably flocks were grazed on the steppe area to the east of the forest land but in time of drought they began to encroach on forest margin. Goats not only eat leaves and shoots of the trees, but they also destroy seedlings and ground vegetation, thus preventing regeneration (Atkinson and Beaumont, 1971; Beaumont, 1985). Woodlands of mid mountainous Jordan were reduced considerably and even parts of the woodlands in the capital were totally wiped out, due to increased urbanization.

Though being of a small area, forest lands produce important environmental and economical benefits. These services are not sufficiently recognized in investment planning and implementation. An emerging key priority is the protection of forests in watersheds to reduce erosion of slopes. Forests in Jordan consist of natural and manmade forests including windbreaks and shelterbelts. The forests are mainly located in the north of the country on the mountainous areas. Until the fifties, forests were seen as government owned and wood logging is allowed after paying certain fees. The forestry department was established in 1953, and since that time and until the sixties, the department work has been mainly focused on preserving existing woodlands and afforestation of small areas, which was less than the logged areas considering the low technical and financial capacity available then. Since the mid sixties, the department's has developed its activities and afforestation rate exceeded logging rate and managed to reduce violations on forests to an acceptable level (Tilawi, 1995). Reforestation programmers have since reclaimed large areas now covered with exotic pines and eucalyptus woods.

The loss of woodland cover has certainly caused vanishing of other plants and wildlife depending on forests. Al-Eisawi and Oran (1995) have reported that the 24 species of Orchids known in Jordan that occur under forest vegetation are threatened with extension due to habitat destruction and some had already gone

**Figure 9:** Vegetation types recognized in Jordan (After: Albert et al., and Boore, 1964).



extinct. Table 3 compiles the areas of various natural woodlands in northern Jordan by different reports and literatures.

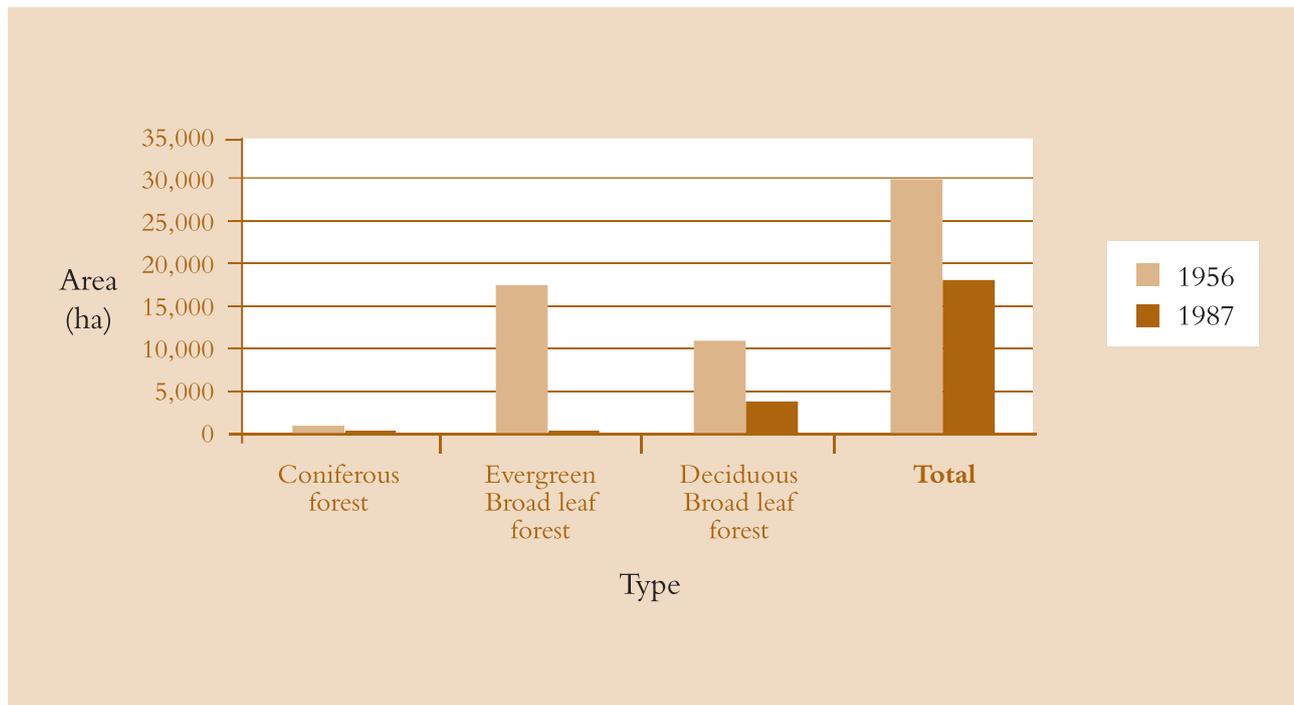
The Mediterranean non forest zone represents a type of habitat that has developed and expanded greatly following the logging of natural woods, but the past 50 years have suffered a great deal of damage and reduction through heavy grazing, construction of new villages, fires, and excessive planting of pines.

The Jordan agenda 21 also pointed out that forest cover is less than one half of one percent of Jordan's land area (MMRAE, 2002). Those areas are fragmented and mostly protected but are degraded with little natural regeneration.

**Table 3:** Northern woodland area (ha) in the north (compiled data).

Woodland	1956	1987
Coniferous forest in the north	1,095	142
Evergreen Broad leaf forest	18,200	14,938
Deciduous Broad leaf forest	11,600	4,000
Total Area (ha)	30,895	19,080

**Figure 10:** Decline in northern woodland area between 1956 and 1987.



Main threat to Jordan biodiversity generally described as the habitats and rangeland degradation. Direct causes leading to degradation can be summarized as:

1. Urban development and encroachment into natural habitats,
2. Agriculture development and associated practices,
3. Deforestation and wood cutting,
4. Over grazing.

Root causes for the above are:

1. Population increase,
2. Lack of environmentally friendly national land use management and policy,
3. Weak enforcement agricultural legislations and “Best Practices” guidelines,
4. Land tenure and ownership conflicts,
5. Poverty related to unsustainable use of natural resources.

Barriers to lift the threat are:

1. Knowledge,
2. Communication,
3. Economy.

#### 2.5.4 Steppe and Saharo Arabian regions

The desert and semi-desert regions comprise more than 85% of Jordan’s land area and is much less populated than the rest. Nevertheless, it is a vulnerable ecosystem that has been subjected to many changes and disturbances during the past 50 years. In some parts, over-extraction of underground water has led to the desiccation of surface vegetation. Overgrazing in the Eastern Desert continues to be a persistent threat to the integrity of this fragile ecosystem.

The human impacts on those regions have been envisaged to be caused directly by cropping of marginal lands which are only suitable for use as rangelands. Evidences of overgrazing have been indicated in both reduced productivity and changing plant community compositions resulting in decreasing carrying capacity.

#### 2.5.5 Main Uses of Wild Plants

Most of the wild and forage plant species can survive in more than one target area. Intensity of the species depends on several factors. These factors were scoped from field interviews with farmers and local communities (Abu-shriha, 2003). The interviewed Farmers documented (88) wild and forage species (Appendix 3). The habitats were classified as forest, mountain/hilltop, hillside, forest perimeter, road side, field border, valley floor, spring vicinity. The most dominant habitat of the majority of these plants is mountains and forests followed by rangelands.

The persistence of drought in the last two decades resulted in a gradual decrease in both distribution and density of these plants. Moreover, agriculture and human disturbances contributed to the former natural stresses and caused an extinction of some species. Species growing near permanent water resources enjoyed the highest density.

The interviewed farmers reported 9 uses of the wild and forage plant species: human food, animal

fodder, medicinal purposes, beverage, fiber, building material, timber, grafting, and some others like gum (from *Pistacia Atlantica*) or ghee production (from *Trigonella foenumgraecum L.*) or using the plant itself for ornamental purposes (*Narcissus*). Spring and summer are the two seasons for collection and use of wild and forage plants. Detailed description of plant use is shown in appendix 3.

### 2.5.6 Threats to the Ecology of Jordan

The main cause of all changes related to environment in general and habitats in specific was the rapid development from a sparsely inhabited country into a modern agricultural and industrial society (the population is over ten times that of 1950). Rapid population growth can exacerbate the mutually reinforcing effects of poverty and environmental damage. The poor are both victims and agents of environmental damages; because they lack resources and technology. Land-hungry farmers resort to cultivating erosion-prone hillsides and moving into tropical or marginal arid areas where crop yields usually drop sharply after just a few years (IUCN, UNEP, WWF, 1991). Rapid population growth often contributes to environmental damage. Traditional land resource management systems may be unable to adapt fast enough to prevent overuse of resources, and government may be unable to keep up with infrastructure and human needs of growing populations.

Slowly evolving intensification of agriculture that occurred in the first half of century was disrupted by the sharp acceleration of population growth in the past four decades (Hatough-Bouran & Disi, 1995). Low agricultural productivity, caused mainly by poor incentives and poor provisions of services, has delayed the demographic transition and encouraged land degradation and deforestation, which in turn lowered productivity. Population growth drives people to cultivate land not previously used for farming in semi

arid areas. The eastern desert has witnessed intensive plowing in marginal land by Bedouins to strengthen claim ship, where rainfall does not exceed 50 mm/annum. Those areas are characterized by soil and climatic conditions poorly suited for annual cropping or for the practices employed by new migrants (Hatough *et al.*, 1986) putting additional pressure and stress on natural habitats resulting from land tenure issues.

Shifting cultivation and grazing have been appropriate traditional responses to abundant land, scarce capital and limited technology. As population densities grew slowly in the first half of this century, those extensive systems evolved into more sensitive ones (southern part of Jordan). This system, however, has proved unable to adapt to the sharply accelerated population growth over the past five decades. Traditional uses of land and fuel have depleted soil and forests and contributed to ecological and agricultural deterioration (Hatough-Bouran & Disi, 1991; 1995). Below is an account to the impacts on Jordanian biodiversity.

During the 1980s the Jordanian government in cooperation with Bedouin herders, was making major strides in grazing management and in wildlife management on rangelands. The Hammad Basin Development Programme was initiated in 1987. A system of rotating grazing reserves was being instituted in which grazing would be permitted until the range began to show signs of stress and then would not be permitted for a period of years, allowing vegetation to recover. Wildlife reserves were permanently established to allow more structurally and biologically diverse habitats to develop. Figures 11 and 12 show the progressive establishment of grazing and wildlife reserves, respectively. The establishment of grazing and wildlife reserves has been accompanied with a wide variety of programmes to conserve biodiversity and range resources, mainly supported by international agencies.

A new trend of rangeland community based reserves are being introduced by the Badia Research and

Development Center (BRDC). In conjunction and coordination with MoA, NCARTT and Lands and Survey Department (LSD).

This model is proving promising solution to issues of livestock needs, resources depletion and land tenure.

## 2.6 Land Use/Cover

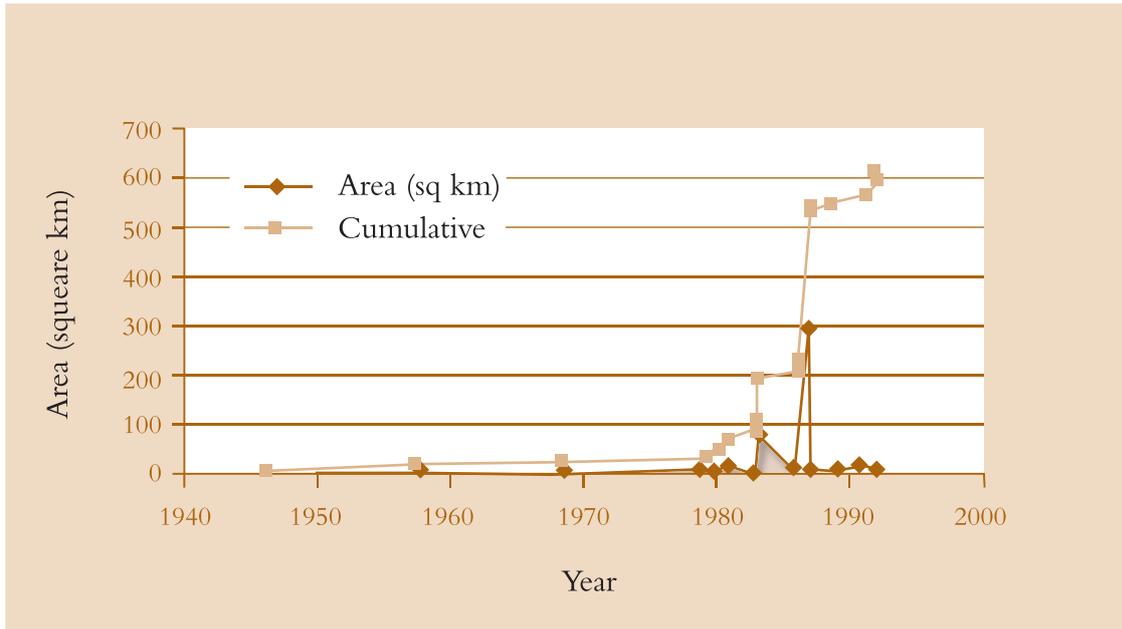
Mapping and identification of land use/cover represents the baseline data for studying global climatic changes and desertification. Categories of land use/cover are usually related to the needs of studies pertinent to gas exchange and green house gases (Belward, 2001), which should be reduced to reasonable levels. At the same time, land use and human activities play important roles in the carbon emission and sequestration. The former

should be reduced to decrease global warming while latter should be increased to fix soil organic carbon.

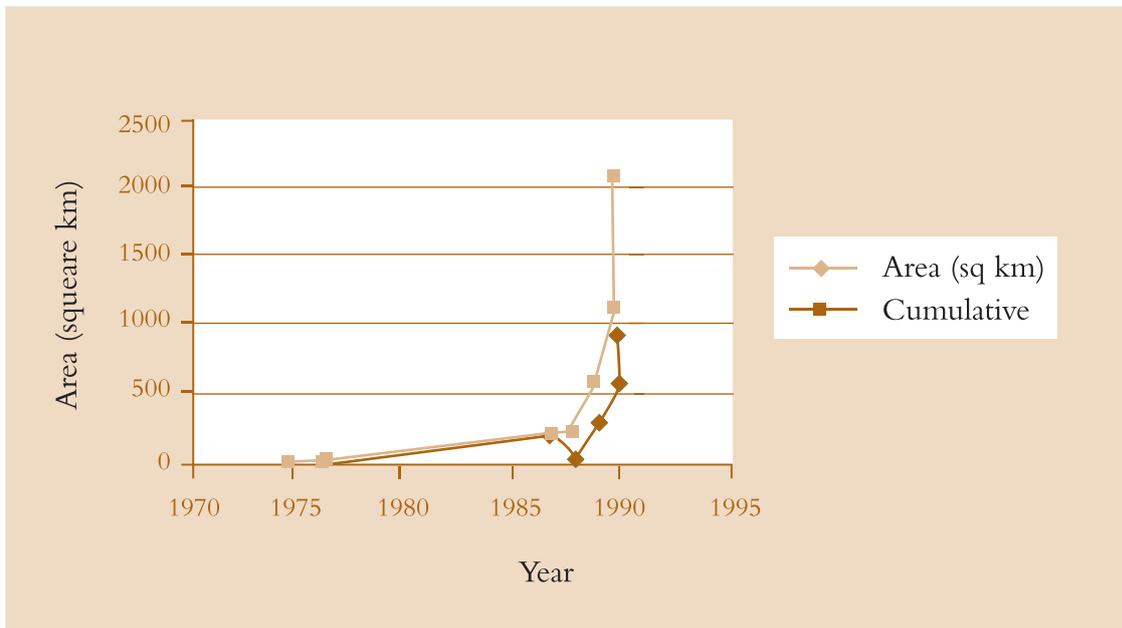
### 2.6.1 Existing Land Use/Cover

Land use/cover in Jordan falls into five broad categories (Table 4) which reflect climate, topography, the availability moisture supply and water resources, and soils. In general, availability of water resources is the most important factor. Discrepancy is observed between figures on existing land use/cover coming from different sources. However, most of studies and figures have shown that agricultural areas form small proportion of the country. According to the Department of Statistics (2003), land use shows that most of the country is dominated by non cultivated areas, classified as rangeland

**Figure 11:** Establishment of rangeland reserves in Jordan (compiled data).



**Figure 12:** Establishment of wildlife reserves in Jordan (compiled data).



**Table 4:** Existing land use in Jordan.

Land use	% of the total area
Non-cultivated rangelands	93.30
Urban areas	1.89
Forests and re-forestation	1.50
Water surfaces (Dead Sea and Gulf of Aqaba)	0.62
Agricultural lands	2.69

The main land use/cover types in Jordan can be summarized as following:

### a. Rangeland

By definition, rangeland includes non-cultivated areas in the high and low rainfall zones. However, most of this land is located in the arid zone which provides important grazing and browse. Livestock is the major source of income for local communities in this zone. Lands in this zone are usually overgrazed by nomadic and semi - nomadic flock owners from late in the winter to mid summer. The highest productive rangelands are located within the 100-250 mm rainfall (steppe grassland and brush). In this zone, barley is cultivated for hay; rainfall is rarely adequate to produce a reasonable crop (100-500 Kg /ha) and failure or, at best, limited vegetative growth is common. Before the advent of the tractor, marginal lands were rarely plowed because of the high labor input required for animal drawn plowing. With the introduction of the tractor on a major scale in the early 1950's, expansion of tillage into the steppe lands speeded up (HTS, 1956). In recent years, this expansion has become increasingly rapid due to factors such as land ownership and territorial conflicts among the Bedu, low input requirements and most important is the limited forage resources. The result is large areas of steppe vegetation have been destroyed and the carrying capacity of the range was much reduced.

### b. Rainfed agriculture

Generally, rainfall amounts and climatic conditions of the country do not support good rainfed agriculture, except for few areas in the northern and western highlands. Therefore, the rainfed agricultural zone is lying within the xeric soil moisture regime in areas where rainfall exceeds 250 mm, although significant production of cereals does occur in some areas where rainfall is between 200 and 250 mm. According to the NSMLUP, there are two main sub-divisions within the rainfed sector, namely fruit trees and field crops. Tree crops dominate the hilly and steeply sloping lands of the western part of the highland plateau. Slopes are generally too steep for cereal and other annual crop production even with soil conservation measures. However, wheat is grown on inappropriately steep slopes in some places. There has been significant expansion of the area under tree crops, especially olives, and this is a trend which has been encouraged by Government under projects like the Zarqa Basin Project and Highland Development Project. On the undulating lands of the major plains of Irbid, Madaba, Karak, Tafila and Shoubak wheat is the major crop, with lesser areas of tobacco, "broom" sorghum and other summer crops of lentil and chickpea.

### c. Irrigated agriculture

Most of irrigated agriculture is located in the Jordan Valley. The area under cultivation is served by surface water supplies transported via the King Abdullah Canal, limited areas in the south of the valley is irrigated from groundwater. The total area under irrigation in Jordan Valley and the southern Ghors in 2003 was estimated to be about 33,000 ha. The major crops are vegetables and trees including citrus and bananas. In the north of the valley, wheat is grown on often stony soils and depends initially on rain, but supplementary irrigation by sprinkler is given at the yield formation stage. In the Disi and Mudawwara areas, deep fossil groundwater is used for the centre pivot irrigation of wheat, forage and potatoes. Important irrigated agriculture is also taking place on the basalt plateau soils of north Jordan, in Mafraq governorate. In these areas, the utilization of

groundwater resources was expanded rapidly into the steppe zone, often for the production of fruit crops. Other irrigated areas are mainly found in south and south east of Amman in the upper Dead Sea ground water basin. Finally, in many of the valleys leading from the highlands to the rift valley, springs are exploited for irrigated fruit and vegetables. There are only limited alluvial areas in most of the valleys and, increasingly, water is pumped to small, gently sloping areas of deeper soils at considerable heights above the stream bed. This kind of production can be seen in wadi al Mujib and wadi al Hassa. The agricultural area in Jordan varies from one year to another depending on the rainfall amounts and available water resources. Summary of the total rainfed and agricultural areas for 2003 is shown in Table 5.

