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# Land Use Vulnerability Assessment in Syria
# Desertification

***Related to the Project Activity***

Programs Containing Measures to facilitate Adaptation to Climate Change

***Project Title***

Enabling activities for preparation of Syria's initial national Communication to the UNFCCC, (Project Nr.00045323).


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Syria - سورية

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The project implemented in the ministry of local administration and Environment (MLAE)/General Commission of Environmental Affairs (GCEA), in collaboration with Global Environmental Facility (GEF) and United Nation Development Programm (UNDP) in Syria.

# Desertification / Land Use: Vulnerability Assessment in Syria

(INC-SY_V&A_ Desertification -En)


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**March / 2009**

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*This report has been approved unanimously by the technical committee, during the Technical Workshop which took place on 24/ 03/ 2009 in the Dedeman Hotel Palmyra.*

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## Main Messages

- Economic policy, increasing population, and increased unsustainable consumption patterns and life style, lead to significant changes in land patterns, and land area per capita of forest, arable and range lands decreased.
- Approximately 18% of the lands in Syria are degraded, mainly induced by human unsustainable activities. Consequently, this degradation can in many cases be reversed by a change in policies and human behavior. Also 95-97% of the land is vulnerable to degradation, and 94% will be impacted by climate change.
- The expansion of agricultural production has not been accompanied by appropriate use of technology, effective agricultural policies or planned urban development, and has resulted in further land resources degradation. These issues, however are cross-border, and require the commitment of national governments to effectively work together regionally to achieve greater sustainability throughout the region.
- Integrated, multi and inter-disciplinary, and participatory management approach has to be considered in the agricultural sector as well as in other sectors and land resources. This is due to the importance and interrelation ship of food security and sustainable management of water and land resources and agricultural policies.
- Urgent need for capacity building including scientific and educational institutions, activation and effective use of science and technology, exchanging experiences and benefiting from indigenous knowledge and experience.
- Rangelands are degrading at an alarming rate, and urgently require sustainable management to optimize their ration contribution to the increasing number of farm animals, as well as the critical ecosystem services they provide. Heavy and early grazing, rangeland cultivation, and recreational activities have already significantly reduced species diversity and density, and led to an increase in soil erosion and sand dune encroachment on agricultural lands.
- Forests occupy only 3% of the countries area, and continue to be impacted by woodcutting, fires, grazing, cultivation and urbanization. Main sustainable forest management challenges include incorporating updated forest policies in national plans, reviewing land tenure regulations, management of water resources, enforcement of legislations, and capacity building.
- Desertification in Syria remains a serious problem, and one that could increase with climate change. The three major current hazards are soil erosion, sand encroachment, and salinization of cropping land. As with other environmental and land resources challenges, desertification transcends national boundaries. Consequently, integration and cooperation of the national land management policies in the region would be a productive and necessary step in minimizing this threat.

## Summary

Arid and semi-arid lands respectively constitute 71 and 23 % of the country area (185,180 $km^2$). The rangeland is 44 %, 33 % is suitable for agriculture, 3 % is forest, and 20 % consist of urban, services, rocky, sandy, rivers and lakes areas. Around 18 % of the land is degraded and is mostly induced by unsustainable human activities. Besides, 95-97% of the land is vulnerable to degradation, and 94% will be impacted by climate change.

The doubled population (18.94 million) and the unsustainable consuming patterns increased demands on agricultural commodities, exerting sever pressures on the natural resources. The average land area per capita dropped by half (0.97 ha), and the arable land by 60% (0.25 ha), and the country still in short of full self sufficiency in some major products, such as barley and maize, despite increases in agricultural production. The arable and rocky and sand lands decreased, whereas the other forms increased over the last 9 years.

The rainfed area decreased and the fallow land increased indicating the degraded conditions of the arable land and the inappropriate agricultural practices. However, the irrigated land increased, and around 89 % of the available water is used for irrigation, mainly by surface irrigation with very low irrigation use efficiency (38 %). This improper management of irrigation water needs quick action to make better use of the water in a highly water stressed area.

Over and early grazing, increasing stock rating, disturbing the natural reproductive and growth of the natural vegetation, wood cutting, excess cultivation, excess water use, and arbitrary urbanization are the causes of land degradation. The main forms of land degradation are; wind erosion affecting 9 % of the country area, water erosion affects 6 %, sand encroachments affects 2 %, and salinization affects 0.1 %. Low degradation affects 66% of the degraded land, moderate degradation affects 25%, and 9% is highly degraded.

Overcoming these complicated interrelated environmental, human, climatic dynamics require sincere commitments from all stakeholders to support scientific efforts to understand these interactions, capacity build up for the adoption of integrated inter and multidisciplinary way of thinking and actions to face the challenges, developing means and productive systems to improve, sustain, increase and optimize the use of resources. There are good opportunities to overcome these problems; more arable land is waiting to be cultivated, using better technologies especially in irrigation systems and networking, adopting Conservation Agriculture, using better varieties or developing better ones, improving animal razing and reproduction techniques, and the endless outlets science and technology could provide.

## Introduction

Desertification is defined by the UN6 Convention to Combat Desertification (UNCCD, 1994) as: ***land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities.*** It is manifested in many forms particularly degradation of plant cover, degradation of water resources, soil degradation, and loss of biodiversity. The land natural resources base provide essential components of living requirements to human societies such as; fresh water, Food, fibers, and timber, and their sustainability is indispensable. However, the human land resources relationship is complex and the local domain is influenced by national, regional and global strategies of production and development, population growth, changes of lifestyle, and consuming patterns (GEO4, 2007; Jordan and others, 1988). The sustainability of these ecosystems is very much affected by human activities, use, and management of the land resources at the individual, household, and community levels (*Blaikie* and *Brookfield*, 1987).

The continued annual high increasing rate of population (2.5%), and changes to unsustainable consumption patterns and lifestyle in Syria have increased demand on commodities and exerted extreme pressures on land resources. These pressures have been accompanied by intensive use of inappropriate technology, poor regulation of common property resources, ineffective agricultural policies and unplanned urban development. They have also resulted in widespread land use change and land resources degradation and desertification in cultivated areas, rangelands, and forests. This in turn, jeopardizes food and water security, and endangers the human wellbeing of the population. The adverse impacts of climate change on agricultural production, however, will exacerbate the threats of land degradation and desertification in the country.

This report will present the state of land degradation and desertification within different land use forms in Syria, drought incidence, the impact of climate change, and options that may help to combat desertification and mitigate the impact of climate change on land resources in Syria.

## Geophysical characteristics

Syria is located at the far west end of Asia, bordering the Mediterranean Sea, extending on185,180 km$^2$ between Northern latitudes 32$^{\circ}$, 20, and 37$^{\circ}$,19 and Eastern longitudes35$^{\circ}$,43,and42$^{\circ}$,25 (ACSAD/ CAMRE/ UNEP, 2004). There are 5 climatic zones; Arid in 71.3% of the land, Semi-arid in 23.1%, sub-humid in 3.3%, humid in 1.4%, and Per-humid in 0.9% (UNESCO, 1997; *Celis, et al.,* 1, 2007). The annual precipitation varies between > 600 mm and < 100 mm and temperatures between –10$^{\circ}$C and 50$^{\circ}$C (Fig.1). The country, however, enjoys the four distinct seasons; a cold wet winter; a worm humid spring, a hot and dry summer, and a moderately cold, windy and humid autumn.

The topographic landscape is divers of mountains, hills, valleys, plains, rivers, and lakes, and the elevation varies between 0 to 3000m above sea level (Fig.1 and 2). Land cover patterns could be differentiated in 8 major physical regions; Coastal Plains, Coastal Mountains, *Ghab*, *Hauran*, Rocky Hills and Uplands, Semi-arid Plains, Arid Interior, and Euphrates Basin (Fig. 1; De *Pauw*, *et al*., 2004). The natural vegetation consists of humid and sub-humid forests, semi arid and arid trees and shrubs, arid bushes, and dry steppe (ACSAD/ CAMRE/ UNEP, 2004).

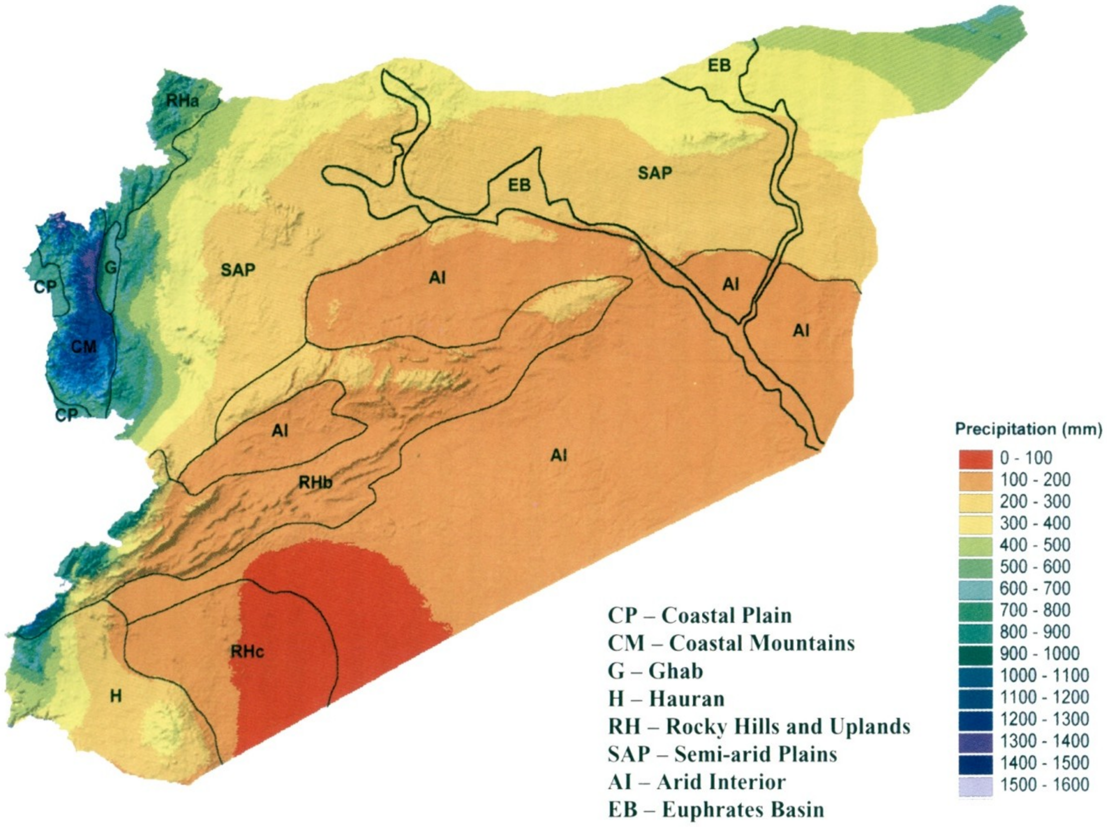



**Fig. (1):** Physical regions and distribution of precipitation in Syria (*De Pauw*, et al., 2004). The black lines define the regions.

The dominating soils are loose, shallow with low fertility, developed on calcium carbonate base prone to degradation. Though other parent materials prevail, and different climatic conditions has influenced the formation of the soils in the country, and the main soil orders (types) are: Arid sols forms 50% of the land; Incept sols 25%; Enti sols 14%; Verti sols 9%; and Mollie sols 2% of the land (ACSAD/ CAMRE/UNEP, 2004).
The annual surface water resources are 18.8 Bm3, where 16 Bm3 are provided by rivers originated from outside the country (Meslmani 2008), and the ground water is estimated by 6.014 Bm3 (ACSAD/ CAMRE/UNEP, 2004). About 89% of the water is used in irrigated agriculture, mainly (83%) by surface application (AASA, 2006).

## Stabilization Zones

Based on the annual average precipitation, the Ministry of Agriculture and Agrarian Reform in Syria (AASA, 2006) divided the country into 5 stabilization zones (Fig.2):

– **Zone 1** with average annual precipitation > 350 mm covering an area of 2.701Mha (14.6% of the country), and is divided into 2 sub-zones; $1_a$) > 600mm, where the production of all rainfed crops(tree crops, wheat, legumes, and summer annuals) is secured; $1_b$) between 600-350mm and is not less than 300mm in every 2 out of

3 years**,** securing crops' yields in 2 seasons (major crops are wheat, legumes, and summer crops)**.**

−**Zone 2** with average annual precipitation between 350-250mm and is not less than 250 mm in 2 out of 3 years**,** securing crops' yields in 2 seasons (major crops are barley, wheat, legumes, and summer crops). It covers an area of 2.474 M ha (13.3% of the country).

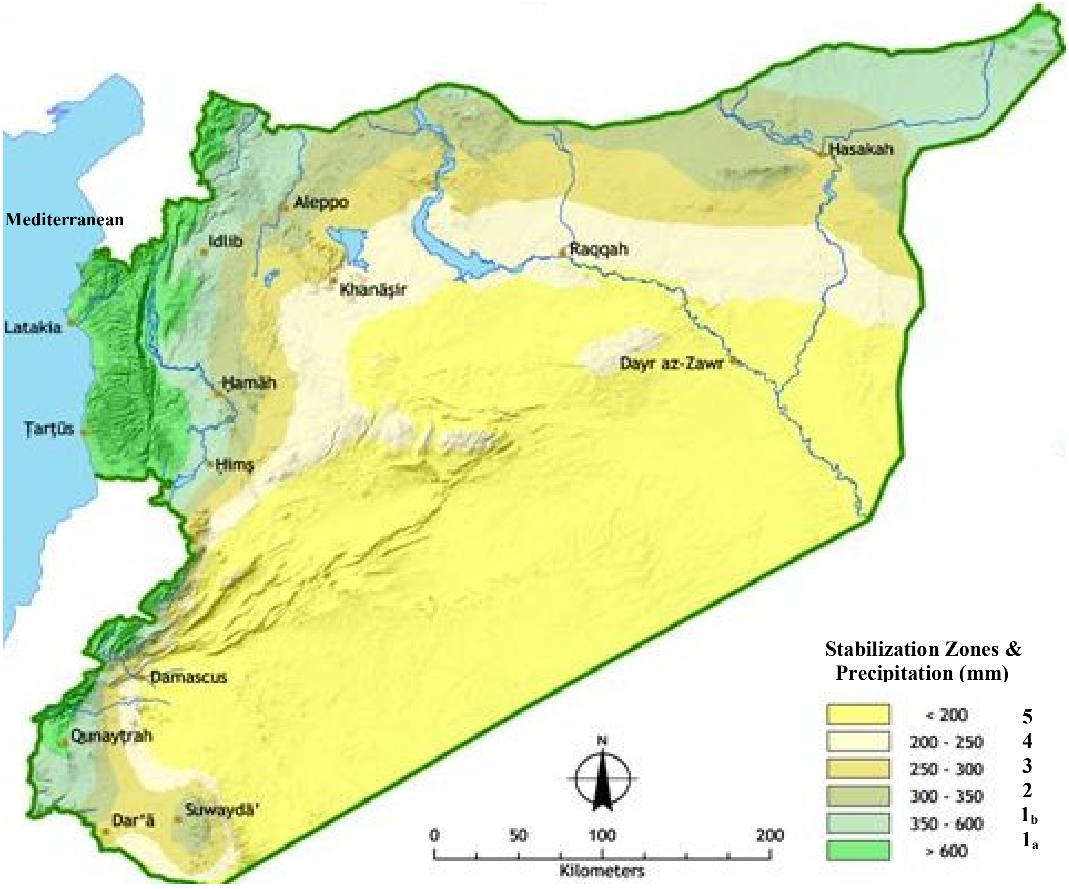



**Fig. (2):** Stabilization Zones, and precipitation in Syria (ICARDA/ AECS/ Bonn U., 2005)

−**Zone 3** with average annual precipitation 250mm and is not less than this average in half of the years, securing crop's yields in 1-2 seasons/ 3 years (major crops barley, legumes). The area is 1.3o3M ha (7.1% of the land).

