

# THE CHALLENGES OF LAND AND WATER RESOURCES DEGRADATION IN JORDAN: DIAGNOSIS AND SOLUTIONS

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## ABSTRACT

Desertification is the loss of complexity of biological and/or economic productivity of crop-, range- or wood-lands. Reasons of such a loss is mainly due to climatic change and unsustainable human activities. The arid and semi-arid lands of Jordan are sensitive to human interference that resulted in a severe depletion of its natural resources and in different forms of land degradation due to multiple interaction of socio-economic factors. Further, degradation will continue if human activities are not carefully controlled and managed. Almost 90% of the land area of Jordan receives less than 200 mm of rainfall annually. This is reflected in poor structural stability of soils and the subsequent vulnerability to excessive erosion following shallow rainstorm events. Such a fragile ecosystem has also been manifested by non sustainable land use patterns and poor vegetative cover of the range land and the remaining forest batches. Therefore, most of the economic activities take place on the remaining 10% of the land area and the competition between different user groups for these lands is, therefore, intense.

Factors such as livestock and grazing practices, inappropriate agricultural and irrigation techniques, the marginalizing of lands, poor socio-economic conditions and a high population growth rate as well as weak institutional arrangements need to be considered in a comprehensive and integrated framework. Rangelands are deteriorating at an accelerated rate due to widespread overgrazing, uncontrolled herd movements, firewood collection, unsuitable cultivation practices, and persisted periodic droughts, all of which worsen ecological conditions.

Cultivation of marginal lands, and unsound practices such as ploughing down slopes, and use of heavy farm machinery have accelerated rate of soil erosion and lowered land productivity. Urbanisation is also steadily encroaching onto good quality agricultural land in the higher rainfall areas of the Jordanian highlands, reducing the traditional production areas of food crops such as wheat and barley.

Jordan suffers from a scarcity of water resources, which is compounded by poor management of existing supplies. Pumping of aquifers for irrigation and municipal uses has been exceeding their renewable safe yield. No serious attempts have been committed to improve natural recharge into these aquifers, encourage water harvesting practices or adopt water conservation measures, especially in irrigation. The current demand for municipal, industrial and agricultural water in Jordan exceeds sustainable water supply and the problem is further aggravated in dry winters like the case in the 1998/99 season.

Irrigation has made crop production possible in many areas but the long-term effects of fertilizers and pesticides on water quality, as well as on soil salinity, have been given only limited attention. Furthermore, poor wastewater treatment, and industrial pollution have compounded the problem. Current and future deterioration of water quality will have marked effects on land degradation.

Socio-economic factors contribute negatively to desertification and to efforts to combat its effects, poverty constitutes a vicious circle linking deterioration of natural resources to deterioration of livelihoods. Also, the population increase is adding an additional pressure to land and water resources, as people need to encroach further on fragile soils, sparse vegetation and limited water resources.

The institutional capabilities of the Government as well as the existing legislation and policies need to address the serious degradation of its agricultural, range and forest lands, and aim to improve land capabilities and increase production for communities will require support. Financial and technical support will be required to introduce new agricultural products, agricultural techniques, water harvesting techniques that will result in increased land productivity, yet with less pressure on fertility and water resources. Also, communities will be encouraged to engage in diversified economic activities that will alleviate pressure on natural resources. This may be accomplished through the adoption of participatory approaches that raise awareness of local communities to threats of desertification and to strengthen local institutions, which are essential for reversing desertification and environmental degradation, especially considering Jordan's transition economy.

## **PHYSIOGRAPHY OF JORDAN**

Jordan is located between latitude 29°-33° North and longitudes 35°-39° east has a total area of about 89,200 km<sup>2</sup> (Figure 1). The country has a Mediterranean climate characterised by predominant winter rainfall with a dry and hot summer. Rainfall decreases gradually from north to south and sharply from west to east. The total precipitation varies greatly from year to year as well as in its distribution during the season. The rainy season extends from October till May, being heaviest between November and March. Furthermore, due to the variable topographic features of Jordan, rainfall distribution varies according to location. Rainfall averages from less than 50 mm in the eastern deserts to 600 mm in the high plateau areas of North Jordan.

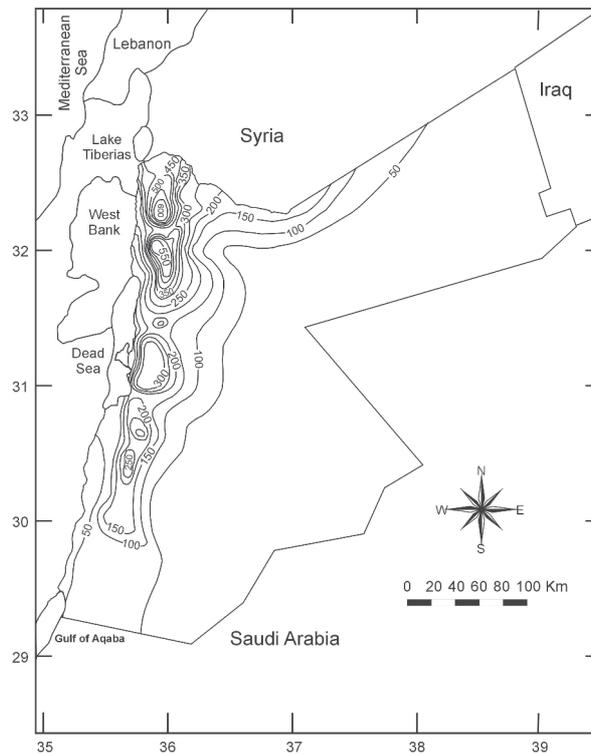


Figure 1. Map of Jordan shows the isohyetal lines of annual rainfall over the country