Other land use/cover types are forming small proportion of the country's area. Although urban area constitutes about 2% of the land, however it is mainly concentrated in the most productive lands of high rainfall zone in Amman, Irbed, Madaba, and Salt. Forests, on the other hand, are mainly found in the high rainfall zone of Ajloun and Jarash and have been altered by agro-forestry systems and cutting (section 2.5.3).

Currently, updated digital maps of land use/cover for the whole country are not available. Sources of land use/cover maps are restricted to research projects and studies that covered particular study sites (e.g: Millington, 1999; Smith *et al.*,1999; Al-Bakri *et al.* 2003;Al-Bakri, 2005 a&b). Other maps were produced as hardcopy sheets by the Royal Jordanian Geographic Center within the 1:50000 topographic maps. These maps, however, were based on the 1980's aerial photography and therefore require updating. This task is seen urgent and needs implementation to provide land use/maps, in hard copy and digital formats, for planners, decision-makers, scientific communities and researchers.

### 2.6.2 Potential Land Use

Based on climatic records and historical survey, a general map of potential land use was delineated by Taimeh (1989) at a very small scale to characterize the country into different regions of capability. The output map (Figure 13) divided the country into five zones and indicated the potential land use. The same map was used to identify aspects of desertification and possible indicators within each zone. Basically, the map followed

**Table 5:** Irrigated and non-Irrigated areas of tree crops, field crops and vegetables in 2003 (adapted from: DOS, 2003).

Crops	Irrigated area (ha)	Non-irrigated area (ha)	Total area (ha)
Tree Crops	33,198.24	52,592.96	85,791.20
Field Crops	5,719.60	112,703.80	118,423.40
Vegetables	32,399.20	2,024.28	34,423.47
Total	71,317.04	167,321.04	
% of the country's area	0.80	1.89	2.69

Most of the country's land is rangeland; existing studies indicated high rate of degradation in the different zones of these lands. Agricultural areas are limited as soils and climate limitations are persistent. Although urban areas constitute a small proportion of the country, they are distributed in the most productive lands. Concluding remarks on existing land use/cover:

- No obvious land use policy and sustainable land use exist.
- An obvious shift between potential and existing land use.
- Lack of land use/cover maps at the country level.

similar pattern of rainfall and bioclimatic zones of the country.

More detailed maps were prepared through the NSMLUP (MoA, 1995) where land suitability code was assigned for each soil mapping unit. These maps were based on criteria of land quality including soil physical and chemical properties, rainfall and temperature and land capability. Suitability rating was coded for different land utilization types (LUT) including rainfed arable, rainfed trees, irrigation, forest and rangeland with controlled grazing. The whole approach was based on biophysical factors and did not implement socio-economic aspects and or possible scenarios of policy and land use planning options. More detailed studies and research (Makhamreh, 1996; Harahsheh *et al.*, 1998; Mazahreh, 1998; Al-Rashdan, 1999; Al-Shoubaki, 1999; Ziadat, 2000; Al-Bakri, 2005 a&b) were carried out for different parts of the country at detailed and semi-detailed levels. In addition the Higher Council for Science and Technology (HCST)/ Badia Research and Development Center (BEDC) produced thematic maps for the Azraq basin (17000 km<sup>2</sup>). Also provided a potential land use digital map based on the thematic approach. Results from these studies indicated an obvious shift between existing and potential land use, the fact that emphasizes the urgent need for sustainable land use options and policy.

Figure 13: Potential land use in Jordan (after Taimeh, 1989).

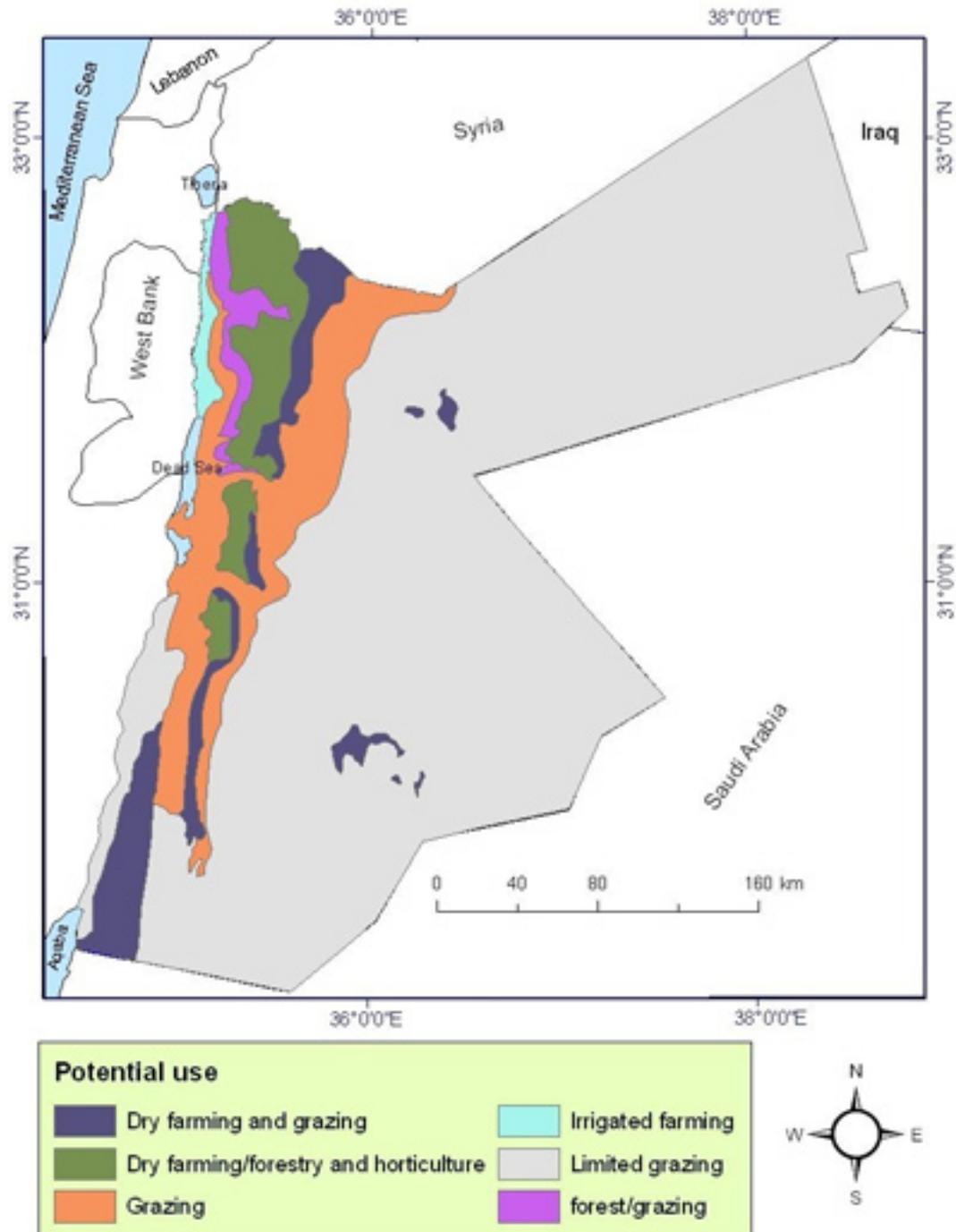
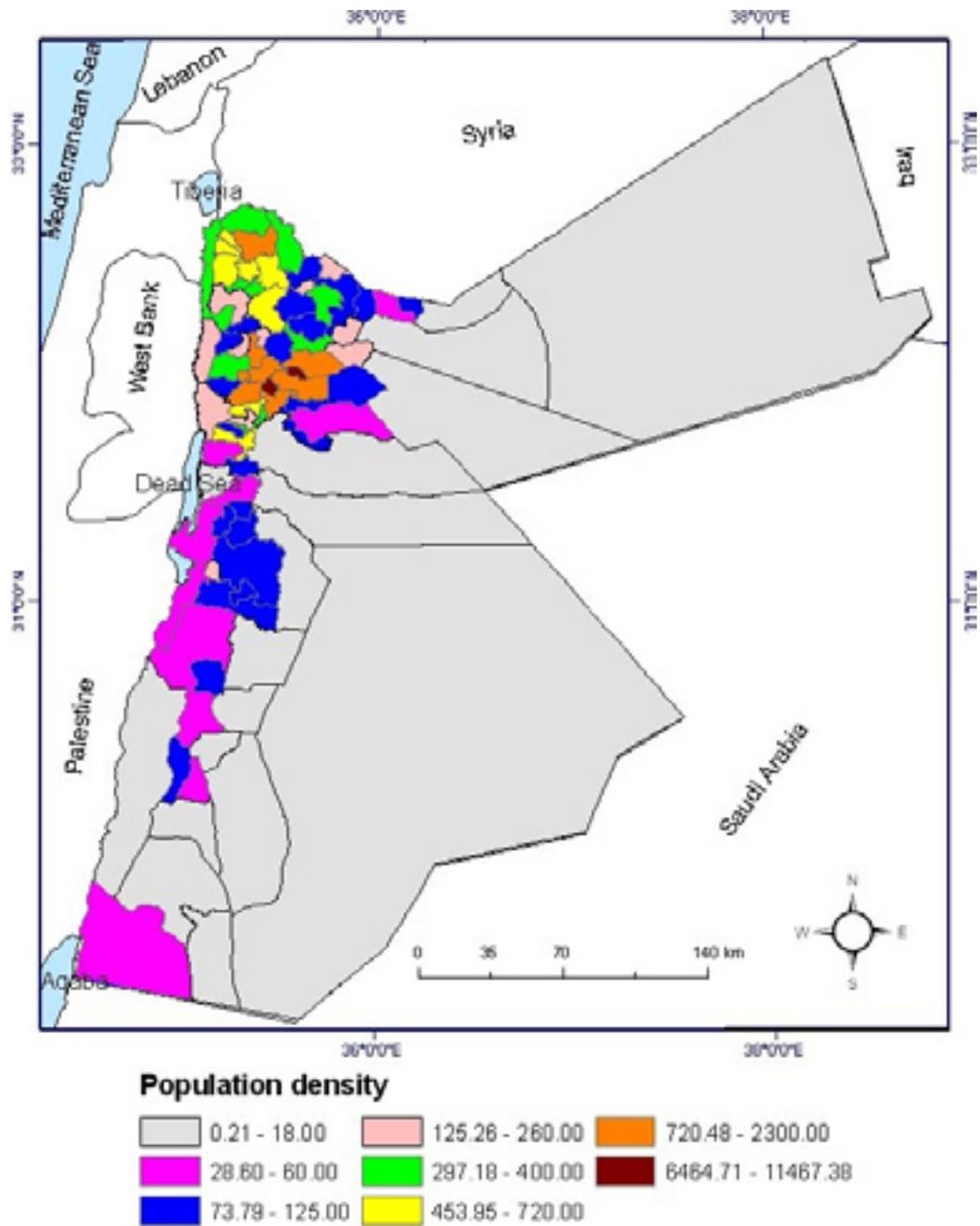


Figure 14: Population Density per square kilometer .



## 3. Socio-economic characterization

### 3.1 Demography

The population in Jordan is characterized by a high rate of birth. The Statistical Year Book of 2003 showed that the population of Jordan in 1994 was 4.139 million (census results). The figure increased to 5.35 millions in 2004 (census results). The crude birth rate for the years 1994 and 2001 were 32 and 28 per thousand, respectively. The rate of natural population increase dropped in the same period from 2.7 to 2.3%. The same period witnessed similar drop in the population growth rate from 3.3 to 2.8% but, obviously, the percentages of actual growth rate were higher than the corresponding figures of natural growth rate due to influx of refugees (major waves in 1948 and 1967), as well as Jordanian expatriates during the 1991 Gulf War, and non Jordanian labourers from the Gulf region.

As in many developing countries, Jordan's demographic transition began with the sharp fall in mortality rates, especially infant and child mortality that followed the end of World War II. This decline was caused largely by improvements in nutrition, medicine, and public health – in particular, expanded programmes for immunization against infectious disease, and improved access to safe water, sanitation, and health services. Infant mortality, which stood at the alarmingly high rate of 160 per 1000 live births in 1950, was roughly halved by 1970 and again by 1985, and now stands at just over 20 per 1000 live births (UN Population Prospects 1950–2050, 1998 Revision).

Mortality in all age groups also declined, leading to increase in life expectancy in Jordan by more than 25

years. From 1950 to 1995, life expectancy for men rose from 42.2 to 68.9 years, and for women from 44.3 to 71.5 years. Jordan's fertility declines were relatively slow to follow its mortality declines. Mortality was already falling in the 1950s, but fertility did not begin to decline until 1970, when the total fertility rate (the number of children a woman could expect to have in her lifetime given current age-specific fertility rates) was about 7.8. The fertility rate declined by nearly 50 per cent over the ensuing 25 years, and is currently at a still-high 4.1 children per woman. The fertility rate is projected to fall to just over two children per woman by the year 2025 (UN Population Prospects 1950–2050, 1998 Revision). However, 'population momentum' will sustain population growth, even when fertility has declined to replacement levels. This momentum occurs because, although on average each woman will have fewer than two children, the number of women reaching childbearing age constitutes a large proportion of the total population. So the crude birth rate, averaged over the total population, will remain high.

Due to the high population growth rate, large percentages of the Jordanian citizens are concentrated in the ages less than 9 years (27.6%). Those who are less than 19 years comprise more than half the population (50.5%). Such a high percentage imposes heavy economic burden on Jordanian families as shown by the statistics of the percentage of the working age group of 15–19 year old (study ages) to be 4.9% of the total working groups of all ages.

Although the country has relatively small population, however distribution and density are two main problems related to population in Jordan. Two million people live in Amman Governorate. About 55% of them live in Central Amman area with an area of only 48 km<sup>2</sup>, which gives the highest population density in Jordan of more than 11,460 persons per km<sup>2</sup>. Next to that comes Zarqa Governorate with population density of more than 6,460 persons per km<sup>2</sup>. To the contrary, the lowest population density is that in Ma'an and Mafraq Governorates where population density in Jafr area reaches 1 person per 5 km<sup>2</sup> and in Ruwaished area is 1 person per 3 km<sup>2</sup>.

The high population densities in the relatively most fertile land of highlands extending from Irbed area in the north to Karak area in the mid-south (Figure 14), on one hand, and the demographic imbalances on the other hand, had imposed serious stresses on land quality of a country characterized by aridity. Such stresses are manifested by continuous degradation of the land quality.

### Facts and Figures

GDP	\$9.94billion (2003).
(Among the major stakeholders)	
Annual GDP Growth Rate:	5.1% (2003)
Currency:	Jordanian Dinar (JD)
Exchange Rate:	0.708 JD = US\$ 1.00
Inflation Rate:	3.2% (2003)
External Debt:	77.1% of annual GDP
Population Growth:	2.5 % (2004 Census)
Poverty:	30% of families (2003)
Unemployment:	12.5% (2004)

## 3.2 Economic Development

Unemployment is considered a fundamental obstacle for social economical development. The government of Jordan has undertaken some broad economic reforms in a long-term effort to improve living standards. These measures have helped in improving economic productivity and have put the country on the foreign investment map. The main challenges facing the country are reducing dependence on foreign grants, reducing the budget deficit, and creating investment incentives to promote job creation.

While the population growth rate of Jordan is rapid, the growth rate was compounded by the successive waves of refugees that have come into the country as a result of a series of conflicts in the region. The impact of these sudden increases of population, where people have always lived in conditions of limited natural resources, has put severe stresses on the social, economical, political and environmental sectors of the country. More recently, Jordan has maintained a wide-ranging programme of economic restructuring and reform developed in co-operation with the International Monetary Fund and the World Bank. Economic stability at the macro level has been restored and the debt burden is more manageable than it was five years ago. However, there are increasing concerns about economic stagnation and overall economic growth rates which are not encouraging. Unemployment is a persistent and growing problem and poverty levels remain unacceptably high. Within the region, Jordan's comparative advantage continues to rest with its highly developed human resources, world class tourist attractions, stable government, and clear commitment to market-oriented economic reform.

With a Human Development Index of 0.729 in year 2004 and an adjusted real GDP per capita of \$ 4977.44, Jordan is ranked among the group of countries with Medium Human Development Indexes. Table 6 shows a selection of development indicators for Jordan from the UNDP Human Development Report of 2004.

With the aim of addressing the economic situation in the country, the government has embarked upon a three year adjustment programme for the years 1999–2001. The programme has the following objectives: economic growth of 4% per year; rescheduling of Paris Club Debt; tariff reduction on imports; faster privatization; lower budget deficit; control of inflation, stability of the Jordanian Dinar and higher reserves at the Central Bank.

### 3.2.1 Economic Liberalization

The government has also liberalized the trade regime sufficiently to secure Jordan's membership in the WTO

(2000), a free trade accord with the US (2000), and an association agreement with the EU (2001) as well as similar agreement with other Arab Countries. On the other hand, the US-led war in Iraq in 2003 created an economic blow to Jordan, which was dependent on Iraq for discounted oil price (worth \$300–\$600 million a year). Several Gulf nations have provided temporary aid to compensate for the loss of this oil; when this foreign aid expires, the Jordanian government has pledged to raise retail petroleum product prices and the sales tax base.

**Table 6:** Selected Development Indicators for Jordan from the UNDP Human Development Report, 2004.

No.	Item	Indicator
1	Human Development Index	0.750
2	Population (million)	5.35
3	Annual population growth rate (%)	2.1
4	Population with sustained access to improved sanitation (%)	99
5	Per capita GDP (US\$)	4,220
6	HDI Ranking	90
7	Life expectancy (years)	70.9
8	Infant mortality rate per 100,000	27.0
9	Health expenditure per capita (US\$/annum)	412
10	Gender related development index	0.734
11	Military expenditure (% of GDP)	8.4
12	Public Expenditure on education ( % of GDP)	4.6
13	Public Expenditure on health (% of GDP)	4.5
14	Adult literacy rate (%)	90.9
15	Internet users (per 1000)	57.7
16	Cellular subscriber (per 1000)	229
17	Population with less than 2.0 US \$/ day (%)	7.4
18	ODA received as % of GDP	5.7

### 3.2.3 Demographic Profile

As mentioned in section 3, the population of Jordan has reached 5.35 million by the end of 2004 (DOS, 2004 census) with a population growth of 2.5%.

Due to the high population growth rate, large percentage of the Jordanian citizens is concentrated in the age's demographic profile less than 9 years (27.6%). Those who are less than 19 years comprise more than half the population (50.5%). Such a high percentage imposes a heavy economic burden on Jordanian families as shown by the statistics of the percentage of the working age group of 15-19 year old (study ages) to be 4.9% of the total working groups of all ages. In

addition, about 70% of the population is below the age of 30.

### 3.2.4 Sources of Income

Jordan's economy has traditionally focused on its natural resources of phosphates, potash, and fertilizer derivatives as well as tourism and foreign aid. Jordan's government plans to reinvigorate economic growth by focusing on information technology (IT), the Qualified Industrial Zones (QIZ) and the Aqaba Special Economic Zone (ASEZ), and expanding tourism. Table 7 shows the percent employed Jordanians by economic activity for the year 2003.

**Table 7:** Percent Distribution of Employed Jordanian Age +15 Years by Economic Activity, 2003.

Economic activity	%
Agriculture	3.55
Mining and Quarrying	1.26
Manufacturing	12.37
Electricity, Gas and Water	1.66
Constructions	6.37
Wholesale and Retail Trade	17.81
Hotels and Restaurants	2.45
Transport, Storage and Communications	9.98
Financial Intermediation	1.76
Real Estate, Renting and Business Activities	3.53
Public Administration	16.62
Education	11.65
Health and Social Work	4.67
Other Community activities	5.61
Private Households with Employed Persons	0.35
Extra-Territorial Organizations and Bodies	0.32
Total	100

Source: Department of Statistics, [www.DOS.gov.jo](http://www.DOS.gov.jo)

### 3.2.5 Urbanization

The population of Jordan is highly urban. In 1952, only 39.6% of Jordan's population lived in urban areas. By 2002, the figure had reached 78.7% which is largely a result of internal rural – to- urban migration, combined with the influx of refugees and migrants, mainly from Palestine and Iraq. The urban population within Amman, Irbid and Zarqa governorates now account for 3.378 millions of people, equaling 63% of the total population of Jordan.

