



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<http://ageconsearch.umn.edu>
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*



International Center
for Agricultural Research
in the Dry Areas



Land Degradation in Jordan – Review of knowledge resources

Dr. Esmat Al Karadsheh, Dr. Samia Akroush, Eng. Safa Mazahreh

Oasis — A global agricultural research-for-development partnership against desertification. Within this partnership, this OASIS project focused on priority land degradation issues that impact on the countries of Jordan, Morocco, Yemen and Pakistan. It was funded by USAID.



Land Degradation in Jordan – Review of knowledge resources

Acknowledgments:

We would like to express gratitude to all that contributed from NCARE; Eng Lubnah Mahasneh/GIS Unit and Dr Yasser Muhwish, Eng Omer Abu Samrah/ARMPH /MoA, Dr Amer Jabarin/University of Jordan and Dr Saeb Khresat/Jordan University for Science and Technology. The continuous support from Dr Faisal Awawdeh/Director General of NCARE and Dr Nasri Haddad/Regional Coordinator West Asia Regional Program - WARP ICARDA is highly appreciated.

Photo credit: Cover photo by Kasem Al Ahmad, ICARDA

Feedback:

ICARDA welcomes comment and feedback on this publication. Please visit www.icarda.org to share your views.

ISBN: 92-9127-264-7

Key words:

Land, degradation, Jordan, agricultural policies

International Center for Agricultural Research in the Dry Areas (ICARDA)

P.O. Box 5466, Aleppo, Syria.

Tel: (963-21) 2213433

Fax: (963-21) 2213490

E-mail: ICARDA@cgiar.org

Website: www.icarda.org

The views expressed are those of the authors, and not necessarily those of ICARDA. Where trade names are used, it does not imply endorsement of, or discrimination against, any product by the Center. Maps have been used to support research data, and are not intended to show political boundaries.

The information provided in this publication is not official U.S. Government information and does not necessarily represent the views or positions of the U.S. Agency for International Development or the U.S. Government

Copyright © 2012 ICARDA (International Center for Agricultural Research in the Dry Areas)

All rights reserved.

ICARDA encourages fair use, sharing and distribution of this information for non-commercial purposes, with proper attribution and citation.

CONTENTS

EXECUTIVE SUMMARY	VII
LIST OF TABLES.....	VIII
LIST OF FIGURES	viii
Land Degradation in Jordan—Review of knowledge resources.....	1
Overview.....	1
1. Introduction.....	1
2. Characterization of Land Degradation in Relationship to Agriculture	4
2.1. Jordanian Bio-geographical regions and forms and types of land degradation:	4
2.2. Causes and extent of land degradation in Badia: Review of knowledge.....	4
2.3. Costs of land degradation	11
3. Response actions to land degradation.....	11
3.1. Review of relevant policies and strategies	12
3.2. Relationship between land degradation and strategies.....	14
3.3. Review of previous and ongoing projects.	16
3.4. Approaches of reviewed projects.....	18
3.4.1. Participatory approach.....	18
3.4.2. Impact assessment	22
3.5. Water harvesting.....	22
4. National/Sector Policy Assessment	23
4.1. Institutional and Governance aspects of LD.....	25
4.2. Stakeholder analysis.....	26
4.3. Indicators needed for analyzing the cost of land degradation	26
4.3.1. The need for socio-economic and institutional Indicators.....	29
4.3.2. Types and levels of socio-economic and institutional indicators	30
4.3.3. Proposed socio-economic indicators of land degradation	30
4.4. Data sources for land degradation assessment.....	31
5. Gaps and Barriers.....	35
6. Conclusion	36
7. References.....	37

LIST OF TABLES

Table 1:	Biogeographic regions in Jordan and causes and stage of degradation.....	5
Table 2:	Desertification assessment by type in Mafraq Governorate.....	8
Table 3:	Jordan ranges and their productivity	10
Table 4:	Implemented range projects in the Badia of Jordan by the MoA.	17
Table 5:	Implemented rangeland projects in the Badia of Jordan by the NCARE.....	17
Table 6:	Implemented rangeland projects by the HCST.....	18
Table 7:	Types of participation during the different stages of projects.	19
Table 8:	Types of adopted approaches implemented by the projects in the Badia.....	20
Table 9:	Activities and the contribution of Sustainable Rangeland Management Project.	21
Table 10:	Stakeholder analysis matrix	27
Table 11:	Socio-economic indicators of land degradation at Global Level—Insecurity.....	30
Table 12:	Socioeconomic indicators of land degradation at global level— Lack of opportunity.....	31
Table 13:	Socioeconomic indicators of land degradation at Global Level— Disempowerment	31
Table 14:	Socioeconomic indicators of land degradation at National Level— Food Insecurity	32
Table 15:	Socio-economic indicators of land degradation at national level— lack of opportunity.....	33
Table 16:	Socio-economic indicators of land degradation at national level— disempowerment.....	33
Table 17:	Socio-economic indicators of land degradation at enterprise level— Food insecurity.....	34
Table 18:	Socioeconomic indicators of land degradation at the enterprise Level— Lack of opportunity.....	34
Table 19:	Socio-economic indicators of land degradation at the enterprise level— disempowerment.....	35

LIST OF FIGURES

Figure 1:	Rainfall Isohyets (26).....	1
Figure 2:	Distribution of Jordanian Badia.....	2
Figure 3:	Biogeographic regions of Jordan.....	5
Figure 4:	Percentage and cumulative reduction in carrying capacity of rangelands in Jordan (15, 19).....	6
Figure 5:	The historical variation of livestock numbers in Jordan (Numbers are aggregated from reports of MoA, (Juneidi, 1996) and Agenda 21).....	7

EXECUTIVE SUMMARY

Land Degradation in Jordan—Review of knowledge resources

This publication is a baseline assessment reviewing the current knowledge of land degradation in the rangelands of Jordan - known as Badia - with a special focus on its causes. It includes a review of current legislation and on-going initiatives to combat land degradation, along with an analysis of the main constraints limiting their effectiveness. It is intended as a guideline for all those involved in organizing the next stages of Oasis and similar project implementation in Jordan – Government officials, international funders and agencies, national research stations, farmers and rural communities.

About land degradation and remediation in Jordan

The dominant types of land degradation in the Jordanian Badia are water and wind erosion, decline in soil fertility, and habitat destruction. The main causative factors are overgrazing, unsustainable agricultural and water management practices and the over-exploitation of vegetative cover. In turn, these are driven by rapid population growth, urban spread into the Badia and the prevailing poverty of the people that is forcing dryland farmers and herders increasingly to adopt non-sustainable land use practices to produce more food in order to meet their needs.

Land degradation processes in Jordan affect not only selected ecosystem components or their functional cycles; they are also destructive processes that negatively impact the entire environmental landscape. In this document the aims are to:

- Characterize land degradation in relationship to agriculture with a focus on agro-ecological zoning or types of farming systems in Jordan;
- Examine policy status in the national development plan, institutions responsibilities and capacity, previous and existing projects, impacts, productivity and extent of diffusion of the available technologies;
- Identify critical knowledge gaps, research and development implications for future activities.

Few researchers argue that Jordan is ignorant of the appropriate technologies available to combat degradation - such as rainwater harvesting - but the problem remains that these technologies are not used sufficiently due to a number of reasons. The main ones include insufficient knowledge of the socio-economic contexts, incorrect identification of the causes of arid land problems and ineffective management of natural resources.

The project team welcomes discussion and perspectives from interested readers. Contact: Dr Esmat Karadsheh (corresponding author, esmatk@yahoo.com).

Land Degradation in Jordan – Review of knowledge resources

OVERVIEW

In general, the dominant types of Land Degradation (LD) in the Jordanian Badia are water and wind erosion, decline in soil fertility, and habitat degradation. The main causative factors are overgrazing, unsustainable agricultural and water management practices and the over-exploitation of vegetative cover. In turn, these are driven by rapid population growth, 2.8% per year (DoS, 2007), urbanization into the Badia and the prevailing poverty of the people in the Badia that is forcing dryland farmers and herders increasingly to adopt non-sustainable land use practices to produce more food and to meet their needs. Land degradation processes in Jordan affect not only selected ecosystem components or their functional cycles; they are also destructive processes that negatively impact on the entire environmental landscape. While these land degradation processes have to a large extent a human-induced local origin, if not addressed appropriately, the negative effects will impact on regional and global environmental goods and services. The purpose of this document is to review the current status of knowledge about land degradation in Jordan in regard to policy and legislation and to document the efforts to combat land degradation that will be used as a guideline reference for organizing the next stages of the Oasis project implementation in Jordan.

1. INTRODUCTION

Jordan is located between 29° 11' to 33° 22' north, and 34° 19' to 39° 18' east, with an area of approximately 90 km² with altitude ranges from less than minus 400 m 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 with rainfall of about 630 mm to desert conditions with less than 50 mm over a distance of only 100 km (1, 26).

More than 90 per cent of the country's area is classified as arid and receives less than 200 mm annual rainfall, with the precipitation pattern being latitude, longitude and altitude dependent. Rainfall decreases from north to south, west to east and from higher to lower altitudes (Fig. 1).

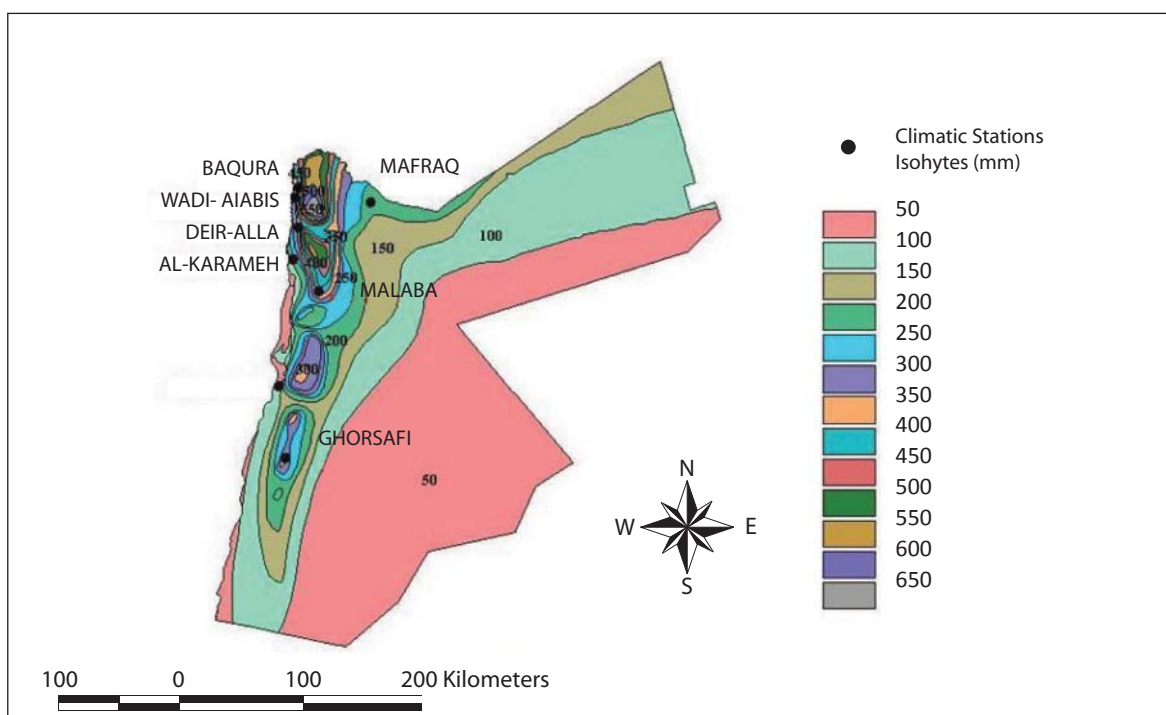


Fig.1: Rainfall Isohyets (26)

The area further inland from the western highlands forms a considerable part of the country and is 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 (26, 35). This region makes up part of Jordan, Syria, Saudi Arabia and Iraq. In Jordan, the Badia extends from north to south along the eastern portion covering about 90 per cent of the country’s total area (Figure 2). The region is subdivided into three main geographical areas, as follows:

- The northern Badia, comprising 26,000 km.
- The middle Badia, comprising 10,000 km.
- The southern Badia, comprising 38,000 km.

The arid and semi-arid lands in Jordan are sensitive to human interference that has produced a severe depletion of its natural resources and various forms of land degradation due to multiple interactions of socio-economic factors. This is accentuated by poor structural stability of soils and the subsequent vulnerability to excessive erosion following intense rainstorm events. Such a fragile ecosystem has also been manifested by unsustainable land use patterns and poor vegetative cover of the rangeland and forests. Therefore, most of the economic activities take place on the remaining 10 per cent of the land area and the competition between different user groups for these lands is high.

Most of Jordan’s arid and semi-arid areas have suffered land degradation. Although the rate of degradation was not identified, several surveys and studies at the country level indicated that Jordan’s land is at the threat of high rates of degradation. There is considerable evidence that poverty is forcing dryland farmers and herders, in particular, into unsustainable practices to produce more food to meet their basic needs, often leading to degradation of their land resources. Generally speaking the process has been accelerated by unsupervised management and land use practices. Among the human practices that aggravate degradation are irrational ploughing, the cultivation of land for barley, the mismanagement of plant residues and the overgrazing of natural vegetation, inappropriate land use, random urbanization, land fragmentation and over-pumping of groundwater. In addition to human induced factors, climatic factors, mainly erratic rainfall and periodic droughts, are contributing to the problem. Besides the above causes, a very important factor of desertification in the country is the high population growth which exerts ever more pressure on the natural resources. It is not only the Badia area suffering from desertification. Assessments in the transition zone (between arid areas in the east and sub-humid areas in the west) show a high risk of desertification and it is expected to lose its productivity over time, due to similar causes.