Jordan can be divided into four main physiographic and, subsequently, agro-climatic zones:

- i. The Jordan Rift Valley (JRV) extends from Lake Tiberias in the North to the Gulf of Aqaba in the South. The area between Lake Tiberias and the Dead Sea is known as the Jordan Valley (JV). This area is considered as the major irrigated area in the country. Elevations range from 197 m below sea level (BSL) in the north to 410 m BSL at the Dead Sea shoreline. Average annual rainfall is less than 200 mm over most of the Valley with little area in the North. Soils of the Valley are associations of the orders Vertisols, Inceptisols and Entisols. It is warm in winter and dry hot in summer. This area covers 1.10% of Jordan's total area. Irrigated area is estimated at 27000 ha.

- ii. The Semi Arid and Semi-Humid zones of the Highland: This highland area overlooks the JRV and comprises the mountain ridges and dissected plateau East of the Jordan valley (JV). Elevation varies from 700 to 1500 m Above Sea Level (ASL). Average annual rainfall exceeds 350 mm. Most potentially productive land occurs within this zone, especially in the north, and it covers around 0.24 million ha, 2.5% of the total area of the country.
- iii. The Steppe Zone: This zone lies to the East and South of the Highland zone. The elevation descends gradually towards the East with an average altitude of 600-800 m ASL. Average annual rainfall ranges between 200 and 350 mm. This zone covers 6.3% of Jordan's total area or about 0.56 million ha. Major soil orders in this zone are Vertisols and Lithic Entisols integrating into Aridisols.
- iv. The Arid Zone: This zone is known in Arabic as (*Badiyah*) which includes desert plains of the granite and sand stone mountains in the Eastern, North Eastern and Southern deserts. Average annual rainfall in that area is less than 200 mm. This zone covers the remaining 90.0% of the total area, or approximately 8.11 million ha.

## POPULATION OF JORDAN

Jordan's population is characterized by high rate of births. The Statistical Year Book of Jordan (DOS, 2002) showed that in 1994 the population was 4,139,000 (census results). The figure increased to 5,182,000 in 2001. The crude birth rate for the same years were 32 and 28 per thousand, respectively. The rate of natural population increase dropped in the same period from 2.7 to 2.3%. The same period witnessed similar drop in the population growth rate from 3.3 to 2.8% but, obviously, the percentages of actual growth rate were higher than the corresponding figures of natural growth rate due to influx of Jordanian expatriates and non Jordanian cheap labourers (136,573 workers carrying valid working permits).

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

About 2 million (1,971,750) people live in the capital Amman District which has an area of 8231 km<sup>2</sup> (population density of 239.6 persons

per km<sup>2</sup>). Next to Amman comes Irbid then Zarqa Governorates with the respective population of 924,470 and 815,130 people and densities of 570.3 and 199.8 persons per km<sup>2</sup>. To the contrary, the lowest population density is that of Ma'an Governorate (3.0 persons per km<sup>2</sup>) which has the largest area of 33,163 km<sup>2</sup>.

The high population densities in the relatively most fertile land of Irbid Governorate had imposed serious stresses on land quality of a country characterized by aridity. Such stresses are manifested by soil erosion due to deforestation, overgrazing, and unsustainable farming practices, especially in upland areas where wheat, Jordan's main crop, is grown.

## **ECONOMIC DEVELOPMENT IN JORDAN**

While the population growth rate of Jordan is quite high, the growth rate was compounded by the successive waves of refugees that have come into the country as a result of series of conflicts in the region. The impact of these sudden increases of population, where people have always lived in conditions of limited natural resources, has put severe stresses on the social, economical, political and environmental sectors of the country. Currently, 90% of the population live on 10% of the surface of the country, with close to 2 million people living in Amman and its environs. More recently, Jordan has maintained a wide-ranging program of economic restructuring and reform developed in co-operation with the IMF and the World Bank. Economic stability at a macro level has been restored and the debt burden is more manageable than it was five years ago. However, there are increasing concerns about economic stagnation and overall economic growth rates are not encouraging. Unemployment is a persistent and growing problem and poverty levels remain unacceptably high. Within the region, Jordan's comparative advantage continues to rest with its well-educated population, world class tourist attractions, stable Government, and clear commitment to market-oriented economic reform.

With a Human Development Index of 0.729 and an adjusted real GDP per capita of \$4977.44 ranking among the group of countries with Medium Human Development Indexes (UNDP Human Development Report, 1998).

## WATER RESOURCES OF JORDAN

Jordan's water resources consist primarily of surface and ground water. Renewable water resources are estimated at about 780 million cubic meters (MCM) per annum, including ground water (275 MCM/year distributed among 12 basins, Figure 2) and usable surface water (505 MCM/year distributed among 15 catchment basins, Figure 3). An additional 143 MCM/year of ground water is estimated to be available from fossil aquifers. Brackish aquifers are not yet fully explored, but at least 50 MCM/year is expected to be available for urban uses after desalination (JICA, 1995). Reclaimed wastewaters (RWW) are being used on an increasing scale for irrigation, primarily in the Jordan River Valley, and can provide at least an additional 80 MCM/year until the year 2010 (El-Naser, 1999).