### 3.2.6 Unemployment

The unemployment rate in 2004 was 12.5%; decreasing from 14.5% in 2003 and 18.8% in 1993. Percentage of women's participation in the labor force is 11.2% in 2003 (up from 6.7% in 1979, 9% in 1987, and 6.6% in the period 1991-1994). Women account for around 13.8% of total employed persons.

### 3.2.7 Health

Jordan's total expenditure on health, based on the latest available statistics, is estimated at \$ 325 million, around 9% of total GDP. About \$168 million of this constitutes government expenditure on public health. The average per capita spending is around \$1,657 per year. Jordan's health care system is regarded as one of the best in the region. Jordan is striving to become a medical hub for the Middle East by offering relatively high-quality care at comparatively inexpensive rates.

### 3.2.8 Poverty

According to the World Bank, the poverty line in 2004 was 392.0 JD/person/month which included about 733,000 citizens while the poverty incidence was 14.2% down from 21.3% in 1997.

### 3.2.9 Selected International Rankings

Jordan's ranking improved substantially in the Global Competitiveness Index (from 44/80 In 2002 to 34/102 in 2003), and in the Business Competitive Index (from 53/80 in 2002 to 41/101 in 2003). The main strengths of the Jordanian economy lie in the quality of the educational system(27/102); the availability of scientists and engineers, where Jordan outranks Singapore (12/102); infrastructure quality, (23/102); judicial independence (23/102); efficiency of legal framework (29/102); protection of minority shareholder interests (19/102);and intellectual property protection (22/102).

### 3.2.10 MDG Indicators

In 2000, a total of 189 political leaders in the world gathered for their countries to collectively sign and endorse the Millennium Development Goals. The MDGs consist of 8 time-bound and measurable goals that cover all sustainable development aspects. The 8 goals are further divided into 18 targets and measured by 48 indicators. The MDGs use the 1990 data as baseline for the purpose of attaining the goals by the year 2015.

The MDGs encapsulate people's basic aspirations for a better life. Between 1990 and 2015 countries have agreed to halve extreme poverty and hunger, achieve universal primary education, promote gender equality, reduce under-five mortality by two thirds, cut maternal mortality by three quarters, combat HIV/ AIDS, malaria and tuberculosis, ensure environmental sustainability and build a global partnership for development.

The Jordan first MDG report published in 2004 has documented the progress towards meeting the MDGs in Jordan. Table 8 illustrates the level of achievement as stated in the Jordan MDGs report.

**Table 8:** Level of achievement of MDGs in Jordan.

Goals	Targets	State of Achievement in 2004
1. Eradicate extreme poverty and hunger	1. Halve, between 1990 and 2015 the proportion of people whose income is less than one dollar a day	On Track
	2. Halve, between 1990 and 2015 the proportion of people who suffer from hunger	On Track
2. Achieve universal primary education	3. Ensure that by 2015 children everywhere, boys and girls alike, will be able to complete a full course of primary schooling	On Track
3. Promote gender equality and empowerment of women	4. Eliminate gender disparity in primary and secondary education preferably by 2005 and in all levels of education no later than 2015	On track except for proportion of seats held by women in parliament
4. Eradicate child mortality	5. Reduce by two-thirds, between 1990 and 2015 the under five mortality rate	On track, except tuberculosis
5. Improve maternal health	6. Reduce by three-quarters, between 1990 and 2015, the maternal mortality ration	On track, except for maternal mortality per 100,000 live births.
6. Combat HIV/ AIDS, Malaria and other diseases	7. Have halted by 2015 and begun to reverse the spread of HIV/ AIDS	Strong
	8. Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases	Strong
7. Ensure environmental sustainability	9. Integrate the principles of sustainable development into country policies and programmes	Potentially
	10. Halve by 2015, the proportion of people without sustainable access to safe drinking water	Achieved
	11. Have achieved by 2020 a significant improvement in the lives of at least 100 million slum dwellers	Potentially
8. Developing a global partnership for development	Jordan is facing the challenge of Goal 8 by working both on external relations and in internal policies. Government's commitment is strong on the modernization of the economic and legal frameworks and the tax system. Yet, more efforts have to be made in order to achieve more effective roles and functions of all the stakeholders within the development process.	

### 3.3 Administrative Structure

#### 3.3.1 General Environmental Profile

Problems of water supply and demand are at the forefront of environmental concerns, with some groundwater aquifers being exhausted beyond natural recharge rates (causing quantity and quality concerns). Moreover, surface water supplies are inadequate in terms of quality and quantity (causing health and welfare concerns). Problems of biological diversity and habitat protection, desertification, as well as the promotion of eco-tourism need to be addressed. Air pollution and solid waste management efforts need much financing to be effective.

The solutions to some of these environmental problems poses a resource's financial and technical burden. Jordan remains, however, one of the leading countries in the region to adopt comprehensive environmental protection measures.

In the midst of such political interest and will, there remains much to be achieved to alleviate pressure on the country's environmental resources. Jordan has embarked on numerous national level activities to protect, rehabilitate, and enhance the major elements of the environment, including water resources, air quality enhancement, and solid waste management. Jordan is one of the leading countries in the region to have adopted an Environmental Strategy. The 1992 Environmental Strategy paved the way for the Environment Law No. 12 (ratified in 1995) and created the General Corporation for Environmental Protection (GCEP). Both the Strategy and the Environment Law were followed by a National Environment Action Plan (NEAP) completed in 1995. In 2003, the Ministry of Environment was created based on the Environmental Protection Law No. 1 for 2003.

#### 3.3.2 Sector and Issue Analysis

The **Industrial Sector** shows a significant growth, a considerable expansion in industrial cities and centers, with a well-established infrastructure. Nevertheless, this sector is facing challenges in competitiveness in the world markets regarding quality, cost and environmental performance. Data shows that industry in Jordan consumes around 32% of the energy resources. However, persistent efforts for enforcing international environmental paradigms (e.g. ISO 14001) are a major goal of the environmental agenda in Jordan. Jordan has developed nascent activities for cleaner production but an effective system of enforcement and incentives for sustainable industries is not yet in place.

The **Agricultural Sector**, although low in its contribution to the GDP but with consideration value added, it is still looked at as the main source for rural development, as well as its role in employment and food security, the social and demographic role it plays. However, the increased use of pesticides and/or chemical fertilizers in agricultural practices still represents a major threat to natural resources of soil, groundwater and human health. Due to the scarcity of water, the agricultural sector is expected to undergo a substantial structural review in the next few years.

The **Transportation Sector** consumes around 40% of the energy resources. The network of roads which extends approximately 7,519 Km, ensured accessibility to all parts of the Kingdom linking urban and rural areas with the main cities and centers. It is evident that the level of pollution with increasing demand on fuel has probably become higher. Strong enforcement of environmental laws is still under-utilized.

The **Energy Sector**, is dependent on Imports with its cost in specific years reaching half the yield obtained from exports. It is estimated that the major import in the near future will be in the energy sector. The annual growth of energy consumption is 4% while the cost of energy supply is around 5% of GDP.

The **Housing Sector** has major focus on the urban areas, and less on the rural areas, whilst marginal houses are deprived of the hygienic and safety measures needed, in terms of location and conditions. Up to 99% of the population is served with potable water supply network, while about 55% are served by the public sewage system. In addition, 96% of the houses are linked to electricity supply, 40% of the houses use solar heaters and there is an escalating demand on this technology.

Regional development of the Kingdom has been the focus of many recent development plans. The plan divides Jordan into three regions (north, middle and south). Around 63% of Jordanians live in the Middle Region due to the concentration of economic activities and the availability of services. On the other hand, only 9.4% of Jordanians live in the Southern region while 27% are living in the North. Balanced regional development is considered as a must for effective and just mechanisms of beneficitation aiming to minimize environmental and social consequences of concentrating development in the Middle.

**The Health sector** has witnessed a remarkable expansion in building hospitals and health centers. Health problems in Jordan arise mainly from water pollution and weak coverage of the sewerage system, and increasing incidence of air pollution.

**The education and training sector** is also witnessing a continuous increase in the percentage of school children and university students as well as high number of postgraduates. There has been a welcome interest in the environmental education process where environmental concepts are integrated into the school curricula. This is, however, accompanied by a high rate of unemployment in university graduates up to 24% (2004).

In addition to the challenges posed by human population growth and pressure exerted on scarce natural resources, Jordan bears the responsibility of credible implementation of international environmental

agreements and conventions it has signed and ratified. The government's interest in applying environmental policies is on the rise with the establishment of a coherent legislative and institutional frame work especially in the adoption of the environmental protection law no. 12 for 1995 and the establishment of the Ministry of Environment.

**Land Resources.** Due to a lack of proper land management, the natural landscape is seriously degraded in areas of uncontrolled urban expansion, mining sites, overused grazing lands, improperly irrigated farm lands (with a resulting increase in soil salinity), and over-harvested forest lands. Given the harsh and arid climate of Jordan, degraded lands in rural areas are generally highly susceptible to soil erosion and/or desertification. Secondary impacts include loss or destruction of habitat for wildlife, which has a major national and international significance for biodiversity.

### 3.3.3 Environmental Management in Jordan

With these environmental issues at the forefront of concerns, great efforts are being exerted. The Government of Jordan, represented by the Ministry of Planning as the prime body responsible for strategic planning and coordination with the Ministry of Environment and Ministry of Finance, (as the prime body responsible for fiscal policy) have decided that debt-swap for environment is a viable option for Jordan. However, these efforts require backstopping, support, and follow-up to be able to meet the increasing focus on the environment sector, either by local institutions or international agencies. To respond to Jordan's keenness in adopting international environmental agreements and conventions, the donor community is being asked to convert part of Jordan's debt to environmental projects executed in-country.

The Government of Jordan has long prioritized its most pressing problems as being the scarce water resources and land degradation. Accordingly, all

relevant ministries, government agencies and other organizations address at various levels these issues.

### A. Governmental Agencies

1. Ministry of Environment
2. Ministry of Agriculture
3. Ministry of Municipal and Rural Affairs
4. Ministry of Water and Irrigation
5. Water Authority of Jordan
6. Jordan Valley Authority
7. Ministry of Energy and Mineral Resources
8. Natural Resources Authority
9. Aqaba Special Economical Zone Authority (ASEZA)
10. Ministry of Planning and International Cooperation.
11. The Hashemite Fund for Badia Development (HFBD)

### B. Semi-Governmental and Research institutes

1. Higher Council for Science and Technology
2. The Royal Scientific Society
3. Research Centres at Jordan Universities
4. Queen Rania Centre for Environmental Research- Jordan University of Science and Technology
5. Badia Research and Development Centre (BRDC)

### C. Non-Governmental Organizations

1. The Royal Society for the Conservation of Nature.
2. Jordan Environment Society.
3. The Jordanian Society for Desertification Control and Badia Development.
4. The Royal Marine Conservation Society of Jordan.
5. Friends of the Environment.

Jordan is one of the 30 original supporters of the World Conservation Strategy, which encouraged countries to prepare a national environmental strategy and provided a framework to that effect. Jordan was the first country in the Middle East to complete a national environmental strategy that includes recommendations for strengthening environmental protection in four strategic areas: establishing a legal framework for environmental management; strengthening two key institutions i.e. Ministry of Environment and the Royal Society for the Conservation of Nature, creating new and upgrading existing protected areas; and strengthening environmental awareness among the public. The strategy aims at sustainable management of natural resources including water, soil, and plant cover, as well as the biological diversity of various flora and fauna in their different agricultural environments. The strategy also aims to maintain the productivity of environmental systems, especially forests, grazing land and agricultural land. However, few activities have taken place since the publication of the strategy.

On 21<sup>st</sup> October 1996, the Government of Jordan ratified the Convention to Combat Desertification, which entered into force on 16<sup>th</sup> December 1996. Jordan prepared and organised awareness campaigns and workshops to initiate the preparation of the National Action Plan. The General Corporation for Environment Protection (now the Ministry of Environment) was assigned for the CCD programme and will act as the National Co-ordinating Body (NCB), with a national focal point appointed from the Land Protection Division. In addition, the Ministry of Agriculture has published its Agricultural Policy that included measures to prevent land degradation. The recently prepared National Strategy for Agricultural Development (The Advisory Economic Council, 2002) for the decade 2000–2010 stressed on sustainable agriculture and protection of natural and biological resources. The Strategy proposed the following programmes:

1. Evaluation and sustainability of resources productivities: This programme entailed several projects of which are survey and classification of soils, soil fertility conservation, watersheds development, and human resources development in land use planning,
2. Conservation of biodiversity. This programme focused on the establishment of additional natural reserves,
3. Reclamation of rocky lands,
4. Development of environmental databases and systems,
5. Monitoring environmental changes; This programme comprises two projects on monitoring vegetative cover and studying biodiversity and prioritisation of treatment of environmental degradation,
6. Watershed management in wadis overlooking the Jordan Valley,
7. Watershed management programmes in the central and northern parts of Jordan,
8. Improved irrigation management,
9. Improvement of dryland farming systems,
10. Optimization of small land holdings,
11. Barley intercropping with forage crops and cactus,
12. Encouragement of pistachio growing,
13. Forest development,
14. Development of agricultural production systems in conjunction with water harvesting and reclaimed water usage.

In 1999, Jordan prepared its National Agenda 21 document under the patronage of the General Corporation for Environment Protection and UNDP assistance. The document outlines several key areas related directly to natural resources and dryland issues and promotes the participatory approach at all levels to ensure success and sustainability. The Agenda also *reflects the integrated approach to environment and development and converges with objectives of poverty alleviation and sustainable human development*. Thus,

Agenda 21 outlines a multi-disciplinary national plan of action for an environmentally sound and sustainable economic development. The *Agenda 21 demonstrates an umbrella document that identifies combating desertification as a national priority* and promotes its integration into the national policy and calls for the involvement of all stakeholders in the implementation of proposed programmes and actions. These include:

1. Rangeland resources,
2. Desertification,
3. Forest resources,
4. Irrigation water,
5. Science and technology for sustainable agriculture
6. Data gathering, managing and networking,
7. Land use policy and legislation and enforcement.

In line of Agenda 21, the UNCCD puts concerns for human welfare at the centre of national efforts to combating desertification with linkages between desertification, socio-economic factors as poverty and food security, migration and demographic factors. As such, integrated and harmonized efforts at the national level and with the participation of all concerned to address desertification and dry land management issues are underway although no concrete measures have yet been taken.

### **3.3.4 Institutional Framework and Arrangements**

In January 2003, the Ministry of Environment (MoE) was established as an entity with the aim to promote protection of the environment, improve its various elements, and to execute this strategy in co-operation with the relevant authorities. As such, all relevant environmentally related matters come under its jurisdiction. The ministry has the legal position to act in all procedures.

Of direct relevance to desertification, Article 4 paragraphs D and Article 23 paragraphs A/10 of the temporarily Law of Protection of the Environment No. 1 (2003) which stipulate that the ministry will address and control sources of soil pollution and ascertain and act upon reasons for soil slides and desertification. In 2005 the soil protection bylaw was issued by the Ministry of Environment.

Contribution to the relevant legislations was also included in Article 19 paragraphs A and B of the former Law of Protection of the Environment No. 12 (1995). The MoE being the assigned National coordinating body of the CCD (the focal point) shall co-ordinate the different activities related to combating desertification.

### 3.3.5 Difficulties facing Environmental Management in Jordan

There are several difficulties and obstacles facing proper implementation of environmental management programmes in Jordan, these are divided into institutional, technical and legislative problems.

#### Institutional:

1. Overlapping and duplication of duties in several governmental agencies with regard to environmental concerns,
2. Narrowness of the concept of «Desertification» in several institutions,
3. Weakness of private sector activities in the field of combating desertification,
4. Lack of proper instruments for monitoring and inspection,
5. Weak reaction by major environmental institutions to the commitment of Jordan to the international conventions.

#### Legislative:

1. Sectoral legislations have not been updated and are ineffective to take into consideration emerging concerns such as desertification,
2. Diversity of legislations governing other sectors and their inter-contradiction in some cases and duplication and overlapping in authorities,
3. Weak enforcement of the articles related to environment conservation and combating desertification,
4. Legislation is far behind the economic, social and environmental change and progress,
5. Lack of cohesion and integration between sector legislation addressing desertification,
6. Presence of several gaps in legislation regarding desertification,
7. Lack of flexibility of legislation and the need to amend it in coordination with Jordan's commitment to international agreements,
8. Weakness of legal advocacy in dealing with desertification issues,
9. Lack of compatibility between national legislation and global environmental law regarding desertification, causes and consequences,
10. Weakness of coordination between legislator and the technician in what's related to law formulation and revision.

#### Technical:

1. The need for technical capacity building to address desertification concerns,
2. Environmental standards and guidelines for addressing desertification are not complete and suffer from several technical gaps,
3. Weak monitoring of environmental quality indicators,

4. Weak auditing programmes for corporations and facilities to ensure environmental/anti desertification compliance,
5. Lack of an environmental/desertification information system,
6. Lack of simplified knowledge of desertification and its relation to social and economic status,
7. Limited professional human resources profile in public environmental institutes,
8. Weak contingency plans dealing with environmental dangers and desertification consequences,
9. Limited participation from the private sector to address desertification concerns,
10. Limited applied research in the science of desertification in academic institutions and weak linkages between research and policy making,
11. Lack of incentives for applying modern environmental/anti desertification management methods,
12. Lack of adequate instruments for monitoring and measuring environmental/combating desertification quality.

In addition to the above difficulties, financial resources are limited and in many cases result in widening the gap between legislation and implementation.

## 4. Legislative framework

Jordan can be considered a committed country towards environment and conservation of natural resources. Which has signed and ratified many international environment agreements and become party to: biodiversity, climate change, climate change-kyoto protocol, desertification, endangered species, hazardous wastes, law of the sea, marine dumping, ozone layer protection and wetlands.

At the country's level, many laws and legislations pertinent to the environment were issued and approved by the government. This part of the NAP will summarize most of the legislations related to land degradation and conservation of land resources. Important omissions, contradictions and in some cases disincentives regarding combating desertification and land degradation.

### 4.1 Environmental Protection Law

The primary environmental legislation is Law No. 1 of 2003 which has substituted the Environmental protection law 1995. The law has identified environment, its components, pollution and deterioration, preservation and protection. Based on the Environment protection law, the Ministry of Environment (MoE) became responsible for issuing the necessary regulations for the implementation of the provisions of this law including regulation of nature protection, water protection, environmental impact assessment, and land and soil protection. The most important tasks of the MoE included the formulation of public policy for the protection of the environment, and preparation of the plans, programmes, and projects,

necessary for the realization of sustainable development. In addition, the MoE is responsible for monitoring and measuring the environment elements and components and coordinating all the national efforts, aimed at preserving the environment.

As a result of the law of environment, the soil protection bylaw was issued in 2005 in accordance with law No.1. In this bylaw, land degradation processes included soil pollution, erosion and desertification. Some plans for protecting land were also included in this by law. The by law explicitly included future plans to combating desertification and decreasing drought effects by all possible means. Observing the causes of soil erosion and desertification, taking effective measures to protect soil and stop desertification and adoption of a national plan to combat desertification (within the UNCCD framework) were the most important proposed future plans of the MoE.

### 4.2 Classification of Jordan Legislations

Environmental legislation relevant to desertification can be categorized as follows:

#### 4.2.1 Desertification

- Environmental Law No. 1 of 2003. Ministry of Environment.
- Agriculture Law No. 44 of 2002. Ministry of Agriculture.