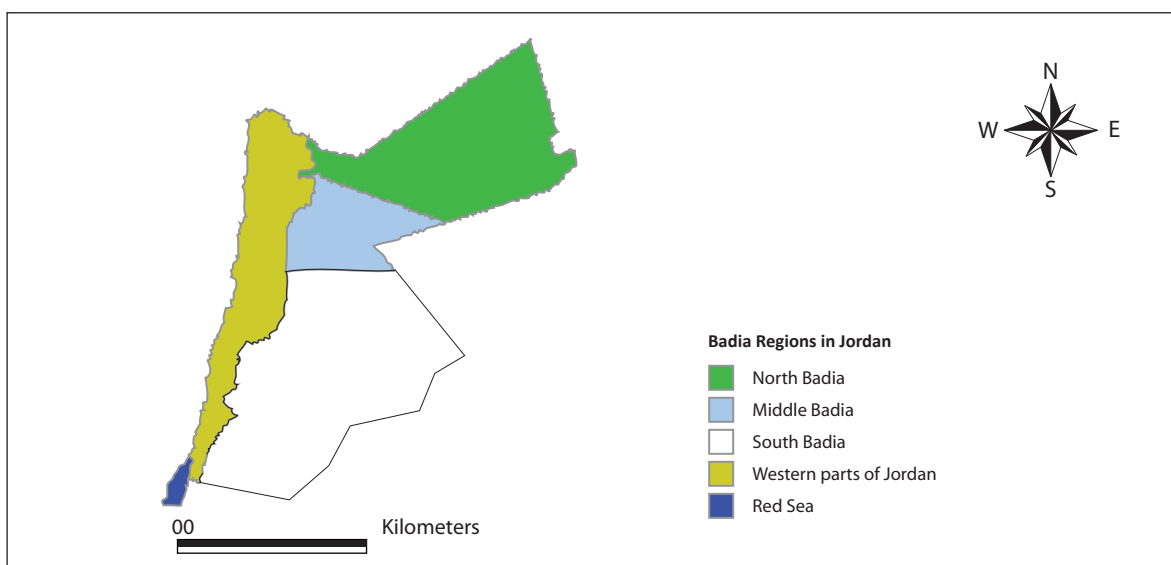


Fig.2. Distribution of Jordanian Badia

Rangelands are being severely degraded because of overgrazing, uprooting of range plants, off-road driving, inadequate cultivation patterns and urbanization (23). This degradation is confirmed by the following observations:

- Decreasing numbers of some important range plants
- Expansion of poisonous and noxious plants
- Regression of large areas of perennial ranges to annual ranges
- Soil erosion and loss of soil fertility
- Loss of rainfall water through runoff
- Salinity and low underground water levels
- Frequent occurrence of wind storms
- Disappearance of wildlife.

If suitable corrective measures are not taken quickly, the trend of degradation will increase and will reach, in many parts of these rangelands, an irreversible stage that may lead to desertification, affecting biodiversity of range species, forage production for grazing animals and environment balance.

Whether the range can fully “recover” is unknown, due to an absence of baseline data (9). Initiatives for the conservation of the Jordanian rangelands are not new - there is a long history of reports recognizing the problems and proposing solutions (9). Most notable among these reports are those by (Park, 1955), (Tuttle, 1971), (Draz, 1979), and (Juneidi and Abu-Zanat 1993). In each case, the authors noted the erosion and degradation in the rangelands and proposed action to arrest the situation. Actions following these reports seem to have been minimal. Indeed, since these reports, it is safe to say that the situation has become substantially worse. Almost certainly, there has been a major expansion in both the size and number of sheep flocks with correspondingly greater pressure on range resources. The greater availability of water-tankers and trucks has meant that pastoralists are able to reach regions previously inaccessible. At the same time, the gradual tightening of restrictions on cross-border movement has meant that the pasture resources of the broader region are no longer available to Jordanian producers.

Currently, natural resources (soil and vegetation) of rangelands in Jordan are generally poor (23). This situation urgently requires demarcation, re-organization, management plans, strategies and action programs for their proper scientific management. Grazing is the optimal way of utilizing these areas, of converting native plants not usable by man to animal products suitable for human consumption. In most cases, present production does not exceed one-sixth to one-third of the potential productivity. The cause of this low productivity is overgrazing of the rangelands, resulting from a higher demand for animal products by a fast increasing population.

This document has been prepared through the Oasis project as a baseline assessment and documentation to review the current knowledge about the status of land degradation in the Jordanian Badia with special focus on the causes that have led to the prevailing situation, compared to the potential. An analysis of the present legislation and initiatives to combat land degradation are presented with an emphasis on the main constraints limiting their effectiveness. This document will be used as a guideline reference for organizing the next stages of Oasis project implementation in Jordan. The main outline of this review will include:

- Characterization of land degradation in relationship to agriculture with a focus on agro-ecological zoning or types of farming systems in Jordan, relevant indicators to the forms and types of land degradation, documented (observed) changes in land use patterns and impacts on land productivity and efforts to combat land degradation and land users’ perception of land degradation – local knowledge as well as efforts to estimate cost of land degradation (at farm and/or national level).

- Dealing with land degradation; Policy status in the national development plan, institutions responsibilities and capacity, previous and existing projects, and impacts, productivity and extent of diffusion of the available technologies.
- Identifying critical knowledge gaps, research and development implications for future activities.

2. CHARACTERIZATION OF LAND DEGRADATION IN RELATIONSHIP TO AGRICULTURE

Global Environment Outlook (UNEP 2000) summarized the key issues affecting land and food in West Asia. Regarding Jordan, the following are mentioned (37):

- Overgrazing and fuel wood gathering have led to the deterioration and desertification of more than 36 million hectares of rangelands in Jordan, Iraq and Syria (AOAD 1995)
- Annual soil loss due to water erosion amounts to 200 tons/hectare in the mountainous area of Jordan (CAMRE/UNEP/ACSAD 1996)
- Poor irrigation techniques have resulted in salinization, alkalinization and nutrient depletion in large areas. The area of irrigated land that is salinized by irrigation is estimated to be 3.5 per cent in Jordan (FAO 1997a)
- Fertile agricultural land around major cities has been lost to urbanization, industrial establishments and transportation infrastructure. One result is that the food gap in the region increased from US\$10,700 million in 1993 to US\$11,800 million in 1994 (FAO/UNESCWA 1994; UNESCWA 1997)
- Deterioration of rangeland and farm productivity is forcing farmers to abandon agricultural land and migrate to cities, increasing pressure on services and infrastructure. The percentage of people living in urban areas has dramatically increased - from 38.9 per cent in 1952 to 78.6 per cent in 1994
- Land degradation is expected to continue unless countries (including Jordan) undertake more mitigation measures. Fortunately, most countries have now launched national action plans to combat desertification.

2.1. Jordanian Bio-geographical regions and forms and types of land degradation:

Many researchers have studied the ecosystems generally occurring in Jordan (26). 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 dry summer. (Al-Eisawi, 1985) indicated the presence of four bio-geographical regions in Jordan (Figure 3), namely, Mediterranean, Irano-Turanian, Saharo-Arabian and Sudanian Penetration. The characteristics of each region, causes and stage of degradation at each region are shown in (Table 1).

2.2. Causes and extent of land degradation in Badia: Review of knowledge

Despite its aridity, Jordan's Badia (rangelands) plays an important role in providing native feed at zero or very low cost, with grazing being a way of life and source of income for a large section of the people inhabiting these areas (23). Rangelands are also the watersheds that receive rainfall, yield surface water and replenish ground water throughout the region east and south of the western Jordan highlands. Traditional grazing cycles were originally based on a transhumance system that allowed for the natural regeneration of forage. Nowadays this situation no longer exists, as traditional grazing rights are mostly ignored (7, 23). Livestock is the major source of income for local communities in this zone, and the lands are usually overgrazed by nomadic and semi-nomadic flock owners from late in the winter through to mid summer. The highest productive rangelands are located within the less than 200 mm annual rainfall (steppe grassland and brush). Barley is cultivated for hay and rainfall is rarely

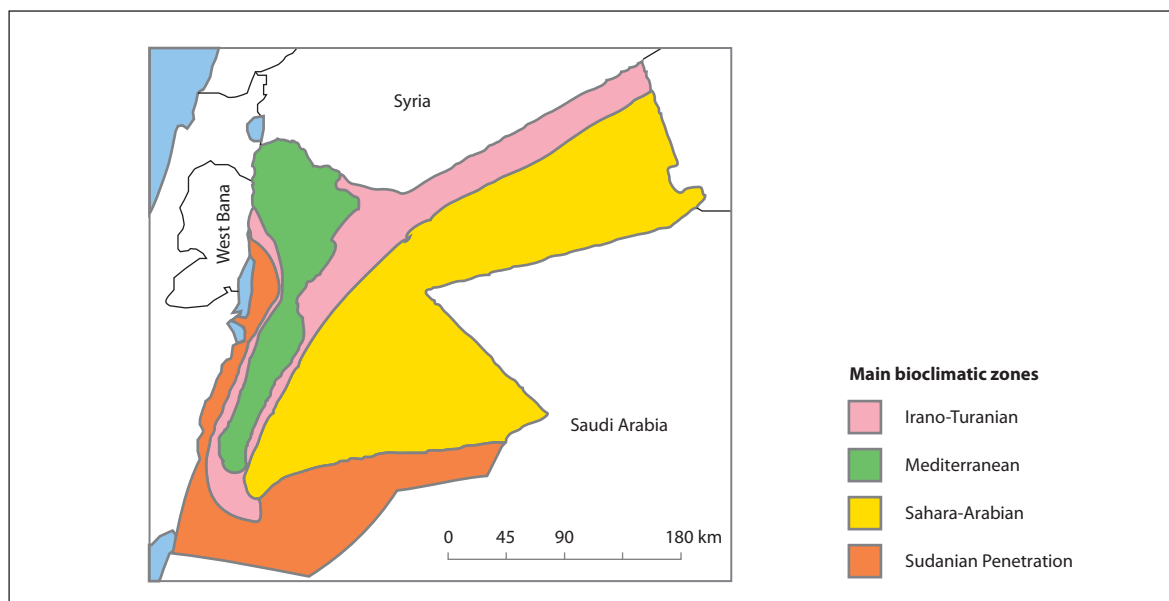


Fig.3. Biogeographic regions of Jordan.

Table 1: Biogeographic regions in Jordan and causes and stage of degradation.

Zone	Characteristics	Causes of Degradation	Stage
Saharo-Arabian and Sudanian Penetration	<ul style="list-style-type: none"> • Desert • Annual rainfall (<100 mm) • covered by sand dunes and desert pavements • Some plant species found inside waterways. 	<ul style="list-style-type: none"> • absence of vegetation cover • dominant desert pavements • high salt and gypsum contents 	advanced
Irano-Turanian climate	<ul style="list-style-type: none"> • Steppe • Intensive agricultural activity of barley cultivation and irrigation • Transitional zone of the Badia • Substantial accumulation of calcareous silt on the soil surface • Low intensity of plant cover 	<ul style="list-style-type: none"> • High rates of wind and water erosion, • Low germination rate of plants, • Overgrazing • Poor rainfall distribution. 	Medium to high
Mediterranean climate	<ul style="list-style-type: none"> • Dry-sub-humid • Rainfall 300->600mm. • Highly developed soil • recession of forest areas, • expansion of urbanized area 	<ul style="list-style-type: none"> • woodland cutting, • urbanization and land fragmentation • water erosion • Low soil organic matter • soil compaction 	High
Jordan Valley	<ul style="list-style-type: none"> • Irrigated agriculture where surface water as main source of irrigation • improper irrigation and fertilization practices • presence of sub surface salty layer (marl) 	<ul style="list-style-type: none"> • soil salinization • Land abandonment in the southern areas resulted from deep plowing and mixing of underlying marl with soil material. 	Medium to high

adequate to produce a reasonable crop (100-500 Kg/ha) and failure or, at best, limited vegetative growth is common. Other land use/cover types form a small proportion of the country's area. Although the urban area constitutes about two per cent of the land, it is mainly concentrated amongst the most productive lands of the high rainfall zone in Amman.

The productivity of Badia areas, officially designated as rangeland (pastureland), varies from one region to another. Chronologically, interest in rangeland assessment, rehabilitation and development in Jordan began as early as the 1950s (HTS, 1956). With the introduction of the tractor on a major scale in the early 1950s, expansion of tillage into the steppe lands speeded up. 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 importantly the limited forage resources. The result is large areas of steppe vegetation have been destroyed and the carrying capacity of the range is much reduced. This is confirmed by many studies and research showing low levels of rangeland productivity that tends 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 and results in yet more pressure on the limited resources of rangelands. Prolonged heavy grazing has changed rangeland quantitatively and qualitatively. In most cases, present production does not exceed one-sixth to one-third of the potential productivity. The cause of this low productivity is overgrazing of the rangelands, resulting from a higher demand for animal products by a fast increasing population. Overgrazing inhibits several plant species from producing enough seeds to maintain suitable vegetation cover. Consequently, several important species have disappeared, and less palatable species have become dominant and taken their place. Many studies and researches showed low levels of rangeland productivity that tend to decrease with time. This was mainly attributed to overgrazing of natural vegetation which has accelerated degradation of rangelands in the low rainfall zones. At the same time, the number of grazing animals is constantly growing 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 per cent to 33 per cent of the amount of vegetation produced by adjacent protected areas (2). (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 as shown in (Figure 4) (13). 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 in that time by about 70 per cent (NAP).

There is still much work to be done to assess the effect of changes on the sustainability of rangelands and their value for future generations. Observations by IFAD missions to Jordan indicated that the

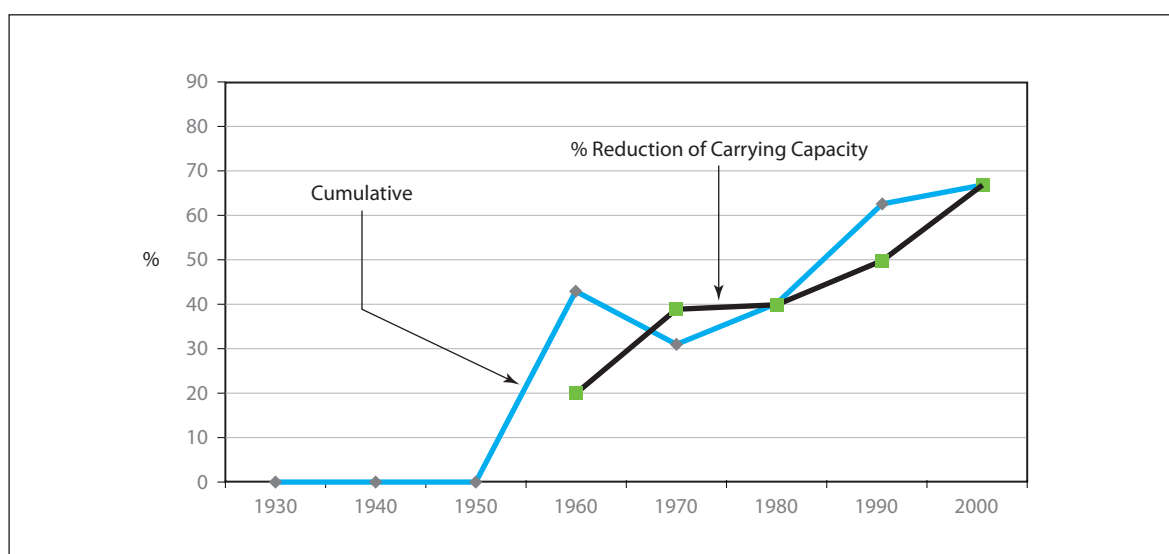


Fig.4: Percentage and cumulative reduction in carrying capacity of rangelands in Jordan (15, 19).