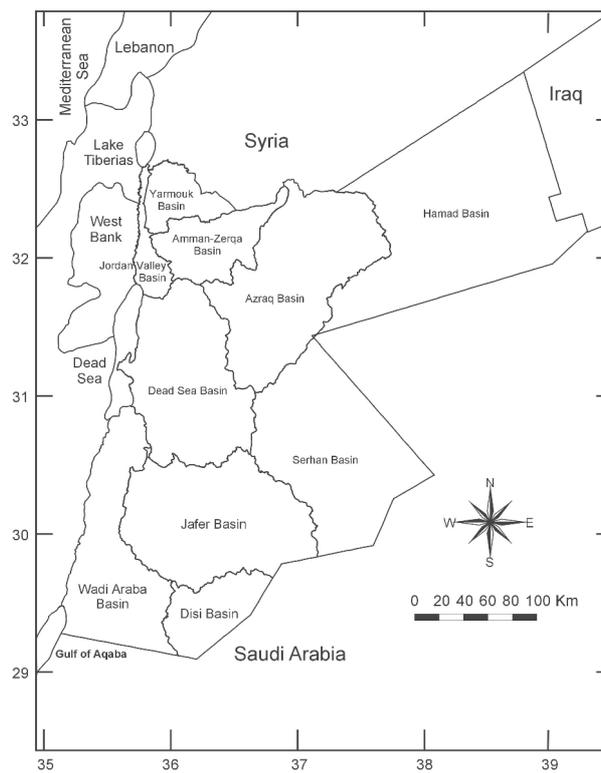


Figure 2. Watersheds of Jordan

Ground water is the major source of water supply in the country. Jordan's water budget for 2000 was approximately 817 MCM, of which more than 473 MCM was provided from ground water sources (412 MCM from renewable; 61 MCM from non-renewable) (Table 1). The total annual recharge of ground water in Jordan is approximately 275 MCM; consequently, about 138 MCM/year was overpumped from ground water resources in 2000.

Surface waters contributed approximately 38% (271 MCM) to the 2000 water budget. Approximately 72 MCM of RWW were reused in 2000 (7% of the water budget). In the last decade, treated wastewater has become an important water resource for restricted uses and has been actively incorporated into the strategic planning of water policy makers in the country.

Table 1. Sources of water and their uses in the year 2000

Water Resource	Water Use Sector (MCM)				
	Municipal	Industrial	Irrigation	Livestock	Total use
Surface water	53.309	2.537	209.670	6.000	271.516
- Jordan Rift Valley	38.464	2.537	121.180	0	162.181
- Springs	14.845	0	38.000	0	52.845
- Base and Flood	0	0	50.490	6.000	56.490
Groundwater	185.735	34.156	252.300	1.413	473.604
- Renewable	176.362	29.586	204.644	1.409	412.001
- Nonrenewable	9.373	4.570	47.656	0.004	61.603
Reclaimed Wastewater	0	0	72.033	0	72.033
- Registered	0	0	66.933	0	66.933
- Not Registered	0	0	5.100	0	5.100
Total	239.004	36.693	534.003	7.413	817.153

Source: Ministry of Water and Irrigation. Personal Communication. 2002.

## GROUND WATER QUALITY

Groundwater quality can be affected by both natural and anthropogenic activities. In aquifers unaffected by human activity, the quality of groundwater results from geochemical reactions between the water and rock matrix as the water moves along flow paths from areas of recharge to areas of discharge. In general, the longer groundwater remains in contact with soluble materials, the greater the concentrations of dissolved materials in the water. The quality of groundwater also can change as the result of the mixing of waters from different aquifers. In aquifers affected by human activity, the quality of water can be directly affected by the

infiltration of anthropogenic chemicals or indirectly affected by alteration of flow paths or geochemical conditions.

Contamination of fresh groundwater by saline water is a common problem in the region. In humid areas of abundant recharge, potential groundwater salinization is limited because of the natural flushing of salts by freshwater. Conversely, in semiarid areas, the absence of natural flushing by freshwater enhances the accumulation of salts and saline water.

In addition to natural sources, groundwater quality can be affected by agricultural, municipal, and industrial activities in the recharge zone of the aquifer. Potential sources of contamination include recycled irrigation water, wastewater from human activities, and waste by-products from industrial activities. Nitrate is an important constituent in fertilizers and is present in relatively high concentrations in human and animal wastes. In general, nitrate concentrations in excess of a few milligrams per liter indicate that water is arriving at the well from shallow aquifers that are polluted from human or animal waste, or from excess nitrates used in agriculture.

A more common problem in Jordan is that agricultural practices have had to contend with irrigation waters of increasing salinity in recent years. In some areas, the increase in salinity has resulted due to over-abstraction of ground waters, sometimes with a resultant intrusion of more saline ground waters, especially in Dhuleil and Azraq areas. In other areas, increased usage of RWW or mixing of fresh waters with saline spring waters, particularly in the southern part of the JV, has adversely affected sustainable agriculture. In addition, several major springs have been contaminated by fecal coliforms (e.g., Wadi El Sir, Ruseifa, Qairawan, Deek, Teis, Qantara, and the springs near Salt). These springs alone produce more than 15 MCM/year to the domestic water supply. Numerous ground water production wells, some associated with these springs and others along the Zarqa River, have become seriously contaminated with fecal coliforms.