#### 4.2.2 Urbanization and Human Settlements

- Public Housing and Urban Development Law No. 28 of 1992. Public Housing and Urban Development Corporation.
- Management and Administration of Government Properties Law No. 17 of 1974. Finance Ministry

#### 4.2.3 Land Use Planning

- Law of Organization of Cities, Villages and Buildings No. 79 of 1966. Prime Minister.
- Public Housing and Urban Development Law No. 28 of 1992. Public Housing and Urban Development Corporation.
- Jordan Valley Law No. 19 of 1988. Jordan Valley Authority.
- Building, Cities and Villages Organization By-law No. 19 of 1985. Greater Amman Municipality.
- Building and Organization of the City Amman No. 67 of 1979. Greater Amman Municipality.

#### 4.2.4 Soil and Agricultural Land

- Environmental Law No. 1 of 2003. Ministry of Environment.
- Soil Protection bylaw 2005.
- Management of Natural Resources Law No. 12 of 1968. Natural Resources Authority.
- Agriculture Law No. 44 of 2002. Ministry of Agriculture.
- Management and Administration of Government Properties Law No. 17 of 1974. Finance Ministry.
- Jordan Valley Authority Law No. 19 of 1988. Jordan Valley Authority.
- Law of Organization of Cities, Villages and Buildings No. 79 of 1966. Prime Minister
- Jordanian Specification JS 1145/ Sludge. 1996. Water Authority

- Civil Defense Order No. 1: The Protection of Forestry in Jordan. 1993. Civil Defense

#### 4.2.5 Biodiversity

- Environmental Law No. 1 of 2003. Ministry of Environment.
- Natural reserves and National Parks bylaw 2005
- Agriculture Law No. 44 of 2002. Ministry of Agriculture.
- Law of Organization of Cities, Villages and Buildings No. 79 of 1966. Ministry of Agriculture and Local Committee.
- Protection of Birds and Wild Life By-law No. 113 of 1973. Royal society for the Conservation of Nature.
- Decision No. 1/ 5 for Cattle farms, 1990. Ministry of Agriculture.
- Decision No. 2/ 5 for Sheep farms, 1990. Ministry of Agriculture.
- Decision No. 3/ 5 for Rabbit farms, 1990. Ministry of Agriculture.
- Decision No. 4/ 5 for Fish Farms, 1990. Ministry of Agriculture.
- Decision No. 4/ 5 for Poultry Farms, 1990. Ministry of Agriculture.
- Decision No. 1/ T for Registration of Animal Feed Centers, 1996. Ministry of Agriculture.
- Civil Defense Order (Decision) No. 1 for the Protection of Forestry, 1993. Civil Defense.

#### 4.2.6 Pesticides and Fertilizers

- Agriculture Law No. 44 of 2002. Ministry of Agriculture.
- Jordan Specification JS 917/ Pesticides-Sulphur Dusting Powder, 1992. Ministry of Agriculture.
- Jordan Specification JS 962/ Fertilizers–Organic Fertilizer, 1993. Ministry of Agriculture.
- Jordan Specification JS 778/ Fertilizer–Solid

- Compound Chemical Fertilizer, 1991. Ministry of Agriculture.
- Jordan Specification JS 769/ Pesticides–Winter Agriculture Spraying Oils, 1991. Ministry of Agriculture.
  - Jordan Specification JS 767/ Pesticides–Summer Agriculture Spraying Oils, 1991. Ministry of Agriculture.
  - Jordan Specification JS 527/ Aerosol, 1987. Ministry of Environment.
  - Jordan Specification JS 336/ Fertilizers–Potassium Nitrate Fertilizer, 1984. Ministry of Agriculture.
  - Jordan Specification JS 334 Fertilizers–Basic Slag (Iron slag) Fertilizer, 1983. Ministry of Agriculture.
  - Jordan Specification JS 332/ Fertilizers–Calcium Nitrate Fertilizer, 1983. Ministry of Agriculture.
  - Jordan Specification JS 249/ Ammonium Sulphate Fertilizer, 1982. Ministry of Agriculture.
  - Jordan Specification JS 290/ Diamonium Phosphate Fertilizer, 1982. Ministry of Agriculture.
  - Jordan Specification JS 39/ Fertilizers–Normal Superphosphate Fertilizer, 1977. Ministry of Agriculture.
  - Jordan Specification JS 344/ Triple Superphosphate Fertilizer, 1984. Ministry of Agriculture.
  - Jordan Specification JS 339/ Fertilizers–Determination of the Water Soluble Magnesium Content, 1984. Ministry of Agriculture.
  - Jordan Specification JS 337/ Fertilizers–Determination of the Water Soluble Potassium Content in the Potassium Fertilizers, 1983. Ministry of Agriculture.
  - Jordan Specification JS 338/ Fertilizers–Determination of Chlorides in the Absence of Organic Material, 1983. Ministry of Agriculture.
  - Jordan Specification JS 330/ Calcium Ammonium Nitrate Fertilizer, 1983. Ministry of Agriculture.

- Jordan Specification JS 432/ Methods of Sampling for Fresh Fruits and Vegetables intended for Analysis of Pesticides Residues, 1985. Ministry of Agriculture.
- Jordan Specification JS 328/ Ammonium Nitrate Fertilizer, 1983. Ministry of Agriculture.

#### 4.2.7 Water, Wastewater and Sewage

- Water Authority Law No. 18 of 1988. Water Authority.
- Law of Organization of Cities, Villages and Buildings No. 70 of 1966. Local Committee.
- Public Health Law No. 21 of 1971. Ministry of Health.
- Prevention of Repulsive and Fees for Solid Waste Collection within Municipality's Boundaries No. 1 of 1978, Municipalities.
- Sewage By-law No. 66 of 1994, Water Authority.
- Industrial and Commercial Waste Water Disposal into the Public Sewage No. 1 of 1998, Water Authority.
- Jordanian Specification No. 202/ Water: Industrial Waste Water of 2003, Water Authority.
- Jordanian Specification No. 893/ Water: Treated Domestic Waste Water of 2002, Water Authority.
- Environmental Law No. 1 of 2003. Ministry of Environment.
- Agriculture Law No. 44 of 2002. Ministry of Agriculture.
- Groundwater By-Law No. 85 of 2002.

#### 4.2.8 Fire

- Agriculture Law No. 44 of 2002. Ministry of Agriculture.
- Municipalities Law No. 29 of 1955. Municipalities
- Civil Defense Law No. 12 of 1959. Civil Defense

- Punishment Law No. 16 of 1960. The Court
- Organization and Management of Ministry of Energy No. 26 of 1985. Ministry of Energy
- Civil Defense Order No. 1/ Storage of Gas Cylinders. 1994. Civil Defense

#### 4.2.9 Radiation

- Environmental Law No. 1 of 2003. Ministry of Environment.
- Nuclear Energy and Prevention Against Radiation Law No. 29 of 2001. Ministry of Energy and Ministry of Environment.
- Organization and Management of Ministry of Energy No. 26 of 1985. Ministry of Energy
- Instructions for Defining Radioactive Activities No. 21 of 1990. Ministry of Energy
- Instruction for Removal of Radioactive Pollution in Laboratory Radioactive Accidents. Ministry of Energy and Civil Defense
- Instructions for Disposal of Radioactive Material. Ministry of Energy
- Instructions for Radioactive Prevention Officers No. 3 of 1990. Ministry of Energy
- Instructions for Safe Management and Disposal of Radioactive Waste No. 1 of 1997. Ministry of Energy.

#### 4.2.10 Public Health

- Public Health Law No. 21 of 1971. Ministry of Health
- Handicraft and Industries Law No. 16 of 1953. Ministry of Health and Prime Minister
- Doctors' (Medical Physicians) Association Law No. 13 of 1972. Doctor's Association
- Dentists' Association Law No. 17. 1972. Dentists' Association
- Pharmacists' Association Law No. 51 .1972. Pharmacists' Association

- Pharmacy Practice Law No.43.1972. Pharmacists' Association and Ministry of Health
- Drugs and Hallucinogens Law No. 11. 1988. Ministry of Health
- Protection of Public Health Against the Dangers of Smoking By-law No. 64. 1974. Ministry of Health.

#### 4.2.11 Cultural and Archaeological Sites

- Law of Antiquities No.21 of 1988. Archaeological Department
- Law of Organization of Cities, Villages and Buildings No. 79 of 1966. Prime Minister.
- Management of Natural Resources Law No. 12 of 1968. Natural Resources Authority
- Quarries By-law No. 8 of 1971. Natural Resources Authority.

#### 4.2.12 Energy and Mineral Resources

- Law of Nuclear Energy and Prevention Against Radiation No. 29 of 2001. Ministry of Energy.
- Management of Natural Resources Law No. 12 of 1968. Natural Resources Authority.
- Public Electricity Law No. 10 of 1996. Ministry of Energy
- Organization of the Ministry of Energy By-Law No. 26 of 1985. Ministry of Energy

#### 4.2.13 Solid Waste

- Environment Law No. 1 of 2003. Ministry of Environment.
- Public Health Law No. 21 of 1971. Ministry of Health.
- Law of Organization of Cities, Villages and Buildings No. 79 of 1966. Local Committee.

- Prevention of Repulsive and Fees for Solid Waste Collection within Municipality's Boundaries No. 1 of 1978. Municipalities.
- Jordan Specification No. 431/Storage-General Precautionary Requirements for Storage of Hazardous Materials. 1985.

#### 4.2.14 Chemicals

- Environment Law No. 1 of 2003. Ministry of Environment.
- Agriculture Law No. 44 of 2002. Ministry of Agriculture.
- Public Health Law No. 21 of 1971. Ministry of Health.
- Pharmacy Practice Law No. 43 of 1972. Pharmacists' Association.
- Civil Defense Order No. 2/ Transport of Chemicals. 1994. Civil Defense.

### 4.3 Deficiencies in Legislation

It should be noted that present legislations did not include a separate draft on desertification causes, aspects, socio-economic impacts and comprehensive plans to combat desertification. Therefore, the NAP is expected to contribute to providing the framework for combating desertification in the country. This, however, requires more authority to be given to the MoE to implement the proposed programmes of the NAP. Among the recommendations to improve the legal umbrella for the Ministry of Environment are:

- Establishment of a specialized environment court.
- Identification of the tools needed to ensure fulfillment of the country to obligations under the UNCCD.
- Encouraging the participatory approach between local communities, the governmental institutions and the NGO's.

- Strengthening local, regional and international cooperation.
- Identification of the main tasks and responsibilities of the different governmental institutions related to the UNCCD. This is important to avoid any possible duplication or interferences between institutions.
- Drafting and issuing a by-law to combat desertification.
- Creating a national center for desert research.

It is clear that the many laws related to desertification were formulated in Jordan. The assessment of the laws and regulations is beyond the objectives of NAP. However, some points can be noticed regarding these regulations:

- Much interference between the different legislations,
- Absence of compulsory legislation concerning land use, although land use policy is already formulated,
- Absence of quantitative environmental indicators and quality functions related to soils and land,
- Many of the laws were issued early last century and need revision and updating.
- Some laws directly related to environment need to be activated.



Photo by: The GEF Small Grants Programme

## 5. Desertification in Jordan

Most of Jordan's arid and semi-arid areas have suffered desertification. Although the rate of desertification was not identified, several surveys and studies at the country's level indicated that Jordan's land is at the threat of high rate of desertification. The process has been accelerated by unsupervised management and land use practices of overgrazing, cultivation and plowing of marginal soils and woodland removal in the high rainfall zones. The regions of irrigated highlands and the Jordan Valley were also affected by aspects of salinization and alkalinization of soil. In addition to human induced factors, climatic factors of irrational rainfall and periodic droughts are contributing to the problem. According to Al-Hadidi (1996), the transition zone (between arid areas in the east and sub-humid areas in the west) has suffered from a high risk of desertification and is expected to lose its productivity over time.

### 5.1 Status of Desertification

Desertification status in Jordan was investigated and tackled by few studies at the country level (Al-Eisawi, 1985; Taimeh, 1989; MoA, 1995; Juneidi, 1993). In terms of desertification status, the country can be divided into four major zones as following:

**I – Zone 1:** Includes the bioclimatic subdivisions of 7, 8 and 9 (Figure 3) and mainly restricted to the Saharo-Arabian and Sudanian Penetration areas. Land regions 2, 5, 6, 7, 12, 13, 16, 17 and eastern parts of 14 are entirely within this zone. The area witnessed high rates of desertification and reached an advanced stage of desertification and can be considered as highly desertified area. Aspects of desertification in this zone

are the absence of vegetation cover, the dominant desert pavements, the high salt contents and dominance of gypsiorthids soils (MOA, 1993). The desertification process within this zone is also accelerated by the low annual rainfall (<100 mm). At the eastern borders with Saudi Arabia, large areas are covered by sand dunes, particularly areas of Wadi Rum, Ghadeer al-Sheikh, Bayer and Mudawwara. The rest of the area is covered with desert pavement almost with no visible plant cover. Some plant species, however, can be found inside waterways.

**II – Zone 2:** Most of this zone is Steppe and located within the Irano-Turanian climate. The area includes bioclimatic subdivisions 2, 3, 4 and 5 and land regions 11 and 15. The area is considered as a transitional zone of the Badia. A previous project (JAZPP, 2000) indicated that the intensive agricultural activity of barley cultivation and irrigation is taking place in the area. The dominant aspects of desertification in this zone are the higher rates of erosion by wind and water, the substantial accumulation of calcareous silt on the soil surface, low germination rate of plants, low intensity of plant cover caused by overgrazing and poor rainfall distribution. The area is also affected by soil surface crust that accelerates erosion by water and a soil compaction problem caused by uncontrolled movement and travel of grazing herds and vehicles. Many parts of this zone, however, have a high resilience; indicated by the high recovery and productivity of the protected natural vegetation inside natural and range reserves (Al-Bakri and Abu-Zanat, 2005).

**III – Zone 3:** This zone falls completely within Mediterranean climate and includes semi-arid and

dry sub-humid zones (climatic subdivisions 1, 2 and 3) and the land regions of 8, 9 and 18. Annual rainfall in this zone is relatively high and varies from 300 mm to more than 600 mm. Existing soils are believed to be developed under humid climate which indicates that this zone has passed through a physical environmental change. Nevertheless, anthropogenic factors of woodland cutting, urbanization and land fragmentation have accelerated desertification in this zone. Currently, observed aspects of desertification includes the recession of forest areas, high rate of water erosion by water, expansion of urbanized area in the high rainfall zone, reduction in soil organic matter and soil compaction and deterioration.

**IV – Zone 4:** This zone includes the irrigated area in Jordan Valley and extends from Tiberia Lake in the north to the Dead Sea in the south. The area is different from other zones in terms of climate, soils and land management. Irrigation is the dominant land use in this zone with surface water as the main source of irrigation. Aspects of desertification in this zone are mainly the soil salinization caused by improper irrigation practices and fertilization and land abandonment in the southern areas resulted from deep plowing and mixing of underlying Marl with soil material.

Generally, the whole process of desertification in these zones is accelerated by the socio-economic factors of low income, inadequate inputs, improper management and overgrazing of natural vegetation.

## 5.2 Causes of Desertification

Generally speaking, land mismanagement and climatic factors of drought and climate change are the main causes of desertification in Jordan. Several practices are aggravating degradation in the first and the second zones. The irrational plowing, the cultivation of land for barley, the mismanagement of plant residues and the overgrazing of natural vegetation are the main causes of desertification in these zones. Causes of desertification

in the third zone include forest cutting, inappropriate land use, random urbanization, land fragmentation and over-pumping of groundwater. In the fourth zone, land degradation aspects and causes are mainly attributed to mismanagement of irrigated lands, particularly in the middle and southern parts of Jordan Valley. In addition to the above causes of desertification, a very important factor of desertification in the country is the high population growth which exerts more pressure on the natural resources to meet the demands of the increasingly growing population.

Following sections include further discussion and analysis of two important causes of desertification, namely irrational cultivation and overgrazing.

### 5.2.1 Irrational Cultivation and Irrigation

Extension of rainfed cultivation to the low rainfall zones to meet the increasing demand on food resulted in accelerated land degradation, as many of the barley-cultivated areas had low suitability to land utilization type. Irrigated cultivation on the other hand had little significance until the beginning of the 1960's. The irrigated areas were scattered around the water sources and along the streams. The expansion of irrigated farming in the eastern parts of the country, where numerous irrigation projects have been initiated, resulted in putting more land under irrigation and the risk of salinization. Originally, these projects aimed to assist in settling the Bedu and reduce the problem of food security. The increased investment in irrigation project by private sector has resulted in intensive irrigation in the low rainfall zones. This has increased stress on water resources, especially in the Badia (arid eastern parts), and resulted in overexploitation of groundwater. Extent and aspects of cultivation were discussed earlier in section 2.6.1.

Thousands of tons of poisonous chemicals (pesticides) were believed to be used in agriculture since the early 1960's. The most prominent pesticides are DDT (used until 1960s), thallium (used largely, until the 1970s),

fluroacetamids, azodrin and other chemicals (Disi and Oran, 1995; Hatough-Bouran and Disi, 1995). The unsupervised use of pesticides and chemical fertilizers is certainly expected to result in polluting soils, water resources, aquatic fauna, vegetation, birds and mammals. Eventually, negative impacts on human health and environment are expected.

### 5.3.2 Overgrazing

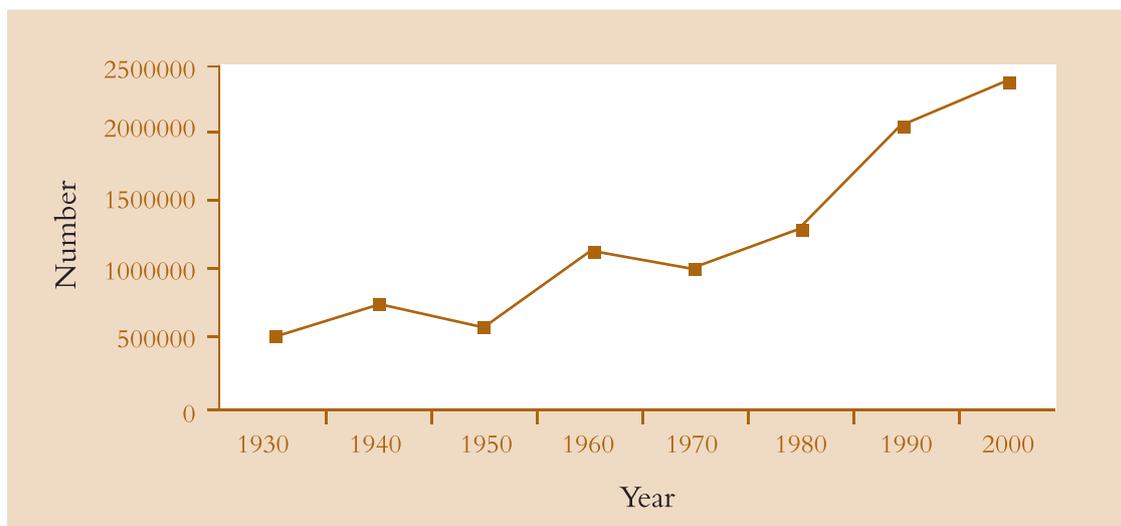
All areas of Jordan named the Badia which receive less than 200 mm of rainfall per annum are officially designated as rangeland (pastureland). Productivity of rangelands varies from one region to another. Chronologically, interest in rangeland assessment, rehabilitation and development in Jordan was as early as 1950's (HTS, 1956). Many studies and research showed low levels of rangeland productivity that tend to decrease with time. This was mainly attributed to overgrazing of natural vegetation which accelerated degradation of rangelands in the low rainfall zones. At the same time, the number of grazing animals is constantly growing (Figure 15) and results in more pressure on the limited resources of rangelands. Prolonged heavy grazing has

changed rangeland quantitatively and qualitatively. Quantitatively, it results in fewer and smaller plants and low vegetative cover. Qualitatively, it results in a decrease in the most palatable and nutritious plants relative to unpalatable plants and those lacking nutrients.