−**Zone 4** with average annual precipitation 250-200mm and is not less than 200mm in half of the years. It is suitable for barley and permanent steppe, covering an area of 1.83M ha (9.9% of the country).

−**Zone 5** with average annual precipitation < 200mm, covering an area of 10.209 M ha (55.1% of the land). It is natural steppe and range land.

The description of these stabilization zones indicate that crop production is not stable and with climate change the annual precipitation is expected to decrease and consequently crops production will decrease endangering the food security of the people (IPCC, 2007).

## Land use

Around 94% of The total area (18.52 M ha) of the country is arid and semi arid land, with only 33% (5.95 M ha) arable land (suitable for cultivation), 44% (8.29 M ha) steppe and rangeland, 3% (0.60 M ha) forest and woods, and 20% (3.68 M ha) consists of urban, services, rocky, sandy, rivers and lakes areas not suitable for agricultural production (Table 1; Fig. 3).

Until the 1970s, natural resources provided sufficient food and agricultural commodities to the population. However, the doubling population over the last 26 years from 8.98 M in 1980 to 18.94 M in 2006 reduced total land area per capita (by 53%) from 2.05 ha in 1980 to 0.97 ha in 2006 (AOAD, 1982; AASA, 2006), exerting sever pressure on land resources to meet the increasing demand for food and other agricultural commodities by the population. The pressure was escalated with the spread of unsustainable consuming patterns and life style in the country, and domestic agricultural production was no longer sufficient. Land patterns significantly changed and the arable Land area per capita decreased significantly from 0.63 ha per capita in 1980 to 0.25 ha per capita in 2006 (Table 2). Similarly the range and forest land per capita declined by 53% and 40% respectively. The major decrease was between 1980 and 1997, later on it was less pronounced especially in forests where no change was observed, indicating that conservation measures and policies were implemented, and a forestation activities have counterbalanced forest degradation and population increase in the country. The arable, and rocky and sandy lands areas respectively decreased by 0.61% (36745 ha**)**, and 3.79% (113056 ha**)** over the last 9 years, whereas the range, forest, urban and services, and lakes areas increased (Table 1).

**Table (1):** Changes of land use areas (ha) between 1997 and 2006 in Syria (AASA 2006)

| Years | Arable | Steppe | Forest | Urban & Services | Rocky & Sandy | Rivers & lakes |
|---|---|---|---|---|---|---|
| 1997 | 5986361 | 8283041 | 521525 | 611316 | 2978094 | 137634 |
| 2006 | 5949616 | 8290331 | 600972 | 657679 | 2865038 | 154335 |
| | **Change** | | | | | |
| Area | **- 36745** | **+ 7290** | **+ 79447** | **+ 46363** | **- 113056** | **+ 16701** |
| % | **- 0.61** | **+ 0.09** | **+ 15.23** | **+ 7.58** | **- 3.79** | **+ 12.13** |

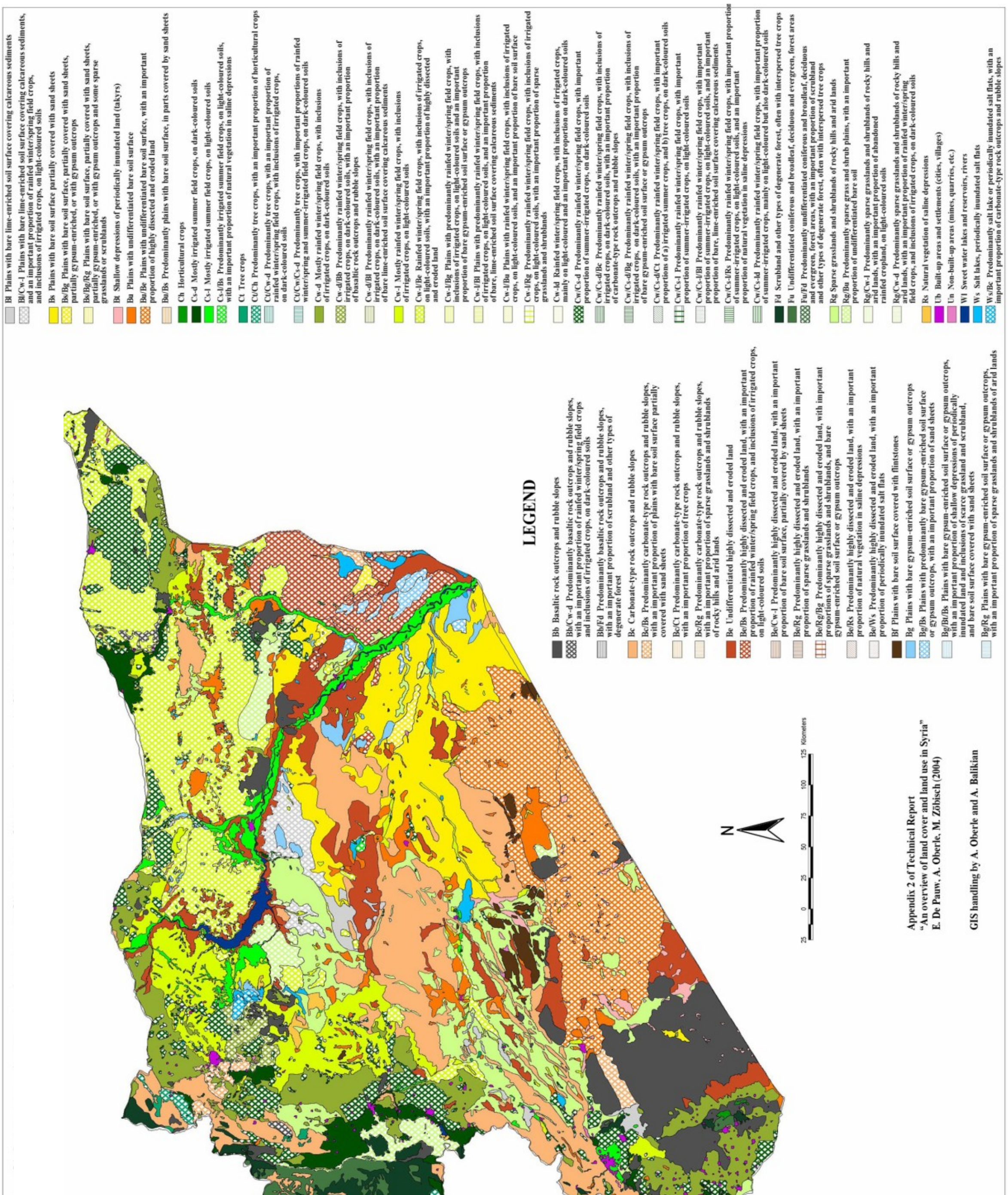



**Figure (3)**: Land cover and land use in Syria. Base year 1989/ 1990.

**Table (2):** Change of main land use forms (Arable, range and steppe, and forest) areas (ha/ capita) over two periods 1980-1997, and 1997-2006 ([a] FAOSTAT, 2008; [b] AASA, 2006; [+] AOAD, 1982).

| 1980 | | | 1997[b] | | | 2006[b] | | |
|---|---|---|---|---|---|---|---|---|
| Arable[a] | Range[a] | Forest[+] | Arable | Range | Forest | Arable | Range | Forest |
| 0.63 | 0.93 | 0.05 | 0.31 | 0.53 | 0.03 | 0.25 | 0.44 | 0.03 |

The fast and unplanned urbanization and arbitrary recreation activities degraded the arable land surrounding cities and towns, especially *Al Ghota* surrounding Damascus city and the orchards surrounding *Aleppo* city (Fig. 4). Also exchanging agricultural crops of low or moderate water requirements with crops of high water requirements have increased irrigation water demand and consequently depleted ground water reserves in a short period of time, and have changed the whole agricultural production system to a less productive and less stable system, especially in areas where water resources are limited. These in turn, affected the livelihood of people in those areas, and have caused partial migration of the inhabitants to other areas for a living (Box 1). Converting forests, woods and steppe lands to cropping lands have further hampered the sustainability of the ecosystem and degraded the land; in some extents the degradation was irreversible (Plate 1). The impact of land use change on land degradation and desertification, and loss of biodiversity is more severe and critical in dry conditions, where ecosystems are harsh and fragile. Climate change, however, will exacerbate these conditions.

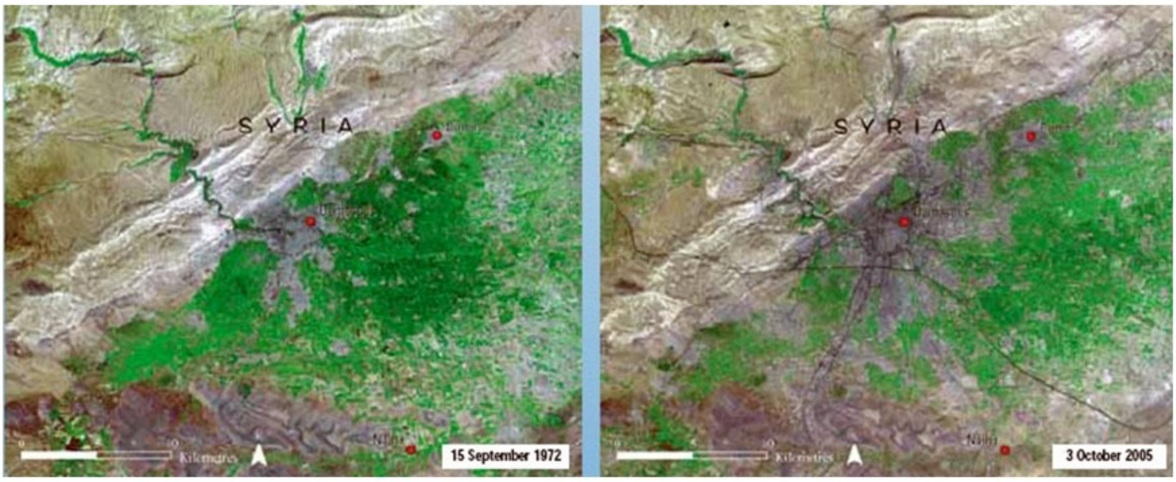
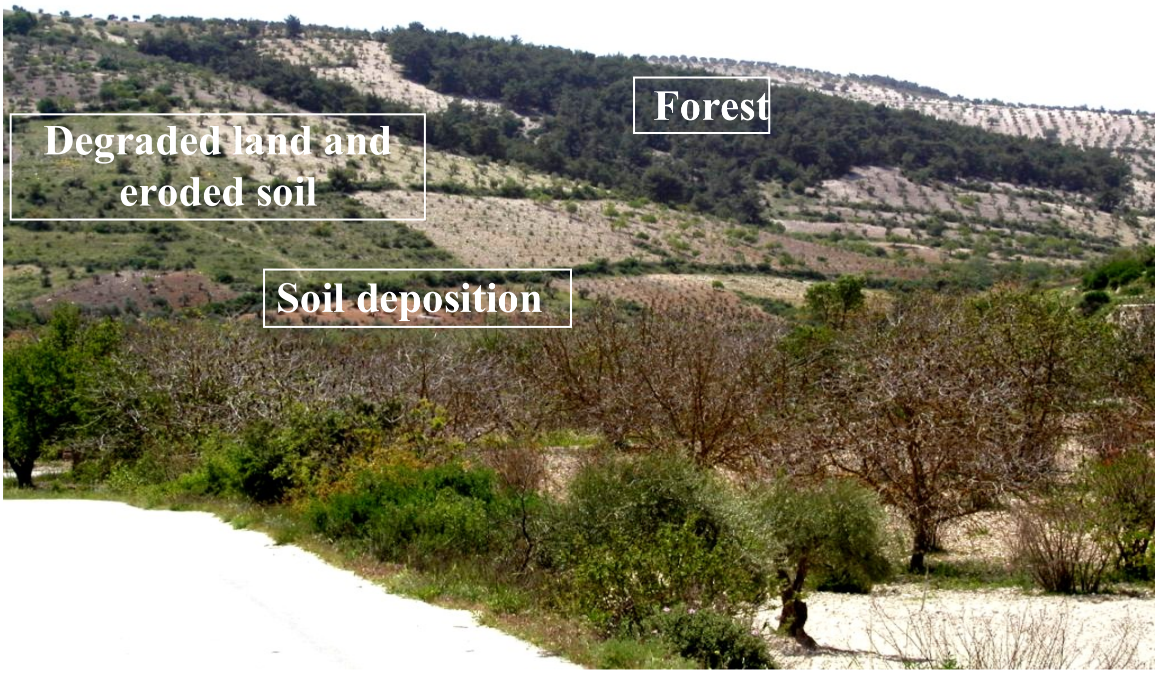



**Figure (4):** Time sequence Satellite images showing the dense vegetation cover in green color (*Al Ghota*) surrounding the city of Damascus (centered red circle) in 1972 compared to the degraded vegetation, where green color diminished to gray surrounding the city indicating increased urbanization even between the orchards in 2005 (UNEP, 2006).

**Box (1):** Impact of intenssive cotton growing in Salamieh area:

Salamieh was among the most productive agricultural areas in Syria. The area is 530,000 ha (5300 $km^2$), with 260681 inhabitants. Half of the population depends on agriculture or related activities, and 18% of the land is cropped. The main field crops are cotton, wheat, barley, lentil, and onions, and the main fruit trees are olives, almonds, grape, and pistachio. The annual rainfall varies between 175mm to 350 mm across the area, and the ground water is the main source for irrigation.