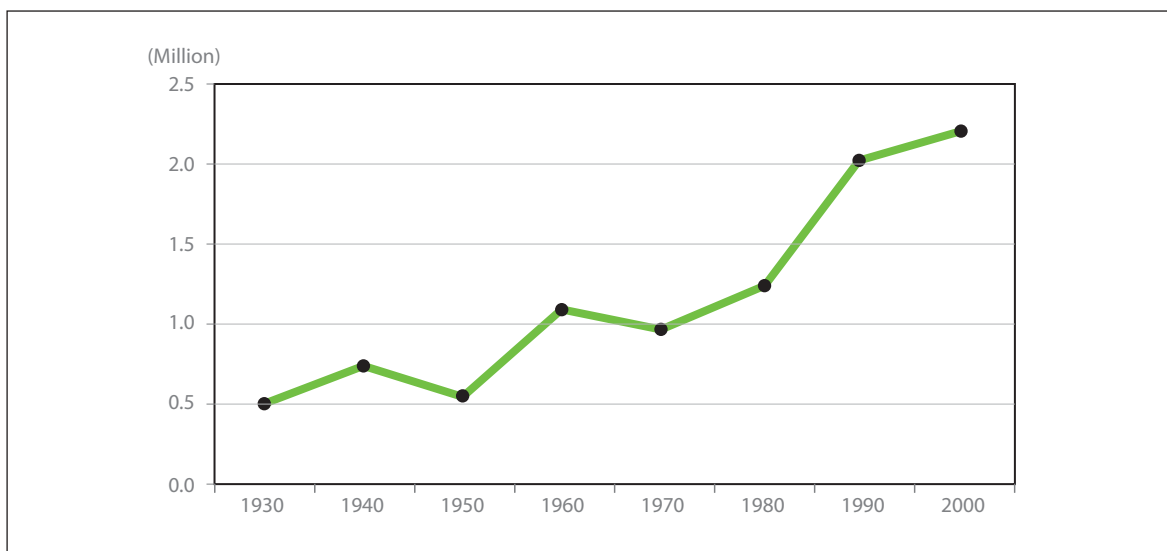


Fig.5: The historical variation of livestock numbers in Jordan (Numbers are aggregated from reports of MoA, (Juneidi, 1996) and Agenda 21)

consumption of green feed doubled from the 1960s to the 1990s, leading to extensive depletion of the seed supply (36). The range supplied 85 per cent of the livestock feed in the 1950-60s, but total consumption was much lower than the 50 per cent “proper utilization factor”. Although the range contribution to animal feed in Jordan was reduced to only 40 per cent in the 1990s, a sharp increase in animal numbers following a sharp rise in imported and subsidized feed grain (Figure 5) has led to the consumption of very large proportions of the standing vegetation (75-90 per cent). According to this study, the area of rangeland subject to intense livestock grazing has been maximized by the establishment of wells and the trucking of water. Furthermore, based on the modeling exercise used by Peter Harris of the IFAD mission in interpreting the available data, the overall forage-energy-utilization level increased from 35 per cent in the 1960s to 67 per cent at present. In simplified terms, this means that at least 290 kg of forage needed to be grown in the 1960s (when there was a more lenient, more sustainable utilization level and high carryover) in exchange for every 100 kg consumed to keep the rangeland in good condition. Under the present regime (overgrazed ranges with little carryover), only 150 kg are grown for every 100 kg consumed. This might explain the cause of the 50 per cent decline in range productivity in Jordan over the last 30 years. Unfortunately, this kind of information is rare and, when available, is often based on distorted or uncertain data.

A study was conducted for desertification assessment and mapping in the north of Jordan using remote sensing and GIS during the period 1983-1997 (12). (Table 2) shows the desertification assessment by type of degradation in Mafraq Governorate. Without doubt, these results illustrate the severity of desertification in the study area. The study of land characteristics has offered answers to some serious problems, such as soil salinity, caused by the ineffective practices of irrigation and shifting cultivation. The erosion analysis highlighted environmental problems, such as the proliferation of quarries in areas better suited to agriculture. The study concluded that there is a need to develop standard methods and criteria for desertification studies. These methods must apply remote sensing data, in such a way as to map and assess continuously and periodically land degradation processes.

Land use changes for four sites within the Badia transition zone of Jordan (Muwaqqar, Fujij, Surra and Um-Al-Quttain) were investigated and quantified over the period from 1953 to 1992 using black and white aerial photographs and Spot Pan Satellite imagery digitally merged with land sat TM (3,4). The most important characteristics of the sites are the high variability of their limited rainfall, thin vegetation cover and the high rate of soil erosion by water and wind. The main trends of change observed at the study sites, mainly due to the pattern of land fragmentation in the area, are; expansion of the urbanized area, shift from rangeland into rainfed cultivation and an incremental loss of rainfed cultivation and rangeland for irrigated fields. Reserve establishment in the study area showed a good example of the potential of semi-arid vegetation to recover when protected.

Table 2: Desertification assessment by type in Mafraq Governorate.

Degree of assessment		Slight	Moderate	High	Very High
Water Erosion	Area (ha)	16441	66793	18404	20628
	%	13.19	53.57	14.76	16.55
Wind Erosion	Area (ha)	30804	20028	19338	2097
	%	24.71	16.06	15.51	41.79
Vegetation Degradation	Area (ha)	3610	10488	35454	72717
	%	2.90	8.41	28.43	58.33
Salinization	Area (ha)	7240	3636	5030	0
	%	5.81	2.92	4.03	0

The present land tenure system is the result of a long conflict between pastoral groups and the administration, and it is the main reason for the destruction of natural vegetation in the steppe and desert rangelands. When Islam introduced the legal package, Al Hema; which is an ancient Islamic traditional grazing system aimed at organizing and reorganizing pasture lands periodically (Shoup, 1990), it was absorbed and practiced by the society willingly. It showed a clear vision for sustainability that is lacking in much legislation nowadays in our civic life. Al Hema was used as an effective mechanism to resolve resource management and land tenure in a progressive framework. Accordingly, for a long period in the past, Jordan's grazing lands were characterized by effective traditional land tenure systems and grazing rights which were associated with tribal institutions. This protected the resources in these lands and organized their use in a way that assisted in their conservation and continued productivity under the prevailing environmental and social conditions. Rangelands productivity began to deteriorate in the 1950s when the rangeland protection system (Al-Hema) and the traditional grazing rights were cancelled and when the declaration of rangelands as state-owned land, open to all, and to new land uses was made. This has led to over-grazing and a real lack of incentive to the livestock owners and the Badia population to protect these rangelands. This deterioration was accompanied by an increase in the number of grazing animals, which exceeded the rangelands carrying capacity and led to the destruction of the plant cover and the decrease of rangeland productive capacity by no less than 6080 per cent. It also reduced the contribution of these rangelands in meeting the needs of the livestock to about 30 per cent only. It follows then that the identification and definition of the ownership of these lands would greatly assist in setting plans for their development and improvement. According to the Agriculture Law No. 20 of 1973, all natural grazing lands are owned by the state; but in practice and reality, the case is the opposite. Failure to enforce existing laws has encouraged the cultivation of the most productive rangelands, resulting in desertification. It is a complex issue, and one that needs careful study to avoid future social and political crises.

Over time communities have tended to change from nomadic Bedouin to settled ones, which are eager to urbanize and reduce dependency on grazing and livestock. Pastoral communities began to plough marginal land at the borders of the Badia to grow cereals in order to confirm property rights, at the point when the survey and registration of lands started in the forties. Settlement of people and building started soon afterwards. Land survey and property registration were resumed in the eighties and most of the marginal grazing and some deep-desert lands were registered. Estimates indicate that at least 1 500 000 hectares (or 15-20 per cent of the traditional grazing land) where the vegetation cover was damaged, were registered to pastoralists. They have become increasingly dependent on alternate income sources, such as employment by the government. (Al-Jaloudy, 2001). As an example, stability and urban expansion accelerated on the marginal lands near the main cities from Ma'an to Mafraq and eastwards along the Syrian border. Large settlements grew deep in the Badia such as Safawi, Rewashed and Reesheh. Government agencies came to provide these communities with services, including education, health, water, electricity, communications etc.



A Bedouin girl with her family's sheep. Over time in Jordan, communities have tended to change from a nomadic to a settled existence.

Arid and semi-arid ecosystems are particularly fragile; therefore, habitat degradation and species losses have been severe. Seven large mammals and at least ten plant species are known to have become locally extinct within the last 90 years and it is estimated that about one million hectares of rangelands have degraded into marginal steppe (NEAP Working Paper, 1995). On average, it has been recorded that rangeland provided about 50 per cent of animal feed over a period of six to eight months, but during the 2006/2007 season and due to drought; the production covered just 20-25 per cent of animal feed and only for a period of three to four months (MoA, Agriculture Situation 2006). The number of livestock is totally out of balance with the available grazing, which has suffered serious mismanagement. The impact of overgrazing on the vegetation is evident from the excessive uprooting of the green matter (grass and bushes), leading to reduced seeding, reduced regeneration, and the consequent loss of plant production in the following year. There is also a change in the floristic composition, a decline in volume and frequency of plants. Despite the increasing numbers of the animals, herders' incomes and prosperity are declining and they remain poor. The causes include lack of sown fodder, decline in traditional management, extending the lambing season to unsuitable months and dependence on complementary feeds. (22) (Al-Jaloudy, 2001).

Overgrazing inhibits several plant species from producing enough seeds to maintain suitable vegetation cover. Consequently, several important species have disappeared, and less palatable species have taken their place and dominate (23). The botanical composition of the natural vegetation was evaluated in Muwaqar Research Station (average rainfall 150 mm) during 1986-1987 (31). During 1986 the number of species recorded was 52, belonging to 46 genera of 19 families, while in 1987 and due to the protection of the study site 150 species belonging to 120 genera of 31 families were recorded. This Station was re-investigated in 1995/96 for the impact of mismanagement of rangeland such as uncontrolled grazing (GRL), and continuous cultivation (CRL) compared to protected rangeland (PRL) on characteristics of soil seed banks (6). The total number of species recorded was 75 belonging to 54 genera and 18 families as well as 13 families not identified. The average number of seeds/m² was 15066, 5270 and 2403 for PRL, GRL and CRL respectively.

It has been concluded that the soil is rich in seeds of different plant species including herbaceous and perennial plants and that the availability of moisture and protection caused the annual plants to germinate and grow. To illustrate the importance of managing grazing and the potential for water harvesting techniques to increase soil moisture, a project was initiated in April 2002 at the Tal Rimah cooperative near Mafraq in northeastern Jordan funded by the U.S. Forest Service (7). In the first

botanical survey, which was carried out before starting the project (2002-03), there were only 22 plant species belonging to 12 different families. However after four years of protection, 51 plant species, belonging to 18 families were recorded in the project area in the 2005/06 survey. In 2006, a new observation of two plant species, *Crocus moabiticus* and *Iris aucheri* in the family of *Iridaceae* were recorded. Species composition varied considerably among the samples collected for these estimates, both inside the treated area and outside. The major differences between the two zones were: (1) the total absence of the grass *Poa bulbosa* in the grazed area and (2) the greater biodiversity in the protected zone. The plant community outside the protected area is dominated by *Siedlitzia florida*, a succulent forb that is relatively unpalatable when green, but grazed readily when mature and dry. Herbaceous forage production in the project area during the 2004 survey was 75 kg/ha inside the reserve compared to 30 kg/ha outside the reserve. Differences between inside and outside the shrub reserve show that grazing can impact rangelands and suggests a potential for greater range forage production under better grazing management (7).

A study of the meteorological data over the last four decades indicated that an average of two years of drought occur each 10-year cycle (8). An update analysis for rainfall distribution over the period 1937-2001, showed that drought frequency over 10 years is 2.43 or about five drought years every 20 years. Based on the available information, it has been possible to conclude with a reasonable degree of certainty that plant biomass is greatly influenced by fluctuations in rainfall (Table 3).

The production of natural rangelands and their contribution in providing livestock feed started to decline in the 1950s when the rangelands were declared as government land with an open access. Among changes observed in this area are the following:

- About 1.0 Million ha of rangelands in the Steppe region were transferred to private ownership. These lands possess high potential for development as rangelands.
- Land fragmentation and degradation started to appear in these newly acquired rangelands as they were treated as a trade commodity, rather than as rangelands for feed production. Development became difficult due also to reasons related to the small plot size of land ownership and social traditions.
- Large areas of rangelands were ploughed, and cleared from surface rocks that protect them from erosion, especially in the eastern areas, for the purpose of claiming land ownership at the time of government land surveys in these areas.
- Due to the continuous decrease in land available for rainfed agriculture and the growing need for livestock feed, about 20,000 ha of rangeland in the Steppe areas were ploughed and planted annually with barley.
- Due to modern transportation means available to livestock owners, the movement of heavy equipment in these areas and the use of trucks to transport animals to grazing areas has led

Table 3: Jordan ranges and their productivity

	Kind of Range		
	Desert Range	Range Land	Total
Area (million Ha)	7.5	1.0	8.5
Rainfall (mm)	<100	100-250	
Feed Unit/du	3	7	
Total Feed Unit (000)	225	70	295
Carrying Capacity (000)	450	140	590

Source: Hassan Gharaybeh, "Livestock Production in Jordan" Working paper for Sym on Agriculture Development in Jordan (Amman: MoA, Dept of Range Management, Fodder and Animal Production, 1974).

to overgrazing and to a great and intensified deterioration of the natural vegetation cover and subsequent accelerated degradation.

- Increased activities and movements in the Badia areas have also contributed to the disruption of the environmental balance, the acceleration of soil erosion and the destruction of the natural vegetation, which has now become confined to areas adjacent to waterways.
- In spite of research efforts that confirmed the availability of opportunities to increase productivity of these lands, the projects implemented by the MoA did not succeed in increasing the rangeland productivity due to a lack of involvement of local people in the development. The Ministry of Agriculture recently started to implement some projects with the participation of local communities as a new approach to secure the involvement of local people in rangeland development.
- The Ministry of Agriculture continued establishing rangeland reserves. The number of reserves is currently 28. These reserves will have positive effects on the protection of plant genetic resources, medicinal and herbal plants, etc.
- Efforts made for the development of rangelands through the implementation of water harvesting techniques showed strong potential for development, which was enhanced by the success of some farmers in establishing large farms using these techniques.