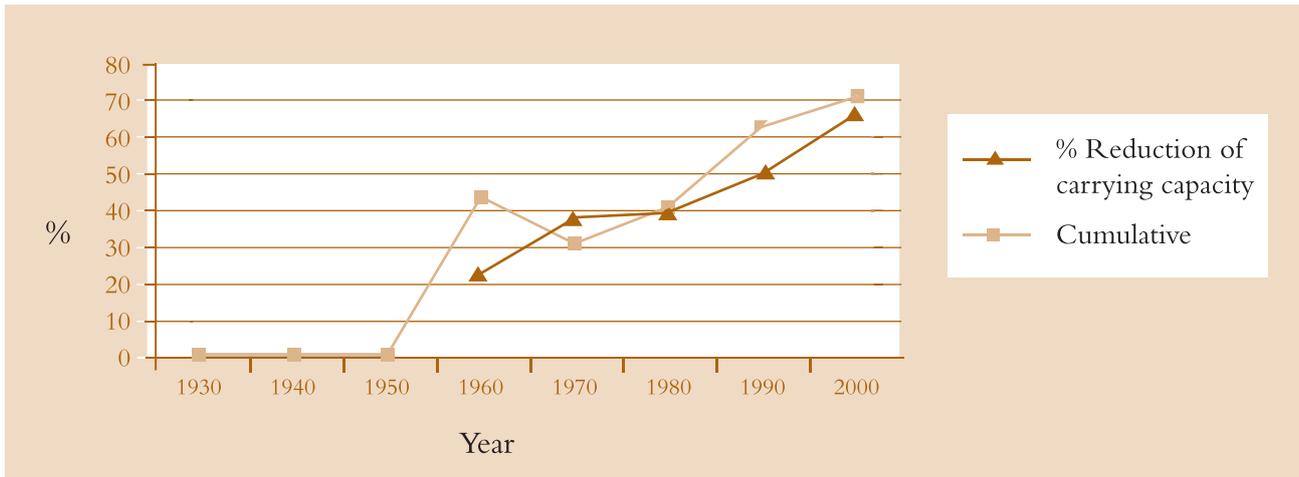
According to Abu-Irmaileh (1994), productivity of the grazed semi-arid areas ranged from 11 % to 33 % of the amount of vegetation produced by adjacent protected areas. Hatough *et al.* (1986) found that grazing reduced productivity, cover and diversity of shrubs while protection resulted in a "highly productive growth of many palatable plants such as *Erucaria bovia* and species of *Avena*, *Lolium*, *Phalaris*, *Bromus*, *Stips*, *Salsola*, *Atriplex*, *Erodium* and others."

In an attempt to support the above assumption for reduction in rangelands carrying capacity, number of livestock and subsequently the reduced carrying capacity has been used to calculate the percentage of decreasing capacity and the cumulative decrease (Figure 16). A continuous decrease in capacity for the last 70 years is observed. According to these estimates the present carrying capacity of rangelands has been decreased by about 70%.

**Figure 15:** The historical variation of livestock numbers in Jordan (Numbers are aggregated from reports of MOA, Juneidi (1996) and Agenda 21)



**Figure 16:** Percentage and cumulative reduction in carrying capacity of rangelands in Jordan. (Numbers are aggregated from reports of MOA, Juneidi (1996) and Agenda 21)



Deteriorating rangeland quality had its impact on wildlife in desert habitats. The damage occurred due to:

- Direct competition between sheep and goats with other herbivores (such as gazelles, seed-eating birds and rodents),
- Loss of food sources for herbivores,
- Loss of food sources for predators (the herbivores whose populations declined),
- Transmittal of diseases from domestic animals to wildlife,
- Loss of structural components of habitat (bushes and trees).

These structural and biological changes were supported by the large number of bird and plant species inside the natural reserves compared with the outside open rangeland.

### 5.3 Processes and Possible Indicators

According to FAO (1984), the natural or induced

processes leading to desertification are considered to be:

1. Degradation of the vegetative cover,
2. Water erosion,
3. Wind erosion,
4. Salinization,
5. Reduction in soil organic matter,
6. Soil crusting and compaction,
7. Accumulation of substances toxic to plants or animals. The first four are major determinative processes: the last three are subordinate. The determinative processes are so designated because their effects are more widespread and they have a major impact on land productivity. The main indicators for monitoring and assessing desertification, grouped according to process, are summarized in Table 9.

Suggested ranges for status, rate and hazard were proposed by FAO/UNEP. In addition to the FAO methodology, several indicators were identified by other studies and research to monitor and assess desertification in the country. Among these indicators are:

1. Substantial reduction in plant cover and productivity,
2. Alteration of target and indigenous plant species,
3. Reduction of forest area,
4. Accumulation of calcareous silt at the surface of the soils,
5. Changes in rainfall patterns and distribution,
6. Salinization of soil and groundwater,
7. Soil compaction and crusting,
8. Changes in seed bank structure and richness,
9. Alteration of soil spectral reflectance (remotely sensed indicator),
10. Reduction in soil organic matter and degradation of soil microbiology.

Selection of the indicators for future monitoring schemes will depend on the availability of baseline data and sensitivity of indicators to change. Generally, any improvement in vegetation conditions and productivity is expected to be reflected on vegetation indicators. Selection of soil indicators, on the other hand, requires a detailed soil database which is not available yet. These facts, therefore, were considered in the NAP programmes in desertification monitoring and assessment.

### Soil Salinization

Salinity of the soils in Jordan resulted from salts that originally exist in the soils, salts that are added to the soil because of improper irrigation practices, and those that result from evaporation of the internal close-to-surface water. The geological salt-rich residues and the extensive use of the land nowadays play an important role in salinization. Results of the available studies indicate that soil salinity in the Jordan Valley varies between slight and medium. The area of saline lands was about 420 ha in the northern Ghors, about 800 ha in the middle ghors and about 125 ha in the southern Ghors. Gypsum in the Jordan Valley is concentrated in the area between the west borders of South Shounah and the borders of the Dead Sea. Salinity in the marginal lands and the Badia, on the other hand, increases with decreasing rainfall. Soil studies that were conducted by the Ministry of Agriculture in 1990 indicated that salts widespread were close to the soil surface in the Badia.

**Table 9.** Desertification process and possible indicators (adapted from FAO/UNEP, 1984).

Desertification process	Assessment factor (indicator)
Degradation of vegetation	1- Canopy cover of perennial plants (%). 2- Range condition (%) of desirable vegetation (climax). 3- Vegetation productivity.
Erosion by water and wind	1- Type of erosion. 2- Subsoil exposed, % of area. 3- Soil thickness (cm). 4- Increase in eroded area, % per year. 5- Sediment deposition in reservoirs. 6- Annual loss of storage (%). 7- Wind erodibility groups (texture of soil). 8- Mean annual wind speed at 2 meters height m/s. 9- Rating of potential sand movement.
Soil salinization	1- Morphological indicators. 2- Soil EC and ESP. 4- Crop yields, % of potential productivity. 5- Surface area adversely affected, % of delineated area.

### 5.3.1 Roles of Remote Sensing and GIS in Mapping and Monitoring of Desertification

Recent development in contemporary tools of remote sensing and GIS is expected to contribute to desertification monitoring. A huge number of researches were focused on monitoring of vegetation and soils. The most commonly used remotely sensed index was the NDVI (Normalized Difference Vegetation Index) derived from high temporal-resolution of NOAA-AVHRR at a resolutions of 1, 4 and 8 km. The Archive of NASA includes NDVI images dated back to 1982. Most of the literature was focused on the African Continent and vegetation changes in the Sahel zone. Most of the research was published in the International

Journal of Remote Sensing, Remote Sensing of Environment, Photogrammetric Engineering and Remote Sensing.

Other sources of high-temporal resolution data (daily data) includes the vegetation instrument onboard SPOT (data available as NDVI images at <http://metart.fao.org/>) and the MODIS (available at <http://modis.gsfc.nasa.gov/>). The latter source is invaluable for monitoring vegetation and land surface changes on daily basis at resolutions of 500-1000 m.

For semi-detailed and detailed studies, moderate and high spatial-resolution data of different platforms can be used for monitoring desertification at a reasonable cost. Examples on these data are: Landsat ETM+, ASTER,

SPOT and IRS. The high competition between the different providers of remotely sensed images resulted in reasonable prices of the multi-spectral data for large aerial coverage. Therefore, it is believed that the integration of remote sensing data, available digital maps within GIS environment provides an invaluable tool for monitoring and assessment of biophysical aspects of desertification.

In Jordan, few studies were carried out to investigate the use of remotely sensed indicators for monitoring desertification. The use of high temporal resolution data was proposed by Al-Bakri and Taylor (2003) to detect areas with low levels of vegetation, in comparison to temporal and spatial distribution of vegetation in fifteen-year time series. Other studies were carried out to investigate the possibility of monitoring vegetation productivity from remote sensing data. Results showed that the low resolution data might not provide accurate estimate of vegetation cover and productivity, particularly in the open rangeland (Edwards *et al.* 1999;

Al-Bakri and Taylor, 2003). The use of high resolution data of SPOT imagery was investigated by Al-Bakri and Abu-Zanat (2005) to monitor vegetation productivity in protected grazing reserve in the low rainfall zone in Jordan. Results showed high correlation between vegetation cover, biomass and remotely sensed NDVI. The study recommended the use of this technology and the derived relationships to monitor vegetation cover and productivity.

The above studies showed the important roles of remote sensing technology in monitoring land resources and subsequently in monitoring desertification. However, more research and study are required to identify and select remotely sensed indices, image processing algorithms and GIS models pertinent to desertification assessment and monitoring in Jordan. Therefore, the NAP proposes the use of these contemporary tools in the suggested programmes for monitoring and assessment of desertification in the country.



# 6. Jordan National Action Plan To Combat Desertification

The Jordan National Strategy and Action Plan (NAP) outlines the basis for performing the relevant tasks, objectives, activities and methodology for implementation to combat desertification in Jordan. Also, NAP describes the present institutional framework of government institutions and non-government organizations responsible for or active in the field of combating desertification. Background to process and methodology of establishing the NAP was discussed in section 1.4.1.

## 6.1 Objectives of the NAP

The overall objective of the NAP is to provide integrated development programmes targeting local communities and environmental components in areas under threat of desertification. The specific objectives of NAP are:

1. To highlight desertification as a national priority and develop a National Action Plan to be integrated within the national policy in a participatory approach to ensure commitment of all stakeholders for its implementation.
2. To outline measures needed to combat desertification and mitigation effects of drought and the misuse of land through effective action at all levels supported by international cooperation and partnership arrangements, in the framework

of an integrated approach contributing to the achievement of sustainable development of affected areas.

The NAP involves long-term integrated strategies that focus simultaneously, in affected areas, on improved productivity of land and the rehabilitation, conservation and sustainable management of land and water resources, leading to improved living conditions, in particular at the community level.

To be able to oversee and execute the NAP, follow up and revise a Higher Commission for Combating Desertification (HCCD) is suggested. Based at the MoE and headed by the Minister, with the following membership:

1. Secretary General of the MoE,
2. Ministry of Agriculture,
3. Ministry of Water and Irrigation,
4. Ministry of Social Development,
5. Ministry of Planning and International Cooperation,
6. Ministry of Municipal Affairs,
7. The Royal Jordanian Geographic Center,
8. The National Center for Agricultural Research and Technology Transfer,
9. The Jordan Badia Research and Development Center,

10. Three members/ institutions on merit,
11. The Hashemite Fund for Badia Development (HFBD),
12. Royal Society for the Conservation of Nature,
13. Jordanian Society for Desertification Control.

## 6.2 NAP Programmes

The NAP includes five major programmes that are mainly “project-based”. The programmes include several projects related to desertification monitoring and control, capacity building, natural resources rehabilitation and development. However, these programmes and the proposed projects provide framework for an action plan to combat desertification. The proposed programmes are mainly the following:

1. Desertification Information System (DIS),
2. Drought prediction and desertification control,
3. Capacity building and institutional development,

4. Restoration of degraded ecosystems of rangelands and forests,
5. Watershed management,
6. Human, social and economic development initiatives.

Each programme has several projects with justification, activity, implementing agencies and initial budget. The following sections include detailed description of the programmes and projects.

As part of the institutional arrangements and given the importance of land degradation and its consequences for land use in Jordan, it is highly recommended to establish the CCD coordination unit at the Ministry of Environment. This will assist in institutionalizing desertification abatement activities at the national level and to mobilize all concerned parties and draw their attention to desertification and degradation, its consequences and needs for action and harmonizing all activities related to desertification at the ministry as well of other institutions. This unit should keep reporting –regularly- on the update of the NAP to the local national institutions and NCCD.

### 6.2.1 Programme One

#### **Desertification Information System (DIS)**

Updated spatial and temporal information pertinent to desertification is crucial for identifying priorities and target areas for action plans. An efficient database should be constructed and made available for researchers, planners and eventually to decision-makers. In Jordan, as in many developing countries, various data have been collected and produced by many projects and institutions and were kept on shelves after the life-duration of the projects. Therefore, effective utilization and updating of existing data is required, particularly maps and surveys.

Consolidated and accurate data should be compiled and made available by the Ministry of Environment in cooperation with the Badia Research and Development Center (BRDC). As a part of the e-government, the proposed DIS will provide information needed for different users including planners, decision makers, academic institutions and NGO's as well as donors agencies. The overall aim of the DIS programme is to build up and activate an updated system relevant to desertification in Jordan. The specific objectives of this programme are:

1. Creation of desertification information network,
2. Capacity development for the Ministry of Environment,
3. Compilation and updating of existing information,
4. Identification of gaps and needed information for monitoring and combating desertification,
5. Socio-economic documentation.

To achieve the above objectives, integrated projects relating to desertification are suggested. These projects are expected to develop the capacity of the Ministry of Environment in desertification monitoring. Output from other programmes and projects will be merged and integrated with DIS to provide information in near real-time for the different beneficiaries and users.

#### **Areas of activities will include:**

- a. Mapping of desertification (status, rate, risk and hazard),
- b. Mapping and updating of land use,
- c. Build up of operational GIS database on desertification.

## **Project Title:** **Establishing a Desertification Database**

### **Justification**

Scattering and discrepancies in data are two major problems that restrict the utilization of data in research and projects related to combating desertification. The need for organized database to store, compile and provide data for the different users has been emphasized by many institutions. Therefore, this proposed project is aiming at building an environmental database where different data sets on land, vegetation, climate, socio-economic and demography are stored, compiled and published through the web. Connecting this database with GIS data of the different institutions including Ministry of Agriculture, Department of Statistics, Ministry of Water and Irrigation, Badia Research and Development Centers universities and NGO's is also a future objective that is required to unify efforts of combating desertification.

### **Objectives**

1. To create a geo-referenced database for environment and desertification studies,
2. To link the different sources of environmental data and National Information Technology Center (NITC) through an environmental information network.

### **Activities**

1. Collection and compilation of data on desertification in Jordan.
2. Creation of GIS database and website on desertification in Jordan.

All relevant information and data from National Soil Map and Land Use Project (NSMLUP), range surveys, Meteorological Department, Ministry of Water and Irrigation, web databases, Royal Jordanian Geographic

Center (RJGC), BRDC, and Department of statistics will be compiled, manipulated in digital format and stored in the database. To achieve this, hardware and software requirements have to be obtained and installed.

### **Expected Outputs**

1. National database on desertification accessible to all the environmental community.
2. Trained people of all concerned agencies on the use of desertification database.

### **Duration**

Construction: Two Years

Operation: continuous

### **Implementing Agencies**

Ministry of Environment, Higher Council for Science and Technology/ (BRDC), Ministry of Agriculture, Ministry of Water and Irrigation, Department of Statistics, Municipality of Amman, National Information Technology Center and NGO's.

**Estimated Budget** US \$500,000

## **Project Title:** **Desertification Mapping.**

### **Justification**

Most of the country's land area receives less than 200 mm of annual rainfall, hence land and land resources are highly sensitive to desertification. In addition to the low rainfall and periodic droughts in the country, human induced factors are accelerating desertification in different parts of the country. Among these factors are the livestock and grazing practices, inappropriate

agricultural and irrigation techniques, the marginalizing of lands, changing socio-economic conditions, absence of land use legislations and a high population growth rate. The impacts of these factors are expected to vary in terms of geographic distribution as ecosystem sensitivity/resilience is location dependant. Therefore, this project aims to map desertification and to identify areas that are already desertified or reached advanced stage of desertification, areas under the risk of desertification and possible future trends of desertification in the country. This, however, requires identification of criteria for each environmental component and integration of provisional methodologies with local and regional conditions to derive detailed and semi-detailed maps of desertification status, rate, hazard and risk in the country. Outputs from this project are expected to identify areas with high priority of rehabilitation and the necessary measures required to combat desertification in the different areas in the country.

### Objectives

1. Mapping of desertification status, rate, risk and hazard in Jordan under the umbrella of a National University.
2. Identification of possible future trends and extent of desertification.
3. Identification of the root-causes of desertification and the necessary measures to combat land degradation problem.
4. Scoping of the high-priorities areas where measures of combating desertification.

### Activities

1. Conducting a comprehensive survey to scope available data and their quality.
2. Completion of missing maps and updating of some maps including land cover/use.
3. Setting and/or selection of the necessary criteria for identification desertification status, rate, risk and hazard.

4. Implementation of GIS and Remote Sensing models for mapping desertification.

### Expected Outputs

1. Identification of desertification-prone areas in Jordan.
2. Production of thematic maps (scale 1:50,000 and 1:10,000) of desertification, existing and potential land use in digital formats, available through project 1 (Environmental Database).
3. Production of Priority maps of areas requiring urgent actions of rehabilitation and restoration.

**Duration** Four years

### Implementing Agencies

Ministry of Environment, International Agencies (UN/FAO), University of Jordan, BRDC and NGO's.

**Estimated Budget** US \$ 1,000,000

### Project Title:

### Public Awareness.

### Justification

Success or failure of projects to combat desertification is determined by involved or targeted local communities. The degree of response, action and involvement of local communities in combating desertification will depend on their awareness towards the causes and consequences of the problem. Lack of participation of all relevant organizations, departments and agencies actively involved in the activities at the national and regional/sub-regional and global levels and lack of coordination between different agencies at the national and at the regional levels are among the problems that face the projects and plans to combat desertification. Therefore, this proposed project is

aiming to raise the public awareness and enhance local communities participation and organizations in a way that desertification becomes more obvious in terms of root-causes, impacts and action plans and measures taken to control and combat this problem.

### **Objectives**

1. Raising up awareness towards the problems of desertification and its consequences.
2. Creating awareness at all levels of the organization and institutions involved in combating desertification.
3. Coordinating national efforts in understanding the causes and impacts of desertification, and the level of training required to combat desertification.

### **Activities**

1. Identification of target groups and their roles in combating desertification.
2. Raise up the public awareness towards sustainable land use through educational, extension and training programmes.
3. Organizing of seminars, workshops and conferences at the country levels.
4. Production of brochures, multimedia presentations through mass media.

5. Conducting awareness campaigns through all appropriate communication channels among children and youth, particularly in arid and semiarid zones of the country.

### **Expected Outputs**

Increased public awareness towards the problem of desertification.

Trained persons at different agencies capable of carrying out public awareness activities

### **Duration**

Four years

### **Implementing Agencies**

Ministry of Environment, Ministry of Agriculture, Ministry of Water and Irrigation, The Hashemite Fund for Human Development ,the Hashemite Fund for Badia Development, Badia Research and Development Center, universities, Municipality of Amman, The Jordanian Society for Combating Desertification.

**Estimated Budget** US \$ 400,000

## 6.2.2 Programme Two

### Drought Prediction and Desertification Control

#### Justification

This programme aims at monitoring of drought to aid in formulating action plans by decision-makers. The project will also focus on combating land degradation through consistent efforts for land resources conservation and mitigating the effects of droughts.