Crops irrigation did not affect the ground water balance until 1950, when economic incentives, mechanization, and government policies encouraged cotton production, a high water requirement crop (1000 mm water), and the irrigated cotton area increased from 1500 ha in 1948 to 14000 ha in 1956. The extensive use of ground water over whelmed annual recharge and the water level dropped at 1-3 m per year. Also increasing water extraction induced water salinization. Consequently most farmers shifted from intensive irrigated cropping systems of cotton/ wheat/ vegetables to rain-fed barley systems (*Ngaido* 1997). The cotton cropped area decreased from 14000 ha in 1956 to 471 ha in 1994, and the total irrigated area decreased from 15129 ha in 1975 to 6715 ha in 2001. Consequently the socio-economic conditions declined and a large number of the people have been facing hardships, and around 67000 inhabitants migrated to other places for a living (ICARDA, 2002).




*Converting forest to cropping land and orchards in Northern Syria degraded land cover and eroded the soil (A. Fares Asfary, 2004)*

*Cultivating rangeland in the Syrian steppe degraded the vegetation cover, and exposed the soil to erosion (H. Habib, 2003; personal communication).*

**Plate (1):** Improper land use change in Syria

## Cultivated land

The land under cultivation constituted 92.2% (5.5 M ha) 0f the arable land in 1997, with only 4.8 M ha cropped and 0.7M ha left bare fallow (Table 3; Fig. 5). In 2006 the cultivated land increased by1.2% (66290 ha), and the bare fallow land increased by 17.7% (126857 ha), whereas, the cropped land decreased by 1.3% (60568 ha). The decrease in the cropped land was in the rainfed area, where substantial part (126857 ha) was left bare fallow, another part (168230 ha) was put under irrigation, and the rest was kept rainfed. The irrigated cropped land increased by 20.1% (234519 ha) by 2006, mainly on the ***expense of rainfed land and partially (66290 ha) the expansion was on the uncultivated*** arable land, and on the expense of the rangeland and forests (Table 3 and Fig. 5). However, the major (64%) increase of irrigated land depended on ground water extraction (AASA, 2006).

**Table (3):** Changes of cultivated, cropped and fallow land areas (ha) and the cropped area per capita (ha/capita) between 1997- 2006 in Syria (AASA 2006).

| Years | Area (ha) | | | | | ha/ capita | | |
|---|---|---|---|---|---|---|---|---|
| | Cultivated | Fallow | Cropped | | | Cropped | | |
| | | | Total | Rainfed | Irrigated | Total | Rainfed | Irrigated |
| **1997** | 5521183 | 718064 | 4803119 | 3635486 | 1167633 | 0.31 | 0.23 | 0.07 |
| **2006** | 5587473 | 844921 | 4742551 | 3340399 | 1402152 | 0.25 | 0.18 | 0.07 |
| **Change** | | | | | | | | |
| **Area** | **+66290** | **+126857** | **- 60568** | **- 295087** | **+ 234519** | **- 0.06** | **- 0.05** | **0.0** |
| **%** | **+ 1.20** | **+ 17.67** | **- 1.26** | **- 8.12** | **+ 20.08** | **- 19.35** | **- 21.74** | **0.0** |

The area of the left bare fallow land varies from year to year depending on the amount of rainfall, soil fertility conditions, and availability of irrigation water, and is practiced to conserve water and accumulate nutrients such as nitrogen and phosphorus, although it exposes the land for soil erosion for 6-15 months (AOAD 2007). These figures indicate that the expansion of the cultivated land was not accompanied with sustainable and appropriate practices; rather, there was excess cultivations, inappropriate farming machinery and technology, excess use of agrochemicals and organic fertilizers, excess use of irrigation water, mono cropping or unsuitable cropping sequences, and overgrazing. Accordingly the land was degraded and desertification was exacerbated in the country (ACSAD/ CAMRE/ UNEP, 2004).

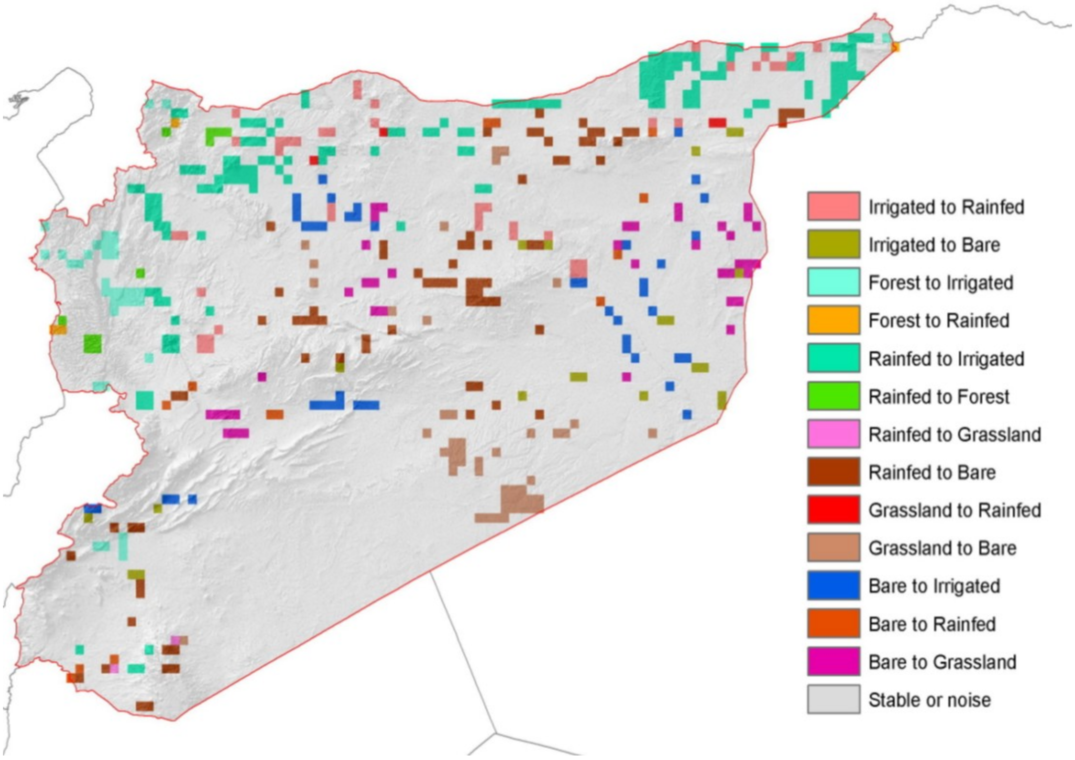



**Figure (5):** Land use/ Land cover changes in Syria between; 1982-1999 (*Celis, et al*., 2007).

The cultivated land had provided sufficient food and fodder to the population with minimal adverse impacts on the environment until late seventies of the last century. Since then, the demand increased with the increasing rate of population growth. Agriculture production significantly increased through expanding cultivated rainfed and irrigated areas, intensifying machinery use, implementing modern technology, use of herbicides, pesticides and fertilizers, expanding green house and aquaculture. This was accompanied by the intensive use of inappropriate technology, poor regulation of common property resources, ineffective agricultural policies and unplanned urban development. These pressures have had severe impacts on agricultural practices, rangeland, forests and biodiversity, and have resulted in widespread land use change and land resources degradation.
Agricultural and food productivity indicators for different food commodities over the last 26 years show trends of gradual and varied self sufficiency rates (SSR) increases and decreases in basic commodities.
The country however still in short of full self sufficiency in some major products such as, barley and maize with an SSR value of 74% and 11% respectively (AOAD, 2007).

## Rangeland

Rangeland is the main (44% of total area) form of vegetation cover in Syria in 2006, an increase of 0.09 % (7290 ha) since 1997 (Table 1, Fig. 5). It hosts 1.5 M people of whom; 0.25 M are agriculturists, and the rest are either nomad or semi nomad' herders

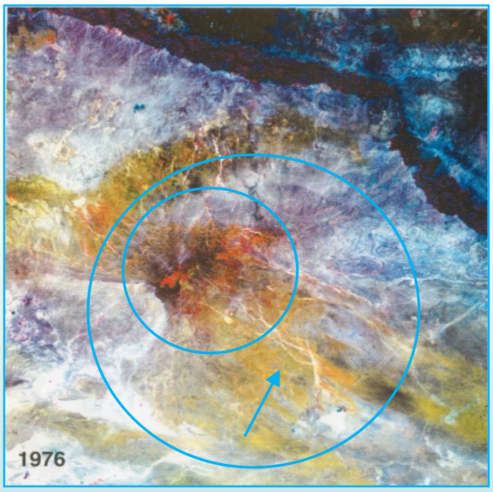
(MAAR, 2007). Its carrying capacity changes annually according to rates and distribution of rainfall, and suffers from low productivity (30-100kg dry matter/ ha) due to harsh climate and overstocking, though it is considered a major source of green fodder to sheep, goats and camels flocks (ACSAD/ CAMRE/ UNEP, 2004; MAAR, 2007). Until 1958, grazing was organized over 7 months in an East and West trip (*Alhema* traditional system), and the rest of the year, herds feed on crops residues in cultivated lands. Thereafter *Alhema* system was lifted, and the steppe was open to cultivation, with minimum adverse impacts on the steppe resources (AASA, 2006; MAAR, 2007). The high increasing rate of population, and consumption patterns increased demand for animal production, and the number of animal heads increased from 2.61 M heads (Sheep, goats, and camels) in 1950 up to 22.83 M in 2006 exerting severe pressure on the steppe. Heavy and early grazing was further increased by the increased feed demand for the increased number of other farm animals to 1.26 M heads in 2006 (AASA, 2006).

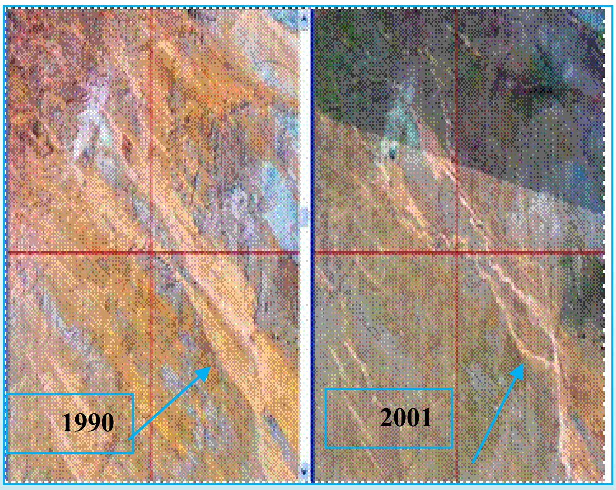
**Wood fuel gathering in degraded rangeland exacerbates land degradation in Syria (A. Loloo, 2001; H. Habib, 2003, personal communication)**

The pressure was escalated by expanding steppe cultivation to 0.55 M ha in 1990, an increase of 14 folds since 1982 (ACSAD/ CAMRE/ UNEP, 2004). Also using tractors and other vehicles facilitated and intensified herders and flocks movements all over the steppe which, enhanced fuel wood gathering and soil damage (MAAR, 2007).

These improper policies, heavy and early grazing, steppe cultivation, fuel wood gathering, and excess trafficking have significantly degraded vegetation density and diversity of herbal annuals and perennials, shrubs and trees, decreased dry mater production by 70%, and have caused an increase in soil erosion (Box 2) and sand dune encroachment on agricultural land (ACSAD/ CAMRE/ UNEP, 2004; ACSAD, 2003; *Kattach*, 2008). Protection measures and rehabilitation showed that, the potential productivity and biodiversity of the steppe is much higher than the present degraded state. After three years of rehabilitation and protection in *Al Bishri* area in the Syrian steppe, for example, fodder production per year increased from 90 kg ha-1 to 320 kg ha-1 and the bare soil decreased from 91 to 32 per cent. Furthermore, the diversity of plants increased from 27 species of 23 genera and 13 families to 83 species of 55 genera and 17 families, and the density of palatable shrubs increased from 0.02 to 4 plants m-2 (*Kattach*, 2008).

**Box (2):** Impact of rangeland cultivation on soil erosion in the Syrian steppe at *Al Bishri* area;

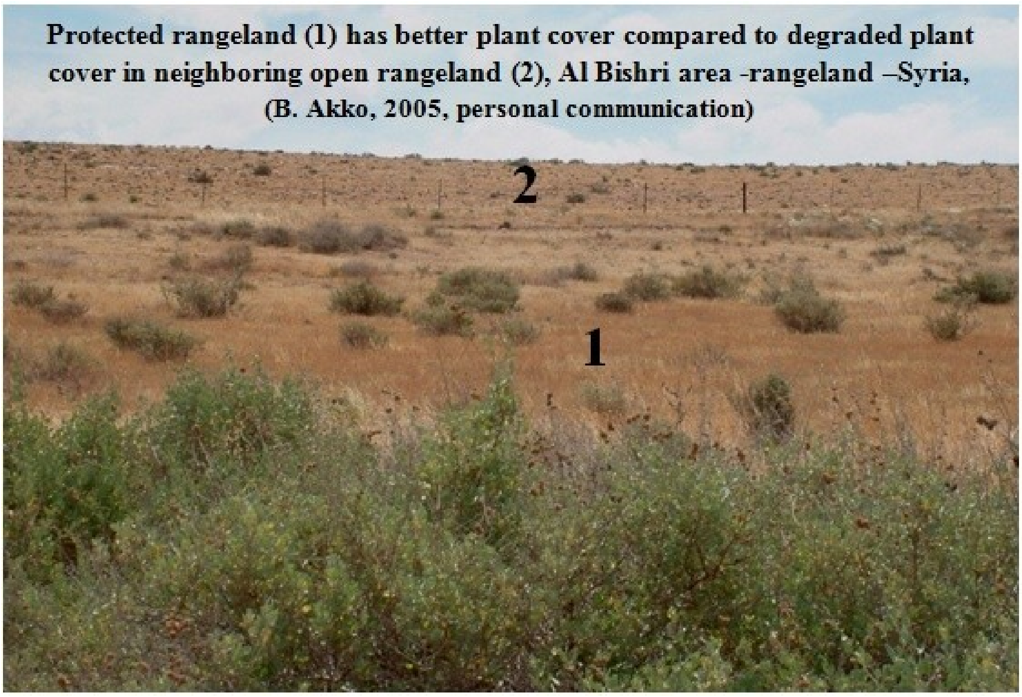



***The Syrian government enhanced the cultivation of the rangeland in 1977 to secure wheat and barley and satisfies the demand on bread and meat by the people. In 1996 the government prohibited the cultivation to prevent land degradation. Satellite images in 1976 show clear gullies (Arrow) due to less soil wind erosion before enhancing cultivation; in 1990 gullies were covered with eroded soil (Arrow) induced by wind erosion from neighboring cultivated rangeland (The land covered with sand increased by 37489 ha during 1985-1993), in 2001 clear gullies (Arrow) indicate less soil wind erosion after the prohibition of cultivation (ACSAD, RS and GIS Unit, 2003).***

## Forest

Forest is the smallest (3%; 0.60 M ha) form of land use in Syria and the total forest area has increased over the last 9 years by 15.23% (Table 1). Wood cutting, early and heavy grazing, arbitrary urbanization and recreation activities, cultivation and fires induced different types of degradation in forests. About 341 and 63 forest fires occurred respectively in Latakia and Al Ghab forests between 1999 and 2002 ravaging 179.22 and 100.54 ha (Ali, 2004). The cleared forest land is cultivated or converted to different land uses, and burnt wood is used as charcoal. Degraded natural forest land summed up to 10440 ha, however, afforestation projects in the country have counter balanced the degradation and have increased the total forest area (Fig. 5).Cleared or degraded forests enhanced soil degradation and losses of rainfall water. The measured rates of soil erosion on cleared forest were up to 200 tons /ha /year (WB/UNDP, 1998), and the rates of surface runoff ranges between 9-22% for burned pine compared to 3-6% in undisturbed forest (*Jaloul and Kbibou*, 1996a). Water impoundments are filled with sediments and had bad wide disturbance of watershed areas. Estimated rate of sediment flow into *Tichreen* reservoir averages 3.11 g/ L compared to 1.44 g/ L at *Balloran Lake (Jaloul and Kbibou, 1996 b)*.