2.3. Costs of land degradation

Because there is a lack of economic data on land degradation, there is no mechanism to determine the financial impact. In a recent study (2004) conducted by the World Bank the cost of environmental degradation in Jordan was estimated to be 3.1 per cent of GDP annually with a total of 205 million JDs estimated for five environmental sectors. The most significant negative impact on health and quality of life was caused by water pollution at an estimated cost of 0.71–1.24 per cent of GDP. Diarrheal illness and mortality are estimated to cost 31 million JD per year. They are caused by lack of access to safe potable water and sanitation, and inadequate domestic, personal and food hygiene. Most of those impacted are children. The damage cost of air pollution associated with mortality and morbidity is estimated at around 0.69 per cent of GDP, while the cost of land degradation comes predominantly from rangeland degradation (0.46 per cent of GDP) and soil salinity (0.14 per cent of GDP). The damage cost from inadequate waste collection, associated with reduction in land prices is estimated at 0.11 per cent of GDP. Finally, the coastal degradation in Aqaba is assessed at around 0.09 per cent of GDP. Although there is some data on land degradation cost, there is a lack of full economic valuation.

3. RESPONSE ACTIONS TO LAND DEGRADATION

Since the destruction of the Badia ecosystem has been acknowledged and with the country's commitments to international conventions, Jordan has established a wide range of initiatives to address the problem of land degradation and to turn the situation around. This has catalyzed governments, research institutions, and communities to find ecologically sustainable approaches to land management. The efforts have concentrated mainly on: national legislation, strategies, programs and research and monitoring. Jordan has in place a substantial body of legislation, programs and strategies for sustainable natural resource management and has developed a range of domestic policy initiatives to encourage and build capacity in communities to address land degradation, especially in Badia. Jordan has also been proactive in implementing projects and initiatives in collaboration with international agency expertise in combating land degradation to cover a range of financial, technology transfer and capacity building support measures. The following sections further explain these issues.

3.1. Review of relevant policies and strategies

The root cause of land degradation problems in Jordan can be attributed to the lack of an effective national policy or guidelines for land use planning. The country needs to invest in capacity development efforts at both systemic (policies) and individual levels to achieve the main objective of developing an effective land use policy that will protect the fertile land from urbanization and assign sustainable use patterns for various types of land. This issue was mentioned in the 1992 national strategy for environmental protection, in the 1996 national action plan for environmental protection, the national strategy for agricultural development, the National Biodiversity Strategy And Action Plan (NBSAP) and the national agenda of 2005. National land use plans and legislation should integrate with an ecosystems approach, linking biophysical with socio-economic requirements to achieve the most sustainable form of land use with the best social and economic results for local communities. It is clear that all national environmental policies have urged the development of a land use plan. Currently, the Ministry of Municipalities and Rural Affairs is coordinating a working group representing many stakeholders to develop the much-needed comprehensive land use plan starting with the designation of land suitable for industrial activities. However, this process needs continuous momentum and capacity development for both the formulation and the implementation phases. In December 2006 the first draft of the plan was released.

Jordan has long prioritized its most pressing problems as being scarce water resources and land degradation (1). Accordingly, all relevant institutions address these issues, when formulating their strategies and future plans. Environmental planning and policy formulation in Jordan came of age in 1992 when the National Environmental Strategy (NES) was formulated. The NES was the first environmental strategy in Jordan and also a first for the Arab region. Based on the NES, Jordan signed and ratified the UN Convention to Combat Desertification (UNCCD) in 1996. In 1995, the National Environmental Action Plan (NEAP) was prepared and remains the environmental guidebook for Jordan. In 2000, Jordan launched its multi-sectoral National Strategy for Sustainable Development which was called "National Agenda 21". Between 1998 and 2005 an array of sectoral policies, strategies and action plans were developed and these paved the ground for a solid policy framework. Many policies were developed between 1998 and 2006 covering water, poverty, agriculture, biodiversity, socio-economic development plan, and desertification. The chronology of environmental and sector-specific planning in Jordan:

- **National Environmental Strategy (NES), 1992**, was the first step carried out to confront environmental problems. The NES included specific chapters on agriculture and land management and water resources. The thematic categorization by the NES was very helpful in developing a scientific policy framework for future policies and action plans in Jordan. Based on the NES, Jordan signed and ratified the UN Convention to Combat Desertification (UNCCD) in 1996.
- **National Environmental Action Plan (NEAP), 1995**, provided a comprehensive assessment of environmental problems and remediation opportunities in Jordan. The NEAP identified environmental priorities needs with special attention recommended for a the following projects related to desertification and land degradation:
 - Development of a national land use planning/zoning system
 - Management of agricultural plastic waste
 - Preservation of forest lands
 - Urban and regional land use planning.
- **Water Strategy and policies, 1998**. Due to the increased demand on water and the scarcity of its supply, the Ministry of Water and Irrigation (MWI) adopted a Water Strategy in 1998. The strategy stresses the need for improved water resources management with particular emphasis on the sustainability of present and future uses. Special emphasis was given to protect Jordan's water resources against pollution, quality degradation, and depletion.
- **National Agenda 21**: Jordan prepared in 2002 its National Agenda 21 document under the supervision of the General Corporation for Environment Protection (Currently MoE). The

document outlined several key areas directly related to natural resources, dry land issues and energy. The Agenda called for promotion of the participatory approach at all levels to ensure success and sustainability. The Agenda 21 outlined a multi-disciplinary national plan of action for an environmentally sound and sustainable economic development. The Agenda 21 acted as an umbrella document that identified combating desertification as a national priority and promotes its integration into national policy. The issue of desertification was addressed specifically in the land resources section and was supported by other sections on rangeland resources management, agricultural land use and alleviation of land degradation. The section on alleviating land degradation focused on measures against soil erosion, soil pollution, and enhancing urban planning issues. For combating desertification, the National Agenda 21 proposed the following strategic objectives:

- Developing a methodology for addressing and mapping the dynamics of desertification, and the processes and hazards in each ecological zone in Jordan
 - Setting up criteria to determine priority areas to combat desertification
 - Diversifying the income of people to mitigate poverty and reduce pressure on land resources
 - Adopting sustainable land use plans and sustainable management of the water resources with the aid of contemporary tools of remote sensing and GIS.
- **National Strategy for Agricultural Development (NSAD)** was prepared in 2002 for the decade 2000-2010. The strategy focused on sustainable agriculture and protection of natural resources. The strategic and operational programs were comprehensive and covered most issues of biodiversity conservation and sustainable use in addition to combating desertification. The NSAD identified certain environmental added values and benefits that could be achieved through its implementation and with the following actions:
 - Conservation of land, water and natural vegetation, through the sustainable utilization that ensures long-term agricultural production
 - Biodiversity conservation in parallel to sustainable agricultural development
 - Improvement of the technical and managerial capabilities of the agricultural sector to cope with climate and environmental changes
 - Halting unplanned expansion of urban areas on agricultural land that are violating current legislation of prohibiting building on agricultural land, through denial of services to these buildings
 - Combating desertification and protecting the environment, the agro-biodiversity and agricultural resources for sustainable development
 - Conservation of agricultural land by controlling soil erosion in steep mountainous areas, through improved agricultural practices and water conservation measures.
 - **Biodiversity Strategy and Action Plan, 2002.** The main strategic goals related to combat desertification are:
 - Conserve biodiversity and use biological resources in a sustainable manner by protecting the various species of animals, plants and microorganisms in their different agricultural environments; and productivity of environmental systems, especially forests, grazing land and agricultural land within a balanced environmental order.
 - Managing natural resources and distributing roles among institutions in a way that conserves the basic natural resources which are necessary for human growth and survival, such as soil, water, plant cover and climate, developing these elements and using them appropriately in a sustainable manner.
 - **The National Agenda was prepared in 2005** and launched in 2006 comprising a comprehensive political and socio-economic reform plan for the country until 2017. The National Agenda contained a special section on environmental sustainability including the arid and desertified zones. This section focused on the following issues including desertification and sustainable land management:

- Survey and criteria definition for desertification hazards and mapping areas accordingly
 - Establish a desertification monitoring system and use it efficiently
 - Conducting socio-economic surveys in drought threatened areas
 - Establish other alternative livelihood measures that could provide incomes in drought prone areas and arid zones.
 - Documenting traditional knowledge on soil protection measures and combating desertification
- **National Capacity Self Assessment (NCSA)** was developed within the framework of the GEF initiative to assess the capacity constraints and potential for implementing the three International Environmental Conventions on Biodiversity, Climate Change and Desertification.
 - National Strategy and Action Plan to Combat Desertification (NAP) was finalized and launched in June, 2006. Although the NAP is still a new document that requires effective awareness programs and a resource mobilization strategy, it can be considered as a framework for action at the country level. The NAP includes six major programs that are mainly “project-based”. However, these programs and the proposed projects provide framework for an action plan to combat desertification. Each program has several projects with justification, activity, implementing agencies and initial budget. The proposed programs are:
 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.
 - **National Strategy and Action Plan for Drought Mitigation.** The Ministry of Agriculture in cooperation with Food and Agricultural Organization of the United Nations (FAO) implemented a project entitled “The drought mitigation strategy in Jordan” this project ended mid 2007. A national strategy and action plan for drought management has been prepared and final recommendations and conclusions were discussed in a national workshop held for this purpose.

3.2. Relationship between land degradation and strategies.

Although land degradation was mentioned in the (NES), Agenda 21, and in the NSAP and is occurring at an accelerated rate in Jordan, it is not yet considered to be the major socio-economic and developmental challenge in the class of water and energy. However, funding for effective implementation is widely viewed as being inadequate and the public budget and the private sector are not allocating enough financial and technical resources for combating land degradation in a systematic way. Methodologies for fund raising should be developed to alleviate land degradation problem. The NAP calls for the establishment of a National Fund to combat desertification under one of its strategic programs. Moreover, the Ministry of Planning is currently developing a resource mobilization strategy for implementing the NAP based on the conceptual analysis and prioritization of NAP activities. It is vital that Jordan puts desertification on the top of its environmental and developmental challenges, to facilitate the process of resource mobilization and allocation from both domestic and international sources. Some good breakthroughs are emerging, as the National Agenda 2006 has placed desertification as one of the main environmental challenges and the national budget has committed financial resources to implementing few suggested activities in the NAP.

Despite good efforts in awareness, education and training programs in Jordan, there is a general inadequacy of sustainable and technically sound programs for various target groups associated with sustainable land management priorities and combating desertification. Such concepts in land

management should be integrated in curricula and taught in higher education and training programs that are based on hands-on examples and lessons learned in sustainable land management issues. The general public, local communities and decision makers should be made aware of various aspects of sustainable land use management. This should include aspects such as tillage techniques, terracing, irrigation limitations, crop use, water harvesting, GIS systems, traditional knowledge and any other aspects that would help communities and decision makers achieve economically and socially viable usage of environmental assets. Most national policies focused on awareness and education; NAP included a strategic program on capacity building based on professional training initiatives on desertification monitoring and control. Many projects that were proposed by the NAP included training and awareness components. However, the actual implementation is still below expectations. The National Strategy for Youth (2004) calls for the integration of environmental concepts in the national curricula and benefiting from experiences of youth participation in environmental management in other countries. The UNCCD puts high emphasis on the participation of key social target groups (local communities, youth, women, etc). This would be in line with Agenda 21, which establishes the need for increased local community involvement based on best dissemination of information to the communities.

The overall efforts of land management and fighting desertification are scattered among many institutions. There is a pressing need to better define specific roles and responsibilities to maximize efficiency and for better integration of available resources. Many organizations are interested in studying and implementing activities for fighting desertification activities. Such a goal has not been specified in previous strategies or action plans related to desertification, but a mechanism similar to that advocated in the biodiversity section might be implemented to coordinate and share data and research results, and to avoid duplication of efforts. The development of coordination mechanisms to ensure that an efficient and cost effective inter-sectoral planning system is developed should be supported.

Although a national bylaw on Environmental Impact Assessment has been developed in Jordan, there are no detailed EIA directives for Impact Assessment on land degradation and desertification. Some capacity development programs and initiatives could be funded for developing the directives and applying them.

While many of the policies and strategies emphasize protection, little is mentioned in the reviewed documents on the issue of rehabilitation. The NAP calls for the development and rehabilitation of forests and rangelands, but is clear that little emphasis has been placed on this issue so far. This is also true for the directives necessary for the implementation of EIA mitigation measures including land rehabilitation and restoration in areas subject to development actions. A national land management plan would take into consideration many environmental, social and economic considerations on a wide scale.

Local communities are the ultimate beneficiary of sustainable land management programs and their empowerment through training, institutional and technical capacity development and financial resources development is a key factor for the success of any desertification control programs. The necessary empowerment of local communities should derive from both documentation and scientific analysis of various forms of traditional knowledge and dissemination of this knowledge through educational and training programs. National policies did not focus on the issue of local community empowerment until the NAP (2006) put great emphasis on that issue through the development of a specific program on human, social and economic development initiatives that are completely based on such empowerment.

The National Agenda 21 called for diversification of the income of people so as to mitigate poverty and reduce pressure on land resources. The National Poverty Reduction Strategy (2000) included the concept of "sustainable livelihoods" in one of its six operational programs. However, the strategy does not reflect a deep and clear understanding and appreciation of the "sustainable livelihoods" concept or the linkages between poverty eradication and natural resource management.

There is a pressing need to develop and implement a national program for monitoring desertification and drought based on a sound system of indicators. This system should be linked to a national program for knowledge management on sustainable land management issues that is accessible to all stakeholders. Currently there are no specific criteria in Jordan for defining the meaning of desertification. Put simply, different people see it in different ways and thus approach the issue from multiple perspectives. These can range from biophysical to socio-economic criteria. It is no surprise that there is no unified database, as this would entail collection of groundwater and surface water, soil characteristics, satellite images, soil deterioration maps, plant cover data, rainfall records, etc. In short, most types of environmental data available would be part of such a database. Such data would ideally be available to all workers in the field, but such a project would be very ambitious. 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. Other maps were produced as hardcopy by the Royal Jordanian Geographic Center within the 1:50000 topographic maps. These maps, however, were based on 1980's aerial photography and therefore require updating. This task is urgent and needs implementation to provide land use/maps, in hard copy and digital formats, for planners, decision-makers, scientific communities and researchers.

Jordan has signed many trade and economic agreements in the last few years in its desire to be integrated into the global economic system. Some of the agreements contain articles and provisions that have a direct and cumulative impact on sustainable land management. Other international agreements signed by Jordan in the agricultural sector contain important provisions related to land management. A capacity development program should be established to raise the awareness of decision makers, professionals and the community at large to the linkages between trade, agriculture and other economic agreements and land degradation issues.