Jordan as well as most of the region countries is located in one of the most unpredictable parts of the world in terms of drought and rainfall variations. Creation of a sub-regional center for drought prediction will help the decision makers to better understand drought cycles and to construct plans to face any drought periods in advance. The Center will also provide information related to drought and optimal measures to resolve droughts and combat the possible impacts. Other roles of the Center would be facilitating the exchange and sharing of information with other regional and sub-regional centers and international organizations including know-how and foster cooperation in conducting surveys that would benefit all concerned parties at national and regional levels.

Initially, two projects within this programme are suggested to monitor and predict droughts and their impacts. The first project will focus on identifying remotely sensed and biophysical indicators for monitoring and prediction of drought and hence will act as an early warning system to identify extent of drought while the second project will focus on identifying the highly affected areas (hot-spots) and the possible economic impacts of the droughts in these areas. In this regard, an agreement was signed between the Ministry of Agriculture and FAO to develop a national strategy to mitigate drought.

#### Project Title:

#### Center of Drought Monitoring and Prediction (CDMP)

#### Justification

Monitoring and prediction of drought are usually needed in near real-time to formulate action plans within the drought period, particularly in arid and semiarid zones where rainfall amounts and distribution are highly variable. This, however, requires the use of efficient methodologies that provide information for decision-makers at reasonable cost and span of time. The use of ground surveys and questionnaires would

not be enough to provide information on the spatial distribution of the problem. Recent developments in remote sensing technology provided efficient methodologies for drought monitoring. Different initiatives were carried out in the African Continent to monitor drought and its spatial distribution. The need for such projects in Jordan and the region is urgent to provide real-time information for decision-makers, planners and local communities.

The use of remotely sensed indicators, coupled with climatic data and models, would enable the construction of drought monitoring centers and networks. Such methodologies can be adopted in Jordan and in the

region for monitoring conditions of vegetation (Al-Bakri and Taylor, 2003) and response to rainfall (Al-Bakri and Suleiman, 2004). These methodologies are based on high temporal resolution data (e.g. NOAA-AVHRR, MODIS, and SPOT-Vegetation) that are available on daily basis and can be downloaded through the world web.

## Objectives

1. Establishing a center for drought prediction and early warning that forms part of regional and global networks.
2. Derivation, adoption and testing of remotely sensed and various techniques such as Dendonograph and Paleo Climate indices related to drought monitoring in Jordan and in the region.
3. Exchange of data and information between drought monitoring centers.
4. Identification of highly affected areas on annual and seasonal basis and in real-time within the season.

## Activities

1. Establishing the drought monitoring center with the required infrastructure and personnel,
2. Analysis of climatic data through different methodological techniques to identify probability of drought and return periods for the different areas in Jordan,
3. Identification of areas with high probabilities of drought,
4. Selection of remotely sensed indices for monitoring drought,
5. Advance training for the staff in the field of remote sensing and high temporal resolution data and their use in drought monitoring,
6. Implementation and testing of methodology, jointly with FAO/UN, WFP/UN and regional international centers.

## Expected Outputs

1. A specialized scientific center on drought prediction and monitoring.
2. Capacity building of the concerned national agencies,
3. Adoption of real-time monitoring method for drought monitoring and prediction,
4. Identification of the areas severely affected by droughts.

## Duration

Construction and training: Five years.

Operation: Continuous.

## Implementing Agencies

Ministry of Water and irrigation, Ministry of Agriculture, Jordan Meteorological Department, University of Jordan and Badia Research and Development Center.

**Estimated Budget** US \$4,000,000

## Project Title:

### Assessment of Drought impacts

## Justification

Combating desertification requires assessment of the highly affected areas to rehabilitate ecosystem and formulate plans to mitigate the socio-economic impacts. The concern of international community, particularly United Nations World Food Programme (WFP), is to implement and translate the drought monitoring indicators into food deficit of people and livestock. Therefore, identification of the severity of drought and its geographic distribution would provide

information for decision-makers to implement further resources and emergency plans to mitigate the effects of droughts at the country level. Further analysis of socio-economic impacts, however, is needed to estimate the possible impacts and damages to resources. Therefore, this project is aiming at assessment of drought impacts in the affected areas. The output from the first project of this programme will be utilized to estimate and assess the damages of droughts and to identify the target communities suffering from drought-impacts.

### Objectives

1. Identification of drought severity and extent on annual/seasonal basis.
2. Identification of affected communities and potential economic impacts.
3. Provide the technical and scientific advice to the decision makers.

### Activities

1. Establishing this component under the umbrella of a national university
2. Providing the necessary equipments and facilities

3. Hiring well qualified and experienced personnel and researchers

### Expected Outputs

1. Annual and seasonal information on geographic distribution and extent of drought affected communities and resources.
2. Estimation of economic impacts of future droughts.

### Duration

Construction and training: three years

Operation: continuous.

### Implementing Agencies

Ministry of Environment, Ministry of Agriculture, Ministry of Water and Irrigation., Badia Research Development Center, The Hashemite Fund for Badia Development, Jordan University, UN/WFP and NGO's.

**Estimated Budget** US \$ 1,000,000.

### 6.2.3 Programme Three

#### Capacity Building and Institutional Development

Building the capacity of institutions and people working in the field of desertification is the first step towards control and combating of desertification. The existing capacities are scattered among both governmental and non-governmental organizations. In addition, legislations and mandates regarding desertification control in Jordan are scattered and intercalated between several governmental agencies. Such situation results in low implementation and enforcement of the current related environmental legislations and expertise that usually results in inefficient monitoring procedures and control.

In addition to the above factors, processes of desertification are dynamic with time and space. Information and databases pertinent to desertification should be rectified and updated at different scales. This would require the use of specialized environmental information systems where contemporary technologies of remote sensing and GIS tools should be implemented. This part was emphasized in the previous programmes and projects. However, the need for personnel, software, hardware and data forms the important part in the “capacity building” programme where training programmes and specialized units are needed. Therefore, the overall objective of this programme is to building up national capacities and to mobilize national resources to combat desertification and reduce its impacts in Jordan through the development of a scientifically based mechanism that provides continuous and reliable information about the state of desertification in Jordan.

#### Objectives

Building the national capacities in the field of combating desertification and monitoring land degradation and developing comprehensive drought preparedness and drought relief schemes is the main aim of this programme. Specific objectives are:

1. Establish a training unit within the Ministry of Environment, under the umbrella of the University of Jordan and in cooperation with Yarmouk University and other universities, capable of planning, coordinating and initiating activities related to combating desertification in Jordan.
2. Establish an academic platform including a Computerized Monitoring Programme for monitoring desertification. This part was included in sections 6.2.1 and 6.2.2.
3. Establishing a National Fund to Combat Desertification (NFCDD).

Capacity building at institutional and community levels to combat desertification and alleviate its adverse impacts will be under the supervision and implementation of Ministries of Environment and Agriculture and the Hashemite Fund for Badia Development.

## **Project Title:**

### **National Training Programmes in Desertification Monitoring and Control**

#### **Justification**

Building capacity of researchers in the field of desertification is needed to ensure successful implementation of the proposed projects. This would require specialized national programmes of training in the fields of desertification monitoring and control. Therefore, this project proposes the creation of a training unit at the Ministry of Environment to follow up training programmes in the different fields and agencies related to desertification, with particular emphasis on remote sensing technology and GIS, rangeland management and rehabilitation, water harvesting and land use planning.

#### **Expected Outputs**

1. A well-established unit to coordinate training programmes supervised by a National University.
2. Desertification control at the Ministry of Environment (Part of Programmes 1 and 2).

#### **Activities**

1. Evaluate the technical background and capabilities of the desertification control unit in the Ministry of Environment.
2. Conduct a series of workshops and technical meetings to define the mandates for the governmental agencies working in the field and come out with a corporation plan that consider the Desertification unit the final reference for the desertification issue in Jordan.
3. Define the training needs and the required technical equipments, so the unit can proceed with its mandates.

4. Training programmes for the staff working at the unit, with emphasis on highly specialized programmes under the supervision of highly qualified experts. About 6-8 people will be trained every year.
5. Coordination and harmonization of approaches of the different projects and programmes addressing desertification issues.
6. Feedback from different projects to identify needs and modifications of programmes.

#### **Duration**

Four years

#### **Implementing Agencies**

Ministry of Environment, Ministry of Agriculture in cooperation with the University of Jordan and the Hashemite University.

**Estimated Budget** US\$ 200,000

## **Project Title:**

### **Establishing a National Fund to Combat Desertification (NFCD)**

#### **Justification**

The UNCCD calls for resource mobilization and disbursement mechanisms that fit in with an integrative bottom-up approach. This would require a complementary source of funding targeted for the local level, and only one of several mechanisms at the national level of supporting implementation of the UNCCD. The proposed project is a national mechanism that is focused on the local community groups, NGOs and civil society to assist in their participation and empowerment.

## Objectives

1. To serve as a mechanism through which small grants to communities can be made based on their priority needs and concerns,
2. Provide fund which can lead to mobilization of other financial resources whether domestic or international,
3. To contribute to the mobilization of financial resources from different possible sources for combating desertification.

## Activities

1. Introduction and consensus building,
2. Proposal Development by Task-Force,
3. Establishing the NFCD at the MoE (Obtain official approval)
4. Operation of the NFCD (Disbursement of small grants to communities, Intensification of resource mobilization efforts, Progress review to make adjustments as needed etc.)

## Expected Outputs

National Trust Fund on Desertification established with clear legal status

## Duration

Two years

## Implementing Agencies

Ministry of Environment and the Hashemite Fund for Badia Development in cooperation with the Global Environmental Facility.

**Estimated Budget** US\$ 2,000,000

## Project Title:

### Desertification Legal Framework for Monitoring and Development

## Justification

Policies and drafts related to desertification play a crucial role in formulation and implementation of action plan. The absence of proper legislations, policies and implementing agency are considered as an integral part of the major causes of desertification of Jordan. As mentioned earlier, many legislations, laws and drafts related to environment and natural resources were issued in Jordan. New laws related to desertification combat and monitoring, in-depth analysis and updating of current legislations are still needed. This would require a legal umbrella and further authorities to be given to the Ministry of Environment. In addition, a specialized court (environment court) is urgently needed to ensure monitoring and auditing of land degradation and desertification. Therefore, this projects aims to establish a legal framework for monitoring desertification and developing resilience measures and control.

## Objectives

1. Developing and updating of existing laws related to desertification.
2. Formulating a law related to desertification monitoring and control.

## Activities

1. Review of existing laws related to desertification.
2. Formulation of a new law related to desertification.

## Expected Outputs

1. A legal framework for desertification monitoring and action plans.

2. Identification of authorities of the Ministry of Environment and other institutions in combating and monitoring of desertification.

### **Duration**

Review of legislations: one Year. Formulation of legal framework: three years.

### **Implementing Agencies**

Ministry of Environment, Ministry of Agriculture, Ministry of Justice, Ministry of Water and Irrigation, Municipality of Amman, NGO's.

**Estimated Budget** US\$ 200.000

## 6.2.4 Programme Four

### Restoration of Degraded Ecosystems of rangelands and forests.

Developing and strengthening integrated development programmes for poverty alleviation and promotion of alternative livelihood systems is the main objective of this programme. Areas of implementation are focused on afforestation, rangelands and sustainable use of wetlands. By this, sustainable development of areas prone to desertification could be possible.

#### Project Title: Community Based Rangeland Rehabilitation

##### Justification

Rangelands are important environments from a socio-economical and Biophysical point of view in Jordan. Thus a special attention should be given to rehabilitate, upgrade and protect this environment. This statement is the overall target for the hereinafter listed projects. Rangelands are defined as lands receiving less than 200 mm average annual rainfall. It covers about 91 % of the country and includes the Badia, steppes and parts of Jordan Valley and Wadi Araba.

Rangelands play an important role in providing native feed at low cost; for a social environment where grazing is a way of life and source of income for a large sector of the people inhabiting these areas. In those areas, rangelands are severely degraded because of overgrazing, uprooting of range plants, off-road driving, inadequate cultivation patterns and urbanization. This degradation is confirmed by decreasing numbers of some important range plants, expansion of poisonous and noxious plants, soil erosion and loss of soil fertility and loss of rainfall water through runoff,

If suitable correction measures are not taken readily, the trend of degradation will increase and will reach in

many parts of these rangelands an irreversible stage that may lead to desertification, and will affect biodiversity of range species, forage production for grazing animals and environment al balance.

Special attention should be focused on indicators such as plant indicators or satellite data used to monitor the actual grazing level in the field. The measure of carrying capacity is important as it determines whether the range is eventually regenerated or destroyed.

Jordanian's Badia is characterized by a wide diversity of archeological sites such as Roman, Nabataean and Islamic old sites. Ecotourism is taking a prominent place in the tourism sector in Jordan and constitutes an important alternative land use for selected rangelands.

There are many archeological sites located in the Badia area (within the rangelands). At present, the contribution of those lands to the feeding calendar of grazing animals is very much less than 25%. This decline in forage productivity is mainly attributed to the prevailing conflict on ownership of rangelands and land tenure, which encouraged all the current miss-practices such as uncontrolled grazing and cultivation of rangelands. Continuous degradation of grazing resources threatens the livelihood of pastoral communities representing 5 % of Jordanian population.

Rangeland resources (soil, water, and vegetation) in Jordan are neither well inventoried nor documented. There is an increasing demand on updated and geo-

referenced data of range sites, range types, botanical composition, forage production, carrying capacity, watering resources and livestock production systems for management and development purposes.

There is a lack of concrete database usually used to specify the indicators of rangeland degradation

## Goal

To reduce rangeland degradation, restore their capacity and promote their Sustainable use.

## Objectives

- A well documented and updated inventory on range resources,
- Restore the productive capacity of rangeland and stabilize rangeland forage and livestock production and Develop a national monitoring and evaluation system for rangelands,
- Protecting rangeland resources (including fauna and flora) and providing ecotourism as an alternative income for pastoral communities.

## Activities

### 1. Inventory

- Collecting and compiling databases on physical, biological and socio-economic aspects of rangeland resources,
- The major components of rangeland inventory include:
  - Identification of range sites,
  - Determining range condition and priorities,
  - Mapping of range condition,
  - Changes in resource status,
  - Identification Plant Key species.

### 2. Restoration

- Survey and assessment of range resources and identifying the appropriate various criteria for identifying carrying capacity,
- The establishment of National Ranger systems,
- Monitor the status and trends of rangeland resources,
- Training and capacity building for rangeland management (Rangers).

### 3. Ecotourism

- Identifying the suitable sites for ecotourism purpose,
- Conducting the necessary scientific and socio-economic surveys,
- Establishing the necessary facilities for tourism purposes and infrastructure,
- Conduct comprehensive awareness and training programme for local communities on the benefits of the project,
- Appropriate training for local communities.

## Duration

Four years

## Implementing Agencies

Ministry of Environment, Ministry of Agriculture, Ministry of Interior and the Badia Research and Development Center.

**Estimated Budget** US\$ 2,000,000

## **Project Title:**

### **Rehabilitation and Development of Forest Environment**

#### **Justification**

Worldwide, Forests are acknowledged to maintain highest Biodiversity and a sustainable income source for the nearby communities. Forests have always played, and still play, an important role in the daily life of the Mediterranean peoples. People have been harvesting forest animal and plant products on a large scale in the region for thousands of years. Moreover, trees and forests attributed longstanding cultural values that have defined the Mediterranean landscapes. Many endangered ecosystems and rare, endemic species in the Mediterranean still coexist in the forest environment, in close relationship with humans.

Considering the limited water resources in most of the Mediterranean countries, forest zones are scientifically known as major recharge zone for the local shallow aquifer systems in each country. Thus maintaining these zones will assist the recharge mechanism for groundwater resources.

The main threats facing non-productive forest areas in Jordan (as in many other Mediterranean countries) are:

- Lack of value attributed to the forest as compared to constructible/productive land.
- The absence of a comprehensive application for a land use master plan that takes into consideration the sensitive criteria of forest's environment. Just recently, the National Governmental Authorities have engaged in the development of a Land Use Master planning at the national level, whereby forests and green areas are given special classification. To date, forests were protected by decrees from either the Ministry of Agriculture or the Ministry of Environment, and valuation of forests has not been

undertaken. Hence awareness of the value of forests is low and the range of environmental and economic services they provide have not been acknowledged.

The option to obtain the same results through eco-friendly use of natural resources is basically non-existent as of today; there is little awareness of the extent and consequences of environmental degradation and of alternatives to the over-exploitation or of the potential economic and social benefits which conservation can yield. Therefore, there is a resistance against the restrictions which conservation could introduce on the hitherto uncontrolled exploitation of natural resources through tree cutting, agricultural encroachment, hunting and grazing.

- Over-exploitation of these natural resources. Where the balance between nature and humankind has been lost. In the last few years and in line with the internationally adopted approaches, conservation and removal of violations and threats to biodiversity were the primary concern of the management bodies. This has led to the disconnection of the local community from the conservation of the forest ecosystems, although a strong sense of pride and ownership remains.

#### **Goal**

Advocate and implement forest rehabilitation programmes and sustainable use of forest resources and to develop good governance models of locally based sustainable forest management.

#### **Objectives**

1. Encourage the protection of forests through local participation and the development of local management plans under the supervision of MoA.
2. Monitor the impacts of drought and Land Use on forest resources.
3. Promoting ecotourism in forest and urban areas.

## Expected Outputs

1. Better forest management schemes are in place.
2. Formulating a set of applicable guidelines, that will focus on establishing an effective mechanism to guide forest cover performance in water scarce and climate adverse environments and adverse impacts on forest resources are regularly monitored.

## Activities

### 1. Forest management

- Identify a forest area/s
- Identify stakeholders and different current uses of the forest groups
- Establish a negotiation platform involving public authorities, experts, local authorities and user groups
- Develop a local management plan taking into consideration:
- Reforestation and maintenance of the forest area
- Conservation and/or sustainable use of local species
- Protection arrangements by local authority and local user groups
- Socio-economic feasibility
- Analyze the experience, lessons learned and inform decision and policymaking.

### 2. Monitoring

Observation of daily patterns over seasonal gradient of the most relevant ecophysiological parameters (leaf water potential; leaf stomata conductance; net CO<sub>2</sub> assimilation rate; chlorophyll fluorescence; soil moisture measurements).

### 3. Ecotourism

- Identify areas suitable for such models (forests, protected areas, valleys, and mountains areas) in connection with municipalities.
- Conducting environmental impact assessment in the identified areas
- Capacity building of the local communities on the management of ecotourism projects
- Conduction of tourist awareness raising campaigns
- Conducting awareness raising of local communities on the economic return of such models within environmentally protected approach
- Development of infrastructure for ecotourism in the selected models

**Duration** Three years

### Implementing Agencies

Ministry of Agriculture- Forest Department, Ministry of Environment and Local Community.