Changing forest to cropping land and recreational activities in coastal areas in Syria degraded vegetation and soil (A. Fares Asfary, 2003)

## Land degradation and desertification

The degraded land in Syria is estimated by 18 % of the countries area, mainly induced by human unsustainable activities including; steppe and forest cultivation, fuel wood gathering, wood cutting, early and heavy grazing, unsuitable cropping systems (rotations, crops, cultivation practices and machinery), inappropriate irrigation systems and networks, excess irrigation and extraction of limited ground water reserves, unplanned urbanization and industrialization, and arbitrary recreation activities ( SA, 1978; *Engle Grecu*, 1980, p.6; ACSAD/ CAMRE/ UNEP 2004).

Interpretations of satellite images (GIMMS NDVI) for land cover changes over two periods; 1982 - 2003, and 1999-2005, showed that, the degraded lands between 1982 and 2003 constituted 34.8 % of the total land, however, the degradation was accompanied with only 24.4 % of other land aggradations, leading to a net apparent degradation change of 10.4% (1.9M ha) in 2003(Table 4). The degradation between 1999 and 2005 was far less (3.5%), and the accompanied improved lands were 11 folds that was degraded, with a net apparent land aggradations of 33.5% (6.2M ha). These figures suggest that major land degradations occurred before 1999, thereafter land management has improved and the extent of degradation decreased.

**Table (4):** Land cover degradation change in Syria between two periods; 1983 - 2003; 1999 – 2005 (ACSAD/ GTZ, 2007)

| Country area (M ha) | Negative trend (%) | Positive trend (%) | Apparent net change | |
|---|---|---|---|---|
| | | | (%) | (M ha) |
| | | Period 1983-2003 | | |
| 18.518 | 34.85 | 24.44 | - 10.41 | - 1.93 |
| | | Period 1999-2005 | | |
| 18.518 | 3.55 | 37.08 | + 33.53 | + 6.21 |

** Not all negative values are attributed to the effect of land degradation. Some values reflect the Installation of greenhouses.*

Loss of vegetation cover, soil wind and water erosion, sand encroachment, and soil salinity (Plate 2) are the main hazards of land degradation in Syria (ACSAD/ CAMRE/ UNEP, 2004; *Ciles*, et al., 2007). Wind erosion affects 9% of the total country area, water erosion affects 6%, sand encroachment affects 2 %, and salinization affects 0.1%. Soil fertility degradation and pollution are not assessed yet except in scattered sites including; *Al Ghota* of Damascus, fertilizers and cement factories, and solid waste landfills. The problem needs serious attention to be controlled. Degradations, however, are manifested on different areas and in different degrees; low, moderate and high (Table 5 and Fig. 6)

The total area of degraded soils is 3.2 M ha, of which 50% is by wind erosion, 33% by water erosion, 13 % by sand encroachment, and 4% by Stalinization (Table 5). However, about 66% of the degraded land exhibit low soil degradation, 25% exhibit moderate soil degradation, and 9% is of highly degraded soil.


**Rangelands with degraded vegetation cover (left) exposed to heavy soil water erosion causing deep gullies, and barren rangeland (right) exposed to wind soil erosion in Syria (A. Loloo, 2001; H. Habib, 2003, personal communication)**

Left; soil Stalinization induced by excess irrigation has put the land out of production in northern Syria. The arrows points the irrigation canal (*H. Habib*, 2003, personal communication). Right; sand encroachment over roads and other networks in Syria (B. Akko, 2005, personal communication)

**Plate 2. Improper land use change in Syria**

**Table (5):** Human induced soil degradation; types, degrees, and areas (1000ha), in Syria (ACSAD/ CAMRE/ UNEP, 2004)

| Degradation types | Degradation degrees and areas | | | Total area |
|---|---|---|---|---|
| | Low | Moderate | High | |
| Wind erosion | 1210 | 380 | 30 | 1620 |
| Water erosion | 902 | 127 | 29 | 1058 |
| Sand encroachment | 11 | 267 | 130 | 408 |
| Salinization | 15 | 20 | 90 | 125 |
| Total | 2138 | 794 | 279 | 3211 |

Wind erosion and sand encroachment affect 25% of the range land, due to its degraded plant cover and loose soil. The estimated amount of eroded soil may reach 0.57Mt per one wind storm (ACSAD/CAMRE/UNEP, 2004). Water erosion occurs mainly on sloppy land, and events of heavy rain storms may create deep gullies, and mobilize large amounts of soil in flat land, especially in the rangeland.

Soil salinization started in the late 1950s, when diesel pumps were used, enabling farmers to irrigate with high amounts of water especially in the Euphrates basin. This practice induced different degrees of salinization in 45% of the irrigated land, and large areas with high degree of soil salinity were put out of agriculture (ACSAD/ CAMRE/ UNEP, 2004). The annual loss of Stalinized land is 3000-5000ha put out of production, although soil reclamation is carried on (*Engle Grecu,* 1980, p.6; SA, 1978; ACSAD/ CAMRE/ UNEP, 2004).

Degradation of plant cover has severe adverse impacts on the diversity of the natural vegetation and soil biomass. Plant diversity is essential for plant cover resilience especially in areas like Syria, where drought, frost and over heat are regular incidents in the ecosystem. Tucker, et al., (1991) reported that the plant cover extension in dry areas may vary up to a distance of 150 km less in a dry than in a rainy year. A plant cover study of a marginal land area in Northern Syria (*Khanasser* valley, *al-Hoss and Shbayth* hill ranges) identified 240 species, belonging to 41 families and165 genera. The climax vegetation of the area was identified as dry steppe forest, and the dominating species of the first and tallest layer of climax vegetation was *Crataegus aronia* with other arboreal species such as *Pistacia* and *Prunus* (Fig. 7). The climax vegetation was destroyed by cutting, heavy and early grazing, and cultivation inducing the degradation of the vegetation to lower stages, where trees were removed and the valuable semi-shrub fodder plants were replaced by less palatable or spiny species (ICARDA/ AECS/ Bonn U., 2005). Many other natural medicinal, ornamental, industrial, and fuel plants were found degraded in the area and with rehabilitation and good management could open further economical income to the people.

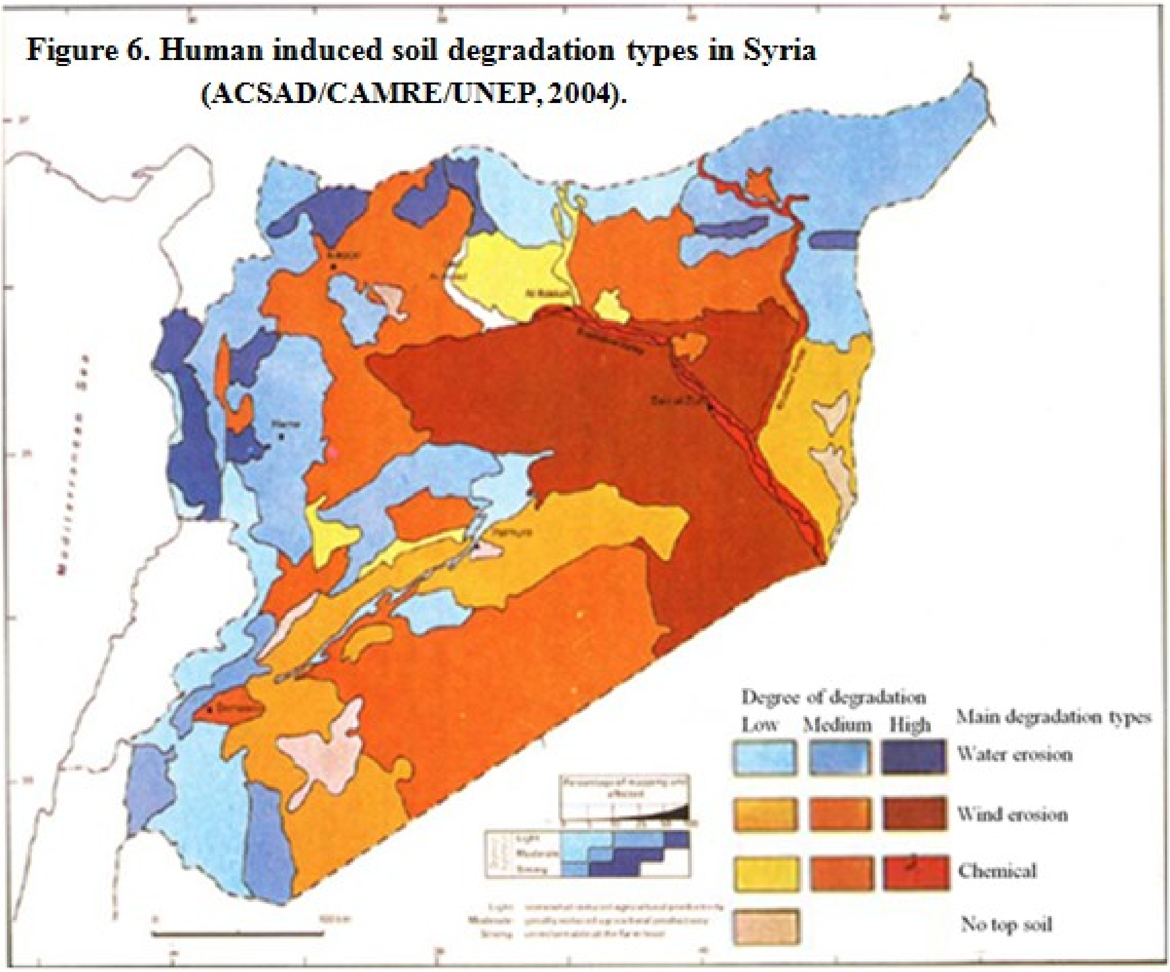



**Figure 6. Human induced soil degradation types in Syria (ACSAD/CAMRE/UNEP, 2004).**

**Figure 7.** Dry steppe - Forest vegetation climax with *Crataegus aronia* as one of the dominating arboreal species in the first layer and some of the dominating tall grasses in the second lower layer such as *Avena* in the *Khanser* Valley area including al - *Hoss* and *Shbayth* hill ranges in Northern Syria (ICARDA/ AECS/ Bonn U., 2005).

Degradation of soil biomass and diversity reduces soil productivity and plant production, yet it is not explored in dry areas. Attention to such resource may improve soil stability and productivity, improves its resistibility to degradation and sustainability in the country and dry areas in general.

Economical losses due to land Salinization and rangeland degradation in 2001 in Syria were valuated by 9.5 B SP per year or about 1.0% of the annual GDP (WB/ METAP, 2004). These figures reveal poor performance of land resource policies due to a number of factors including; centralized governance, low profile expertise, arbitrary planning, lack of public participation and single approach oriented management.

The Syrian government has been making great efforts over the last 10 years aiming to combat land degradation and desertification through afforestation and rangeland rehabilitation projects, fixing sand dunes, establishing green belts and wind breaks, enhancing sprinkler and drip irrigation net works, rationalizing ground water use, and introducing sustainable cropping systems such as Conservation Agriculture (Appendix 1). The government has prepared the national action plan (NAP) for combating desertification in accordance with the national commitment to implement The UNCCD items. However, these efforts are limited, because the activities are affecting small proportion of the degraded land, and need further intensification, expansion, integration, and the participation of the people (ACSAD/CAMRE/UNEP, 2004; MAAR, 2007).

## Vulnerability, drought and climate change

According to UNESCO indicators, vulnerability of land to degradation and desertification is related to their annual amounts of precipitation where, lands receiving 125-250 mm per annum are highly vulnerable, and lands with 250-500mm annual precipitation are vulnerable to a less degree (ACSAD/ CAMRE/ UNEP, 2004). However, higher rainfall areas are also slightly vulnerable to degradation except sloppy areas. These indicators suggest that more than 71% (Arid area) of the area in Syria is highly vulnerable to degradation and another 23% (Semi arid area) is vulnerable to a less degree to degradation and desertification. The vulnerability of the different land use forms, however, varies between and within their categories according to their distribution in the different agro climatic zones in the country (Fig. 1 & 2; table 6). Except forests/ closed scrubland, 95-97% of the other LULCTs are vulnerable to degradation. About 70% of the barren/sparsely vegetated land, 40% of the steppe, 13% of the rainfed crops, and 23% of the irrigated crops are highly vulnerable to degradation. The rest of these LULCTs areas (3-5%) are slightly vulnerable to degradation. The forest/closed scrubland has no highly vulnerable areas, whilst 18% is vulnerable and 82% is slightly vulnerable.

**Table (6):** Distribution (%) of major land cover and land use types (LCLUTs) in relation to agro climatic zones (*Celis*, et al., part 1, 2007)

| LCLUTs | Agro climatic zones | | |
|---|---|---|---|
| | Arid | Semi-arid | Sub-humid |
| **Barren/sparsely vegetated** | 70 | 26 | 4 |
| **Open scrubland/ grassland** | 40 | 56 | 4 |
| **Rainfed cropland** | 13 | 84 | 3 |
| **Irrigated cropland** | 23 | 72 | 5 |
| **Forest/closed scrubland** | 0 | 18 | 82 |

Soil assessment in Syria indicated that 50% of the soils are highly vulnerable to erosion (ACSAD/ CAMRE/ UNEP, 2004). The vulnerability is exacerbated in arid and semiarid areas in the country, and is clearly depicted in figures (1) and (6).

Drought is a natural event and is linked to eventual decrease of precipitation (Fig. 8). It may strike any time of the year, and when it strikes at a critical stage of crop growth, e.g., flowering or grain filling stages, plant production drops drastically. In Syria there are two drought cycles; 1) A dry year every 10 years and, 2) Three dry years every 25 years. Extreme drought events, however, may kill annual and tree plants, destroying the natural vegetation cover to a lower layer sequence of development with no trees and shrubs, and they may not be regained. Thus it has severe impact on land cover degradation, especially in dry lands where ecosystems are harsh and fragile. On the other hand the impact of land cover degradation on drought is still controversy (Herrmann and Hutchinson, 2005). Drought adverse impacts may also threaten the wellbeing of the population particularly in rural areas.