The capacity of national organizations to co-ordinate and network with regional and global programs and organization should be enhanced through capacity development for networking and outreach and opening communication channels with regional and global stakeholders for better sharing of experiences and developing practical partnerships. The corresponding decision makers do have the outreach and networking capacity needed. The ability to leverage these capacities for greater local participation will require a clear and transparent effort to help and establish these linkages.

3.3. Review of previous and ongoing projects.

Knowledge gained from other projects implemented in Jordan and related to land degradation and other ongoing projects is expected to assist the Oasis Project in proper planning and implementation of activities. The review of each project will cover general information, project approach, main activities, major achievements, constraints, lessons learned, and conclusions and recommendations. The projects and implementing institutions covered by the review are:

- **Ministry of Agriculture (MoA).** The MoA is the leading institution in the number of implemented range development projects in the Badia of Jordan (Table 4). Two projects are relevant here; these are (1) National Program for Rangeland Rehabilitation and Development (NPRRD); and (2) Sustainable Rangeland Management Project (SRMP).
- **The National Center for Agricultural Research and Extension (NCARE).** The NCARE implemented the projects shown in (Table 5) to evaluate the adaptability and introduction of fodder shrubs and trees to increase forage production for small ruminants. The project entitled "Development of Integrated Crop/Livestock Production in the Low Rainfall Areas of the Mashreq and Maghreb Regions (M & M) dealt very closely with local communities and was selected to benefit from its experience in the field of community approach. The Badia Benchmark Project was also considered as a pioneer in the methodology and approach used to rehabilitate middle Badia.
- **The Higher Council for Sciences and Technology (HCST).** The HCST funded several projects in the Badia of Jordan (Table 6); recently the staff of Badia Research and Development Program at the HCST implemented a project entitled "Community-based Rangeland Rehabilitation" at

Tal-Rimah in the Mafraq Governorate. The “Community-based Rangeland Rehabilitation at Tal-Rimah” and “Improving Feed Resources at Tal-Hassan” projects were selected to highlight the lessons learned from the implemented activities.

- **Faculty of Agriculture/University of Jordan (FA).** Participated in the execution of two projects: (1) The Improvement of Agricultural Productivity in Arid and Semi-Arid Zones of

Table 4: Implemented range projects in the Badia of Jordan by the MoA.

No.	Project Title	Financing Agency	Duration	Main Activities
1.	Strengthening the Range Department to Implement the National Program for Rangeland Rehabilitation and Development (TPC/JOR/0067(A))	FAO	2000-2002	Capacity building.
2.	National Program for Rangeland Rehabilitation and Development (NPRRD)-Phase I.	IFAD-loan	1998-ongoing	Community participatory approach in rangeland management planning and implementation.
3.	Sustainable Rangeland Management Project (SRMP).	CIDA-Canada	1998-2000	Develop and test local community participatory mechanisms in rangeland development.
4.	Development of Forestry and Rangeland, WFP Assisted Project 2422/Extension II + III	World Food Program	1992-1997	Rangeland development, afforestation and seedling production.
5.	Strengthening Forest and Range Management (JOR/92/004).	FAO	1992-1994	Training on making forest and range management.
6.	Forestry and Rangeland Development Project (JOR/87/007).	UNDP	1988-1990	Training on making forest and range inventories.
7.	Regional Rangeland Management Project (RAB/84/025).	UNDP	1986-1992	Training on Holistic Rangeland Management Implementation of Ma'in Perimeter.

Table 5: Implemented rangeland projects in the Badia of Jordan by the NCARE.

No.	Project Title	Duration	Activities
1.	Community-Based optimization of the Management of Scarce Water Resources in Agriculture in West Asia and North Africa (Badia Benchmark Project)	4 years	<ul style="list-style-type: none"> • Implementation of water harvesting interventions. • Mapping and general characterization of sites. • Monitoring. • Database management and updating. • Public awareness. • Capacity Building. • Research.
2.	Developing Sustainable Livelihoods of Agro-pastoral Communities of West Asia and North Africa (Mashreq & Magreb Project, M&M)		<ul style="list-style-type: none"> • Training and capacity building • Support local associations establishment • Enhance communal rangeland management • Promote water harvesting techniques • Diversifying production and income generation
3.	Communal Management and Optimization of Mechanized Micro catchment Water Harvesting for Combating Desertification in East Mediterranean Region.		<ul style="list-style-type: none"> • Spreading water harvesting technologies using Vallerani Tractor • Community participation

Table 6: Implemented rangeland projects by the HCST.

No.	Project Title	Duration	Activities
1.	Improving Feed Resources at Tal-Hassan.	1995-1998	<ul style="list-style-type: none"> • Water harvesting techniques (contour ridges, contour furrows) and plantation of fodder shrubs (<i>Atriplex halimus</i> and <i>Atriplex nummularia</i>). • Soil amendments with phosphatic fertilizers and Biohumin. • Assessment of soil seed bank. • Production of forage crops (alfalfa, Sudan grass, barley) under irrigation.
2.	Integrated Management Plan for Marab Suweid	1996-2002	<ul style="list-style-type: none"> • Water spreading structures. • Biomass production assessment of native vegetation versus barley cultivation.
3.	Community-based Rangeland Rehabilitation at Tal-Rimah.	2002-2004	<ul style="list-style-type: none"> • Water harvesting structures (contour ridges) and fodder plantations (<i>Atriplex</i> species and <i>Salsola vermiculata</i>).

Jordan Project (JAZPP) and (2) Conservation and Sustainable Use of Dryland Agrobiodiversity in Jordan project (Agrobiodiversity). The two projects were selected to highlight the water harvesting structures and the community driven activities.

3.4. Approaches of reviewed projects

3.4.1. Participatory approach

Participatory approach means that decisions are taken at the lowest level, with full consultation and involvement of users. It is a process in which stakeholders influence policy formulation, alternative uses, and management decisions. The types and scale of interventions and management of the targeted resources (land, water, vegetation...) should involve users, planners and policy-makers at all levels. The process of participation is broad; therefore, no universal interpretations or models of participation are applicable to all development projects.

Participation could be as a **means** or as a **goal** in itself. Participation is seen as a process whereby local people cooperate or collaborate with externally introduced development programs or projects and participation becomes the means whereby such initiatives can be more effectively implemented. Participation is seen as a goal and can be expressed as the empowering of people in terms of their acquiring the skills, knowledge and experience to take greater responsibility for their development. Only M & M, NPRRD, SRMP and Agrobiodiversity projects adopted participation as a goal to empower the local communities. The other projects used participation as a vehicle to demonstrate the different activities and lack the plans for community empowerment for self-management.

The main phases of any project are problem identification, project design, planning, implementation, monitoring and evaluation, and impact assessment. None of the revised projects participated with local communities in all of these five phases. Traditionally, local communities used to be involved only in the implementation phase. The success or failure of projects is closely associated with the extent of involvement of local communities in the different project phases. The participation of communities in all phases of the project, if possible, will induce effective motivation and collaboration and access to local indigenous knowledge.

The types of effort which are undertaken in projects to promote participation range from obtaining information to self-management (Table 7). Visiting local communities is commonly practiced to obtain direct, updated and specific information about the targeted natural resources or community that might help in the preparation of work plans. The approach of obtaining information from the community and deciding what they will do is considered as "passive participation" or "advisory approach".

Table 7: Types of participation during the different stages of projects.

Project Phases	Type of Participation				
	Information	Consultation	Active Involvement	Assuming Responsibility	Self-Management
Problem Identification	N	N	N	N	N
Project Design	N	N	N	N	N
Planning	NPRRD SRMP Tal-Rimah Agrobio M & M BBM	NPRRD SRMP Tal-Rimah Agrobio M & M BBM	NPRRD SRMP Agrobio M & M BBM	N	N
Implementation	NPRRD SRMP Tal-Rimah Agrobio M & M BBM	NPRRD SRMP Tal-Rimah Agrobio M & M BBM	SRMP Tal-Rimah Agrobio M & M BBM	N	N
Monitoring & Evaluation	N	N	N	N	N
Impact Assessment	N	N	N	N	N

The second level of participation is consultation where officials discuss with local communities the main problems and share ideas about possible interventions aiming to alleviate the intensity of these problems. The third level of participation is the effective involvement of the community in the planning process; selection of sites, types and scale of interventions, and incentives are discussed and agreed upon. Implementing the negotiated work plans by the communities under the supervision of officials is the fourth level of participation, where communities assume responsibility about the implementation phases and feel that they have an essential role in the project, which stimulates motivation and responsibility.

The self-management level of participation is when a community manages all aspects of the implemented project interventions at a particular location. To ensure the sustainability of this level of participation a mechanism is needed to clarify the links between officials, community members especially landowners/land users and the management committee of the location where interventions are taking place. The self-management level or commonly labelled “sustainable empowerment” of local communities, should be the ultimate goal of projects dealing with natural resources. Developing the capacities and skills of the collaborating community members about the proper use of the resources and giving them a chance to develop a stake in the project is essential for achieving the self-management level.

In all the reviewed projects, the local communities did not participate in either of the first two phases (problem identification and project design) or in the last two phases (monitoring and evaluation, and impact assessment). Why are local communities not commonly involved in problem identification and project design? Simply because the mandate of the regional and international organizations is to initiate development programs to tackle vital issues for developing countries such as water scarcity, degradation of natural resources and poverty in rural and pastoral communities. These programs are offered to the National Institutions of a particular country for approval and to get assistance from these institutions for implementing the different activities of the proposed projects.

The staff of the National Institutions are usually contacted to help in the selection of sites and communities for demonstrating project activities. Therefore, the targeted communities have no

real role in the problem identification or project design. Consequently, the number of collaborating farmers or stock owners is usually insignificant compared to the size of the targeted community. The collaborating members of these communities show interest in participation with projects to get some benefits such as digging cisterns, fencing lands, eligibility to receive improved rams or barley grains or a temporary job (laborer or guard). In other words, farmers' collaboration in most cases is driven by desire for benefits not commonly concerned with project objectives such as the sustainable use of natural resources.

It is rare to find a community participating in the monitoring and evaluation processes of the implemented projects. For the community, this issue is very important to feel it is having a real role in the process. For the officials, it is vital to know precisely how the communities evaluate the various activities on the different aspects of their livelihood. Moreover, most of the reviewed projects are lacking the impact assessment component, which makes extracting the lessons learned and validating the outcomes of these projects a difficult task. The communities targeted by NPRRD, SRMP, Tal-Rimah, Agrobiodiversity and M & M projects were informed, consulted and became involved in the planning and implementation phases of these projects. Except for M & M, none of the reviewed projects achieved an acceptable and sustainable level of participation.

The potential for improved production and the various different types of incentives were the main triggering factors behind any effective collaboration. The close and active participation of the stakeholders is an essential pre-requisite to success in any intervention utilizing common resources. The local communities should feel that they have an essential role in the project, which stimulates motivation and responsibility.

The Benchmark Project is expected to adopt the "active participation" in all stages of the project, which means that officials have to work with users to make plans and decisions. The participatory approach is completely different from the "advisory approach", where top-down decisions are forced on local communities.

(Table 8) shows the types of adopted approaches by the projects under revision. The participatory approach was practiced by NPRRD, SRMP, M & M, and Agrobiodiversity projects, where formal and informal socioeconomic surveys (Rapid Rural Appraisal) were conducted. The proposed work plans were negotiated with local communities and the expectations from project interventions

Table 8: Types of adopted approaches implemented by the projects in the Badia.

Project Title	Types of Approaches		
	Participatory	Advisory	Technology Transfer
Improvement of Agricultural Productivity in Arid and Semi-Arid Zones of Jordan Project (JAZPP).			X
Conservation and Sustainable Use of Dryland Agrobiodiversity in Jordan Project (Agrobiodiversity).	X		
Community-based Rangeland Rehabilitation at Tal-Rimah.			X
Improving feed resources at Tal-Hassan.			X
National Program for Rangeland Rehabilitation and Development (NPRRD)-Phase I.	X		
Sustainable Rangeland Management Project (SRMP).	X		
Development of Integrated Crop/Livestock Production in the Low Rainfall Areas of the Mashreq and Maghreb Regions (M & M)	X		

were discussed. Several rounds of informative discussions highlighted the responsibilities of local communities and the expected rewards or incentives. Most of the revised projects covered all the costs associated with project activities including the digging of cisterns and re-vegetation and in some cases paying the salaries of guards to protect the rehabilitated sites.

The participatory approaches adopted by some of the revised projects are summarized in the following paragraphs.

- **The National Program for Rangeland Rehabilitation and Development (NPRRD).** This Ministry of Agriculture has selected seven pilot areas to demonstrate the different activities of NPRRD project. These areas are Menshiat El-Ghiath and Ruqban (Mafraq), Shrief (Karak), Touana (Tafila), Mreigha, Husseyiniyah and Hashimiah (Ma'an). Local communities in the selected areas were interviewed using the PRA to identify the true rangeland users and their willingness to participate effectively in the project. The rangeland users and the project staff participated in developing and drafting the work plans. The negotiated work plans were implemented by the two groups (willing rangeland users and project staff) at each pilot area. At each pilot area, a Rangeland Management Group (RMG) consisting of five members: four representing the rangeland users from local community and an officer from the Directorate of Agriculture of the pilot area. The RMG is responsible for implementing the work plans, organizing meetings for training and extension, and monitoring the activities. From a theoretical point of view, the above hierarchal structure seems good but lacks qualified personnel from the different disciplines to implement the work plans and monitor the different activities. This shortcoming should be avoided in the hierarchal structure of future projects.
- **The Sustainable Rangeland Management Project (SRMP).** The three main components of this project are training, developing the community range management model and building the relationship between Governmental institutions and NGOs. Six locations were selected in Tafila (Gharandel and Buseira villages), Madaba (Faisalayah and Fayha villages) and Amman (Nquairah and Mhareb villages) Governorates. In each location, the village leaders and officials of the various Governmental institutions were consulted before conducting the PRA surveys. A Community Rangeland Management Action Plan was the output of the PRA surveys and community participatory development process. The village's community members who participated in the PRA jointly developed these plans with the project staff. These plans address the means to improve range conditions and the livelihood of those living off the range resources. The majority of farmers showed a real willingness to participate in the project because of small credits for micro-projects. The contributing proportion of the **SRMP** and beneficiary into these micro-projects varies according to activity (Table 9).
- **Mashreq-Maghreb Project.** The main objective of this regional project is to develop productive and sustainable small ruminant-based systems, through the integration of crop and livestock production, both within and across arable and rangeland production systems. The participating countries agreed upon certain criteria for selecting the communities. According to these criteria, two communities were selected in Mafraq Governorate; the Harsh-Breiqa at the northern part of Jordan and Mkaifteh to the south-east of Harsh-Breiqa villages. Rapid Rural Appraisal surveys were conducted in the two communities to establish a baseline data of geophysics and socio-economics. The surveys revealed several constraints to the development of small ruminants in the two targeted communities. The project staff

Table 9: Activities and the contribution of Sustainable Rangeland Management Project.