**Estimated Budget** US\$ 1,500,000

## 6.2.5 Programme Five

### Watershed Management

The use of water resources especially groundwater has exceeded the sustainable level for many years because of lack of effective management policy and ease in law enforcement. Over pumping of groundwater has reached an alarming level in many aquifers where overdraft is more than 200% of the safe yield in many places such as Azraq basin and Amman-Zerqa basin. Therefore, immediate measures have to be taken to manage the water resources in a sustainable manner. Such measures should not be limited to supply management options but it should rather cover demand management. Under this programme, some projects are suggested to augment supply and manage water more efficiently. The additional water supply that can be made available could be used to increase and improve rangeland by water spreading; reduce water salinity by recharging groundwater; and improve water use efficiency. This programme is aiming to enhance the integrated management and conservation of water in arid area. The suggested projects will focused on the following areas:

1. Documentation of traditional knowledge on soil and water conservation
2. Artificial recharge of groundwater.
3. House roof water harvesting
4. National water harvesting project for improving range land productivity.
5. Use of reclaimed water for Greenbelt areas around villages and along roads in arid areas of Jordan

### Project Title: Documentations of Traditional Knowledge on Soil and Water Conservation

#### Justification

Old civilization in the arid part of Jordan had to cope with dry land areas which are completely lacking enough surface and ground water resources. In spite of that, evidence has shown that several water saving techniques were used by agriculture. These include stone arrangement for water harvesting, underground dams, terraces for soil and water conservation, rain harvesting in cisterns and water spreading. The remains of these practices can be found near Petra, Ma'an, Jawa of the north and many other places. The agricultural

systems were dated back to the Nabatean period (2nd century B.C – 2nd century D.C.) and were attributed to their ability to adapt to the desert environment. Settlement and agriculture activities did not stop after the Nabatean but continued to the Byzantine and later during Umayyad period till the middle of the eight century. The remnants of old agriculture reflect a tremendous traditional knowledge in the construction of water and soil conservation works. Despite a large number of studies on this aspect, it seems that there are still more questions than answers related to this aspect like: did the agricultural systems were functional? Was the climate different? Was the system capable of sustaining agriculture? What would happen during periods of no rain?

Therefore, it is important to study traditional knowledge on soil and water conservation in order to understand

their adoption to physical and social conditions of that period. These methods can be used as basic to some extent to modern technologies.

## Objectives

This project aims at documentation of traditional and old practices of water harvesting and soil and water conservation with the following specific objectives:

1. To define the characteristics of traditional knowledge.
2. To document the engineering aspect of soil and water conservation.
3. To study the hydrological aspect of traditional knowledge.
4. To draw up an inventory of traditional knowledge in Jordan.
5. To identify the successful techniques suitable with modern technology.

## Activities

1. Collect published material (thesis, papers, reports and books).
2. Conduct field survey in order to determine the time and type of soil and water conservation works.
3. Carry out field study on the hydrological aspect of water harvesting.
4. Document traditional practices using harvested water.
5. Prepare engineering drawings of the old methods of soil and water conservation.
6. Adopt traditional knowledge to modern technology.

## Expected Outputs

1. Conservation of indigenous and traditional knowledge for soil and water conservation and sustainable agriculture.

2. Dissemination of such knowledge and practices for potential adoption.
3. Improve on traditional knowledge to be adoptable to existing social and physical conditions of today's agriculture. **Duration** Two years

## Implementing Agencies

Local Farmers, Ministry of Agriculture, Badia Research and Development Center and the Hashemite Fund for Badia Development.

**Estimated Budget** US\$ 200,000

## Project Title:

### Artificial Recharge of groundwater

## Justification

In Jordan, most of groundwater resources are located in arid areas but their discharge zones are in the semi-humid areas. However, in the vicinity of the pumping wells there are good site that can be used to infiltrate water to the shallow aquifer. This might be an ideal condition for utilization the desert flood for this purpose especially when this water has no beneficial use downstream. The final destination of the flood water is evaporation from the mudflat areas. In the eastern basin, the volume of runoff can reach 90 MCM on the average. The objectives of this project are:

1. Increase the volume of recharged water to aquifers
2. Improve the water quality and increase safe yield
3. Make use of flood water for beneficial purposes

## Activities

A pilot project will be established in a selected desert wadi where there is a potential recharge area. The area of the wadi Catchment can be from 20-50 km<sup>2</sup>. On this Catchment different techniques for artificial recharge will be tested and evaluated.

## Beneficiary

Local people who will use groundwater as well as the Ministry of Water and Irrigation specialists who will be exposed and trained on this approach.

## Expected Outputs

1. Increase the volume of recharged water and thus increase safe yield.
2. Establish a good experience in artificial use that can be used for other sites.
3. Improve the vegetation cover in the recharge area.
4. Personal of MWI will be trained on the artificial recharge techniques.

## Duration

Five years

## Implementing Agency

Ministry of Water and Irrigation

**Budget**      US\$ 1,000,000

## Project Title:

### House Roof Water Harvesting

## Justification

Water scarcity in Jordan forms major challenge for the water sector manager. With the growing demand for clean water for domestic uses, the other uses such as agriculture and industrial have to use less quality

water. A significant part of the domestic water use is for house gardening and landscaping and for this use, lower quality water can be used and help in securing some water for the real domestic use which demands clean water.

A national programme to promote water harvesting from the house roofs to be used in gardening and landscaping is one of the promising options to help in solving the growing demand for clean water. The programme will include some kind of incentives for those who have roof-collecting systems mainly in the arid parts of the country.

## Objectives

To promote using roof collecting systems to collect rainfall water and use it in home gardening and landscaping.

## Activities

Establishing a fund for house roof water harvesting systems,

Training on how to construct a simple low cost roof water collection scheme and garden irrigation network,

## Target Groups

Low income families in the arid parts of the country

## Expected Outputs

Enhancing the concept public participation and improving public awareness in the target areas

Lowering water bill for domestic use,

### **Duration**

Two years

### **Implementing Agencies**

National non-governmental organizations (NGO's), National Centre for Agricultural Research and Technology Transfer (NCARTT).

### **Estimated Budget**

US\$ 1,000,000 as a revolving fund

### **Project Title:**

## **National Rainfall Water Harvesting Project for Agriculture Farming**

### **Justification**

Water consumption for agricultural uses form more than two third of the national figure. Most of this water is from high quality groundwater. A project that encourages collecting and using rainfall flood in farming will release some of the pressure on groundwater and save more good quality water for human uses.

### **Objectives**

To promote using rainfall water collecting systems to collect runoff water and use it as supplementary irrigation in fruit and vegetables farming.

### **Activities**

Establishing a subsidized fund for farmers to construct rainfall-collecting system for agricultural uses, and constructing model farms that uses harvested rainfall water for arid zone farming, selecting tolerant species

and efficient irrigation systems.

### **Beneficiaries**

Local farmers who use groundwater for farming

### **Expected Outputs**

Reducing pressure on limited groundwater basins

### **Duration**

Five years

### **Implementing Agencies**

Ministries of Water and Agriculture, Jordanian Farmers Union, Agriculture Loan Bank, Badia Research and Development Center.

### **Estimated Budget**

US\$ 5,000,000 (partially revolving)

### **Project Title:**

## **Use of Reclaimed Water for Greenbelt areas around villages and along roads in arid areas of Jordan**

### **Justification**

The long term objective of Ministry of Water and Irrigation is to provide most of towns and villages with sewage systems and treatment plant. These plants could be of low cost type that produce reclaimed water of acceptable quality to irrigate forest and green areas around populated centers. The aim of this proposal is to build a pilot project with a treatment plant coupled

with a reuse component in a small village which will be selected in the northern Badia. The project can be run by the BRDC and used for research and demonstration purposes. The wastewater treatment plant will use low-cost technology with a capacity of about 50-100 m<sup>3</sup>/day. At the beginning of the project, wastewater will be transported to the plant using truck tankers.

### **Objectives**

The main objectives of this project are to demonstrate to the community and the government the advantages of such a system which are:

1. Reduce the hazard of polluting groundwater from cesspool and septic tanks.
2. Increase green area and thus combat desertification and reduce wind erosion.

### **Activities**

1. Establish a small size low-cost wastewater treatment plant.

2. Select a reuse site and equip it with irrigation system.
3. Plant indigenous woody plant that are adoptable to the area.

### **Expected Outputs**

1. A treatment plant with a reuse component will be completed.
2. Local experience gained to be transferred to other communities.

### **Duration**

Four years

### **Implementing Agencies**

Local Community, Ministry of Water and Irrigation and the Badia Research and Development Center.

**Budget**                      US\$ 200,000

## 6.2.6 Programme six

### **Human, Social and Economic Development (initiatives) Program.**

In conformance with the NAP framework Jordanian concerned authorities will launch the Human, social and economic development initiative as a program coherently in the implementation phase.

As exhibited in the opening chapters human intrusion in the ecological balance is proven as a major cause of desertification. Most of the said interferences are resulting from economic needs and social competition, particularly when land tenure is concerned. Human adverse impacts on resources are a cause of huge concern for researchers and planners, since the reversibility requires consistent efforts and community specific action and activities.

The goal of this program is to stream line the stake holders activities in relation to resource management, and to initiate with the relevant communities a proactive role with a reasonable value added for the coherent economic and social activities suggested.

The essence of the program should be human development, in terms of training and capacity building of the target communities. The enhancement of knowledge and cumulative experience are essential components.

The above goal and objectives will be coupled with model integrated community development in the arid lands of Jordan (Badia). Starting with a comprehensive assessment of the available infrastructure and services followed by surveys of potential neighboring resources to capitalize on during the integrated planning phase. The major objective in this component is sustainability, adding value to the local economy through investment in the resources and the indigenous knowledge.

The following projects will ensure the fulfillment of the vision:

#### **Project title:**

#### **Modules of comprehensive training for communities**

#### **Justification**

The majority of remote communities targeted by this strategy are the end users of natural resources that are much in demand for the livelihoods of those peoples and form at the same time essential components of the natural system hierarchy. Unlimited accessibility by local communities to those resources and the abused utilization is one root cause of desertification.

In this project the attempt is made to integrate awareness with hands on experience to avoid mal practices, in addition, improving livelihoods requires a major effort in the eye opening training to introduce standard practices to elevate productivity levels of individuals in: sanitation, nutrition, education in family affairs and some technical topics such as: record keeping, good financial accounting and marketing skills.

The up grading of basic needs and skills of members in a nucleolus family will trigger a chain effect in the communities, with a particular emphasis on the gender issue focusing on females.

A special attention should be given to the integrated approach making sure that training is closely associated to available development opportunities, and the target communities contributing with suitable initiatives.

### Objectives

1. Elevate community members intellectual levels with regards to the resource base status and management,
2. Improve livelihoods.

### Activities

Short term training will take place with the local periphery, designed to respond to the needs and short comings of members in the community in the topics mentioned above;

1. Survey the needs,
2. Assess and design small training modules by experts in the relevant fields,
3. Consider local active people to assist and train, introducing their concepts of needs and solutions,
4. Link training to the developmental activities that will take place in the vicinity, making sure the community understand the objectives clearly,
5. Conduct a post evaluation.

### Expected Outputs

1. Enhanced productivity,
2. Improved house hold income
3. Improved interaction with the local ecological resources.

### Duration

Five years.

### Implementing Agencies

Qualified NGOs: RSCN. In addition to; MoA, BRDC and NCARTT.

**Estimated Budget** \$1,000,000

### Project title:

## Integrated socio economic development of communities in the arid lands of Jordan

### Justification

The term integration has been used in this proposal to emphasis a holistic approach which consistently embodies sustainability in various activities. The concept of the proposal is to exhibit the ability in developing a working model for human and resource sustainable interaction in the arid zones.

It is proposed to select three communities: north, middle and south Badia of Jordan that fit the criteria of; Bedouin tribe, remotely located within the arid zone, local economy is based on traditional livestock management and low income.

Simple and basic techniques and activities are to be proposed within the integrated development methodology, with a full commitment of the targeted stakeholders.

The most important aspect of the proposal is the learning process equally for both the supply and the demand ends. This process should be subjected to continuous joint review events by the planners and the stakeholders. Out comes and lessons learned should be document systematically aiming for a credible reference in the topic.

To carry out the project a qualified interdisciplinary planning team should be formed, monitoring indicators designed and base line data properly documented. Strong links are necessarily to be established with the Project titled: Modules of comprehensive training for communities. That is to maximize benefits and save resources.

### **Objective**

1. Sustainable improvement of arid land community livelihoods,
2. Accumulated lessons learned,
3. introduce improved arid land use practices and resource management techniques,

### **Activities**

1. Base line data and resource base surveys,
2. Community needs and potential assessment,
3. Out reach and training,

4. Proposed development plans, with public hearing held for the stake holders,
5. Monitor selected indicators,

### **Expected Outputs**

1. Per capita income improvement,
2. References documenting cumulative knowledge,
3. Improved ecological conditions in the target location.

### **Duration**

Five to seven years.

### **Implementing Agencies**

Multiple concerned government agencies and selected NGOs.

**Budget**            \$5,000,000











# Appendix 1

## Surface Water Basins in Jordan.

Basin Name	Catchment area (km <sup>2</sup> )	Annual Rainfall (mm)	Annual Discharge(MCM)
Yarmouk River	1426	375	260
Jordan River north side wadis	2028	536	56
Jordan River south side wadis	434	374	29
Zarka River	3739	262	59
Dead Sea wadis	1510	226	61
Wadi Mujib	6787	134	84
Wadi Hasa	2603	114	36
North Wadi Araba area	1453	62	12
South Wadi Araba area	1500	42	3
Wadi Yutum	3170	63	3
Azraq	12710	68	27
Jafr	12360	45	10
Hammad	19270	71	5
Sirhan	15730	60	15
Southern Desert (Dissi)	5200	38	2

(Sources: Shatanawi, M, 2002 and MWI open files).

## Dams in the Jordan Valley.

Dam	River/Valley	Capacity (MCM)	Water Use
King Talal	Zarqa	86	Irr., Elc.
Wadi Al Arab	Wadi Al Arab	20	M&I, Irr.
Kafrain	Kafrain	11	Irr.
Shueib	Shueib	2.3	Irr., Rech.
Ziglab	Ziglab	4.3	Irr.
Karammah	Al Mallaha	55.1	Irr.
Mujib	Mujib	35	M&I, Irr
Tannur	Al Hasa	16.8	Irr.
Mujib	Al-Mujib	32	Irr, M&I, Elc.

(M&I: Municipal and Industry, Elc.: Electricity, Irr: Irrigation, Rech.: Recharge)

(Source: <http://www.mwi.gov.jo/index>)

## Groundwater Basins in Jordan.

Basin	Safe yield (MCM/year)	Description
Yarmouk Basin	40	Overexploited with pumping rate of 59 MCM/year.
North Jordan Valley	15	Water is found in two systems, upper cretaceous limestone and lower cretaceous sandstone
Jordan Valley Floor	21	Alluvial fans and other sediments form the aquifer. The water quality is good for irrigation.
Amman-Zarka area	88	From shallow and deep systems, The most urbanized area, about 40 MCM/year returns to the ground water from used water. The pumping rate is about 154 MCM/year.
Upper Dead sea Basin	46	Limestone aquifer. Half of this quantity appears as springs and base flow. Abstraction reaches 63 MCM/year
Lower Dead sea Basin	6	Below the upper Dead Sea basin. Estimated abstraction is about 8 MCM/year
Wadi Araba Basin	3.5	Alluvial deposits and fans form the aquifer. Located in the northern part of Wadi Araba area. Mostly of saline water and good for irrigation.
Red Sea basin	5.5	Located in the southern part of Wadi Araba. Brackish water and not fully utilized.
Jafr basin	27	Relatively limited water compared to the wide area of the basin. Over exploitation in some parts increased the water salinity to more than 2800 mg/l.
Azraq basin	30-45	Water is founded in the three aquifer systems. Most of the pumped water is from the shallow aquifer system, which is over exploited. The pumping rate is more than double the safe yield.
Disi-Mudawwara basin	125	Fossil water in the deep aquifer system of limited recharge. The pumping rate increases from 15 MCM/year in 1983 to about 85 MCM/year in 1995.
Sirhan and Hamad basins	13	Sparsely available compared to the wide area. Water is founded in the shallow aquifer system. Limited quality and high in salinity. Only 2.5 MCM/year is used.

(Source: Shatanawi 2001 and MWI open files)



Photo: Courtesy of Grafica

# Appendix 2

## Land regions in Jordan

### Land region 1: Jordan Valley

This unit includes the area from the Dead Sea to the Syrian border, and contains the active valley of the River Jordan. Also included in this Region are the limited areas of alluvium and Lisan deposits (Marl) along the eastern shore of the Dead Sea. The region lies within the hot arid climatic zone. In the moisture regimes of the soil taxonomy, the southern third of the valley is aridic, the central third is ustic aridic and the northern third is ustic. The alluvia of the Ghor form the most extensively irrigated lands within the valley, supporting vegetable and fruit crops. In the north of the valley, wheat is grown on the higher lying pans of the Ghor which lie upslope of the King Abdullah canal.

### Land region 2: Wadi Araba

This includes the Jordan Rift Valley south of the Dead Sea to the Gulf of Aqaba. The wadi varies in elevation from the - 392m of the Dead Sea to a maximum of 355 m at Jebel Er Risha about two thirds of the way to Aqaba, before descending again to sea-level at Aqaba. The wadi lies wholly within the hot desert zone, with only 80 mm of annual rainfall at Ghor Safi south of the Dead Sea. It has, in Soil taxonomy terms, a hyperthermic temperature regime and aridic moisture regime. The region is dominated by coarse textured soils with very stony nature and calcic horizons. Irrigated agriculture is carried out successfully on the camborthids and torrifluents of the Ghor Safi area. Except for the

torripsamments, most of the soils contain moderate to high levels of soluble salts requiring initial leaching and a high leaching fraction to maintain a favorable salt balance.

### Land region 3: Wadi Araba Escarpment

Includes the steeply sloping and eroded lands with an altitude range of -100 m to 1250 m. The region encompasses a thermic regime in the upper third and a hyperthermic regime in the lower two thirds. The upper edge of the escarpment lies within the xeric moisture regime grading downslope into ustic-aridic transition, to aridic in the lower half to two thirds of the region. Xerochrepts, both typic and calcixerollic are occurring in the upper part of the escarpment where they occur largely in colluvial deposits and are associated with lithic subgroups. Few ustic subgroups are found in the very narrow zone in which there are both a hyperthermic regime and significant rainfall. Aridisol great groups comprising calciorthids and camborthids occur in the lower parts of the escarpment while Torriorthents dominate in the Kurnub sandstone areas. In all great groups, lithic subgroups form a high proportion (up to 50 percent) of the soils, excluding rock. In the Basement Complex area, much of the escarpment is covered by a mantle of windblown sand and torripsamments are the dominant great group with camborthids in mixed stony colluvium, where the sand cover is thin or non-existent, and torriorthents occur on very gravelly alluvial fans.

### **Land region 4: Jordan Valley Escarpment**

This long narrow escarpment runs from the Yarmouk River in the north to Wadi Hasa in the south. The highest altitude of the escarpment is about 1200 m descending to a minimum at the Dead Sea. The escarpment encompasses the thermic and hyperthermic temperature regimes and the xeric, ustic, ustic-aridic and aridic moisture regimes. The complex distribution of temperature and moisture regimes in this region resulted in six map units been delineated within this region with xerochrepts and torriorthents dominating most of the region.

### **Land region 5: Araba Hills Dissected Basement Plateau**

The region runs from the Saudi border north along the Gulf of Aqaba to the escarpment of Ras en-Naqb. The region lies within the aridic moisture regime, except for a narrow strip along the upper edge of the escarpment to the Wadi Araba where there is an aridic-xeric transitional moisture regime. The entire region lies within the thermic temperature regime except for a few of the lowest level valleys. Torriorthents are the dominant soils followed by calciorthids, while small areas of torriorthents are found in recent channels and torripsamments on dunes and sand mantles.

### **Land region 6: Disi-Ram Highlands**

The region consists of cliff-faced sandstone buttes and masses with wide intervening valleys running north-south and filled by deep colluvial and alluvial mantles including talus on the upper slopes, and sandy alluvium including significantly large mud-flats. Sandy Aeolian deposits cover much of the slopes with both recent dunes and older sand sheets. The Region lies wholly within the aridic moisture and thermic temperature regimes. Rainfall is too little for cultivation, but occasional precipitation is channeled

to wadis, basins and sandy fans to provide a significant cover of shrub in these areas which provide important browse. Torripsamments are the dominant soils, reflecting the large area of Aeolian dunes and sand sheets. Calciorthids are found on colluvial fans, upper alluvial fans and some depressions. Camborthids are found mainly in medium textured alluvium and in fine textured alluvial depressions, while torriorthents are found on the stony talus slopes and upper parts of colluvial and alluvial fans.