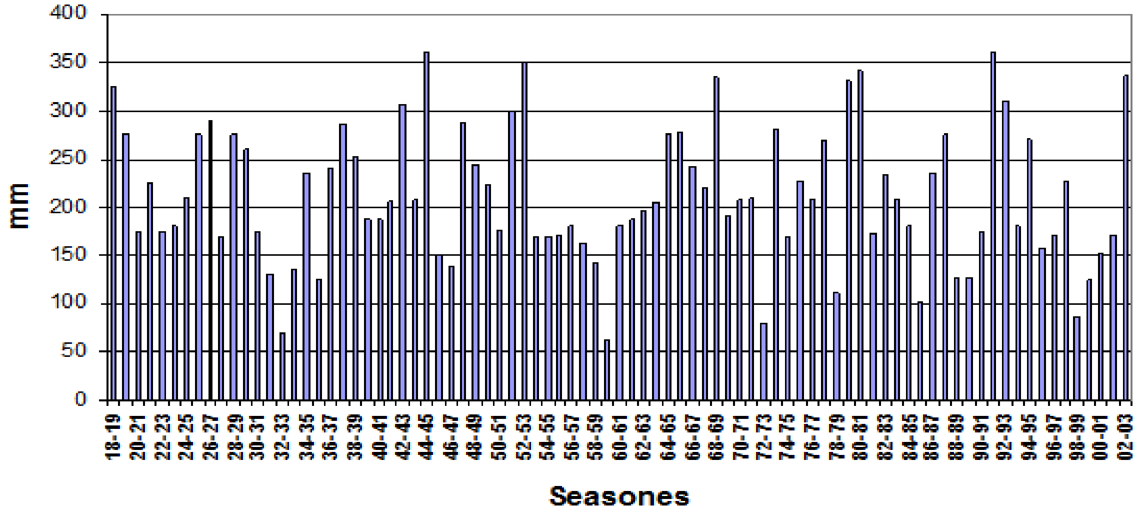



**Figure 8. Annual precipitation for 86 years (1918-2003) with 36 years ≥ average (210mm) and 50 years < average Damascus-Syria (ACSAD, 2005). Severe drought events (≤ 100mm) occurred 4 times in a cycle of 26 years, and 3 cycles of 12 years. Other 11 wetter (>100 and ≤ 150mm) drought events also occurred with different intervals.**

Climate change impact assessment models expect negative effects on land resources in Syria (IPCC 2007). Water availability may decrease by up to 40 mm per year, the temperature may rise by up to 3 or 4 °C leading to decreases in main crops production between 15-35 % or 5-20 % depending on high or low organic matter inputs respectively. Expectations also include; possible extinction of some plant species, increases of heat waves and hot days, decreases in cold days, shorter growing season, increases in drought affected areas, frequent heavy rainfall events. The adverse impacts of these effects include; increasing lands vulnerability to degradation especially in arid areas, increasing demand for irrigation water, decreasing crops production, increasing loss of biodiversity, more people affected by desertification, and increasing soil erosion.

The impact on temperature and rainfall intensity are investigated by using 27 years (1980-2007) of daily temperature and precipitation data for 2 sites in two agricultural areas in the country; Breda as site (1) in northern Syria at 300m above sea level, with 273mm mean annual precipitation over 27 years (ICARDA, 2006); *Izraa* as site (2) in southern Syria at 575m above sea level, with 297 mm mean annual precipitation over the same period (ACSAD, 2008). The sites were selected to represent the cultivated area that is highly vulnerable to degradation and is expected to be highly impacted by climate change. The data indicate slight increases, though not significant, in the mean maximum temperatures and minimum temperatures for the hot months (May-October) and cool months (November-April) in the year (Fig. 9, 10, 11, 12). The frequency of heavy rain events (>30mm - > 50mm) tends to increase in 1999 on ward at Breda only (Fig. 13), whereas no changes were observed at *Izraa*.