## **WATER RESOURCES DEVELOPMENT PROJECTS**

In 1957, the Government of Jordan started to implement irrigation projects in the JV in order to provide the area with sufficient quantity of irrigation water. The work started by implementing King Abdullah Canal (KAC) project which has a total length of 110 km. It is a transport open canal, with a maximum width of 11.30 m, a maximum (water) depth of 2.80

m and a maximum conveyance capacity of approx. 20 m<sup>3</sup>/s. The canal irrigates approximately 23,710 ha of arable land.

The water resources for the canal come from the Yarmouk River (48%), the conveyer from Lake Tiberias (24%), King Talal Reservoir (KTR) (15%), Mukheibeh wells (5%), the side wadis in the northern part of the Valley (4%) and the side wadis in the southern part of the Valley (4%). Apart from the area irrigated from the Canal, approximately 745 ha is irrigated directly from other sources (from KTR, and Hisban-Kafrin Dam), through separate conveyors (MWI, 2000).

Several dams were constructed during the last three decades; their overall holding capacity is 160 MCM, with a total investment cost of \$365 million. Major properties of these dams are presented in Table 2.

Table 2. General characteristics of major reservoirs of Jordan

Reservoir	Location	Live Storage (MCM)	Height (m)	Cost (Millions Dollars)
King Talal	Zarqa River	75	108	102.1
Wadi Arab	Wadi Arab	16.9	82.5	60.1
Karamah	Wadi Malaha	55	45	76.3
Kafrein	Wadi Kafrein	8.5	37	27.0
Wadi Shueib	Wadi Shueib	1.43	32	1.7
Sharhabeel	Wadi Zeglab	3.9	48	11.7
Total		160	---	364.6

The potential for further development of surface water resources rests principally with the construction of the proposed Al-Wehda Dam on the Yarmouk River. This dam would provide an annual safe yield of about 105 MCM, 55 MCM would be needed for manufacturing and industrial uses in Irbid region and the remaining 50 MCM will be used to intensify agricultural production in the JV.

In the JV, there are about 240 tube wells in South Jordan Valley distributed in three major areas, out of which, 104 tube wells in Kufrein area, 62 tube wells in South Shuenh area and 58 tube wells in Rama area. The remaining number is distributed in different areas in Southern JV. Only 64% of these wells are licensed, and total annual extraction was about 35.4 MCM in 1999, about 28.2 MCM of which were used for agriculture activities, 1.3 MCM were used for industrial purposes and the remaining were used for dual purposes. Average water salinity in these wells is 1600 ppm, which is considered of high value for some types of fruit trees. Mostly, water extracted from these tube wells has a value of salinity about 2000 ppm, which restricts the expansion of some type of agriculture cultivation using this quality of water.

Although irrigated agriculture in the JV comprises the food basket of the country, irrigated agriculture in the highlands has become of comparable significance. Sections to follow will be devoted to describe all environmental components that may contribute to land degradation or combating desertification in both the Highland and the most important strategic area of the JV.

## **AGRICULTURAL DEVELOPMENT IN JORDAN**

Agricultural sector in Jordan consumes about 65% of the total available water supply, where municipal, industrial and rural sectors consumption was 28.9%, 4.7% and 1.4% respectively, in 1999 (Ministry of Water and Irrigation (MWI), 2000). Although the agriculture sector consumes more than 65% of the country's water resources, contribution of agriculture to the gross national production was less than 2.25% in the year 2001 (DOS, 2001). In order to maintain an effective balance in water supply and demand importation of food grains and energy must be increased. The current virtual water imported, according to estimates of MWI, is about 6.0 billion cubic meters per year. This is approximately seven times Jordan's annual water budget and 10 times Jordan's renewable water supply (El-Naser, 1999).

Total irrigated area in Jordan is estimated to be about 76.5 thousand ha in the year 2000 distributed as follows: JV and Southern Ghor 28.2 thousands ha which forms 38% and high lands 47.6 thousand ha which forms about 62 % (DOS, 2002).

## **IRRIGATED AGRICULTURE IN THE HIGHLAND**

Jordan is one of the most water scarce countries in the world. Consequently, water is the single most critical natural resource since virtually all aspects of sustainable economic, social, and political development in the country depend on the availability of an adequate water supply.

With an irrigated area of about 843,000 dunums distributed between the JRV (316,000 dunums) and the highlands and desert areas (527,000 dunums), agriculture is the biggest water consumer (~ 65% of the available water). Expansion in irrigated agriculture in the Highland and desert areas

has been very rapid in the past three decades of the last century. For example, irrigated area in the 1976 was only 69,088 dunums. Irrigated areas in the highland and the Desret utilize more than 50% of the groundwater resources which, in turn, amount to 54% of the water resources of Jordan. Twelve groundwater basins have been identified in Jordan; these include two fossil aquifers: Al-Disi and Al-Jafar. Some of these basins have more than one aquifer. The annual safe yield of the renewable groundwater supply is estimated to be 277MCM. An additional 143 MCM per year are considered available from non-renewable fossil aquifers that are sustainable for between 40 and 100 years. In 1998, over-draft was about 157MCM in six basins. Consequently, the water level in these basins is declining and some aquifers (especially Al-Dhuleil Aquifer) show serious deterioration in their water quality (increasing chloridic salinity, Abu-Sharar and Rimawi, 1993) due to increased salinity.