Type of Micro-Project Activities	Project Contribution (%)	Beneficiary Contribution (%)
Rangeland management	60	40
Income generating	30	70
Socio-cultural	70	30
Infrastructure	80	20

discussed the major constraints on production with local communities and several solutions were suggested. The proposed solutions were evaluated from an economic point of view and those which showed higher expected returns were selected to be implemented later in the workplan. This participatory approach was developed later in Faa-Housha community and empowered gradually to reach the self management phase. This is the only projected implemented in Jordan where the local community plan, implement and manage all the activities related to rural development.

3.4.2. Impact assessment

None of the reviewed projects contained elements of impact assessment. The projects tackling the various types of natural resources are expected to evaluate the impact of interventions in three areas: environmental, socio-economical and political. Previous oversight of this important issue could be attributed to lack of expertise in this field, non relevant interventions that will be shown if assessment was done, or failure to cover this issue donor or the country's counterpart who participated in preparing the Project Document or in implementing the activities of project. It was mentioned in one of the reports that the short period (three years) of the project was not sufficient to carry out an impact assessment.

3.5. Water harvesting

At a time when drought and increasing demands for water deepen the problem of water scarcity in the arid regions of the Mediterranean, it becomes essential to assess the potential of traditional methods for harvesting, as a mean of sustainable development. Water harvesting (WH) is a method of water collection that has, historically, been applied in arid and semiarid regions where rainfall is either not sufficient to sustain a good crop and pasture growth or where, due to the erratic nature of precipitation, the risk of crop failure is very high. As a more accurate definition, the process of collecting and concentrating water from runoff into a run-on area where the collected water is directly applied to the cropping area and stored in the soil profile for immediate use by the crop. It has been employed for thousands of years to irrigate and restore productivity to the land, provide drinking water (to both humans and animals), minimize risk in drought prone areas, increase groundwater recharge, and reduce storm water discharges. Today, water harvesting is now being employed all over the world and as new developments have been made, more and more regions are employing water harvesting to help offset pressures on existing water resources and to combat desertification and rehabilitate degraded desert habitats.

As the appropriate choice and deployment of technique depends on the amount of rainfall and its distribution, soil type and depth, land topography, and local socio-economic factors, these systems tend to be very site-specific. Different indigenous techniques and systems were developed in different parts of the world, and they are still referred to in the literature by their traditional names. Among these are *Haffir* and *Teru* in Sudan, *Gessour* in Tunisia, *Khadin* or *Tank* in India, *Lacs Calinaires* in Algeria, *Caag* and *Gawans* in Somalia, *Sayl* in Yemen, *Khuls* in Pakistan, and *Boqueras* in Spain.

The arid lands of Jordan receive about 160 mm of rainfall annually and have a Mediterranean climate. No economic crop can be grown with this amount of rainfall. Farmers in the area depend on livestock and other forms of agriculture using limited groundwater. Today many different organizations, including various government organizations, are experimenting with methods using WH as an alternative to groundwater extraction and as a way to augment crop production and development in the region. Such studies are looking at research into the following four areas of WH; testing specific WH techniques, studying soil surface characteristics, studying and modeling runoff behavior and finally analyzing the economy of WH techniques.

In Jordan, WH technology is making leaps and bounds with the implementation of large scale WH projects initiated by the government, specifically Jordan's Ministry of Agriculture, and various university organizations (e.g. ACSAD). The "Jordan Highland Development Project" was put into action in 1972 which involved using rock dams, contour stone bunds, trapezoidal bunds and earth contour

bunds to increase soil moisture around trees planted on steep lands. A project was launched in 1987 to diversify farmer's production by introducing trees in suitable areas. Lack of water resources limited this option. However, the introduction of the *negarim* to support almond trees in Mouaqar area/ Jordan was a great success (Oweis and Taimah 1996). It indicates that 50 to 60 per cent of the rain in this environment can be captured and utilized by the plants. Experience with rainwater harvesting conducted by ICARDA in co-operation with such national institutions as NCARE and UoJ includes Micro-catchment and Macro-catchment systems. Among the widely used micro-catchment WH techniques are contour ridges, semi-circular and trapezoidal bunds, and small runoff basins. To overcome the contouring difficulties, semi-circular and trapezoidal bunds are usually used. Earthen bunds in the shape of a semi-circle, a crescent, or a trapezoid facing directly upslope are created at a spacing that allows sufficient catchments to provide the required runoff water, which accumulates in front of the bund, where plants are grown. Usually they are placed in staggered rows. These experiences and many others show that the productivity of rainwater in the drier environments can be substantially increased when a proper water harvesting technique is implemented.

4. NATIONAL/SECTOR POLICY ASSESSMENT

There is a consensus among the different studies conducted on land degradation (LD) in Jordan that the main obstacles facing it can be categorized into three main items: 1) Knowledge and Technological aspects; 2) Institutional and Governance; and 3) Economic and Financial (IFAD, 2006). In reality, the three items are highly interrelated. In this report we provide a concise policy assessment of LD through covering the following:

- Main institutions dealing directly and indirectly with LD and their roles
- A stakeholders' analysis related to public policies on LD in Jordan.

The main players dealing with LD issues in Jordan include public, non-governmental institutions and international agencies. The main public institutions are:

- Ministry of Agriculture (MoA)
- National Center for Agriculture Research and Extension (NCARE)
- Ministry of Water and Irrigation (MWI)
- Higher Agricultural Council
- Ministry of Planning and International Cooperation (MoPIC)
- Agriculture Credit Corporation
- Ministry of Environment (MoEn)
- Higher Council for Science and Technology/ Badia Center

The civil society organizations include:

- Farmers Organizations/ Union
- Micro Credit Facilities
- Universities and Research Centers

The main international and regional agencies that have been working in Jordan for decades include:

- United Nations Agencies (mainly FAO and UNDP)
- International Center for Agricultural Research in Dry Lands (ICARDA)
- World Bank and IFAD
- Bilateral Agencies (USAID + GTZ)

The Ministry of Agriculture (MoA): In recent years and due to the high growth in Jordan's economy in general, the contribution of the agricultural sector to Gross Domestic Product (GDP) decreased to very low levels. Despite this fact, the agriculture sector is still considered as one of the important sectors due to its integrated role in rural development and through providing much of fresh horticultural products and raw material for agro-industries.

The National Strategy for Agricultural Development (NSAD) that was instituted by the government concluded that agricultural development is a must, to help control migration from rural areas, conserve natural resources, protect the natural environment, and ensure sustainable development. Among the many constraints that were spelled out by the Strategy and facing the sustainable agricultural development are those related to agricultural resources. These include:

- Continuous decline in the area of productive agricultural land, due to the encroachment of urban activities on agricultural lands, in the absence of a law that regulates land use for different purposes throughout the Kingdom;
- An increase in random construction outside urban planning zones, due to poor enforcement of legislation regulating building on agricultural land;
- The fragmentation of agricultural land, converting larger parcels into small production units unsuitable for mechanized agriculture, resulted in large uncultivated areas being left each year.
- The poor management of rangelands, the destruction of plant cover, weakening of productive capacities of rangelands, and the allocation of about 10 million du of rangelands known as claimed tribal lands to private owners, without proper plans for their development and management as a natural resource. This facilitated its entrance into the real-estate business and its use for non-agricultural purposes;
- The deterioration of the rangeland's natural vegetation due to overgrazing, the absence of a national comprehensive and integrated plan for rangeland development, and the continued urban encroachment on forest lands;
- The fluctuation of rainfall from one season to another, and its irregular seasonal distribution, emergence of clear indicators of decreasing rainfall and an increase in the occurrence of periodical drought cycles as noted during the last three decades;
- A continuous decline in the quantity and quality of fresh water available for agriculture;
- Continued encroachment on forestland through uncontrolled grazing, illegal tree cutting, and using forestlands for government and civil uses;

The National Centre for Agricultural Research and Extension (NCARE): NCARE is a leading institution in LD that works under the umbrella of the MoA. The center has completed several projects and programs dealing with resource conservation and rehabilitation, sustainable natural and agricultural resources management and livelihood improvement. Many of these programs were conducted in collaboration with international and regional agencies such as ICARDA, IFAD, OPEC, UNDP, USAID and GTZ.

Many of the early mentioned projects addressed the issues of enhancing the productivity of agriculture through efficient and sustainable management practices with full participation of rural communities. Some of these programs focused also on water-harvesting activities as one means to increase land productivity and decrease degradation. These programs also addressed policy and institutional issues related to sustainable system management.

Ministry of Environment (MoEN): The Ministry of Environment has substituted the General Corporation for Environmental Protection that was established in 1995 in an attempt to bring all issues to do with the environment under one body. At present, the MoEN is responsible for coordinating all environmental policies of the government in the Kingdom.

In full collaboration with the UNDP, the MoEN prepared an action plan for combating desertification in Jordan and to mitigate the effect of the continuous droughts that hit Jordan in the last decade. The action plan was built on the assumption of utilizing and building on plans and programs previously designed to combat desertification and drought. According to the UNCCD, the main objectives of these programs were: to identify the factors contributing to desertification as a first step required to formulate feasible measures necessary to combat desertification; to specify the respective roles of the different stakeholders and decision-makers; integrate with regional and sub-regional programs, that consider seasonal and inter-annual climate predictions; and to identify appropriate measures to combat desertification with particular emphasis on the community-based approach and poverty alleviation.

The National Action Plan for combating desertification (NAP) which has been prepared by UNDP and published in 2006 is expected to integrate long-term strategies, within the national policies for sustainable development, to combat and mitigate desertification.

Ministry of Water and Irrigation (MoWI): This is the most important institution dealing with water issues in Jordan. The Ministry was established in 1988 and it was formed from the two already existing authorities: 1) Water Authority of Jordan and 2) the Jordan Valley Authority. The major responsibilities of the Ministry of Water and Irrigation are to devise water policies, to embark on strategic planning and resource development programs, to prepare water allocation options, to provide a water resources database, and to monitor and control water quality.

Ministry of Planning and International Cooperation (MoPIC): The key role of the ministry of planning and international cooperation is to provide, source and manage the necessary funds for development projects through loans, grants and technical assistance. This role is conducted in co-ordination with the Ministry of Finance and the General Budget Department. In addition, the Ministry plays an important role in networking and liaising between international financial donors and local ministries and governmental institutions. In relation to land degradation policies, the MoPIC plays a critical role in reviewing all plans put by ministries of agriculture and environment, and then coordinates with potential funding agencies. The MoPIC has been the main funding channel for the majority of LD projects such as those funded by IFAD.

Ministry of Finance (MoF): The MoF is the responsible agency for budgetary and financial issues in general. It administers the budget relating to independent agencies such as NCARE projects and manages the financial side of all loans or international finance for environmental projects. It is also involved in the financial schemes related to taxing or subsidizing policies.

Civil Society Organizations: In addition to the government bodies mentioned above there are several other non-governmental organizations (NGOs) that play a role in environmental protection activities. Some of these have developed several programs and projects such as:

- The Royal Society for Conservation of Nature (RSCN)
- The Jordan Environment Society and the Desertification Combating Society
- The Noor El-Hussein Foundation
- The Jordan Valley Foundation who is making real impact among land users on the conservation of natural ecosystems, combating land degradation and promotion of alternative livelihoods.

4.1. Institutional and Governance aspects of LD

A recent report by IFAD concluded that with regards to institutional and governance aspects, Jordan has achieved good progress by setting key strategies, policies and through preparing a good quality legislative framework. Nevertheless, the report stresses the need for policy and legislative refinement for adopting a fully integrated “ecosystem approach” to combat land degradation. A major policy issue

in this regard is the absence of clear and integrated land use planning legislation which hinders the sustainable management of land resources in Jordan.

Another critical institutional aspect that is linked to the LD issue is the lack of clear economic and financial incentive policies. This is mainly related to the inadequate allocation of financial resources to combat LD. Previous and current policies are still ignoring the financial power that can be deployed through price policies, fiscal policies, and also through improved ownership arrangements to promote sustainable resource use and reduce the level of land degradation.

Policies related to LD in Jordan still lack the dimension of economic and social costs. Their inclusion can only be achieved through adopting proper valuation techniques that consider the impact of national and international economic and agricultural agreements on land management systems. This calls for considering several socio-economic indicators in any proposed policy and institutional analysis such as: 1) population growth that is increasing the land and ecosystem degradation due to increasing pressure on local resources to provide additional food; 2) poverty which is forcing many resource users to rely on short term strategies rather than long term investment in land and resources; 3) the lack of financial resources and compensation mechanisms; and so on.

4.2. Stakeholder analysis

Stakeholder analysis is an essential part of understanding the land degradation problem in Jordan. It is conducted to increase the understanding of the social-cultural and institutional context within which natural resource management and utilization is being done, and therefore within which an intervention will occur. In other words, it is needed to:

- Identify different categories of stakeholders and anticipate the kinds of influence they could exert;
- Identify potential areas of synergy, collaboration and collaborators;
- Identify potential conflicts of interest between stakeholders;
- To identify participants to involve in relevant steps of project design; and
- To identify appropriate forms of stakeholder participation

A stakeholder analysis matrix in relation to combat land degradation problem in Jordan is shown in table 10.