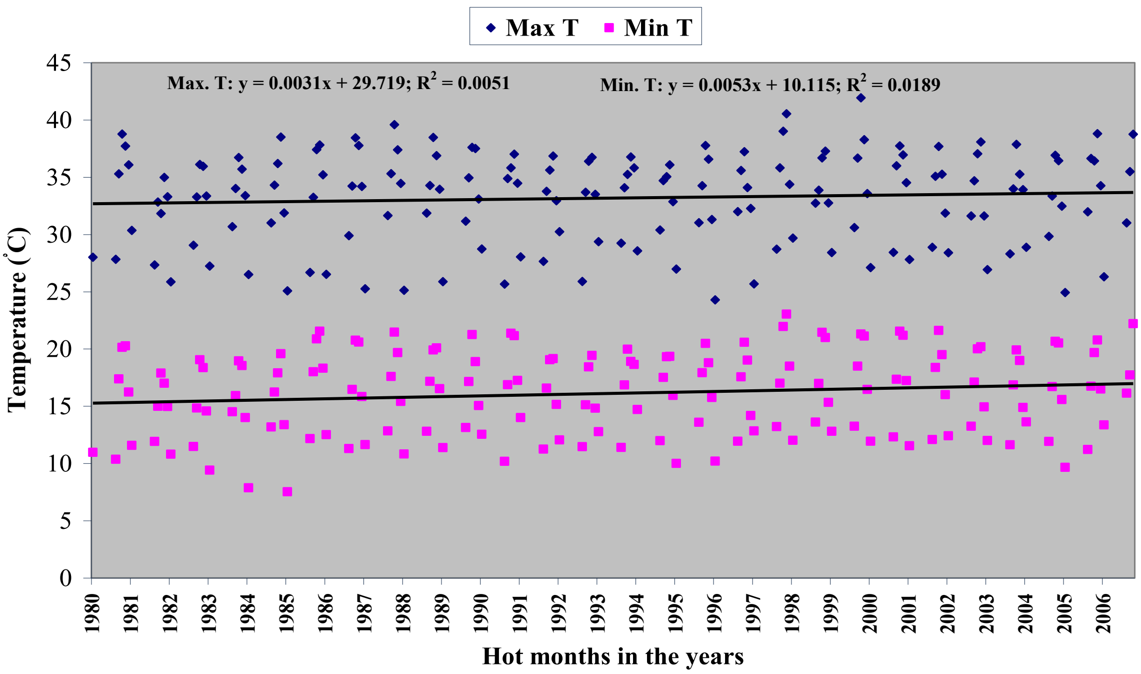



**Figure (9):** Mean Max. & Min. T in the hot months (May - Oct.) at Breda – Syria.

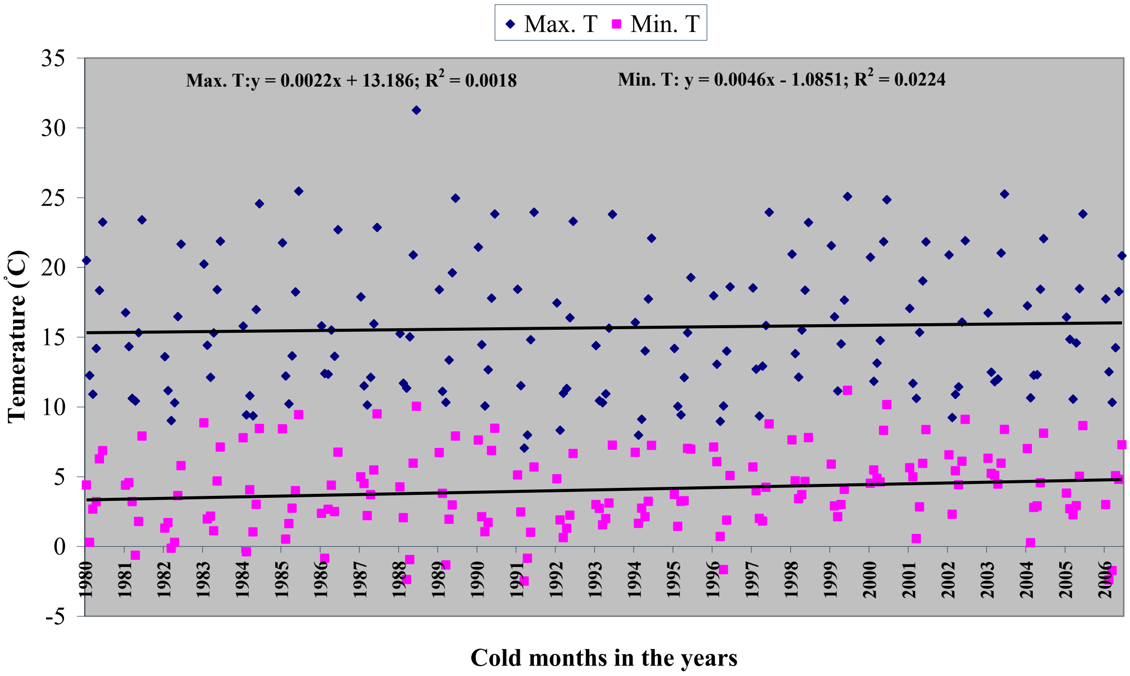



**Figure (10):** Mean Max. & Min. T in the cold months (Nov.– Apr.) at Breda – Syria.

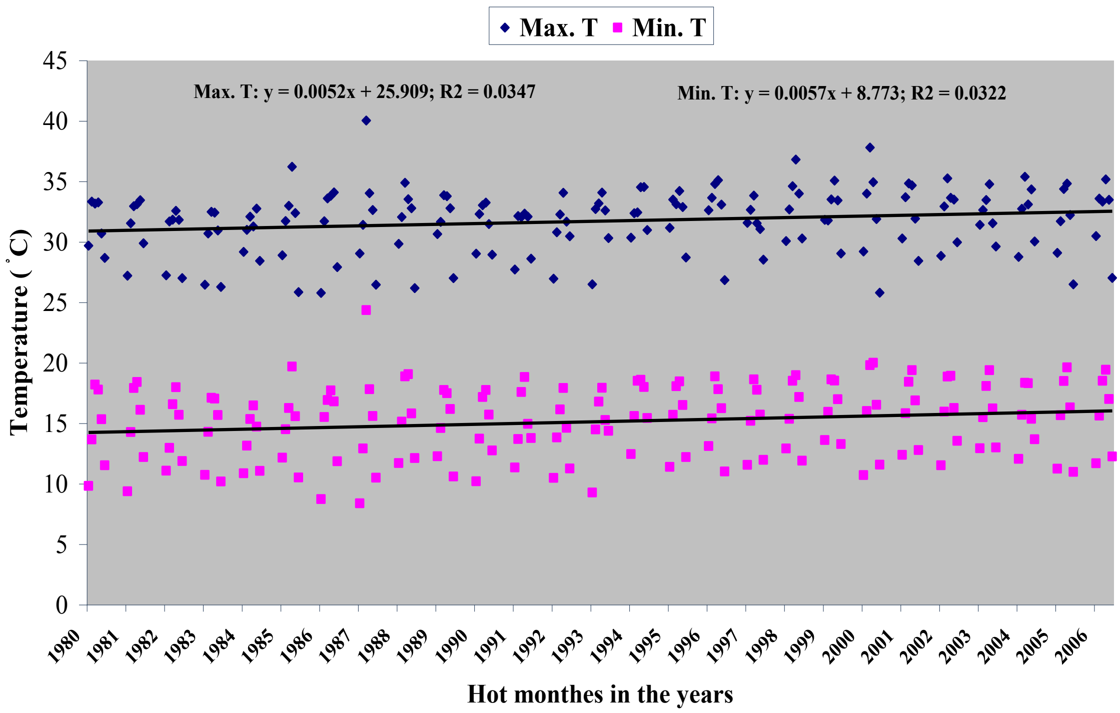



**Figure (11):** Mean Max. & Min. T in the hot months (May - Oct.) at *Izraa* – Syria.

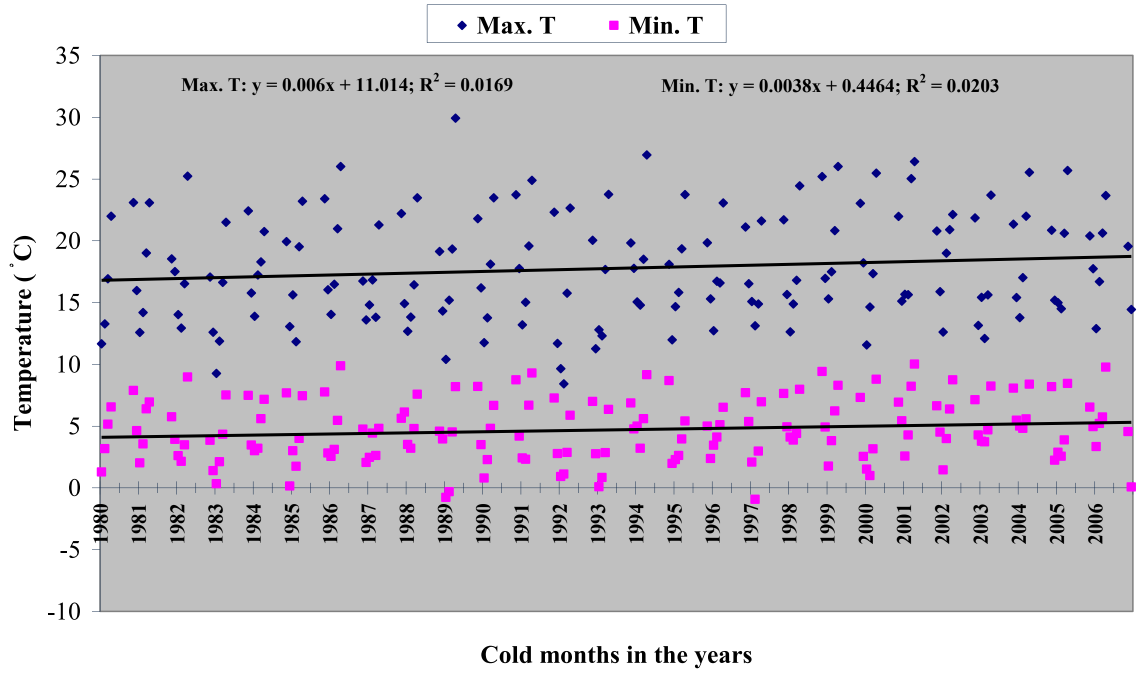



**Figure (12):** Mean Max. & Min. T in the cold months (Nov.– Apr.) at *Izraa* – Syria.

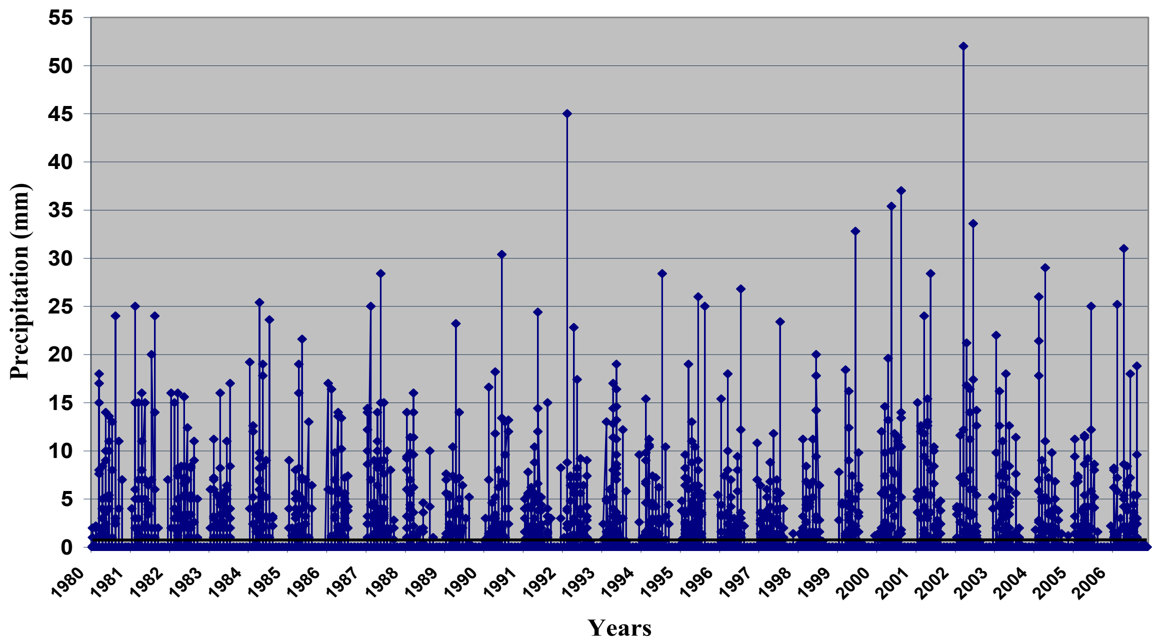



**Figure (13):** Daily Precipitation for the period 1980-2007 at Breda – Syria.

The daily temperature, precipitation, and solar radiation for the same period were used in a barley crop growth simulation model (*Wahbi* and *Sinclair*, 2005) to assess the impact of agricultural practices on barley production and to find ways to mitigate the reduction of crop production caused by the adverse impact of climate change on total precipitation. Four scenarios of 4different planting dates were used; $D_1$on 1/10; $D_2$ on 1/11; $D_3$ on 15/11; and $D_4$ on 1/12.The different planting dates lead to changes in harvest dates and in the amount of precipitation available to the crop (Table 7). At Breda harvesting dates were between April/1 and May/31, and at *Izraa* they were between March/25 and May/26, however there were 3 extreme cases in mid February. At both sites harvest dates extended over 2 months with planting date 1/10 ($D_1$), and over a month to 37 days with the other dates. This has affected the amount of precipitation during the life cycle of the crop, and the minimum amounts were between 81 to126mm and 106 to 111mm at Breda and *Izraa* respectively. The maximum amounts were respectively between 343 to 373mm and 373 to 505mm at Breda and *Izraa*. The decreases were between 55–100 mm at Breda and between 40 - 130 mm at *Izraa*. This reduction in the total precipitation the crop may receive during its life cycle, is due to the fact that early harvesting loses the benefits of precipitation in April and May (Fig. 14), and consequently crop production have decreased.

**Table (7):** Annual precipitations, crop growing seasons' precipitations and harvest dates for the 4 planting dates during the period 1980 - 2007 at *Breda* and *Izraa* - Syria

| Periods | Precipitation (mm) | Harvest dates |
|---|---|---|
| | ***Breda*** | |
| **1, Oct. – 30, Sep** | 183 - 414 | - |
| **$D_1$** | 111 - 373 | 16/Feb – 13/May |
| **$D_2$** | 126 - 363 | 1/April – 6/May |
| **$D_3$** | 101 - 361 | 19/April – 22/May |
| **$D_4$** | 81 - 343 | 29/April – 31/May |
| | ***Izraa*** | |
| **1, Oct. – 30, Sep** | 106 - 505 | - |
| **$D_1$** | 111 - 373 | 16/Feb – 16/April |
| **$D_2$** | 106 - 461 | 25/March – 26/April |
| **$D_3$** | 107 - 460 | 7/April – 15/May |
| **$D_4$** | 107 - 450 | 31/April – 24/May |

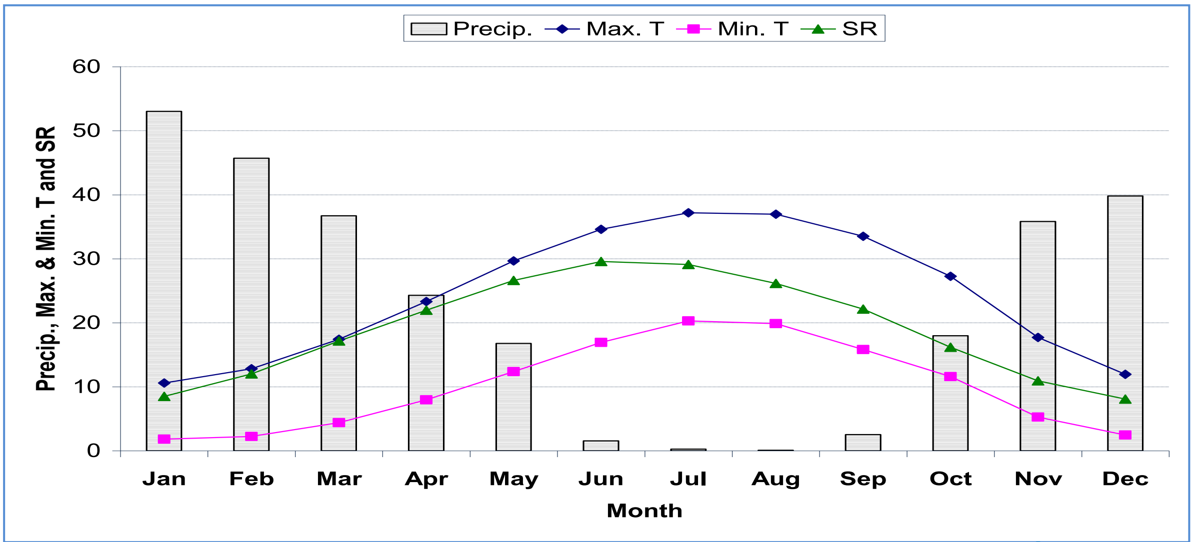



**Figure (14)**: Monthly means of Max. T and Min. T (º C), Solar Radiation "SR" (MJ/ $m^2$/day) and Precipitation (mm) for the period 1980-2007, at Breda-Syria.

Total dry mater production varied with the different planting dates. It increased with the increasing precipitation the crop received and decreased with the decrease of precipitation (Fig. 15 and 16). The best planting dates for higher crop production were $D_2$ and $D_3$. These planting date scenarios, however, could be used to help farmers to determine the suitable planting date. The model could also help in other assessments and in providing or developing more options to combat desertification and to mitigate the adverse impacts of climate change.

According to the investigated expected impacts of climate change on agricultural production, 94% of the country will be directly impacted, and consequently endangering the status of the natural resources including; water, vegetation, soil, and biodiversity. However, the present situation of land degradation and desertification in Syria is alarming and stresses the need for a comprehensive and integrated strategy to overcome present and future critical food security challenges, combating desertification, and mitigating the impacts of climate change. The strategy and actions should be planned and executed with the participation of government institutions and the people otherwise the country will not be able to cope with these challenges.

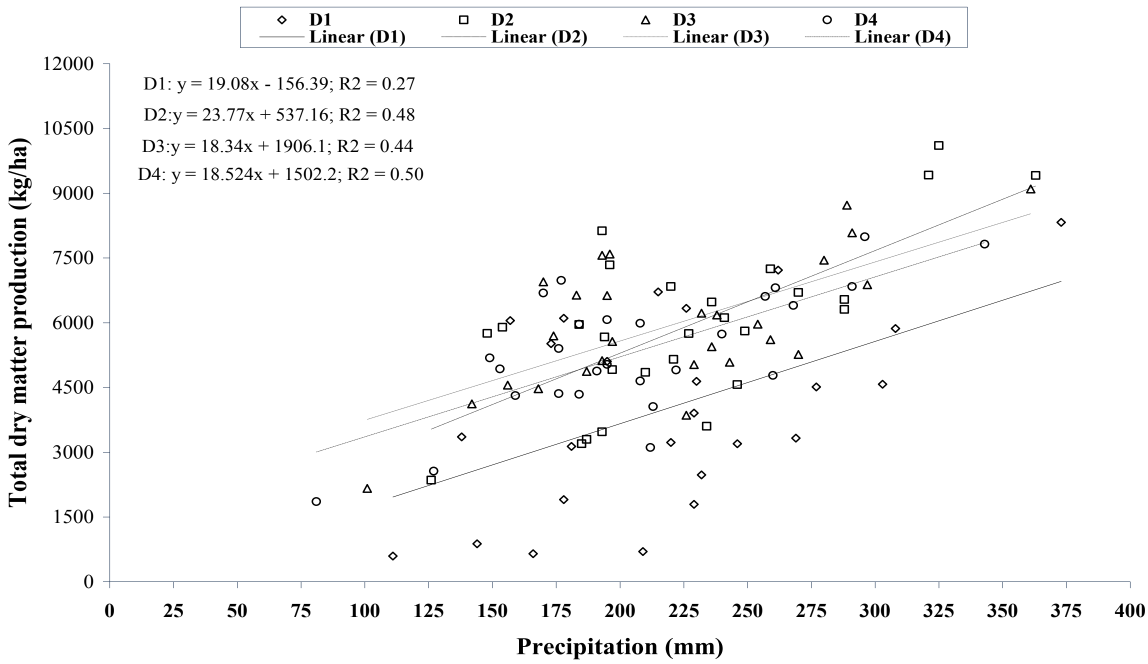



**Figure (15):** Total dry matter production in relation to the precipitations During crop growing periods for the 4 planting dates at Breda.

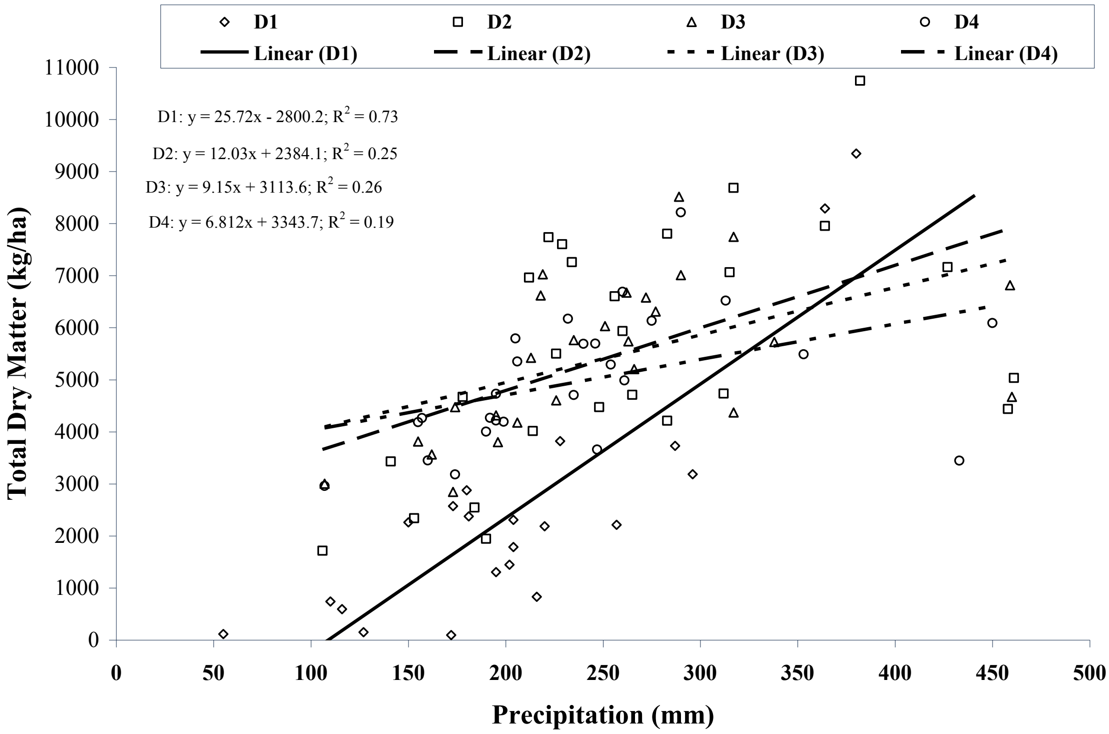



**Figure (16):** Total dry matter production in relation to the precipitations during crop growing periods for the 4 planting dates at *Izraa*.

## Challenges and Opportunities

Despite this state of degradation there are great opportunities to overcome land resources degradation and increase food production in Syria. The aim needs healthy and sustainable environment to be achieved. This requires;

- Setting proper policies and strategies to manage land resources and mitigate the impact of climate change.
- Mobilization and mainstreaming of financial resources to protect the natural base of resources.
- Modernizing farm management and applying proper techniques and technology in the production process.
- Adoption and application of ; integrated management techniques, multi and inter-disciplinary and participatory approach in assessing and managing the scarce resources of arable, range and forest lands, as well as in combating desertification and mitigation of climate change.
- Applying and disseminating Conservation Agriculture to optimize and sustain the resources, and to increase production to achieve food security, mitigate climate change impacts and to combat desertification.
- Capacity building and supporting extension services in various aspects of land uses as they are basic pillars for sustainable management of land resources.
- Substantially supporting research activities and scientific and education institutions to improve our understanding of the environment, activate the role of science in solving the problems, developing suitable and economical management options and practices, and developing and improving techniques.

The big challenge ahead is to increase, improve, sustain and optimize the use of natural resources to improve agricultural production and the livelihood of the people. It is the responsibility of governments, people, and scientists at the local, national, regional and global levels to develop more productive and sustainable options to farmers, herders, and producers. Our production values are still below the natural potential and the natural energy inputs. A promising system to improve agricultural production is Conservation Agriculture, which is based on simulating the natural ecosystems of forests and steppes, where nutrients, water, carbon and energy cycles are semi closed, and they are used in a more efficient and sustainable manner. The exploited area for cropping is still less than the area suitable for cropping and needs proper expansion. Improving the efficiency of irrigation systems and net works is of vital necessity as it increases the available water for agriculture and other uses, by saving an amount of the water already lost by the present surface irrigation. Developing new crop varieties of more drought tolerance and more efficient in converting sunlight to dry matter and the genetic resource potential is in our natural diverse vegetation waiting for exploration to achieve this goal. Capacity building towards an integrated multi and inter-disciplinary and participatory approach way of thinking since early school is necessary, to solve the problems to enable future generations to secure their wellbeing. Science and technology are yet not used efficiently in the country, although the outlets they may provide are unlimited.