Water demand in Jordan is being met by over pumping from renewable aquifers, exploiting fossil water, and curbing use by rationing of the municipal water supply. The water scarcity is exacerbated by rapid population increases, the growing industrial and services (including tourism) sector, inefficient irrigation practices, inadequate wastewater treatment capacity, and inefficient water management and use. A national strategy focusing primarily on new water supply is neither technically, nor financially feasible. Consumption and demand management are key to Jordan's economic and social future. Over the short term, the best and most cost-effective options for reducing the gap between demand and supply are improving the management of existing water resources and improving the quality and availability of TWW for reuse in irrigation. Although reduction in water consumption should be carried out on the expense of irrigated areas in the Highland, recent studies demonstrate clearly that agricultural demand for water can be reduced without decreasing the total irrigated area or the value of agricultural production (*Ad hoc* Committee of Irrigated Agriculture, 2001). Indeed, proper water usage along with proper production technology and crop selection might actually increase agriculture's contribution to the economy and at the same time decrease its water usage. Switching cropping patterns to encourage the import of "virtual water" would further benefit the issue of water conservation and curtail highland losses to salinity.

In general, farmers in Jordan can be classified into four categories: 1) educated farmers, including some professional agricultural engineers, 2) tribal community farmers 3) illiterate farmers, and 4) Investors on large farms that usually employ professional agricultural engineers to run the farms. Irrigated farming in the Highland has been developed by almost all

of the above categories. Because of specific skills required in agricultural production in the Highland, irrigated agriculture in that area has become a major source of soil salinization and erosion. Farmers usually tend to abandon their land once salinity buildup reaches a threatening level. Moreover, net return from unit volume of irrigation water is usually far below the corresponding values recognized from irrigated agriculture in the JV (Abu-Sharar and Battikhi, 2002).

Cropping patterns in the highlands range from vegetables and fruit trees, to wheat and barley. The predominant vegetables are tomatoes, potatoes, onions, watermelon, cauliflower and squash while the predominant trees are olives, grapes and citrus. In 1998, the total water consumption for irrigation in the highlands was 453 MCM of which 242 MCM were extracted from groundwater and the remaining 211 MCM from surface water resources. Accordingly, irrigated agriculture in the highlands uses about 55% of Jordan's groundwater, but returns very low value for cubic meter. Most vegetable crop are cultivated in open fields and, subsequently, their water consumption is relatively high provided the relatively long growing season that is characterized with high temperatures and long days.

In 2000, the Policy Implementation Project funded by USAID carried out a Rapid Appraisal study on the Amman-Zarqa Basin farmers to measure, among other things, on-farm water efficiency. The study concluded that the highlands farmers could significantly improve irrigation water efficiency through obtaining a better understanding of the inefficiencies of their current systems and through adopting improved irrigation practices. The estimated potential water saving was in the range of 15-20%.

## CAUSES OF DESERTIFICATION

Desertification in Jordan is due to a combination of changing natural conditions over a long (geological) period and the effects of man on the land within the historical period. Agricultural and pastoral activities have been the dominant human factors in desertification since the Roman Era. Natural causes of desertification can mainly be attributed to:

1. Soil erosion in the Highland Zone: Long term records of the Highland weather stations repeatedly show rainstorm events of more than 100 mm depth of, most likely, high rainfall intensity.

Such intense rainstorms usually generate extensive soil erosion, especially at steep and long slopes. Moreover, man induced destruction of natural forests by deforestation and expansion of farmland (land cultivation) and grazing into these forests over the past centuries.

2. Overgrazing of the rangeland in the Steppe Zone by sheep and goats. Overgrazing is beyond the capacity of that and, thus, a steady degradation in the land quality has been taking place. Very poor results and often crop failure generally accompany the expansion of arable farming onto these lands. Structural stability of the surface soil, and thus extent of soil erosion occupies intermediate grade between these of the Highland and the Desert soils.
3. Wind and water erosion in the Desert region. Such a process is of a history-long age. Desert soil has a phenomenal poor surface structural stability which can be manifested in terms of surface crust formation and, subsequently, very low steady state infiltration rate which usually does not exceed  $5.0 \text{ mm hr}^{-1}$  (Abu-Sharar 1993; 1996; Abu-Sharar and Salameh, 1995). The fragile soil structure is subject to extensive wind and water erosion, especially when rainfall intensity exceeds infiltration rate. In addition, dramatic changes brought about by irrigated agriculture and, the subsequent, desertification trends on the improved lands remain of concern.

As for the JRV, Qaisi (2001) reported additional environmental problems like declining water quality, depletion and pollution of groundwater resources, destruction of natural vegetation and habitats, loss of stratification and hydrological stability in the Dead Sea, increasing collapse phenomenon in the Southern Ghors and deterioration in landscape visual amenity.