4.3. Indicators needed for analyzing the cost of land degradation

A systematic assessment of the cost of land degradation is needed. The following are important characteristics of this approach:

- To be objective
- To assure consistency (objectives, processes, implementation etc.)
- Follow up and evaluation processes
- Measurement of impacts
- Improving policy making process;

Table 10: Stakeholder analysis matrix

Stakeholder	Characteristics	Interests	Potential impact on Land degradation	Stakeholder Strategy related to LD
Ministry of Agriculture	<ul style="list-style-type: none"> • Fundamental Decision Maker. • Policy and process owner who determines institutional administrative policy and procedures 	<ul style="list-style-type: none"> • Regulatory, monitoring, technical and financial support. • Achieve GOJ goals related to social welfare and reduce poverty • Sustainable use and conservation 	<ul style="list-style-type: none"> • Very high 	<ul style="list-style-type: none"> • LD is a major issue in Agric. Strategy of the MoA • Deep involvement in initiatives related to LD.
Ministry of Water & Irrigation	<ul style="list-style-type: none"> • Fundamental decision maker. • Policy and process owner who determines institutional administrative policy and procedures 	<ul style="list-style-type: none"> • Regulatory, monitoring, technical and financial support related to water issues. • Provision of water and protecting water resources • Achieve GOJ goals related to social welfare and reduce poverty 	<ul style="list-style-type: none"> • High 	<ul style="list-style-type: none"> • Water-related issues are the main concern of the MoWI
Ministry of Environment	<ul style="list-style-type: none"> • Fundamental decision maker. • Policy and process owner who determines institutional administrative policy and procedures 	<ul style="list-style-type: none"> • Regulatory, monitoring, technical and financial support. • Environmental protection • Implementing Int. treaties and agreements • Achieve GOJ goals related to social welfare and reduce poverty • Sustainable use and conservation 	<ul style="list-style-type: none"> • High 	<ul style="list-style-type: none"> • LD is a major issue in the MoE • Involved in initiatives and projects related to LD.
Farmers	<ul style="list-style-type: none"> • Rainfed farmers (mainly cereals)-majority are poor in resources. • Investors (under irrigation), high value crops, fruit trees, vegetables... etc. • Sheep & goats raisers 	<ul style="list-style-type: none"> • Investors and users of natural resources • Achieving maximum profits 	<ul style="list-style-type: none"> • Very High in terms of Land degradation (could be severe impacts) • Pollution of soils and water through using chemicals (fertilizers & pesticides) 	<ul style="list-style-type: none"> • No strategies at farm-levels • Limited actions by farmers
Community-based Development organizations (CBO)	<ul style="list-style-type: none"> • Should be representative and effective partners 	<ul style="list-style-type: none"> • Local development • Local regulator • Sustainable use and conservation 	<ul style="list-style-type: none"> • Limited 	<ul style="list-style-type: none"> • strategies are linked with the government action plans • Limited actions based on available resources mainly by donors

Table 10: Stakeholder analysis matrix (Continued)

Stakeholder	Characteristics	Interests	Potential impact on Land degradation	Stakeholder Strategy related to LD
Agriculture Credit Corporation	<ul style="list-style-type: none"> • Semi-public institution • Lending funds for agricultural activities at relatively low interest rates • Easier lending conditions compared to commercial banks 	<ul style="list-style-type: none"> • Promote agricultural development 	<ul style="list-style-type: none"> • Medium (unless the lending process is restricted to sustainable activities) 	<ul style="list-style-type: none"> • Limited actions
National Center for Agriculture Research (NCAR)	<ul style="list-style-type: none"> • Public research institution. • Implementer of research policy 	<ul style="list-style-type: none"> • Regulatory and monitoring 	<ul style="list-style-type: none"> • High 	<ul style="list-style-type: none"> • Based on the MoA strategies
Int. & regional Research Institutions	<ul style="list-style-type: none"> • Research • Cooperation with local research institutions • Providing technical and financial support 	<ul style="list-style-type: none"> • Applied research • Training • Consulting • Sustainable use and conservation 	<ul style="list-style-type: none"> • High/ Medium 	<ul style="list-style-type: none"> • Depends on the implemented programs and action plans
Universities	<ul style="list-style-type: none"> • Research & teaching institution. • Implementer of academic policy 	<ul style="list-style-type: none"> • Academic research • Teaching • Consulting 	<ul style="list-style-type: none"> • Medium 	<ul style="list-style-type: none"> • Based on the Ministry of Higher Education strategies • Own mandates and priorities • Cooperation with other national and international research institutions
Higher Agricultural Council	<ul style="list-style-type: none"> • Fundamental Decision Maker. 	<ul style="list-style-type: none"> • Regulatory and monitoring 	<ul style="list-style-type: none"> • High 	<ul style="list-style-type: none"> • Based on the MoA strategies
Ministry of Trade & Industry	<ul style="list-style-type: none"> • Decision Maker. • Policy and process related to imports of animal feeds 	<ul style="list-style-type: none"> • Regulatory, monitoring, technical and financial support. • Implementing Int. treaties and agreements (WTO) • Achieve GOJ goals related to social welfare and reduce poverty 	<ul style="list-style-type: none"> • High 	<ul style="list-style-type: none"> • Linked to government strategy
Ministry of Planning	<ul style="list-style-type: none"> • Decision Maker. • Policy and process related to international cooperation • Monitoring spending on funded projects 	<ul style="list-style-type: none"> • Seeking funding • Implementing Int. treaties and agreements (WTO) • Achieve GOJ goals related to social welfare and reduce poverty 	<ul style="list-style-type: none"> • High/ Medium 	<ul style="list-style-type: none"> • Linked to government strategy and priorities

There are several types of indicators that are needed to measure the “cost of environmental degradation”. The indicators are highly related to the definition of land degradation which is a result of environmental conditions and inappropriate human management. These indicators can be classified into:

- **Technical indicators** (rainfall, wind, temperatures, soil and water salinity etc.)
- **Socio-economic indicators and Institutional Indicators.** These indicators are needed to study the root causes of land degradation. At the same time they are needed to study the consequences of land degradation and desertification which may include:
 - Poverty and food insecurity combined with extreme climatic variation such as drought, whether natural or anthropogenic
 - Lack of opportunity
 - Disempowerment.

These indicators also help in identifying the options available to poor farmers and land users (land managers) to improve their lands as well as identifying those constraints facing small farmers vs richer farmers.

Socio-economic indicators help in understanding the main causes of land degradation by poor land managers who:

- Are often forced to degrade land for their day-to-day survival (e.g., to ensure food provision)
- Have poor access to land, credit, cash, labor, and livestock;
- Lack infrastructure
- Lack information and technology to improve agricultural yields and face political marginalization to improve their lives.

Due to the centrality of poverty as a root cause, and consequence, of land degradation – in which the causes and consequences of land degradation are more pronounced among the poorest segments of the world’s population – socio-economic indicators are framed by key characteristics of poverty:

- Insecurity (Food Insecurity) e.g., vulnerability to adverse shocks and limited means to cope;
- lack of opportunity (e.g., lack of income, credit, land, and other assets to attain basic necessities such as food, clothing and shelter; and
- Disempowerment (e.g., voicelessness and lack of power to influence decisions).

4.3.1. The need for socio-economic and institutional Indicators

In general, indicators are needed as an essential part of any management by objectives and for the continuous improvement of land management systems. Socio-economic indicators are part of the overall indicator set used in the assessment process. However, these indicators are highly related to the wellbeing of the society in general and the targeted community in specific.

These indicators can be used in measuring the cost of land degradation and to identify some policy parameters that can be used in mitigating the negative impacts of land degradation in the drylands of the targeted countries.

Indicators are structured information that provide evidence for proper decisions, considering transparency as a priority. They can be used as policy instruments for measuring policy impacts and can also be strategy-driven benchmarks to measure targets and planning instruments used in priority setting.

4.3.2. Types and levels of socio-economic and institutional indicators

Different types of socioeconomic and institutional indicators are frequently used in the assessment process:

- qualitative indicators
- quantitative indicators
- efficiency indicators
- effectiveness indicators
- performance indicators

Indicators can be taken at different levels:

- Global level
- National (Regional) level
- Unit (enterprise) level

Indicators can also refer to:

- Inputs and outputs
- Costs of resources
- Outcome of certain processes
- Structures of performance
- Development process.

4.3.3. Proposed socio-economic indicators of land degradation

Based on the above presentation of the nature of socio-economic indicators, the following are believed to be the most appropriate indicators for Jordan. Many of these indicators were developed by the Land Degradation Assessment in Drylands initiative (LADA) (FAO 2006). The indicators are presented in the following tables at the three identified levels: 1) Global; 2) National; and 3) Unit (enterprise).

Tables 11, 12 and 13 show the socio-economic indicators at the global level for the “Food insecurity, Lack of opportunity and Disempowerment” criteria of poverty, respectively. These indicators can be used for conducting a comparative analysis among the different countries in the region or among those participating in the Oasis project.

Table 11: Socio-economic indicators of land degradation at Global Level – Insecurity

Insecurity: Food insecurity	Description
Percentage of rural population below poverty line	Income/ consumption
GDP per capita	Income/ consumption
Rural population density	Demographic pressure
Annual internal renewable water supply per person (m3)	Water depletion
Food production index	Agricultural yields/food
Percentage of rural children under five who are underweight	Malnutrition
Rural infant mortality rate per 1000 live births	Malnutrition
Future population density/pressures	Demographic pressure

Table 12: Socioeconomic indicators of land degradation at global level– Lack of opportunity

Lack of opportunity	Description
Poverty gap index/income Gini coefficient	Distribution of wealth
Discrepancies in GDP per capita	Discrepancies in wealth
Mean per capita expenditure of rural population	Assets
Agricultural GDP	Employment
Number of hectares of agricultural land per farmer	Marginal land/land pressure

Table 13: Socioeconomic indicators of land degradation at Global Level-Disempowerment

Disempowerment	Description
Percent school enrollment rates of girls and boys	Provision of information
Rural male and female literacy rate	Provision of information
(Percentage) rural population access to safe water (proxy)	Infrastructure
Hectares per tractor/access to technology	Hectares per tractor /access to technology
Density of road network (in kilometers per hectare of agricultural land)“	Density of road network (in kilometers per hectare of agricultural land)“

Tables 14, 15 and 16 summarize the socio-economic indicators at the national level for the “Food Insecurity, Lack of Opportunity and Disempowerment” criteria of poverty, respectively. These indicators can be used for conducting a comparative analysis among the different countries in the region or those participating in the Oasis project.

Tables 17, 18 and 19 show the socio-economic indicators at the enterprise (village and farmer level indicators) for the “Food Insecurity and Lack of Opportunity and Disempowerment” criteria of poverty, respectively. These indicators can be used for conducting a comparative analysis among the different countries in the region or those participating in the Oasis project.

Other indicators that can also be considered in the LD socio-economic and policy analysis may include external or exogenous conditioning factors such as:

- The flow of remittances from migrants
- Land-user motives
- Livelihood dynamics that influence livelihood change in the direction of more sustainable, less degrading land management.

4.4. Data sources for land degradation assessment

The two main sources of data that can be used in the analysis include: Primary and secondary data sets. The primary data is usually collected by field surveys, focus groups, telephone, mail, internet, etc. The secondary data is collected from other sources, published and unpublished records of Dept. of statistics, Ministries of agriculture, industry and environment, reports published by international agencies such as WB, USAID, GTZ, and ICARDA.

Table 14: Socioeconomic indicators of land degradation at National Level–Food Insecurity

Insecurity: Food insecurity	Description
Percentage of rural population below poverty line	Income/Consumption
Household consumption expenditure rates	Income/Consumption
Agricultural population vs. total population	Demographic Pressure
(Percentage of) rural households with potable water	Water depletion
Gender balance between urban and rural	Demographic pressure
Value of Production (VoP) per hectare of cropland	Agricultural yields/food
Rural population density (persons per km ²) by arable land	Demographic pressure
Rural population density (persons per km ²) in relation to agro-climatic zones and soil type (rural population/land ratio)	Demographic pressure
Percentage of potential arable land	Agricultural yields/food
Percentage of farmers without access to cultivable land	Agricultural yields/food
Food production index	Agricultural yields/food
Increased distance walked by household members to collect water	Water depletion
Dependence on public relief and emergency aid	Agricultural yields/food
Percentage of rural children under five who are underweight	Malnutrition
Percentage of rural children who are stunted	Malnutrition
Percentage of children who are “wasted” (weight for height)	Malnutrition
Rural infant mortality rate per 1000 live births	Malnutrition
Per capita calorie, fat and protein intake	Malnutrition
Change in water availability per capita (m ³)	Water depletion
Number of people forced to migrate due to drought, conflict, or other extreme event	Drought and conflict
Net migration rate (rural to urban – excludes traditional migratory patterns by nomadic groups)	Demographic
Future population density/pressure	Demographic
Number of deaths due to drought, conflict, or other extreme event	Drought and conflict

Analysis tools that can be used in LD assessment:

- Quantitative and qualitative analysis
- Simple statistical descriptive analysis (mean, mode, STD deviation, histograms)
- Causality analysis: Linear and non-linear regression analysis. Simple regression analysis or systems
- Quantitative policy analysis: Policy Analysis Matrix
- Market level analysis
- Community models
- General Equilibrium Models.

Table 15: Socio-economic indicators of land degradation at national level – lack of opportunity

Lack of opportunity	Description
Discrepancies in household consumption expenditure rates	Distribution of wealth
Discrepancies in GDP per capita	Distribution of wealth
Rural infant mortality rate per 1000 live births	Malnutrition
High percentage of land to high income group	Distribution of wealth
Type of land tenure	Land tenure
Ease of access to land and resources for women and men	Land tenure
Evidence of inequality in the distribution of property rights (between rich and poor and women and men)	Land tenure
Ease of access to land registries and title services for women and men	Land tenure
Unemployment rate	Employment
Percentage of agricultural labor force	Employment
Percentage of non-agricultural labor force	Employment
Availability of credit schemes	Assets
Male and female access to cash and credit	Assets
Mean per capita expenditure of rural population	Assets
Density of road network (in kilometers per hectare of agricultural land)	Assets
Land ownership (proxy)	Assets
Rural land/labor ratio	Employment
(Percentage of) farmers without access to cultivable land	Marginal land
Number of hectares of agricultural land per farmer	Marginal land
Percentage of cultivation on open access land, common property and private property	Land tenure
Security of land tenure for women and men	Land tenure
Clarity of land ownership/property rights for women and men	Land tenure
(Percentage of) residents using traditional fuels	Marginal land
Rural to urban migration rate (excludes traditional migratory balance between urban and rural)	Employment
Number of hectares of agricultural land per farmer	Marginal land

Table 16: Socio-economic indicators of land degradation at national level – disempowerment

Disempowerment	Description
Rural male and female literacy rate	Provision of information
(Percentage of) farmers cultivating on steep slopes	Marginal land
Percent school enrollment rates of girls and boys	Provision of information
Location and type of input and output suppliers, traders, and market	Access to technology
Hectares per tractor	Access to technology
Government spending in rural infrastructure	Infrastructure
Density of road network (in kilometers per hectare of agricultural land)	Infrastructure
(Percentage) rural population access to safe water	Infrastructure
Presence of toilet, TV, radio, corrugated iron sheets for roof cover, etc.	Infrastructure

Table 17: Socio-economic indicators of land degradation at enterprise level – Food insecurity