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# Appendix

## Efforts of the Syrian Government to Combat Desertification (ACSAD/ CAMRE/ UNEP, 2004)

**1 – مشروع تطوير البادية** ويهدف إلى: التوسع في إعادة الغطاء النباتي ،ووقف زحف الصحراء ،وإنتاج كميات من المنتجات الحيوانية مساهمة في الاكتفاء الذاتي .

**2- مشروع التشجير الحراجي:**

بدأ المشروع أثناء الخطة الخمسية الأولى عام 1960 ويهدف المشروع إلى تحريج المساحات غير الصالحة للزراعات الاقتصادية وقد تم تحريج مساحة 144000 هكتار حتى عام 1992 شملت الأراضي الجبلية والطرق ومداخل المدن ولازال المشروع مستمراً في تحريج مساحات في مختلف المحافظات.

**3- مشروع تربية وتنمية الغابات:**

ويهدف إلى تربية وتنمية الغابات على أسس علمية من اجل تحسين أوضاعها وقد بدأ في اللاذقية وانتشر في المحافظات الأخرى وبلغ الإنفاق المحلي على المشروع /198379 / ليرة سورية.

**4- مشروع مكافحة حرائق الغابات:**

بدأ تنفيذ المشروع في عام 1994 بهدف تحديث وسائل الوقاية لمكافحة حرائق الغابات التي تعتبر الخطر الأكبر الذي يهدد الغابات السورية ، وأهم أنشطته إنشاء أبراج المراقبة ومراكز إطفاء متطورة تقوم بالتدريب في هذا المجال تبلغ تكلفة المشروع 642000 ألف ليرة سورية.

**5- مشروع التشجير المثمر:**

بدأ تنفيذ هذا المشروع عام 1977 ويشمل جميع الأراضي الجبلية والهضابية في جميع المحافظات عدى محافظتي الرقة ودير الزور، وبلغت المساحة المستصلحة فيه حتى عام 1993 حوالي 200000 هكتار.

**6- مشروع الحزام الأخضر :**

بدأ تنفيذ هذا المشروع عام 1980 ويشمل على استصلاح وتشجير جميع الأراضي الواقعة بين خطي أمطار 250 –300 ملم في محافظات الرقة – الحسكة– دير الزور، وقد بلغت المساحة المستصلحة حتى عام 1993 نحو 86000 هكتار ومخطط لتنفيذ 5500 هكتار لعام 1994 بالتمويل المحلي وبدعم من برنامج الغذاء العالمي .

**7- مشروع تطوير الزراعة بالمنطقة الجنوبية:**

ويهدف إلى استصلاح الأراضي بإزالة الصخور منها وجعلها قابلة للاستثمار الزراعي وإدخال أفضل الأساليب الزراعية الحديثة وتأمين الآليات الزراعية وشق طرق زراعية ، بدأ تنفيذ المشروع في عام 1986

( ويشمل محافظات درعا – السويداء – ريف دمشق – القنيطرة ) وفي مواقع مختارة ، تزيد معدلات الأمطار فيها عن 350 ملم وقد بلغت المساحة المستصلحة في المشروع حتى عام 1993 حوالي 22.000 هكتار ووضعت له خطة لعام 1994 لتنفيذ مساحة 3200 هكتار وتبلغ تكلفة المشروع 30,9 مليون دولار .

**8- مشروع الشهيد علي العلي لتطوير التشجير المثمر :**

بدأ التنفيذ عام 1986 ويشمل محافظات حمص – حماه – حلب – طرطوس – اللاذقية وينفذ العمل في مواقع مختارة يزيد معدل مطول الأمطار فيها عن 300 ملم

وبلغت المساحة المستصلحة فيه حتى عام 1993 حوالي 32000 هكتار ووضعت له الخطة عام 1994 لاستصلاح مساحة 4200 هكتار .

**9 – هناك إجراءات هامة جداً في مجال الري والتسميد :**

إقامة محطات بحوث الري .

تحليل التربة قبل التسميد لإعطاء معادلة سمادية دقيقة تلبي احتياجات النبات دون زيادة.

التوجه نحو طرق ري حديثة لتوفير المياه والاستفادة من كل قطرة ماء.

إقامة محطات صرف صحي لتنقية مياه المجاري.

**10- إنشاء مراكز البذور الرعوية:**

وتهدف هذه إلى تأمين البذور الرعوية اللازمة لإنتاج الغراس الرعوية في المشاتل وتنفيذ خطة للنثر الاصطناعي في المحميات المنتشرة في البادية . وطرأ تطور ملحوظ على كميات البذور الرعوية التي يتم جمعها ، والجدول 3 يبين ذلك .

**الجدول 3. كميات البذور الرعوية التي جمعت لإنتاج الغراس لا رعوية في المشاتل**

| كمية البذور / طن | العام |
|---|---|
| 19.7 | 1985 |
| 43.912 | 1990 |
| 54.323 | 1995 |
| 63.00 | 1998 |
| قلت بسبب الأمطار | 1999 |
| قلت بسبب الأمطار | 2000 |

**11 – إنشاء المشاتل الرعوية :**

يهدف إلى إنشاء المشاتل الرعوية تأمين أنواع مختلفة من الغراس الرعوية المتأقلمة محلياً، والمتحملة للجفاف، والتي يمكن استخدامها في تنمية الغطاء النباتي في المناطق المتدهورة رعوياً في البادية السورية. وقد بلغ عدد المشاتل المحدثة لهذه الغاية 13 مشتلاً رعوياً موزعة في المحافظات كما يلي (الجدول 4) :

**الجدول 4. المشاتل الرعوية في المحافظات السورية**

| عدد المشاتل | المحافظة |
|---|---|
| 1 | السويداء |
| 1 | ريف دمشق |
| 4 | حمص |
| 2 | حماه |
| 1 | حلب |
| 1 | الرقة |
| 1 | دير الزور |
| 2 | الحسكة |

وقد ازداد عدد الغراس المنتجة من 5 مليون غرسه رعوية عام 1986 إلى 7 مليون عام 1990 وإلى 9 مليون عام 2000 . تستخدم هذه الغراس في تحسين الغطاء النباتي في المحميات الرعوية وتأمين حاجة القطاعين التعاوني والخاص مجاناً لاستخدامها في تحسين مراعيهم . وتنتج المشاتل بالدرجة الأولى الغراس الرعوية التالية : ( الروثا ( *Salsola vermiculata* )، الرغل أبيض الفروع (السوري) *Atriplex leucoclada* ، القطف الملحي( *Atriplex halimus*) وبالدرجة الثانية الرغل الأمريكي *Atriplex canescens* ، الفصة الشجيرية (*Medicago arbarea*) ، الأثل( *Tamarix spp*) ، الرغل الكاليفورني *Atriplex polycarpa* ).

**12 – المحميات الرعوية :**

نظراً للأهمية الكبيرة للمحميات الرعوية ولتطبيق نظام الحمى في البادية فقد أولت الدولة جلى اهتمامها في هذا المجال من خلال مشروع تطوير البادية ويهدف إنشاء المحميات الرعوية إلى الأمور عديدة أهمها :

- إعادة الأنواع النباتية المنقرضة إلى البادية السورية .
- تحسين وضع الغطاء النباتي الطبيعي في المناطق المتدهورة رعوياً .
- تأمين جزء من الملف الاحتياطي للثروة الحيوانية خلال فترات الجفاف وبالتالي تخفيف الضغط في الطلب على الأعلاف .
- استخدام المحميات الرعوية محطات إرشادية لتوعية مربي الأغنام في البادية لتوعيتهم مدى أهمية وقيمة النباتات الرعوية والحفاظ عليها من الانقراض وذلك من خلال المقارنة بين المناطق المحمية و غيرها من المناطق المجاورة.

وبناءً عليه فإن إنشاء المحميات الرعوية خطوة هامة و عملية للحد من زحف الصحراء والتصحر . وقد قامت وزارة الزراعة والإصلاح الزراعي ممثلة بمديرية البادية في إنشاء المحميات الرعوية منذ عام 1984 حيث أنشأت في البادية ثلاث محميات رعوية كانت النواة وبداية الانطلاق في هذا المجال و هذه المحميات هي محمية مراغة في بادية حلب ومحمية الزراب في بادية دير الزور ، محمية الشدادي في بادية الحسكة . وزاد العدد إلى أن وصل إلى 36 محمية رعوية طبيعية عام 2000 موزعة النحو التالي (الجدول 5):

**الجدول 5. المحميات الرعوية والطبيعية حتى عام 2000**

| المحافظة | عدد المحميات | نوعها |
|---|---|---|
| السويداء | 2 | رعوية |
| ريف دمشق | 3 | رعوية |
| حمص | 5 | رعوية |
| حمص | 1 | طبيعية |
| حماه | 4 | رعوية |
| حلب | 5 | رعوية |
| الرقة | 5 | رعوية |
| دير الزور | 7 | رعوية |

وقد تم حماية مساحة حوالي 470 الف مكتار في هذه المواقع كما يتم سنوياً زراعة النباتات في هذه المواقع حوالي 200.000 مكتار . وتستخدم في عملية تنمية وإحياء هذه المواقع ثلاث أساليب تسير جنباً إلى جنب وتهدف إلى الحصول على مواقع رعوية جيدة ومحسنة . وهذه الأساليب هي :

ـ الحماية : حيث تحمى مناطق يكون فيها الغطاء النباتي الرعوي جيد ومتنوع لإفساح المجال أمام النباتات الطبيعية بتكوين ثمارها ونثر بذورها بشكل طبيعي.

ـ النثر المباشر: ينفذ هذا الأسلوب في الأماكن التي يتواجد فيها نباتات طبيعية بكمية قليلة والتي تحصل على كمية كافية من الأمطار التي تساعد على إنتاج البذور الرعوية.

ـ زراعة الشتول الرعوية: ينفذ هذا الأسلوب في الأماكن التي انعدام فيها النبت الطبيعي أو التي فيها النباتات الطبيعية غير المستساغة من قبل الأغنام كالنباتات الشوكية و السامة.

**13- المحمية الطبيعية لتنمية الموارد الطبيعية والأحياء البرية/ التليلة /:**

تقع المحمية شرق تدمر (32) كم ومساحتها الإجمالية ( 22000 ) مكتار.أنشأت هذه المحمية بهدف الحفاظ على البيئة وصيانة الموارد الطبيعية عن طريق:

ـ إعادة الحياة البرية إلى المنطقة بإعادة الحيوانات المنقرضة من المنطقة مثل الغزال العربي ( الريم ) والمها العربي.
ـ الحفاظ على الحيوانات الموجودة من الانقراض.
ـ إعادة الغطاء النباتي بزراعة النباتات الرعوية.

كما يتم تنمية المراعي في ثلاث جمعيات تحيط بالمحمية وهي:

جمعية ارك ومساحتها 34000 هكتار ، جمعية المنبطح ومساحتها 85000 هكتار ، جمعية العباسية ومساحتها 15000 هكتار.

**14- إنشاء الواحات الخضراء:**

الواحة عبارة عن موقع محدد في البادية يتم تحديده وزراعته بالأشجار الحراجية و المثمرة ويهدف إلى :

ـ إعطاء منظر جمالي للطرقات.
ـ الحفاظ على البيئة.
ـ إرشاد سكان التجمعات في البادية لتشجيعهم على تشجير أراضيهم بالأشجار المقاومة للجفاف.
ـ خدمة المسافرين على طريق عام (دمشق – تدمر – دير الزور) .
ـ إيجاد فرص عمل لسكان البادية.

المساهمة في الحد من التصحر و هجوم الرمال باتجاه الطريق.

ويتبع لمديرية البادية /4/ واحات خضراء موزعة على طريق دمشق – تدمر – دير الزور

**15- إنشاء مراكز تحسين الأغنام:**

أنشأت هذه المراكز لتكون محطات إرشادية علمية تشارك في أعمال البحوث وتعمل على تطبيق نتائجها العلمية في مجال الأغنام وتحسين المراعي وتعميمها على المربين،وتهدف هذه المراكز إلى:

ـ اتباع طرق الانتخاب لأغنام عواس لزيادة الإنتاج.
ـ دراسة الغطاء النباتي واستنباط افضل السبل لتحسينه.
ـ حماية المراعي وتحديد الحمولات الرعوية المناسبة لمواقع الرعي.
ـ تحسين الأغنام عن طريق إنتاج كباش محسنة وتوزيعها على المربين.
ـ المساهمة بسد جزء من احتياجات السوق المحلية من اللبن واللحم.

**16-مشروعات لمكافحة التصحر :**

نذكر من هذه المشروعات

ـ إنشاء محطة لاستصلاح الترب المتملحة في وادي الفرات .
ـ تنفيذ مشروع لإعادة توطين الأراضي المتملحة في وادي الفرات الأدنى .
ـ تثبيت الكثبان الرملية في منطقة الكسرة وشملت مساحة 500 هكتار .
ـ تنفيذ المشروع المتكامل لمكافحة التصحر في جبل البشري .
ـ إقامة 28 محمية رعوية تغطي مساحة 250 ألف هكتار مع 13 مشتلا رعويا النتاج 15 مليون غرسه .
ـ تنفيذ مشروع التشجير المثمر في الأراضي المنحدرة والتي يزيد فيها عن 300 ملم وبلغت المساحة المستصلحة حتى عام 1993 حوالي 232 ألف هكتار .
ـ تنفيذ مشروع تطوير المنطقة الجنوبية بالأحزمة الخضراء وقد تم حتى عام 1990 استصلاح 182 ألف هكتار.
ـ تنفيذ مشروع الأحزمة الخضراء في المناطق المجاورة للبادية لوقف وحف الصحراء وبلغت المساحة المستصلحة حوالي134 ألف هكتار .
ـ التخطيط لتنفيذ مشاريع متعددة في مجال التشجير الحراجي المثمر وإقامة الأحزمة الخضراء وخاصة حول المدن المهددة بالرمال الزاحف.

### 1.5– مشروع مكافحة التصحر وتثبيت الكثبان الرملية في منطقة الكسرة – محافظة دير الزور

يعود ظهور الكثبان الرملية في المنطقة التي تتوضع على مسافة 50 كم غرب دير الزور إلى إقامة سد الفرات وما نجم عن ذلك من تنظيم لجريان المياه اعتبارا من عام 1974. وقد أدى ذلك إلى اختزال مجرى النهر وغياب ظاهرة الفيضان السنوية كما ترافق مع إزالة الغطاء الغابوي الطبيعي في الموقع وحراثة الأراضي التي انحسرت عنها المياه. ولقد ساهم في تفاقم مشكلة طبيعة التربة الرملية للموقع وتكسير الطبقة الغرينية الرقيقة التي كانت تغطي هذه التربة نتيجة للحراثة.