## **EFFORTS TO COMBAT DESERTIFICATION**

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, abolishing agriculture to other professions, discouraging environment of investment in the agricultural sector, increasing prices of

agricultural inputs, deficiencies in “know-how” of soil-water management in the arids and the introduction of new competitive commercial crops in irrigated agriculture (Abu-Shriha, 2003).

Consequences of land degradation are thought to comprise diminishing agriculture areas, deserting agriculture to other professions, switch to cash-crops like tobacco, 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.

## **CONVENTIONAL METHODS OF SOIL CONSERVATION**

The following practices are employed in soil conservation projects in Jordan (Abu-Sharar, 2001):

1. Contour cultivation.
2. Ripping.
3. Terracing: Here different types of terraces may be constructed depending on soil type and climatic conditions. These terraces are employed in high and low rainfall areas and can be classified as follow:
  - 3.1. Diversion banks.
  - 3.2. Contour (absorption banks).
  - 3.3. Gradoni terraces.
  - 3.4. Bench terraces.
  - 3.5. Contour stone terraces.

## **WATER HARVESTING**

More than 90% of Jordan's area receive less than 200 mm of annual rainfall. In addition, we demonstrated in earlier sections the poor structural stability of such soils which results in surface crust formation and substantial reduction in infiltration rate to a minimal value of about 4 mm hr<sup>-1</sup>. In such conditions, extensive soil erosion may take place in response to shallow rainstorm of relatively low intensity. Soils of that agroclimatic zone may be rehabilitated and may become productive if:

- water for irrigation is provided in a carefully scheduled management,
- proper crop is selected, and
- soil physical conditions are improved, especially increasing soil structural stability and, subsequently, infiltration rate and water holding capacity.

The above objective can be met in a way or another by adopting techniques like spreading and detention of flood water for a finite duration to permit sufficient infiltration. In order to implement this approach, a system of structures is required. These may be classified into detention, dispersion, and diversion structures:

### **Detention structures**

These are built of locally available material like soil, gravel, stone, boulder, and rock. Height of these structures is usually less than 10 m across wadis or valleys. The purpose is to slow down and retain flood water as well as to heal gullies. The detention structures are suitable for water detention in relatively deep wadi courses with gullied side valleys of gentle slopes. Therefore, such structures are site specific and require considerable amount of stones and provision of hauling construction material.

### **Dispersion Structures**

Dispersion or spreading of flood water over larger areas of the flood plain is usually achieved by the provision of low-level structures (2-4 m high). These structures (known sometimes as deflection dams) are preferably constructed of gabions extending across a portion of the entire width of the alluvial plane. The flood flows are thus raised up to the top of the dam and caused to disperse over greater portion of the flood plain. The result is an increased amount of water flowing into the alluvium outside banks of the normal channel. Structures have to be designed to withstand overtopping.

### **Diversion Structure**

The objective here is diversion of partial flood flows through a channel other than the main course of the wadi in order to benefit additional areas from the detention or dispersion of flood water. This kind of structures can be observed in the very ancient human settlement of Jawa (in the north of Jordan). Concrete or gabions are recommended construction material for that kind of structures.

### **JORDAN STRATEGY TO COMBAT DESERTIFICATION**

Jordan has long prioritised its most pressing problems as being the scarce water resources and land degradation. Accordingly, all relevant institutions address these issues, especially the Ministry of Water and Irrigation. Jordan is one of the 30 original supporters of the World Conservation Strategy. In October 1996, Jordan ratified the Convention to Combat Desertification. National Strategy for Agricultural Development (*Ad hoc* Committee of the Irrigated Agriculture, 2001) for the decade 2000-2010 stressed on sustainable agriculture and protection of natural and biological resources. Finally, with the advent of the 21<sup>st</sup> Century, Jordan prepared its National Agenda 21. The document outlines several key areas related directly to natural resources and dryland issues and promotes the participatory approach at all levels to ensure success and sustainability. The Agenda also reflects the integrated approach to environment and development and converges with objectives of poverty alleviation and sustainable human development.

### **EXISTING ENVIRONMENTAL LEGISLATION**

The primary environmental legislation is Law No. 12 of 1995 which has recently been substituted by the temporary Law No. 1 of 2003. Environmental legislation forms the backbone of environment protection in Jordan. The enforcement of these laws constitutes one of the most essential tools that translate theory into reality. This section highlights salient features of Jordan's environmental management capacity, in particular these factors affecting the potential to combat desertification. Environmental legislation

of relevance to combat desertification along with governmental departments to be held responsible on enacting them are categorized as follows:

### **Wastewater and Sewage**

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

### **Soil and Agricultural Land**

Environmental Law No. 1. 2003. MoE.  
 Management of Natural Resources Law No. 12. 1968. Natural Resources Authority.  
 Agriculture Law No. 44. 2002. Ministry of Agriculture.  
 Management and Administration of Government Properties Law No. 17. 1974. Finance Ministry.  
 Jordan Valley Authority Law No. 19. 1988. Jordan Valley Authority.  
 Law of Organization of Cities, Villages and Buildings No. 79. 1966. Prime Minister.  
 Jordanian Specification JS 1145/ Sludge. 1996. Water Authority.  
 Civil Defense Order No. 1: The Protection of Forestry in Jordan. 1993. Civil Defence.