### **Land region 7: South Jordan Dissected Sandstone Plateau**

Parent materials are mainly colluvial and alluvial fans, pediment fans and gently sloping pediment on sandstone. Active wadis, with recent alluvium and depressions, and old lacustrine deposits are important components of this region. Sand sheets cover some of the quaternary basin and lacustrine deposits in places. The sandstones in this region are silty in places and give rise to medium textured parent materials unlike their much coarser counterparts in region 6. The altitude varies from 650 to 1150 m, with generally much more subdued relative relief than region 6. The entire region lies within the aridic moisture regime and most of the south-western portion within the hyperthermic temperature regime. The soils of this region are dominantly medium textured, but very stony parent materials with the predominance of torriorthents. Other soil types include gypsiorthids, calciorthids, camborthids and to a less extent torripsamments on thin sand sheets.

### **Land region 8: Northern Highlands Dissected Limestone Plateau**

This agriculturally important region is extending from Yarmouk River in the north to Wadi Wala in the south. The altitude range varies from sea-level to 1050 m. the entire region is typically Mediterranean and has a xeric moisture regime, with a range in

precipitation of between 250 mm and 500 mm. The region contains a wide range of soil types, reflecting the wide range of physical characteristics. Xerochrepts and chromoxererts are the major soils with typic subgroup occur predominantly in the western half of the region and calcixerollic in the eastern half. Lithic subgroups are occurring on the shallow eroded areas of the steeper slopes and in particular, the hill tops and upper slopes from which most of the residual soils have been eroded. Soils of this region are mainly clay and considered the most rainfed productive soils in the Kingdom, particularly in Irbed and Madaba plains. Reflecting the physical complexity of this region, there are a total of 16 soil map units (Table 5).

### **Land region 9: Central Highlands Dissected Limestone Plateau**

The region lies has xeric moisture and thermic temperature regimes, rainfall between 200 mm and 350 mm and arid Mediterranean climate merging to semi-arid steppe to the east. The Xerochrepts soils occupy almost 80 percent of the region. Occurrence of a calcic horizon at depths mainly between 50–80cm, 9 reflects the lower rainfall and reduced leaching in this region. In the west and north of the region, cracking vertisols with clay content in excess of 40 percent are occurring.

### **Land region 10: Southern Highlands Dissected Limestone Plateau**

This region is the smallest of the eighteen and occupies the high altitude (1300–1736 m) plains and hills of the Tafila and Shoubak. The area has the coldest winters and most frequent snowfall of any part of Jordan. The rainfall at Shoubak averages 315 mm and the region generally is slightly drier than region 9. The region lies largely within the xeric moisture regime and wholly within the thermic temperature regime. Xerochreptic soils constitute more than 73 % of this region with high stone content in the soil and at the surface; cultivated

land has had to be cleared of stones to allow tillage. Along the eastern and southern margins, transitional subgroups of calciorthids and camborthids are found. On the plains near Tafila, there is a small but important area of more clayey soils which are included in the vertic xerochrepts subgroup.

### **Land region 11: Jordan Highland Plateau**

This region includes the major Steppe vegetation with low rainfall. The region has undulating plains and rolling, moderately steep hilly terrain. The major soil types are transitional xerochreptic subgroups of calciorthids and camborthids.

### **Land region 12: Jafr Basin**

The region lies within the arid moisture and thermic temperature regimes. The main soil types include typic calciorthids and camborthids on colluvial and alluvial fans associated with cambic gypsiorthids. Torriorthents are also found in the steeply sloping, stony colluvium of the highly dissected margins of the basin.

### **Region 13: East Jordan Limestone Plateau**

The largest of the regions and mainly consists of the highly dissected rocks of the Umm Rijam and Muwaqqar chalk and marl formations in the west (700–1000 m altitude range), with very gently undulating paleofans and limestone plateau to the east and north ; included are the sediments of the Azraq depression at 500 m altitude. A feature of the region is the large number of very broad, shallow wadi channels running eastward to the Azraq–Sirhan depressions. The region has arid moisture regime and hyperthermic temperature regime. Major soil subgroups are the typic camborthids and calciorthids. Gypsiorthids are the dominant soils in parts of the Azraq Basin and on the lowest gavel terraces around the Basin, with a horizon

of 10–20 cm thickness with a high content of ‘sugary’ crystalline gypsum which lies immediately above the weakly weathered parent rock. Torriorthents and torrifuvents are found in the middle and lower reaches of the wadis. An important feature of the wadi soils of all subgroups is their relatively low salinity.

#### **Region 14: Hafira-Jinz Depressions**

This region includes the area of more or less internal drainage, with drainage lines which are largely fault controlled. Most of the Region lies at an altitude between 850 m and 900 m. Aridic moisture and thermic temperature regimes dominate the area. However, along the margins of the Qa’a and in some wadis a xeric-aridic transitional moisture regime is found. The major soil subgroup is typic camborthids and to a less extent typic calciorthids on the slopes and hill crests overlying Muwaqqar Chalk and Marl. Torriorthents occur predominantly on the steep colluvial and talus slopes of the deeply dissected Umm Rijam chert.

#### **Region 15: North Jordan Basalt Plateau**

Consists of basaltic lava plateau with Aeolian silt deposits. Transitional xeric-aridic moisture regime is dominant while xeric regime exists in a few wadis and depressions. The thermic temperature regime dominant all over the region, except the southern margins at Azraq Basin where a hyperthermic temperature regime prevails. The major soil subgroups are xeric and xerochreptic calciorthids on the middle and upper slopes of the interfluves. Xerochreptic paleorthids are the second most common subgroup on the very gently sloping interfluves. Lithic subgroups are also common in this area on the crests and craters while camborthids occur in the valleys, basins and lower footslopes.

#### **Region 16: North-east Jordan Basalt plateau**

Includes the lava flows from Syrian border at altitude of 1100 m in the north to wadi Sirhan in the south at the border of Saudi Arabia with an elevation of 450 m. The region is entirely within the aridic moisture regime, thermic temperature regime in the north and hyperthermic temperature regime in the southwest. In the south, the area is less well defined with the basalts overlaying limestones and in turn overlain by aeolian sand. Depositional basins of up to 7 km<sup>2</sup> and volcanic cones are features of this region. Within these basins, the soil moisture regime is more properly xeric-aridic transitional. Typic Camborthids are the dominant soil subgroup followed by lithic torriorthents and typic calciorthids with dense calcic horizons which have the appearance of weathered chalked when first dug. The most saline areas of the region are usually dominated by cambic gypsiorthids in association with typic camborthids. Typic xerochrepts and xeric torriorthents occur around the margins of basins, and in the wadi alluvium of the lower reaches of the larger wadis. Important characteristics region is the shallow soil depth in almost 30% of the area.

#### **Region 17: North-east Jordan Limestone Plateau**

The Region is an undulating plateau formed on Tertiary limestones with altitude ranging from 960 m in the southeast to a minimum altitude of 600 m in the north-west at the Syrian border. Over most of the area slopes seldom exceed 5 percent. The region has aridic moisture and the thermic temperature regimes. The dominant soil subgroup is the typic camborthids with a stony silty clay loam or silty clay texture, yellowish red to red color and a very strongly developed angular blocky structure. The surface is typically a gavel

covered desert pavement. Typic calciorthids are found on old terraces, fans and on more sloping sites. Lithic camborthids and torriorthents occur on the slopes to wadi channels and depressions, and to the east of the Wadi Ruweishid north of the Azraq-Iraq highway. Cambic gypsiorthids are recognized in Qa'a' soils while some wadi channels contain typic torrifuvents. The wadi alluvium is relatively shallow, even in the major Wadi Ruweishid it seldom exceeds 2 m and is often less than 1 m. It overlies older, weathered soils derived either from Pleistocene alluvium or Tertiary limestone and chalks. The upper younger alluvium has high silt content and aeolian dust is likely to be an important component. The older, weathered, soil material has a higher clay content. These observations and properties are evidences on the high rate of desertification that altered the characteristics of the area. So far, the area is still suffering from high erosion by water and wind accelerated by plowing and irrational grazing.

### **Region 18: Ajloun Highlands Dissected Limestone Plateau**

Region 18 has the highest rainfall in Jordan, in excess of 500 mm, and a sub-humid Mediterranean climate that supports the highest proportion of oak and pine forest in the country. The region has xeric moisture and thermic temperature regimes. Intensive rainfed agriculture is taking place in the area, particularly cultivation of fruit trees of wild cultivars and olive groves. Cereal crops are grown on the undulating plateau remnants and in the larger valleys. Description

and analysis of existing and potential land use of this region is detailed by Al-Bakri (2005 a&b).

The dominant soil subgroup is typic xerochrepts with more than 5 % calcixerollic xerochrepts. Soils of these subgroups have low content of calcium and include yellowish red silt clay and clays and brown and strong brown clays of the same texture. The redder variant corresponds to the old "terra rosa" classification and occurs mainly on the undulating plateau deposits, steep upper slopes and in lower valley slope mantles. The brown variant occurs in colluvial material of steep middle and upper slopes. Lithic xerochrepts and xerothents together comprise 30 % of the region with shallow stony clays and silty clay with reddish and brown colored soils. True vertisols of vertic xerochrepts occur on, with a very low percentage, on the undulating plateau remnants and in some of the wadi bottom alluvium. Haploxerolls with their moderate to high organic matter content occupy about 4 % of the region. Rock outcrops are a common feature of the landscape of this region. Therefore, lithic subgroups and rock together occupy about 60 % of the region, and emphasizes the fragile nature of the soil environment and the importance of the relatively small proportion of good, deeper soils. Improper farming practices that accelerate soil erosion, woodland and forest cutting, land fragmentation and uncontrolled expansion of urban and rural settlement at the cost of cultivable land are the major causes of land degradation in this region (Khresat *et al.*, 1998; Taimeh, 1989; Al-Bakri 2005a&b).



## Appendix 3

**Habitat, main uses, parts used and season of collection and use of the wild and forage species as indicated by local farmers.**

Species	Habitat	Main Uses	Parts Used	Season
1. <i>Anabasis spp.</i>	Rangeland	Feed	Whole plant	Summer
2. <i>Seidlitzia spp.</i>	Rangeland	Feed	Whole plant	Summer
3. <i>Aaronsonia spp.</i>	Forest, Mountain, Range, Hillside	Ornamental	Flowers	Spring
4. Golden cotula	Forest, Mountain, Rangeland	Medicine, Beverage	Leaves, Flowers, Whole plant	Summer, Winter, Spring
5. Crown Daisy	Rangeland	Food	Stem, Phloem	Spring
6. Prickly Burnet	Rangeland	Medicine, Building	Seeds, Leaves Whole plant	Around the year
7. <i>Quercus spp.</i>	Forest, Mountain	Food, fodder, timber	Fruits, Seeds Stem	Summer Around the year
8. <i>Pistacia spp.</i>	Forest, Mountain	Gum	Stem bleeding	
9. Autumn Mandrake	Forest, Mountain		Seeds	
10. Garden Rocket	Valley floor, Spring vicinity	Food	Whole plant	Winter , Spring
11. <i>Ashillea spp.</i>	Valley floor, Spring floor	Food, Medicine, Beverage	Leaves Whole plant	Winter , Spring
12. Sneezewort	Forest, Mountain	Food, Medicine,	Flowers, Whole plant	Spring
13. Palestine Vetch	Forest, Mountain, Rangeland	Food	Seeds	Summer, Spring
14. Purple Winged Pea	Forest, Mountain	Food	Fruits, Seeds	Spring
15. <i>Veronica spp.</i>	Valley floor, Spring vicinity	Feed	Fruits	Spring
16. Ciliate Love	Valley floor, Spring vicinity	Food, Medicine, Feed	Seeds	Around the year
17. Wild Rue	Rangeland	Medicine	Fruits	Summer

18. <i>Melilotus spp.</i>	Forest, Mountain	Medicine	Flowers	
19. <i>Imperata spp.</i>	Valley floor, Spring vicinity	Building, Fiber, Crafts	Whole plant	Summer , Around the year
20. Rose Dock	Valley floor, Spring vicinity, Forest, Mountain, Rangeland	Food , Feed	Leaves, Stem, Seeds	Winter
21. <i>Anehusa spp.</i>	Forest, Mountain		Leaves, Fruits	Spring, Summer
22. Spiny Broom	Forest, Mountain, Valley floor, Spring vicinity			
23. White Wall Rocker	Valley floor, Spring vicinity, Forest, Mountain	Food	Leaves, Flowers	Winter, Spring
24. <i>Malva spp.</i>	Valley floor, Spring vicinity, Forest, Mountain	Food, Fodder, Medicine	Leaves, Stem, Fruit, Whole plant	Winter, Spring
25. <i>Cynara spp.</i>	Forest, Mountain, Rangeland	Food, Feed	Stem, Seeds	Spring
26. <i>Ononis spp.</i>	Forest, Mountain, Rangeland	Food, Medicine	Fruits	Spring
27. <i>Ranunculus spp.</i>	Rangeland		Stem	Spring
28. <i>Papaver spp.</i>	Forest, Mountain	Medicine	Flowers	Spring
29. Egyptain Hartwort	Forest, Mountain	Feed	Seeds, Fruits, Leaves	Winter, Spring
30. Oleander	Valley floor, Spring vicinity	Building, Timber	Stem	Year around
31. Wave-Leaved Fleabane	Forest, Mountain	Food, Feed	Whole plant	Spring
32. Rough Hawkbit	Valley floor, Spring vicinity, Rangeland	Feed	Whole plant	Spring
33. White Broom	Valley floor, Spring vicinity, Forest, Mountain, Field border	Feed, Timber	Stem, Whole plant	Year around

34. <i>Portulaca spp.</i>	Valley floor, Spring vicinity, Forest, Mountain	Food	Whole plant	Summer , Winter , Spring
35. Silvery Whitlow wort	Rangeland	Food, Medicine, Ornamental	Whole plant	Spring
36. Musk Dead nettle	Forest, Mountain, Rangeland	Food, Medicine, Beverage	Whole plant	Winter, Spring, Year around
37. <i>Lepidium spp.</i>	Forest, Mountain, Rangeland, Road side	Food	Whole plant	Spring
38. <i>Chenopodium spp.</i>	Rangeland			Spring
39. <i>Crocus aleppicus</i>	Forest, Mountain, Rangeland	Food, Fodder, Medicine	Leaves, Whole plant	Winter, Spring
40. Common Narcissus	Rangeland	Ornamental	Flowers	Winter
41. Thyme	Forest, Mountain	Food, Medicine, Beverage	Leaves, Whole plant	Summer, Winter, Spring
42. <i>Pyracantha spp.</i>	Forest, Mountain, Rangeland, Forest perimeter		Flowers	Spring
43. <i>Colchicum spp.</i>	Valley floor, Springs	Food	Leaves	Spring
44. <i>Cyclamen</i>	Forest, Mountain	Food, Fodder	Leaves, Whole plant	Spring
45. Long-Stamened Garlic	Forest, Mountain Valley floor, Spring vicinity	Food	Stem	
46. <i>Carlina spp.</i>		Food	Leaves	Winter, Spring
47. <i>Beta Vulgaris</i>	Valley floor, Rangeland	Food	Leaves, Whole plant	Spring
48. Rocket	Forest, Mountain, Valley floor, Spring vicinity	Fiber	Whole plant	Summer
49. <i>Juncus spp.</i>	Valley floor, Rangeland			Spring

50. <i>Gynandriris spp.</i>	Valley floor, Spring vicinity		Roots	
51. <i>Crocus spp.</i>	Forest, Mountain	Food, Medicine	Leaves, Seeds, Stem, Whole plant	Spring
52. <i>Foeniculum spp.</i>	Forest, Mountain, Valley floor, Spring Vicinity	Food, Medicine, Beverage	Leaves, Whole plant	Spring
53. <i>Thlaspi spp.</i>	Forest, Mountain	Feed, Medicine, Beverage	Leaves, Seeds, Stem, Flowers	Summer , Spring , Around the year
54. <i>Artemisia spp.</i>	Rangeland	Feed, Timber	Whole plant	Spring
55. <i>Noaea spp.</i>	Hillside	Feed	Whole plant	Summer , Spring
56. <i>Stippa spp.</i>	Valley floor, Mountain	Food, Medicine, Building, Timber	Flowers, Leaves, Stem, Whole plant	Around the year
57. Grape Hyacinth	Forest, Mountain, Rangeland		Leaves, Stem	Summer
58. Clammy Inula	Rangeland	Feed	Fruits, Leaves	Summer
59. Honey suckle	Forest, Mountain	Medicine	Whole plant	Around the year
60. <i>Calotropis procera</i>	Forest, Mountain, Rangeland	Food, Medicine	Whole plant	Summer
61. <i>Alhagi spp.</i>	Forest, Mountain, Rangeland	Food	Stem, Whole plant	Winter, Spring
62. Thumble Thistle	Forest, Mountain	Food, Medicine	Leaves, Stem, whole plant	Winter, Spring
63. Dwarf chicory	Mountain, Rangeland, Valley floor, Spring vicinity	Medicine	Fruits, Stem	Summer
64. Bramble, Black berry	Valley floor, Spring vicinity	Feed	Leaves	Spring
65. Sea Squill	Forest, Mountain			
66. Common Asphodel	Mountain	Medicine	Fruit	Summer

67. <i>Silene spp.</i>	Forest, Mountain, Rangelands, Hillside	Food	Whole plant	Winter, Spring
68. <i>Boletus badius</i>	Forest, Mountain	Food	Leaves, Flowers, Stem	Spring
69. <i>Sinapis spp.</i>	Rangelands	Medicine	Leaves, Flowers	Summer
70. <i>Raphanus spp.</i>	Forest, Mountain	Food, Medicine	Leaves, Flowers, Fruits, Roots	Spring, Summer
71. Common Caper	Forest, Mountain, Rangelands, Hillside	Medicine	Leaves	Spring
72. <i>Varthemia spp.</i>	Forest, Mountain	Medicine	Fruits	Summer
73. Squirting Cucumber	Forest, Mountain	Medicine	Flowers, Fruits	Spring, Summer
74. African Fleabane	Forest, Mountain, Rangelands	Feed	Whole plant	Summer
75. Field Eryngo	Rangelands	Feed, Medicine	Flowers, Stem, Whole plant	Spring
76. Nettle	Forest, Mountain, Rangelands	Medicine	Seeds	Summer
77. <i>Glancium spp.</i>	Forest, Mountain, Rangelands	Food	Stem, Fruits, Whole plant	Spring
78. <i>Sternbergia spp.</i>	Forest, Mountain, Rangelands	Feed, Medicine	Leaves, Flowers	Spring, Summer, Year around
79. <i>Achillea spp.</i>	Valley floor, Spring vicinity, Rangelands		Leaves, Fruits, Seeds, Flowers	Spring
80. Common Giant Fennel	Forest, Mountain, Rangelands	Food	Leaves	Spring, Summer
81. <i>Salvia spp.</i>	Forest, Mountain	Food	Leaves	Spring, Summer
82. <i>Echium spp.</i>	Mountain, Rangelands	Food	Leaves, Stem	Winter, Spring
83. Green Arum	Forest, Mountain, Rangelands, Hillside			

84. Fenugreek	Mountain	Ghee	Flowers	Winter
85. Pale Centaury	Valley floor, Springs, Rangelands	Food, Feed	Stem, Whole plant	Spring , Summer
86. <i>Cynodon spp.</i>	Field perimeter, Forest, Mountain, Rangelands, Forest perimeter	Medicine	Whole plant	Spring, Year around
87. <i>Nepeta spp.</i>	Valley floor, Spring vicinity	Food, Medicine	Leaves, Whole plant	Summer, Year around
88. Shrubby Restharrow	Forest, Mountain	Feed, Medicine, Timber	Seeds, Flowers, Leaves, Stem	Year around
89. <i>Prosopis spp.</i>	Forest, Mountain	Food, Medicine, Beverage	Roots, Whole plant	Year around

Whole plant = above the ground vegetation. Beverage = Plants are boiled with water and the extract is used as drink.