ولقد ظهرت مشكلة الانجراف الريحي للرمال وتفاقمت بوتيرة متسارعة. فقد تمت تغطية مساحات واسعة ضمن المصطبة الدنيا والمصطبة الثالثة للفرات بالرمال والكثبان الرملية. كما زحفت الرمال على المصطبة الثالثة.

وبناء على طلب من وزارة الزراعة والإصلاح الزراعي في الجمهورية العربية السورية قام خبراء المركز العربي بالتعاون مع خبراء وزارة الزراعة بوضع الدراسة الفنية [30] التي تضمنت إيجاد الحلول المناسبة للمشكلة وتلافي الأضرار الناجمة عنها. وقد بوشر بتطبيق الإجراءات الفنية اعتبارا من عام 1984 ونتيجة لذلك فقد تم تحقيق ما يلي:

1. تحويل مناطق الرمال والكثبان الرملية القريبة من ضفة النهر إلى غابة صناعية من الأشجار الحراجية وبمساحة تزيد عن 200 هكتار.
2. تحويل مناطق الكثبان الرملية في المصطبة الثالثة للنهر إلى غابة من الشجيرات الرعوية وبمساحة تزيد على 300 هكتار. وتثبيت الكثبان الرملية الموجودة في المنطقة.
3. إدخال بعض الأنواع النباتية الحراجية والرعوية في كلا الموقعين ولأول مرة.
4. توقف مشكلة حركة الرمال والكثبان الرملية تماما في المنطقة وعودة الحياة البرية إلى ما كانت عليه في كلا الموقعين.

### 2.5– مشروع جبل البشري

تم تحضير السياسة الوطنية للتربة في سورية من قبل منظمة الأغذية والزراعة للأمم المتحدة وبرنامج الأمم المتحدة للبيئة في عام 1992 ( [31] ). ولقد أوضحت هذه الدراسة بان الانجراف الريحي للتربة يعتبر مشكلة جدية في شرقي البلاد وأوصت " بمشروع يمول دوليا لتقصي مصدر المشكلة ولتعميم تقنيات ملائمة لمكافحة انجراف التربة بواسطة الرياح، وممارسات ملائمة في إدارة الرعي تخفف من وطأة المشكلة". ينفذ من قبل المركز العربي لدراسات المناطق الجافة والأراضي القاحلة بالتعاون مع وزارة الزراعة والإصلاح الزراعي في سورية والوكالة الألمانية للتعاون الفني (GTZ) . ويشكل الاستشعار عن بعد المكون الرئيسي لهذا المشروع.

### 3–5 مشروع التشجير المثمر

يهدف هذا المشروع إلى استصلاح الأراضي المنحدرة ذات الأمطار أكثر من 300 مم/سنة عن طريق نقب الأراضي لكسر الطبقة الصماء وتحسين الخواص الفيزيائية للتربة :

- تعزيل الحجارة من التربة لاستثمارها .
- إقامة المدرجات الكونتورية لزراعتها .
- تقديم المساعدات الفنية للمزارعين وأيضا الغراس .
- إعطاء معونة غذائية للفلاحين .
- تقسيط القرض المعطى للفلاحين لاستصلاح الأراضي لأجل طويل .
- ابتدأ المشروع عام 1977 وما يزال مستمرا .
- بلغت المساحة المستصلحة ضمن فعاليات المشروع حتى 1993 حوالي 000 232 هكتار
- يمتلك المشروع آليات ثقيلة خاصة بالتشجير ونقب التربة وإزالة الحجارة وإقامة المدرجات.

### 5-4 مشروع تطوير المنطقة الجنوبية لإقامة الأحزمة الخضراء الزراعيــة (مشــروع الشــهيد عبــد الكــريم الشمري)

يهدف هذا المشروع إلى :

- استصلاح حوالي 170 الف مكتار في المحافظات الجنوبية ، وقد ارتفع هذا الرقم في الخطــط الخمســية اللاحقة حيث وصل 252 الف هكتار وحتى تاريخ 1990 فقد تم استصلاح 182.000 مكتار في كل من محافظتي درعا والسويداء وذلك لصالح زراعة المحاصيل الحقلية والتشجير المثمــر وإقامــة التجــارب الزراعية الإرشادية لصالح مواعيد الزراعة واستعمال البذار المحسن وتحديد أعماق التربة المناسبة .
- تقديم الخبرة والمشورة الفنية وإقامة الأيام الحقلية .
- تقديم الآليات الزراعية : جرارات وصهاريج .
- دعم الغراس المجانية .
- دعم غذائي للفلاحين المشمولة أراضيهم بالمشروع .
- زيادة الغلة الزراعية وإضافة أراضي زراعية جاهزة للاستثمار .
- بلغت ميزانية المشروع حوالي /145/ مليون دولار نصفها من العملة الأجنبية .

### 5-5 مشاريع الأحزمة الخضراء وإقامة مصدات الرياح (مشروع الشهيد العبود)

يهدف هذا المشروع إلى إقامة أشرطة خضراء ملاصقة للبادية بخطوط أمطار من 250 - 300 مم/سنة، وذلك لوقف تقدم الصحراء نحو مناطق الاستقرار في المنطقة الهامشية .

ومن مزايا المشروع :

- إقامة خطوط خضراء لوقاية المناطق الزراعية والمعمورة من خطر تقدم التصحر .
- إقامة مزارع الأشجار المثمرة المتحملة للجفاف وإجراء دراسات حول إمكانية زراعة الأشجار بأمطــار بين 250 - 300 مم/سنة .
- تقديم مساعدات فنية وغذائية للفلاحين.
- استصلاح الأراضي بتقبها وإقامة المصاطب لتجميع مياه الأمطار .
- تم استصلاح وزراعة حوالي / 134/ الف مكتار ضمن هذا المشروع في مختلف المحافظات .

### 5-6 مشروع الشهيد على العلي لتطوير التشجير الحراجي والمثمر

يهدف هذا المشروع إلى استصلاح 10 الف هكتار في المنطقة الجنوبية والساحلية ، ففــي المنطقــة الجنوبيــة يهــدف المشروع إلى إقامة المدرجات على المناطق الجبلية والهضابية وتعزيل الحجارة وتقب التربة ، ويشــمل حــوالي 15 الــف مكتار في مناطق رنكوس - عسال الورد - الجبة من ريف دمشق وحمص وحماه ، ويشمل 8000 مكتــار بهــدف إقامــة المدرجات في مناطق اللاذقية ،القرداحة، الحفة ، وشمال اللاذقية من أجل زراعة المنحدرات المطيــرة وإقامــة المنــاطق الخضراء لحماية التربة من الانجراف المائي وترشيد الاستغلال السيء للمناطق الجبلية.

ويقدم هذا المشروع خدماته بقروض طويلة الأجل للفلاحين ، تشمل استصلاح الأراضي وإعطــاء الغــراس المناســبة والآليات الزراعية الخاصة بمختلف المناطق .

ابتدأ المشروع عام 1986 وبلغت ميزانيته الإجمالية /382/ مليون ليرة منها /100/ مليون مارك الماني .

### 5-7 مشروع إعادة التحريج وتطوير الغابات

تقوم مديرية التحريج والغابات بتحريج المناطق المناسبة مطريا لإقامة الغابات وإعادة تحريج الغابات المحروقة وإقامــة مصدات الرياح ، حيث يتم إنتاج /30/ مليون غرسة حراجية سنويا وتحريج حوالي 25 الف مكتار ســنويا ، ومكافحــة الحرائق في الغابات ، والإنذار المبكر عن الآفات التي تصيب الغابات بغية حمايتها ، وتحريج مداخل المدن السورية مثل : طريق دمشق - حلب - دير الزور ودمشق - تدمر حيث بلغ تحريج حرم الطرق حوالي 435 كم من الجمهورية العربيــة

السورية، كذلك تحريج حرم بحيرة الأسد وبحيرات السدود السطحية الأخيرة في المنطقة الوسطى والساحلية حيث بلغت هذه المناطق 28 الف هكتار.

**5 –8 مشروع تشجير وإقامة الأحزمة الخضراء في محافظة القنيطرة**

تم من خلال هذا المشروع تشجير حوالي /32/ الف هكتار في محافظة القنيطرة حيث أن الهدف الرئيسي لهـذا المشـروع استصلاح الأراضي المحجرة وقلب التربة وتعزيلها وإقامة المدرجات على المواقع الهضابية والمرتفعة وإقامـة المـزارع الخاصة بإنتاج التفاحيات والعنب إضافة إلى مناطق التحريج المختلفة . وقد وضعت خطة لاستصلاح 20 الف هكتار أخرى لصالح الاستثمار الزراعي الحراجي والمثمر في المحافظة المذكورة .

**5-9 مشروع حماية المدن من خطر التصحر بالأشرطة الخضراء**

**1.9.5** مشروع الحزام الأخضر حول مدينة دير الزور من الناحية الغربية والجنوبية من المدينة

يهدف هذا المشروع لإقامة حزام أخضر لتخفيف العواصف الغبارية عن مدينة دير الزور وخاصة في فصل الصيف ، حيث يبلغ عرض هذا الحزام حوالي /2/كم في المنطقة الغربية من دير الزور ، ويصل إلى /1,5/ كم في المنطقة الجنوبية التـي ما زالت في طور الإنشاء والتوسع ، وتبلغ مساحة هذا الحزام في المنطقة الغربية 2000 هكتار .

**2.9.5** مشروع الحزام الأخضر في منطقة الزربة وجبل الحص في محافظة حلب

ويشمل حوالي 22 الف هكتار تشجير حراجي ومثمر حيث وضعت الدراسات الفنية المتعلقة بتصنيف التربة ودراسات عن اقتصادية المشروع .

وفي عام 1995 تم إعداد برنامج العمل الوطني لمكافحة التصحر ، بالإضافة إلى أن الجمهورية العربية السورية تقوم حالياً بإعداد الخطة الوطنية لمكافحة التصحر بدعم من برنامج الأمم المتحدة الإنمائي (UNDP) ومكتـب التصـحر والجفـاف الأونسو (UNSO) والتي سيتم إنجازها خلال عام 2002 .

ويذكر أن العديد من الإجراءات قد اتخذتها الحكومة في مجال مكافحة التصحر مثل :

- قرار منع فلاحة البادية
- تحويل طرق الري التقليدي إلى الري الحديث ( بالتنقيط والرش ) خلال مدة أقصـاها أربع سنوات

**7 ـ ملامح الخطة الوطنية لمكافحة التصحر في الجمهورية العربية السورية**

أعدت سورية خطتها الوطنية لمكافحة التصحر وتم اعتمادها اعتباراً من شهر آب 2002 وأتت هذه الخطة انسجاماً مـع ما تم الالتزام به من قبل حكومة الجمهورية العربية السورية بتنفيذ بنود الاتفاقية الدولية لمكافحة التصحر والتي تم التوقيـع عليها عام 1994 والمصادقة عليها عام 1997 حيث قامت وزارة الدولة لشؤون البيئة (مديرية سـلامة الأراضـي) بالبـدء بإعداد الخطة الوطنية لمكافحة التصحر عام 1999 وتم الانتهاء منها عام 2002 حيث حظيت بإجمـاع وطنـي ومصـادقة المجلس الأعلى لسلامة البيئة عليها بتاريخ 2002/5/13 .

**وتضمنت الخطة العديد من المواضيع كان من أهمها :**

7 ـ 1 الوضع الراهن للموارد الطبيعية في سورية: (التربة ، والغطاء النباتي ، والمناخ ، والموارد المائية)

7 ـ 2 حالة التصحر في سورية (أسبابها ومظاهرها) :

ـ **أسبابها :** (الانجراف المائي ، والانجراف الريحي ، والتملح ، وتلوث التربة ، والتلف الناتج عن الإنتـاج الزراعـي ، وتأثير الزراعة ذات المدخلات المرتفعة في التربة والبيئة ، وسوء استعمال الأراضي ، والأسباب الإدارية والاجتماعية ) .

ـ **المنعكسات الاجتماعية والاقتصادية للتصحر .**

7 ـ 3 الإجراءات المتخذة لمكافحة التصحر :

**ـ المشاريع القائمة بمجال مكافحة التصحر**

**ـ نشاطات وإجراءات مختلفة :**

أ ـ الخطة الوطنية للعمل البيئي.

ب ـ أجندة القرن الـ 21 .

ج ـ في مجال السياسات والبرامج والاستراتيجيات .

د ـ في مجال التدريب والإرشاد .

و ـ في مجال التعليم .

ي ـ في مجال التعاون الإقليمي

7 ـ 4 الآثار الاقتصادية والاجتماعية لظاهرة التصحر في سورية.

7 ـ 5 الإجراءات المقترحة لمكافحة التصحر وتخفيف آثار الجفاف في المجالات التالية :

ـ في مجال التربة .

ـ في مجال الموارد المائية والمناخ .

ـ في مجال الغطاء النباتي .

ـ في مجال التعاون والتوعية والإعلام .

ـ في المجالات الاجتماعية والاقتصادية .

ـ في المجال التشريعي .

ـ في مجال البحث العلمي .

*7 ـ 6 المشاريع المقترحة في الخطة الوطنية لمكافحة التصحر :*

ـ مشروع التنمية المتكاملة لبادية ريف دمشق .

ـ مشروع مكافحة الانجراف الريحي في البادية السورية .

ـ مشروع استخدام بدائل الطاقة في تنمية البادية السورية .

ـ مشروع شق طرق ترابية في البادية للتخفيف من السير العشوائي .

ـ مكافحة الانجراف المائي في المنطقة الساحلية .

ـ مشروع مكافحة تردي الأراضي الجبسية وإدارتها في المناطق المروية .

ـ مشروع دراسة تلوث الأراضي و المياه في غوطة دمشق .

ـ مشروع تحسين إنتاجية الأراضي المروية في سورية (وادي الفرات) .

ـ مشروع تنمية وتحسين استثمار الموارد العلفية .

ـ مشروع الواحات الريفية والأحزمة الحراجية .

ـ مشروع تعزيز دور المشاركة الشعبية في التنمية المتكاملة لمكافحة التصحر .

ـ مشروع تقييم أراضي منطقتي الاستقرار الأولى والثانية المروية للمنطقة الجنوبية في سورية (القنيطرة ـ درعا ـ السويداء) ووضع خارطة خصوبية .

ـ مشروع حفر الأقنية الرومانية .

هذا من ناحية ومن ناحية أخرى فقد تم تنفيذ العديد من المشاريع تضمنها برنامج العمل الوطني لمكافحة التصحر مثل :

1 ـ مشروع التنمية المتكاملة في البادية السورية لمساحة 3 مليون هكتار .

2 ـ مشروع التنمية الزراعية في المنطقة الجنوبية في محافظات (القنيطرة ـ درعا ـ السويداء ـ ريف دمشق) .

3 ـ مشروع التنمية الزراعية في جبل الحص .

4 ـ مشروع التنمية الزراعية في المنطقة الوسطى والساحلية .