### **Biodiversity**

Environmental Law No. 1. 2003. MoE.  
Agriculture Law No. 44. 2002. Ministry of Agriculture.  
Law of Organization of Cities, Villages and Buildings No. 79. 1966. Ministry of Agriculture and Local Committee.  
Protection of Birds and Wild Life By-law No. 113. 1973. Royal society for the Conservation of Nature.  
Decision No. 1/ 5 for Cattle farms. 1990. Ministry of Agriculture.  
Decision No. 2/ 5 for Sheep farms. 1990. Ministry of Agriculture.  
Decision No. 3/ 5 for Rabbit farms. 1990. Ministry of Agriculture.  
Decision No. 4/ 5 for Fish Farms. 1990. Ministry of Agriculture.  
Decision No. 4/ 5 for Poultry Farms. 1990. Ministry of Agriculture.  
Decision No. 1/ T for Registration of Animal Feed Centers. 1996. Ministry of Agriculture.  
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## **DEFICIENCIES IN LEGISLATION**

Deficiencies in Jordan legislations can be summarized as follow:

- 1- Interdepartmental and multiple responsibilities on the environment sector. In the lack of coordination, this leads to hinder enacting laws, bylaws and instructions.
- 2- Slow court proceedings.
- 3- Personal and social interferences with legal procedures in favour of law violation.
- 4- Ambiguities in some law articles that help avoid penalties.
- 5- Absence of scientific reference to each case of argued environment

component which help avoid conviction.

- 6- Absence of comprehensive legislation concerning land use.
- 7- Some of the old penalties have become light in comparison with the magnitude of the environmental damage it deals with.
- 8- The current Environment Law No. 1 of 2003 has several deficiencies of which:
  - absence of any article dealing with soil conservation and combating desertification.
  - absence of articles dealing with crimes of environmental nature like illegal dumping of dangerous solid wastes or their importation to the country, contaminating soil, civil responsibilities and compensations for environmental damages.
  - absence of public participation in environmental policy making and the public role in environmental legislation.

## **RECOMMENDATIONS TO REHABILITATE JORDAN LEGISLATION**

- 1- Occasional review and updating of the environmental legislations.
- 2- Passing a bylaw dealing with soil conservation and combating desertification.
- 3- Establishment of environmental fund to help combat desertification and to be sponsored *in-part* from the fees and fines generated from the application of the Environment Law No.1 of 2003.
- 4- Encouraging the industrial sector to preserve and promote environment by passing a legislation that ensures partial tax and fee exemptions when complying with the requirement of healthy environmental.
- 5- Establishment of a specialized Environment Court.

In addition to the above recommendations, several local experts recommended the following:

- 1-Acknowledgement of the necessity to amend the current legislation to ensure that Jordan can fulfill its obligations under in the international Convention to Combat Desertification;
- 2-Enforcement of Article 25 of the Environment Law No.1 of 2003.
- 3-Authorization of the Jordan Society to Combat Desertification to undertake responsibility in combating desertification.
- 4-Drafting and Issuing a by-law to Combat Desertification.
- 5-Encouragement and training of Jordanian women to start income-generating projects such as agribusiness. This can be achieved through the integration strategies for poverty eradication into efforts to combat desertification and to mitigate adverse impacts of drought.
- 6-Strengthening local, regional and international cooperation.
- 7-Cooperation among interested governmental organizations.
- 8-Establishment of proper institutional mechanisms to avoid duplication and to promote mobilization and usage of existing bilateral and multilateral financial mechanisms and supports in this regard.

## **COOPERATION WITH INTERNATIONAL AGENCIES**

In addition to the UNCCD, Jordan is party to other environmental-related international agreements including Bio-Diversity, Climate Change, Ramsar Convention, International Trade and Endangered Species, and Ozone Layer Protection. Jordan has developed a National Environmental Action Plan in which environmental issues were prioritised and various solutions put forward. The Government is attempting to address the serious degradation of its agricultural, range and forestlands, aiming to improve land capabilities and increase production for communities. Ministry of Environment has launched the process for the development of a strategy and action plan for the sustainable use of biodiversity.

Given the limited resources, at both human and financial levels, various agencies play an important role, through financial and technical assistance to help Jordan meet these objectives. Most of these initiatives address aspects of land degradation and contribute to the national efforts to combating desertification. However, a lot is still need to be done mainly in areas of co-ordination, harmonisation and integration, as well as capacity building and the provision of additional resources.

UNDP is among the key players in the environment field and has been and continues to be involved in development projects and programmes

in Jordan. UNDP has been involved in a number of projects, with the Government of Jordan, which has a bearing on dry land management. UNDP assisted the Ministry of Water and Irrigation in a project to help in planning and managing Jordan's water resources. *The project involved upgrading a databank containing information on Jordan's water resources and consumption as well as transfer of technology to measure water supply versus usage.*

UNDP has also been involved in a number of projects that addresses biodiversity issues. Jordan has completed its Biodiversity Country Study and is now proceeding with the preparation of the Biodiversity Strategy and Action Plan, an obligation to the Convention on Biodiversity. Another initiative that has a bearing on dry-land management is the regional project on conservation of agro-biodiversity, which focuses on identifying, and conservation of the major threatened crops. The project has five national components in countries of the region that are implemented in a complementary manner.