Insecurity: Food insecurity	Description
Hours of available rural water supply	Water depletion
Female headed households (proxy)	Income/consumption
Changing ratio of staple (subsistence) vs. cash (marketed) crops produced by women and by men	Agricultural yields/food
Change in quantity of household consumption derived from forest and fisheries products	Agricultural yields/food
Increased amount of time spent to obtain water	Water depletion
Increased distance walked to by household members to collect water	Water depletion
Amount of meat available in market	Malnutrition
Number of months facing hunger	Malnutrition
Abandonment of (farm) land	Drought or conflict
Number of households rendered homeless due to conflict	Conflict
Change in diversity of diet (meat, legumes, eggs, fish, etc.)/ frequency of meat, poultry or fish consumption	Malnutrition
Concern about livelihood of children	Malnutrition

Table 18: Socioeconomic indicators of land degradation at the enterprise Level – Lack of opportunity

Lack of opportunity	Description
Ease of access to land registries and title services for women and men	Land tenure
Ease of access to land and resources for women and men	Land tenure
Type of land tenure	Land tenure
High percentage of land to high income group	Distribution of wealth
Off-farm employment for women and men	Employment
Quantity of annual income derived from farm (cultivation, livestock) and non-farm activities	Employment
Availability of credit schemes	Assets
Male and female access to cash and credit	Assets
Number of livestock (sheep, goat, cattle etc.)	Assets
Rural households with adequate water for livestock	Assets
Availability of financial services/infrastructure	Assets
Presence of banking institutions	Assets
Distance to nearest banking center	Assets
Distance to nearest market	Assets
Transport problems due to bad roads	Assets
Price of transport	Assets
Decline in quantity of annual household consumption that is derived from the common land	Land tenure
Decline in the existence of sustainable Common Pool Resource (CPR) management institutions	Land tenure
Security of land tenure for women and men	Land tenure
Clarity of land ownership/property rights for women and men	Land tenure
Residents using traditional fuels	Marginal land
Existence of manure contracts between farmers and herders	Marginal land
(Seasonal) migration of men (excludes traditional patterns by nomadic groups)	Employment
Changing roles of women and men	Employment
Increase in non-farm employment for women and men	Employment

Table 19: Socio-economic indicators of land degradation at the enterprise level – disempowerment

Disempowerment	Description
Presence of telephones	Provision of information
Presence of internet access	Provision of information
Price of transport	Infrastructure
Transport problems due to bad roads	Infrastructure
Distance to nearest market	Infrastructure
Rural population access to safe water	Infrastructure
Distance to market (input and output suppliers)	Access to technology
Access to tools in market	Access to technology
Availability/access to cart	Access to technology
Farmers with access to irrigation	Access to technology
Cultural practices and spiritual beliefs and taboos that may be inhibiting use of technology and information to conserve land and soils	Cultural practices
Female and male roles in traditional land management and modern land management	Cultural practices
Change in women's indigenous knowledge associated with land management	Provision of information
Change in men's indigenous knowledge associated with land management	Provision of information
Increased/reduced availability of tools in market	Access to technology
Availability of extension services/agricultural education	Provision of information
Frequency of extension services/agricultural education	Provision of information
Development of locally adapted demand based agricultural research and extension	Provision of information
Farmers using soil conservation/land management practices (e.g., use of less extensive tillage, terracing, mixed and perennial cropping, livestock rotation, and forage restoration)	Provision of information
Integration of farmer knowledge in tool development	Access to technology
Increased/reduced availability of consumer goods and services	Infrastructure
Presence of small-scale rural infrastructure projects	Infrastructure
Increase in farmer owned small cooperatives	Infrastructure
Installation of water pipes	Infrastructure

5. GAPS AND BARRIERS

Despite all the effort so far, there remain some key barriers and constraints which hinder progress leading to the adoption of improved approaches that address land degradation issues and alleviate rural poverty. These barriers can be grouped into three main categories:

Knowledge and technological, there is a *lack of effective information and knowledge management*- from collection to dissemination- resulting in interventions that do not address land use planning in an integrated manner, also impeding the synergies that would be possible through the application of the UNCCD with other UN Conventions;

Institutional and governance, with a lack of concrete experience that *integrate* the sustainable management of resources and poverty alleviation efforts leading to the application of the existing policy and legislative framework – greater effort is required to fine-tune and add effectiveness to the inter/intra-institutional coordination framework, within a fully integrated land use planning approach; and

Economic and financial barriers, with insufficient and inadequate allocation of financial resources. Compensation mechanisms to cover costs in switching to the SLM practices and incentives that allow for alternative livelihoods and exit strategies are missing.

Through the Oasis project a sound foundation for complementary efforts that may reduce some of the barriers and address negative impacts associated with land degradation on the country's ecosystems can be built. The proposed project activities will go together with previous activities and provide a more holistic approach for pursuing adoption and up-scaling of sustainable land management practices at both the local, governorate and national levels.

6. CONCLUSION

In regions where food security and poverty alleviation are priorities, such as Jordan and many others in the region, the primary emphasis regarding land is its availability, the abatement of land degradation, and efficient land and water management. Degradation will continue if human activities are not carefully managed. The message currently being propagated by the FAO is to encourage countries in arid and semi-arid areas to identify reasons for land degradation.

Field observations indicate a gradual increase in land degradation in Jordan. Major reasons for such a phenomenon are argued to be encroaching urbanization into the traditional agricultural land, persistent drought seasons, water shortage, deforestation, losses in land productivity, decreasing agricultural feasibility of traditional crops, decreasing availability of cheap labor, switching agriculture to other professions, discouraging an environment of investment in the agricultural sector, increasing prices of agricultural inputs, deficiencies in "know-how" of soil-water management in the arid lands and the introduction of new competitive commercial crops in irrigated agriculture. Consequences of land degradation are thought to include diminishing agriculture areas, abandoning agriculture for other professions, switch to cash-crops, over exploitation of natural land, practicing monoculture crops (losses of native genetic resources), over exploitation of natural vegetation cover for human and animal use, soil and water pollution by chemical fertilizers and pesticides.

The combination of limited resources and environmental constraints, coupled with a growing population and rapid urbanization, has posed an enduring challenge for both policy makers and citizens, especially the poor. Environmental legislation forms the backbone of environment protection in Jordan. The enforcement of these laws constitutes one of the most essential tools to translate theory into reality. This should be coupled with occasional review and updating of the environmental legislation.

The challenge of lower than optimum rainfall is truly daunting but little concerted efforts to increase the effectiveness of rain, to explore the potential of water harvesting, and to develop better crop and soil management practices have been made. Improved utilization of the better dryland cropping areas will allow climatically marginal cropland to be returned to good grazing land. Few researchers argue that Jordan, as well as most of MENA countries are ignorant of the appropriate technologies to combat desertification such as rainwater harvesting but the problem remains that these technologies are not used sufficiently due to insufficient knowledge of the socioeconomic contexts, incorrect identification of the causes of the arid land problems and ineffective management of natural resources.

7. REFERENCES

- Abu-Sharar, T.M. 2006. The challenges of land and water resources degradation in Jordan: Diagnosis and solutions. *Desertification in the Mediterranean Region: A Security Issue*, 201–226.
- Abu-Irmaileh, B. E., 1994. Al-Mowaqqar, a model for arid rangelands in Jordan. *Journal of Arid Environments*, 28:155-162.
- Al-Bakri, J. T. and Taylor, J. C., 2003, Application of NOAA-AVHRR for monitoring vegetation conditions and biomass in Jordan, *Journal of Arid Environments*, Volume 54, No. 3: 579-593.
- Al-Bakri, J. T. and Taylor, J. C., Brewer, T. R., 2001, Monitoring land uses change in the Badia transition zone in Jordan using aerial photography and satellite imagery. *Geographical Journal*. 167(3):248-262.
- Al-Hadidi, L. M.1996. Evaluation of desertification risk in Jordan using some climatic parameters. Unpublished M.Sc. thesis, University of Jordan, Amman, Jordan.
- Al-Shawahneh, N., 1996. Assessment of Soil Seed Bank in Al-Muwaqqar Region in Jordan. Unpublished MSc thesis, University of Jordan, Amman, Jordan.
- Al-Tabini, R., James L. , Hani S. , Derek B., Ismaiel A., and Jerry H. 2008. Tal Rimah Range Rehabilitation – Recreating a Valuable Resource. Jordan Component of the Sustainable Development of Drylands Project. Report # 4
- Aresvik, O., 1976. *The Agricultural Development of Jordan*. Praeger Publisher. ISBN 0-275-00450-3.
- Blench, R. Rangeland degradation and socio-economic changes among the Bedu of Jordan: results of the 1995 IFAD.
- DREGNE, H. 2002. Land Degradation in the Drylands. *Arid Land Research and Management*, 16:99-132.
- ESCWA. 2007. Land degradation assessment and prevention: selected case studies from the ESCWA region.
- Harahsheh, H., Tateishi, R., El-Qudah, O., 1998. Remote sensing and geographic information system applications for land use and land suitability mapping: Case study—Irbid District, Jordan. *The Arab World Geographer* 1: 6-23.
- Hatough, A. Al-Eisawi, D.M. and Disi, A.M. 1986. The effect of conservation on wildlife in Jordan. *Environmental Conservation*, 13(4): 331-335.
- JAZPP, 2001. Final report of the Improvement of Arid Zone Productivity Project. EC-funded project, SEM/O3/628/021.
- Juneidi, J.M., Abu-Zanat, M., 1993. Jordan agricultural sector review: low rainfall zone, Agricultural Policy Analysis Project, Phase II (APAP II), USAID, Amman, Jordan.
- Khresat, S., 2006. Major Causes of Land Degradation and Desertification in Jordan. Proc. 18th World Congress of Soil Science July 9-15, 2006 - Philadelphia, Pennsylvania, USA
- Khresat, S. A., Rawajfih, Z., Mohammad, M., 1998. Land degradation in north-western Jordan: Causes and processes. *Journal of Arid Environments* 39: 623-629.
- Mazahreh, S. S., 1998, Alternatives for land utilization in an arid to semi-arid region in Jordan. Unpublished MSc Thesis, University of Jordan, Amman, Jordan.
- Ministry of Agriculture. 2003. *The National Strategy for Agricultural Development 2002-2010*.
- Ministry of Agriculture. 2001. *National Rangeland strategy for Jordan*.
- Ministry of Agriculture, Jordan, 1995. *The soils of Jordan, Report of the National Soil Map and Land Use Project, Volume 2: Main Report*, Ministry of Agriculture, Amman, Jordan.

Ministry of Agriculture, Jordan, 1993. The Soils of Jordan: Level 1 (Reconnaissance Survey), National Soil Map and Land Use Project. Ministry of Agriculture, Jordan.

Ministry of Environment. 2001. Jordan Biodiversity-First National Report.

Ministry of Environment. 2006. Environmental Profile of Jordan 2006. National Capacity Self Assessment for Global Environmental Management Project (NCSA)- Jordan

Ministry of Environment. 2006. National capacity assessment report and action plan. National Capacity Self Assessment for Global Environmental Management Project (NCSA)- Jordan

Ministry of Environment. 2006. National Strategy and Action Plan to Combat Desertification.

Ministry of Environment. 2007. Third Country Report on “The Implementation of the United Nations Convention to Desertification (UNCCD) Combat”.

MMRAE. 2002. Jordan Agenda 21: Towards Sustainable Development. MMRAE/UNDP/Capacity 21. Makhamreh, Z. M., 1996. Optimal land use alternatives for arid to semi-arid area in Jordan. Unpublished MSc Thesis, University of Jordan, Amman, Jordan.

Nasr, M. 1999. Assessing Desertification and Water Harvesting in the Middle East and North Africa: Policy Implications. ZEF–Discussion Papers on Development Policy No. 10, Center for Development Research, Bonn, July. pp. 59.

Sharaiha, R. and F. Ziadat. 2008. Alternative Cropping Systems to Control Soil Erosion in the Arid to Semi-Arid Areas of Jordan. *Arid Land Research and Management*, 22:16–28.

Syoof, M., 1988. Botanical composition, distribution and adaptation of natural vegetation under Semi arid conditions in Jordan. Unpublished MSc thesis, University of Jordan, Amman, Jordan.

Taimah, A., Y., 1989, Desertification in Jordan. In: V. Faenza and D. Randazzo (eds.), *Disastri Ambientale Desertificazione (Environmental Disasters and Desertification)*, Proceedings of the International Conference on Desertification, Palermo, June 1989, pp. 237-261.

The General Corporation for the Environment Protection. 2001. Jordan’s Report about Sustainable Development to Johannesburg Summit 2002.

Ziadat, F. M., 2000. Application of GIS and Remote Sensing for Land Use Planning in the Arid Areas of Jordan. Unpublished PhD Thesis, Cranfield University, Bedford, UK.

Ziadat, F. B. Hattar, and A. Baqain. 2006. Farmers’ verification of improved land-use alternatives in the transitional Badia of Jordan. *Renewable Agriculture and Food Systems*: 21(4); 207–215.

http://www.ifad.org/lrkm/theme/range/arid/arid_2.htm

www.fao.org/docrep/nonfao/LEAD/X6188e/X6188e00.pdf

<http://www.unep.org/GEO/geo3/english/170.htm>

About ICARDA and the CGIAR



Established in 1977, the International Center for Agricultural Research in the Dry Areas (ICARDA) is one of 15 centers supported by the CGIAR. ICARDA's mission is to contribute to the improvement of livelihoods of the resource-poor in dry areas by enhancing food security and alleviating poverty through research and partnerships to achieve sustainable increases in agricultural productivity and income, while ensuring the efficient and more equitable use and conservation of natural resources.

ICARDA has a global mandate for the improvement of barley, lentil and faba bean, and serves the non-tropical dry areas for the improvement of on-farm water use efficiency, rangeland and small-ruminant production. In the Central and West Asia and North Africa (CWANA) region, ICARDA contributes to the improvement of bread and durum wheats, kabuli chickpea, pasture and forage legumes, and associated farming systems. It also works on improved land management, diversification of production systems, and value-added crop and livestock products. Social, economic and policy research is an integral component of ICARDA's research to better target poverty and to enhance the uptake and maximize impact of research outputs.



The Consultative Group on International Agricultural Research (CGIAR) is a strategic alliance of countries, international and regional organizations, and private foundations supporting 15 international agricultural Centers that work with national agricultural research systems and civil society organizations including the private sector. The alliance mobilizes agricultural science to reduce poverty, foster human well being, promote agricultural growth and protect the environment. The CGIAR generates global public goods that are available to all.

The World Bank, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), and the International Fund for Agricultural Development (IFAD) are cosponsors of the CGIAR. The World Bank provides the CGIAR with a System Office in Washington, DC. A Science Council, with its Secretariat at FAO in Rome, assists the System in the development of its research program.