Another area of focus is supporting the Government of Jordan to its efforts in the Climate Change area and contribution towards the decrease of GHG emissions and global warming. UNDP assisted the Government to prepare and submit its communication report and to further assess the country in studying the vulnerability of the water sector to climate change effects. This additional component focused in testing different scenarios of climate change and the preparation of mitigation scenarios.

UNDP has also been involved in the provision of technical and financial assistance in the field of natural reserves protection and management, two main globally significant reserves were addressed, mainly the Dana Wildland and Azraq wetland Reserves. The efforts focused protection and management aspects through promoting the participation of the local communities in these efforts. *The participatory approach endeavour resulted in addressing the socio-economic factors of these communities and contributed to the creation of employment opportunities, mainly in eco-tourism activities, improvement of the standard of living, and thus ensuring the sustainability of the projects and replication of the experiences in the region.*

Another major endeavour of UNDP, that also has a bearing on dry land management, is the Debt Swap initiative that is being promoted as an option to debt forgiveness by the main debtor of Jordan provided that debt is paid through the implementation of projects that address environmental problems. In a participatory approach, UNDP assisted different players in the environment field, both governmental and non-governmental, in the

preparation of a priority list of projects that are in line and compatible to the priority list of the debtors. The list has a wide range of projects that focuses on dry land management and combat desertification issues, and will be promoted to different donors and international agencies. *The initiative, awaiting government endorsement, can be utilized as a main tool for resource mobilization and can be used in the preparation of the project's resource mobilization strategy.*

The UNDP/GEF Small Grants Programme has supported small NGOs and local communities in their initiatives in tackling a range of environmental problems at the grass roots level. Many of these initiatives addressed issues relevant to halting land degradation and water management. The programme provides a successful example for *involving local communities, mainly women, to ensure the continuity and sustainability of efforts that directly affect the livelihood of these communities.*

The World Bank (WB) has been involved in several projects in Jordan largely dealing with economic restructuring. Currently, the WB, in collaboration with the Ministry of Agriculture, is implementing an "Initiative for Collaboration to Control Natural Resources Degradation (*Desertification of arid lands in the Middle East*)".

The German Technical Co-operation (GTZ) is supporting numerous projects in Jordan focussing on water, agriculture and institutional strengthening. GTZ assists the formation of national information systems for the Ministries of Planning, Economics, and Finance as well as a series of downstream institutions in order to improve state services such as procedures for customs, land registry, and up-to-date standardisation, metrology and norms.

Another major player is the USAID programme that addresses three concerns central to Jordan's future development: too little water; too many people; and too few jobs. This formulation highlights the fact that the real constraints in Jordan are systemic in nature, cutting across several sectors at once. USAID's Jordan strategy for the current five-year period (1997-2001) incorporates three strategic objectives *linking environmental issues to socio-economic factors*:

- 1- Improved water resources management: to increase the efficiency of water use in Jordan through innovative technologies and to improve the quality of wastewater used in agriculture.

2- Increased practice of family planning: to improve the quality and availability of health care for mothers and infants and to meet the demand for family planning services in Jordan.

3- Increased economic opportunities for Jordanians: To provide balance of payments support to help reduce Jordan's external debt burden; to assist Jordan in implementing its economic reform program and to increase the availability of credit to micro-enterprises and small businesses.

CIDA is supporting "The Sustainable Rangeland Management Project" which is hosted by the Ministry of Agriculture and aims at developing and maintaining a programme to prevent soil erosion and to propose a rangeland management scheme to prevent further degradation. It expects to institute a rangeland directorate, develop an information network to facilitate exchanges on local experiences in rangeland management and to strengthen relationships between the various organisations with work concerning rangelands. In addition it tries to *contribute to the alleviation of poverty in disadvantaged rural communities through income generating activities as well as trying to bring them into the process of rangeland management.*

EuroCom initiated a new project in May 1999 which is being co-financed by the EU budget line "LIFE Third Countries". The project focuses on the "Environmental Law Enforcement". The co-operation partner of EuroCom is the General Corporation for Environment Protection. The current project should take into consideration ongoing activities in order to avoid overlap and to maximise resources used and to play a co-ordination role for a coherent framework.

## **NONGOVERNMENTAL ORGANIZATIONS**

Non Governmental Organizations (NGOs) activities in Jordan address two main issues: the problems facing the Palestinian refugees living in the camps and the people who live under the poverty line. These activities consist mainly in solving the specific refugees' problems in urban or suburban areas, whereas the help for the poor is mainly provided in the areas far from the city centres, especially in the desert areas.

In the past decade, however, a variety of environmentally oriented NGOs have sprung up, alongside the increased activities among some of the more established ones such as the Royal Society for the Conservation of

Nature (RSCN). RSCN mainly manages protected areas; however, its main impact lies in *the promotion of local community involvement, awareness raising, and focus on socio-economic factors.*

The Jordanian Society for Desertification Control & Badia Development (JSDCBD) has specialised in studies and research related to desertification and Badia development. It tries to identify desertification problems, causes and impacts and attempts to propose solutions. In co-operation with other NGOs such as the Jordan Environment Society (JES), it has *focused on utilizing media channels to raise public awareness to combat desertification* and seeks their support for its programme. It emphasises the protection of natural plant cover to establish environmental balance and promotes the investment in water harvesting projects.

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